OMERO Documentation

Release 5.2.4

The Open Microscopy Environment

May 27, 2016

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

The OMERO 5.2.4 documentation is divided into three parts:

About the OMERO Platform introduces the user-facing client applications and how to get started, details the CLI client, and indicates where users can access further help and support.

System administrators wanting to install and manage an OMERO server can find instructions in the *System Administrator Documentation*.

Developers can find more specific and technical information about OMERO in the *Developer Documentation*.

Additional online resources can be found at:

- Downloads[1]
- Features (movie tutorials coming soon)[2]
- Security vulnerabilities[3]
- OMERO API documentation - OmeroJava API[4], OmeroPy API[5], OmeroBlitz / Slice API[6]
- User help website[7]
- Script sharing service[8]
- Partner projects to extend OMERO[9]
- Demo server[10] - now managed by the main OME team, providing the latest released version of OMERO for you to try out (barring a short lag time for upgrading).

OMERO version *5.2* uses the January 2015 release[11] of the OME Data Model[12]. The *OMERO version history* page details the development of OMERO functionality over time.

A summary of breaking changes and new features for version 5.2 can be found on the pages below:

- *What's new for OMERO users*
- *What's new for OMERO sysadmins*
- *What's new for OMERO developers*

The source code is hosted on Github. To propose changes and fix errors, go to the documentation repository[13], fork it, edit the file contents and propose your file changes to the OME team using Pull Requests[14]. Alternatively, click on "Edit on GitHub" in the menu.

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[1] http://downloads.openmicroscopy.org/latest/omero/
[2] http://www.openmicroscopy.org/site/products/omero/feature-list
[3] http://www.openmicroscopy.org/site/products/omero/secvuln
[4] http://downloads.openmicroscopy.org/latest/omero/api/
[5] http://downloads.openmicroscopy.org/latest/omero/api/python/
[6] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/
[7] http://help.openmicroscopy.org/
[8] http://www.openmicroscopy.org/site/community/scripts
[9] http://www.openmicroscopy.org/site/products/partner/
[10] http://qa.openmicroscopy.org.uk/registry/demo_account/
[11] http://www.openmicroscopy.org/Schemas/Documentation/Generated/OME-2015-01/ome.html
[12] http://www.openmicroscopy.org/site/support/ome-model/
[13] https://github.com/openmicroscopy/ome-documentation/
[14] http://help.github.com/articles/using-pull-requests

Part I

About the OMERO Platform

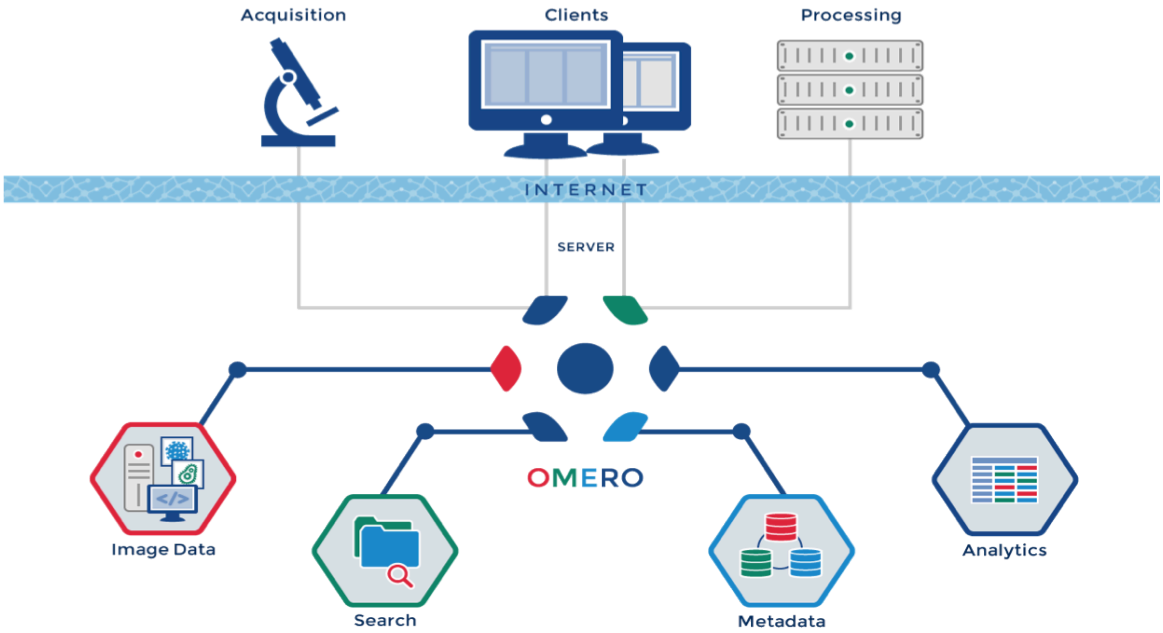
CHAPTER

ONE

INTRODUCTION

OME Remote Objects (OMERO) is a modern client-server software platform for visualizing, managing, and annotating scientific image data. OMERO lets you import and archive your images, annotate and tag them, record your experimental protocols, and export images in a number of formats. It also allows you to collaborate with colleagues anywhere in the world by creating user groups with different permission levels. OMERO consists of a Java server, several Java client applications, as well as Python and C++ bindings and a Django-based web application.

The OMERO clients are cross-platform. To run on your computer they require Java 1.7 or higher to be installed. This can easily be installed from http://java.com/en if it is not already included in your OS. The OMERO.insight client gets all of its information from a remote OMERO.server — the location of which is specified at login. Since this connection utilises a standard network connection, the client can be run anytime the user is connected to the internet.



This documentation is for the new OMERO 5 Platform. This version is designed to improve our handling of complex multidimensional datasets. It allows you to upload your files in their original format, preserving file names and any nested directory structure in the server repository. For more technical information, please refer to the *Developer Documentation*. You can read about the development of OMERO in the *OMERO version history*.

CHAPTER

TWO

OMERO CLIENTS

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

2.1 OMERO clients overview

Most laboratories use a number of different imaging platforms and thus require tools to manage, visualize and analyze heterogeneous sets of image data recorded in a range of file formats. Ideally a single set of applications, running on a user's laptop or workstation, could access all sets of data, and provide easy-to-use access to this data.

OMERO ships as a server application called **OMERO.server** and a series of client applications (known simply as clients): **OMERO.web**, **OMERO.insight** and **OMERO.importer**. All run on the major operating systems and provide image visualization, management, and annotation to users from remote locations. With a large number of OMERO.server installations worldwide, OMERO has been shown to be relatively easy to install and get running.

OMERO.insight and OMERO.importer are desktop applications written in Java and require Java 1.7 (or higher) to be installed on the user's computer (automatically installed on most up-to-date OS X and Windows systems).

Our user assistance help website[1] provides a series of workflow-based guides to performing common actions in the client applications, such as importing and viewing data, exporting images and using the measuring tool.

Our partners within the OME consortium are also producing new clients and modules for OMERO, integrating additional functionality, particularly for more complex image analysis. See the Partner Projects[2] page for more details.

2.1.1 OMERO.web

OMERO.web is a web-based client for users who wish to access their data in the browser. This offers a similar view to the OMERO.insight desktop client. Figures *OMERO.web user interface* and *OMERO.web image viewer* present the user interface. Developers can use the *OMERO.web framework* to build customized views.

For more information and guides to using OMERO.web, see our help website[3].

2.1.2 OMERO.insight

OMERO.insight provides a number of tools for accessing and using data in an OMERO server. Figures *OMERO.insight* and *OMERO.insight ImageViewer and Measurement Tool* present the user interface. To find out more, see the OMERO.insight user guides[4].

Among many features, the noteworthy OMERO.insight elements are:

- DataManager, a traditional tree-based view of the data hierarchies in an OMERO server. DataManager supports access to all image metadata, annotations, tags

[1] http://help.openmicroscopy.org/
[2] http://www.openmicroscopy.org/site/products/partner/
[3] http://help.openmicroscopy.org/
[4] http://help.openmicroscopy.org/

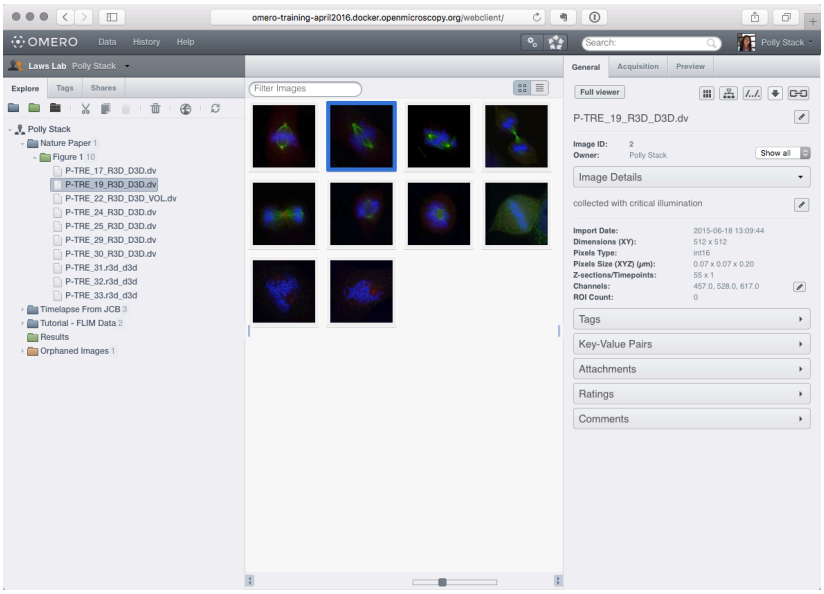


Figure 2.1: OMERO.web user interface

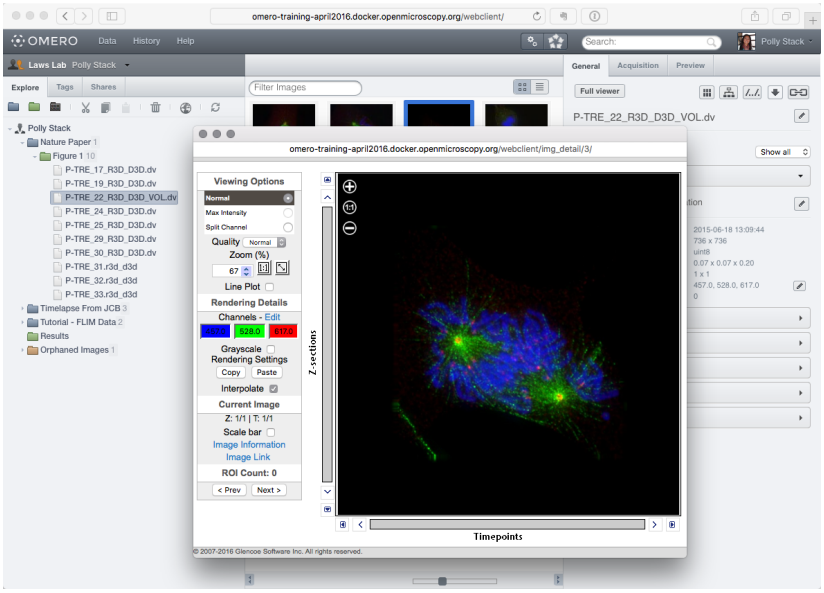


Figure 2.2: OMERO.web image viewer

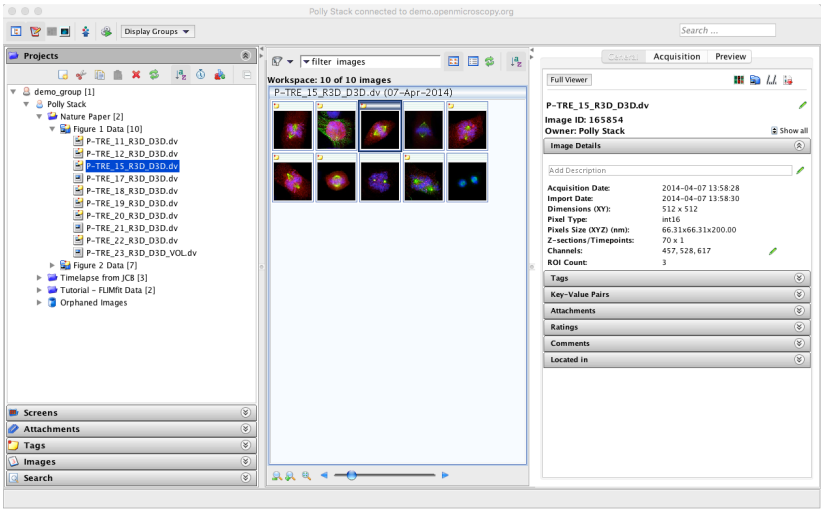


Figure 2.3: OMERO.insight

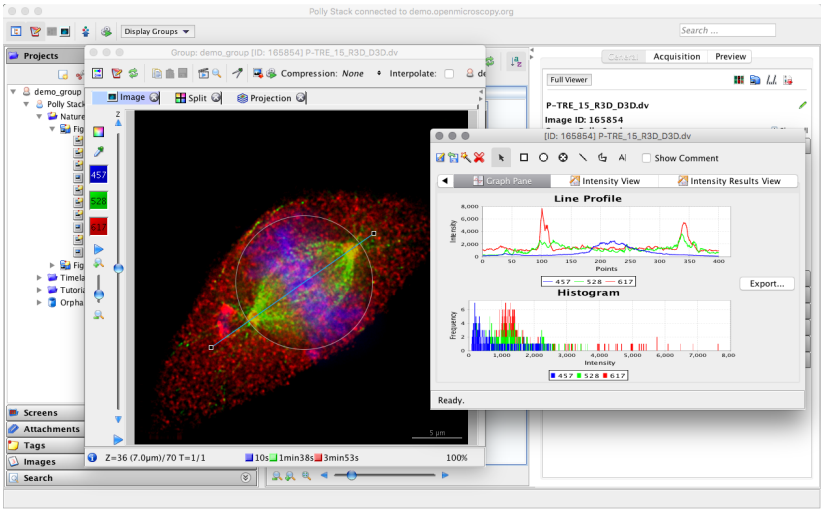


Figure 2.4: OMERO.insight ImageViewer and Measurement Tool

- ImageViewer, for visualization of 5D images (space, channel, time). The ImageViewer makes use of the OMERO server's Rendering Engine, and provides high-performance viewing of multi-dimensional images on standard workstations (e.g. scrolling through space and time), without requiring installation of high-powered graphics cards. Most importantly, image viewing at remote locations is enabled. Image rendering settings are saved and chosen by user ID
- Measurement Tool, a sub-application of ImageViewer that enables size and intensity measurements of defined regions-of-interest (ROIs)
- Working Area, for viewing, annotating, and manipulating large sets of image data
- user administration
- image import

Our user assistance help website[5] features a number of workflow-based guides to importing, viewing, managing and exporting your data using OMERO.insight.

2.1.3 OMERO.importer

The OMERO.importer is part of the OMERO.insight client, but can also run as a stand-alone application. The OMERO.importer allows the import of proprietary image data files from a filesystem accessed from the user's computer to a running OMERO server. This tool uses a standard file browser to select the image files for import into an OMERO server.

The tool uses Bio-Formats for translation of proprietary file formats in preparation for upload to an OMERO Server. Visit Supported Formats[6] for a detailed list of supported formats.

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2.2 Command Line Interface as an OMERO client

The CLI (Command Line Interface) is a set of Python[7] based system-administration, deployment and advanced user tools. Most of commands work remotely so that the CLI can be used as a client against an OMERO server.

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[5] http://help.openmicroscopy.org/
[6] http://www.openmicroscopy.org/site/support/bio-formats/supported-formats.html
[7] http://www.python.org

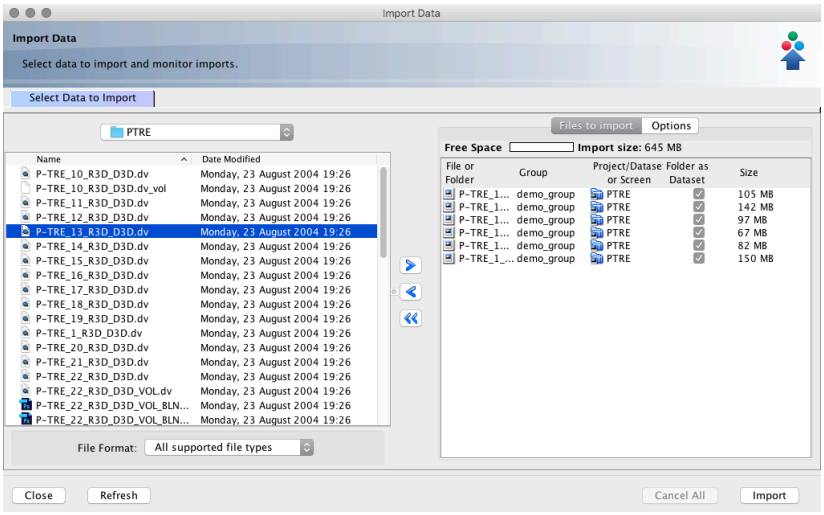

Figure 2.5: OMERO.importer

2.2.1 Installation

Check you have Python[8] installed by typing:

```
$ python --version
Python 2.7.9
```

Additionally, Ice[9] must be installed on your machine:

```
$ python -c "import Ice"
```

Check the *server requirements* for the minimum and maximum supported versions.

The CLI is currently bundled:

- with the OMERO.server including all functionalities of the CLI
- with the OMERO.python including all functionalities of the CLI except for the import functionality

Download the version corresponding to your system from the OMERO downloads[10] page.

Note: The CLI is bundled with the OMERO.server but that does not imply you must use that directory as a server. You can download the server zip to a number of machines and use the CLI commands from each machine to access an existing OMERO instance.

Once the correct bundle is downloaded, the Python libraries of the CLI are located under the `lib/python` directory and the executable is under the `bin` directory. To start the CLI in shell mode:

```
$ bin/omero
OMERO Python Shell. Version 5.2.4-ice35
Type ''help'' for more information, ''quit'' or Ctrl-D to exit
omero>
```

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

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[8] http://www.python.org
[9] https://zeroc.com
[10] http://downloads.openmicroscopy.org/latest/omero/

2.2.2 Overview

Command line help

The CLI is divided into several commands which may themselves contain subcommands. You can investigate the various commands available using the *-h* or *--help* option:

```
$ bin/omero -h
```

Again, you can use *-h* repeatedly to get more details on each of these sub-commands:

```
$ bin/omero admin -h
$ bin/omero admin start -h
```

The **omero help** command can be used to get info on other commands or options.

command
: Display the information on a particular command:

```
$ bin/omero help admin       # same as bin/omero admin -h
```

In addition to the CLI commands which can be listed using *--list*, **omero help** can be used to retrieve information about the *debug* and *env* options:

```
$ bin/omero help debug     # display help about debugging options
$ bin/omero help env       # display help about environment variables
```

--all
: Display the help for all available commands and options

--recursive
: Recursively display the help of commands and/or options. This option can be used with either the *command* or the *--all* option:

```
$ bin/omero help --all --recursive
$ bin/omero help user --recursive
```

--list
: Display a list of all available commands and subcommands

Command line workflow

There are three ways to use the command line tools:

1. By explicitly logging in to the server first i.e. by creating a session using the **omero login** command, e.g.:

```
$ bin/omero login username@servername:4064
Password:
```

During login, a session is created locally on disk and will remain active until you logout or it times out. You can then call the desired command, e.g. the **omero import** command:

```
$ bin/omero import image.tiff
```

2. By passing the session arguments directly to the desired command. Most commands support the same arguments as **omero login**:

```
$ bin/omero -s servername -u username -p 4064 import image.tiff
Password:
```

The *--sudo* option is available to all commands accepting connection arguments. For instance to import data for user *username*:

```
$ bin/omero import --sudo root -s servername -u username image.tiff
Password for owner:
```

3. By calling the desired command without login arguments. You will be asked to login:

```
$ bin/omero import image.tiff
Server: [servername]
Username: [username]
Password:
```

Once you are done with your work, you can terminate the current session if you wish using the **omero logout** command:

```
$ bin/omero logout
```

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2.2.3 Import images

The CLI import command allows you to import images to an OMERO.server from the command line, and is ideally suited for anyone wanting to use a shell-scripted or web-based front-end interface for importing. Based upon the same set of libraries as the standard importer, the command line version supports the same file formats and functions in much the same way. Visit Supported Formats[11] for a detailed list of supported formats.

Import command

To import a file `image.tif`, use:

```
$ bin/omero import image.tif
```

Some of the options available to the import command are:

-h, --help
Display the help for the import command

--java-help
Display the help for the Java options of the import command

Java options can be passed after `--`, e.g.:

```
bin/omero import image.tif -- --name=test --description=description
```

--advanced-help
Display the advanced help for the import command

[11] http://www.openmicroscopy.org/site/support/bio-formats/supported-formats.html

Some advanced import options are described in the *In-place import* section.

-f

Display all the files that would be imported, then exit:

```
$ bin/omero import -f image.tif
$ bin/omero import -f images_folder
```

This will output a list of all the files which would be imported in groups separated by "#" comments. Note that this usage does not require a running server to be available.

--depth DEPTH

Set the number of directories to scan down for files (default: 4):

```
$ bin/omero import --depth 1 images_folder
```

--skip SKIP

Specify optional step to skip during import.

The import of very large datasets like High-Content Screening data or SPIM data can be time and resource consuming both at the client and at the server level. This option allows the disabling of some non-critical steps and thus faster import of such datasets. The caveat associated with its usage is that some elements are no longer generated at import time. Some of these elements, like thumbnails, will be generated at runtime during client access. Available options that can be skipped are currently:

all Skip all optional steps described below

checksum Skip checksum calculation on image files before and after transfer

This option effectively sets the *--checksum_algorithm* to use a fast algorithm, `File-Size-64`, that considers only file size, not the actual file contents.

minmax Skip calculation of the minima and maxima pixel values

This option will also skip the calculation of the pixels checksum. Recalculating minima and maxima pixel values post-import is currently not supported. See *Calculation of minima and maxima pixel values* for more information.

thumbnails Skip generation of thumbnails

Thumbnails will usually be generated when accessing the images post-import via the OMERO clients.

upgrade Skip upgrade check for Bio-Formats

Example of usage:

```
$ bin/omero import large_image --skip all
$ bin/omero import large_image --skip minmax
```

Multiple import steps can be skipped by supplying multiple arguments:

```
$ bin/omero import large_image --skip checksum --skip minmax
```

-T, **--target** TARGET

Select an import target. See *Using import targets* for more information.

--debug DEBUG

Set the debug level for the command line import output:

```
$ bin/omero import images_folder --debug WARN
```

--report

Report emails to the OME team. This flag is mandatory for the *--upload* and *--logs* arguments.

--email EMAIL
: Set the contact email to use when reporting errors. This argument should be used in conjunction with the *--report* and *--upload* or *--logs* arguments.

--upload
: Upload broken files and log file (if any) with report

  The following command would import a broken image and upload it together with the import log if available in case of failure:

```
$ bin/omero import broken_image --report --upload --email my.email@domain.com
```

--logs
: Upload log file (if any) with report

  The following command would import a broken image and upload only the import log if available in case of failure:

```
$ bin/omero import broken_image --report --logs --email my.email@domain.com
```

Command Line Importer

The CLI import plugin calls the `ome.formats.importer.cli.CommandLineImporter` Java class. The Linux OMERO.importer also includes an `importer-cli` shell script allowing calls to the importer directly from Java. Using `importer-cli` might look like this:

```
./importer-cli -s localhost -u user -w pass image.tif
```

To use the `ome.formats.importer.cli.CommandLineImporter` class from java on the command line you will also need to include a classpath to the required support jars. Please inspect the `importer-cli` script for an example of how to do this.

The Command Line Importer tool takes a number of mandatory and optional arguments to run. These options will also be displayed on the command line by passing no arguments to the importer:

```
 Usage:  importer-cli [OPTION]... [path [path ...]]...
   or:   importer-cli [OPTION]... -

Import any number of files into an OMERO instance.
If "-" is the only path, a list of files or directories
is read from standard in. Directories will be searched for
all valid imports.

Session arguments:
  Mandatory arguments for creating a session are 1- either the OMERO server hostname,
username and password or 2- the OMERO server hostname and a valid session key.
  -s SERVER        OMERO server hostname
  -u USER        OMERO username
  -w PASSWORD        OMERO password
  -k KEY        OMERO session key (UUID of an active session)
  -p PORT        OMERO server port (default: 4064)

Naming arguments:
All naming arguments are optional
  -n NAME                                Image or plate name to use
  -x DESCRIPTION                        Image or plate description to use
  --name NAME                                Image or plate name to use
  --description DESCRIPTION                Image or plate description to use

Optional arguments:
```

```
  -h                                        Display this help and exit
  -f                                        Display the used files and exit
  -c                                        Continue importing after errors
  -l READER_FILE                          Use the list of readers rather than the default
  -d DATASET_ID                              OMERO dataset ID to import image into
  -r SCREEN_ID                             OMERO screen ID to import plate into
  -T TARGET                               target for imports
  --report                                Report errors to the OME team
  --upload                                Upload broken files and log file (if any) with report. Required
  --logs                                  Upload log file (if any) with report. Required --report
  --email EMAIL                              Email for reported errors. Required --report
  --debug LEVEL                              Turn debug logging on (optional level)
  --annotation-ns ANNOTATION_NS              Namespace to use for subsequent annotation
  --annotation-text ANNOTATION_TEXT       Content for a text annotation (requires namespace)
  --annotation-link ANNOTATION_LINK       Comment annotation ID to link all images to

Examples:

  $ importer-cli -s localhost -u user -w password -d 50 foo.tiff
  $ importer-cli -s localhost -u user -w password -d Dataset:50 foo.tiff
  $ importer-cli -f foo.tiff
  $ importer-cli -s localhost -u username -w password -d 50 --debug ALL foo.tiff

For additional information, see:
http://www.openmicroscopy.org/site/support/omero5.2/users/cli/import.html
Report bugs to <ome-users@lists.openmicroscopy.org.uk>
```

See also:

Advanced import scenarios

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2.2.4 Using import targets

The CLI import options `-d` or `-r` can be used to specify, respectively, the import target Dataset or Screen by ID. The option `-T, --target` adds more ways of specifying the import target.

The general form of the target argument is:

```
<action or Class>[:<discriminator>]:<pattern>
```

where the discriminator is optional. Thus a target must contain one or two colons. Any further colons will be read as part of the pattern. If the discriminator is omitted a default will be used depending on the action or Class. Currently the following actions and classes are supported: Dataset, Screen and regex.

Importing to a Dataset or Screen

For Dataset and Screen the currently supported discriminators are `name` and `id`. If the discriminator is omitted the default used is `id`. So:

```
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:id:2
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:2
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -d 2
```

will all have the same effect of importing the image to the Dataset with ID 2.

The `name` discriminator can be used to select the target by name, and so:

```
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:name:Sample01
```

will import the image to the Dataset with name Sample01. If more than one Dataset exists with the specified name the most recently created will be used. If no Dataset exists with the specified name a new Dataset will be created for the import.

The choice of Dataset can be specified by adding a qualifying character to the discriminator: + to use the most recent, − to use the oldest, % to only import if there is a unique target or @ to create a new container even if one with the correct name already exists.

For example:

```
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:+name:Samples
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:-name:Samples
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:%name:Samples
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:@name:Samples
```

The first case is equivalent to the previous example, the most recent Dataset will be used. In the second case the oldest Dataset will be used. In the third case the import should fail if multiple datasets with that name exist. In the first three cases a new Dataset will be created if none exists. In the last case a new Dataset should be created even if one or more already exist.

If the name contains spaces or other characters that cannot be used on the command line the pattern should be enclosed in quotes:

```
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T Dataset:name:"New Dataset"
```

To import a plate to a Screen target the same syntax can be used as in all the examples above, for example:

```
$ bin/omero import ~/images/bd-pathway/2015-12-01_000/ -T Screen:+name:Pathway
```

Importing using regular expressions

The local path of the file to be imported can be used to specify the target Dataset or Screen using a regular expression using the action `regex`. For this action the only discriminator is `name` and if the discriminator is omitted the qualified form of this `+name` will be used. The sequence `(?<Container1>.*?)` is a named-capturing group used to specify the Dataset or Screen name in the regular expression, the specific name `Container1` must be used here. For example:

```
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T "regex:^.*images/(?<Container1>.*?)"
```

would use a Dataset with name being the path following `images/`, in this case `dv`.

The `name` discriminator can be explicitly used and, as in the previous section, also qualified:

```
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T "regex:+name:^.*images/(?<Container1>.*?)"
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T "regex:-name:^.*images/(?<Container1>.*?)"
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T "regex:%name:^.*images/(?<Container1>.*?)"
$ bin/omero import ~/images/dv/SMN10ul03_R3D_D3D.dv -T "regex:@name:^.*images/(?<Container1>.*?)"
```

These each work in the same way as the previous Dataset examples.

In some cases the importable files may be in nested directories, this is often the case with plates and some multi-image formats. A regular expression can be used to pick a higher level directory as the Screen or Dataset name. For example, if several BD Pathway HCS files are under the following paths:

```
~/images/bd-pathway/week-1/2015-12-01_000/
~/images/bd-pathway/week-2/2015-12-09_000/
~/images/bd-pathway/week-2/2015-12-11_000/
```

and the intended Screens for the import are `week-1` and `week-2` then the following could be used:

```
$ bin/omero import ~/images/bd-pathway/ -T "regex:+name:^.*bd-pathway/(?<Container1>[^/]*)/.*"
```

which would import one Plate into the Screen `week-1` and two Plates into the Screen `week-2`, creating those Screens if necessary.

A useful way of determining the nested structure to help in constructing regular expressions is the option `-f` which displays the used files but does not import them:

```
$ bin/omero import -f ~/images/bd-pathway/week-1
...
2016-03-30 15:58:56,574 701        [      main] INFO      ome.formats.importer.ImportCandidates - 59 fil
#=====================================
# Group: /Users/colin/images/bd-pathway/week-1/2009-05-01_000/Experiment.exp SPW: true Reader: loci.for
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/Experiment.exp
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/20X NA 075 Olympus Confocal.geo
...
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/Well D11/DsRed - Confocal - n000000.tif
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/Well D11/DsRed - Confocal - n000001.tif
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/Well D11/DsRed - Confocal - n000002.tif
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/Well D11/Transmitted Light - n000000.tif
```

which shows that all the files for one particular Plate from the example above are under:

```
/Users/colin/images/bd-pathway/week-1/2009-05-01_000/
```

For more information on the regular expression syntax that can be used in templates see: java.util.regex.Pattern documentation[12].

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

2.2.5 Manage sessions

The **omero sessions** plugin manage user sessions stored locally on disk. Several sessions can be active simultaneously, but only one will be used for a single invocation of *bin/omero*:

```
$ bin/omero sessions -h
```

Login

The **omero login** command is a shortcut for the **omero sessions login** subcommand which creates a connection to the server. If no argument is specified, the interface will ask for the connection credentials:

```
$ bin/omero login
Previously logged in to localhost:4064 as root
Server: [localhost:4064]
Username: [root]
Password:
```

Some of the options available to the **omero login** command are:

`connection`
: Pass a connection string under the form `[USER@]SERVER[:PORT]` to instantiate a connection:

[12] http://docs.oracle.com/javase/7/docs/api/java/util/regex/Pattern.html

```
$ bin/omero login username@servername
Password:
$ bin/omero login username@servername:14064
Password:
```

-s SERVER, **--server** SERVER
Set the name of the server to connect to:

```
$ bin/omero login -s servername
Username: [username]
```

-u USER, **--user** USER
Set the name of the user to connect as:

```
$ bin/omero login -u username -s servername
Password:
```

-p PORT, **--port** PORT
Set the port to use for connection. Default: 4064:

```
$ bin/omero login -u username -s servername -p 14064
Password:
```

-g GROUP, **--group** GROUP
Set the group to use for initalizing a connection:

```
$ bin/omero login -u username -s servername -g my_group
Password:
```

-k KEY, **--key** KEY
Use a valid session key to join an existing connection.

This option only requires a server argument:

```
$ bin/omero login servername -k 22fccb8b-d04c-49ec-9d52-116a163728ca
```

-w PASSWORD, **--password** PASSWORD
Set the password to use for the connection.

--sudo ADMINUSER
Create a connection as another user.

The sudo functionality is available to administrators as well as group owners:

```
$ bin/omero login --sudo root -s servername -u username
Password for root:
$ bin/omero login --sudo owner -s servername -u username
Password for owner:
```

Multiple sessions

Stored sessions can be listed using the **omero sessions list** command:

```
$ bin/omero sessions list
 Server    | User | Group           | Session                                | Active    | Started
-----------+------+-----------------+----------------------------------------+-----------+---------------
 localhost | test | read-annotate-2 | 22fccb8b-d04c-49ec-9d52-116a163728ca | Logged in | Fri Nov 23 14:
 localhost | root | system          | 1f800a16-1dc2-407a-8a85-fb44005306be | True      | Fri Nov 23 14:
(2 rows)
```

Session keys can then be reused to switch between stored sessions using the *omero login -k* option:

```
$ bin/omero sessions login -k 22fccb8b-d04c-49ec-9d52-116a163728ca
Server: [localhost]
Joined session 1f800a16-1dc2-407a-8a85-fb44005306be (root@localhost:4064).
$ bin/omero sessions list
 Server    | User | Group           | Session                                | Active    | Started
-----------+------+-----------------+----------------------------------------+-----------+---------------
 localhost | test | read-annotate-2 | 22fccb8b-d04c-49ec-9d52-116a163728ca | True      | Fri Nov 23 14:
 localhost | root | system          | 1f800a16-1dc2-407a-8a85-fb44005306be | Logged in | Fri Nov 23 14:
(2 rows)
```

Sessions directory

By default sessions are saved locally on disk under the OMERO user directory located at `~/omero/sessions`. The location of the current session file can be retrieved using the **omero sessions file** command:

```
$ bin/omero sessions file
/Users/ome/omero/sessions/localhost/root/aec828e1-79bf-41f3-91e6-a4ac76ff1cd5
```

To customize the OMERO user directory, use the `OMERO_USERDIR` environment variable:

```
   $ export OMERO_USERDIR=/tmp/omero_dir
   $ bin/omero login root@localhost:4064 -w omero
   Created session bf7b9fee-5e3f-40fa-94a6-1e23ceb43dbd (root@localhost:4064). Idle timeout: 10.0 min.
   $ bin/omero sessions file
/tmp/omero_dir/omero/sessions/localhost/root/bf7b9fee-5e3f-40fa-94a6-1e23ceb43dbd
   $ bin/omero logout
```

If you want to use a custom directory for sessions exclusively, use the `OMERO_SESSIONDIR` environment variable:

```
$ export OMERO_SESSIONDIR=/tmp/my_sessions
$ bin/omero login root@localhost:4064 -w omero
Created session bf7b9fee-5e3f-40fa-94a6-1e23ceb43dbd (root@localhost:4064). Idle timeout: 10.0 min. Cur
$ bin/omero sessions file
/tmp/my_sessions/localhost/root/bf7b9fee-5e3f-40fa-94a6-1e23ceb43dbd
$ bin/omero logout
```

Note: The `OMERO_SESSION_DIR` environment variable introduced in 5.1.0 to specify a custom sessions directory is deprecated in 5.1.1 and above in favor of `OMERO_SESSIONDIR`.

If you have been using `OMERO_SESSION_DIR` and want to upgrade your custom sessions directory without losing locally stored sessions:

- either set `OMERO_SESSIONDIR` to point at the same location as `OMERO_SESSION_DIR/omero/sessions`
- or move all local sessions stored under the `OMERO_SESSION_DIR/omero/sessions` directory under the `OMERO_SESSION_DIR` directory and replace `OMERO_SESSION_DIR` by `OMERO_SESSIONDIR`.

Switching current group

The **sessions group** command can be used to switch the group of your current session:

```
$ bin/omero group list          # list your groups
$ bin/omero sessions group 2    # switch to group by ID or Name
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

2.2.6 Manage tags

The `omero tag` subcommands manage the creation, linking and listing of tag annotations. All subcommands can be listed using the *-h* option:

```
$ bin/omero tag -h
```

Create tags

To create a new tag annotation, use the `omero tag create` command:

```
$ bin/omero tag create
Please enter a name for this tag: my_tag
```

To create a tag set containing two existing tags of known identifiers `1259` and `1260`, use the `omero tag createset` command:

```
$ bin/omero tag createset --tag 1259 1260
Please enter a name for this tag set: my_tag_set
```

For both tags and tag sets, the name and an optional description can be passed using the *--name* and *--desc* options:

```
$ bin/omero tag create --name my_tag --desc 'description of my_tag'
$ bin/omero tag createset --tag 1259 1260 --name my_tag_set --desc 'description of my_tag_set'
```

List tags

To list all the tags owned by the current user, use the `omero tag list` command:

```
$ bin/omero tag list
+- 1261:'my_tag_set'
|\
| +- 1259:'my_tag'
| +- 1260:'my_tag_2'
+- 1264:'my_tag_set_2'
|\
| +- 1260:'my_tag_2'
| +- 1263:'my_tag_4'

Orphaned tags:
> 1262:'my_tag_3'
```

To list all the tag sets owned by the current user, use the `omero tag listsets` command:

```
$ bin/omero tag listsets
--------|-------------------------------------------------------------------------------------------------------------
ID      |Name
--------|-------------------------------------------------------------------------------------------------------------
1261    |my_tag_set
1264    |my_tag_set_2
--------|-------------------------------------------------------------------------------------------------------------
```

Link tags

Tags can be linked to objects on the server using the `omero tag link` command. The object must be specified as `object_type:object_id`. To link the tag of identifier `1260` to the Image of identifier `1000`, use:

```
$ bin/omero tag link Image:1000 1260
```

Delete tags

Tags can be deleted using the `omero delete` command. The tag or tag set must be specified as `TagAnnotation:tag_id`. To delete tag `123` use:

```
$ bin/omero delete TagAnnotation:123
```

By default the tags within a tag set will not be deleted with the tag set. To delete any included tags use the *`--include`* option:

```
$ bin/omero delete TagAnnotation:123 --include TagAnnotation
```

See also:

Deleting objects

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

2.2.7 Moving objects between groups

The `omero chgrp` command moves objects between groups. Further help is available using the *`-h`* option:

```
$ bin/omero chgrp -h
```

The **chgrp** command will remove entire graphs of objects based on the IDs of the topmost objects. The command can be modified to include the movement of objects that would, by default, be excluded or exclude objects that would, by default, be included using the *`--include`* and *`--exclude`* options.

It is also possible to move objects lower in the hierarchy by specifying the type and ID of a topmost object and the type of the lower object. For instance, moving all of the images under a given project.

By default the command confirms the movement of the target objects but it can also provide a detailed report of all the moved objects via a *`--report`* option. A *`--dry-run`* option can be used to report on what objects would be moved without actually moving them.

Examples

Basic move

```
$ bin/omero chgrp 5 OriginalFile:101
$ bin/omero chgrp Group:5 Project:51
$ bin/omero chgrp ExperimenterGroup:5 Project:51
$ bin/omero chgrp lab_group Project:51
```

In the first line, the original file with ID 101 will be moved to the group with ID 5. In the second and third, project 51 will be moved to group 5 including any datasets inside only that project and any images that are contained within moved datasets only. If group 5 is named 'lab_group' then the last line will have the same effect as the previous two. Note that any linked annotations will also be moved.

Moving multiple objects

Multiple objects can be specified with each type being followed by an ID or a comma-separated list of IDs. The order of objects or IDs is not significant, thus all three calls below are identical in moving project 51 and datasets 53 and 54 to group 5.

```
$ bin/omero chgrp 5 Project:51 Dataset:53,54
$ bin/omero chgrp 5 Dataset:54,53 Project:51
$ bin/omero chgrp 5 Dataset:53 Project:51 Dataset:54
```

Moving lower level objects

To move objects below a specified top-level object the following form of the object specifier is used.

```
$ bin/omero chgrp 5 Project/Dataset/Image:51
```

Here the all of images under the project 51 would be moved. It is not necessary to specify intermediate objects in the hierarchy and so:

```
$ bin/omero chgrp 5 Project/Image:51
```

would have the same effect as the call above.

Including and excluding objects

--include
: Linked objects that would not ordinarily be moved can be included in the move using the *–include* option:

  ```
  $ bin/omero chgrp 5 Image:51 --include Annotation
  ```

  This call would move any annotation objects linked to the image.

--exclude
: Linked objects that would ordinarily be moved can be excluded from the move using the *–exclude* option:

  ```
  $ bin/omero chgrp 5 Project:51 --exclude Dataset
  ```

  This will move project 51 but not any datasets contained in that project.

The two options can be used together:

```
$ bin/omero chgrp 5 Project/Dataset:53 --exclude Image --include FileAnnotation
```

This will move any datasets under project 53, that are not otherwise contained elsewhere, excluding any images in those datasets but including any file annotations linked to the moved datasets. In this case the images that are not otherwise contained in datasets will be orphaned.

Further options

--ordered
Move the objects in the order specified.

Normally all of the specified objects are grouped into a single move command. However, each object can be moved separately and in the order given. Thus:

```
$ bin/omero chgrp 5 Dataset:53 Project:51 Dataset:54 --ordered
```

would be equivalent to making three separate calls:

```
$ bin/omero chgrp 5 Dataset:53
$ bin/omero chgrp 5 Project:51
$ bin/omero chgrp 5 Dataset:54
```

--report
Provide a detailed report of what is moved:

```
$ bin/omero chgrp 5 Project:502 --report
```

--dry-run
Run the command and report success or failure but does not move the objects. This can be combined with the *--report* to provide a detailed confirmation of what would be moved before running the move itself.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

2.2.8 Deleting objects

The `omero delete` command deletes objects. Further help is available using the *-h* option:

```
$ bin/omero delete -h
```

The **delete** command will remove entire graphs of objects based on the IDs of the topmost objects. The command can be modified to include the deletion of objects that would, by default, be excluded or exclude objects that would, by default, be included using the *--include* and *--exclude* options.

Additionally, objects of the three annotation types, *FileAnnotation*, *TagAnnotation* and *TermAnnotation* are not deleted by default when the objects to which they are linked are deleted.

It is also possible to delete objects lower in the hierarchy by specifying the type and ID of a topmost object and the type of the lower object. For instance, deleting all of the images under a given project.

By default the command confirms the deletion of the target objects but it can also provide a detailed report of all the deleted objects via a *--report* option. A *--dry-run* option can be used to report on what objects would be deleted without actually deleting them.

Examples

Basic delete

```
$ bin/omero delete OriginalFile:101
$ bin/omero delete Project:51
```

In the first line, the original file with ID 101 will be deleted. In the second, the project with ID 51 will be deleted including any datasets inside only that project and any images that are contained within moved datasets only. Note that any linked file, tag or term annotations will not be deleted.

Deleting multiple objects

Multiple objects can be specified with each type being followed by an ID or a comma-separated list of IDs. The order of objects or IDs is not significant, thus all three calls below are identical in deleting project 51 and datasets 53 and 54.

```
$ bin/omero delete Project:51 Dataset:53,54
$ bin/omero delete Dataset:54,53 Project:51
$ bin/omero delete Dataset:53 Project:51 Dataset:54
```

Deleting lower level objects

To delete objects below a specified top-level object the following form of the object specifier is used.

```
$ bin/omero delete Project/Dataset/Image:51
```

Here the all of images under the project 51 would be deleted. It is not necessary to specify intermediate objects in the hierarchy and so:

```
$ bin/omero delete Project/Image:51
```

would have the same effect as the call above. Links can also be deleted and so:

```
$ bin/omero delete Project/DatasetImageLink:51 Dataset/DatasetImageLink:53
```

would effectively orphan all images under project 51 and dataset 53 that are not also under other datasets.

Including and excluding objects

--include
: Linked objects that would not ordinarily be deleted can be included in the delete using the *–include* option:

  ```
  $ bin/omero delete Image:51 --include FileAnnotation,TagAnnotation,TermAnnotation
  ```

  As mentioned above these three annotation types are not deleted by default and so this call overrides that default by including any of the three annotation types in the delete:

  ```
  $ bin/omero delete Image:51 --include Annotation
  ```

  This call would also delete any annotation objects linked to the image.

--exclude
Linked objects that would ordinarily be deleted can be excluded from the delete using the *–exclude* option:

```
$ bin/omero delete Project:51 --exclude Dataset
```

This will delete project 51 but not any datasets contained in that project.

The two options can be used together:

```
$ bin/omero delete Project/Dataset:53 --exclude Image --include FileAnnotation
```

This will delete any datasets under project 53, that are not otherwise contained elsewhere, excluding any images in those datasets but including any file annotations linked to the deleted datasets. In this case the images that are not otherwise contained in datasets will be orphaned.

For an example on deleting tags directly see *Delete tags*.

Further options

--ordered
Delete the objects in the order specified.

Normally all of the specified objects are grouped into a single delete command. However, each object can be deleted separately and in the order given. Thus:

```
$ bin/omero delete Dataset:53 Project:51 Dataset:54 --ordered
```

would be equivalent to making three separate calls:

```
$ bin/omero delete Dataset:53
$ bin/omero delete Project:51
$ bin/omero delete Dataset:54
```

--report
Provide a detailed report of what is deleted:

```
$ bin/omero delete Project:502 --report
...
omero.cmd.Delete2 Project 502... ok
Steps: 3
Elapsed time: 0.597 secs.
Flags: []
Deleted objects
Dataset:603
DatasetImageLink:303
Project:503
ProjectDatasetLink:353
Channel:203
Image:503
LogicalChannel:203
OriginalFile:460,459
Pixels:253
Fileset:203
FilesetEntry:253
FilesetJobLink:264,265,262,263,261
IndexingJob:315
JobOriginalFileLink:303
MetadataImportJob:312
```

```
PixelDataJob:313
ThumbnailGenerationJob:314
UploadJob:311
StatsInfo:72
```

--dry-run
Run the command and report success or failure but do not delete the objects. This can be combined with the *--report* to provide a detailed confirmation of what would be deleted before running the delete itself.

See also:

Command Line Interface as an OMERO admin tool System administrator documentation for the Command Line Interface

Command Line Interface as an OMERO development tool Developer documentation for the Command Line Interface

CHAPTER

THREE

ADDITIONAL RESOURCES

- About OMERO[1] introduces OMERO for new users, while the Features List[2] provides an overview of the platform features with those that are new for OMERO 5.2 highlighted.
- Workflow-based user assistance guides are provided on our help website[3].
- As OMERO is an open source project with developers and users in many countries, *connecting to the community* can provide you with a wealth of experience to draw on for help and advice.
- Our partners within the OME consortium are working on integrating additional functions and modules with OMERO. See the Partner Projects[4] page for details of the latest extensions which could help OMERO meet your research needs more fully.
- You can also extend the functionality of OMERO using OMERO.scripts, our version of plugins. Guides to some of the scripts which ship with OMERO releases are already provided, but you can also check out our Script Sharing[5] page to find extra ones.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

3.1 Community support

The Open Microscopy Environment[6] provides a number of resources for both our user and developer communities to assist in use and development of our software. Contributions through our mailing lists and forums are always welcome.

3.1.1 Web

The Open Microscopy Environment website is at http://www.openmicroscopy.org/site. Bio-Formats can be found at http://www.openmicroscopy.org/site/products/bio-formats.

3.1.2 Mailing lists

The following lists are provided:

- ome-users[7] – support with installation and general use or miscellaneous queries, as well as bug reporting
- ome-devel[8] – development discussion and support

Note: You can email these lists without subscribing but posts by non-members will be moderated before going out to all members. We endeavor to approve all genuine posts within 24 hours on working days, but we encourage you to subscribe to take advantage of our active and supportive community.

[1] http://www.openmicroscopy.org/site/products/omero/
[2] http://www.openmicroscopy.org/site/products/omero/feature-list
[3] http://help.openmicroscopy.org/
[4] http://www.openmicroscopy.org/site/products/partner/
[5] http://www.openmicroscopy.org/site/community/scripts
[6] http://www.openmicroscopy.org/site
[7] http://lists.openmicroscopy.org.uk/mailman/listinfo/ome-users/
[8] http://lists.openmicroscopy.org.uk/mailman/listinfo/ome-devel/

3.1.3 Forums

Discussion on a number of topics is also available through our forums[9]. Forums include:

- OME Announcements[10]
- OMERO[11]
  - User Discussion[12]
  - Installation and Deployment[13]
  - Developer Discussion[14]
- Bio-Formats[15]
  - User Discussion[16]
- OME Data Model[17]
  - User Discussion and Suggestions[18]

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

3.2 What's new for OMERO 5.2 for users

Updates and new features for OMERO 5.2 include:

- improved support for screen data formats (amongst others) and import times for images with many ROIs
- reworked display of metadata and annotations in the right hand pane of both clients
- improved support for attaching analytical results
- significant improvement in client performance including for loading data and drag and drop actions
- the size limit for exporting images is now 12k x 12k pixels

Note that you can no longer launch the desktop clients via Java Web Start as we have dropped support for this due to technical issues beyond our control[19].

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

3.3 OMERO version history

3.3.1 5.2.4 (May 2016)

This is a security release to fix the cleanse.py script used by the "bin/omero admin cleanse" command, which was not properly respecting user permissions and may lead to data loss.

[9] http://www.openmicroscopy.org/community/
[10] http://www.openmicroscopy.org/community/viewforum.php?f=11
[11] http://www.openmicroscopy.org/community/viewforum.php?f=3
[12] http://www.openmicroscopy.org/community/viewforum.php?f=4
[13] http://www.openmicroscopy.org/community/viewforum.php?f=5
[14] http://www.openmicroscopy.org/community/viewforum.php?f=6
[15] http://www.openmicroscopy.org/community/viewforum.php?f=12
[16] http://www.openmicroscopy.org/community/viewforum.php?f=13
[17] http://www.openmicroscopy.org/community/viewforum.php?f=14
[18] http://www.openmicroscopy.org/community/viewforum.php?f=15
[19] http://blog.openmicroscopy.org/tech-issues/future-plans/2015/09/23/java-web-start/

See 2016-SV1-cleanse[20] for details. The script and command have now been made admin-only.

It is highly suggested that you upgrade your server or apply the patch available from the security page.

3.3.2 5.2.3 (May 2016)

A bug-fix release. Improvements include:

- fixed problem with float images
- all scripts currently exposed to users via our website have been reviewed and fixed where necessary so they are all now 5.2.x compatible, and a new omero-install workflow has been developed to ensure these are reviewed regularly going forward
- better support for metadata annotations in clients including tag/tagset support and performance issues
- fixes in OMERO.web for deleting MIFs
- improvements to the navigation of large datasets and display of plates in OMERO.web
- other OMERO.web bug fixes
- OMERO.insight and CLI import improvements
- other OMERO.insight bug fixes, including for downloading data

Developer updates include:

- Java gateway improvements

System administrator updates include:

- Ice 3.6.2 support for UNIX-like systems, including specific installation walkthroughs
- redis support for websessions caching
- a fix to allow OMERO.web to be run in a Docker container
- improved OMERO.web configuration
- warnings added regarding the end of Windows support in the 5.3.0 release[21] (note that we will be preparing a guide for migrating from Windows for existing servers and adding it to the documentation as soon as we can)

This release also upgrades the version of Bio-Formats which OMERO uses to 5.1.9. See whats-new for more information[22].

3.3.3 5.2.2 (February 2016)

A bug-fix release which also introduces some new client features. Improvements include:

- display of ROI masks in OMERO.web image viewer
- display of OMERO.tables data for Wells in the OMERO.web right hand panel
- 'Populate Metadata' script to enable generation of OMERO.tables for Wells is now usable from both OMERO.web and OMERO.insight (note this is still in development and has some limitations)
- measurement tool fixes
- fixed pixel size metadata and scalebar in OMERO.web image viewer for images with pixel size units other than micrometer
- fixed OMERO.web handling of turning off interpolation of pixels
- previous and next buttons fixed in OMERO.web image viewer
- delete and change group performance improvements
- better handling of dates in search
- client support for map annotations in OME-TIFF
- disabled orphaned container feature

[20] http://www.openmicroscopy.org/info/vulnerabilities/2016-SV1-cleanse
[21] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/
[22] https://www.openmicroscopy.org/site/support/bio-formats5.1/about/whats-new.html

- OMERO.web clean-up to remove obsolete volume viewer

Developer updates include:

- Python API examples for creating Polygon and Mask shapes
- Python API example for "Populate Metadata" to create OMERO.tables for Wells
- OMERO.tables documentation extended
- updated 'What's New for developers' to clarify that `pojos` has been renamed as `omero.gateway.model`
- dynamic scripts functionality documented
- dynamic loading of omero.client server settings into HTTP sessions

System administrator updates include:

- clarification of OMERO.web documentation for nginx deployment, including an experimental solution to resolve download issues
- documentation of hard-linking issues for in-place import on linux systems

Note that the OMERO Virtual Appliance has been discontinued and will not be updated for version 5.2.2 or any later releases.

This release also upgrades the version of Bio-Formats which OMERO uses to 5.1.8. See whats-new for more information[23].

3.3.4 5.2.1 (December 2015)

A bug-fix release focusing on improving installation documentation and workflows. Other improvements include:

- bug fix for missing hierarchy when viewing High Content Screening data
- improvements to the right-hand panel in OMERO.insight
- measurement tool fixes
- OMERO.web fix for displaying size units

System administrator updates include:

- improved installation documentation, including detailed walkthroughs for specific OS
- OMERO.web deployment fixes

Developer updates include:

- OMERO Javadocs now link to the relevant version of Bio-Formats Javadocs for inherited methods
- clean-up of server dependencies
- jstree clean-up
- CLI graph operation improvements for deleting
- minimal-omero-client and pom-omero-client clean-up

This release also upgrades the version of Bio-Formats which OMERO uses to 5.1.7.

3.3.5 5.2.0 (November 2015)

A full, production-ready release of OMERO 5.2.0; dropping support for Java 1.6; featuring major upgrading of OMERO.web; re-working of the Java Gateway; and introducing new user features and many fixes and performance improvements:

- improved support for many file formats via Bio-Formats 5.1.5
- faster import for images with a large number of ROIs
- performance improvements for OMERO.web including faster data tree loading
- Java Web Start has been dropped, it is no longer possible to launch the desktop clients from the web
- reworked display of metadata and annotations in both UI clients

[23] https://www.openmicroscopy.org/site/support/bio-formats5.1/about/whats-new.html

- many bugs fixed

Developer and system administrator updates include:

- the OMERO web framework no longer bundles a copy of the Django package, this dependency must be installed manually
- updated jstree to 3.08 and now using json for all tree loading to substantially improve performance
- removed FastCGI support, OMERO.web can be deployed using WSGI
- configuration property `omero.graphs.wrap` which allowed switching back to the old server code for moving and deleting data has now been removed. You should migrate to using the new graph request operations before 5.3 when the old request operations will be removed
- introduced new Java Gateway to facilitate the development of Java applications
- aligned OMERO Rect with OME-XML schema for ROI. Clients using the OMERO.blitz server API to work with ROIs will need to be updated

3.3.6 5.1.4 (September 2015)

A bug-fix release covering all components. Improvements include:

- channel buttons fixed in OMERO.web
- improved UI experience when moving annotated data between groups in OMERO.web
- improved performance for loading annotations in the right-hand panel of OMERO.web
- much better handling of ROIs covering large planes in OMERO.insight
- rendering setting fixes for copy and paste actions in OMERO.insight
- rendering fixes for floating point data
- Admins can now configure whether the clients interpolate images by default
- better formatting of Delta-T and exposure times in the clients
- directories are now preserved when downloading multiple original files
- various improvements to the OMERO-ImageJ handling of ROIs and measurements, including the ability to name measurement tables
- current session key can now be returned via the CLI
- other CLI improvements including usability of 'chmod' for downgrading group permissions, and listing empty tagsets
- added support for groups in OMERO.matlab methods

Developer updates include:

- improvements to web logging to log full request and status code
- fixed joda-time version mismatch
- cleanup of old insight code to remove remaining references to OMERO.editor

Support for deployment of OMERO.web using FastCGI has also been deprecated in this release and is scheduled to be removed in 5.2.0. Sysadmins should move to using WSGI instead. We are also intending to stop distributing Java Webstart for launching OMERO.insight from your browser, as security concerns mean browsers are increasingly moving away from supporting this type of application. You can read further information regarding this decision on our Web Start blog post[24].

3.3.7 5.1.3 (July 2015)

A bug-fix release which also introduces some new functionality. Improvements include:

- tagging actions extended; you can now use tag sets to tag images on import
- tagging ome-tiff images at import has also been fixed

[24] http://blog.openmicroscopy.org/tech-issues/future-plans/2015/09/23/java-web-start/

- greatly improved workflow and bug fixes for the Share functionality in OMERO.web which enables you to share images with users outside of your group (including removal of part of the UI)
- group admins and owners can now change ownership of data via the CLI
- better reporting for the 'delete' and 'chgrp' functionality in the CLI
- fixed display of images in plates with multiple acquisitions
- fixed export of results as .xls files from OMERO.insight
- improved workflow for ImageJ and OMERO interactions
- support for WSGI OMERO.web deployment
- fixed OMERO.mail service for web errors
- fixes for ROI display in OMERO.web (thanks to Luca Lianas of CRS4)
- fixes and workflow improvements for running scripts and script dialogs

Developer updates include:

- OMERO.web clean-up (removal of '-locked')
- reorganization of the server bundle to move various licenses and dependencies under a new 'share' folder
- refactoring of 'Chown2', 'Chmod2', 'Chgrp2' and 'Delete2'
- addition of dynamic scripts
- the 'rstring' implementation is now more lenient and should better handle unicode
- Bio-Formats submodule removed from OMERO; decoupling effort means OMERO now consumes the Bio-Formats release build from the artifactory

This release also includes the fix for the Java security issue, as discussed in the recent blog post[25]. Testing suggests this fix should not have any performance implications. You should upgrade your Java version to take advantage of the security fix.

3.3.8 5.1.2 (May 2015)

A bug-fix release which also introduces some new functionality. Improvements include:

- support for Read-Write groups
- the LDAP plugin can now set users as group owners whether on creation or via the improved sync_on_login option
- users logged into the webclient can now automatically log in via webstart
- results tables from ImageJ/Fiji can be attached to images in OMERO and the ImageJ/Fiji workflow has been improved
- better delete functionality and warnings in the UI
- improved graph operations like 'delete' and 'chgrp', as well as the new 'chmod' operation (for changing group permissions), are now used across the clients including the CLI
- an API for setting and querying session timeouts is now available via the CLI
- magnification now reflects microscopy values (e.g. 40x) rather than a percentage in both clients
- more readable truncation of file names in the OMERO.insight data tree
- OMERO.web fixes and improvements including:
  - interpolation
  - optimization of plate grid and right-hand panel
  - option to download single original files
  - significant speed-up in loading large datasets
- deployment fixes include:
  - new default permissions on the var/ directory

[25] http://blog.openmicroscopy.org/tech-issues/2015/07/21/java-issue/

  - better checks of the DropBox directory permissions
  - new and some deprecated environment variables
  - a startup check for lock files on NFS
  - use /var/run for omero.fcgi

Critical bugs which were fixed include:

- the in-place import file handle leak (which was a regression in 5.1.1)
- various unicode and unit failures were corrected

3.3.9 5.1.1 (April 2015)

A bug-fix release focusing on user-facing issues and cleaning resources for developers. Improvements include:

For OMERO.web:

- significant review of the web share functionality
- correction of thumbnail refreshing
- fixes to the user administration panel
- fix for embedding of the Javascript image viewer

For OMERO.insight:

- improved open actions
- tidying of the menu structure
- correction of the mouse zoom behavior
- fix for the Drag-n-Drop functionality

Other updates include:

- overhaul of the CLI session log-in logic
- cleaning and testing of all code examples
- further removal of the use of deprecated methods

3.3.10 5.1.0 (April 2015)

A full, production-ready release of OMERO 5.1.0; updating the Data Model to the January 2015 schema, including support for units and new more flexible user-added metadata; and introducing new user features, new supported formats and many fixes and performance improvements:

- support for units throughout the Data Model allowing for example, pixel sizes for electron microscopy to be stored in nanometers rather than being set as micrometers
- new, searchable key-value pairs annotations for adding experimental metadata (replacing OMERO.editor, which has been removed)
- improved workflow for rendering settings in the UI and parity between the clients
- import images to OMERO from ImageJ and save ROIs and overlays from ImageJ to OMERO
- importing as another user, previously only available for administrators, is now usable by group owners as well, allowing you to import data that will then be owned by the user you import it for
- improved performance for moving and deleting data
- removed the auto-levels calculation for initial rendering settings to substantially speed up performance, by using the min/max pixel intensities, or defaulting to full pixel range where min/max is unavailable
- import times are much improved for large datasets such as HCS and SPIM data
- improved performance for many file formats and new supported formats via Bio-Formats (now over 140)

- new OMERO.mail feature lets admins configure the server to email users
- support for configuring the server download policy to control access to original file download for public-facing OMERO.web deployments
- many developer updates such as removal of deprecated methods, and updates to OMERO.web and the C++ implementation (see the 5.1.0-m1 to 5.1.0-m5 developer preview release details below and the 'What's New' for developers page)

3.3.11 5.1.0-m5 (March 2015)

Developer preview release - **only intended as a developer preview for updating code before the full public release of 5.1.0. Use at your own risk**.

Changes include:

- implementation of OMERO.mail for emailing users via the server
- performance improvements for importing large datasets
- support for limiting the download of original files
- various fixes for searching and filtering map annotations and converting between units
- deprecation of IUpdate.deleteObject API method
- versioning of all JavaScript files to fix browser refresh problems
- clarifying usage of OMERO.web views and templates including RequestContext

3.3.12 5.1.0-m4 (February 2015)

Developer preview release - **only intended as a developer preview for updating code before the full public release of 5.1.0. Use at your own risk**.

Changes include:

- final Database changes - image.series is now exposed in Hibernate
- improved deletion performance
- client bundle clean-up
- other clean-up work including pep8 and removal of deprecated methods and components
- new Map annotations are now included in the UI and search functionality
- ImageJ plugin updates which allow
  - importing of images and saving ROIs to OMERO from within the plugin
  - viewing images stored in OMERO and their ROIs generated within OMERO from within the plugin
  - updating ROIs on OMERO-stored images within the plugin and saving these back to OMERO without needing to re-import the image
- OMERO.matlab updates re: annotations
- OMERO.tables internal HDF5 format has changed

With thanks to Paul Van Schayck and Luca Lianas for their contributions.

3.3.13 5.0.8 (February 2015)

This is a bug-fix release for one specific issue causing OMERO.insight to crash when trying to open the Projection tab for an image with multiple z-stacks.

3.3.14 5.0.7 (February 2015)

This is a bug-fix release covering a number of issues:

- rendering improvements including 32-bit and float support
- vast improvements in Mac launching (separate clients for your Java version)
- faster import of complex plates
- OMERO.dropbox improvements
- ROI and measurement tool fixes
- OMERO.matlab updates

3.3.15 5.1.0-m3 (December 2014)

Developer preview release - 3 of 4 development milestones being released in the lead up to 5.1.0. **Only intended as a developer preview for updating code before the full public release of 5.1.0. Use at your own risk**.

Changes affecting developers include:

- implementation of units in the OMERO clients
- conversions between units
- OMERO.web updates
- server-side Graph work to improve speed for moving and deleting
- OMERO.insight bug-fixes especially for ROIs

3.3.16 5.1.0-m2 (November 2014)

Developer preview release - 2 of 3 development milestones being released in the lead up to 5.1.0. **Only intended as a developer preview for updating code before the full public release of 5.1.0. Use at your own risk**.

Model changes include:

- units support, meaning units now have real enums
- minor fixes for model changes introduced in m1

The units changes mean that the following fields have changed:

- Plane.PositionX, Y, Z; Plane.DeltaT; Plane.ExposureTime
- Shape.StrokeWidth; Shape.FontSize
- DetectorSettings.Voltage; DetectorSettings.ReadOutRate
- ImagingEnvironment.Temperature; ImagingEnvironment.AirPressure
- LightSourceSettings.Wavelength
- Plate.WellOriginX, Y
- Objective.WorkingDistance
- Pixels.PhysicalSizeX, Y, Z; Pixels.TimeIncrement
- StageLabel.X, Y, Z
- LightSource.Power
- Detector.Voltage
- WellSample.PositionX, Y
- Channel.EmissionWavelength; Channel.PinholeSize; Channel.ExcitationWavelength
- TransmittanceRange.CutOutTolerance; TransmittanceRange.CutInTolerance; TransmittanceRange.CutOut; TransmittanceRange.CutIn

- Laser.RepetitionRate; Laser.Wavelength

Other changes that may affect developers include:

- ongoing C++ implementation improvements
- ongoing work to add unit support in OMERO.insight
- further flake8 work
- removal of webtest app from OMERO.web to a separate repository
- removal of deprecated methods in IContainer and RenderingEngine
- removal of deprecated services IDelete and Gateway
- Blitz gateway fixes
- CLI fixes
- ROI and tables work

3.3.17 5.0.6 (November 2014)

This is a critical security fix for two vulnerabilities:

- 2014-SV3-csrf[26]
- 2014-SV4-poodle[27]

It is strongly suggested that you upgrade your server and follow the steps outlined on the security vulnerability pages.

Additionally, a couple of bug fixes for system administrators are included in this release.

3.3.18 5.1.0-m1 (October 2014)

Developer preview release - 1 of 3 development milestones being released in the lead up to 5.1.0. **Only intended as a developer preview for updating code before the full public release of 5.1.0. Use at your own risk**.

Model changes include:

- channel value has changed from an int to a float
- acquisitionDate on Image is now optional
- Pixels and WellSample types are no longer annotatable
- the following types are now annotatable: Detector, Dichroic, Filter, Instrument, LightSource, Objective, Shape
- introduction of a "Map" type which permits storing key-value pairs, and a Map annotation type which allows linking a Map on any annotatable object

Other changes that may affect developers include:

- strict flake8'ing of all Python code
- C++ build is now based on CMake and is hopefully much more user-friendly
- new APIs: SendEmail and DiskUsage
- the password table now has a "changed" field

3.3.19 5.0.5 / 4.4.12 (September 2014)

This is a critical security fix for two vulnerabilities:

- 2014-SV1-unicode-passwords[28]

[26] http://www.openmicroscopy.org/info/vulnerabilities/2014-SV3-csrf
[27] http://www.openmicroscopy.org/info/vulnerabilities/2014-SV4-poodle
[28] http://www.openmicroscopy.org/info/vulnerabilities/2014-SV1-unicode-passwords

- 2014-SV2-empty-passwords[29]

It is highly suggested that you upgrade your server and follow the steps outlined on the security vulnerability pages.

3.3.20 5.0.4 (September 2014)

This is a bug-fix release for the Java 8 issues. It also features a fix for uploading masks in OMERO.matlab.

You need to upgrade your OMERO server if you want to take advantage of further improvements in Bio-Formats support for ND2 files.

3.3.21 5.0.3 (August 2014)

This is a bug-fix release addressing a number of issues including:

- improved metadata saving in MATLAB
- many bug fixes for ND2 files
- several other bug fixes to formats including LZW, CZI, ScanR, DICOM, InCell 6000
- support for NDPI and Zeiss LSM files larger than 4GB
- export of RGB images in ImageJ
- search improvements
- group owner enhancements
- Webclient updates including multi-file download

To take advantage of improvements in Bio-Formats support for ND2 files, you need to upgrade your OMERO.server as well as your clients.

3.3.22 5.0.2 (May 2014)

This is a bug-fix release addressing a number of issues across all components, including:

- import improvements for large image datasets
- shared rendering settings
- better tagging workflows
- disk space usage reporting for OMERO.web admins
- OMERO.matlab annotation handling
- custom Web Start intro page templates
- searching by image ID

To take advantage of improvements in Bio-Formats support for .czi files, you need to upgrade your OMERO.server as well as your clients.

3.3.23 4.4.11 (April 2014)

This is a bug-fix release for the Java Web Start issue. You only need to upgrade if this is a blocker for you and you cannot upgrade to 5.0.x as yet. Also note that the OMERO.insight-ij plugin version 4.4.x no longer works for Fiji, we are working on a fix for this. Plugin version 5.0.x is unaffected.

[29] http://www.openmicroscopy.org/info/vulnerabilities/2014-SV2-empty-passwords

3.3.24 5.0.1 (April 2014)

This is a bug-fix release addressing a number of issues across all components, including:

- code signing to fix the Java Web Start issues
- stability improvements to search
- MATLAB fixes
- improvements to groups, user menus, file name settings etc
- new import scenario documentation covering 'in-place' importing.

3.3.25 5.0.0 (February 2014)

This represents a major change in how the OMERO server handles files at import compared with all previous versions of OMERO. Referred to as 'OMERO.fs', this change means that OMERO uses Bio-Formats to read your files directly from the filesystem in their original format, rather than converting them and duplicating the pixel data for storage. In addition, it continues our effort to support new multidimensional images. The changes are especially important for sites working with large multi-GB datasets, e.g. long time lapse, HCS and digital pathology data.

3.3.26 4.4.10 (January 2014)

This is a bug-fix release addressing a number of issues across all components, including:

- improved tile-loading
- better network-disconnect handling
- more flexible
- webapp deployment
- Ice 3.5.1 support (except Windows)
- improved modification of metadata, users and groups

3.3.27 4.4.9 (October 2013)

This is a bug-fix release addressing a number of issues across all components, also including:

- Ice compatibility issues
- new scripting sharing service
- new user help website
- new partner project pages.

The minimum system requirement is Java 1.6 (Java 1.5 is no longer supported).

A security vulnerability was identified and resolved, meaning that we strongly recommend all users upgrade their OMERO clients and servers.

3.3.28 4.4.8p1 (July 2013)

This is a patch release addressing a network connection problem in the clients introduced by a new version of Java.

3.3.29 4.4.8 (May 2013)

This is bug-fix release addressing two specific issues: a problem with the OMERO.insight client for Linux, and image thumbnails not loading for Screens/Plates in Private/Read-Only groups in OMERO.web. You only need to upgrade if you are an OMERO.insight user on Linux or you are using OMERO.web to view HCS data in Private or Read-Only groups.

3.3.30 4.4.7 (April 2013)

This is a point release including several new features and fixes across all components. This includes improvements in viewing of 'Big' tiled images, new permission features, new OMERO.web features, and several utility functions in OMERO.matlab.

3.3.31 4.4.6 (February 2013)

This is bug-fix release addressing a number of issues across all components. This includes a major fix to repair the C++ binding support for Ice 3.4. There has also been a potentially breaking update to the CLI.

3.3.32 4.4.5 (November 2012)

This is bug-fix release focusing on improvements to the OMERO clients. OMERO.web now supports "batch de-annotation", filtering of images by name and improved export to OME-TIFF and JPEG. OMERO.insight has fixes to thumbnail selection and image importing and exporting.

3.3.33 4.4.4 (September 2012)

This is a bug-fix release addressing a number of issues across all components.

- OMERO.insight fixes include connection and configuration options and tagging on import.
- OMERO.web improvements include big image and ROI viewer fixes, improved admin and group functionality and rendering/zooming fixes.
- OMERO.server now has improved LDAP support and VM and homebrew deployments as well as fixes for file downloads above 2GB, permissions, memory leaks and JDK5.

3.3.34 4.4.3 (August 2012)

This is a critical security fix for:

- 2012-SV1-ldap-authentication[30]

Anyone using OMERO 4.4.2 or earlier with LDAP authentication should immediately upgrade to 4.4.3.

3.3.35 4.4.2 (August 2012)

This release is a major bug fix for archiving files larger than 2 GB. If you do not archive files larger than 2 GB, you do not need to upgrade your clients or your server. There is also a minor fix for an OMERO.imagej plugin security issue, but it is only necessary to update the version of Bio-Formats that is installed in ImageJ.

3.3.36 4.4.1 (July 2012)

This is a minor release which fixes two import issues. See #9372[31] and #9377[32]. If you are not using BigTIFF or PerkinElmer .flex files, then you do not need to upgrade.

3.3.37 4.4.0 (July 2012)

This is a major release, which focuses on providing new functionality for controlling access to data, as well as significant improvements in our client applications.

The major theme of 4.4.0 is what we refer to as "Permissions", the system by which users control access to their data. It is now possible to move data between groups, and much, much more.

[30] http://www.openmicroscopy.org/info/vulnerabilities/2012-SV1-ldap-authentication
[31] https://trac.openmicroscopy.org/ome/ticket/9372
[32] https://trac.openmicroscopy.org/ome/ticket/9377

We also added a few more things for users in 4.4.0, like:

- OMERO.insight webstart
- Importing from OMERO.insight is now complete
- Better integration of OMERO.insight with ImageJ
- A bottom-to-top reworking of the OMERO.web design

For developers and sysadmins, there are a few things as well:

- Support for Ice 3.4
- Removed support for PostgreSQL 8.3

3.3.38 Beta 4.3.4 (January 2012)

This is a point release is a security update to address an LDAP vulnerability.

3.3.39 Beta 4.3.3 (October 2011)

This point release is a short follow on to 4.3.2 to handle various issues found by users.

3.3.40 Beta 4.3.2 (September 2011)

This is a point release, focusing on fixes for OMERO.web, export, and documentation. A couple of LDAP fixes were also added, following requests from the community. We also included something many of you have asked for some time, OMERO on virtual machines.

3.3.41 Beta 4.3.1 (July 2011)

This point release focuses on fixes for Big Images, OMERO.web and others.

3.3.42 Beta 4.3.0 (June 2011)

This is a major release, focusing on new functionality for large, tiled images, and significant improvements in our client applications.

The major theme of 4.3.0 is what we refer to as "Big Images", namely images with X,Y images larger that 4k x 4k. With this release, OMERO's server and Java and web clients support tiling and image pyramids. This means we have the functionality you have probably seen in online map tools, ready for use in any image file format supported by OMERO (and obviously Bio-Formats). This is especially important for digital pathology, and other uses of stitched imaging.

While the major focus of 4.3.0 was Big Images, there are a number of other new updates. For users, we have worked hard to synchronise functionality and appearance across the OMERO clients. This includes viewing of ROIs in OMERO.web. We are not done, but we have made a lot of progress. Moreover, data import is now MUCH faster and available from within OMERO.insight.

3.3.43 Beta 4.2.2 (December 2010)

Fixes blocker reported using 4.2.1. Starting with this milestone, all tickets for the insight client are managed on Trac.

3.3.44 Beta 4.2.1 (November 2010)

This is a point release, focusing on fixes for delete functionality, and significant improvements in the way OMERO.web production server is deployed.

3.3.45 Beta 4.2.0 (July 2010)

This release is a major step for OMERO, enabling a number of critical features for a fully functional data management system:

- User and Group Permissions and data visibility between users
- updates to the OME SPW Model and improvements in HCS data visualisation
- SSL connection between OMERO clients and server;
- full scripting system, accessible from command line and within OMERO.insight, including Figure Export and FLIM Analysis
- ROIs generated in OMERO.insight stored on server
- extended use of OMERO.Tables for analysis results
- performance improvements for import and server-side import histories
- revamped, fully functional OMERO.web web browser interface
- upgrade of Backend libraries in OMERO.server

3.3.46 Beta 4.1.1 (December 2009)

This release fixes a series of small bugs in our previous Beta 4.1 release.

3.3.47 Beta 4.1 (October 2009)

Improved support for metadata, especially for confocal microscopy; OMERO supports all of the file formats enabled by Bio-Formats. Export to OME-TIFF and QuickTime/AVI/MPEG from OMERO. Various improvements to OMERO clients to improve workflow and use.

This release introduces OMERO.qa - a feedback mechanism, to allow us to communicate more effectively with our community. OMERO.qa supports uploading of problematic files, and tracking of responses to any user queries. Moreover, OMERO.qa includes a demo feature: in collaboration with Urban Liebel at Karlsruhe Institute of Technology, we are providing demo accounts for OMERO. Use the Demo link at qa to contact us if you are interested in this.

For users who have had problems with memory-based crashes in OMERO.insight, the new OpenGL-based ImageViewer may be of interest. Also, we are now taking advantage of our modeling of HCS data, and releasing our first clients that support Flex, MIAS, and InCell 1000 file formats. OMERO.dropbox has been substantially extended, and now supports all the file formats supported by OMERO.

3.3.48 Beta 4.0.1 (April 2009)

A quick patch release that fixes some bugs and adds some new functionality:

- Fixed Windows installation and updated docs.
- Bug fixes (scriptingEngine, importer).
- Fix .lif import, add Li-Cor 2D (OMERO does gels!).
- API .dv and OME .ome.tiff now supported by OMERO.fs.
- Support negative pixel values in Rendering Engine.
- Archived images are now fully supported in OMERO.
- OMERO.web merged with OmeroPy in distribution.

3.3.49 Beta 4.0 (March 2009)

This release consists of a major change in the remoting infrastructure, complete migration of existing OMERO clients to the ICE framework, two new OMERO clients, and integration of OMERO.editor into OMERO.insight.

OMERO.server updates:

- remove JBOSS, and switch all remoting to ICE
- improve session management, supporting creation of many thousands of session
- addition of an import service for server-side importing
- DB upgrades to support the metadata completion facilities
- substantial improvement to the interaction between the indexing engine and the rest of server.

OMERO.importer updates:

- migration to Blitz interface, giving much faster performance
- more efficient importing, complete metadata support for Zeiss LSM510, Leica LIF, Zeiss ZVI, Applied Precision DV, and MetaMorph STK
- addition of command line importer for batch import

OMERO.insight updates:

- migration to Blitz interface, giving much faster performance
- updates to metadata display, include complete support for OME Data Model
- much expanded integration of protocol management via OMERO.editor, within OMERO.insight
- support for image delete
- refinement of Projection Interface

OMERO.web: all new browser-based client for OMERO. Enables sharing of images with colleagues with an account on server.

OMERO.editor: a management tool for experimental protocols, now fully integrated with OMERO.insight, so that protocols and experimental descriptions can be saved along with images and datasets. Includes a new parameters function, so that protocols in traditional documents can be easily imported into OMERO. Supports, tables and .xls files. Also runs as a standalone application.

OMERO.fs: a new OMERO client, that monitors a specific directory and enables automatic imports. In its first incarnation, has quite limited functionality, supporting automatic import of LSM510 files only.

3.3.50 Beta 3.2 (November 2008)

The final update in the Beta3.x series. A number of fixes:

- faster thumbnailing and better support for large numbers of thumbnails
- improved handling of Leica .lei and Zeiss .zvi files
- extended support for reading OMERO.editor files in OMERO.insight
- measurement tool fixes in OMERO.insight
- fixed memory problem in OMERO.insight on Windows
- fixed thumbnailing and session bugs on OMERO.server
- fixed DB upgrades for older PostgreSQL versions

3.3.51 Beta 3.0 (June 2008)

This release of OMERO is a major update of functionality. In OMERO.server, we have added support for StructuredAnnotations a flexible data management facility that allows essentially any kind of accessory data to be linked to images and experiments stored in OMERO. Alongside this, we provide an indexing engine, that provides a flexible searching facility for essentially any text stored in an installation of OMERO.server. Finally, we are releasing our first examples of clients that use the OMERO.blitz

server, a flexible, distributed interface that supports a range of client environments. One very exciting addition is OMERO matlab, a gateway that can be used to access OMERO from Matlab®.

OMERO Beta3.0 includes a substantial reworking of our clients as well. OMERO.insight has been substantially updated, with an updated interface to provide a more natural workflow and support for many different types of annotations, through the StructuredAnnotations facility. The new search facilities are supported with smart user interfaces, with auto-complete, etc. New file formats have been added to OMERO.importer, including support for OME-XML, and an improved import history facility is now available. Finally, Beta3.0 includes the first release of our experimental electronic notebook tool, OMERO.editor. This represents our recent efforts to capture as much metadata around an experiment as possible.

3.3.52 Beta 2.3.3 insight (April 2008)

A new Beta 2.3.3 OMERO.insight has been released, this adds rotation to ellipse figure, and new format for saving intensity values.

Note: this version saves the ROIs in a format which is incompatible with previous saved ROIs.

3.3.53 Beta 2.3.1 importer (February 2008)

A new Beta 2.3.1 OMERO.importer has been released which includes a number of new formats: Zeiss AxioVision ZVI (Zeiss Vision Image), Nikon NIS-Elements .ND2 , Olympus FluoView FV1000, ICS (Image Cytometry Standard), PerkinElmer UltraView, and Jpeg2000.

The OMERO downloads for Beta 2.3 include a number of new options: a new import history feature, a Windows server installation, and a new tagging feature for OMERO.insight.

Note: milestone:3.0-Beta2.3 and prior Mac OS X installers for OMERO.server do not work on Mac OS X Leopard (10.5). Please follow the UNIX-based platform manual install instructions. Mac OS X installers for OMERO.insight and OMERO.importer work just fine under Leopard and can be used.

3.3.54 Beta 2.3 (December 2007)

This is a patch release for OMERO.server to fix a memory problem. In OMERO.insight, updating of the tagging facility, viewing of others' rendering settings and support for server-side compression of images before transport to client.

3.3.55 Beta 2.2 (November 2007)

In this release we have updated OMERO.server to run a newer version of JBOSS and provided support for copying display settings across a range of images. More new file formats. OMERO.insight has been updated to support copying display settings across many images. Image Viewer has been substantially updated.

3.3.56 Beta 2.1 (August 2007)

This is a client-only release. OMERO.insight now supports basic ROI measurements and a series of new file formats have been added. The OMERO downloads for Beta 2.0 have been simplified. OMERO.insight and OMERO.importer have been combined into a single download file called 'OMERO.clients' and the user documentation is now included inside of the server and client downloads.

3.3.57 Beta 2.0 (June 2007)

Note: this version will still work with the Beta 1 server release.

This major update provided our first support for multiple platforms via OMERO.Blitz. OMERO.insight now supports viewing work of multiple users. Beta 2 is our first release of the Web2.0-like 'tag' system developed in collaboration with Usable Image[33]. This version addresses issues with using our tools under Java 1.6

[33] http://www.openmicroscopy.org/site/about/project-history/catriona

3.3.58 Beta 1.1 (March 2007)

Patch release to fix time-out issues.

3.3.59 Beta 1 (January 2007)

The first public OMERO release, providing simple data management. Limited file format support (DV, STK, TIFF). Simple data visualization and management.

3.3.60 Milestone M3 (November 2006)

Rendering and compression API and client-side import. Access control and permissions system. Importer based on Bio-Formats.

3.3.61 Milestone M2 (July 2006)

The stateful rendering service is functional and all rendering code moved from Shoola Java client to the server. Also, the stateless services (IQuery,IUpdate,IPojos) are frozen and testing and documentation is checked and solidified.

3.3.62 Milestone M1 (April 2006)

Contains minimal functionality needed to run Shoola Java client without Perl server to demonstrate acceleration of metadata access. Application deployed on JBoss (http://www.jboss.org). No ACLs or permissions.

CHAPTER

FOUR

QUICKSTART SERVER ACCESS

If your institution does not have an existing OMERO.server for you to connect to, you can apply for an account on our demo server. Alternatively, you can create your own using a virtual appliance (a step-by-step guide for how to do this is provided).

Note: The virtual appliance is being discontinued. Previous versions will remain available for download but OMERO 5.2.1 will be the most recent release.

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

4.1 OMERO demo server

Take advantage of the OMERO platform and ask for a free demo account.

To register for a free demo account, please visit the registration page[1].

We will contact you and provide you with a server name, username and password, please be patient as it may take a few days to process your application after we receive it.

If you have already requested a demonstration account:

- your username and password will be emailed to you.

Once you have these, follow the instructions below.

4.1.1 Service-level agreement

By using the OMERO Demo Server, you agree to the following:

- You use this service at your own risk, and we provide NO GUARANTEE OR WARRANTY WHATSOEVER regarding uptime, security, data provenance or access, or any other service.
- You should not use the OMERO Demo server as a repository for any important data, or data that must be held in any secure or specific way.
- The responsibility for any data loaded onto the OMERO Demo Server is entirely your own.
- We reserve the right to remove any images, data, accounts or other data or structure without notice or request.

We welcome comments or ideas from your use of and experience with the OMERO Demo Server on the OMERO User discussion forum[2] or ome-users mailing list[3].

4.1.2 Getting started with your demo account

To log on and try the demo server you have two options:

[1] http://qa.openmicroscopy.org.uk/registry/demo_account/
[2] http://www.openmicroscopy.org/community/viewforum.php?f=4
[3] http://lists.openmicroscopy.org.uk/mailman/listinfo/ome-users/

1. *Using the OMERO.insight client*

Download the OMERO.insight client for your platform, install it and run it as a stand-alone application. You will need to have permissions allowing you to install software on your computer, and you will need to update the client if the demo server is upgraded (we will email you to inform you).

2. *Using the OMERO.web client*

The web client does not allow you to import data or create new ROIs.

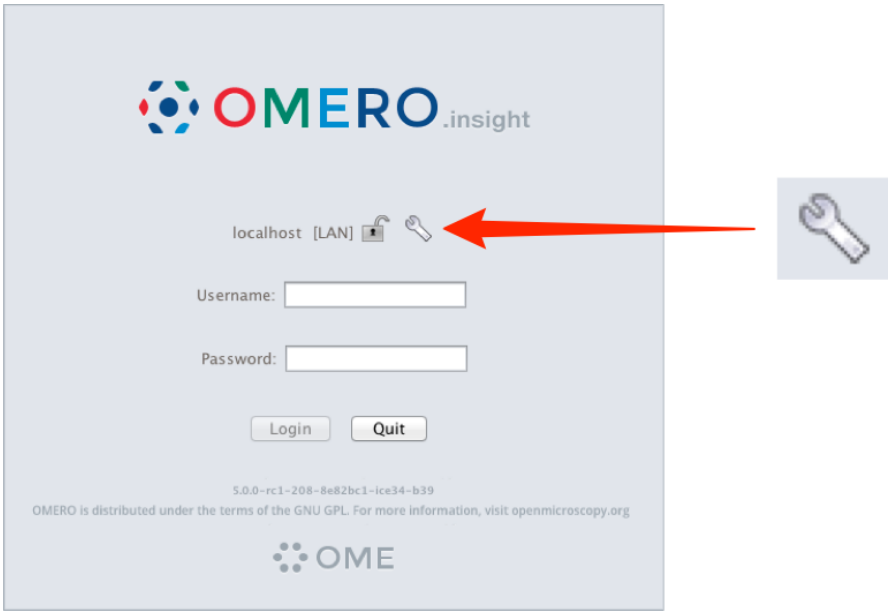
Using the OMERO.insight client

Download the **OMERO.insight** client for your platform by clicking on the appropriate link on the downloads page[4].

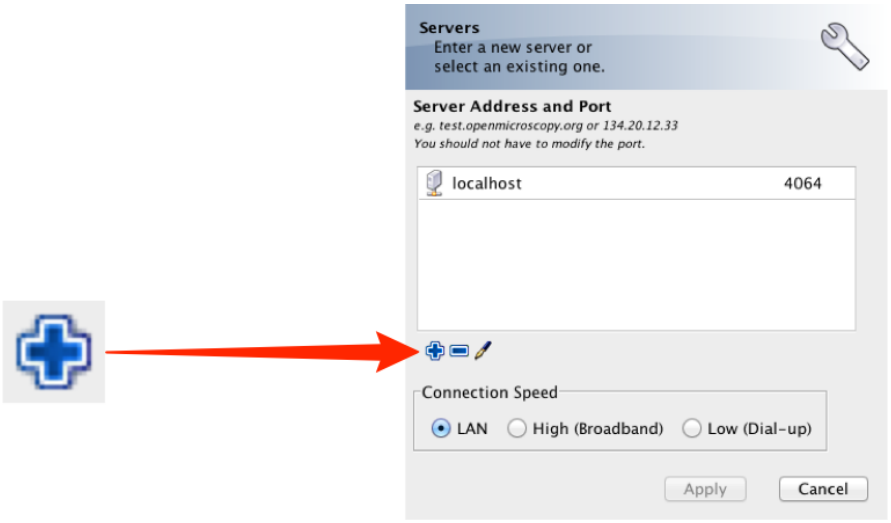
After download, unzip and install the OMERO.insight client as you would for any other application.

Launch OMERO.insight, and you will see the login screen.

Click the **Spanner** icon.



In the **Servers** window, click the + icon.



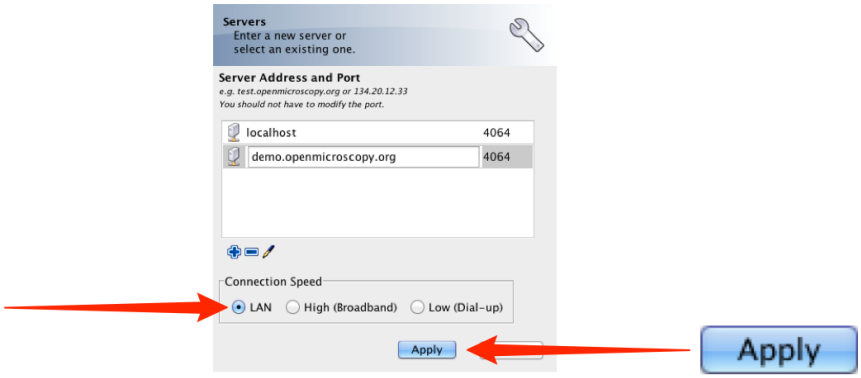
[4] http://downloads.openmicroscopy.org/latest/omero/

Enter the **Server Address**: demo.openmicroscopy.org

The port will automatically be set to 4064.

Select your network connection speed.

Click **Apply**



Enter the username and password provided.

Click **Login**

Using the OMERO.web client

To use the OMERO.web client click on the following link:

OMERO.web[5]

The server name is entered automatically, and you enter your demo account username and password as described above.

Please change your password as soon as you have logged in. The easiest way to do this is via: Web Admin[6]

[5] http://demo.openmicroscopy.org/webclient/login
[6] http://demo.openmicroscopy.org/webadmin/myaccount/edit/

4.1.3 Further guides and help

- Workflow-based user assistance guides are available on our help website[7]. These use screenshots to illustrate how to perform common tasks such as importing and viewing data, and using the measurement tool.
- An overview of some OMERO's features is available in a short showcase video at:

  Showcase Video[8]
- If you have any questions, suggestions, comments or proposals, please take advantage of the OME community's expertise and join our forums or mailing lists:

  Forums[9]

  Mailing Lists[10]
- For more information on OME and OMERO please visit:

  Open Microscopy Environment[11]

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

4.2 OMERO virtual appliance

Note: The virtual appliance is being discontinued. Previous versions will remain available for download but OMERO 5.2.1[12] will be the most recent release.

The OMERO virtual appliance is a quick, easy, and low-cost way to try out OMERO.server on your laptop or desktop. This enables you to make an informed decision about whether committing to an OMERO.server install is right for you.

Virtualization enables canned, ready to run software environments to be created and used, in the form of VM (Virtual Machine), or to be distributed for others to use, in the form of virtual appliances. A Virtual Appliance is essentially a file that describes how to create a new Virtual Machine on demand. The virtualized software environment can contain an entire OS (Operating System), such as Windows or Linux, and any other software that runs in that OS, such as, in this case, OMERO.server and its associated software prerequisites. Once created and started, you can log into the OS and use it as though it were a real machine. One way to think of this is as though you had an entire computer in a window on your desktop.

When using virtualization software, the OS that is running the virtualization software is referred to as the "**host OS**". When you use virtualization, the OS running within a virtual machine is referred to as the "**guest OS**". This allows us to be explicit about which OS we are working in.

This technology allows the OME Project to distribute a canned, ready-to-run environment containing an OMERO.server, freeing you from having to install the server and prerequisites yourself, and letting you concentrate on evaluating the functionality of the OMERO platform.

Note: The virtual hard-drive used by the OMERO virtual appliance is 30GB in size and you should keep track of the amount of this space you have consumed and, if necessary, delete data that is not required. If your data is likely to exceed this space whilst you are evaluating OMERO then it is worthwhile going through the *Increasing HD size* before you start working with OMERO in earnest.

4.2.1 Getting started

To use the virtual appliance you should do the following:

- Install VirtualBox

[7] http://help.openmicroscopy.org/
[8] http://cvs.openmicroscopy.org.uk/snapshots/movies/omero-4-4/mov/OMERO-Showcase.mov
[9] http://www.openmicroscopy.org/community/
[10] http://www.openmicroscopy.org/site/community/mailing-lists/
[11] http://www.openmicroscopy.org/site
[12] http://downloads.openmicroscopy.org/latest/omero-virtual-appliance/

- Download the OMERO.server virtual appliance[13]
- Import the virtual appliance into VirtualBox to create a virtual machine
- Start the virtual machine

Each of these points is outlined in full detail below. Once you have everything installed, the virtual appliance should just work straight out of the box but if you have any problems, there is further guidance available for *Troubleshooting OMERO virtual appliance* and *Working with OMERO virtual appliance*.

Install VirtualBox

Download VirtualBox from the VirtualBox Downloads page[14] and follow the installation process for your platform. If in doubt, you should download, or upgrade to, the latest version of VirtualBox. Once VirtualBox is installed, run the application. Depending upon your platform and version, the VirtualBox interface should look similar to the following screenshot:

Figure 4.1: VirtualBox installation

Download the OMERO.server virtual appliance

The virtual appliance has its own download page[15] and will have a filename similar to omero-va-5.2.4.ova.

Import OMERO virtual appliance into VirtualBox

- Start VirtualBox then select **'File/Import Appliance'**. You will be presented with a dialog box.
- Select and navigate to the location where you downloaded the the virtual appliance file.
- Select your OVA file then click **open**.

This process is indicated in the screenshot below.

- Click **continue**. You will be presented with a range of options for the VM that will be built from the appliance.
- You can accept the defaults by clicking **Import**.

[13] http://downloads.openmicroscopy.org/latest/omero-virtual-appliance/
[14] https://www.virtualbox.org/wiki/Downloads
[15] http://downloads.openmicroscopy.org/latest/omero-virtual-appliance/

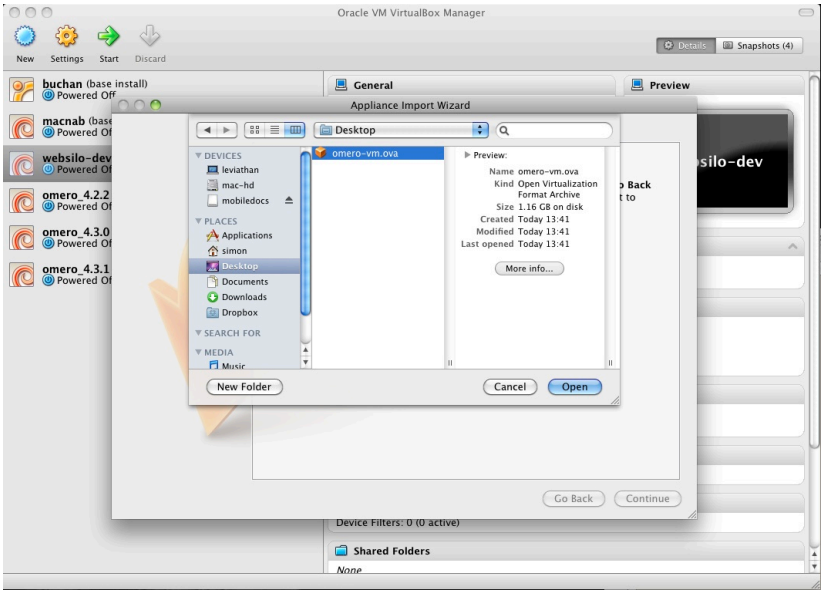


Figure 4.2: Import of the OMERO virtual appliance

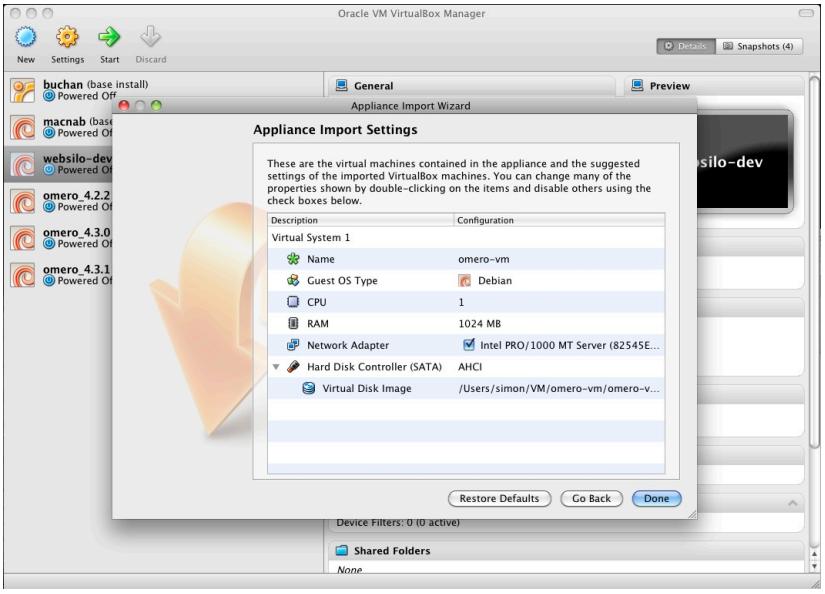


Figure 4.3: Virtual appliance import settings

You should now see a progress bar as your new virtual machine is built from the appliance. This may take a few minutes depending upon your hardware.

When the import procedure is complete, your new VM should appear in the VirtualBox VM library ready for use.

Networking

Our virtual appliance is distributed with VirtualBox's built in Host-Only Network Address Translation (NAT) preconfigured. This means that the IP address for the VM is 10.0.2.15 as this is the default VirtualBox Host-Only NAT address. Using this address is the simplest way to distribute a virtual appliance when you do not know the setup of a user's network.

Port-forwarding settings

Your host OS cannot connect directly to 10.0.2.15 but needs to use port-forwarding. This means that you connect to your localhost on a specific port and the communications to and from that port are forwarded to specified ports on the guest VM.

Our virtual appliance should be preconfigured with the correct port-forwarding setting during the import process. However, it is best to double check that these settings are correct:

- Select your VM in the VirtualBox VM Library
- Click on **Settings** then select the **Network** tab
- Click on **Advanced**
- Click on **Port Forwarding**

If the table in the window that appears is empty then port forwarding is not setup. The required port-forwarding settings are as follows:

Name	Protocol	Host IP	Host Port	Guest IP	Guest Port
omero-ssl	TCP	127.0.0.1	4064	10.0.2.15	4064
omero-unsec	TCP	127.0.0.1	4063	10.0.2.15	4063
omero-web	TCP	127.0.0.1	8080	10.0.2.15	8080
ssh	TCP	127.0.0.1	2222	10.0.2.15	22

When correctly setup in VirtualBox, your port forwarding settings should look like this:

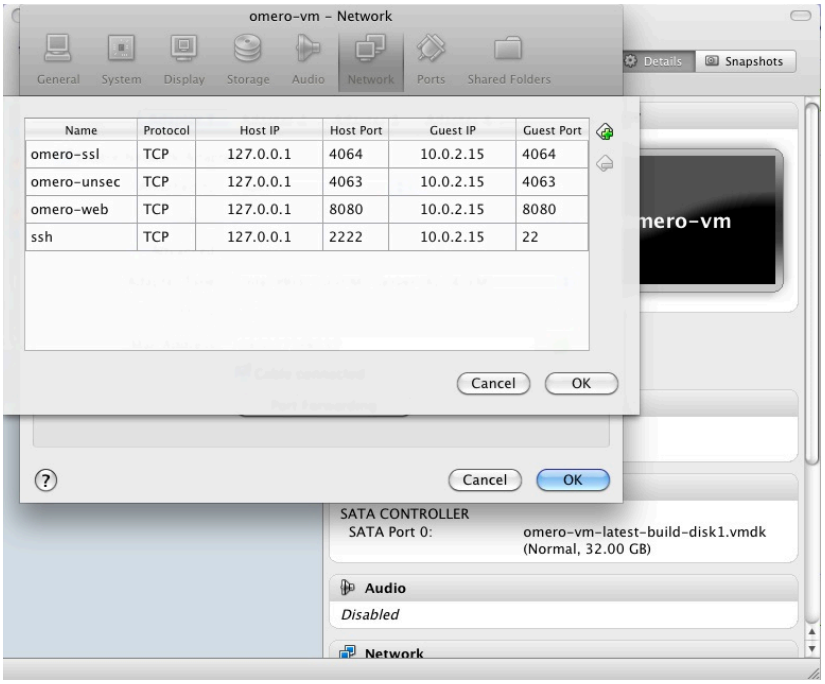


Figure 4.4: VirtualBox port forwarding

If you are on Linux or Mac OS X, you can either use our port forwarding setup script or you can set up port forwarding manually.

On Microsoft Windows systems you will have to set up port forwarding manually as the script requires a Bash shell.

The script can be downloaded from the online version of this documentation; see http://www.openmicroscopy.org/site/support/omero/users/virtual-appliance.html.

After obtaining the script, it can be used in the following manner:

```
$ bash setup_port_forwarding.sh $VMNAME
```

where $VMNAME is the name of your VM.

Note: By default the scripts create a VM named **omerovm** and the pre-built appliance is named **omero-vm**

Adding port forwarding manually is achieved by editing the port forwarding table shown above. Use the + to add a new row to the table, then click in each cell and type in the required settings.

Now you are ready to start your VM. Select the VM in the VirtualBox VM library then click **start**.

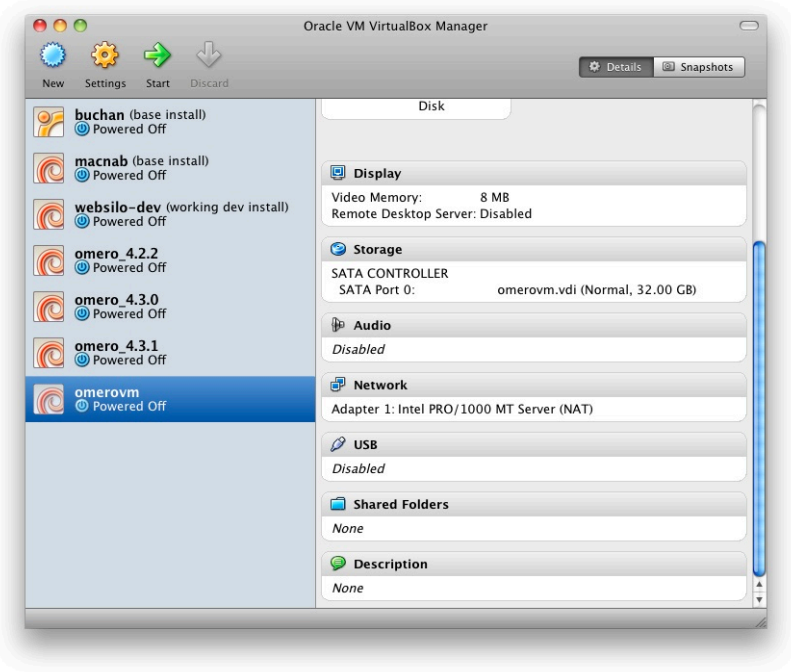


Figure 4.5: VirtualBox VM manager

A window should open containing a console for your VM which should now be going through its standard boot process. OMERO.server is automatically started at boot time, meaning that you should be able to interact with OMERO without further setup.

Figure 4.6: Booting the virtual appliance

Credentials

The following accounts are preconfigured in the OMERO virtual appliance: an OS account, for logging into the VM as the **omero** user, and a single OMERO.server account which is used to access the OMERO.server software as the OMERO.server **root** user.

Virtual Appliance OS credentials

Username	Password
omero	omero

A 'root' OS account is not needed as the omero account is able to run administrative commands via sudo with no password required.

OMERO.server credentials

Username	Password
root	omero

You can use this administrative account to create as many user level accounts as you require in the usual way.

4.2.2 Using the virtual appliance

Further guidance on how to interact with the server and troubleshoot common issues is available. See *Working with OMERO virtual appliance* and *Troubleshooting OMERO virtual appliance*. In particular, *increasing the base memory allocation* may significantly improve import performance.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Working with OMERO virtual appliance

Now that your VM is up and running you have a choice about how to interact with it.

- You can connect to OMERO.web from your host browser. Go to http://localhost:8080/webclient.
- You can **use OMERO.clients from within your host OS.** This will allow you to import data via a GUI and manage that data once imported. To do so, download the OMERO.insight client[16] and follow the instructions below. More information can be found on our help website[17] which provides workflow-based guides to using the OMERO.clients.
- Alternatively, you can interact with the server command line interface by SSH (Secure Shell)'ing into the guest VM or by opening a console within the VM itself. Administrators may need to use one of these methods to restart the server and/or change configuration parameters. In this case, you must have an SSH client installed on your host machine to use to connect to the OMERO.server.

Note: The following examples assume that the OMERO VM is up and running on the same machine that you are working on.

OMERO.web

Go directly to http://localhost:8080/webclient to log in with user: "root" / pw: "omero".

Note: If you receive a 502 nginx error on first attempting to connect to the web app on http://localhost:8080/webclient/ please restart the virtual machine and try again.

OMERO.insight

You can run regular OMERO clients on your host machine and connect to the server in the VM. Our example uses OMERO.insight running on Mac OS X to connect to the VM.

- Download[18] and install OMERO.insight

[16] http://downloads.openmicroscopy.org/latest/omero/
[17] http://help.openmicroscopy.org/
[18] http://downloads.openmicroscopy.org/latest/omero/

- Start OMERO.insight
- Click the spanner icon situated above the password box to enter the server settings box shown below.

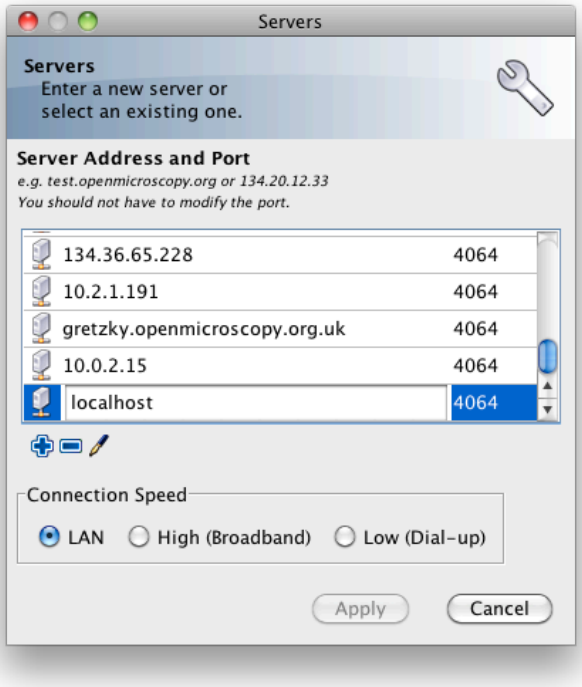


Figure 4.7: Setting OMERO.insight server address and port number

- Use the + icon to add a new server entry with the address *localhost* and the port *4064* then click apply
- You can now use the login credentials given above to log into OMERO.insight using the login window shown below (user: "root" / pw: "omero").

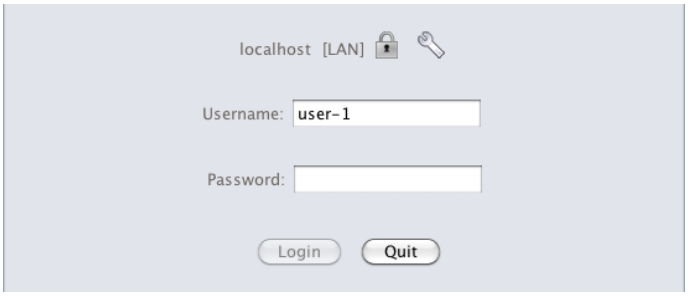


Figure 4.8: OMERO.insight login window

- OMERO.insight should now load up and display the main window.

You can now use OMERO.insight to import and manage images on a locally running virtual server just like you would use the standard remote server.

Note: A Getting Started guide is available for OMERO.insight on our help website[19] if you need further assistance to download and install the software.

Secure Shell

You can log into your VM using SSH, allowing you to use the *Command Line Interface as an OMERO client*. In the following example, we assume that you have an SSH client installed on your host machine and also that your VM is up and running.

[19] http://help.openmicroscopy.org/getting-started-5.html

You can log into the VM using the above credentials and the following command typed into a terminal:

```
$ ssh omero@localhost -p 2222
```

This invokes the SSH program telling it to login to the localhost on port 2222 using the username *omero*. Remember that earlier you set up port forwarding to forward port 2222 on the host machine to port 22 (the default SSH port) on the guest VM. You should be prompted for a password. Once you have successfully entered your password, you should be greeted by a prompt similar to the following:

```
omero@omerovm:~$
```

There are two potential complications to this method, (1) if you have used a VM before then there could be old SSH fingerprints set up, (2) the first time that you log into the VM you will be asked to confirm that you wish to continue connecting. If you get the following message after you invoke SSH, you need to remove the old fingerprints:

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@    WARNING: REMOTE HOST IDENTIFICATION HAS CHANGED!     @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
IT IS POSSIBLE THAT SOMEONE IS DOING SOMETHING NASTY!
Someone could be eavesdropping on you right now (man-in-the-middle attack)!
It is also possible that the RSA host key has just been changed.
The fingerprint for the RSA key sent by the remote host is
60:e0:d2:e8:fb:25:bf:09:53:9d:9d:59:59:45:cf:aa.
Please contact your system administrator.
Add correct host key in /Users/rleigh/.ssh/known_hosts to get rid of this message.
Offending key in /Users/rleigh/.ssh/known_hosts:14
RSA host key for localhost has changed and you have requested strict checking.
Host key verification failed.
```

You can do this using the following command typed into the terminal:

```
$ ssh-keygen -R [localhost]:2222 -f ~/.ssh/known_hosts
```

This should produce output similar to:

```
$ ssh-keygen -R [localhost]:2222 -f ~/.ssh/known_hosts
/Users/rleigh/.ssh/known_hosts updated.
Original contents retained as /Users/rleigh/.ssh/known_hosts.old
```

The first time that you log into the VM you will also be asked to confirm that you wish to connect to this machine by a message similar to the following:

```
$ ssh omero@localhost -p 2222
The authenticity of host '[localhost]:2222 ([127.0.0.1]:2222)' can't be established.
RSA key fingerprint is 60:e0:d2:e8:fb:25:bf:09:53:9d:9d:59:59:45:cf:aa.
Are you sure you want to continue connecting (yes/no)?
```

You should confirm that you wish to continue connecting, after which you will be prompted for your password as usual:

```
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '[localhost]:2222' (RSA) to the list of known hosts.
omero@localhost's password:
```

After which, you should have a prompt indicating that you have a shell open and logged into the VM:

```
omero@localhost's password:
Linux omerovm 2.6.32-5-686 #1 SMP Mon Jun 11 17:24:18 UTC 2012 i686

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Thu Apr  5 10:32:18 2012 from 10.0.2.2
omero@omerovm:~$ _
```

Log into the VM directly

Note: Due to the frequent changes in the VirtualBox Guest Additions, key mappings between the host and guest OS do not always work. We recommend using SSH as the primary way of interacting with the Virtual Appliance CLI.

When you start your VM using the VirtualBox GUI, as outlined above, a window will be displayed showing the boot process for the machine as it starts up, just like with a real piece of hardware. Once the boot process has finished you will see a prompt displayed in this window like so:

```
[System startup messages]

Debian GNU/Linux 6.0 omerovm tty1

omerovm login: _
```

You can log into the console of the VM directly using the user account credentials above.

```
omerovm login: omero
Password: _
```

There is no GUI on the current OMERO virtual appliance so you will have to use the Bash shell which looks like this:

```
omero@omerovm:~$ _
```

From here you can interact with OMERO.server via the *Command Line Interface as an OMERO client*. You will need to login as the 'omero' user to access the OMERO CLI (user: "omero" / pw: "omero"). Logout using Ctrl-D.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Troubleshooting OMERO virtual appliance

Networking not working

Occasionally, during the boot process, the VirtualBox DHCP server fails to allocate an IP address to the OS in the guest VM. This means that OMERO.clients, such as OMERO.insight, cannot connect to the OMERO.server in the VM.

- **CAUSE:** We believe that this is an intermittent VirtualBox bug that resurfaces across many versions VirtualBox #4038[20] and previously VirtualBox #3655[21]

[20] https://www.virtualbox.org/ticket/4038
[21] https://www.virtualbox.org/ticket/3655

- **DIAGNOSIS:** Check whether the guest VM has been allocated the reserved host-only NAT IP address. If 10.0.2.15 does not appear in the output from **ifconfig** then this issue has occurred. The easiest way to verify this is to log into the guest VM console and check the output from executing the following command:

```
$ ifconfig
```

- **SOLUTION:** An easy, but unreliable, fix is to reboot the guest VM. The preferred fix is to log into the guest VM console and execute the following commands, which will cause the guest OS to release its IP lease before requesting a new lease:

```
$ dhclient -r
$ dhclient -eth0
```

Port conflict when OMERO.server already running in Host OS

If you are already running an instance of the OMERO.server in your host OS then there will be a conflict due to the ports assigned to VirtualBox port-forwarding already being in use.

- **SOLUTION 1:** Turn off the OMERO.server in the host environment by issuing the following command:

```
$ omero admin stop
```

- **SOLUTION 2:** Alter the port-forwarding settings for your OMERO.VM as described in the *Port-forwarding settings* section. For example, increment the host port settings for omero-ssl, omero-unsec, and omero-web.

Note: We are assuming that your host OS is not already running services on those ports. You can check whether something is already listening on any of these ports by running the following commands (Mac OS X) which should return the prompt without any further output if there is nothing listening:

```
$ lsof -nP | grep -E '(:4063)|(:4064)'
```

Slow import speed due to low memory allocation

By default, the base memory of the VM is set to 1024 MB to allow it to run on any machine. However, this is likely to result in very poor import performance such that increasing the memory allocation to 2048 MB should result in import speeds being improved by a factor of 3-4 times.

To increase the base memory allocation, right-click on the OMERO virtual appliance in Virtual Box and select *Settings*:

Then go to the *System* tab:

Increase the Base Memory by typing into the text box:

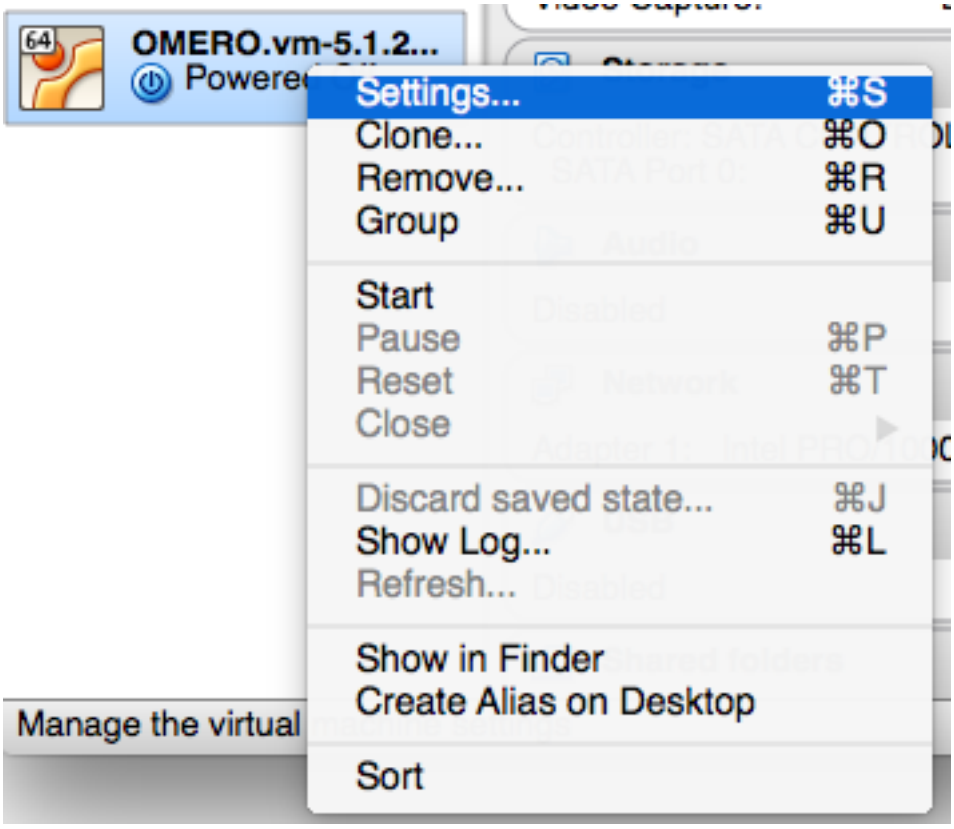
If your VM is already running, you will need to restart it for this change to take effect.

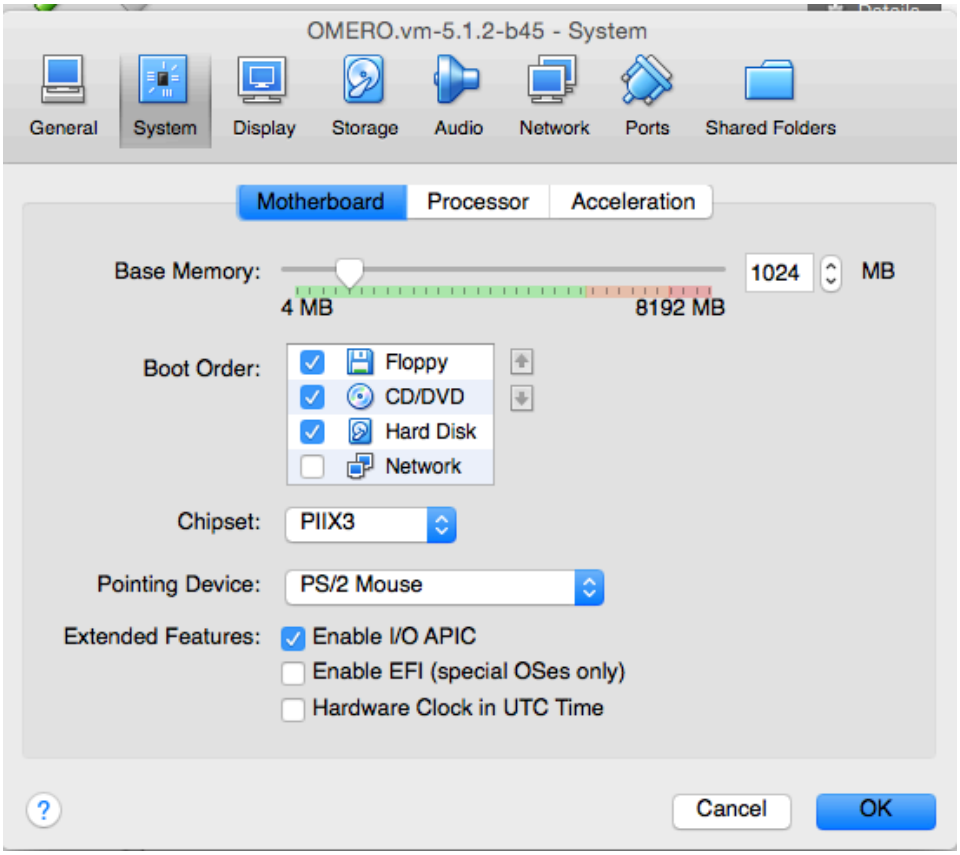
Alternatively, you can use the command line:

```
VBoxManage modifyvm OMERO.vm-5.2.4-bxx --memory 2048
```

VM will not boot because the HDD (Hard Disk Drive) is full

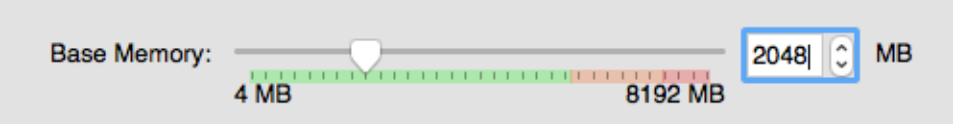
If you fill the virtual HDD used by your VM then the OS may be unable to boot and you will lose access to your OMERO.server install. You may also get a "error 28: no space left on device" message. To log into your VM you will need to use the recovery mode. Start the VM and at the Grub screen, use the down arrow followed by return to select the recovery mode entry, e.g.






```
Debian GNU/Linux, with Linux 2.6.32-5-686 (recovery mode)
```

as illustrated in this example of the Grub screen:




```
                GNU GRUB  version 1.98+20100804-14
 ------------------------------------------------------------------------
|Debian GNU/Linux, with Linux 2.6.32-5-686                               |
|Debian GNU/Linux, with Linux 2.6.32-5-686 (recovery mode)               |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
 ------------------------------------------------------------------------
```

Do not worry if your VM has a kernel number different to 2.6.32-5-686, the important thing is that you select the entry labeled "recovery mode". At this point, the VM should rapidly boot into the recovery mode and enable you to log in as the *omero* user. Administrative commands may be run as root by using **sudo**.

Once you have logged in, you have a number of options but the recommended courses of action are:

1. Delete unnecessary files using standard Linux command line tools like *rm* to make space for the VM to boot normally, then use your favored OMERO client to login and delete more files. A useful place to start might be by deleting the logs stored in /var/logs.
2. Increase the size of your virtual HDD. If you have filled your existing HDD then it is likely that the volume of data you are storing is too big for the default HDD. You should use the instructions in the *Increasing HD size* section following to ensure that the size of virtual HDD you have available is suitable for the volumes of data that you are collecting.

Increasing HD size

Image data can become very large and easily fill available hard-drive space. By default, the OMERO virtual appliance is supplied with a 30GB virtual hard-drive. Before using the appliance, consider the volume of data you will be working with whilst evaluating OMERO and whether you need to increase the size of the virtual hard-drive to accommodate it.

The following is a step-by-step guide; be aware that this is not a risk-free procedure and you should backup your VM before proceeding.

Preliminary steps

Acquiring a Ubuntu Linux ISO Download an Ubuntu Linux ISO[22]. The most up-to-date version is fine.

Backing up your VM Before you proceed further, you should create a clone of the omero-vm and subsequently work on the copy so that if something gets broken you can always start again. The easiest way to do this is from the command line.

Note: If you are on Windows then you should navigate to `C:\Program Files\Oracle\VirtualBox\` because the VBoxManage tools are not added to your path by default.

Start a shell and, assuming that your VM has the default name of omero-vm, use the following command:

[22] http://www.ubuntu.com/download/desktop

```
$ VBoxManage clonevm omero-vm --mode machine --options keepallmacs --name omero-vm-2 --register
```

This will create a copy of your VM called omero-vm-2 which you can make alterations to. This means that you can always return to the original omero-vm if you break anything. From now on **only** make changes to omero-vm-2.

Extending the HDD

By default, your virtual hard-drive attached to omero-vm-2 is of a type which cannot be extended; so you need to change this by cloning your HDD from the VDMK type to VDI type:

```
$ VBoxManage clonehd omero-vm-2-disk1.vmdk omero-vm-2-disk1.vdi --format VDI
```

You now need to increase the size of your virtual HDD. The following command resizes the HDD to 60GB but you should select a size to suit the amount of data you plan to store in OMERO:

```
$ VBoxManage modifyhd omero-vm-2-disk1.vdi --resize 60000
```

Adding the extended HDD to the VM clone You now need to tell VirtualBox to use `omero-vm-2-disk1.vdi` instead of `omero-vm-2-disk1.vmdk` which is currently attached to the VM. Whilst you are on the *Storage* tab you will also attach the Ubuntu ISO that you downloaded earlier to your VM. This will allow you to use the tools that ship with Ubuntu to make changes to the filesystem within your VM.

1. Start VirtualBox and select omero-vm-2 in the VM library.
2. Right-click *Settings* then select the *Storage* tab.
3. Right-click on *omero-vm-2-disk1.vmdk* and select *Remove attachment*.
4. Next to the *SATA Controller* entry, click the *Add Hard Disk* icon with a green plus sign. In the pop-up dialog, select *Choose existing disk*. Now navigate to the location where VirtualBox stores your virtual machines and enter the `omero-vm-2` directory. Select the `omero-vm-2 disk1.vdi` and click *open*.
5. Add an *IDE Controller* using the *Add Controller* icon. Select this new controller then click *Add CD/DVD device* followed by *Choose Disk*. Navigate to the location of your Ubuntu ISO, select it and click *OK*.

The storage for your OMERO VM should now look similar to *Virtual Appliance storage settings*.

Click *OK* to return to the VirtualBox VM library. With omero-vm-2 selected, ensure that the storage details match what you expect, e.g. omero-vm-2-disk1.vdi is connected to your SATA Port 0. The size for this disk should also more or less match what you specified earlier with the *VBoxManage modifyhd* command. The reported numbers do not exactly matchup, e.g. a virtualised HDD of 60GB size will be reported as 58.59GB.

Reallocating space on the VA HDD Start the omero-vm-2 VM. Ubuntu linux should boot and you should eventually see a welcome screen giving you the option to try Ubuntu or to install it. You can now start the GParted software and resize your partitions.

1. Select try Ubuntu and you should be presented with a graphical desktop.
2. Start the *gparted* tool using the menu option under *System* → *Administration* → *GParted Partition Editor*.
3. The GParted GUI will display information similar to *Virtual Appliance HDD in GParted*.
4. Right-click the entry for */dev/sda5* and select *Swapoff*.
5. Right click on */dev/sda5* and click *Delete* to remove the swap partition.
6. Delete */dev/sda2* in the same way. This should leave two entries, one for */dev/sda1* and one for unallocated space.
7. Right-click */dev/sda1* and select *Resize*. Now drag the right arrow to the right until the entry for *Free space following (MiB)* is about 2000, then click *Resize/Move*.

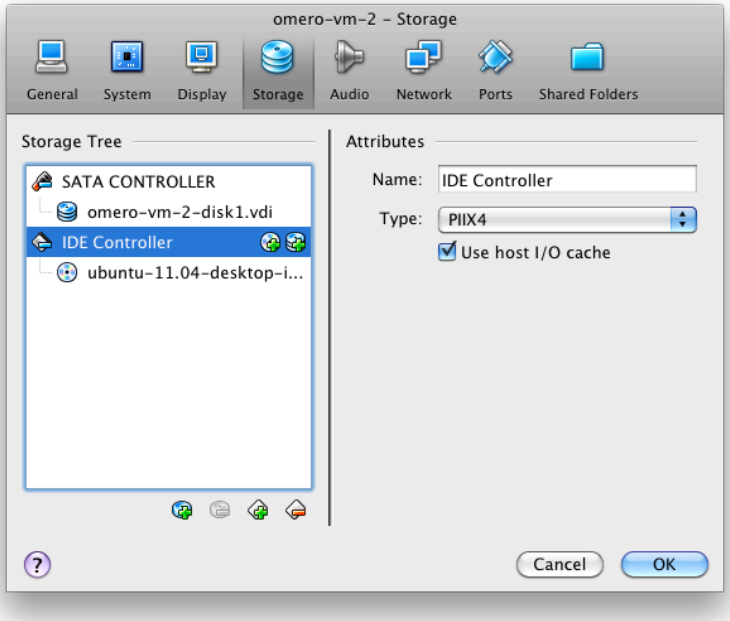


Figure 4.9: Virtual Appliance storage settings

8. Right click the entry for unallocated space and select *New* from the pop-up menu. Select *linux-swap* from the *File system* drop-down menu then *Add*.

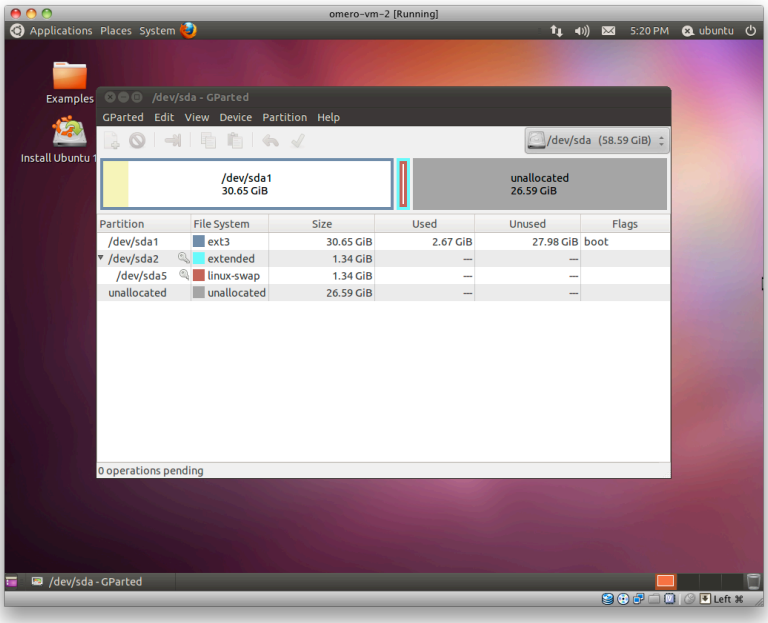


Figure 4.10: Virtual Appliance HDD in GParted

Up until this point you have not actually applied any of your changes to the HDD, you have only specified a list of changes that should be made. You can now go ahead and apply them by selecting the *Edit* → *Apply All Operations* menu item, then clicking *Apply* in the confirmation dialog box.

When the operations have completed, dismiss the dialog with the *Close* button, close GParted, then shutdown the VM.

Changing HDD settings inside the VA You no longer need the Ubuntu ISO so you can detach it from your VM. Ensure that omero-vm-2 is selected then click *Settings* and select the *Storage* tab. Right-click the *IDE Controller* entry and select *Remove Controller*, then click *OK* to return the VirtualBox VM library.

Start the omero-vm-2 VM and allow it to boot. As root then issue the `df -h` command. Verify that the size of the */dev/sda1* is approximately what you expect, e.g. if you allocated a 60GB virtual HDD then after size conversions and swap allocation you should end up with */dev/sda1* reported as being around 56GB.

Within the VM you need to add the UUID of the new swap partition to the `/etc/fstab` file because you deleted the old one and created a new swap meaning that the IDs will no longer match.

```
$ vim /etc/fstab
```

Move your cursor to the entry that looks similar to the following:

```
UUID=SOME-LONG-ALPHA-NUMERIC-STRING none swap sw 0 0
```

then press `i` to enter "insert mode". Delete the alphanumeric string so that the entry looks similar to the following:

```
UUID= none swap sw 0 0
```

and place your cursor after the equals sign. You can now issue a command from within the VIM editor to insert your new swap UUID into the `fstab` file.

```
[Insert Mode] <CTRL-R> =system('/sbin/blkid -t TYPE=swap | cut -c18-53') <return>
```

Save your file and quit VIM:

```
[Command Mode] :wq <return>
```

Now reboot your VM with

```
$ shutdown -r now
```

Once your VM has rebooted you should now have a working VM with a larger virtual HDD.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Part II

System Administrator Documentation

CHAPTER

FIVE

SERVER BACKGROUND

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

5.1 What's new for OMERO 5.2 for sysadmins

- OMERO clients are no longer distributed as Java Web Start applications. This decision is discussed at length in our Java Web Start blog post[1]. We recognize that this will be problematic for some institutional users and are working to expand the functionality of OMERO.web to mitigate this as far as possible.
- The *Version requirements* section provides extensive details about which operating systems and dependency versions we intend to support for the life of 5.2 and the likely changes to these for the next major release (currently planned to be 5.3). Most notably, we have dropped support for Java 1.6 and changed the Python dependencies.
- The OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[2] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.
- FastCGI support was removed in OMERO 5.2 and OMERO.web can be deployed using WSGI *Deployment (Unix/Linux)*.
- The configuration property `omero.graphs.wrap` which allowed switching back to the old server code for moving and deleting data has now been removed. You must migrate to using the new request operations.
- Add support for Ice 3.6. With Ice 3.6, the Python bindings are provided separately. This allows to install the RPM packages provided by ZeroC. Then run `pip install zeroc-ice` to install the Ice Python bindings if your package manager does not provide the Ice python packages.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

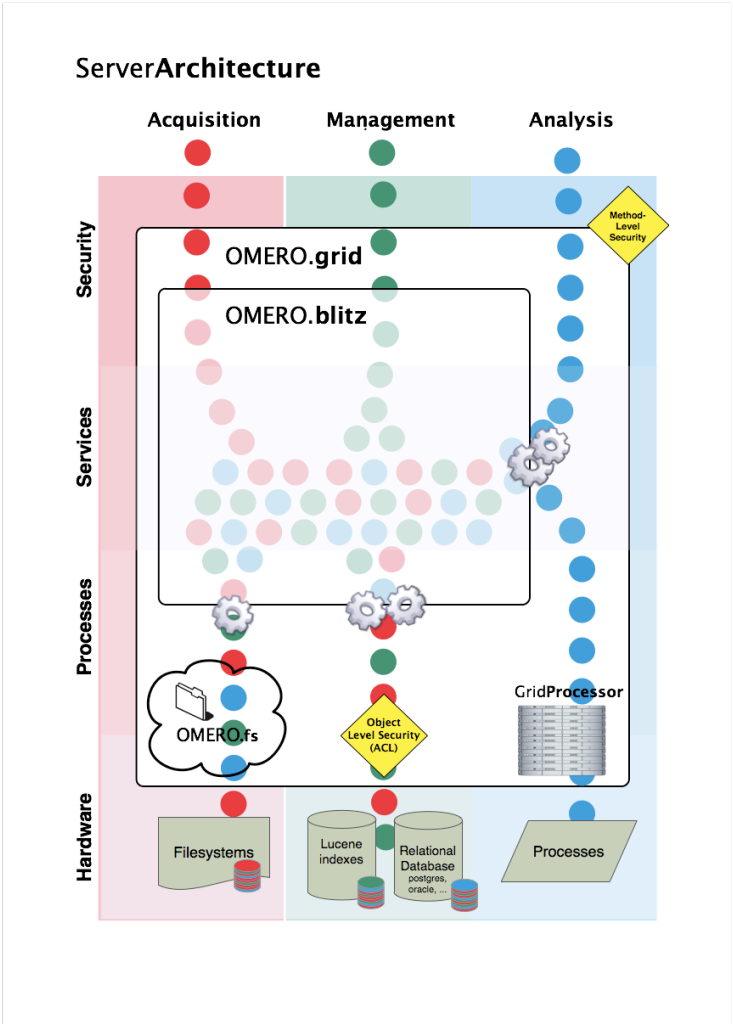
5.2 Server overview

The OMERO server system provides storage and processing of image data which conforms to the OME Specification[3]. It can be run on commodity hardware to provide your own storage needs, or run site-wide to provide a large-scale collaborative environment.

Although getting started with the server is relatively straightforward, it does require installing several software systems, and more advanced usage including backups and integrated logins, needs a knowledgeable system administrator.

You may find the *OMERO clients overview* user guide useful before working through the installation and maintenance guides provided in this section of the documentation.

[1] http://blog.openmicroscopy.org/tech-issues/future-plans/2015/09/23/java-web-start/
[2] https://docs.djangoproject.com/en/1.8/releases/1.8/
[3] http://www.openmicroscopy.org/site/support/ome-model/specifications/



5.2.1 Developing the server

The server system is composed of several components, each of which runs in a separate process but is co-ordinated centrally.

- *OMERO.blitz* - the data server provides access to metadata stored in a relational database as well as the binary image data on disk.
- *OMERO.dropbox* - a filesystem watcher which notifies the server of newly uploaded or modified files and runs a fully automatic import (designed as the first implementation of *OMERO.fs* referred to in the architecture diagram).

If you are interested in building components for the server, modifying an existing component, or just looking for more background information, there is a section about the server within the *Developer Documentation*; the best starting point is the *OMERO.server overview* for developers.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

5.3 System requirements

5.3.1 Hardware

OMERO.server

The system requirements for OMERO.server vary greatly depending on image size and number of users. At a minimum we suggest:

- Single core 1.33GHz Intel or AMD CPU
- 2GB RAM
- 500MB of hard drive space for OMERO.server distribution

The recommended OMERO.server specification we suggest for between 25-50 users is:

- Quad core 1.33GHz Intel or AMD CPU
- 8GB RAM
- 500MB hard drive space for OMERO.server distribution
- Hard drive space proportional to the image sizes expected (likely between 10 and 100TB)

Hard drive space should be proportional to the image sizes expected. The drive space should permit **proper locking**, which is often not the case with remotely mounted shares. See the *Unix* and *Windows* binary repository sections for more information.

RAM is not going to scale linearly, particularly with the way the JVM works. You are probably going to hit a hard ceiling between 4 and 6GB for JVM size (there is really not much point in having it larger anyway). With a large database and aggressive PostgreSQL caching your RAM usage could be larger. Still, even for a large deployment, it is not cost effective to use more than a few GBs of RAM for this purpose. *Performance and monitoring* provides information about fine-tuning the server processes' memory usage. In summary, depending on hardware layout 16, 24 or 32GB of RAM would be ideal for your OMERO server. If you have a separate database server more than 16GB of RAM may not be of much benefit to you at all.

CPU is not something that an OMERO system is usually ever limited by. However, when it is limited, it is almost always limited by GHz and not by the CPU count. So you are not going to get a huge OMERO performance increase by, for example, throwing 24 cores at the problem. In summary, depending on hardware layout 2 × 4, 2 × 6 system core count should be more than enough.

Example production server set-ups provides details on some production set-ups currently in use by OMERO admins, along with how many users and the amount of data they support, which you may find helpful.

OMERO.insight and OMERO.importer

The recommended client specification is:

- Single core 1.33GHz Intel or AMD CPU
- 2GB RAM
- 200MB hard drive space for OMERO.clients distribution

Large imports may require 4GB RAM.

Client configuration

When performing some operations the clients make use of temporary file storage and log directories. The table below indicates the default values for each directory and the environment variables for overriding their locations:

Client directory	Environment variable	Default location (UNIX)	Default location (Windows)
OMERO user directory	`OMERO_USERDIR`	`$HOME/omero`	`%HOMEPATH%\omero`
Temporary files	`OMERO_TMPDIR`	`$HOME/omero/tmp`	`%HOMEPATH%\omero\tmp`
Local sessions	`OMERO_SESSIONDIR`	`$HOME/omero/sessions`	`%HOMEPATH%\omero\sessions`
Log files		`$HOME/omero/log`	`%HOMEPATH%\omero\log`

Note that setting `OMERO_USERDIR` will also change the default location for the temporary files and the local sessions.

If your home directory is stored on a network, possibly NFS mounted (or similar), then these temporary files are being written and read over the network. This can slow access down.

See also:

Troubleshooting performance issues with the clients Troubleshooting section about client performance issues on NFS

5.3.2 Software

Each component of the OMERO platform has a separate set of prerequisites. Where possible, we provide tips on getting started with each of these technologies, but we can only provide free support within limits.

Package	OMERO.server	Java	Python	Ice	PostgreSQL
OMERO.importer	Required	Required			
OMERO.insight	Required	Required			
OMERO.server		Required	Required	Required	Required
OMERO.web	Required		Required	Required	
OMERO.py	Required for some functionality		Required	Required	
OMERO.cpp	Required for some functionality			Required	

For full details on which versions of these are supported for OMERO 5.2 and how we intend to update these going forward, see the *Version requirements* section.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

5.4 Version requirements

5.4.1 Summary of changes for OMERO 5.2 and planned changes for 5.3

Criteria for what is considered to be supportable includes whether support by both upstream developers and operating system distributions will be available for the lifetime of the 5.2 release (including security support), and also upon our resources allocated to CI and testing. If we are not actively testing it, we cannot claim it is supported or functional. Software components must be provided and supported either by an operating system distribution or their original developers.

This section contains a summary of the changes made to the minimum version requirements for the 5.2 release and also planned changes for the following 5.3 release, albeit tentatively at this point. The intent is to provide a roadmap in order that sysadmins may plan ahead and ensure that prerequisites are in place ahead of time to ease future upgrades. The following sections provide more detailed information and the rationale for the changes.

Operating systems

- Microsoft Windows
  - [5.2] 7 / Server 2008R2 supported, 8 (client) recommended / Server 2012R2 (server) recommended
  - [5.3] Unsupported for OMERO.server or hosting OMERO.web, client support only
  - Rationale: see blog post explanation[4]
- MacOS X
  - [5.2] 10.8 dropped. 10.9 deprecated, 10.10 recommended, 10.11 upcoming
  - [5.3] 10.8 dropped, 10.9 deprecated, 10.10 supported , 10.11 recommended
  - Test server only on 10.10+ for 5.2.
  - Rationale: 10.8 no longer has security support and it still leaves 3 versions to support. MacOS X is typically suited only to client use, not serious server deployment, so limit testing accordingly.
- Linux (CentOS/RHEL)
  - [5.2] 7.x recommended, 6.x supported
  - [5.3] 7.x recommended, 6.x deprecated
  - Rationale: There is still a significant CentOS 6 userbase, so retain support for 5.2 and potentially continue to support for 5.3 depending upon demand and usage.
- Linux (Ubuntu LTS)

[4] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

  - [5.2] 12.04 dropped, 14.04 recommended
  - [5.3] 12.04 dropped, 14.04 recommended
  - Only LTS versions are supported and tested. Non-LTS versions following a supported LTS release are likely to work but are not officially supported or tested.
  - Rationale: No change in this timeframe.
- Linux (Debian)
  - [5.2] 7 deprecated, 8 recommended
  - [5.3] 7 deprecated, 8 recommended
  - Rationale: No change in this timeframe.

Bitness

Currently 32- and 64-bit systems are supported for client and server on all platforms with the exception of MacOS X (64-bit only).

- [5.2] Dropped 32-bit support for Ice and native code [server]
- [5.3] Deprecate 32-bit support for Ice and native code [client]
- Rationale: It is not practical to run a server on a 32-bit system due to its memory requirements, so it is safe to drop 32-bit support for OMERO.server in 5.2 given that it is de-facto 64-bit-only today. There are still a significant number of 32-bit Windows clients (~60%), so support should be retained until this changes. Maintaining custom builds of Ice for 32-bit systems is extremely costly, and so we could consider dropping them for 5.3. This also depends upon Ice support for 32-bit systems.

Components

- PostgreSQL
  - [5.2] 9.2 dropped, 9.3 deprecated, 9.4+ recommended
  - [5.3] 9.2 dropped, 9.3 deprecated, 9.4+ recommended
  - Rationale: Current releases available for all supported systems from upstream and for CentOS/RHEL 6.x officially via SCL (software collections).
- Python
  - [5.2] 2.6 deprecated and not recommended, 2.7 recommended, 3.x not supported
  - [5.3] 2.6 dropped, 2.7 recommended, 3.x not supported
  - Rationale: 2.7 is provided by all systems except for CentOS/RHEL 6.x, however it is available officially via SCL. Note that 3.3 is also available via SCL, so there is potential for a 3.x migration in the 5.3 timeframe. Dropping 2.6 for 5.3 unifies python support with a single major version, and removes a number of portability issues, but most importantly is a requirement of Django 1.8[5]. Python 2.6 will continue to work for 5.2 with Django 1.6, but this is not recommended due to security vulnerabilities.
- GCC
  - [5.2] 4.4 dropped, 4.6+ deprecated, 4.8+ recommended, 5 supported
  - [5.3] 4.6+ dropped, 4.8 and 4.9 supported, 5 recommended
  - Rationale: 4.4 is the CentOS/RHEL 6.x default, 4.8 the 7.x default. The SCL DeveloperToolset3 brings CentOS 6 up to GCC 4.9.1, which makes the new baseline GCC 4.6 (Ubuntu 12.04 and Travis). This will allow use of a limited subset of C++11 features across all platforms in 5.2+. The downside is that while programs and libraries built with the SCL DeveloperToolset3 will generally be link-compatible with the system libraries, use of these libraries with end user code will require the DeveloperToolset3 toolchain and libraries.

The planned changes for 5.2 depend upon our support of CentOS/RHEL 6.x and Ubuntu 12.04.

- LLVM/clang

[5] https://docs.djangoproject.com/en/1.8/releases/1.8/

  - [5.2] 3.4 and 3.5 supported, 3.6 recommended and 3.7 supported
  - [5.3] 3.4 deprecated, 3.5 and 3.6 supported, 3.7 recommended
  - Rationale: It is the current toolchain on MacOS/FreeBSD and is working well; 3.3 dropped due to no longer being used by current toolchains
- Microsoft Visual Studio
  - [5.2] 2010 dropped, 2012 deprecated, 2013 recommended,
  - [5.3] 2012 deprecated, 2013 recommended, 2015 supported 2015 supported
  - Rationale: The minimum (and maximum) MSVC version is determined by the Windows Ice builds provided by ZeroC, and as such is limited by our Ice version requirements. Raising the limit in 5.2 will permit use of newer language features.
- Ice
  - [5.2] 3.4 dropped, 3.5 recommended, 3.6 supported
  - [5.3] 3.4 dropped, 3.5 deprecated, 3.6 recommended
  - Rationale: 3.4 is no longer supported by ZeroC with 3.5 being current. By the release of 5.3, Ice 3.6 will have been out for some time and should be well tested.
- Java
  - [5.2] 6 dropped, 7 deprecated, 8 recommended
  - [5.3] 7 deprecated, 8 recommended
  - Rationale: It will be 2 years this February since the last Java 6 security update. Java 7 is supported on all supported operating systems above, and in most cases is the default Java version on those systems (it is now 8 on some). This was mentioned recently, and also by the Fiji developers; 5.1 would be an opportune time to deprecate or preferably drop Java 6. Also note that we no longer actively test with a Java 6 JVM; all internal testing is on Java 7 or 8 (Oracle and OpenJDK), and there are some client issues with OpenJDK6. Also note that Ice 3.6 drops Java 6 support. For 5.2 deprecate 7; this is because security support ends in April 2015.
  - The requirement for 7 in the Windows clients is less urgent, but will encourage migration to a non-deprecated Java version ahead of the removal of support for 6.
- Apache
  - [5.2] 2.2 deprecated, 2.4 recommended
  - [5.3] 2.4 recommended
  - Rationale: 2.2 is the CentOS/RHEL 6.x and Ubuntu 12.04 version, both of which will be dropped in 5.3 if CentOS 6 is dropped, otherwise they will remain deprecated.
- mod_wsgi
  - 3.5+ recommended
  - Rationale: Choice of mod_wsgi version support is made by the OS vendors, who may choose to continue with an older version with security patches applied. For more information refer to mod_wsgi installation[6].
- nginx
  - [5.2] 1.4 deprecated, 1.6 supported, 1.8 recommended, 1.10 upcoming
  - [5.3] 1.4 dropped, 1.6 supported, 1.8 supported, 1.10 recommended

5.4.2 Support levels

The following sections use the terminology in the table below to describe the support status of a given component, as it progresses from being new and not supported, to supported and tested on a routine basis, and to finally being old and no longer supported nor tested.

[6] https://modwsgi.readthedocs.org/en/develop/installation.html

Level	Meaning	Description
Upcoming	unsupported/new	New version not yet regularly tested and not officially supported; may or may not work (use at own risk)
Supported	supported/suboptimal	Version which is tested, confirmed to work correctly, but may not offer optimal performance/experience
Recommended	supported/optimal	Version which is regularly tested, confirmed to work correctly, recommended for optimal performance/experience
Deprecated	supported/deprecated	Version which is less tested, expected to work correctly, but may not offer optimal performance/experience; official support will be dropped in the next major OMERO release
Dropped	unsupported/old	Old version no longer tested and no longer officially supported; may or may not work (use at own risk)
Broken	unsupported/broken	Known to not work
Unsupported	unsupported/misc	Not supported for some reason other than the above

5.4.3 Operating system support

The following subsections detail the versions of each operating system which are supported by both its upstream developers (for security and general updates) and by OME for OMERO building and server and client deployment.

Microsoft Windows

General overview[7] (under 'W' in the index)

Version	Release date	Upstream (mainline)	support (extended)	OMERO 5.1	OMERO 5.2	OMERO 5.3	Details
Vista	from Jan 2007	to Apr 2012	to Apr 2017	Dropped	Dropped	Dropped	Ref[8]
Win 7	from Oct 2009	to Jan 2015	to Jan 2020	Recommended	Supported	Unsupported†	Ref[9]
Server 2008 R2	from May 2008	to Jan 2018	to Jan 2023	Recommended	Supported	Unsupported	Ref[10]
Win 8	from Oct 2012	to Jan 2018	to Jan 2023	Supported	Recommended	Unsupported†	Ref[11]
Server 2012	from Oct 2012	to Jan 2018	to Jan 2023	Supported	Recommended	Unsupported	Ref[12]
Win 10	from July 2015	to Oct 2020	to Oct 2025	Unsupported	Unsupported	Unsupported†	Ref[13]

† Unsupported for OMERO.server and OMERO.web deployment. Client support will continue or is upcoming (Windows 10)

Insufficient resources are available for regular CI deployment and testing of OMERO.server so a decision has been made to drop support in favor of other priorities. See this blog post for full details[14].

UNIX (MacOS X)

General overview[15]

Version	Release date	Upstream support	Homebrew support	OMERO 5.1	OMERO 5.2	OMERO 5.3
10.8	from Feb 2012	Ended	Ended	Deprecated	Dropped	Dropped
10.9	from Jun 2013	Supported	Supported	Recommended	Supported	Deprecated
10.10	from Oct 2014	Supported	Supported	Supported	Recommended	Supported
10.11	from Sep 2015	Supported	Supported	Supported	Upcoming	Recommended

Apple do not formally announce end of life for their releases, but with the three latest releases being supported this puts 10.9 as the minimum version suitable for use. We have regular CI testing of 10.9, 10.10 and 10.11 builds plus developer testing of building and client and server deployment. 10.8 is marked as dropped since it is no longer tested by the CI infrastructure (node retired).

[7] http://support.microsoft.com/gp/lifeselectindex
[8] http://support.microsoft.com/lifecycle/?p1=11737
[9] http://support.microsoft.com/lifecycle/?p1=14481
[10] http://support.microsoft.com/lifecycle/?p1=17383
[11] http://support.microsoft.com/lifecycle/?p1=16799
[12] http://support.microsoft.com/lifecycle/?p1=16526
[13] https://support.microsoft.com/en-gb/lifecycle?C2=18165
[14] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/
[15] http://en.wikipedia.org/wiki/OS_X

UNIX (FreeBSD)

It only really makes sense to support the base toolchain for major releases and the Ports tree (which is continually updated); these will be covered in the dependencies, below.

Linux (CentOS and RHEL)

General overview for RHEL[16] and CentOS[17]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3	Details
5	from Mar 2007	to Mar 2017	Dropped	Dropped	Dropped	Ref[18]
6	from Nov 2010	to Nov 2020	Recommended	Supported	Deprecated	Ref[19]
7	from June 2014	to June 2024	Supported	Recommended	Recommended	Ref[20]

Only RHEL and CentOS 6 are supported at present. Given the long life of enterprise releases, we intend to support only the latest release at any given time or else it ties us into very old dependencies; 6.x is already quite long in the tooth, however is in wide use and so will require supporting for 5.1 at a minimum. 7.x can be the recommended version once it is properly tested by us and has appropriate CI support. There is currently extensive CI support for building and deployment with CentOS 6 but it is not used directly by developers in general.

Linux (Fedora)

General overview[21]

Due to the fast pace of Fedora development, it only really makes sense to support the current and perhaps the previous release; these will be covered in the dependencies, below.

Linux (Ubuntu)

General overview[22]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
12.04 (.4) LTS	from Apr 2012	to Apr 2017	Deprecated	Dropped	Dropped
14.04 LTS	from Apr 2014	to Apr 2019	Recommended	Recommended	Recommended
14.10	from Oct 2014	to Jul 2015	Dropped	Dropped	Dropped
15.04	TBA	TBA	Supported	Supported	Dropped
15.10	TBA	TBA	Unsupported	Unsupported	Upcoming

Only the LTS releases are supported due to resource limitations upon CI and testing. Only the last two LTS releases are supported (being a bit more frequent than CentOS/RHEL). There is currently no CI testing for any version, but some developer use of 12.04 LTS, 14.04 LTS and more recent non-LTS releases.

Linux (Debian stable)

General overview[23]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3	Details
6.0	from Feb 2011	to Feb 2016	Dropped	Dropped	Dropped	Reference[24]
7.0	from May 2013	TBA	Recommended	Deprecated	Deprecated	Reference[25]
8.0	TBA	TBA	Unsupported	Supported	Supported	Reference[26]

Stable releases 7.x and 6.x are supported. There is no CI testing for any version, and some developer use of 7.x.

[16] https://access.redhat.com/site/articles/3078
[17] http://wiki.centos.org/FAQ/General#head-fe8a0be91ee3e7dea812e8694491e1dde5b75e6d
[18] http://wiki.centos.org/FAQ/General#head-fe8a0be91ee3e7dea812e8694491e1dde5b75e6d
[19] http://wiki.centos.org/FAQ/General#head-fe8a0be91ee3e7dea812e8694491e1dde5b75e6d
[20] http://wiki.centos.org/FAQ/General#head-fe8a0be91ee3e7dea812e8694491e1dde5b75e6d
[21] https://fedoraproject.org/wiki/Fedora_Release_Life_Cycle
[22] https://wiki.ubuntu.com/Releases
[23] https://www.debian.org/releases/
[24] https://www.debian.org/releases/squeeze/
[25] https://www.debian.org/releases/wheezy/
[26] https://www.debian.org/releases/jessie/

Linux (Debian testing and unstable)

Due to the fast pace of Debian developement, it only really makes sense to support the last one or two stable releases; the testing and unstable requirements will be covered in the dependencies, below.

5.4.4 Hardware support

Microsoft Windows

Supports amd64 (64-bit) and i386 / x86 (32-bit) for all supported versions; most systems are today running x64 with most hardware being x64, but there is still a niche of x86 users, estimated <25% and falling globally. On Windows, crude estimates are that OMERO.server is 66% amd64, OMERO.insight is 40% amd64, Bio-Formats is 70% amd64. However, note that OMERO.server deployment on Windows is rare, and the i386 systems are not likely to be production servers.

Unix (MacOS X)

Currently all supported versions are amd64 (64-bit) only.

Unix (FreeBSD)

Supports amd64 (64-bit) and i386 / x86 (32-bit) for all supported releases. Other platforms are supported, but may require manual building of prerequisites.

Linux (RHEL and CentOS)

Version 6 supports amd64 (64-bit) and i386 / x86 (32-bit). Version 7 supports amd64 (64-bit) only. Crude estimates (Linux+MacOS) are that OMERO.server is 98% amd64, OMERO.insight is 98% amd64, Bio-Formats is 78% amd64.

Linux (other)

Most distributions support i386 / x86 (32-bit) as well, while some support additional architectures such as 32-bit and/or 64-bit arm and powerpc.

Additional notes

The OMERO server is 64-bit-only due to the large memory requirements. On the client side, there is a requirement for 32-bit support for Windows clients and to a lesser extent on Linux, and zero on MacOS X at present. Dropping 32-bit support for OMERO.server and C++ Ice and other builds should be considered, given the vast reduction in the support burden and steadily dropping need for these builds.

5.4.5 Dependencies

The following subsections detail the versions of each dependency needed by OMERO which are supported by both its upstream developers (for security and general updates) and by OME for OMERO building and server and client deployment.

Note: Versions in brackets are in development distributions and may change without notice.

Package lists

Operating system	Details
CentOS 6 / RHEL 6	Reference[27]
CentOS 7 / RHEL 7	Reference[28]
Fedora (general)	Reference[29]
Fedora 19	Reference[30]
Fedora 20	Reference[31]
Fedora 21	Reference[32]
Ubuntu	Reference[33]
Debian	Reference[34]
Homebrew	Reference[35]
FreeBSD Ports	Reference[36]

PostgreSQL

General overview[37]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
9.2	from Sep 2012	to Sep 2017	Deprecated	Dropped	Dropped
9.3	from Sep 2013	to Sep 2018	Recommended	Deprecated	Deprecated
9.4	from Dec 2014	to Dec 2019	Supported	Recommended	Recommended
9.5	TBA	TBA	Unsupported	Unsupported	Upcoming
Details		Reference[38]			

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
9.2	7.x	19	N/A	N/A	Yes	Yes
9.3	N/A	20, 21	14.04	N/A	N/A	Yes
9.4	N/A	N/A	14.10	(8.0)	N/A	Yes
9.5	N/A	N/A	N/A	N/A	N/A	N/A
Details		Ref[39]	Ref[40]	Ref[41]		

The PostgreSQL project provides packages[42] for supported platforms. Therefore distribution support is not critical since 9.3 and 9.4 are available for all platforms.

[27] http://mirror.centos.org/centos/6/os/x86_64/Packages/
[28] http://mirror.centos.org/centos/7/os/x86_64/Packages/
[29] https://fedoraproject.org/wiki/Releases
[30] https://admin.fedoraproject.org/pkgdb/packages/*/?branches=f19&status=&owner=
[31] https://admin.fedoraproject.org/pkgdb/packages/*/?branches=f20&status=&owner=
[32] https://admin.fedoraproject.org/pkgdb/packages/*/?branches=f21&status=&owner=
[33] http://packages.ubuntu.com/search?keywords=foo&searchon=names&suite=all&section=all
[34] https://packages.debian.org/search?keywords=foo&searchon=names&suite=all&section=all
[35] https://github.com/Homebrew/homebrew/tree/master/Library/Formula
[36] http://svnweb.freebsd.org/ports/head/
[37] http://www.postgresql.org/support/versioning/
[38] http://www.postgresql.org/support/versioning/
[39] https://apps.fedoraproject.org/packages/postgresql
[40] http://packages.ubuntu.com/search?keywords=postgresql&searchon=names&suite=all&section=all
[41] https://packages.debian.org/search?keywords=postgresql&searchon=sourcenames&suite=all&section=all
[42] http://www.postgresql.org/download/

Python

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3	Details
2.6	from Oct 2008	to Oct 2013	Deprecated	Deprecated	Dropped	Reference[43]
2.7	from Jul 2010	to 2020	Recommended	Recommended	Recommended	Reference[44]
3.2	from Feb 2011	to Feb 2016	Unsupported	Unsupported	Unsupported	Reference[45]
3.3	from Sep 2012	to Sep 2017	Unsupported	Unsupported	Unsupported	Reference[46]
3.4	from Mar 2014	TBA	Unsupported	Unsupported	Unsupported	Reference[47]
3.5	TBA	TBA	Unsupported	Unsupported	Unsupported	Reference[48]

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
2.6	6.x	N/A	10.04	6.0, 7.0	N/A	Yes
2.7	7.x	19, 20, 21	12.04, 13.04, 13.10, 14.04, 14.10, (15.04)	7.0, (8.0)	Yes	Yes
3.2	N/A	N/A	12.04	7.0	N/A	Yes
3.3	N/A	19, 20	13.04, 13.10	N/A	N/A	Yes
3.4	N/A	21	14.04, 14.10, (15.04)	(8.0)	Yes	Yes
3.5	N/A	N/A	N/A	N/A	N/A	N/A
Details		Python 2[49] Python 3[50]	Python 2[51] Python 3[52]	Python 2[53] Python 3[54]		

At the moment 2.7 support is present upstream for the foreseeable future; 3.x versions continue to be released and retired regularly in parallel. The limiting factor will be distribution support for 2.7 as major packages are slowly switching to 3.x, and this might cause problems if our python module dependencies are no longer available without major effort. Ice 3.5 in particular has dropped 2.7 support for Windows, and has a significant cost in providing custom rebuilds; this has been rectified in Ice 3.6 with the Python module being installable with `pip` using any Python version.

The supported version of the Django module used by OMERO.web (1.8) requires Python 2.7. The older version (1.6) will work with Python 2.6 but lacks security support, and is consequently not recommended for production use.

GCC

General overview[55]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
4.4	from Apr 2009	to Mar 2012	Deprecated	Dropped	Dropped
4.5	from Apr 2010	to Jul 2012	Deprecated	Dropped	Dropped
4.6	from Mar 2011	to Apr 2013	Supported	Deprecated	Dropped
4.7	from Mar 2012	to Apr 2013	Supported	Deprecated	Dropped
4.8	from Mar 2013	to May 2014	Recommended	Recommended	Deprecated
4.9	from Apr 2014	to Jun 2015	Recommended	Recommended	Supported
5	from Apr 2015	TBA	Unsupported	Supported	Recommended

[43] http://legacy.python.org/dev/peps/pep-0361/
[44] http://legacy.python.org/dev/peps/pep-0373/
[45] http://legacy.python.org/dev/peps/pep-0392/
[46] http://legacy.python.org/dev/peps/pep-0398/
[47] http://legacy.python.org/dev/peps/pep-0429/
[48] https://www.python.org/dev/peps/pep-0478
[49] https://apps.fedoraproject.org/packages/python
[50] https://apps.fedoraproject.org/packages/python3
[51] http://packages.ubuntu.com/search?keywords=python2&searchon=names&suite=all&section=all
[52] http://packages.ubuntu.com/search?keywords=python3&searchon=names&suite=all&section=all
[53] https://packages.debian.org/search?keywords=python2&searchon=sourcenames&suite=all&section=all
[54] https://packages.debian.org/search?keywords=python3&searchon=sourcenames&suite=all&section=all
[55] https://gcc.gnu.org/develop.html#timeline

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
4.4	6.x	N/A	10.04, 12.04, 13.04, 13.10, 14.04, 14.10	6.0, 7.0	Yes	N/A
4.5	N/A	N/A	12.04	N/A	Yes	N/A
4.6	N/A	N/A	12.04, 13.04, 13.10, 14.04, 14.10	7.0, (8.0)	Yes	N/A
4.7	N/A	N/A	13.04, 13.10, 14.04, 14.10	7.0, (8.0)	Yes	Yes
4.8	7.x	19, 20	13.10, 14.04, 14.10, (15.04)	(8.0)	Yes	Yes
4.9	N/A	21	14.04, 14.10, (15.04)	(8.0)	Yes	Yes
5.0	N/A	N/A	N/A	N/A	N/A	N/A
Details		Ref[56]	Ref[57]	Ref[58]		

GCC 4.2 support was dropped with the dropping of MacOS 10.6; the current baseline is GCC 4.4.

LLVM/clang

General overview[59]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
3.4	from Jan 2014 to May 2014	from Jan 2014 to May 2014	Recommended	Supported	Supported
3.5	from Sep 2014	to Sep 2014	Supported	Recommended	Supported
3.6	from Feb 2015	to Jul 2015	Unsupported	Supported	Recommended
3.7	from Sep 2015	TBA	Unsupported	Unsupported	Supported

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
3.4	N/A	20, 21	12.04, 13.10, 14.04, 14.10, (15.04)	(8.0)	Yes	Yes
3.5	N/A	(22)	14.10, (15.04)	(8.0)	Yes	Yes
3.6	N/A	N/A	N/A	(8.0)	N/A	N/A
3.7	N/A	N/A	N/A	N/A	N/A	N/A
Details		Ref[60]	Ref[61]	Ref[62]		

Note that clang++ 3.4 is used in FreeBSD 10.1 and MacOS 10.9 and 10.10. clang++ 3.6 is used in MacOS 10.10 and 10.11 (Xcode 7). Also note that the MacOS version deviates from the official releases and has some features disabled or crippled such as the address sanitizer and OpenMP.

Microsoft Visual Studio

General overview[63]

Version	Release date	Upstream (mainline)	support (extended)	OMERO 5.1	OMERO 5.2	OMERO 5.3
2010	from Jun 2010	to Jul 2015	to Jul 2020	Deprecated	Dropped	Dropped
2012	from Oct 2012	to Jan 2018	to Jan 2023	Supported	Deprecated	Deprecated
2013	from Jan 2014	to Apr 2019	to Apr 2024	Recommended	Recommended	Supported
2015	from Jun 2015	to Oct 2020	to Oct 2025	Unsupported	Unsupported	Supported

[56] https://apps.fedoraproject.org/packages/gcc
[57] http://packages.ubuntu.com/search?keywords=g%2B%2B&searchon=names&suite=all&section=all
[58] https://packages.debian.org/search?keywords=g%2B%2B&searchon=names&suite=all&section=all
[59] http://llvm.org/releases/
[60] https://apps.fedoraproject.org/packages/clang
[61] http://packages.ubuntu.com/search?keywords=clang&searchon=names&suite=all&section=all
[62] https://packages.debian.org/search?keywords=clang&searchon=names&suite=all&section=all
[63] http://support2.microsoft.com/lifecycle/search/?sort=PN&alpha=Visual+Studio

The version to use is largely dependent upon the Ice support for a particular Visual Studio version.

- Ice 3.6 supports 2015, 2013 and 2012
- Ice 3.5 supports 2013, 2012 and 2010
- Ice 3.4 supports 2010 and 2008

In general later versions have better C++ standards conformance and correctness, and should be preferred where possible.

Ice

General overview[64]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3	Details
3.3	from May 2008	to May 2009	Dropped	Dropped	Dropped	Ice 3.3[65] Ice 3.3.1[66]
3.4	from Mar 2010	to Jun 2011	Deprecated	Dropped	Dropped	Ice 3.4[67] Ice 3.4.2[68]
3.5	from Mar 2013	to Oct 2013	Recommended	Recommended	Deprecated	Ice 3.5[69] Ice 3.5.1[70]
3.6	from June 2015	to TBA	Unsupported	Supported	Recommended	Ice 3.6.0[71] Ice 3.6.1[72] Ice 3.6

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
3.3	N/A	N/A	10.04	6.0	N/A	N/A
3.4	N/A	N/A	12.04, 13.04, 13.10	7.0	N/A	N/A
3.5	N/A	19, 20, 21	14.04, 14.10, (15.04)	(8.0)	Yes	Yes
3.6	N/A	N/A	N/A	N/A	N/A	N/A

Java

General overview[74]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3	Details
6	from Dec 2006	to Feb 2013	Deprecated	Dropped	Dropped	Reference[75]
7	From Jul 2011	to Apr 2015	Supported	Deprecated	Deprecated	Reference[76]
8	From Mar 2014	to Mar 2017	Recommended	Recommended	Recommended	Reference[77]

[64] https://zeroc.com/download.html
[65] https://forums.zeroc.com/forum/announcements/3851-ice-3-3-released
[66] https://forums.zeroc.com/forum/announcements/4362-ice-3-3-1-released
[67] https://forums.zeroc.com/forum/announcements/4946-ice-3-4-released
[68] https://forums.zeroc.com/forum/announcements/5541-ice-3-4-2-released
[69] https://forums.zeroc.com/forum/announcements/6093-ice-3-5-0-released
[70] https://forums.zeroc.com/forum/announcements/6283-ice-3-5-1-released
[71] https://forums.zeroc.com/forum/announcements/6631-ice-3-6-0-and-ice-touch-3-6-0-released
[72] https://forums.zeroc.com/forum/announcements/45941-ice-3-6-0-and-ice-touch-3-6-1-released
[73] https://forums.zeroc.com/forum/announcements/46347-ice-ice-e-and-ice-touch-3-6-2-released
[74] http://www.oracle.com/technetwork/java/eol-135779.html
[75] http://www.oracle.com/technetwork/java/eol-135779.html
[76] http://www.oracle.com/technetwork/java/eol-135779.html
[77] http://www.oracle.com/technetwork/java/eol-135779.html

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
6	6.x, 7.x	N/A	10.04, 12.04, 13.04, 13.10, 14.04, 14.10, (15.04)	6.0, 7.0, (8.0)	N/A	Yes
7	6.x, 7.x	19, 20, 21, (22)	12.04, 13.04, 13.10, 14.04, 14.10, (15.04)	7.0, (8.0)	N/A	Yes
8	N/A	19, 20, 21, (22)	14.10, (15.04)	(8.0)	N/A	Yes
Details		Ref 1[78] Ref 2[79]	Ref[80]	Ref[81]		

Note that all distributions provide OpenJDK 6, 7 and/or 8 due to distribution restrictions by Oracle. Oracle Java may be used if downloaded separately.

Oracle no longer allow general downloading of Java 6. Java 7 is available for all platforms except for OSX 10.6 (where it is installable manually by unpacking the 10.7 installer). Some 1.8 OpenJDK versions are broken (Debian/Ubuntu 1.8.0u40 broken), but some work (1.8.0u25, FreeBSD). 1.8 should become recommended once working versions exist in all distributions.

OpenGL

General overview[82]

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
2.0	in Sep 2004	N/A	Unsupported	Unsupported	Unsupported
2.1	in Jun 2006	N/A	Unsupported	Unsupported	Unsupported
3.0	in Aug 2008	N/A	Unsupported	Unsupported	Unsupported
3.1	in Mar 2009	N/A	Unsupported	Unsupported	Unsupported
3.2	in Aug 2009	N/A	Unsupported	Unsupported	Unsupported
3.3	in Mar 2010	N/A	Unsupported	Unsupported	Unsupported
4.0	in Mar 2010	N/A	Unsupported	Unsupported	Unsupported
4.1	in Jul 2010	N/A	Unsupported	Unsupported	Unsupported
4.2	in Aug 2010	N/A	Unsupported	Unsupported	Unsupported
4.3	in Aug 2012	N/A	Unsupported	Unsupported	Unsupported
4.4	in Jul 2013	N/A	Unsupported	Unsupported	Unsupported
4.5	in Aug 2014	N/A	Unsupported	Unsupported	Unsupported

[78] https://apps.fedoraproject.org/packages/java-1.7.0-openjdk
[79] https://admin.fedoraproject.org/pkgdb/package/java-1.8.0-openjdk/
[80] http://packages.ubuntu.com/search?keywords=jdk&searchon=names&suite=all&section=all
[81] https://packages.debian.org/search?keywords=jdk&searchon=names&suite=all&section=all
[82] http://en.wikipedia.org/wiki/OpenGL

Distribution support

Version	Windows	CentOS/RHEL	Fedora	Ubuntu	Debian	MacOS	FreeBSD Ports
2.0	Varies*	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
2.1	Varies†	Varies†	Varies†	Varies†	Varies†	10.7, 10.8, 10.9, 10.10 (legacy profile)	Varies†
3.0	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
3.1	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
3.2	Varies†	Varies†	Varies†	Varies†	Varies†	10.7, 10.8 (core profile)	Varies†
3.3	Varies†	Varies†	Varies†	Varies†	Varies†	10.9, 10.10 (core profile min)	Varies†
4.0	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
4.1	Varies†	Varies†	Varies†	Varies†	Varies†	10.9, 10.10 (core profile max)	Varies†
4.2	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
4.3	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
4.4	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
4.5	Varies†	Varies†	Varies†	Varies†	Varies†	N/A	Varies†
Details						Ref[83]	

* Driver/hardware dependent, but the Windows Vista/7/8 DirectX 9 requirement is mostly the same as OpenGL 2.0, so any badged machine should have OpenGL 2.0-capable hardware (it will also require a functional driver)

† Driver/hardware dependent

Support is largely down to the system hardware (GPU) and drivers. There are no guarantees for 2.0 and greater on Windows (1.4 only guaranteed), but AMD, Intel and nVidia all provide GL drivers supporting newer versions. The minimum baseline is probably 2.1. However, 3.2/3.3 is probably the baseline for most hardware under 5 years old, with 4.x being the typical baseline for hardware from a year ago.

Apache

General overview[84] and website[85].

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
2.2	from Dec 2005	TBA	Supported	Supported	Supported
2.4	from Feb 2012	TBA	Recommended	Recommended	Recommended

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
2.2	6.x	N/A	10.04, 12.04, 13.10	6.0, 7.0	N/A	Yes
2.4	7.x	19, 20, 21, (22)	13.10, 14.04, 14.10, (15.04)	(8.0)	N/A	Yes
Details		Ref[86]	Ref[87]	Ref[88]		

Apache 2.2+ requires mod_wsgi which is included in the standard distribution on CentOS 7 (or has to be installed from external repository, for CentOS6). For more information refer to mod_wsgi installation[89].

nginx

General overview[90] and roadmap[91]

[83] https://developer.apple.com/opengl/capabilities/index.html
[84] http://www.apachehaus.com/index.php?option=com_content&view=article&id=119&Itemid=104
[85] http://httpd.apache.org/
[86] https://apps.fedoraproject.org/packages/httpd
[87] http://packages.ubuntu.com/search?keywords=apache&searchon=names&suite=all&section=all
[88] https://packages.debian.org/search?keywords=apache&searchon=names&suite=all&section=all
[89] https://modwsgi.readthedocs.org/en/develop/installation.html
[90] http://nginx.org/en/download.html
[91] http://trac.nginx.org/nginx/roadmap

Version	Release date	Upstream support	OMERO 5.1	OMERO 5.2	OMERO 5.3
1.4	from Apr 2013	to Mar 2014	Supported	Deprecated	Dropped
1.6	from Apr 2014	TBA	Recommended	Supported	Supported
1.8	from Apr 2015	TBA	Unsupported	Recommended	Supported
1.10	from April 2016	TBA	Unsupported	Upcoming	Recommended

Distribution support

Version	CentOS/RHEL	Fedora	Ubuntu	Debian	Homebrew	FreeBSD Ports
1.4	N/A	19, 20	13.10, 14.04	N/A	N/A	N/A
1.6	EPEL	21, (22)	14.10, (15.04)	(8.0), 7.0 bpo	N/A	N/A
1.8	N/A	N/A	N/A	N/A	Yes	Yes
1.10	N/A	N/A	16.04	N/A	N/A	N/A
Details			Ref[92]	Ref[93]		

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

5.5 Example production server set-ups

5.5.1 Micron, Oxford

The OMERO server at Micron, Oxford[94] houses two OMERO instances, the databases for both these instances, and a single OMERO.web instance which serves them both. The second OMERO instance (Raff OMERO) originated from another group's private OMERO server, which is now managed by Micron, but there was no way to merge this data into the main server. The main OMERO instance is configured to interface to a departmental LDAP server to authenticate users and get initial authorization details.

OMERO Data1 in the diagram is a large filestore server which hosts all the image data. This is made available to the OMERO server itself via a Samba mount. This server has 36 TiB of space of which OMERO is using 16 TiB and Raff OMERO is using 600 GiB. This is backed up to a tape robot.

OMERO Processor1 consists of a 32 core, 128GiB RAM processing machine for doing image analysis. This is connected on a completely private network to the OMERO server (to avoid issues with configuring OMERO.grid to be secure) and runs scripts using OMERO.grid.

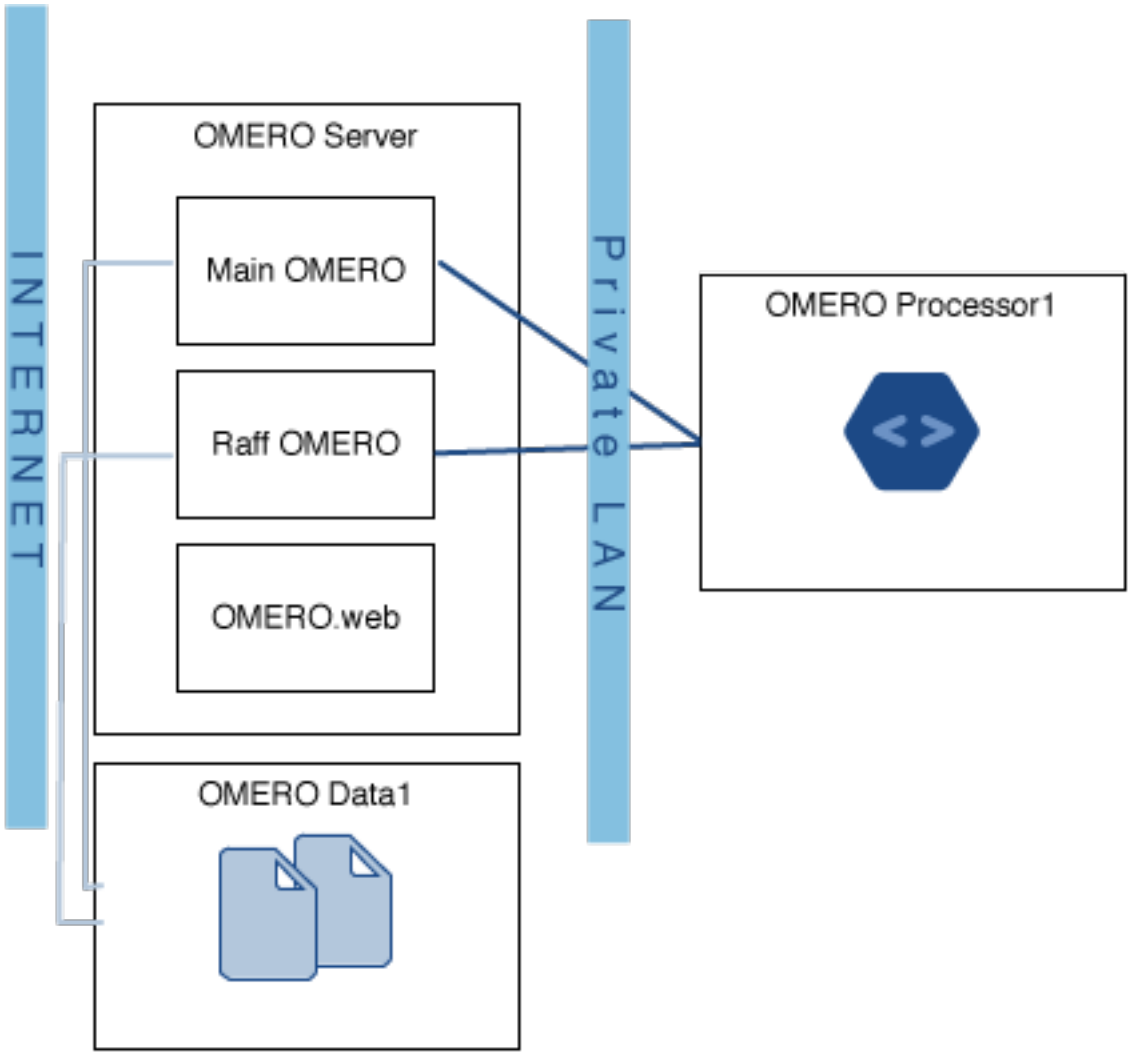
Stats

- 90 users
- 40 groups
- 36 TiB of data storage space, of which 16.6 TiB is currently in use
- Performance statistics to come

5.5.2 Biozentrum, University of Basel

The OMERO server at Biozentrum[95] has around 82 users and currently uses 9.8 TB of data storage space, with an average monthly increase of 200-300 GB. It is run on CentOS 6.5 with data hosted on an NFS-mounted NAS system.

[92] http://packages.ubuntu.com/search?keywords=nginx&searchon=names&suite=all&section=all
[93] https://packages.debian.org/search?keywords=nginx&searchon=names&suite=all&section=all
[94] http://www2.bioch.ox.ac.uk/microngroup/micron_home.php
[95] http://www.biozentrum.unibas.ch



Hardware

Remote storage consists of:

- NFS-mounted NAS system

Local storage consists of:

- 2 x 146 GB 6Gbit/s SAS HD, RAID 1. OS and OMERO software
- 2 x 128 GB SSD, RAID 1, Postgres DB
- 2 x 600 GB 6Gbit/s SAS HD, scratch space, buffer, etc.

Computational resources:

- IBM x3550 M4, dual-CPU Intel(R) Xeon(R) E5-2643 3.3GHz, physical
- 32 GB of memory

Network infrastructure

- 1 Gbit/s Ethernet, local, VPN support, dedicated

5.5.3 GReD Research Center, Clermont-Ferrand, France

The Genetics, Reproduction and Development Research Center[96] has 65 users and currently uses 3 TB of storage, with an average monthly increase of 90 GB. It is run on Debian Squeeze.

Hardware

- 11 TB of storage spread over 8 local hard drives (2 TB), RAID 5

Computational resources:

- 1 Intel Xeon E5506 (4 physical cores)
- 8 GB of memory

Network infrastructure

The server is hosted inside the faculty of medicine where the network works at 100 Mbit/s. There are are 4 Gbit/s ports on the server but only one is currently in use.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

5.6 Known limitations

5.6.1 Time zone

We do not recommend changing the time zone on your server. The server is currently set to use local time and changing time zones will result in a mismatch between the original data import times stored in the server and the way the clients report them. A fix for this is forthcoming but will not be in 5.1.

5.6.2 Java issues

OpenJDK8 is supported, however some builds of some releases (such as the current Ubuntu build of 8u40) have broken JPEG support, reported for OpenJDK[97] and Ubuntu[98]. See #12612[99] and this ome-users thread[100] for more information. OracleJDK8 is also supported, but the earliest releases have had problems. The latest OpenJDK8 or OracleJDK8 should work correctly (we have checked both OpenJDK 1.8.0_45-internal and OracleJDK 1.8.0_66). OpenJDK and OracleJDK version 7 are also supported (we have tested OracleJDK 1.7.0_80 and OpenJDK 1.7.0_85).

5.6.3 Windows OS issues

Failure response on import for new databases

If you have import failures with an error such as:

```
java.lang.RuntimeException: Failure response on import!
Category: ::omero::grid::ImportRequest
Name: import-request-failure
Parameters: {stacktrace=java.lang.RuntimeException: omero.ValidationException
    serverStackTrace = "ome.conditions.ValidationException: could not
```

[96] https://www.gred-clermont.fr
[97] http://icedtea.classpath.org/bugzilla/show_bug.cgi?id=1393
[98] https://bugs.launchpad.net/ubuntu/+source/openjdk-8/+bug/1421501
[99] https://trac.openmicroscopy.org/ome/ticket/12612
[100] http://lists.openmicroscopy.org.uk/pipermail/ome-users/2015-November/005723.html

```
insert: [ome.model.core.Pixels]; SQL [insert into pixels (creation_id,
external_id, group_id, owner_id, permissions, update_id,
dimensionOrder, methodology, physicalSizeXUnit, physicalSizeX,
physicalSizeYUnit, physicalSizeY, physicalSizeZUnit, physicalSizeZ,
pixelsType, relatedTo, sha1, significantBits, sizeC, sizeT, sizeX,
sizeY, sizeZ, timeIncrementUnit, timeIncrement, version, waveIncrement,
waveStart, image, image_index, id) values (?, ?, ?, ?, ?, ?, ?, ?, ?,
?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?)];
nested exception is org.hibernate.exception.DataException: could not
insert: [ome.model.core.Pixels]
```

when trying to import data to a new database (or possibly one just upgraded to 5.1), it may be an issue with the language encoding during database initialization leading to corrupted Unicode characters, such that any import containing these characters (e.g. µ) will fail with the above exception. A `SET CLIENT_ENCODING TO 'UTF8';` command has been added to the database initialization instructions on *OMERO.server installation* to prevent this.

UTF-8 character limitations in passwords

Windows does not handle non-Latin characters well in the command prompt (console). If you use Unicode characters in your passwords, you may find they are not correctly formed. Therefore, we recommend you avoid them if at all possible.

Binary delete

On Windows servers not all binary files corresponding to a delete may be removed from the binary repository. See *Binary data* for more details.

5.6.4 Ubuntu issues

Importing using desktop clients

Under older Ubuntu installations, the 'import folder' option in the desktop clients currently does not work.

5.6.5 Windows issues

C++ compilation problems

OMERO.cpp will not currently build on Windows due to exceeding DLL symbol limits on this platform, leading to a failure when linking the DLL. It is hoped that this platform limitation can be worked around in a future OMERO release.

5.6.6 Searching

5.6.7 Too many open file descriptors

Starting with OMERO 5, the server works directly from original files. At times, this requires a significant number of open file handles. If you are having problems with large or frequent imports, are seeing "Too many open file descriptors" or similar, you may need to increase the maximum number of open files per process. On Linux, this may be done by setting the *nofile* limit in `/etc/security/limits.conf`, for example:

```
omero  soft  nofile  10000
omero  hard  nofile  12000
```

This permits the *omero* user to have 10000 open files per process, which may be increased up to a maximum of 12000 by the user. The username and limits will need adjusting for the specifics of your installation and usage requirements. Note that these settings take effect only for new logins, so the server and the shell or environment the server is started from will require restarting. Run `ulimit -a` as the user running OMERO to verify that the changes have taken effect.

5.6.8 Deleting datasets

If you have a dataset containing any images which are also present in any other datasets, you will not be able to delete it. First, you must remove the shared images by cutting the links.

5.6.9 Changing group permissions

If a group contains a projection made by one member from data owned by another user, you cannot make the group into a private group.

5.6.10 File format support

Large images with floating-point pixel data

Pyramids of image tiles are currently not generated for images with floating-point pixel data, meaning the imported image will be scrambled if it is over a certain size (configurable using `omero.pixeldata.max_plane_height` and `omero.pixeldata.max_plane_width` but set to 3192x3192 pixels by default). This primarily affects the following file formats:

- Gatan DM3
- MRC
- TIFF

Calculation of minima and maxima pixel values

If images are imported with one of the *`omero import --skip`* options skipping calculation of the global minima and maxima pixel values, OMERO clients will use the extrema of the pixel type range by default. Users can adjust the minima/maxima via the rendering settings. Recalculating minima and maxima pixel values after import is currently not supported.

Flex data in OMERO.tables

If you are using the advanced configuration setting `FlexReaderServerMaps` for importing Flex data split between multiple directories for use with *OMERO.tables*, you should not upgrade beyond 5.0.x. Neither the 5.1 line nor OMERO 5.2 support this functionality.

5.6.11 LDAP

Enabling synchronization of LDAP on user login may override admin actions carried out in the clients, see *Synchronizing LDAP on user login* for details.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

5.7 Groups and permissions system

See also:

OMERO permissions history, querying and usage

5.7.1 Summary

A user may belong to one or more groups, and the data in a group may now **at most** be shared with users in the same group on the same OMERO server. The degree to which their data is available to other members of the group depends on the permissions settings for that group. Whenever a user logs on to an OMERO server, they are connected under one of their groups. All data they import and any work that is done is assigned to the current group, however the user can now easily copy their data into another group.

5.7.2 Users

Administrator Your OMERO server will have one or more administrators. Each group can be administrated by any of your server administrators. The administrators control all settings for groups.

Group owner Your group may have one or more owners. The group owner has some additional rights within each group than a standard group member, including the ability to add other members to the group.

Group member This is the standard user.

Groups and users must be created by the server administrator. Users can then be added by the administrator or by one of the group owners assigned by the administrator. This would typically be the PI of the lab. The group's owners or server administrator can also choose the permission level for that group. See the Help guide for managing groups[101] for more information about how to administrate them in OMERO.

5.7.3 Group permission levels

The various permission levels are:

Private This group is the most restrictive:

- A private *Group owner* can see and control who the group members are and can view their data.
- As a *Group member*, you will only ever be able to see your own data.
- This can be used for general data storage, access and analysis, but has very limited collaboration potential other than for the *Group owner* to see other group members' data.

Potential use cases of Private group:

- A PI as *Group owner* and their student, as a *Group member*, can access the student's data. A student might use this as somewhere to store all of their data and from here, the PI and/or student might decide which data could/should be copied into a more collaborative group where additional members would also be able to view the data.
- An institutional repository type structure where data are being archived, but not necessarily open for general viewing.

Read-only This group is the intermediate option that allows visibility of other users and their data, but minimal ability to annotate their data:

- The *Group owner* can control group members as above and can perform some annotations on the other group members data.
- *Group member* can see who other members are and view their data, but cannot annotate another members' data at all.

Potential use cases of Read-only group:

- A scientist might move data into a read-only group when they want other group members to access and view their data. Their PI, as a group owner could then annotate and/or add Regions of Interest (ROIs) to their images.
- For an institutional repository where data are being archived and then available for other users in the institute to view; this could be standard storage of all original data, or for data that is included in publications.

Read-annotate This is a more collaborative group:

- *Group member* can view other members, their data and can make annotations on those other members' data.

Potential use cases of Read-annotate group:

- This could be used by a group of scientists working together with data for a publication.

[101] http://help.openmicroscopy.org/sharing-data.html#owner

Read-write This group essentially allows all the group members to behave as if they co-own all the data:

- *Group member* can view, annotate, edit and **delete** all data; the only restriction is that they cannot move other members' data into another group.

Potential use cases of Read-write group:

- A group of scientists working in a completely collaborative way, trusting every member of the group to have equal rights and access to all the data.

See also:

Help guide for sharing data[102] Workflow guide covering the groups and permissions system

5.7.4 Changing group permissions

It is possible for the *Group owner* or server *Administrator* to change the permissions level on a group after it has been created and filled with data, with the following limitations:

- It is not possible to 'reduce' permissions to *Private* if the group contains a projection made by one member from data owned by another user. In other circumstances, reducing permissions to private will warn of loss of annotations etc. as noted below, but will still be possible.
- Only *Administrator* can promote a group to *Read-write* permissions. **Make certain all the members understand that this allows anyone in the group to permanently delete any of the data before performing this action.**

Warning: Please be very careful before downgrading a group's permission level. If a user has annotated other users' data and the group is downgraded, any links to annotations that are not permitted by the new permissions level will be lost.

5.7.5 Permissions on your and other users' data

What can you do with your data?

All OMERO users in all groups can perform all actions on their own data.

The main actions available include, but are not limited to:

- create projects and/or datasets
- import data
- delete data
- edit names and descriptions of images
- change rendering settings on images
- annotate images (rate, tag, add attachments and comments)
- de-annotate (remove annotations that you have added)
- use Regions of Interest (ROIs) (add, import, edit, delete, save and analyze them)
- run scripts
- move data between groups, if you belong to more than one group

What can you do with someone else's data in your group?

Actions available for you on someone else in your group's data will depend both on the permissions of the group you are working in, and what sort of user you are. See the table below for a quick reference guide to permissions available on other people's data.

Some of these policies may evolve as the permissions functionality matures in response to user feedback. Please let us know any comments or suggestions you have via our mailing lists[103] or through the forums[104].

[103] http://www.openmicroscopy.org/site/community/mailing-lists
[104] http://www.openmicroscopy.org/community/

5.7.6 Permissions tables

The following are the permissions valid for users working on data belonging to other group members. These permissions depend on the group permissions and on the type of the user performing the action.

Administrator

Action	*Private*	*Read-only*	*Read-annotate*	*Read-write*
View	Y	Y	Y	Y
Annotate	N	Y	Y	Y
Delete	Y	Y	Y	Y
Edit	Y	Y	Y	Y
Move between groups	Y	Y	Y	Y
Remove annotations	Y	Y	Y	Y
Mix data	N	Y	Y	Y

Group owner

Action	*Private*	*Read-only*	*Read-annotate*	*Read-write*
View	Y	Y	Y	Y
Annotate	N	Y	Y	Y
Delete	Y	Y	Y	Y
Edit	Y	Y	Y	Y
Move between groups	N	N	N	N
Remove annotations	Y	Y	Y	Y
Mix data	N	Y	Y	Y

Group member

Action	*Private*	*Read-only*	*Read-annotate*	*Read-write*
View	N	Y	Y	Y
Annotate	N	N	Y	Y
Delete	N	N	N	Y
Edit	N	N	N	Y
Move between groups	N	N	N	N
Remove annotations	N	N	N	Y
Mix data	N	N	N	Y

Key

Action Action on other users' data

Annotate Add annotations (rating, tag, attachment, comment ROI) to another users' data. Also create & save ROIs (save ROIs that you draw on another users' data).

Delete Delete data such as images or ROIs. ROIs may have been added by others or yourself.

Edit Modify the name or description of other users' objects such as images.

Mix data Copy, Move or Remove other users' data to or from your Projects, Datasets or Screens. Copy, Move or Remove your or others' data to or from others' Projects, Datasets or Screens.

Note: You should always be able to remove annotations (such as tags) that you linked to other users' data (you own the link). The link can be deleted, but the tag itself will not be deleted.

Move between groups Only the admin has the right to move other users' data between groups.

Note: The admin does not have to be member of the destination group.

Remove annotations Remove annotations made by others on your data.

Render Create your own rendering settings (this will not modify the settings of the owner).

View View other users' data such as images. View ROIs added by others. Draw ROIs on other users' data, but they cannot be saved.

5.7.7 Issues to be aware of

ROIs

- You can never edit (change text or move) other users' ROI.
- Any ROIs added to other users' data will not affect ROIs added by the owner.

Tags and attachments

- A tag or attachment is 'owned' by the person who creates it or uploads it to the server.
- The link between a tag or an attachment is 'owned' by the person who annotates an image with that tag or attachment i.e. makes a link between the tag/attachment and the image.
- De-annotation deletes the link between the tag/attachment and image but does not remove/delete the tag or attachment from the system.

Scripts

- Although all users can run scripts on other users' data, the actions within those scripts will be subject to the restrictions of the permissions detailed in the tables above.

CHAPTER

SIX

SERVER INSTALLATION AND MAINTENANCE

This chapter contains instructions for installing OMERO.server, and for troubleshooting, backing-up, and upgrading your server installation.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1 Server installation on UNIX (and UNIX-like platforms)

The pages below provide guidance on how to install and set up OMERO.server on any of the supported UNIX and UNIX-like platforms. Specific walkthroughs are provided for several systems, with detailed step-by-step instructions. However, reading through the main *OMERO.server installation* guide first is recommended as this gives an overview of the entire process and introduces the additional pages listed below.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.1 OMERO.server installation

This section covers the installation of OMERO.server on UNIX and UNIX-like platforms. This includes all BSD, Linux and Mac OS X systems. Depending upon which platform you are using, you may find a more specific walk-through listed below.

See also:

OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.5 Instructions for installing OMERO.server from scratch on CentOS 6 with Python 2.7 and Ice 3.5.

OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.6 Instructions for installing OMERO.server from scratch on CentOS 6 with Python 2.7 and Ice 3.6.

OMERO.server installation on CentOS 7 and Ice 3.5 Instructions for installing OMERO.server from scratch on CentOS 7 with Ice 3.5.

OMERO.server installation on CentOS 7 and Ice 3.6 Instructions for installing OMERO.server from scratch on CentOS 7 with Ice 3.6.

OMERO.server installation on Ubuntu 14.04 and Ice 3.5 Instructions for installing OMERO.server from scratch on Ubuntu 14.04 with Ice 3.5.

OMERO.server installation on Ubuntu 14.04 and Ice 3.6 Instructions for installing OMERO.server from scratch on Ubuntu 14.04 with Ice 3.6.

OMERO.server installation on OS X with Homebrew Instructions for installing and building OMERO.server on Mac OS X with Homebrew using our special formulas (i.e. from the source code via Homebrew). **You do not need to refer to this page to install the prerequisites with Homebrew and then install the server zip from the downloads page.**

Prerequisites

Installation will require:

- a clean, minimal operating system installation
- a "root" level account for which you know the password

Note: If you are unsure of what it means to have a "root" level account, or if you are generally having issues with the various users/passwords described in this install guide, please see *Which user account and password do I use where?*.

The installation and configuration of the prerequisite applications are mostly outside the scope of this document. For Linux distributions, use of the default package manager is recommended. For BSD systems, the ports system provides all the prerequisites. For MacOS X, Homebrew is recommended. This guide provides the package names to install for a number of contemporary systems. However, the names and versions provided vary between releases. Please do check for similar packages if the one documented here is not available for your system as it may be provided under an alternative name. "Debian" refers to Debian and derivative distributions such as Ubuntu. "RedHat" refers to RedHat and related distributions such as CentOS, Fedora and Scientific Linux.

- For Ubuntu you need to enable the **universe** repository. This should be enabled by default. If not enabled, it may be enabled by editing `/etc/apt/sources.list` directly, in which case the entries may already exist but are commented out, or by using Synaptic (10.04 and 10.10) or Ubuntu Software Center (11.04 onwards). Update your package lists to ensure that you get the latest packages:

  ```
  $ sudo apt-get update
  ```

  Install packages by running:

  ```
  $ sudo apt-get install package
  ```

  where *package* is the package name to install.

The following subsections cover the details for each package, in the order recommended for installation.

Java SE Runtime Environment (JRE)

If possible, install one of the following packages:

System	Package
BSD Ports	java/openjdk7
Debian	openjdk-7-jre
Homebrew	N/A (install Oracle Java)
RedHat	java-1.8.0-openjdk

OMERO works with the OpenJDK JRE provided by most systems, or with Oracle Java. Version 7 or later is recommended.

Your system may already provide a suitable JRE, in which case no extra steps are necessary. Linux distributions usually provide OpenJDK, and older MacOS X versions have Java installed by default. Oracle Java is no longer provided by BSD or Linux distributions for licensing reasons. If your system does not have Java available, for example on newer MacOS X versions, or the provided version is too old, Oracle Java may be downloaded from the Oracle website[1].

Warning: Security
Installing Oracle Java outside the system's package manager will leave your system without regular distribution-supplied security updates, and so is not recommended.

To check which version of Java is currently available:

[1] http://www.oracle.com/technetwork/java/javase/downloads/index.html

```
$ which java
/usr/bin/java
$ java -version
java version "1.7.0_51"
Java(TM) SE Runtime Environment (build 1.7.0_51-b13)
Java HotSpot(TM) 64-Bit Server VM (build 24.51-b03, mixed mode)
```

Python 2

Check you have Python (and check its version) by running:

```
$ python --version
Python 2.7.10
```

Note: OMERO does not currently support Python 3; you must use 2.7.

The following Python packages are required:

Package	Functionality	Downloads
Django[2] (1.8) [3]	OMERO.web	Django[4] page
Pillow[5] [6]	OMERO.web and Figure Export	Pillow[7] page
Matplotlib[8]	OMERO.web	Matplotlib page[9]
NumPy (1.2.0 or higher) [10]	Scripting	Numpy/Scipy page[11]
PyTables (2.1.0 or higher)	*OMERO.tables*	PyTables page[12]

Note: Some of these can be ignored if you wish to forego some functionality but we recommend you just install everything. For example, scripting is enabled by default so should not be assumed optional even if you never expect your users to run scripts from the clients.

If possible, install the following packages:

System	Package
BSD Ports	lang/python27 graphics/py-pillow math/py-matplotlib math/py-numpy devel/py-tables science/py-scipy
Debian	python2.7 python-pil python-matplotlib python-numpy python-tables python-scipy
Homebrew	python pillow numpy matplotlib
RedHat	python

Note: CentOS 6 users should read *OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.5* or *OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.6* and follow the instructions there to install Python and the required modules.

Ice

Note: OMERO 5.2 supports 3.5 and 3.6 on UNIX and UNIX-like platforms. You must install the correct version of OMERO.server (see Downloads[13]).

[2] https://www.djangoproject.com/

[3] The currently supported version of the django module used by OMERO.web (1.8) requires Python 2.7. The older version (1.6) will work with Python 2.6 but lacks security support, and is consequently *not recommended for production use*. Python 2.7 and Django 1.8 (https://docs.djangoproject.com/en/1.8/releases/1.8/) are required for security support.

[4] https://pypi.python.org/pypi/Django

[5] http://pillow.readthedocs.org

[6] Make sure to have libjpeg (http://libjpeg.sourceforge.net/) installed when building Pillow (http://pillow.readthedocs.org). We currently do not support version 3.0+.

[7] https://pypi.python.org/pypi/Pillow

[8] http://matplotlib.org/

[9] http://matplotlib.org/

[10] May already have been installed as a dependency of Matplot Lib.

[11] http://www.scipy.org/Download

[12] https://pytables.github.io/downloads.html

[13] http://downloads.openmicroscopy.org/latest/omero/

The Ice version may vary, depending upon the distribution version you are using. The Ice versions in currently supported versions of Debian and Ubuntu[14] are shown in the *Ice* of the *Version requirements* page.

Using the latest version of Ice is recommended, where possible. If your package manager provides Ice packages, using these is recommended where possible. Distribution-provided packages often have additional bugfixes which are not present in the upstream releases.

If needed, source and binary packages are available from ZeroC[15]. The latest release is available from the ZeroC website[16].

Note: CentOS 6 users should read *OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.5* or *OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.6* and follow the instructions there to install Ice.

Note: ZeroC[17] Ice can always be built from source code for specific platforms if a binary package is not available.

Note: With Ice 3.6, the Python bindings are provided separately. If your package manager does not provide Ice python packages, run `pip install zeroc-ice` to install the Ice Python bindings. See Using the Python Distribution[18] for further details.

OMERO.web

Please install one of **apache** (and its wsgi module) or **nginx** and Gunicorn in order to run OMERO.web.

System	Packages
BSD Ports	www/apache24 www/nginx
Debian	apache2 libapache2-mod-wsgi nginx
Homebrew	nginx
RedHat	httpd mod_wsgi nginx

OMERO.scripts

If you wish to run the "Movie Maker" script, please install **mencoder**.

System	Packages
BSD Ports	multimedia/mencoder
Debian	mencoder
Homebrew	mplayer
RedHat	mencoder

Installation

Once the above prerequisites have been downloaded, installed and configured appropriately, the OMERO server itself may be installed. You may wish to create a user account solely for the purpose of running the server, and switch to this user for the next steps.

Server directory

Firstly, a directory needs to be created to contain the server. In this case `~/omero` is used as an example:

```
$ mkdir -p ~/omero
```

Next, change into this directory:

[14] https://wiki.ubuntu.com/Releases
[15] https://zeroc.com
[16] https://zeroc.com/download.html
[17] https://zeroc.com
[18] https://doc.zeroc.com/display/Ice36/Using+the+Python+Distribution

```
$ cd ~/omero
```

OMERO.server

The release `OMERO.server.zip` is available from the OMERO downloads[19] page. Download the version matching the version of Ice installed on your system before continuing.

Installing a development version from source is also possible. See the *Installing OMERO from source* section for further details. This is not recommended unless you have a specific reason *not* to use a release version.

Once you have obtained the OMERO.server zip archive matching the version of Ice installed, unpack it:

```
$ unzip OMERO.server-5.2.4-ice35-byy.zip
```

If your system does not provide an **unzip** command by default, install one of the following:

System	Package
BSD Ports	archivers/unzip
Debian	unzip
Homebrew	unzip
RedHat	unzip

Optionally, give your OMERO software install a short name to save some typing later, to reflect what you set `OMERO_PREFIX` to in the *Environment variables* section, below:

```
$ ln -s OMERO.server-5.2.4-ice35-byy OMERO.server
```

This will also ease installation of newer versions of the server at a later date, by simply updating the link.

Environment variables

If using distribution-provided packages such as Debian or RPM packages, or via the homebrew or macports package manager, it should not be necessary to set any environment variables. However, if using third-party packages for any required components, several variables may require setting in order for them to function correctly.

Please note that the precise details of these environment variables can change as new versions of software are released.

There are several methods for setting environment variables; which is most appropriate will depend upon how the OMERO server is started. Options include:

`/etc/security/pam_env.conf` Global environment set at login by PAM

`/etc/profile` or `/etc/profile.d/omero` Global Bourne shell defaults (also used by derived shells such as **bash** and **zsh**)

`~/.profile` User's Bourne shell defaults (also used by derived shells)

`/etc/bash.bashrc` Global **bash** defaults

`~/.bashrc`, `~/.bash_profile` or `~/.bash_login` User's **bash** configuration.

If OMERO is started as a service using an init script, a global setting should be preferred. If being started by hand using a particular user, a user-specific configuration file may be more appropriate.

The following environment variables may be configured:

`LD_LIBRARY_PATH` (Linux) or `DYLD_LIBRARY_PATH` (MacOS X) The Ice and PostgreSQL libraries must be on the library search path. If using the packages provided by your distribution, this will already be the case. If using third-party binary distributions the `lib` (or `lib64` if present and using a 64-bit system) directory for each will require adding to the library search path.

`OMERO_PREFIX` This is not strictly required, but may be set for convenience to point to the OMERO server installation, and is used in this documentation as a shorthand for the installation path.

`OMERO_TMPDIR` Directory used for temporary files. If the home directory of the user running the OMERO server is located on a slow filesystem, such as NFS, this may be used to store the temporary files on fast local storage.

[19] http://downloads.openmicroscopy.org/latest/omero/

PATH The search path must include the programs **java**, **python**, **icegridnode** and PostgreSQL commands such as **psql**. If using the packages provided by your distribution, this will already be the case. If using third-party binary distributions such as the ZeroC Ice package, Oracle Java, or PostgreSQL, the `bin` directory for each must be added to the path. The OMERO `bin` directory may also be added to the search path (`$OMERO_PREFIX/bin` if `OMERO_PREFIX` has been set).

PYTHONPATH The Ice `python` directory must be made available to python. If using the Ice packages provided by your distribution, this will already be the case. If using the ZeroC ice package, add the `python` directory to the python path. For Ice 3.6, this should never be required.

Warning: The `OMERO_HOME` environment variable is used internally by OMERO. Unless you really know what you are doing, it is strongly recommended that you do not set this variable (see *Setting the OMERO_HOME environment variable* for details). You can use a different name of your choice instead, indicated by `OMERO_PREFIX` in this documentation.

After making any needed changes, either source the corresponding file or log back in for them to take effect. Run `env` to check them.

Note: CentOS 6 users should read *OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.5* or *OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.6* and set the needed environment variables as documented.

Creating a database

On most systems, a "postgres" user will be created which has admin privileges, while the UNIX `root` user itself does *not* have admin privileges. Therefore it is necessary to either become the `postgres` user, or use **sudo** as shown below.

For the purposes of this guide, the following dummy data is used:

```
Username: db_user
Password: db_password
Database: omero_database
```

Warning: Security
These dummy values are examples only and should **not** be used. For a live or public server install these values should be altered to reflect your security requirements—i.e. use your own choice of username and password instead. These should **not** be the same username and/or password as your Linux/Mac/Windows root user!
You should also consider restricting access to your server machine, but that is outside the scope of this document.

- Create a non-superuser database user and record the name and password used. You will need to configure OMERO to use this username and password later on.:

```
$ sudo -u postgres createuser -P -D -R -S db_user
Enter password for new role:       # db_password
Enter it again:       # db_password
```

- Create a database for OMERO to reside in:

```
$ sudo -u postgres createdb -E UTF8 -O db_user omero_database
```

- Check to make sure the database has been created, you have PostgreSQL client authentication correctly set up and the database is owned by the **db_user** user.

```
$ psql -h localhost -U db_user -l
Password for user db_user:
        List of databases
   Name          |  Owner   | Encoding
---------------+----------+-----------
 omero_database | db_user  | UTF8
 postgres       | postgres | UTF8
```

```
 template0      | postgres | UTF8
 template1      | postgres | UTF8
(4 rows)
```

If you have problems, especially with the last step, take a look at *OMERO.server and PostgreSQL* since the authentication mechanism is probably not properly configured.

Location for the your OMERO binary repository

- Create a directory for the OMERO binary data repository. `/OMERO` is the default location and should be used unless you explicitly have a reason not to and know what you are doing.
- This is *not* where you want the OMERO application to be installed, it is a *separate* directory which the OMERO.server will use to store binary data.
- You can read more about the *OMERO binary repository*.

```
$ sudo mkdir /OMERO
```

- Change the ownership of the directory. `/OMERO` **must** either be owned by the user starting the server (it is currently owned by the system root) or that user **must** have permission to write to the directory. You can find out your username and edit the correct permissions as follows:

```
$ whoami
omero
$ sudo chown -R omero /OMERO
```

Configuration

- Optionally, review `~/omero/OMERO.server/etc/omero.properties`, which contains all default settings. Do not edit this file—it is for reference only. Any configuration settings you would like to change can be changed in the next step. Alternatively, you can view a parsed version of the file under *Configuration properties glossary* or parse it yourself with `omero config parse`.
- Change any settings that are necessary using `omero config`, including the name and/or password for the 'db_user' database user you chose above or the database name if it is not "omero_database". (Quotes are only necessary if the value could be misinterpreted by the shell. See link[20])

```
$ cd ~/omero/OMERO.server
$ bin/omero config set omero.db.name 'omero_database'
$ bin/omero config set omero.db.user 'db_user'
$ bin/omero config set omero.db.pass 'db_password'
```

  You can also check the values that have been set using:

```
$ cd ~/omero/OMERO.server
$ bin/omero config get
```

- If you have chosen a non-standard *OMERO binary repository* location above, be sure to configure the `omero.data.dir` property. For example, to use `/srv/omero`:

```
$ omero config set omero.data.dir /srv/omero
```

[20] http://www.openmicroscopy.org/community/viewtopic.php?f=5&t=360#p922

- Create the OMERO database initialization script. You will need to provide a password for the newly created OMERO root user, either by using the `--password` argument or by entering it when prompted. Note that this password is for the root user of the **OMERO.server**, and is not related to the root system user or a PostgreSQL user role.

```
$ cd ~/omero/OMERO.server
$ bin/omero db script --password omero_root_password
```

```
Using OMERO5.2 for version
Using 0 for patch
Using password from commandline
Saving to /home/omero/OMERO5.2__0.sql
```

> **Warning: Security**
> For illustrative purposes, the default password for the OMERO root user is shown as `omero_root_password`. However, you should **not** use this default values for your installation, but use your own choice of password instead. This should **not** be the same password as your Linux/Mac/Windows root user or the database user!

- Initialize your database with the script.

```
$ psql -h localhost -U db_user omero_database < OMERO5.2__0.sql
```

  At this point you should see some output from PostgreSQL as it installs the schema for new OMERO database.

- Before starting the OMERO.server, run the OMERO diagnostics script to check that all of the settings are correct, e.g.

```
$ bin/omero admin diagnostics
```

- You can now start the server using:

```
$ bin/omero admin start
Creating var/master
Initializing var/log
Creating var/registry
No descriptor given. Using etc/grid/default.xml
```

- If multiple users have access to the system running OMERO you should restrict access to the `OMERO.server/etc` and `OMERO.server/var` directories, for example by changing the permissions on them:

```
$ chmod 700 ~/omero/OMERO.server/etc ~/omero/OMERO.server/var
```

  You should also consider restricting access to the OMERO data repository. The required permissions will depend on whether you are using *Advanced import scenarios*.

- Test that you can log in as "root", either with the OMERO.insight client or on the command-line:

```
$ bin/omero login
Server: [localhost]
Username: [root]
Password:         # omero_root_password
```

  You will be prompted for an OMERO username and password. Use the username and password set when running `bin/omero db script`.

JVM memory settings

The OMERO server starts a number of Java services. Memory settings for these are calculated on a system-by-system basis. An attempt has been made to have usable settings out of the box, but if you can afford to provide OMERO with more memory, it will

certainly improve your overall performance. See *Memory configuration* on how to tune the JVM.

OMERO.web and administration

In order to deploy OMERO.web in a production environment such as Apache or Nginx please follow the instructions under *OMERO.web deployment*.

Note: The internal Django webserver can be used for evaluation and development. In this case please follow the instructions under *OMERO.web deployment for developers*.

Enabling movie creation from OMERO.

OMERO has a facility to create AVI/MPEG Movies from images. The page *OMERO.movie* details how to enable it.

Post-installation items

Backup

One of your first steps after putting your OMERO server into production should be deciding on when and how you are going to *backup your database and binary data*. Please do not omit this step.

Security

It is also now recommended that you read the *Server security and firewalls* page to get a good idea as to what you need to do to get OMERO clients speaking to your newly installed OMERO.server in accordance with your institution or company's security policy.

Advanced configuration

Once you have the base server running, you may want to try enabling some of the advanced features such as *OMERO.dropbox* or *LDAP authentication*. If you have **Flex data**, you may want to watch the HCS configuration screencast[21]. See the Feature list[22] for more advanced features you may want to use, and *Configuration properties glossary* on how to get the most out of your server.

If your users are going to be importing many files in one go, for example multiple plates, you should make sure you set the maximum number of open files to a sensible level (i.e. at least 8K for production systems, 16K for bigger machines). See *Too many open files* for more information.

Troubleshooting

My OMERO install doesn't work! What do I do now? Examine the *Troubleshooting OMERO* page and if all else fails post a message to our ome-users[23] mailing list discussed on the *Community support* page. Especially the *Server fails to start* and *Remote clients cannot connect to OMERO installation* sections are a good starting point.

OMERO diagnostics

If you want help with your server installation, please include the output of the diagnostics command:

```
$ bin/omero admin diagnostics

================================================================================
OMERO Diagnostics 5.2.4
================================================================================
```

[21] http://cvs.openmicroscopy.org.uk/snapshots/movies/omero-4-1/mov/FlexPreview4.1-configuration.mov
[22] http://www.openmicroscopy.org/site/products/omero/feature-list
[23] http://lists.openmicroscopy.org.uk/mailman/listinfo/ome-users

```
Commands:   java -version                   1.7.0     (/usr/bin/java)
Commands:   python -V                       2.7.9     (/usr/bin/python)
Commands:   icegridnode --version           3.5.1     (/usr/bin/icegridnode)
Commands:   icegridadmin --version          3.5.1     (/usr/bin/icegridadmin)
Commands:   psql --version                  9.4.5    (/usr/bin/psql)

Server:     icegridnode                     running
Server:     Blitz-0                         active (pid = 30324, enabled)
Server:     DropBox                         active (pid = 30343, enabled)
Server:     FileServer                      active (pid = 30345, enabled)
Server:     Indexer-0                       active (pid = 30348, enabled)
Server:     MonitorServer                   active (pid = 30351, enabled)
Server:     OMERO.Glacier2                  active (pid = 30353, enabled)
Server:     OMERO.IceStorm                  active (pid = 30376, enabled)
Server:     PixelData-0                     active (pid = 30393, enabled)
Server:     Processor-0                     active (pid = 30394, enabled)
Server:     Tables-0                        inactive (disabled)
Server:     TestDropBox                     inactive (enabled)

OMERO:      SSL port                        4064
OMERO:      TCP port                        4063

Log dir:    /home/omero/OMERO.server-5.0.1-ice35-b21/var/log exists

Log files:  Blitz-0.log                     3.0 MB        errors=0    warnings=9
Log files:  DropBox.log                     4.0 KB        errors=0    warnings=1
Log files:  FileServer.log                  0.0 KB
Log files:  Indexer-0.log                   10.0 KB       errors=0    warnings=5
Log files:  MonitorServer.log               2.0 KB
Log files:  OMEROweb.log                    642.0 KB      errors=0    warnings=1
Log files:  OMEROweb_request.log            0.0 KB
Log files:  PixelData-0.log                 7.0 KB        errors=0    warnings=4
Log files:  Processor-0.log                 2.0 KB        errors=0    warnings=1
Log files:  Tables-0.log                    n/a
Log files:  TestDropBox.log                 n/a
Log files:  master.err                      0.0 KB        errors=2    warnings=0
Log files:  master.out                      0.0 KB
Log files:  Total size                      3.83 MB

Environment:OMERO_HOME=(unset)
Environment:OMERO_NODE=(unset)
Environment:OMERO_MASTER=(unset)
Environment:OMERO_TEMPDIR=(unset)
Environment:PATH=/usr/local/bin:/usr/bin:/bin
Environment:ICE_HOME=(unset)
Environment:LD_LIBRARY_PATH=(unset)
Environment:DYLD_LIBRARY_PATH=(unset)

OMERO SSL port:4064
OMERO TCP port:4063
OMERO data dir: '/OMERO'        Exists? True    Is writable? True
OMERO temp dir: '/home/omero/tmp'        Exists? True    Is writable? True   (Size: 0)

JVM settings: Blitz-${index}                        -Xmx621m -XX:MaxPermSize=512m -
XX:+IgnoreUnrecognizedVMOptions
JVM settings: Indexer-${index}                      -Xmx414m -XX:MaxPermSize=512m -
XX:+IgnoreUnrecognizedVMOptions
JVM settings: PixelData-${index}                    -Xmx621m -XX:MaxPermSize=512m -
XX:+IgnoreUnrecognizedVMOptions
JVM settings: Repository-${index}                   -Xmx414m -XX:MaxPermSize=512m -
```

```
XX:+IgnoreUnrecognizedVMOptions

OMERO.web status... You are deploying OMERO.web using apache and mod_wsgi. Can-
not check status.
Django version: 1.8.7
```

Update notification

Your OMERO.server installation will check for updates each time it is started from the *Open Microscopy Environment* update server. If you wish to disable this functionality you should do so now as outlined on the *OMERO upgrade checks* page.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.2 OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.5

This installation walkthrough should be read in conjunction with *OMERO.server installation* and *OMERO.web deployment*.

Running OMERO on CentOS 6 has a number of special requirements which deviate from the standard installation instructions. The instructions below will set up Python 2.7 and Ice 3.5 on CentOS 6. We tested the installation with Python 2.7 from IUS[24] and used a virtual environment[25] to install the various dependencies required to install an OMERO.server. It is also possible to use SCL Python (for example `walkthrough_centos6_py27.sh`) but such solution could have potential side effects.

Setting up

Python 2.7

CentOS 6 provides Python 2.6. However, OMERO.web requires Python 2.7 in order to use Django 1.8[26]. While Django 1.6 may be used with Python 2.6, this version of Django no longer has security support. In consequence, it is necessary to upgrade to Python 2.7 in order to obtain Django security updates, which are required for a production deployment.

Ice 3.5

The RPM packages provided by ZeroC for CentOS 6 use the Python 2.6 provided by the system. OMERO will need an Ice build which uses Python 2.7. A version of Ice 3.5 built against Python 2.7 installed above is available at http://downloads.openmicroscopy.org/ice/experimental. Ice will be installed into `/opt`.

Installing prerequisites

The following steps are run as root.

Install Java 1.8, Ice 3.5 and PostgreSQL 9.4:

To install Java 1.8 and other dependencies:

```
# epel-release will be pulled as a dependency
yum -y install https://centos6.iuscommunity.org/ius-release.rpm

# installed for convenience
yum -y install unzip wget tar

# install Java
yum -y install java-1.8.0-openjdk
```

[24] https://ius.io/
[25] https://virtualenv.readthedocs.org/en/latest/
[26] https://docs.djangoproject.com/en/1.8/releases/1.8/

```
# install dependencies

yum -y install \
        python27 \
        python27-devel \
        libjpeg-devel \
        libpng-devel \
        libtiff-devel \
        hdf5-devel \
        zlib-devel \
        freetype-devel

# install pip and virtualenv using Python 2.6
yum -y install python-pip

pip install --upgrade virtualenv

#if virtualenv is not installed (unlikely)
#yum -y install python27-pip
#pip2.7 install virtualenv

# TODO: this installs a lot of unecessary packages:
yum -y groupinstall "Development Tools"

export PYTHONWARNINGS="ignore:Unverified HTTPS request"
```

To install Ice 3.5:

```
curl -o /etc/yum.repos.d/zeroc-ice-el6.repo \
http://download.zeroc.com/Ice/3.5/el6/zeroc-ice-el6.repo

yum -y install db53 db53-utils mcpp
mkdir /tmp/ice-download
cd /tmp/ice-download

wget http://downloads.openmicroscopy.org/ice/experimental/Ice-3.5.1-b1-centos6-iuspy27-x86_64.tar.gz

tar -zxvf /tmp/ice-download/Ice-3.5.1-b1-centos6-iuspy27-x86_64.tar.gz

# Install under /opt
mv Ice-3.5.1-b1-centos6-iuspy27-x86_64 /opt/Ice-3.5.1

# make path to Ice globally accessible
# if globally set, there is no need to export LD_LIBRARY_PATH
echo /opt/Ice-3.5.1/lib64 > /etc/ld.so.conf.d/ice-x86_64.conf
ldconfig
```

To install PostgreSQL 9.4:

```
# install Postgres
# Postgres, reconfigure to allow TCP connections
yum -y install http://yum.postgresql.org/9.4/redhat/rhel-6-x86_64/pgdg-centos94-9.4-2.noarch.rpm
yum -y install postgresql94-server postgresql94

service postgresql-9.4 initdb
sed -i.bak -re 's/^(host.*)ident/\1md5/' /var/lib/pgsql/9.4/data/pg_hba.conf
chkconfig postgresql-9.4 on
service postgresql-9.4 start
```

The remaining dependencies will be installed in a virtual environment:

```
# Install the OMERO dependencies in a virtual environment
# Create virtual env.
# -p only required if virtualenv has been installed with python 2.6

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u
/home/omero/omeroenv/bin/pip install --upgrade pip

/home/omero/omeroenv/bin/pip2.7 install -r requirements_centos6_py27_ius.txt

deactivate
```

See `requirements_centos6_py27_ius.txt`

Create an omero system user, and a directory for the OMERO repository:

```
useradd -m omero

mkdir -p "$OMERO_DATA_DIR"
chown omero "$OMERO_DATA_DIR"
```

Create a database user and initialize a new database for OMERO:

```
echo "CREATE USER $OMERO_DB_USER PASSWORD '$OMERO_DB_PASS'" | \
    su - postgres -c psql
su - postgres -c "createdb -E UTF8 -O '$OMERO_DB_USER' '$OMERO_DB_NAME'"

psql -P pager=off -h localhost -U "$OMERO_DB_USER" -l
```

The following settings will need adding to your OMERO startup script or to the omero user's environment (for example in a shell startup script). Add the absolute path to the `bin` directory of the virtual environment `/home/omero/omeroenv` to the `PATH` variable:

```
# Environment file for OMERO

export ICE_HOME=/opt/Ice-3.5.1
export PATH="$ICE_HOME/bin:/home/omero/omeroenv/bin:$PATH"
#Remove commented out export below if Ice is not set globally accessible
#export LD_LIBRARY_PATH="$ICE_HOME/lib64:$ICE_HOME/lib:$LD_LIBRARY_PATH"
export PYTHONPATH="$ICE_HOME/python:$PYTHONPATH"
export SLICEPATH="$ICE_HOME/slice"
```

These settings will enable Python 2.7, and set the necessary environment variables for Ice 3.5 to work.

For example, download `omero-centos6py27ius.env` into `/home/omero` and run:

```
echo source \~omero/omero-centos6py27ius.env >> ~omero/.bashrc
```

Install OMERO.server

The following steps are run as the omero system user.

Download, unzip and configure OMERO. The rest of this walkthrough assumes the OMERO.server is installed into the home directory of the omero system user.

Note that this script requires the same environment variables that were set earlier in *settings.env*, so you may need to copy and/or source this file as the omero user.

You will need to install the server corresponding to your Ice version.

Install `server-ice35.zip`:

```
cd ~omero
SERVER=http://downloads.openmicroscopy.org/latest/omero5.2/server-ice35.zip
wget $SERVER
unzip -q OMERO.server*
```

Configure:

```
ln -s OMERO.server-*/ OMERO.server
OMERO.server/bin/omero config set omero.data.dir "$OMERO_DATA_DIR"
OMERO.server/bin/omero config set omero.db.name "$OMERO_DB_NAME"
OMERO.server/bin/omero config set omero.db.user "$OMERO_DB_USER"
OMERO.server/bin/omero config set omero.db.pass "$OMERO_DB_PASS"
OMERO.server/bin/omero db script -f OMERO.server/db.sql --password "$OMERO_ROOT_PASS"
psql -h localhost -U "$OMERO_DB_USER" "$OMERO_DB_NAME" < OMERO.server/db.sql
```

Installing a web server

To Deploy OMERO.web, you can use either Nginx or Apache. Follow the steps to install your chosen web server.

Nginx

See also *OMERO.web Nginx and Gunicorn deployment (Unix/Linux)*.

The following steps are run as root.

Install Nginx 1.8, install the requirements to run OMERO.web in the virtual environment, deactivate it and copy the Nginx OMERO configuration file into the Nginx configuration directory, and disable the default configuration:

```
cat << EOF > /etc/yum.repos.d/nginx.repo
[nginx]
name=nginx repo
baseurl=http://nginx.org/packages/centos/\$releasever/\$basearch/
gpgcheck=0
enabled=1
EOF

#install nginx
yum -y install nginx

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u

# Install OMERO.web requirements
/home/omero/omeroenv/bin/pip2.7 install -r ~omero/OMERO.server/share/web/requirements-py27-nginx.txt

deactivate

# set up as the omero user.
su - omero -c "bash -eux setup_omero_nginx.sh"

mv /etc/nginx/conf.d/default.conf /etc/nginx/conf.d/default.disabled
cp ~omero/OMERO.server/nginx.conf.tmp /etc/nginx/conf.d/omero-web.conf

service nginx start
```

Apache

See also *OMERO.web Apache and mod_wsgi deployment (Unix/Linux)*.

As the **omero** system user, configure OMERO.web by running the following commands:

```
OMERO.server/bin/omero config set omero.web.application_server wsgi
OMERO.server/bin/omero web config apache --http "$OMERO_WEB_PORT" > OMERO.server/apache.conf.tmp
OMERO.server/bin/omero web syncmedia
```

The following steps are run as root.

The version of Apache installed is 2.2, see the note below if you wish to use version 2.4.

Install Apache 2.2, install the requirements to run OMERO.web in the virtual environment, deactivate it and add the path to the virtual environment python to the `python-path` parameter of the `WSGIDaemonProcess` directive:

```
#install Apache 2.2
yum -y install httpd

# install mod_wsgi compiled against 2.7
yum -y install python27-mod_wsgi

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u

# Install OMERO.web requirements
/home/omero/omeroenv/bin/pip2.7 install -r ~omero/OMERO.server/share/web/requirements-py27-apache.txt

deactivate

# Add virtual env python to the python-path parameter of the WSGIDaemonProcess directive
sed -i 's/\(python-path\=\)/\1\/home\/omero\/omeroenv\/lib64\/python2.7\/site-packages:/' ~omero/OMERO.

cp ~omero/OMERO.server/apache.conf.tmp /etc/httpd/conf.d/omero-web.conf

chkconfig httpd on
service httpd start
```

Note: If you wish to use Apache 2.4 with mod_wsgi, see omero-install[27] for a possible solution.

Running OMERO

The following steps are run as the omero system user.

OMERO should now be set up. To start the server run:

```
OMERO.server/bin/omero admin start
```

If you deploy with Nginx, to start the OMERO.web client run:

```
OMERO.server/bin/omero web start
```

The last command is **not** necessary if you deploy with Apache.

[27] https://github.com/ome/omero-install

Nginx or Apache should already be running so you should be able to log in as the OMERO root user by going to http://localhost/ in your web browser. Please read the SELinux section below.

In addition some example *init.d* scripts are available should you wish to start OMERO and OMERO.web automatically:

```
cp omero-init.d /etc/init.d/omero
chmod a+x /etc/init.d/omero

cp omero-web-init.d /etc/init.d/omero-web
chmod a+x /etc/init.d/omero-web

chkconfig --del omero
chkconfig --add omero
chkconfig --del omero-web
chkconfig --add omero-web
```

omero-init.d

omero-web-init.d

Securing OMERO

The following steps are run as root.

If multiple users have access to the machine running OMERO you should restrict access to OMERO.server's configuration and runtime directories, and optionally the OMERO data directory:

```
chmod go-rwx ~omero/OMERO.server/etc ~omero/OMERO.server/var

# Optionally restrict access to the OMERO data directory
#chmod go-rwx "$OMERO_DATA_DIR"
```

Regular tasks

The following steps are run as root.

The default OMERO.web session handler uses temporary files to store sessions which should be deleted at regular intervals, for instance by creating a cron job:

```
OMERO_USER=omero
OMERO_SERVER=/home/omero/OMERO.server
su - ${OMERO_USER} -c "${OMERO_SERVER}/bin/omero web clearsessions"
```

Copy the following commands into the appropriate location:

```
cp omero-web-cron /etc/cron.daily/omero-web
chmod a+x /etc/cron.daily/omero-web
```

omero-web-cron

SELinux

The following steps are run as root.

If you are running a system with SELinux enabled (it is enabled by default on CentOS 6[28]) and are unable to access OMERO.web you may need to adjust the security policy:

```
if [ $(getenforce) != Disabled ]; then
    yum -y install policycoreutils-python
    setsebool -P httpd_read_user_content 1
    setsebool -P httpd_enable_homedirs 1
    semanage port -a -t http_port_t -p tcp 4080
fi
```

Installing Web apps

The following steps are run as root.

It is possible to add Web applications to OMERO. If your app required some extra Python packages installed using `pip`, those packages should be also installed in the virtual environment. For example, OMERO.figure[29] requires `reportlab` and `markdown`:

```
virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
source /home/omero/omeroenv/bin/activate
/home/omero/omeroenv/bin/pip2.7 install reportlab markdown
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.3 OMERO.server installation on CentOS 6 with Python 2.7 and Ice 3.6

This installation walkthrough should be read in conjunction with *OMERO.server installation* and *OMERO.web deployment*.

Running OMERO on CentOS 6 has a number of special requirements which deviate from the standard installation instructions. The instructions below will set up Python 2.7 and Ice 3.6 on CentOS 6. We tested the installation with Python 2.7 from IUS[30] and used a virtual environment[31] to install the various dependencies required to install an OMERO.server. It is also possible to use SCL Python (for example `walkthrough_centos6_py27.sh`) but such solution could have potential side effects.

Setting up

Python 2.7

CentOS 6 provides Python 2.6. However, OMERO.web requires Python 2.7 in order to use Django 1.8[32]. While Django 1.6 may be used with Python 2.6, this version of Django no longer has security support. In consequence, it is necessary to upgrade to Python 2.7 in order to obtain Django security updates, which are required for a production deployment.

Ice 3.6

With Ice 3.6, the Python bindings are provided separately. This allows to install the RPM packages provided by ZeroC for CentOS 6. Then run `pip install zeroc-ice` to install the Ice Python bindings if your package manager does not provide the Ice python packages. See Using the Python Distribution[33] for further details.

[28] http://wiki.centos.org/HowTos/SELinux
[29] http://figure.openmicroscopy.org/
[30] https://ius.io/
[31] https://virtualenv.readthedocs.org/en/latest/
[32] https://docs.djangoproject.com/en/1.8/releases/1.8/
[33] https://doc.zeroc.com/display/Ice36/Using+the+Python+Distribution

Installing prerequisites

The following steps are run as root.

Install Java 1.8, Ice 3.6 and PostgreSQL 9.4:

To install Java 1.8 and other dependencies:

```
# epel-release will be pulled as a dependency
yum -y install https://centos6.iuscommunity.org/ius-release.rpm

# installed for convenience
yum -y install unzip wget tar

# install Java
yum -y install java-1.8.0-openjdk

# install dependencies

yum -y install \
        python27 \
        python27-devel \
        libjpeg-devel \
        libpng-devel \
        libtiff-devel \
        hdf5-devel \
        zlib-devel \
        freetype-devel

# install pip and virtualenv using Python 2.6
yum -y install python-pip

pip install --upgrade virtualenv

#if virtualenv is not installed (unlikely)
#yum -y install python27-pip
#pip2.7 install virtualenv

# TODO: this installs a lot of unecessary packages:
yum -y groupinstall "Development Tools"

export PYTHONWARNINGS="ignore:Unverified HTTPS request"
```

To install Ice 3.6:

```
cd /etc/yum.repos.d
wget https://zeroc.com/download/rpm/zeroc-ice-el6.repo

yum -y install gcc-c++
yum -y install db53 db53-utils
yum -y install ice-all-runtime ice-all-devel

yum -y install openssl-devel bzip2-devel expat-devel

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u

/home/omero/omeroenv/bin/pip2.7 install "zeroc-ice>3.5,<3.7"

deactivate
```

To install PostgreSQL 9.4:

```
# install Postgres
# Postgres, reconfigure to allow TCP connections
yum -y install http://yum.postgresql.org/9.4/redhat/rhel-6-x86_64/pgdg-centos94-9.4-2.noarch.rpm
yum -y install postgresql94-server postgresql94

service postgresql-9.4 initdb
sed -i.bak -re 's/^(host.*)ident/\1md5/' /var/lib/pgsql/9.4/data/pg_hba.conf
chkconfig postgresql-9.4 on
service postgresql-9.4 start
```

The remaining dependencies will be installed in a virtual environment:

```
# Install the OMERO dependencies in a virtual environment
# Create virtual env.
# -p only required if virtualenv has been installed with python 2.6

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u
/home/omero/omeroenv/bin/pip install --upgrade pip

/home/omero/omeroenv/bin/pip2.7 install -r requirements_centos6_py27_ius.txt

deactivate
```

See `requirements_centos6_py27_ius.txt`

Create an omero system user, and a directory for the OMERO repository:

```
useradd -m omero

mkdir -p "$OMERO_DATA_DIR"
chown omero "$OMERO_DATA_DIR"
```

Create a database user and initialize a new database for OMERO:

```
echo "CREATE USER $OMERO_DB_USER PASSWORD '$OMERO_DB_PASS'" | \
    su - postgres -c psql
su - postgres -c "createdb -E UTF8 -O '$OMERO_DB_USER' '$OMERO_DB_NAME'"

psql -P pager=off -h localhost -U "$OMERO_DB_USER" -l
```

The following settings will need adding to your OMERO startup script or to the omero user's environment (for example in a shell startup script). Add the absolute path to the `bin` directory of the virtual environment `/home/omero/omeroenv` to the `PATH` variable:

```
echo "export PATH=\"/home/omero/omeroenv/bin:$PATH\"" >> ~omero/.bashrc
```

These settings will enable Python 2.7, and set the necessary environment variables for Ice 3.6 to work.

Install OMERO.server

The following steps are run as the omero system user.

Download, unzip and configure OMERO. The rest of this walkthrough assumes the OMERO.server is installed into the home directory of the omero system user.

Note that this script requires the same environment variables that were set earlier in *settings.env*, so you may need to copy and/or source this file as the omero user.

You will need to install the server corresponding to your Ice version.

Install `server-ice36.zip`:

```
cd ~omero
SERVER=http://downloads.openmicroscopy.org/latest/omero5.2/server-ice36.zip
wget $SERVER -O OMERO.server-ice36.zip
unzip -q OMERO.server*
```

Configure:

```
ln -s OMERO.server-*/ OMERO.server
OMERO.server/bin/omero config set omero.data.dir "$OMERO_DATA_DIR"
OMERO.server/bin/omero config set omero.db.name "$OMERO_DB_NAME"
OMERO.server/bin/omero config set omero.db.user "$OMERO_DB_USER"
OMERO.server/bin/omero config set omero.db.pass "$OMERO_DB_PASS"
OMERO.server/bin/omero db script -f OMERO.server/db.sql --password "$OMERO_ROOT_PASS"
psql -h localhost -U "$OMERO_DB_USER" "$OMERO_DB_NAME" < OMERO.server/db.sql
```

Installing a web server

To Deploy OMERO.web, you can use either Nginx or Apache. Follow the steps to install your chosen web server.

Nginx

See also *OMERO.web Nginx and Gunicorn deployment (Unix/Linux)*.

The following steps are run as root.

Install Nginx 1.8, install the requirements to run OMERO.web in the virtual environment, deactivate it and copy the Nginx OMERO configuration file into the Nginx configuration directory, and disable the default configuration:

```
cat << EOF > /etc/yum.repos.d/nginx.repo
[nginx]
name=nginx repo
baseurl=http://nginx.org/packages/centos/\$releasever/\$basearch/
gpgcheck=0
enabled=1
EOF

#install nginx
yum -y install nginx

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u

# Install OMERO.web requirements
/home/omero/omeroenv/bin/pip2.7 install -r ~omero/OMERO.server/share/web/requirements-py27-nginx.txt

deactivate

# set up as the omero user.
su - omero -c "bash -eux setup_omero_nginx.sh"

mv /etc/nginx/conf.d/default.conf /etc/nginx/conf.d/default.disabled
```

```
cp ~omero/OMERO.server/nginx.conf.tmp /etc/nginx/conf.d/omero-web.conf

service nginx start
```

Apache

See also *OMERO.web Apache and mod_wsgi deployment (Unix/Linux)*.

As the **omero** system user, configure OMERO.web by running the following commands:

```
OMERO.server/bin/omero config set omero.web.application_server wsgi
OMERO.server/bin/omero web config apache --http "$OMERO_WEB_PORT" > OMERO.server/apache.conf.tmp
OMERO.server/bin/omero web syncmedia
```

The following steps are run as root.

The version of Apache installed is 2.2, see the note below if you wish to use version 2.4.

Install Apache 2.2, install the requirements to run OMERO.web in the virtual environment, deactivate it and add the path to the virtual environment python to the `python-path` parameter of the `WSGIDaemonProcess` directive:

```
#install Apache 2.2
yum -y install httpd

# install mod_wsgi compiled against 2.7
yum -y install python27-mod_wsgi

virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
set +u
source /home/omero/omeroenv/bin/activate
set -u

# Install OMERO.web requirements
/home/omero/omeroenv/bin/pip2.7 install -r ~omero/OMERO.server/share/web/requirements-py27-apache.txt

deactivate

# Add virtual env python to the python-path parameter of the WSGIDaemonProcess directive
sed -i 's/\(python-path\=\)/\1\/home\/omero\/omeroenv\/lib64\/python2.7\/site-packages:/' ~omero/OMERO.

cp ~omero/OMERO.server/apache.conf.tmp /etc/httpd/conf.d/omero-web.conf

chkconfig httpd on
service httpd start
```

Note: If you wish to use Apache 2.4 with mod_wsgi, see omero-install[34] for a possible solution.

Running OMERO

The following steps are run as the omero system user.

OMERO should now be set up. To start the server run:

```
OMERO.server/bin/omero admin start
```

[34] https://github.com/ome/omero-install

If you deploy with Nginx, to start the OMERO.web client run:

```
OMERO.server/bin/omero web start
```

The last command is **not** necessary if you deploy with Apache.

Nginx or Apache should already be running so you should be able to log in as the OMERO root user by going to http://localhost/ in your web browser. Please read the SELinux section below.

In addition some example *init.d* scripts are available should you wish to start OMERO and OMERO.web automatically:

```
cp omero-init.d /etc/init.d/omero
chmod a+x /etc/init.d/omero

cp omero-web-init.d /etc/init.d/omero-web
chmod a+x /etc/init.d/omero-web

chkconfig --del omero
chkconfig --add omero
chkconfig --del omero-web
chkconfig --add omero-web
```

```
omero-init.d
omero-web-init.d
```

Securing OMERO

The following steps are run as root.

If multiple users have access to the machine running OMERO you should restrict access to OMERO.server's configuration and runtime directories, and optionally the OMERO data directory:

```
chmod go-rwx ~omero/OMERO.server/etc ~omero/OMERO.server/var

# Optionally restrict access to the OMERO data directory
#chmod go-rwx "$OMERO_DATA_DIR"
```

Regular tasks

The following steps are run as root.

The default OMERO.web session handler uses temporary files to store sessions which should be deleted at regular intervals, for instance by creating a cron job:

```
OMERO_USER=omero
OMERO_SERVER=/home/omero/OMERO.server
su - ${OMERO_USER} -c "${OMERO_SERVER}/bin/omero web clearsessions"
```

Copy the following commands into the appropriate location:

```
cp omero-web-cron /etc/cron.daily/omero-web
chmod a+x /etc/cron.daily/omero-web
```

```
omero-web-cron
```

SELinux

The following steps are run as root.

If you are running a system with SELinux enabled (it is enabled by default on CentOS 6[35]) and are unable to access OMERO.web you may need to adjust the security policy:

```
if [ $(getenforce) != Disabled ]; then
    yum -y install policycoreutils-python
    setsebool -P httpd_read_user_content 1
    setsebool -P httpd_enable_homedirs 1
    semanage port -a -t http_port_t -p tcp 4080
fi
```

Installing Web apps

The following steps are run as root.

It is possible to add Web applications to OMERO. If your app required some extra Python packages installed using `pip`, those packages should be also installed in the virtual environment. For example, OMERO.figure[36] requires `reportlab` and `markdown`:

```
virtualenv -p /usr/bin/python2.7 /home/omero/omeroenv
source /home/omero/omeroenv/bin/activate
/home/omero/omeroenv/bin/pip2.7 install reportlab markdown
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.4 OMERO.server installation on CentOS 7 and Ice 3.5

This is an example walkthrough for installing OMERO on CentOS 7, using a dedicated system user, and should be read in conjunction with *OMERO.web deployment*. You can use this as a guide for setting up your own test server. For production use you should also read the pages listed under *Optimizing Server Configuration*.

These instructions assume your Linux distribution is configured with a UTF-8 locale (this is normally the default).

For convenience in this walkthrough the main OMERO configuration options have been defined as environment variables. When following this walkthrough you can either use your own values, or alternatively source the following file:

```
OMERO_DB_USER=db_user
OMERO_DB_PASS=db_password
OMERO_DB_NAME=omero_database
OMERO_ROOT_PASS=omero_root_password
OMERO_DATA_DIR=/OMERO

OMERO_WEB_PORT=80

export OMERO_DB_USER OMERO_DB_PASS OMERO_DB_NAME OMERO_ROOT_PASS OMERO_DATA_DIR OMERO_WEB_PORT

export PGPASSWORD="$OMERO_DB_PASS"
```

`settings.env`

[35] http://wiki.centos.org/HowTos/SELinux
[36] http://figure.openmicroscopy.org/

Installing prerequisites

The following steps are run as root.

Install Java 1.8, Ice 3.5 and PostgreSQL 9.4:

To install Java 1.8 and other dependencies:

```
yum -y install epel-release

# installed for convenience
yum -y install unzip wget

# install Java
yum -y install java-1.8.0-openjdk

# install dependencies

yum -y install \
        python-pip python-devel python-virtualenv \
        numpy scipy python-matplotlib python-tables

yum -y install \
        zlib-devel \
        libjpeg-devel \
        gcc
pip install --upgrade pip

pip install -r `dirname $0`/requirements.txt
```

To install Ice 3.5:

```
curl -o /etc/yum.repos.d/zeroc-ice-el7.repo \
http://download.zeroc.com/Ice/3.5/el7/zeroc-ice-el7.repo

yum -y install ice ice-python ice-servers
```

To install PostgreSQL 9.4:

```
# install Postgres
# Postgres, reconfigure to allow TCP connections
yum -y install http://yum.postgresql.org/9.4/redhat/rhel-7-x86_64/pgdg-centos94-9.4-2.noarch.rpm
yum -y install postgresql94-server postgresql94

PGSETUP_INITDB_OPTIONS=--encoding=UTF8 /usr/pgsql-9.4/bin/postgresql94-setup initdb

sed -i.bak -re 's/^(host.*)ident/\1md5/' /var/lib/pgsql/9.4/data/pg_hba.conf
systemctl start postgresql-9.4.service

systemctl enable postgresql-9.4.service
```

See `requirements.txt`

Create an omero system user, and a directory for the OMERO repository:

```
useradd -m omero
chmod a+X ~omero

mkdir -p "$OMERO_DATA_DIR"
chown omero "$OMERO_DATA_DIR"
```

Create a database user and initialize a new database for OMERO:

```
echo "CREATE USER $OMERO_DB_USER PASSWORD '$OMERO_DB_PASS'" | \
    su - postgres -c psql
su - postgres -c "createdb -E UTF8 -O '$OMERO_DB_USER' '$OMERO_DB_NAME'"

psql -P pager=off -h localhost -U "$OMERO_DB_USER" -l
```

Installing OMERO.server

The following steps are run as the omero system user.

Download, unzip and configure OMERO. The rest of this walkthrough assumes the OMERO.server is installed into the home directory of the omero system user.

Note that this script requires the same environment variables that were set earlier in *settings.env*, so you may need to copy and/or source this file as the omero user.

You will need to install the server corresponding to your Ice version.

Install `server-ice35.zip`:

```
cd ~omero
SERVER=http://downloads.openmicroscopy.org/latest/omero5.2/server-ice35.zip
wget $SERVER
unzip -q OMERO.server*
```

Configure:

```
ln -s OMERO.server-*/ OMERO.server
OMERO.server/bin/omero config set omero.data.dir "$OMERO_DATA_DIR"
OMERO.server/bin/omero config set omero.db.name "$OMERO_DB_NAME"
OMERO.server/bin/omero config set omero.db.user "$OMERO_DB_USER"
OMERO.server/bin/omero config set omero.db.pass "$OMERO_DB_PASS"
OMERO.server/bin/omero db script -f OMERO.server/db.sql --password "$OMERO_ROOT_PASS"
psql -h localhost -U "$OMERO_DB_USER" "$OMERO_DB_NAME" < OMERO.server/db.sql
```

Installing a web server

To Deploy OMERO.web, you can use either Nginx or Apache. Follow the steps to install your chosen web server.

Nginx

See also *OMERO.web Nginx and Gunicorn deployment (Unix/Linux)*.

The following steps are run as root.

Install Nginx 1.8, copy the Nginx OMERO configuration file into the Nginx configuration directory, and disable the default configuration:

```
# The following is only required to install
# latest stable version of nginx
# Default will be 1.6.3 if not set
cat << EOF > /etc/yum.repos.d/nginx.repo
[nginx]
name=nginx repo
baseurl=http://nginx.org/packages/centos/\$releasever/\$basearch/
gpgcheck=0
enabled=1
```

```
EOF

#install nginx
yum -y install nginx

pip install -r ~omero/OMERO.server/share/web/requirements-py27-nginx.txt

# set up as the omero user.
su - omero -c "bash -eux setup_omero_nginx.sh"

sed -i.bak -re 's/( default_server.*)/; #\1/' /etc/nginx/nginx.conf
mv /etc/nginx/conf.d/default.conf /etc/nginx/conf.d/default.disabled
cp ~omero/OMERO.server/nginx.conf.tmp /etc/nginx/conf.d/omero-web.conf

systemctl enable nginx

systemctl start nginx
```

Apache

See also *OMERO.web Apache and mod_wsgi deployment (Unix/Linux)*.

As the **omero** system user, configure OMERO.web:

```
OMERO.server/bin/omero config set omero.web.application_server wsgi
OMERO.server/bin/omero web config apache24 --http "$OMERO_WEB_PORT" > OMERO.server/apache.conf.tmp
OMERO.server/bin/omero web syncmedia
```

The following steps are run as root.

Install Apache 2.4 and copy the Apache OMERO configuration file into the Apache configuration directory:

```
yum -y install httpd mod_wsgi

# Install OMERO.web requirements
pip install -r ~omero/OMERO.server/share/web/requirements-py27-apache.txt

cp ~omero/OMERO.server/apache.conf.tmp /etc/httpd/conf.d/omero-web.conf

rm -rf /run/httpd/* /tmp/httpd*

systemctl enable httpd.service

systemctl start httpd
```

Running OMERO

The following steps are run as the omero system user.

OMERO should now be set up. To start the server run:

```
OMERO.server/bin/omero admin start
```

If you deploy with Nginx, to start the OMERO.web client run:

```
OMERO.server/bin/omero web start
```

The last command is **not** necessary if you deploy with Apache.

Nginx or Apache should already be running so you should be able to log in as the OMERO root user by going to http://localhost/ in your web browser. Please read the SELinux section below.

In addition some example *systemd.service* scripts are available should you wish to start OMERO and OMERO.web automatically:

```
cp omero-systemd.service /etc/systemd/system/omero.service

cp omero-web-systemd.service /etc/systemd/system/omero-web.service

systemctl daemon-reload

systemctl enable omero.service
systemctl enable omero-web.service
```

```
omero-systemd.service
omero-web-systemd.service
```

Securing OMERO

The following steps are run as root.

If multiple users have access to the machine running OMERO you should restrict access to OMERO.server's configuration and runtime directories, and optionally the OMERO data directory:

```
chmod go-rwx ~omero/OMERO.server/etc ~omero/OMERO.server/var

# Optionally restrict access to the OMERO data directory
#chmod go-rwx "$OMERO_DATA_DIR"
```

Regular tasks

The following steps are run as root.

The default OMERO.web session handler uses temporary files to store sessions which should be deleted at regular intervals, for instance by creating a cron job:

```
OMERO_USER=omero
OMERO_SERVER=/home/omero/OMERO.server
su - ${OMERO_USER} -c "${OMERO_SERVER}/bin/omero web clearsessions"
```

Copy this script into the appropriate location:

```
cp omero-web-cron /etc/cron.daily/omero-web
chmod a+x /etc/cron.daily/omero-web
```

```
omero-web-cron
```

SELinux

The following steps are run as root.

If you are running a system with SELinux enabled[37] and are unable to access OMERO.web you may need to adjust the security policy:

```
if [ $(getenforce) != Disabled ]; then
    yum -y install policycoreutils-python
    setsebool -P httpd_read_user_content 1
    setsebool -P httpd_enable_homedirs 1
    semanage port -a -t http_port_t -p tcp 4080
fi
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.5 OMERO.server installation on CentOS 7 and Ice 3.6

This is an example walkthrough for installing OMERO on CentOS 7, using a dedicated system user, and should be read in conjunction with *OMERO.web deployment*. You can use this as a guide for setting up your own test server. For production use you should also read the pages listed under *Optimizing Server Configuration*.

These instructions assume your Linux distribution is configured with a UTF-8 locale (this is normally the default).

For convenience in this walkthrough the main OMERO configuration options have been defined as environment variables. When following this walkthrough you can either use your own values, or alternatively source the following file:

```
OMERO_DB_USER=db_user
OMERO_DB_PASS=db_password
OMERO_DB_NAME=omero_database
OMERO_ROOT_PASS=omero_root_password
OMERO_DATA_DIR=/OMERO

OMERO_WEB_PORT=80

export OMERO_DB_USER OMERO_DB_PASS OMERO_DB_NAME OMERO_ROOT_PASS OMERO_DATA_DIR OMERO_WEB_PORT

export PGPASSWORD="$OMERO_DB_PASS"
```

settings.env

Installing prerequisites

The following steps are run as root.

Install Java 1.8, Ice 3.6 and PostgreSQL 9.4:

To install Java 1.8 and other dependencies:

```
yum -y install epel-release

# installed for convenience
yum -y install unzip wget

# install Java
yum -y install java-1.8.0-openjdk
```

[37] http://wiki.centos.org/HowTos/SELinux

```
# install dependencies

yum -y install \
        python-pip python-devel python-virtualenv \
        numpy scipy python-matplotlib python-tables

yum -y install \
        zlib-devel \
        libjpeg-devel \
        gcc
pip install --upgrade pip

pip install -r `dirname $0`/requirements.txt
```

To install Ice 3.6:

```
cd /etc/yum.repos.d
wget https://zeroc.com/download/rpm/zeroc-ice-el7.repo

yum -y install gcc-c++
yum -y install libdb-utils
yum -y install openssl-devel bzip2-devel expat-devel

yum -y install ice-all-runtime ice-all-devel

pip install "zeroc-ice>3.5,<3.7"
```

To install PostgreSQL 9.4:

```
# install Postgres
# Postgres, reconfigure to allow TCP connections
yum -y install http://yum.postgresql.org/9.4/redhat/rhel-7-x86_64/pgdg-centos94-9.4-2.noarch.rpm
yum -y install postgresql94-server postgresql94

PGSETUP_INITDB_OPTIONS=--encoding=UTF8 /usr/pgsql-9.4/bin/postgresql94-setup initdb

sed -i.bak -re 's/^(host.*)ident/\1md5/' /var/lib/pgsql/9.4/data/pg_hba.conf
systemctl start postgresql-9.4.service

systemctl enable postgresql-9.4.service
```

See `requirements.txt`

Create an omero system user, and a directory for the OMERO repository:

```
useradd -m omero
chmod a+X ~omero

mkdir -p "$OMERO_DATA_DIR"
chown omero "$OMERO_DATA_DIR"
```

Create a database user and initialize a new database for OMERO:

```
echo "CREATE USER $OMERO_DB_USER PASSWORD '$OMERO_DB_PASS'" | \
    su - postgres -c psql
su - postgres -c "createdb -E UTF8 -O '$OMERO_DB_USER' '$OMERO_DB_NAME'"

psql -P pager=off -h localhost -U "$OMERO_DB_USER" -l
```

Installing OMERO.server

The following steps are run as the omero system user.

Download, unzip and configure OMERO. The rest of this walkthrough assumes the OMERO.server is installed into the home directory of the omero system user.

Note that this script requires the same environment variables that were set earlier in *settings.env*, so you may need to copy and/or source this file as the omero user.

You will need to install the server corresponding to your Ice version.

Install `server-ice36.zip`:

```
cd ~omero
SERVER=http://downloads.openmicroscopy.org/latest/omero5.2/server-ice36.zip
wget $SERVER -O OMERO.server-ice36.zip
unzip -q OMERO.server*
```

Configure:

```
ln -s OMERO.server-*/ OMERO.server
OMERO.server/bin/omero config set omero.data.dir "$OMERO_DATA_DIR"
OMERO.server/bin/omero config set omero.db.name "$OMERO_DB_NAME"
OMERO.server/bin/omero config set omero.db.user "$OMERO_DB_USER"
OMERO.server/bin/omero config set omero.db.pass "$OMERO_DB_PASS"
OMERO.server/bin/omero db script -f OMERO.server/db.sql --password "$OMERO_ROOT_PASS"
psql -h localhost -U "$OMERO_DB_USER" "$OMERO_DB_NAME" < OMERO.server/db.sql
```

Installing a web server

To Deploy OMERO.web, you can use either Nginx or Apache. Follow the steps to install your chosen web server.

Nginx

See also *OMERO.web Nginx and Gunicorn deployment (Unix/Linux)*.

The following steps are run as root.

Install Nginx 1.8, copy the Nginx OMERO configuration file into the Nginx configuration directory, and disable the default configuration:

```
# The following is only required to install
# latest stable version of nginx
# Default will be 1.6.3 if not set
cat << EOF > /etc/yum.repos.d/nginx.repo
[nginx]
name=nginx repo
baseurl=http://nginx.org/packages/centos/\$releasever/\$basearch/
gpgcheck=0
enabled=1
EOF

#install nginx
yum -y install nginx

pip install -r ~omero/OMERO.server/share/web/requirements-py27-nginx.txt

# set up as the omero user.
su - omero -c "bash -eux setup_omero_nginx.sh"
```

```
sed -i.bak -re 's/( default_server.*)/; #\1/' /etc/nginx/nginx.conf
mv /etc/nginx/conf.d/default.conf /etc/nginx/conf.d/default.disabled
cp ~omero/OMERO.server/nginx.conf.tmp /etc/nginx/conf.d/omero-web.conf

systemctl enable nginx

systemctl start nginx
```

Apache

See also *OMERO.web Apache and mod_wsgi deployment (Unix/Linux)*.

As the **omero** system user, configure OMERO.web:

```
OMERO.server/bin/omero config set omero.web.application_server wsgi
OMERO.server/bin/omero web config apache24 --http "$OMERO_WEB_PORT" > OMERO.server/apache.conf.tmp
OMERO.server/bin/omero web syncmedia
```

The following steps are run as root.

Install Apache 2.4 and copy the Apache OMERO configuration file into the Apache configuration directory:

```
yum -y install httpd mod_wsgi

# Install OMERO.web requirements
pip install -r ~omero/OMERO.server/share/web/requirements-py27-apache.txt

cp ~omero/OMERO.server/apache.conf.tmp /etc/httpd/conf.d/omero-web.conf

rm -rf /run/httpd/* /tmp/httpd*

systemctl enable httpd.service

systemctl start httpd
```

Running OMERO

The following steps are run as the omero system user.

OMERO should now be set up. To start the server run:

```
OMERO.server/bin/omero admin start
```

If you deploy with Nginx, to start the OMERO.web client run:

```
OMERO.server/bin/omero web start
```

The last command is **not** necessary if you deploy with Apache.

Nginx or Apache should already be running so you should be able to log in as the OMERO root user by going to http://localhost/ in your web browser. Please read the SELinux section below.

In addition some example *systemd.service* scripts are available should you wish to start OMERO and OMERO.web automatically:

```
cp omero-systemd.service /etc/systemd/system/omero.service

cp omero-web-systemd.service /etc/systemd/system/omero-web.service

systemctl daemon-reload

systemctl enable omero.service
systemctl enable omero-web.service
```

```
omero-systemd.service
omero-web-systemd.service
```

Securing OMERO

The following steps are run as root.

If multiple users have access to the machine running OMERO you should restrict access to OMERO.server's configuration and runtime directories, and optionally the OMERO data directory:

```
chmod go-rwx ~omero/OMERO.server/etc ~omero/OMERO.server/var

# Optionally restrict access to the OMERO data directory
#chmod go-rwx "$OMERO_DATA_DIR"
```

Regular tasks

The following steps are run as root.

The default OMERO.web session handler uses temporary files to store sessions which should be deleted at regular intervals, for instance by creating a cron job:

```
OMERO_USER=omero
OMERO_SERVER=/home/omero/OMERO.server
su - ${OMERO_USER} -c "${OMERO_SERVER}/bin/omero web clearsessions"
```

Copy this script into the appropriate location:

```
cp omero-web-cron /etc/cron.daily/omero-web
chmod a+x /etc/cron.daily/omero-web
```

```
omero-web-cron
```

SELinux

The following steps are run as root.

If you are running a system with SELinux enabled[38] and are unable to access OMERO.web you may need to adjust the security policy:

[38] http://wiki.centos.org/HowTos/SELinux

```
if [ $(getenforce) != Disabled ]; then
    yum -y install policycoreutils-python
    setsebool -P httpd_read_user_content 1
    setsebool -P httpd_enable_homedirs 1
    semanage port -a -t http_port_t -p tcp 4080
fi
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.6 OMERO.server installation on Ubuntu 14.04 and Ice 3.5

This is an example walkthrough for installing OMERO on Ubuntu, using a dedicated system user, and should be read in conjunction with *OMERO.web deployment*. You can use this as a guide for setting up your own test server. For production use you should also read the pages listed under *Optimizing Server Configuration*.

These instructions assume your Linux distribution is configured with a UTF-8 locale (this is normally the default).

For convenience in this walkthrough the main OMERO configuration options have been defined as environment variables. When following this walkthrough you can either use your own values, or alternatively source the following file:

```
OMERO_DB_USER=db_user
OMERO_DB_PASS=db_password
OMERO_DB_NAME=omero_database
OMERO_ROOT_PASS=omero_root_password
OMERO_DATA_DIR=/OMERO

OMERO_WEB_PORT=80

export OMERO_DB_USER OMERO_DB_PASS OMERO_DB_NAME OMERO_ROOT_PASS OMERO_DATA_DIR OMERO_WEB_PORT

export PGPASSWORD="$OMERO_DB_PASS"
```

settings.env

Installing prerequisites

The following steps are run as root.

Install Java 1.8, Ice 3.5 and PostgreSQL 9.4:

To install Java 1.8 and other dependencies:

```
apt-get update

# installed for convenience
apt-get -y install unzip wget

# install Java
apt-get -y install software-properties-common
add-apt-repository -y ppa:openjdk-r/ppa
apt-get update
apt-get -y install openjdk-8-jre

# install dependencies

apt-get update
apt-get -y install \
        unzip \
```

```
        wget \
        python-{matplotlib,numpy,pip,scipy,tables,virtualenv}

# require to install Pillow
apt-get -y install \
        libtiff5-dev \
        libjpeg8-dev \
        zlib1g-dev \
        libfreetype6-dev \
        liblcms2-dev \
        libwebp-dev \
        tcl8.6-dev \
        tk8.6-dev

pip install --upgrade pip

# upgrade required since pillow is already installed
pip install --upgrade -r requirements.txt
```

To install Ice 3.5:

```
apt-get -y install ice-services python-zeroc-ice
```

To install PostgreSQL 9.4:

```
# install Postgres
apt-get -y install apt-transport-https
add-apt-repository -y "deb https://apt.postgresql.org/pub/repos/apt/ trusty-pgdg main"
wget --quiet -O - https://www.postgresql.org/media/keys/ACCC4CF8.asc | apt-key add -
apt-get update
apt-get -y install postgresql-9.4
service postgresql start
```

See `requirements.txt`

Create an omero system user, and a directory for the OMERO repository:

```
useradd -m omero
chmod a+X ~omero

mkdir -p "$OMERO_DATA_DIR"
chown omero "$OMERO_DATA_DIR"
```

Create a database user and initialize a new database for OMERO:

```
echo "CREATE USER $OMERO_DB_USER PASSWORD '$OMERO_DB_PASS'" | \
    su - postgres -c psql
su - postgres -c "createdb -E UTF8 -O '$OMERO_DB_USER' '$OMERO_DB_NAME'"

psql -P pager=off -h localhost -U "$OMERO_DB_USER" -l
```

Installing OMERO.server

The following steps are run as the omero system user.

Download, unzip and configure OMERO. The rest of this walkthrough assumes the OMERO.server is installed into the home directory of the omero system user.

Note that this script requires the same environment variables that were set earlier in *settings.env*, so you may need to copy and/or source this file as the omero user.

You will need to install the server corresponding to your Ice version.

Install `server-ice35.zip`:

```
cd ~omero
SERVER=http://downloads.openmicroscopy.org/latest/omero5.2/server-ice35.zip
wget $SERVER
unzip -q OMERO.server*
```

Configure:

```
ln -s OMERO.server-*/ OMERO.server
OMERO.server/bin/omero config set omero.data.dir "$OMERO_DATA_DIR"
OMERO.server/bin/omero config set omero.db.name "$OMERO_DB_NAME"
OMERO.server/bin/omero config set omero.db.user "$OMERO_DB_USER"
OMERO.server/bin/omero config set omero.db.pass "$OMERO_DB_PASS"
OMERO.server/bin/omero db script -f OMERO.server/db.sql --password "$OMERO_ROOT_PASS"
psql -h localhost -U "$OMERO_DB_USER" "$OMERO_DB_NAME" < OMERO.server/db.sql
```

Installing a web server

To Deploy OMERO.web, you can use either Nginx or Apache. Follow the steps to install your chosen web server.

Nginx

See also *OMERO.web Nginx and Gunicorn deployment (Unix/Linux)*.

The following steps are run as root.

Install Nginx 1.8, copy the Nginx OMERO configuration file into the Nginx configuration directory, and disable the default configuration:

```
# require to install more recent version of nginx
# w/o the version installed is 1.4.6
add-apt-repository -y ppa:nginx/stable

apt-get update
apt-get -y install nginx

pip install -r ~omero/OMERO.server/share/web/requirements-py27-nginx.txt

# set up as the omero user.
su - omero -c "bash -eux setup_omero_nginx.sh"

cp ~omero/OMERO.server/nginx.conf.tmp /etc/nginx/sites-available/omero-web
rm /etc/nginx/sites-enabled/default
ln -s /etc/nginx/sites-available/omero-web /etc/nginx/sites-enabled/

service nginx start
```

Apache

See also *OMERO.web Apache and mod_wsgi deployment (Unix/Linux)*.

As the **omero** system user, configure OMERO.web:

```
OMERO.server/bin/omero config set omero.web.application_server wsgi
OMERO.server/bin/omero web config apache24 --http "$OMERO_WEB_PORT" > OMERO.server/apache.conf.tmp
OMERO.server/bin/omero web syncmedia
```

The following steps are run as root.

Install Apache 2.4 and copy the Apache OMERO configuration file into the Apache configuration directory, and disable the default configuration:

```
apt-get -y install apache2 libapache2-mod-wsgi

# Install OMERO.web requirements
pip install -r ~omero/OMERO.server/share/web/requirements-py27-apache.txt

# Modify the default value set for the ''WSGISocketPrefix'' directive in ''apache.conf.tmp''
sed -i -r -e 's|(WSGISocketPrefix run/wsgi)|#\1|' -e 's|# (WSGISocketPrefix /var/run/wsgi)|\1|' ~omero/OM
cp ~omero/OMERO.server/apache.conf.tmp /etc/apache2/sites-available/omero-web.conf
a2dissite 000-default.conf
a2ensite omero-web.conf

service apache2 start
```

Running OMERO

The following steps are run as the omero system user.

OMERO should now be set up. To start the server run:

```
OMERO.server/bin/omero admin start
```

If you deploy with Nginx, to start the OMERO.web client run:

```
OMERO.server/bin/omero web start
```

The last command is **not** necessary if you deploy with Apache.

Nginx or Apache should already be running so you should be able to log in as the OMERO root user by going to http://localhost/ in your web browser.

In addition some example *init.d* scripts are available should you wish to start OMERO and OMERO.web automatically:

```
cp omero-init.d /etc/init.d/omero
chmod a+x /etc/init.d/omero

cp omero-web-init.d /etc/init.d/omero-web
chmod a+x /etc/init.d/omero-web

update-rc.d -f omero remove
update-rc.d -f omero defaults 98 02
update-rc.d -f omero-web remove
update-rc.d -f omero-web defaults 98 02
```

```
omero-init.d
omero-web-init.d
```

Securing OMERO

The following steps are run as root.

If multiple users have access to the machine running OMERO you should restrict access to OMERO.server's configuration and runtime directories, and optionally the OMERO data directory:

```
chmod go-rwx ~omero/OMERO.server/etc ~omero/OMERO.server/var

# Optionally restrict access to the OMERO data directory
#chmod go-rwx "$OMERO_DATA_DIR"
```

Regular tasks

The following steps are run as root.

The default OMERO.web session handler uses temporary files to store sessions which should be deleted at regular intervals, for instance by creating a cron job:

```
OMERO_USER=omero
OMERO_SERVER=/home/omero/OMERO.server
su - ${OMERO_USER} -c "${OMERO_SERVER}/bin/omero web clearsessions"
```

Copy the following commands into the appropriate location:

```
cp omero-web-cron /etc/cron.daily/omero-web
chmod a+x /etc/cron.daily/omero-web
```

```
omero-web-cron
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.7 OMERO.server installation on Ubuntu 14.04 and Ice 3.6

This is an example walkthrough for installing OMERO on Ubuntu, using a dedicated system user, and should be read in conjunction with *OMERO.web deployment*. You can use this as a guide for setting up your own test server. For production use you should also read the pages listed under *Optimizing Server Configuration*.

These instructions assume your Linux distribution is configured with a UTF-8 locale (this is normally the default).

For convenience in this walkthrough the main OMERO configuration options have been defined as environment variables. When following this walkthrough you can either use your own values, or alternatively source the following file:

```
OMERO_DB_USER=db_user
OMERO_DB_PASS=db_password
OMERO_DB_NAME=omero_database
OMERO_ROOT_PASS=omero_root_password
OMERO_DATA_DIR=/OMERO

OMERO_WEB_PORT=80

export OMERO_DB_USER OMERO_DB_PASS OMERO_DB_NAME OMERO_ROOT_PASS OMERO_DATA_DIR OMERO_WEB_PORT
```

```
export PGPASSWORD="$OMERO_DB_PASS"
```

settings.env

Installing prerequisites

The following steps are run as root.

Install Java 1.8, Ice 3.6 and PostgreSQL 9.4:

To install Java 1.8 and other dependencies:

```
apt-get update

# installed for convenience
apt-get -y install unzip wget

# install Java
apt-get -y install software-properties-common
add-apt-repository -y ppa:openjdk-r/ppa
apt-get update
apt-get -y install openjdk-8-jre

# install dependencies

apt-get update
apt-get -y install \
        unzip \
        wget \
        python-{matplotlib,numpy,pip,scipy,tables,virtualenv}

# require to install Pillow
apt-get -y install \
        libtiff5-dev \
        libjpeg8-dev \
        zlib1g-dev \
        libfreetype6-dev \
        liblcms2-dev \
        libwebp-dev \
        tcl8.6-dev \
        tk8.6-dev

pip install --upgrade pip

# upgrade required since pillow is already installed
pip install --upgrade -r requirements.txt
```

To install Ice 3.6:

```
apt-get -y install db5.3-util
apt-get -y install libssl-dev libbz2-dev libmcpp-dev libdb++-dev libdb-dev

apt-key adv --keyserver keyserver.ubuntu.com --recv 5E6DA83306132997
apt-add-repository "deb http://zeroc.com/download/apt/ubuntu`lsb_release -rs` stable main"
apt-get update
apt-get -y install zeroc-ice-all-runtime zeroc-ice-all-dev

pip install "zeroc-ice>3.5,<3.7"
```

To install PostgreSQL 9.4:

```
# install Postgres
apt-get -y install apt-transport-https
add-apt-repository -y "deb https://apt.postgresql.org/pub/repos/apt/ trusty-pgdg main"
wget --quiet -O - https://www.postgresql.org/media/keys/ACCC4CF8.asc | apt-key add -
apt-get update
apt-get -y install postgresql-9.4
service postgresql start
```

See `requirements.txt`

Create an omero system user, and a directory for the OMERO repository:

```
useradd -m omero
chmod a+X ~omero

mkdir -p "$OMERO_DATA_DIR"
chown omero "$OMERO_DATA_DIR"
```

Create a database user and initialize a new database for OMERO:

```
echo "CREATE USER $OMERO_DB_USER PASSWORD '$OMERO_DB_PASS'" | \
    su - postgres -c psql
su - postgres -c "createdb -E UTF8 -O '$OMERO_DB_USER' '$OMERO_DB_NAME'"

psql -P pager=off -h localhost -U "$OMERO_DB_USER" -l
```

Installing OMERO.server

The following steps are run as the omero system user.

Download, unzip and configure OMERO. The rest of this walkthrough assumes the OMERO.server is installed into the home directory of the omero system user.

Note that this script requires the same environment variables that were set earlier in *settings.env*, so you may need to copy and/or source this file as the omero user.

You will need to install the server corresponding to your Ice version.

Install `server-ice36.zip`:

```
cd ~omero
SERVER=http://downloads.openmicroscopy.org/latest/omero5.2/server-ice36.zip
wget $SERVER -O OMERO.server-ice36.zip
unzip -q OMERO.server*
```

Configure:

```
ln -s OMERO.server-*/ OMERO.server
OMERO.server/bin/omero config set omero.data.dir "$OMERO_DATA_DIR"
OMERO.server/bin/omero config set omero.db.name "$OMERO_DB_NAME"
OMERO.server/bin/omero config set omero.db.user "$OMERO_DB_USER"
OMERO.server/bin/omero config set omero.db.pass "$OMERO_DB_PASS"
OMERO.server/bin/omero db script -f OMERO.server/db.sql --password "$OMERO_ROOT_PASS"
psql -h localhost -U "$OMERO_DB_USER" "$OMERO_DB_NAME" < OMERO.server/db.sql
```

Installing a web server

To Deploy OMERO.web, you can use either Nginx or Apache. Follow the steps to install your chosen web server.

Nginx

See also *OMERO.web Nginx and Gunicorn deployment (Unix/Linux)*.

The following steps are run as root.

Install Nginx 1.8, copy the Nginx OMERO configuration file into the Nginx configuration directory, and disable the default configuration:

```
# require to install more recent version of nginx
# w/o the version installed is 1.4.6
add-apt-repository -y ppa:nginx/stable

apt-get update
apt-get -y install nginx

pip install -r ~omero/OMERO.server/share/web/requirements-py27-nginx.txt

# set up as the omero user.
su - omero -c "bash -eux setup_omero_nginx.sh"

cp ~omero/OMERO.server/nginx.conf.tmp /etc/nginx/sites-available/omero-web
rm /etc/nginx/sites-enabled/default
ln -s /etc/nginx/sites-available/omero-web /etc/nginx/sites-enabled/

service nginx start
```

Apache

See also *OMERO.web Apache and mod_wsgi deployment (Unix/Linux)*.

As the **omero** system user, configure OMERO.web:

```
OMERO.server/bin/omero config set omero.web.application_server wsgi
OMERO.server/bin/omero web config apache24 --http "$OMERO_WEB_PORT" > OMERO.server/apache.conf.tmp
OMERO.server/bin/omero web syncmedia
```

The following steps are run as root.

Install Apache 2.4 and copy the Apache OMERO configuration file into the Apache configuration directory, and disable the default configuration:

```
apt-get -y install apache2 libapache2-mod-wsgi

# Install OMERO.web requirements
pip install -r ~omero/OMERO.server/share/web/requirements-py27-apache.txt

# Modify the default value set for the ''WSGISocketPrefix'' directive in ''apache.conf.tmp''
sed -i -r -e 's|(WSGISocketPrefix run/wsgi)|#\1|' -e 's|# (WSGISocketPrefix /var/run/wsgi)|\1|' ~omero/OM
cp ~omero/OMERO.server/apache.conf.tmp /etc/apache2/sites-available/omero-web.conf
a2dissite 000-default.conf
a2ensite omero-web.conf

service apache2 start
```

Running OMERO

The following steps are run as the omero system user.

OMERO should now be set up. To start the server run:

```
OMERO.server/bin/omero admin start
```

If you deploy with Nginx, to start the OMERO.web client run:

```
OMERO.server/bin/omero web start
```

The last command is **not** necessary if you deploy with Apache.

Nginx or Apache should already be running so you should be able to log in as the OMERO root user by going to http://localhost/ in your web browser.

In addition some example *init.d* scripts are available should you wish to start OMERO and OMERO.web automatically:

```
cp omero-init.d /etc/init.d/omero
chmod a+x /etc/init.d/omero

cp omero-web-init.d /etc/init.d/omero-web
chmod a+x /etc/init.d/omero-web

update-rc.d -f omero remove
update-rc.d -f omero defaults 98 02
update-rc.d -f omero-web remove
update-rc.d -f omero-web defaults 98 02
```

```
omero-init.d
omero-web-init.d
```

Securing OMERO

The following steps are run as root.

If multiple users have access to the machine running OMERO you should restrict access to OMERO.server's configuration and runtime directories, and optionally the OMERO data directory:

```
chmod go-rwx ~omero/OMERO.server/etc ~omero/OMERO.server/var

# Optionally restrict access to the OMERO data directory
#chmod go-rwx "$OMERO_DATA_DIR"
```

Regular tasks

The following steps are run as root.

The default OMERO.web session handler uses temporary files to store sessions which should be deleted at regular intervals, for instance by creating a cron job:

```
OMERO_USER=omero
OMERO_SERVER=/home/omero/OMERO.server
su - ${OMERO_USER} -c "${OMERO_SERVER}/bin/omero web clearsessions"
```

Copy the following commands into the appropriate location:

```
cp omero-web-cron /etc/cron.daily/omero-web
chmod a+x /etc/cron.daily/omero-web
```

```
omero-web-cron
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.8 OMERO.server installation on OS X with Homebrew

Overview

This walk-through demonstrates how to install OMERO on a clean Mac OS X system (10.9 or later) using Homebrew. Note that this demonstrates how to install OMERO.server *from the source code* via Homebrew, in addition to all its prerequisites.

These instructions are implemented in a series of automated scripts[39] which install OMERO via Homebrew from a fresh configuration.

Prerequisites

Xcode

Homebrew requires the latest version of Xcode. Install **Xcode** and the Command Line Tools for Xcode from the App Store. If you have already installed it, make sure all the latest updates are installed.

Java

Oracle Java may be downloaded from the Oracle website[40].

After installing JDK 7 or JDK 8, check your installation works by running:

```
$ java -version
java version "1.8.0_31"
Java(TM) SE Runtime Environment (build 1.8.0_31-b13)
Java HotSpot(TM) 64-Bit Server VM (build 25.31-b07, mixed mode)

$ javac -version
javac 1.8.0_31
```

Requirements

All the requirements for OMERO will be installed under `/usr/local`. See also: Installation instructions on the Homebrew wiki[41].

Install Homebrew and make sure `/usr/local/bin` is prepended to your `PATH`:

```
$ ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
$ export PATH=/usr/local/bin:$PATH
```

Update Homebrew and run 'brew doctor' to fix potential issues beforehand:

[39] https://github.com/ome/omero-install/tree/develop/osx
[40] http://www.oracle.com/technetwork/java/javase/downloads/index.html
[41] https://github.com/Homebrew/homebrew/blob/master/share/doc/homebrew/Installation.md

```
$ brew update
$ brew doctor
```

Install git if not already present:

```
$ brew list | grep "\bgit\b" || brew install git
```

Install PostgreSQL database server:

```
$ export LANG=${LANG:-en_US.UTF-8}
$ export LANGUAGE=${LANGUAGE:-en_US:en}
$ brew install postgresql
```

You should install OMERO using Python 2.7 provided by Homebrew since it makes using Homebrew-provided modules simpler, for example the Ice python bindings needed by OMERO. For a more thorough description of the Homebrew solution, see the Homebrew and Python[42] page. Note that the automated script linked above tests the OMERO installation using the Homebrew Python.

To install the Python provided by Homebrew:

```
$ brew install python
```

Check that Python is working and is version 2.7:

```
$ which python
/usr/local/bin/python
$ python --version
Python 2.7.9
```

The installation of OMERO via Homebrew depends upon two alternate repositories containing extra formulae: https://github.com/Homebrew/homebrew-science for the HDF5 formula and https://github.com/ome/homebrew-alt for all the OME-provided formulae and older versions of Ice. To add these, run:

```
$ brew tap homebrew/science
$ brew tap ome/alt
```

Note: The Homebrew formulae used below provide Python bindings. As described in Homebrew and Python[43], you should **not** be in an active virtual environment when you `brew install` them.

See the `step01_deps.sh` script for the steps described above.

OMERO installation

OMERO 5.2.4 server

To install and deploy the 5.2.4 release of OMERO.server, run:

```
$ brew install omero52 --with-nginx --with-cpp
$ export PYTHONPATH=$(brew --prefix omero52)/lib/python
$ export ICE_CONFIG=$(brew --prefix omero52)/etc/ice.config
```

[42] https://github.com/Homebrew/homebrew/blob/master/share/doc/homebrew/Homebrew-and-Python.md
[43] https://github.com/Homebrew/homebrew/blob/master/share/doc/homebrew/Homebrew-and-Python.md

This will install the OMERO server to /usr/local/Cellar/omero, which means you will find the log files in `/usr/local/Cellar/omero/|release|/var/log`. The binaries will be linked to `/usr/local/bin`:

```
$ which omero
/usr/local/bin/omero
```

Install OMERO python dependencies:

```
$ pip install -r $(brew --prefix omero52)/share/web/requirements-py27-nginx.txt
$ cd /usr/local
$ bash bin/omero_python_deps
```

Start database server:

```
$ pg_ctl -D /usr/local/var/postgres -l /usr/local/var/postgres/server.log -w start
```

Create database and user:

```
$ createuser -w -D -R -S db_user
$ createdb -E UTF8 -O db_user omero_database
$ psql -h localhost -U db_user -l
```

Set database parameters in OMERO:

```
$ omero config set omero.db.name omero_database
$ omero config set omero.db.user db_user
$ omero config set omero.db.pass db_password
```

Create and run script to initialize the OMERO database:

```
$ export ROOT_PASSWORD=${ROOT_PASSWORD:-omero}
$ export PSQL_SCRIPT_NAME=${PSQL_SCRIPT_NAME:-OMERO.sql}
$ omero db script --password $ROOT_PASSWORD -f $PSQL_SCRIPT_NAME
$ psql -h localhost -U db_user omero_database < $PSQL_SCRIPT_NAME
$ rm $PSQL_SCRIPT_NAME
```

Set up OMERO data directory:

```
$ export OMERO_DATA_DIR=${OMERO_DATA_DIR:-~/OMERO.data}
$ mkdir -p $OMERO_DATA_DIR
$ omero config set omero.data.dir $OMERO_DATA_DIR
```

See the OMERO installation script `step02_omero.sh`

Development server

If you wish to build OMERO.server from source for development purposes, using the git repository, first use Homebrew to install the OMERO dependencies:

```
$ brew install --only-dependencies omero
```

The default version of Ice installed by the OMERO formula is currently Ice 3.5.

Prepare a place for your OMERO code to live, e.g.:

```
$ mkdir -p ~/code/projects
$ cd ~/code/projects
```

If you installed Ice 3.5, you will need to set `SLICEPATH` to be able to build the server, i.e. `export SLICEPATH=/usr/local/share/Ice-3.5/slice`.

If you want the development version of OMERO.server, you can clone the source code from the project's GitHub account to build locally:

```
$ git clone --recursive git://github.com/openmicroscopy/openmicroscopy
$ cd openmicroscopy && ./build.py
```

Note: If you have a GitHub account and you plan to develop code for OMERO, you should make a fork into your own account and then clone this fork to your local development machine, e.g.

```
$ git remote add  git://github.com/YOURNAMEHERE/openmicroscopy
$ cd openmicroscopy && ./build.py
```

See also:

Installing OMERO from source Developer documentation page on how to check out to source code

Build System Developer documentation page on how to build the OMERO.server

Then prepend the development `bin` directory to your `PATH` to pick the right executbale:

```
$ export PATH=~/code/projects/openmicroscopy/dist/bin:$PATH
```

and follow the steps for setting up the database and OMERO data directory as mentioned in the previous section.

OMERO.web

Basic setup for OMERO using Nginx:

```
$ export HTTPPORT=${HTTPPORT:-8080}
$ omero web config nginx-development --http $HTTPPORT > $(brew --prefix omero52)/etc/nginx.conf
```

See installation script `step03_nginx.sh`

For detailed instructions on how to deploy OMERO.web in a production environment such as Apache or Nginx please see *OMERO.web deployment*.

Note: The internal Django webserver can be used for evaluation and development. In this case please follow the instructions under *OMERO.web deployment for developers*.

Startup/Shutdown

If necessary start PostgreSQL database server:

```
$ pg_ctl -D /usr/local/var/postgres -l /usr/local/var/postgres/server.log -w start
```

Start OMERO:

```
$ omero admin start
```

Start OMERO.web:

```
$ omero web start
$ nginx -c $(brew --prefix omero52)/etc/nginx.conf
```

Now connect to your OMERO.server using OMERO.insight or OMERO.web with the following credentials:

```
U: root
P: omero
```

Stop OMERO.web:

```
$ nginx -c $(brew --prefix omero52)/etc/nginx.conf -s stop
$ omero web stop
```

Stop OMERO:

```
$ omero admin stop
```

See example script for a basic functionality test: `step04_test.sh`

Common issues

General considerations

If you run into problems with Homebrew, you can always run:

```
$ brew update
$ brew doctor
```

Also, please check the Homebrew Bug Fixing Checklist[44].

Below is a non-exhaustive list of errors/warnings specific to the OMERO installation. Some if not all of them could possibly be avoided by removing any previous OMERO installation artifacts from your system.

Database

Check to make sure the database has been created and 'UTF8' encoding is used

```
$ psql -h localhost -U db_user -l
```

This command should give similar output to the following:

```
                        List of databases
   Name          | Owner   | Encoding |  Collation  |    Ctype    | Access privileges
-----------------+---------+----------+-------------+-------------+-------------------
 omero_database | db_user | UTF8     | en_GB.UTF-8 | en_GB.UTF-8 |
```

[44] https://github.com/mxcl/homebrew/wiki/Bug-Fixing-Checklist

```
 postgres       | ome      | UTF8     | en_GB.UTF-8 | en_GB.UTF-8 |
 template0      | ome      | UTF8     | en_GB.UTF-8 | en_GB.UTF-8 | =c/ome           +
                |          |          |             |             | ome=CTc/ome
 template1      | ome      | UTF8     | en_GB.UTF-8 | en_GB.UTF-8 | =c/ome           +
                |          |          |             |             | ome=CTc/ome
(4 rows)
```

Macports/Fink

```
Warning: It appears you have MacPorts or Fink installed.
```

Follow uninstall instructions from the Macports guide[45].

PostgreSQL

If you encounter this error during installation of PostgreSQL:

```
Error: You must ‘‘brew link ossp-uuid’ before postgresql can be installed
```

try:

```
$ brew cleanup
$ brew link ossp-uuid
```

szip

If you encounter an MD5 mismatch error similar to this:

```
==> Installing hdf5 dependency: szip
==> Downloading http://www.hdfgroup.org/ftp/lib-external/szip/2.1/src/szip-2.1.tar.gz
Already downloaded: /Library/Caches/Homebrew/szip-2.1.tar.gz
Error: MD5 mismatch
Expected: 902f831bcefb69c6b635374424acbead
Got: 0d6a55bb7787f9ff8b9d608f23ef5be0
Archive: /Library/Caches/Homebrew/szip-2.1.tar.gz
(To retry an incomplete download, remove the file above.)
```

then manually remove the archived version located under `/Library/Caches/Homebrew`, since the maintainer may have updated the file.

numexpr (and other Python packages)

If you encounter an issue related to numexpr complaining about NumPy having too low a version number, verify that you have not previously installed any Python packages using **pip**. In the case where **pip** has been installed before Homebrew, uninstall it:

```
$ sudo pip uninstall pip
```

[45] http://guide.macports.org/chunked/installing.macports.uninstalling.html

and then try running `python_deps.sh` again. That should install **pip** via Homebrew and put the Python packages in correct locations.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.9 OMERO.server binary repository

About

The OMERO.server binary data repository is a fundamental piece of server-side functionality. It provides optimized and indexed storage of original file, pixel and thumbnail data, attachments and full-text indexes. The repository's directories contain various files that, together with your SQL database, constitute the information about your users and their data that OMERO.server relies upon for normal operation.

Layout

The repository is internally laid out as follows:

```
/OMERO
/OMERO/Pixels             <--- Pixel data and pyramids
/OMERO/Files              <--- Original file data
/OMERO/Thumbnails         <--- Thumbnail data
/OMERO/FullText           <--- Lucene full text search index
/OMERO/ManagedRepository  <--- OMERO.fs filesets, with import logs
/OMERO/BioFormatsCache    <--- Cached Bio-Formats state for rendering
```

Your repository is not:

- the "database"
- the directory where your OMERO.server binaries are
- the directory where your OMERO.client (OMERO.insight or OMERO.importer) binaries are
- your PostgreSQL data directory

Locking and remote shares

The OMERO server requires proper locking semantics on all files in the binary repository. In practice, this means that remotely mounted shares such as AFS, CIFS, and NFS can cause issues. If you have experience and/or the time to manage and monitor the locking implementations of your remote filesystem, then using them as for your binary repository should be fine.

If, however, you are seeing errors such as NullPointerExceptions, "Bad file descriptors" and similar in your server log, then you will need to use directly connected disks.

Warning: If your binary repository is a remote share and mounting the share fails or is dismounted, OMERO will continue operating using the mount point instead! To prevent this, make the mount point read-only for the OMERO user so that no data can be written to the mount point.

Changing your repository location

Note: It is **strongly** recommended that you make all changes to your OMERO binary repository with the server shut down. Changing the `omero.data.dir` configuration does **not** move the repository for you, you must do this yourself.

Your repository location can be changed from its `/OMERO` default by modifying your OMERO.server configuration as follows:

```
$ cd OMERO.server
$ bin/omero config set omero.data.dir /mnt/really_big_disk/OMERO
```

The suggested procedure is to shut down your OMERO.server instance, move your repository, change your `omero.data.dir` and then start the instance back up. For example:

```
$ cd OMERO.server
$ bin/omero admin stop
$ mv /OMERO /mnt/really_big_disk
$ bin/omero config set omero.data.dir /mnt/really_big_disk/OMERO
$ bin/omero admin start
```

The `omero.managed.dir` property for the OMERO.fs managed repository may be adjusted similarly, even to a directory outside `omero.data.dir`.

Note: The managed repository should be located and configured to allow the OMERO server processes fast access to the uploaded filesets that it contains.

Access permissions

Your repository should be owned by the same user that is starting your OMERO.server instance. This is often either yourself (find this out by executing `whoami`) or a separate `omero` (or similar) user who is dedicated to running OMERO.server. For example:

```
$ whoami
omero
$ ls -al /OMERO
total 24
drwxr-xr-x   5  omero  omero   128 Dec 12  2006 .
drwxr-xr-x   7  root    root   160 Nov  5 15:24 ..
drwxr-xr-x   3  omero  omero  4096 Dec 20 10:13 BioFormatsCache
drwxr-xr-x   2  omero  omero  1656 Dec 18 14:31 Files
drwxr-xr-x 150  omero  omero 12288 Dec 20 10:00 ManagedRepository
drwxr-xr-x  25  omero  omero 23256 Dec 10 19:06 Pixels
drwxr-xr-x   2  omero  omero    48 Dec  8  2006 Thumbnails
```

Repository size

At minimum, the binary repository should be comfortably larger than the images and other files that users may be uploading to it. It is fine to set `omero.data.dir` or `omero.managed.dir` to very large volumes, or to use logical volume management to conveniently increase space as necessary.

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.10 OMERO.server and PostgreSQL

In order to be installed, OMERO.server requires a running PostgreSQL instance that is configured to accept connections over TCP. This section explains how to ensure that you have the correct PostgreSQL version and that it is installed and configured correctly.

Ensuring you have a valid PostgreSQL version

For OMERO 5.2, PostgreSQL version 9.4 or later is required; version 9.4 is recommended. Make sure you are using a supported version[46].

[46] http://www.postgresql.org/support/versioning/

You can check which version of PostgreSQL you have installed with any of the following commands:

```
$ createuser -V
createuser (PostgreSQL) 9.4.1
$ psql -V
psql (PostgreSQL) 9.4.1
$ createdb -V
createdb (PostgreSQL) 9.4.1
```

If your existing PostgreSQL installation is version 9.3 or earlier, it is recommended that you upgrade to a more up-to-date version. Before upgrading, stop the OMERO server and then perform a full dump of the database using **pg_dump**. See the *OMERO.server backup and restore* section for further details.

If using a Linux distribution-provided PostgreSQL server, upgrading to a newer version of the the distribution will usually make a newer version of PostgreSQL available. If the database was not migrated to the new version automatically, restore your backup after installing, configuring and starting the new version of the database server. If a PostgreSQL server was not provided by your system, EnterpriseDB[47] provide an installer.

Checking PostgreSQL port listening status

You can check if PostgreSQL is listening on the default port (`TCP/5432`) by running the following command:

```
$ netstat -an | egrep '5432.*LISTEN'
tcp        0      0 0.0.0.0:5432            0.0.0.0:*               LISTEN
tcp        0      0 :::5432                 :::*                    LISTEN
```

Note: The exact output of this command will vary. The important thing to recognize is whether or not a process is listening on `TCP/5432`.

If you cannot find a process listening on `TCP/5432` you will need to find your `postgresql.conf` file and enable PostgreSQL's TCP listening mode. The exact location of the `postgresql.conf` file varies between installations.

It may be helpful to locate it using the package manager (`rpm` or `dpkg`) or by utilizing the `find` command. Usually, the PostgreSQL data directory (which houses the `postgresql.conf` file, is located under `/var` or `/usr`:

```
$ sudo find /etc -name 'postgresql.conf'
$ sudo find /usr -name 'postgresql.conf'
$ sudo find /var -name 'postgresql.conf'
/var/lib/postgresql/data/postgresql.conf
```

Note: The PostgreSQL data directory is usually only readable by the user `postgres` so you will likely have to be `root` in order to find it.

Once you have found the location of the `postgresql.conf` file on your particular installation, you will need to enable TCP listening. The area of the configuration file you are concerned about should look similar to this:

```
#listen_addresses = 'localhost'         # what IP address(es) to listen on;
                                        # comma-separated list of addresses;
                                        # defaults to 'localhost', '*' = all
#port = 5432
max_connections = 100
# note: increasing max_connections costs ~400 bytes of shared memory per
# connection slot, plus lock space (see max_locks_per_transaction).  You
# might also need to raise shared_buffers to support more connections.
#superuser_reserved_connections = 2
#unix_socket_directory = *
```

[47] http://www.enterprisedb.com/

```
#unix_socket_group = *
#unix_socket_permissions = 0777         # octal
#bonjour_name = *                       # defaults to the computer name
```

PostgreSQL HBA (host based authentication)

OMERO.server must have permission to connect to the database that has been created in your PostgreSQL instance. This is configured in the *host based authentication* file, `pg_hba.conf`. Check the configuration by examining the contents of `pg_hba.conf`. It's important that at least one line allows connections from the loopback address (`127.0.0.1`) as follows:

```
# TYPE  DATABASE    USER        CIDR-ADDRESS          METHOD
# IPv4 local connections:
host    all         all         127.0.0.1/32          md5
# IPv6 local connections:
host    all         all         ::1/128               md5
```

Note: The other lines that are in your `pg_hba.conf` are important either for PostgreSQL internal commands to work or for existing applications you may have. **Do not delete them**.

Completing configuration

After making any configuration changes to `postgresql.conf` or `pg_hba.conf`, reload the server for the changes to take effect.

```
$ sudo service postgresql reload
```

See also:

PostgreSQL[48] Interactive documentation for the current release of PostgreSQL.

Connections and Authentication[49] Section of the PostgreSQL documentation about configuring the server using *postgresql.conf*.

Client Authentication[50] Chapter of the PostgreSQL documentation about configuring client authentication with *pg_hba.conf*.

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.1.11 OMERO.web deployment

OMERO.web is the web application component of the OMERO platform which allows for the management, visualization (in a fully multi-dimensional image viewer) and annotation of images from a web browser. It also includes the ability to manage users and groups.

OMERO.web is an integral part of the OMERO platform and can be deployed with:

- WSGI[51] using a WSGI capable web server such as Apache 2.2+[52] (with mod_wsgi[53] enabled) or nginx[54] and gunicorn[55],
- The built-in Django lightweight development server (for **testing** only; see the *OMERO.web deployment for developers* page).

If you need help configuring your firewall rules, see the *Server security and firewalls* page.

[51] http://wsgi.readthedocs.org
[52] http://httpd.apache.org/
[53] http://www.modwsgi.org/
[54] http://nginx.org/
[55] http://docs.gunicorn.org/

Prerequisites

- OMERO and its prerequisites (see *OMERO.server installation*).
- Python 2.7
  - **Pillow**[56] **should be available for your distribution. We currently do not** support version 3.0+.
  - Matplotlib[57] should be available for your distribution
- A WSGI capable web server

Deployment (Unix/Linux)

There are a number of good ways to easily deploy OMERO.web. If you have installed Nginx or Apache, OMERO can automatically generate a configuration file for your web server. The location of the file will depend on your system, please refer to your web server's manual. See *Customizing your OMERO.web installation* for additional customization options.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

OMERO.web Apache and mod_wsgi deployment (Unix/Linux)

Apache 2.2+ with mod_wsgi configuration (Unix/Linux)

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[58] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.

OMERO.web uses the Web Server Gateway Interface (WSGI)[59] as a primary deployment platform. The Python standard PEP 3333[60] that describes how a web server communicates with web applications.

Apache default configuration (Unix/Linux) Install Django 1.8[61] using package requirements file:

```
$ pip install -r share/web/requirements-py27-apache.txt
```

Note: For more details refer to how to install Django 1.8[62] or hot to upgrade Django to 1.8[63].

Additional settings can be configured by changing the following properties:

- `omero.web.application_server.max_requests` to 500
- `omero.web.wsgi_workers` to (2 x NUM_CORES) + 1

  Note: Do not scale the number of workers to the number of clients you expect to have. OMERO.web should only need 4-12 worker processes to handle many requests per second.

Apache configuration (Unix/Linux) If you have installed Apache, install mod_wsgi[64].

OMERO can automatically generate a configuration file for your web server. The location of the file will depend on your system, please refer to your web server's manual. See *Customizing your OMERO.web installation* for additional customization options.

Set the following:

[57] http://matplotlib.org/
[58] https://docs.djangoproject.com/en/1.8/releases/1.8/
[59] http://wsgi.readthedocs.org/en/latest/learn.html
[60] https://www.python.org/dev/peps/pep-3333/
[61] https://docs.djangoproject.com/en/1.8/releases/1.8/
[62] https://docs.djangoproject.com/en/1.8/topics/install/#install-the-django-code
[63] https://docs.djangoproject.com/en/1.8/topics/install/#remove-any-old-versions-of-django
[64] http://www.modwsgi.org/

```
$bin/omero config set omero.web.application_server "wsgi"
```

Creates symlinks for static media files

```
$bin/omero web syncmedia
```

To create a site configuration file for inclusion in the main Apache configuration redirect the output of the following command into a file:

```
$ bin/omero web config apache
```

```
<VirtualHost _default_:80>

  WSGIDaemonProcess omeroweb processes=5 threads=1 maximum-requests=0 display-name=%{GROUP} user=omero

  WSGIScriptAlias / /home/omero/OMERO.server/lib/python/omeroweb/wsgi.py process-group=omeroweb

  <Directory "/home/omero/OMERO.server/lib/python/omeroweb">
    WSGIProcessGroup omeroweb
    WSGIApplicationGroup %{GLOBAL}
    Order allow,deny
    Allow from all
  </Directory>

  Alias /static /home/omero/OMERO.server/lib/python/omeroweb/static
  <Directory "/home/omero/OMERO.server/lib/python/omeroweb/static">
      Options -Indexes FollowSymLinks
      Order allow,deny
      Allow from all
  </Directory>

</VirtualHost>

# see https://code.google.com/p/modwsgi/wiki/ConfigurationIssues
WSGISocketPrefix run/wsgi
# Use this on Ubuntu/Debian/MacOSX systems:
# WSGISocketPrefix /var/run/wsgi
```

To configure an HTTPS server follow the Apache documentation[65].

Then reload Apache.

Running OMERO.web (Unix/Linux) OMERO.web is used in 'daemon' mode where UNIX sockets are used to communicate between the Apache child processes and the daemon processes which are to handle a request. **OMERO.web does not provide any management for these 'daemon' processes;** `bin/omero web start/status/stop` **will not work as they are for managing gunicorn processes only.**

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

OMERO.web Nginx and Gunicorn deployment (Unix/Linux)

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual instal-

[65] http://httpd.apache.org/docs/trunk/mod/mod_ssl.html

lation of the Django dependency is required. It is highly recommended to use Django 1.8[66] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.

OMERO.web uses the Web Server Gateway Interface (WSGI)[67] as a primary deployment platform. The Python standard PEP 3333[68] that describes how a web server communicates with web applications.

Gunicorn default configuration (Unix/Linux) Install Django 1.8[69] and Gunicorn >= 19.3[70] using the package requirements file:

```
$ pip install -r share/web/requirements-py27-nginx.txt
```

Note: For more details refer to how to install Django 1.8[71] or upgrade Django to 1.8[72].

Additional settings can be configured by changing the following properties:

- `omero.web.application_server.max_requests` to 500
- `omero.web.wsgi_workers` to (2 x NUM_CORES) + 1

  Note: **Do not** scale the number of workers to the number of clients you expect to have. OMERO.web should only need 4-12 worker processes to handle many requests per second.

- `omero.web.wsgi_args` Additional arguments. For more details check Gunicorn Documentation[73].

Nginx configuration (Unix/Linux) If you have installed Nginx, OMERO can automatically generate a configuration file for your web server. The location of the file will depend on your system, please refer to your web server's manual. See *Customizing your OMERO.web installation* for additional customization options.

To create a site configuration file for inclusion in a system-wide nginx configuration redirect the output of the following command into a file:

```
$ bin/omero web config nginx
```

```
upstream omeroweb {
    server 127.0.0.1:4080 fail_timeout=0;
}

server {
    listen 80;
    server_name $hostname;

    sendfile on;
    client_max_body_size 0;

    # maintenance page serve from here
    location @maintenance {
        root /home/omero/OMERO.server/etc/templates/error;
        try_files $uri /maintainance.html =502;
    }
```

[66] https://docs.djangoproject.com/en/1.8/releases/1.8/
[67] http://wsgi.readthedocs.org/en/latest/learn.html
[68] https://www.python.org/dev/peps/pep-3333/
[69] https://docs.djangoproject.com/en/1.8/releases/1.8/
[70] http://gunicorn.org
[71] https://docs.djangoproject.com/en/1.8/topics/install/#install-the-django-code
[72] https://docs.djangoproject.com/en/1.8/topics/install/#remove-any-old-versions-of-django
[73] http://docs.gunicorn.org/en/stable/settings.html

```
    # weblitz django apps serve media from here
    location /static {
        alias /home/omero/OMERO.server/lib/python/omeroweb/static;
    }

    location @proxy_to_app {
        proxy_set_header X-Forwarded-Proto $scheme;
        proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
        proxy_set_header Host $http_host;
        proxy_redirect off;
        proxy_buffering off;

        proxy_pass http://omeroweb;
    }

    location / {

        error_page 502 @maintenance;
        # checks for static file, if not found proxy to app
        try_files $uri @proxy_to_app;
    }

}
```

Note: OMERO.web requires `body_in_file_only` adjusted in your default nginx config because nginx must buffer incoming data. Make sure you have that set to the following config:

```
http {
    ...
    sendfile on;
    send_timeout 60s;
    client_max_body_size 0;
    ...
}
```

To configure an HTTPS server follow the nginx documentation[74].

Running OMERO.web (Unix/Linux) Start the Gunicorn worker processes listening by default on 127.0.0.1:4080:

```
$ bin/omero web start
... static files copied to '/home/omero/OMERO.server/lib/python/omeroweb/static'.
Starting OMERO.web... [OK]
```

The Gunicorn workers are managed **separately** from other OMERO.server processes. You can check their status or stop them using the following commands:

```
$ bin/omero web status
OMERO.web status... [RUNNING] (PID 59217)
$ bin/omero web stop
Stopping OMERO.web... [OK]
Django WSGI workers (PID 59217) killed.
```

Download limitations In order to offer users the ability to download data from OMERO.web you have to deploy using *EXPERIMENTAL: Async workers*. OMERO.web is able to handle multiple clients on a single worker thread switching context as necessary while streaming binary data from OMERO.server. Depending on the traffic and scale of the repository you should

[74] http://nginx.org/en/docs/http/configuring_https_servers.html

configure connections and speed limits on your server to avoid blocking resources. We recommend you run benchmark and performance tests. It is also possible to apply *Download restrictions* and offer alternative access to binary data.

Note: Handling streaming request/responses requires proxy buffering to be turned off. For more details refer to Gunicorn deployment[75] and Nginx configuration[76].

Note: `omero.web.application_server.max_requests` should be set to 0

Benchmark We run example benchmarks on rendering thumbnails and 512x512 pixels planes for 100 concurrent users making 5000 requests in total:

```
$ ab -n 5000 -c 100 https://server.openmicroscopy.org/omero/webclient/render_thumbnail/size/96/1234/
This is ApacheBench, Version 2.3 <$Revision: 1430300 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Server Software:        nginx/1.9.9
Server Hostname:        server.openmicroscopy.org
Server Port:            80

Document Path:          /omero/webclient/render_thumbnail/size/96/31851/
Document Length:        1880 bytes

Concurrency Level:      100
Time taken for tests:   224.488 seconds
Complete requests:      5000
Failed requests:        0
Write errors:           0
Total transferred:      10450000 bytes
HTML transferred:       9400000 bytes
Requests per second:    22.27 [#/sec] (mean)
Time per request:       4489.763 [ms] (mean)
Time per request:       44.898 [ms] (mean, across all concurrent requests)
Transfer rate:          45.46 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        0    0   0.3      0       3
Processing:   435 4446 685.2   4363    7644
Waiting:      432 4446 685.3   4362    7644
Total:        435 4446 685.1   4363    7644

Percentage of the requests served within a certain time (ms)
  50%   4363
  66%   4553
  75%   4670
  80%   4750
  90%   5072
  95%   5398
  98%   6795
  99%   6955
 100%   7644 (longest request)


$ ab -n 5000 -c 100 http://server.openmicroscopy.org/omero/webclient/render_image/1234/20/0/
This is ApacheBench, Version 2.3 <$Revision: 1430300 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/
```

[75] http://docs.gunicorn.org/en/stable/deploy.html
[76] http://nginx.org/en/docs/http/ngx_http_proxy_module.html#proxy_buffering

```
Server Software:        nginx/1.9.9
Server Hostname:        server.openmicroscopy.org
Server Port:            80

Document Path:          /omero/webclient/render_image/1234/20/0/
Document Length:        24293 bytes

Concurrency Level:      100
Time taken for tests:   247.154 seconds
Complete requests:      5000
Failed requests:        0
Write errors:           0
Total transferred:      122515000 bytes
HTML transferred:       121465000 bytes
Requests per second:    20.23 [#/sec] (mean)
Time per request:       4943.080 [ms] (mean)
Time per request:       49.431 [ms] (mean, across all concurrent requests)
Transfer rate:          484.09 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        0    0   0.4      0       4
Processing:   482 4898 855.3   4737    8303
Waiting:      476 4898 855.3   4737    8303
Total:        482 4898 855.2   4737    8303

Percentage of the requests served within a certain time (ms)
  50%   4737
  66%   5041
  75%   5250
  80%   5397
  90%   5862
  95%   6621
  98%   7301
  99%   8062
 100%   8303 (longest request)
```

Troubleshooting In order to identify why OMERO.web is not available run:

```
$ bin/omero web status
```

Then consult nginx `error.log` and `OMERO.server/var/log/OMEROweb.log`

For more details check *OMERO.web issues*.

Debugging To run the WSGI server in debug mode, enable Gunicorn logging[77] using `omero.web.wsgi_args`:

```
$ bin/omero config set omero.web.wsgi_args -- "--log-level=DEBUG --error-logfile=/home/omero/OMERO.server
```

EXPERIMENTAL: Gunicorn advance configuration (Unix/Linux)

Note: Experimental configurations are not ready for production use. Configuration may change. Features may not work properly.

OMERO.web deployment can be configured with sync and async workers. Sync workers are faster and recommended for a data repository with *Download restrictions*. If you wish to offer users the ability to download data then you have to use async workers; read more about *Download limitations*.

[77] http://docs.gunicorn.org/en/stable/settings.html#logging

For more details refer to Gunicorn design[78].

EXPERIMENTAL: Sync workers

Note: Experimental configurations are not ready for production use. Configuration may change. Features may not work properly.

- Install futures[79]

```
$ pip install futures
```

Additional settings can be configured by changing the following properties:

- The number of worker threads for handling requests, see Gunicorn threads[80]

```
$ bin/omero config set omero.web.wsgi_worker_class
$ bin/omero config set omero.web.wsgi_threads $(2-4 x NUM_CORES)
```

EXPERIMENTAL: Async workers

Note: Experimental configurations are not ready for production use. Configuration may change. Features may not work properly.

- Install Gevent >= 0.13[81]

```
$ pip install "gevent>=0.13"
```

Additional settings can be configured by changing the following properties:

- The maximum number of simultaneous clients, see Gunicorn worker-connections[82]

```
$ bin/omero config set omero.web.wsgi_worker_class gevent
$ bin/omero config set omero.web.wsgi_worker_connections 1000
$ bin/omero config set omero.web.application_server.max_requests 0
```

Logging in to OMERO.web

Once you have deployed and started the server, you can use your browser to access the OMERO.webclient:

- **http://your_host/omero** OR, for development server: **http://localhost:4080**

OMERO.web Maintenance (Unix/Linux)

- Session cookies `omero.web.session_expire_at_browser_close`:
  - A boolean that determines whether to expire the session when the user closes their browser. See Django Browser-length sessions vs. persistent sessions documentation[83] for more details. Default: `True`.

```
$ bin/omero config set omero.web.session_expire_at_browser_close "True"
```

  - The age of session cookies, in seconds. Default: `86400`.

[78] http://docs.gunicorn.org/en/stable/design.html
[79] https://pypi.python.org/pypi/futures
[80] http://docs.gunicorn.org/en/stable/settings.html#threads
[81] http://www.gevent.org/
[82] http://docs.gunicorn.org/en/stable/settings.html#worker-connections
[83] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#browser-length-vs-persistent-sessions

Figure 6.1: OMERO.web login

```
$ bin/omero config set omero.web.session_cookie_age 86400
```

- Session engine:
  - Each session for a logged-in user in OMERO.web is kept in the session store. Stale sessions can cause the store to grow with time. OMERO.web uses by default the OS file system as the session store backend and does not automatically purge stale sessions, see Django file-based session documentation[84] for more details. It is therefore the responsibility of the OMERO administrator to purge the session cache using the provided management command:

    ```
    $ bin/omero web clearsessions
    ```

    It is recommended to call this command on a regular basis, for example as a *daily cron job*, see Django clearing the session store documentation[85] for more information.
  - OMERO.web offers alternative session backends to automatically delete stale data using the cache session store backend, see Django cached session documentation[86] for more details. After installing all the cache prerequisites set the following:

    ```
    $ bin/omero config set omero.web.session_engine django.contrib.sessions.backends.cache
    ```

    * Memcached[87]:

      ```
      $ bin/omero config set omero.web.caches '{"default": { "BACKEND": "django.core.cache.backend
      ```

    * EXPERIMENTAL: Redis 2.4+[88] requires django-redis-cache 1.6.5+[89]:

      ```
      $ pip install django-redis-cache>=1.6.5
      $ bin/omero config set omero.web.caches '{"default": {"BACKEND": "redis_cache.RedisCache", "
      ```

Note: The generated Nginx and Apache configuration files will automatically display a maintenance page if an attempt is made to access OMERO.web whilst it is not running.

[84] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#using-file-based-sessions
[85] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#clearing-the-session-store
[86] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#using-cached-sessions
[87] https://memcached.org/
[88] http://redis.io/
[89] http://django-redis-cache.readthedocs.org/en/latest/intro_quick_start.html

Customizing your OMERO.web installation

By default OMERO.web expects to be run from the root URL of the web server. This can be changed by setting `omero.web.prefix` and `omero.web.static_url`. For example, to make OMERO.web appear at *http://example.org/omero/*:

```
$ bin/omero config set omero.web.prefix '/omero'
$ bin/omero config set omero.web.static_url '/omero/static/'
```

and regenerate your web-server configuration (see *Deployment (Unix/Linux)*).

The front-end webserver (Nginx, Apache) can be setup to run on a different host from OMERO.web. You will need to set `omero.web.application_server.host` to ensure OMERO.web is accessible on an external IP.

All configuration options can be found on various sections of *Web* developers documentation. For the full list, refer to *Web* properties or:

```
$ bin/omero web -h
```

The most popular configuration options include:

- Debug mode, see `omero.web.debug`.
- Customize login page with your own logo, see `omero.web.login_logo`.
- Customizing index page, see `omero.web.index_template`.
- Enabling a public user see *Public data in the repository*.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Python installation requirements for OMERO. # ========== # # pip install -r requirements.txt # Pillow<3.0

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Python installation requirements for OMERO. # ========== numexpr==1.4.2 tables==2.4.0 Pillow<3.0

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Python installation requirements for OMERO. # ========== # # pip install -r requirements_centos6_py27.txt # tables matplotlib Pillow<3.0

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Python installation requirements for OMERO. # ========== # # pip install -r requirements_centos6_py27_ius.txt # numpy matplotlib Pillow<3.0 omego==0.3.0

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.2 Server installation on Windows

Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.server and OMERO.web deployment. See this blog post[a] for details. If you are installing a new server, we highly recommend you use a different OS (see *Version requirements*).

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.2.1 OMERO.server installation

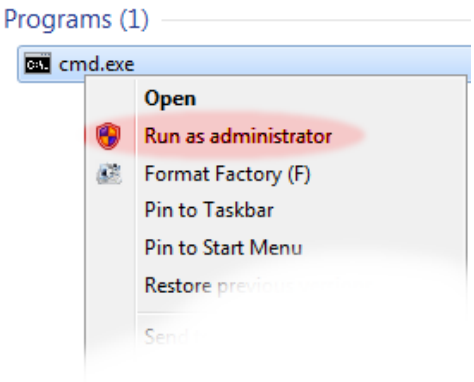
Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.server and OMERO.web deployment. See this blog post[a] for details. If you are installing a new server, we highly recommend you use a different OS (see *Version requirements*).

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

Limitations

Installation **will require an "Administrator" level account** for which you know the password. If you are unsure of what it means to have an "Administrator" level account, or if you are generally having issues with the various users/passwords described in this install guide, please see *Which user account and password do I use where?*.

- Unless you are clear on the differences, **you should also open all consoles as an administrator to prevent file permission issues.**



- Significant testing has taken place on Windows Server 2012 and we recommend this version.
- *OMERO.movie* is not supported on Windows at present.
- A reboot is required after installing the prerequisites.

Note: The default user paths on Windows usually contain spaces so you will need to ensure the the server installation path has no spaces, `C:\OMERO.server` for example.

Prerequisites

Note: The installation of these prerequisite applications is largely outside the scope of this document.

Do not mix 32bit (x86) and 64bit (amd64) packages - install either all 32bit or all 64bit. Check your JRE as well.

The following are necessary:

Java SE Development Kit (JDK)

Java SE Downloads are available from http://www.oracle.com/technetwork/java/javase/downloads/index.html.

Java 8 is recommended.

Ice

Note: OMERO 5.2 supports Ice 3.5. You will need to pick the matching server download for the version of Ice you have installed.

If you are using precompiled packages of Ice and Python (recommended) you should use the versions specified below. In particular since OMERO does not support Python 3 **it will not work with the ZeroC Ice 3.5 package for Windows**. However, Ice 3.5 will work when built against Python 2.7.

You can download Ice 3.5.1 built against Python 2.7 from our Ice downloads page[90], unzip the archive and move the extracted directory to `C:\`.

If you plan to develop for C++, be sure to read the instructions on the *OMERO C++ language bindings* page.

Python 2

Note: OMERO does not currently support Python 3.

Make sure you install the correct Python 2 version for your Ice version:

- If you have downloaded Ice 3.5.1 from our downloads page, you will need to install Python 2.7[91].

Python 2.7.9 is strongly recommended. OMERO has been successfully tested with this version and there were problems noticed with later versions.

As these are the "vanilla" python distributions (no extra libraries), you might need to install further dependencies, making sure to download the correct version (32/64-bit) for your Python distribution.

32/64-bit 32-bit or 64-bit Python may be used. You can obtain 64-bit precompiled dependencies from http://www.lfd.uci.edu/~gohlke/pythonlibs.

Python for Windows extensions Python for Windows extensions (PyWin32) is required. The installer is available from the PyWin download page[92].

The version you need is: `pywin32-XXX.win32-py2.7.exe` (or `pywin32-XXX.win-amd64-py2.7.exe` for 64-bit Python) where XXX should be the latest release number and A and B stand for the Python version, for example `pywin32-218.win32-py2.7.exe`.

PostgreSQL (9.4 or higher)

PostgreSQL has to be installed and configured to accept TCP connections. PostgreSQL 9.2 and earlier are not supported. 9.4 or later is recommended.

The *One click installer* can be found on the PostgreSQL Windows download page[93].

- You must install PostgreSQL as a service if you want to follow this document.

[90] http://downloads.openmicroscopy.org/ice/3.5.1/
[91] https://www.python.org/downloads/release/python-279/
[92] http://sourceforge.net/projects/pywin32/files/pywin32/
[93] http://www.postgresql.org/download/windows

1. Run the downloaded installer. You may be prompted for permission to continue with a "user account control" dialog. Click *yes* to continue. The installer will now start.
2. Choose the installation directory. The default is fine.
3. Choose the data directory. The default is fine, but if you want to keep the data in a specific location, you may choose an alternative location here.
4. Enter a password for the special "postgres" system account. OMERO does not use this account, but you will need to record the password for creating the database, below.
5. Enter the port number for PostgreSQL to listen on for incoming connections. The default, 5432, is fine and should not be changed.
6. Select the locale. The default here is fine.
7. PostgreSQL will now be installed and started.

Environment variables

For the prerequisite software to run properly, your PATH and PYTHONPATH environment variables must be configured. This is particularly important for Ice, which does not set the required variables by default.

Update your Windows environment variables: (REQUIRES RESTART!)

1. Locate the *System* control panel page on the Start Menu under *Settings* → *Control Panel*, open it and navigate to the *Advanced* tab (on Windows Vista the dialog will be visible after clicking the *Change settings* link on the *System* control panel page):

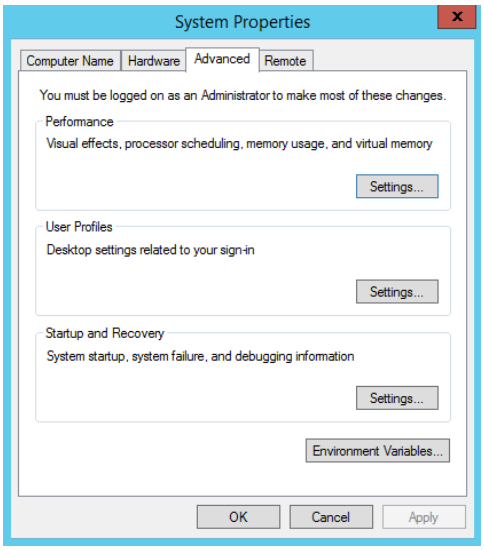
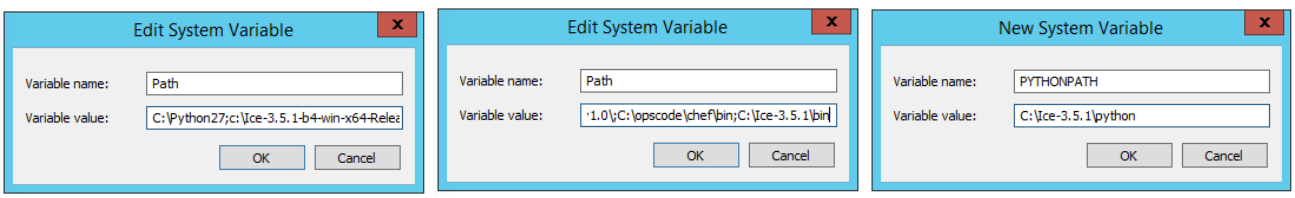


Figure 6.2: Advanced System Properties

2. Open the *Environment Variables* dialog by clicking on the *Environment Variables...* button of the above dialog:
3. Edit the existing *System* environment variable *Path* and add a new variable pointing to the Ice installation `bin` directory. At the front of the *Path* variable also add a new string pointing to the Python installation directory (e.g. `C:\Python27`). Then add a brand new *System* environment variable called *PYTHONPATH* pointing to the Ice installation `python` location:



When setting the ENV variables, make sure you write in the correct paths. You must have entries for:

- python (the first PATH entry, e.g. "C:\Python27;%Sys…)

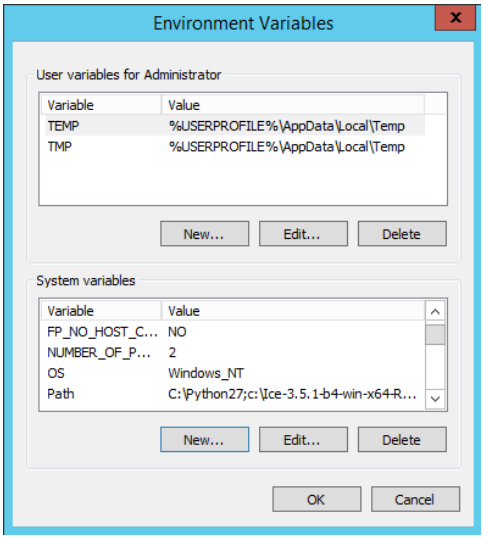


Figure 6.3: Environment Variables

- icebin (the last PATH entry, e.g. "…;C:\Ice-3.5.1\bin;")
- PYTHONPATH pointing to the python folder in the ICE installation (e.g. "C:\Ice-3.5.1\python;")

Warning: Remember that the Windows path separator is the semicolon ; and must be appended after every entry. Make sure the first inserted ENV PATH entry (the python path) finishes with a semicolon (eg. "C:\Python27;%SystemRoot%…") otherwise you could corrupt other system applications.

4. **Restart your computer**. For environment changes to take effect in background services, a restart is unfortunately necessary. See http://support.microsoft.com/kb/821761 for more information.

Creating a database for OMERO

- Open pgAdmin III; you can find it on the Start Menu under *Programs* → *PostgreSQL* → *pgAdmin III*.
- Connect to the database by double-clicking on the *PostgreSQL* database (or right-click and choose *Connect*) and providing your *postgres* user login password set during the installation, above.
- Create a new (non-superuser) database user for OMERO:
  1. Right-click on *Login Roles* and select *New Login Role...*.
  2. On the *Properties* tab, enter a name for the OMERO database user (referenced as `db_user` below) as the `Role name`, for example `omero`. On the *Definition* tab, enter the password for the user twice and then press *OK*. Make sure you record this username and password for later use; you will need to configure OMERO to use your username and password by setting the `omero.db.name` and `omero.db.pass` properties.
- Create a new database for OMERO:
  1. Right-click on *Databases* and select *New Database* ...
  2. On the *Properties* tab, enter a name for the OMERO database (referenced as `omero_database` below) as the `Name`, for example `omero`, then press *OK*.
  3. Switch to the *Definition* tab and make sure `UTF8` is set for the `Encoding` property.

Location for your OMERO binary repository

See also:

OMERO.server binary repository

- Create a directory for the OMERO binary data repository (`C:\OMERO` is the default location and should be used unless you explicitly have a reason not to and know what you are doing).

- This is *not* where you want the OMERO application to be installed, it is a *separate* directory that OMERO.server will use to store binary data:

```
C:\mkdir OMERO
```

- If necessary change the ownership of the directory. `C:\OMERO` *must* either be owned by the user starting the server or that user *must* have permission to write to the directory. Please see *OMERO.server binary repository* for more details.

When performing some operations the clients make use of temporary file storage and log directories. By default these files are stored below the user's home directory (on Windows `C:\Users\<username>`) in `omero\tmp`, `omero\log` and `omero\sessions`.

Note: If your home directory is stored on a network (NFS mounted or similar), then file read and write operations occur over the network. This can slow access down. Installing OMERO on a network mapped drive is strongly discouraged.

The OMERO.server also accesses the `omero\tmp` and `omero\log` folders of **the user account running the server process**. As the server makes heavier use of these folders than the clients, if that user's home folder is stored on a network the server can be slowed down. To get around this for the OMERO.server you can define an `OMERO_TMPDIR` environment variable pointing to a temporary directory located on the local file system e.g. `C:\tmp\`.

Installation

- Download and extract the OMERO.server zip file, and note its location. Below it is referred to as `C:\OMERO.server`.
- Optionally, review *Configuration properties glossary*, which contains all default settings. Any configuration settings you would like to change can be changed in the next step.
- Change any settings that are necessary using `bin\omero config`, including the name and/or password for the 'db_user' database user you chose above or the database name if it is not "omero_database". (Quotes are only necessary if the value could be misinterpreted by the shell. See link[94]).

```
C:\> cd C:\OMERO.server
C:\OMERO.server\> bin\omero config set omero.db.name omero_database
C:\OMERO.server\> bin\omero config set omero.db.user db_user
C:\OMERO.server\> bin\omero config set omero.db.pass db_password
```

- If you have chosen a non-standard *OMERO binary repository* location above, be sure to configure the `omero.data.dir` property.

  When using `C:\` style file paths it is necessary to "escape" the backslashes. For example:

```
C:\> bin\omero config set omero.data.dir C:\\OMERO
```

- Create the OMERO database initialization script. You will be asked for the version of the script which you would like to generate, where both defaults can be accepted. Finally, you will be asked to enter and confirm password for your newly created OMERO root user.

  Warning: For illustrative purposes, the default password for the OMERO rootuser is `root_password`. However, you should not use this default value for your installation but use your own choice of password instead.
  This should **not** be the same password as your Linux/Mac/Windows root user!

```
C:\> cd C:\OMERO.server
C:\OMERO.server> bin\omero db script --password root_password

Using OMERO5.2 for version
Using 0 for patch
Using password from commandline
```

[94] http://www.openmicroscopy.org/community/viewtopic.php?f=5&t=360#p922

```
Saving to C:\OMERO.server\OMERO5.2__0.sql
```

The generated SQL file is found in the folder where you called the "omero db script" command. This could cause a permission denied error in the populate db step if the postgres user cannot access that location. Move the file to a different location or use the -f option.

- Initialize your database with the script.

  1. Launch *SQL Shell (psql)* from the Start Menu under *Programs* → *PostgreSQL* → *SQL Shell (psql)*

     ```
     Server [localhost]:
     Database [postgres]: omero_database
     Port [5432]:
     Username [postgres]: db_user
     Password for user db_user:
     Welcome to psql 9.3.4, the PostgreSQL interactive terminal.

     Type:  copyright for distribution terms
            h for help with SQL commands
            ? for help with psql commands
            g or terminate with semicolon to execute query
            q to quit

     Warning: Console code page (437) differs from Windows code page
              (1252) 8-bit characters might not work correctly. See psql
              reference page ''Notes for Windows users'' for details.
     ```

  2. Execute the following to populate your database (**the forward slashes are intentional** - if you get a permission denied error it is because the path is wrong, not the slashes):

     ```
     omero=> SET client_encoding = 'UTF8';
     omero=> \i C:/OMERO.server/OMERO5.2__0.sql
     ...
     ...
     omero=> \q
     ```

- Before starting the OMERO.server, you should run the OMERO diagnostics script so that you check that all of the settings are correct, e.g.

  ```
  C:\OMERO.server\> bin\omero admin diagnostics
  ```

  The diagnostic tool may say that psql is not found. This should not be a problem but you can fix it by adding its bin folder to the path. For example, `C:\Program Files (x86)\PostgreSQL\9.3\bin`. Remember to reboot after changing the environment.

- You can now start the server using:

  ```
  C:\OMERO.server> bin\omero admin start
  Creating C:\OMERO.server\var\master
  Creating C:\OMERO.server\var\registry
  No descriptor given. Using etc\grid\windefault.xml
  Installing OMERO.master Windows service.
  Successfully installed OMERO.master Windows service.
  Starting OMERO.master Windows service.
  Waiting on startup. Use CTRL-C to exit
  ...
  ```

  If you have chosen a non-default install directory (other than `C:\OMERO.server`), the output will look like this:

  ```
  C:\OMERO.server> bin\omero admin start
  Found default value: C:\OMERO.server\var\master
  Attempting to correct...
  Converting from C:\OMERO.server to C:\OMERO.server
  ```

```
Changes made: 6
No descriptor given. Using etc\\grid\\windefault.xml
...
```

- If you would like to move the directory again, see `bin\winconfig.bat --help`, which gets called automatically on an initial install.
- You can now test that you can log-in as "root", either with the OMERO.insight client or command-line:

```
C:\OMERO.server> bin\omero login
Server: [localhost]
Username: [root]
Password:         # root_password
```

JVM memory settings

The OMERO server starts a number of Java services. Memory settings for these are calculated on a system-by-system basis. An attempt has been made to have usable settings out of the box, but if you can afford to provide OMERO with more memory, it will certainly improve your overall performance. See *Memory configuration* on how to tune the JVM.

OMERO.web and administration

Note: In order to deploy OMERO.web in a production environment such as IIS please follow the instructions under *OMERO.web deployment*.

Otherwise, the internal Django webserver can be used for evaluation and development. In this case, you need to install Django and turn debugging on, in order that static files can be served by Django:

```
C:\OMERO.server> C:\Python27\Scripts\pip.exe install -r share/web/requirements-py27-win.txt
C:\OMERO.server> bin\omero config set omero.web.application_server development
C:\OMERO.server> bin\omero config set omero.web.debug True
```

then start by

```
c:\OMERO.server> bin\omero web start
INFO:__main__:Application Starting...
INFO:root:Processing custom settings for module omeroweb.settings
...
Validating models...

0 errors found
Django version 1.8, using settings 'omeroweb.settings'
Starting development server at http://127.0.0.1:4080/
Quit the server with CTRL-BREAK.
```

Note: As OMERO.web 5 is based on Django 1.8[95], `omero.web.session_engine` and `omero.web.caches` should be unset.

```
C:\omero_dist>bin\omero config set omero.web.session_engine
C:\omero_dist>bin\omero config set omero.web.caches
```

If your deployment requires additional cache store please follow Django documentation[96] for more details.

[95] https://docs.djangoproject.com/en/1.8/releases/1.8/
[96] https://docs.djangoproject.com/en/1.8/topics/cache/

Once you have deployed and started the server you can use your browser to access the OMERO.web interface:

- http://localhost:4080/

Figure 6.4: OMERO.web login

Post-installation items

Additional libraries

The following are optional depending on what services you require:

Package	Functionality	Downloads
Django (1.8)	OMERO.web	Django website[97]
Pillow (2.9.0)	OMERO.web and Figure Export	Pillow[98]
Matplotlib	OMERO.web	Matplotlib page[99]
PyTables (2.1.0 or higher)	*OMERO.tables*	PyTables page[100]
NumPy (1.2.0 or higher) [101]	Scripting	Numpy/Scipy page[102]
Numexpr (2.4.3 or higher)		Numexpr page[103]
pyparsing (2.0.3 or higher)		pyparsing page[104]
python-dateutil (2.4.2 or higher)		python-dateutil page[105]
pytz		pytz page[106]
six (1.9.0 or higher)		six page[107]
virtualenv (12.1.1 or higher)		virtualenv page[108]

Backup

One of your first steps after putting your OMERO server into production should be deciding on when and how you are going to *backup your database and binary data*. Please do not omit this step.

[97] https://www.djangoproject.com/
[98] http://pillow.readthedocs.org
[99] http://matplotlib.org/
[100] https://pytables.github.io/downloads.html
[101] May already have been installed as a dependency of Matplot Lib.
[102] http://www.scipy.org/Download
[103] https://pypi.python.org/pypi/numexpr
[104] http://pyparsing.wikispaces.com
[105] https://pypi.python.org/pypi/python-dateutil
[106] http://pytz.sourceforge.net/
[107] https://pypi.python.org/pypi/six
[108] http://docs.python-guide.org/en/latest/dev/virtualenvs/

Security

You should read the *Server security and firewalls* page to get a good idea as to what you need to do to get OMERO clients speaking to your newly installed OMERO.server in accordance with your institution or company's security policy.

Advanced configuration

Once you have the base server running, you may want to try enabling some of the advanced features such as *OMERO.dropbox* or *LDAP authentication*. If you have ***Flex data***, you may want to watch the HCS configuration screencast[109]. See the Feature list[110] for more advanced features you may want to use, and *Configuration properties glossary* on how to get the most out of your server.

If your users are going to be importing many files in one go, for example multiple plates, you should make sure you set the maximum number of open files to a sensible level (i.e. at least 8K for production systems, 16K for bigger machines). See *Too many open files* for more information.

Troubleshooting

If you encounter a problem which is not addressed by the *Troubleshooting OMERO* page, you can post a message to our ome-users[111] mailing list as discussed on the *Community support* page. Especially the *Server fails to start* and *Remote clients cannot connect to OMERO installation* sections are a good starting point.

OMERO diagnostics

Please include the output of the diagnostics command when asking for help with your server installation:

```
C:\opt\OMERO.server> bin\omero admin diagnostics

================================================================================
OMERO Diagnostics 5.2.4
================================================================================


Commands:  java -version            1.8.0    (C:\Program Files\Java\jdk1.7.0_51\bin\java.EXE -
- 2 others)
Commands:   python -V                    2.7.6     (C:\Python27\python.EXE -- 2 others)
Commands:    icegridnode --version              3.5.1       (c:\opt\Ice-3.5.1-win-x64-
Release\bin\icegridnode.EXE)
Commands:    icegridadmin --version             3.5.1       (c:\opt\Ice-3.5.1-win-x64-
Release\bin\icegridadmin.EXE)
Commands:  psql --version           9.3.4    (C:\Program Files\PostgreSQL\9.3\bin\psql.EXE)

Server:     icegridnode                     running
Server:     Blitz-0                         active (pid = 1384, enabled)
Server:     DropBox                         inactive (disabled)
Server:     FileServer                      inactive (disabled)
Server:     Indexer-0                       active (pid = 3872, enabled)
Server:     MonitorServer                   inactive (disabled)
Server:     OMERO.Glacier2                  active (pid = 5744, enabled)
Server:     OMERO.IceStorm                  active (pid = 3520, enabled)
Server:     PixelData-0                     active (pid = 3096, enabled)
Server:     Processor-0                     inactive (disabled)
Server:     Tables-0                        inactive (disabled)
Server:     TestDropBox                     inactive (enabled)
Server:     OMERO.master                    active (running as LocalSystem)
```

[109] http://cvs.openmicroscopy.org.uk/snapshots/movies/omero-4-1/mov/FlexPreview4.1-configuration.mov
[110] http://www.openmicroscopy.org/site/products/omero/feature-list
[111] http://lists.openmicroscopy.org.uk/mailman/listinfo/ome-users

```
OMERO:      SSL port                        4064
OMERO:      TCP port                        4063

Log dir:    C:\opt\OMERO.server-5.0.1-ice35-b21\var\log exists

Log files:  Blitz-0.log                     38.0 KB
Log files:  DropBox.log                     n/a
Log files:  FileServer.log                  n/a
Log files:  Indexer-0.log                   64.0 KB       errors=0    warnings=2

Log files:  MonitorServer.log               n/a
Log files:  OMEROweb.log                    n/a
Log files:  PixelData-0.log                 3.0 KB        errors=0    warnings=2

Log files:  Processor-0.log                 n/a
Log files:  Tables-0.log                    n/a
Log files:  TestDropBox.log                 n/a
Log files:  master.err                      1.0 KB        errors=2    warnings=2

Log files:  master.out                      0.0 KB
Log files:  Total size                      0.11 MB


Environment:OMERO_HOME=(unset)
Environment:OMERO_NODE=(unset)
Environment:OMERO_MASTER=(unset)
Environment:OMERO_TEMPDIR=(unset)
Environment:PATH=C:\Program    Files\PostgreSQL\9.3\bin;C:\Python27;c:\opt\Ice-3.5.1-
win-x64-Release\bin;C:\Program Files\Java\jdk1.7.0_51\bin;C:\Windows\system32;C:\Windows;C:\W
Environment:ICE_HOME=c:\opt\Ice-3.5.1-win-x64-Release
Environment:LD_LIBRARY_PATH=(unset)
Environment:DYLD_LIBRARY_PATH=(unset)

OMERO data dir: 'C:\\opt\\omerodata'    Exists? True    Is writable? True
OMERO temp dir: 'C:\Users\omero\AppData\Roaming\omero\tmp'     Exists? True
Is writable? True   (Size: 0)
OMERO.web status... [NOT STARTED]
```

Update notification

Your OMERO.server installation will check for updates each time it is started from the *Open Microscopy Environment* update server. If you wish to disable this functionality you should do so now as outlined on the *OMERO upgrade checks* page.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.2.2 OMERO.server binary repository

Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.server and OMERO.web deployment. See this blog post[a] for details. If you are installing a new server, we highly recommend you use a different OS (see *Version requirements*).

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

About

The OMERO.server binary data repository is a fundamental piece of server-side functionality. It provides optimized and indexed storage of original file, pixel and thumbnail data, attachments and full-text indexes. The repository's directories contain various files that, together with your SQL database, constitute the information about your users and their data that OMERO.server relies upon for normal operation.

Layout

The repository is internally laid out as follows:

```
C:\OMERO
C:\OMERO\Pixels             <--- Pixel data and pyramids
C:\OMERO\Files              <--- Original file data
C:\OMERO\Thumbnails         <--- Thumbnail data
C:\OMERO\FullText           <--- Lucene full text search index
C:\OMERO\ManagedRepository  <--- OMERO.fs filesets, with import logs
C:\OMERO\BioFormatsCache    <--- Cached Bio-Formats state for rendering
```

Your repository is not:

- the "database"
- the directory where your OMERO.server binaries are
- the directory where your OMERO.client (OMERO.insight or OMERO.importer) binaries are
- your PostgreSQL data directory

Locking and remote shares

The OMERO server requires proper locking semantics on all files in the binary repository. In practice, this means that remotely mounted shares such as AFS, CIFS, and NFS can cause issues. If you have experience and/or the time to manage and monitor the locking implementations of your remote filesystem, then using them as for your binary repository should be fine.

If, however, you are seeing errors such as NullPointerExceptions, "Bad file descriptors" and similar in your server log, then you will need to use directly connected disks.

Warning: If your binary repository is a remote share and mounting the share fails or is dismounted, OMERO will continue operating using the mount point instead! To prevent this, make the mount point read-only for the OMERO user so that no data can be written to the mount point.

Repository location

Note: It is **strongly** recommended that you make all changes to your OMERO binary repository with the server shut down. Changing the `omero.data.dir` configuration does **not** move the repository for you, you must do this yourself. Remember that `C:\` style paths must have backslashes escaped. We strongly discourage the use of network mapped drives as locations for either the binary repository or the OMERO.server installation.

Your repository location can be changed from its `C:\OMERO` default by modifying your OMERO.server configuration as follows:

```
C:\> cd C:\OMERO.server
C:\OMERO.server\> bin\omero config set omero.data.dir D:\\OMERO
```

The suggested procedure is to shut down your OMERO.server instance, move your repository, change your `omero.data.dir` and then start the instance back up. For example:

```
C:\> cd C:\OMERO.server
C:\OMERO.server\> bin\omero admin stop
C:\OMERO.server\> move C:\OMERO D:\
C:\OMERO.server\> bin\omero config set omero.data.dir D:\\OMERO
C:\OMERO.server\> bin\omero admin start
```

The `omero.managed.dir` property for the OMERO.fs managed repository may be adjusted similarly, even to a directory outside `omero.data.dir`.

Note: The managed repository should be located and configured to allow the OMERO server processes fast access to the uploaded filesets that it contains.

Access permissions

Your repository should be owned or accessible by the same user that is starting your OMERO.server instance which may be different from the user you use to start OMERO. See *OMERO.server Windows Service* for more information.

To modify the access permissions to the binary repository, the `OMERO` folder properties can be accessed and the permissions settings changed (see *Repository Folder Permissions*). Another option (useful for batch permission changes) is the `icacls` (Windows 7) / `cacls` (Windows XP) command line utility. Please note that the new permissions will appear as *Special Permissions* in the *Security* tab when viewing folder properties. An example invocation allowing the user *omeservice* to read (*R*) and write (*W*) from and to the `OMERO` directory:

```
C:\>icacls OMERO /grant omeservice:RW
processed file: OMERO
Successfully processed 1 files; Failed processing 0 files
```

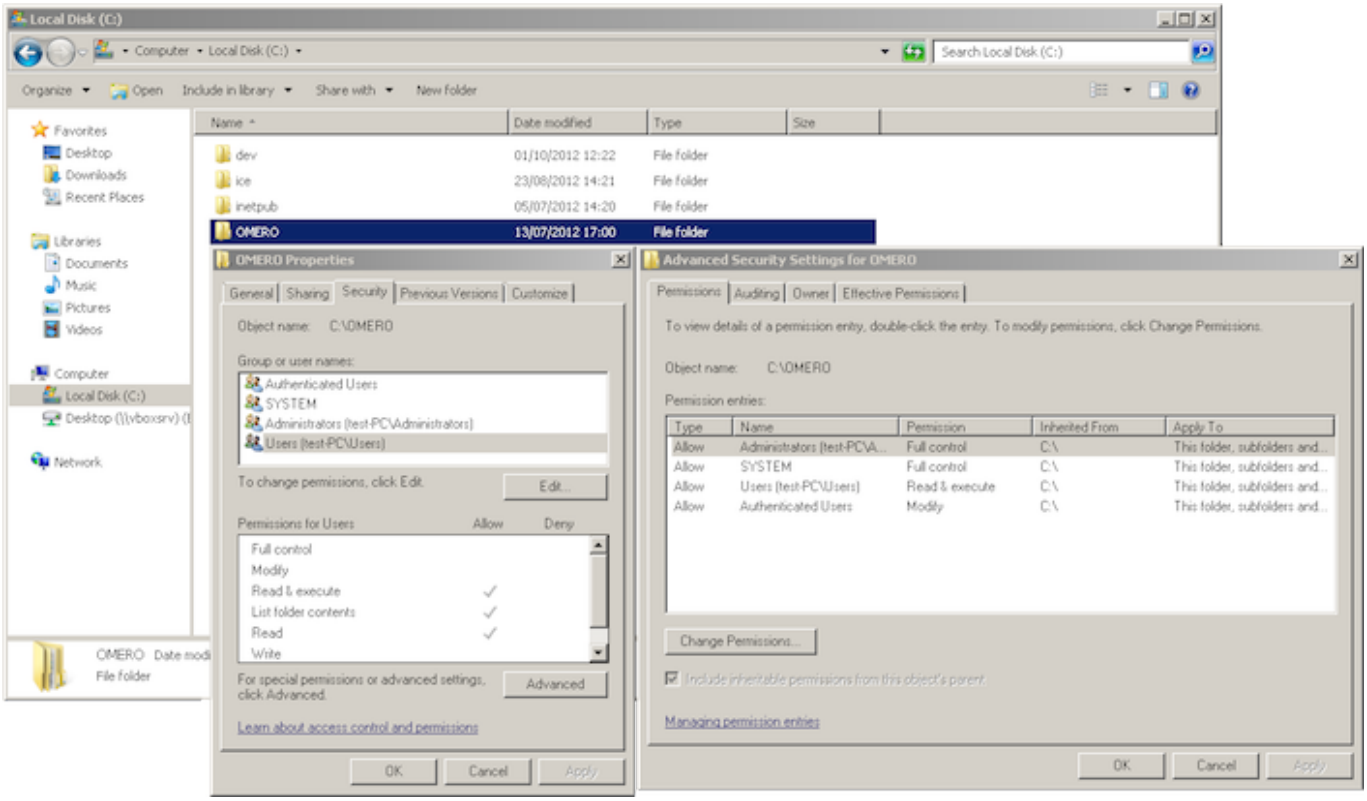


Figure 6.5: Repository Folder Permissions

Repository size

At minimum, the binary repository should be comfortably larger than the images and other files that users may be uploading to it. It is fine to set `omero.data.dir` or `omero.managed.dir` to very large volumes, or to use logical volume management to conveniently increase space as necessary.

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.2.3 OMERO.server and PostgreSQL

Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.server and OMERO.web deployment. See this blog post[a] for details. If you are installing a new server, we highly recommend you use a different OS (see *Version requirements*).

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

In order to be installed, OMERO.server requires a running PostgreSQL instance that is configured to accept connections over TCP. This section explains how to ensure that you have the correct PostgreSQL version and that it is installed and configured correctly.

For Windows-specific installation instructions, first see *OMERO.server installation*.

Ensuring you have a valid PostgreSQL version

For OMERO 5.2, PostgreSQL version 9.4 or later is required; version 9.4 is recommended. Make sure you are using a supported version[112].

If your existing PostgreSQL installation is version 9.3 or earlier, it is recommended that you upgrade to a more up-to-date version. Before upgrading, stop the OMERO server and then perform a full dump of the database using **pg_dump**. See the *OMERO.server backup and restore* section for further details.

If a PostgreSQL server was not provided by your system, EnterpriseDB[113] provide an installer.

Checking PostgreSQL port listening status

You can check if PostgreSQL is listening on the default port (`TCP/5432`) by running the following command:

```
C:\> netstat -an | find "5432"
```

Note: The exact output of this command will vary. The important thing to recognize is whether or not a process is listening on `TCP/5432`.

If you cannot find a process listening on `TCP/5432` you will need to find your `postgresql.conf` file and enable PostgreSQL's TCP listening mode. The exact location of the `postgresql.conf` file varies between installations.

Once you have found the location of the `postgresql.conf` file on your particular installation, you will need to enable TCP listening. The area of the configuration file you are concerned about should look similar to this:

```
#listen_addresses = 'localhost'         # what IP address(es) to listen on;
                                        # comma-separated list of addresses;
                                        # defaults to 'localhost', '*' = all
#port = 5432
max_connections = 100
# note: increasing max_connections costs ~400 bytes of shared memory per
# connection slot, plus lock space (see max_locks_per_transaction).  You
```

[112] http://www.postgresql.org/support/versioning/
[113] http://www.enterprisedb.com/

```
# might also need to raise shared_buffers to support more connections.
#superuser_reserved_connections = 2
#unix_socket_directory = *
#unix_socket_group = *
#unix_socket_permissions = 0777         # octal
#bonjour_name = *                       # defaults to the computer name
```

PostgreSQL HBA (host based authentication)

OMERO.server must have permission to connect to the database that has been created in your PostgreSQL instance. This is configured in the *host based authentication* file, `pg_hba.conf`. Check the configuration by examining the contents of `pg_hba.conf`. It's important that at least one line allows connections from the loopback address (`127.0.0.1`) as follows:

```
# TYPE  DATABASE    USER        CIDR-ADDRESS          METHOD
# IPv4 local connections:
host    all         all         127.0.0.1/32          md5
# IPv6 local connections:
host    all         all         ::1/128               md5
```

Note: The other lines that are in your `pg_hba.conf` are important either for PostgreSQL internal commands to work or for existing applications you may have. **Do not delete them**.

See also:

PostgreSQL[114] Interactive documentation for the current release of PostgreSQL.

Connections and Authentication[115] Section of the PostgreSQL documentation about configuring the server using *postgresql.conf*.

Client Authentication[116] Chapter of the PostgreSQL documentation about configuring client authentication with *pg_hba.conf*.

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.2.4 OMERO.web deployment

Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.web deployment. See this blog post[a] for details. If you are deploying a new installation of OMERO.web, we highly recommend you use a different OS (see *Version requirements*).
The guidance below applies to OMERO **5.2**. Code fixes for OMERO.web deployment on Windows have not been back-ported to the 5.1 line and this guide cannot be used to deploy OMERO.web 5.1.x on Windows.

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

OMERO.web is the web application component of the OMERO platform which allows for the management, visualization (in a fully multi-dimensional image viewer) and annotation of images from a web browser. It also includes the ability to manage users and groups.

OMERO.web is an integral part of the OMERO platform and can be deployed with:

- IIS 6.0 or 7.0 on Microsoft Windows
- WSGI[117] using a WSGI capable web server such as Apache 2.2+[118] (with mod wsgi[119] enabled).
- The built-in Django lightweight development server (for **testing** only; see the *OMERO.web deployment for developers* page)

[117] http://wsgi.readthedocs.org/en/latest/
[118] http://httpd.apache.org
[119] http://modwsgi.readthedocs.org/en/develop/

If you need help configuring your firewall rules, see the *Server security and firewalls* page.

Prerequisites

- OMERO and its prerequisites (see *OMERO.server installation*).
- Python 2.7
  - **Pillow**[120] **should be available for your distribution. We currently do not** support version 3.0+.
  - Matplotlib[121] should be available for your distribution
- IIS or WSGI capable web server

Deployment (Windows)

See *Customizing your OMERO.web installation* for additional customization options.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

OMERO.web IIS deployment (Windows)

Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.server and OMERO.web deployment. See this blog post[a] for details. If you are installing a new server, we highly recommend you use a different OS (see *Version requirements*).

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

IIS configuration (Windows)

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[122] on Windows. For more information see *Python* on the *Version requirements* page.

Install Django 1.8[123] using package requirements file:

```
C:\> pip install -r C:\OMERO.server\share\web\requirements-py27-win.txt
```

Note: For more details refer to Django 1.8 installation on Windows[124].

Install additional Python libraries:

Download the following whl files then run:

```
set PYTHONPIP=C:\Python27\Scripts\pip.exe

%PYTHONPIP% install matplotlib-1.4.3-cp27-none-win_amd64.whl
%PYTHONPIP% install numpy-1.9.2+mkl-cp27-none-win_amd64.whl
%PYTHONPIP% install numexpr-2.4.3-cp27-none-win_amd64.whl
%PYTHONPIP% install Pillow-2.8.1-cp27-none-win_amd64.whl
%PYTHONPIP% install pyparsing-2.0.3-py2-none-any.whl
%PYTHONPIP% install python_dateutil-2.4.2-py2.py3-none-any.whl
%PYTHONPIP% install pytz-2015.2-py2.py3-none-any.whl
```

[121] http://matplotlib.org/
[122] https://docs.djangoproject.com/en/1.8/releases/1.8/
[123] https://docs.djangoproject.com/en/1.8/releases/1.8/
[124] https://docs.djangoproject.com/en/1.8/howto/windows/

```
%PYTHONPIP% install six-1.9.0-py2.py3-none-any.whl
%PYTHONPIP% install tables-3.1.1-cp27-none-win_amd64.whl
%PYTHONPIP% install virtualenv-12.1.1-py2.py3-none-any.whl

%PYTHONPIP% install pywin32-219-cp27-none-win_amd64.whl
C:\Python27\Scripts\pywin32_postinstall.py -install
```

A straightforward set of steps is required to get the ISAPI WSGI[125] handler for OMERO.web working with your IIS deployment.

- Ensure that the ISAPI for IIS options are installed.
- Download and install an ISAPI WSGI[126]. If you download the *Source Distribution* (should be compatible with all versions of Windows/IIS) unzip the archive and run:

  ```
  python setup.py install
  ```

  Alternatively if you are using a 32-bit system you can use the *Windows Installer*.
- For extended compatibility with multiple IIS versions ISAPI WSGI uses the IIS 6 WMI interface to interact with your IIS deployment. If you are using IIS 7 you must enable the IIS 6 WMI backwards compatibility options. Also make sure to install the ISAPI extensions and filters, as shown in the figure below. For further information see IIS Documentation - ISAPI Filters[127] respectively IIS Documentation - ISAPI/CGI Restrictions[128]

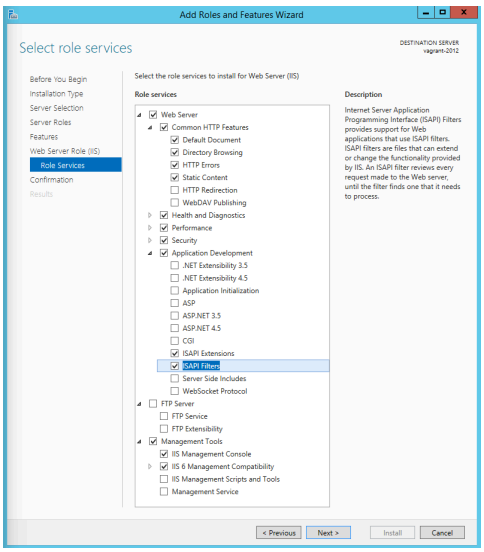


Figure 6.6: IIS 8 configuration options

- The *Advanced Settings...* for the application pool assigned to your default site require modification using the *IIS Manager* as follows:
  - *Idle Time-out (minutes)* - to stop the worker process from suspending during inactivity periods, this setting needs to be changed to 0.
- To avoid rendering errors on OMERO.web it is recommended to add the custom HTTP response header in the Web site pane.
- Make sure that OMERO's log directory has full read/write permissions for all users
- Configure OMERO.web bindings for IIS

[125] http://code.google.com/p/isapi-wsgi/
[126] http://code.google.com/p/isapi-wsgi/downloads/list
[127] https://www.iis.net/configreference/system.webserver/isapifilters
[128] https://www.iis.net/configreference/system.webserver/security/isapicgirestriction

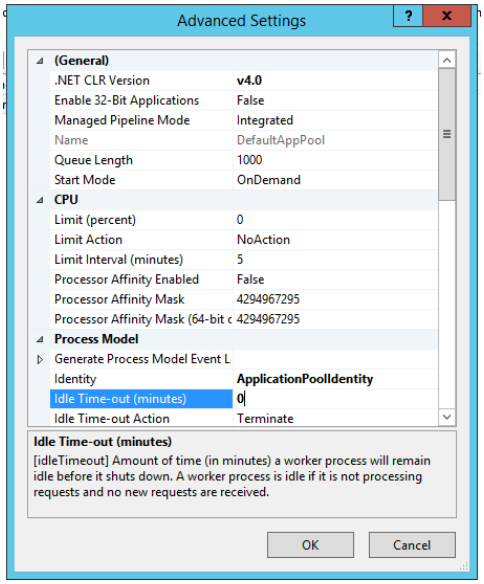
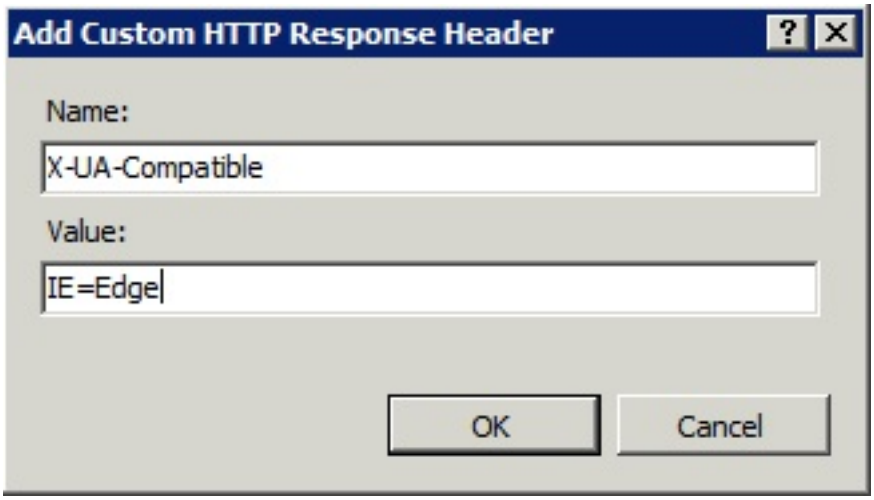


Figure 6.7: IIS 8 Application Pool Advanced Settings




```
C:\OMERO.server> bin\omero web iis
```

This will automatically add two applications, */omero* and */static*, to the default web site and application pool. You can customize these locations by setting `omero.web.prefix` and `omero.web.static_url`.

Note: You can make manual changes to the IIS OMERO configuration but they may be lost when OMERO.server is upgraded.

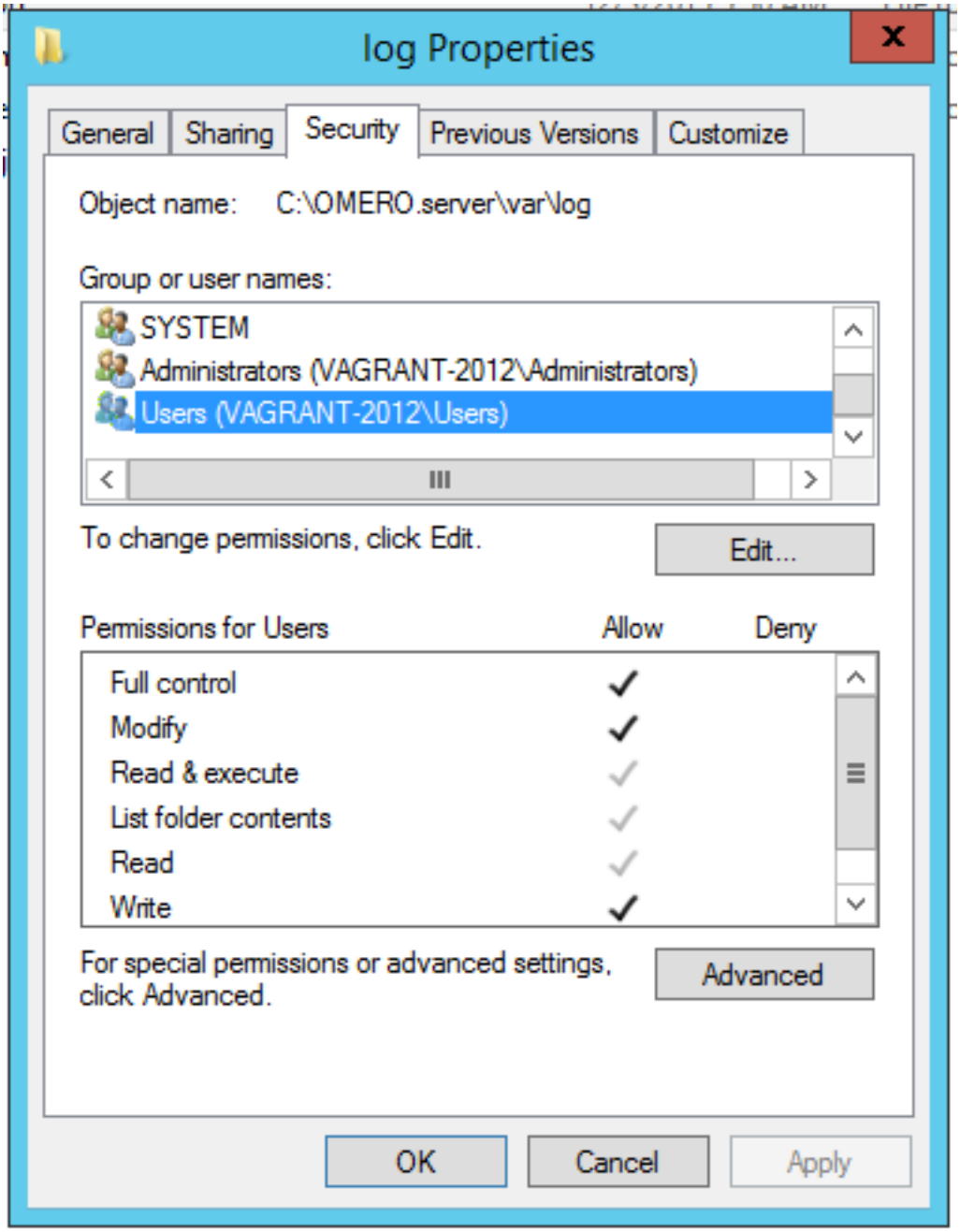
Note: As OMERO.web 5 is based on Django 1.8[129], `omero.web.session_engine` and `omero.web.caches` should be unset.

```
C:\omero_dist>bin\omero config set omero.web.session_engine
C:\omero_dist>bin\omero config set omero.web.caches
```

If your deployment requires additional cache store please follow the Django documentation[130] for more details.

If you wish to use Apache or Nginx please follow the Unix instructions

[129] https://docs.djangoproject.com/en/1.8/releases/1.8/
[130] https://docs.djangoproject.com/en/1.8/topics/cache/



Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

OMERO.web Apache and mod_wsgi deployment (Unix/Linux)

Apache 2.2+ with mod_wsgi configuration (Unix/Linux)

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[131] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.

OMERO.web uses the Web Server Gateway Interface (WSGI)[132] as a primary deployment platform. The Python standard PEP 3333[133] that describes how a web server communicates with web applications.

[131] https://docs.djangoproject.com/en/1.8/releases/1.8/
[132] http://wsgi.readthedocs.org/en/latest/learn.html
[133] https://www.python.org/dev/peps/pep-3333/

Apache default configuration (Unix/Linux) Install Django 1.8[134] using package requirements file:

```
$ pip install -r share/web/requirements-py27-apache.txt
```

Note: For more details refer to how to install Django 1.8[135] or hot to upgrade Django to 1.8[136].

Additional settings can be configured by changing the following properties:

- `omero.web.application_server.max_requests` to 500
- `omero.web.wsgi_workers` to (2 x NUM_CORES) + 1

  Note: **Do not** scale the number of workers to the number of clients you expect to have. OMERO.web should only need 4-12 worker processes to handle many requests per second.

Apache configuration (Unix/Linux) If you have installed Apache, install mod_wsgi[137].

OMERO can automatically generate a configuration file for your web server. The location of the file will depend on your system, please refer to your web server's manual. See *Customizing your OMERO.web installation* for additional customization options.

Set the following:

```
$bin/omero config set omero.web.application_server "wsgi"
```

Creates symlinks for static media files

```
$bin/omero web syncmedia
```

To create a site configuration file for inclusion in the main Apache configuration redirect the output of the following command into a file:

```
$ bin/omero web config apache
```

```
<VirtualHost _default_:80>

  WSGIDaemonProcess omeroweb processes=5 threads=1 maximum-requests=0 display-name=%{GROUP} user=omero

  WSGIScriptAlias / /home/omero/OMERO.server/lib/python/omeroweb/wsgi.py process-group=omeroweb

  <Directory "/home/omero/OMERO.server/lib/python/omeroweb">
    WSGIProcessGroup omeroweb
    WSGIApplicationGroup %{GLOBAL}
    Order allow,deny
    Allow from all
  </Directory>

  Alias /static /home/omero/OMERO.server/lib/python/omeroweb/static
  <Directory "/home/omero/OMERO.server/lib/python/omeroweb/static">
      Options -Indexes FollowSymLinks
      Order allow,deny
      Allow from all
  </Directory>
```

[134] https://docs.djangoproject.com/en/1.8/releases/1.8/
[135] https://docs.djangoproject.com/en/1.8/topics/install/#install-the-django-code
[136] https://docs.djangoproject.com/en/1.8/topics/install/#remove-any-old-versions-of-django
[137] http://www.modwsgi.org/

```
</VirtualHost>

# see https://code.google.com/p/modwsgi/wiki/ConfigurationIssues
WSGISocketPrefix run/wsgi
# Use this on Ubuntu/Debian/MacOSX systems:
# WSGISocketPrefix /var/run/wsgi
```

To configure an HTTPS server follow the Apache documentation[138].

Then reload Apache.

Running OMERO.web (Unix/Linux) OMERO.web is used in 'daemon' mode where UNIX sockets are used to communicate between the Apache child processes and the daemon processes which are to handle a request. **OMERO.web does not provide any management for these 'daemon' processes;** `bin/omero web start/status/stop` **will not work as they are for managing gunicorn processes only.**

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

OMERO.web Nginx and Gunicorn deployment (Unix/Linux)

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[139] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.

OMERO.web uses the Web Server Gateway Interface (WSGI)[140] as a primary deployment platform. The Python standard PEP 3333[141] that describes how a web server communicates with web applications.

Gunicorn default configuration (Unix/Linux) Install Django 1.8[142] and Gunicorn >= 19.3[143] using the package requirements file:

```
$ pip install -r share/web/requirements-py27-nginx.txt
```

Note: For more details refer to how to install Django 1.8[144] or upgrade Django to 1.8[145].

Additional settings can be configured by changing the following properties:

- `omero.web.application_server.max_requests` to 500
- `omero.web.wsgi_workers` to (2 x NUM_CORES) + 1

  Note: Do not scale the number of workers to the number of clients you expect to have. OMERO.web should only need 4-12 worker processes to handle many requests per second.

- `omero.web.wsgi_args` Additional arguments. For more details check Gunicorn Documentation[146].

[138] http://httpd.apache.org/docs/trunk/mod/mod_ssl.html
[139] https://docs.djangoproject.com/en/1.8/releases/1.8/
[140] http://wsgi.readthedocs.org/en/latest/learn.html
[141] https://www.python.org/dev/peps/pep-3333/
[142] https://docs.djangoproject.com/en/1.8/releases/1.8/
[143] http://gunicorn.org
[144] https://docs.djangoproject.com/en/1.8/topics/install/#install-the-django-code
[145] https://docs.djangoproject.com/en/1.8/topics/install/#remove-any-old-versions-of-django
[146] http://docs.gunicorn.org/en/stable/settings.html

Nginx configuration (Unix/Linux) If you have installed Nginx, OMERO can automatically generate a configuration file for your web server. The location of the file will depend on your system, please refer to your web server's manual. See *Customizing your OMERO.web installation* for additional customization options.

To create a site configuration file for inclusion in a system-wide nginx configuration redirect the output of the following command into a file:

```
$ bin/omero web config nginx
```

```
upstream omeroweb {
    server 127.0.0.1:4080 fail_timeout=0;
}

server {
    listen 80;
    server_name $hostname;

    sendfile on;
    client_max_body_size 0;

    # maintenance page serve from here
    location @maintenance {
        root /home/omero/OMERO.server/etc/templates/error;
        try_files $uri /maintainance.html =502;
    }

    # weblitz django apps serve media from here
    location /static {
        alias /home/omero/OMERO.server/lib/python/omeroweb/static;
    }

    location @proxy_to_app {
        proxy_set_header X-Forwarded-Proto $scheme;
        proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
        proxy_set_header Host $http_host;
        proxy_redirect off;
        proxy_buffering off;

        proxy_pass http://omeroweb;
    }

    location / {

        error_page 502 @maintenance;
        # checks for static file, if not found proxy to app
        try_files $uri @proxy_to_app;
    }

}
```

Note: OMERO.web requires `body_in_file_only` adjusted in your default nginx config because nginx must buffer incoming data. Make sure you have that set to the following config:

```
http {
    ...
    sendfile on;
    send_timeout 60s;
    client_max_body_size 0;
    ...
}
```

To configure an HTTPS server follow the nginx documentation[147].

Running OMERO.web (Unix/Linux) Start the Gunicorn worker processes listening by default on 127.0.0.1:4080:

```
$ bin/omero web start
... static files copied to '/home/omero/OMERO.server/lib/python/omeroweb/static'.
Starting OMERO.web... [OK]
```

The Gunicorn workers are managed **separately** from other OMERO.server processes. You can check their status or stop them using the following commands:

```
$ bin/omero web status
OMERO.web status... [RUNNING] (PID 59217)
$ bin/omero web stop
Stopping OMERO.web... [OK]
Django WSGI workers (PID 59217) killed.
```

Download limitations In order to offer users the ability to download data from OMERO.web you have to deploy using *EXPERIMENTAL: Async workers*. OMERO.web is able to handle multiple clients on a single worker thread switching context as necessary while streaming binary data from OMERO.server. Depending on the traffic and scale of the repository you should configure connections and speed limits on your server to avoid blocking resources. We recommend you run benchmark and performance tests. It is also possible to apply *Download restrictions* and offer alternative access to binary data.

Note: Handling streaming request/responses requires proxy buffering to be turned off. For more details refer to Gunicorn deployment[148] and Nginx configuration[149].

Note: `omero.web.application_server.max_requests` should be set to 0

Benchmark We run example benchmarks on rendering thumbnails and 512x512 pixels planes for 100 concurrent users making 5000 requests in total:

```
$ ab -n 5000 -c 100 https://server.openmicroscopy.org/omero/webclient/render_thumbnail/size/96/1234/
This is ApacheBench, Version 2.3 <$Revision: 1430300 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Server Software:        nginx/1.9.9
Server Hostname:        server.openmicroscopy.org
Server Port:            80

Document Path:          /omero/webclient/render_thumbnail/size/96/31851/
Document Length:        1880 bytes

Concurrency Level:      100
Time taken for tests:   224.488 seconds
Complete requests:      5000
Failed requests:        0
Write errors:           0
Total transferred:      10450000 bytes
HTML transferred:       9400000 bytes
Requests per second:    22.27 [#/sec] (mean)
Time per request:       4489.763 [ms] (mean)
Time per request:       44.898 [ms] (mean, across all concurrent requests)
```

[147] http://nginx.org/en/docs/http/configuring_https_servers.html
[148] http://docs.gunicorn.org/en/stable/deploy.html
[149] http://nginx.org/en/docs/http/ngx_http_proxy_module.html#proxy_buffering

```
Transfer rate:          45.46 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        0    0   0.3      0       3
Processing:   435 4446 685.2   4363    7644
Waiting:      432 4446 685.3   4362    7644
Total:        435 4446 685.1   4363    7644

Percentage of the requests served within a certain time (ms)
  50%   4363
  66%   4553
  75%   4670
  80%   4750
  90%   5072
  95%   5398
  98%   6795
  99%   6955
 100%   7644 (longest request)



$ ab -n 5000 -c 100 http://server.openmicroscopy.org/omero/webclient/render_image/1234/20/0/
This is ApacheBench, Version 2.3 <$Revision: 1430300 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Server Software:        nginx/1.9.9
Server Hostname:        server.openmicroscopy.org
Server Port:            80

Document Path:          /omero/webclient/render_image/1234/20/0/
Document Length:        24293 bytes

Concurrency Level:      100
Time taken for tests:   247.154 seconds
Complete requests:      5000
Failed requests:        0
Write errors:           0
Total transferred:      122515000 bytes
HTML transferred:       121465000 bytes
Requests per second:    20.23 [#/sec] (mean)
Time per request:       4943.080 [ms] (mean)
Time per request:       49.431 [ms] (mean, across all concurrent requests)
Transfer rate:          484.09 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        0    0   0.4      0       4
Processing:   482 4898 855.3   4737    8303
Waiting:      476 4898 855.3   4737    8303
Total:        482 4898 855.2   4737    8303

Percentage of the requests served within a certain time (ms)
  50%   4737
  66%   5041
  75%   5250
  80%   5397
  90%   5862
  95%   6621
  98%   7301
  99%   8062
 100%   8303 (longest request)
```

Troubleshooting In order to identify why OMERO.web is not available run:

```
$ bin/omero web status
```

Then consult nginx `error.log` and `OMERO.server/var/log/OMEROweb.log`

For more details check *OMERO.web issues*.

Debugging To run the WSGI server in debug mode, enable Gunicorn logging[150] using `omero.web.wsgi_args`:

```
$ bin/omero config set omero.web.wsgi_args -- "--log-level=DEBUG --error-logfile=/home/omero/OMERO.server
```

EXPERIMENTAL: Gunicorn advance configuration (Unix/Linux)

Note: Experimental configurations are not ready for production use. Configuration may change. Features may not work properly.

OMERO.web deployment can be configured with sync and async workers. Sync workers are faster and recommended for a data repository with *Download restrictions*. If you wish to offer users the ability to download data then you have to use async workers; read more about *Download limitations*.

For more details refer to Gunicorn design[151].

EXPERIMENTAL: Sync workers

Note: Experimental configurations are not ready for production use. Configuration may change. Features may not work properly.

- Install futures[152]

```
$ pip install futures
```

Additional settings can be configured by changing the following properties:

- The number of worker threads for handling requests, see Gunicorn threads[153]

```
$ bin/omero config set omero.web.wsgi_worker_class
$ bin/omero config set omero.web.wsgi_threads $(2-4 x NUM_CORES)
```

EXPERIMENTAL: Async workers

Note: Experimental configurations are not ready for production use. Configuration may change. Features may not work properly.

- Install Gevent >= 0.13[154]

```
$ pip install "gevent>=0.13"
```

Additional settings can be configured by changing the following properties:

- The maximum number of simultaneous clients, see Gunicorn worker-connections[155]

```
$ bin/omero config set omero.web.wsgi_worker_class gevent
$ bin/omero config set omero.web.wsgi_worker_connections 1000
$ bin/omero config set omero.web.application_server.max_requests 0
```

[150] http://docs.gunicorn.org/en/stable/settings.html#logging
[151] http://docs.gunicorn.org/en/stable/design.html
[152] https://pypi.python.org/pypi/futures
[153] http://docs.gunicorn.org/en/stable/settings.html#threads
[154] http://www.gevent.org/
[155] http://docs.gunicorn.org/en/stable/settings.html#worker-connections

Logging in to OMERO.web

Once you have deployed and started the server, you can use your browser to access the OMERO.webclient:

- **http://your_host/omero** OR, for development server: **http://localhost:4080**

Figure 6.8: OMERO.web login

OMERO.web Maintenance (Windows)

- Session cookies `omero.web.session_expire_at_browser_close`:
  - A boolean that determines whether to expire the session when the user closes their browser. See Django Browser-length sessions vs. persistent sessions documentation[156] for more details. Default: `True`.

```
C:\omero_dist>bin\omero config set omero.web.session_expire_at_browser_close "True"
```

  - The age of session cookies, in seconds. Default: `86400`.

```
C:\omero_dist>bin\omero config set omero.web.session_cookie_age 86400
```

- Session engine:
  - Each session for a logged-in user in OMERO.web is kept in the session store. Stale sessions can cause the store to grow with time. OMERO.web uses by default the OS file system as the session store backend and does not automatically purge stale sessions, see Django file-based session documentation[157] for more details. It is therefore the responsibility of the OMERO administrator to purge the session cache using the provided management command:

```
C:\omero_dist>bin\omero web clearsessions
```

    It is recommended to call this command on a regular basis, for example as a daily cron job, see Django clearing the session store documentation[158] for more information.

    Note: OMERO.web offers alternative session backends to automatically delete stale data using the cache session store backend, see Django cached session documentation[159] for more details. After installing all the cache prerequisites set the following:

```
C:\omero_dist>bin\omero config set omero.web.caches '{"default": { "BACKEND": "django.core.cach
C:\omero_dist>bin\omero config set omero.web.session_engine django.contrib.sessions.backends.ca
```

    ---

[156] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#browser-length-vs-persistent-sessions
[157] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#using-file-based-sessions
[158] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#clearing-the-session-store
[159] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#using-cached-sessions

Customizing your OMERO.web installation

All configuration options can be found on various sections of *Web* developers documentation. For the full list, refer to *Web* properties or:

```
C:\omero_dist>bin\omero web -h
```

The most popular configuration options include:

- Debug mode, see `omero.web.debug`.
- Customize login page with your own logo, see `omero.web.login_logo`.
- Customizing index page, see `omero.web.index_template`.
- Enabling a public user see *Public data in the repository*.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.2.5 OMERO.server Windows Service

Warning: OMERO 5.2 is the last major version which will feature Windows support for OMERO.server and OMERO.web deployment. See this blog post[a] for details. If you are installing a new server, we highly recommend you use a different OS (see *Version requirements*).

[a] http://blog.openmicroscopy.org/tech-issues/future-plans/deployment/2016/03/22/windows-support/

OMERO.server installs a Windows Service to make the startup of the software automatic at Windows boot time.

The `omero admin start` command creates and starts a Windows service. In turn, `omero admin stop` stops and deletes the OMERO Windows service. Therefore, once `omero admin start` succeeds, it is possible to use all the regular Windows utilities, like `sc.exe` or the Services Manager, to stop OMERO.server without having the service removed completely.

If required, the OMERO.server service can be run as a different user (by modifying the *Log On* settings of the Windows service).

Service *Log On* user

Default Windows Local System user

When no specific Windows user has been defined using `omero config set`, the OMERO.server starts as the *Local System* user. This user has enough permissions to access data on the local file system. In most circumstances that should allow the OMERO.server service to access data inside the binary repository.

Custom user

A custom user can be configured to run the OMERO.server service. You can configure the OMERO Windows user by setting *omero.windows.user* and *omero.windows.pass*:

```
C:\OMERO.server\> bin\omero config set omero.windows.user USERNAME
C:\OMERO.server\> bin\omero config set omero.windows.pass PASSWORD
```

Warning: Setting *omero.windows.pass* exposes your user password in the OMERO configuration.

The user credentials can also be specified on the command line when running `omero admin start`. The `-u` parameter value is the user name, while the value of `-w` corresponds to the user's password:

```
C:\OMERO.server\> bin\omero admin start -u omeservice -w password
```

You can verify that a different user has been set as the *Log On* user for the OMERO.server service by accessing the Windows Services Manager (see *Windows Service Log On User Settings*).

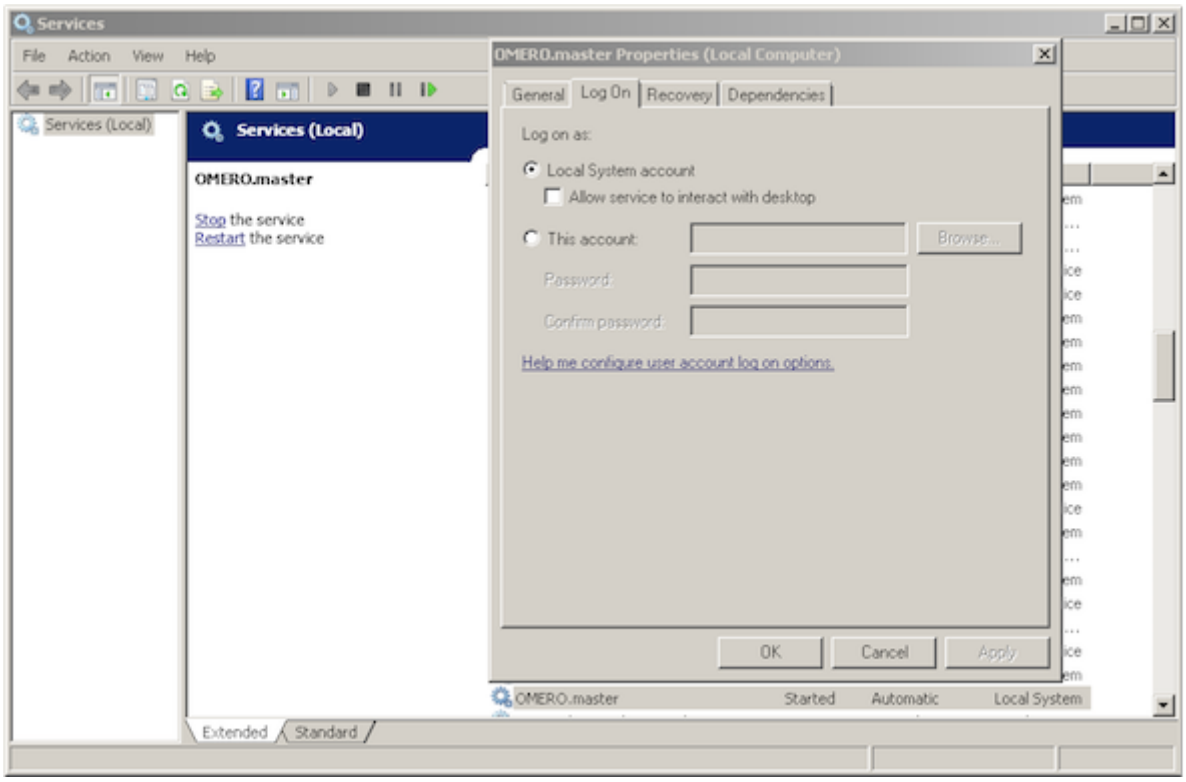


Figure 6.9: Windows Service *Log On* User Settings

Service startup mode

To start the Services Manager, simply navigate to *Start* → *All Programs* → *Accessories* → *Run* (Windows 7). In the dialog, type in `services.msc` and select *OK* (see *Run Windows Services Manager*).

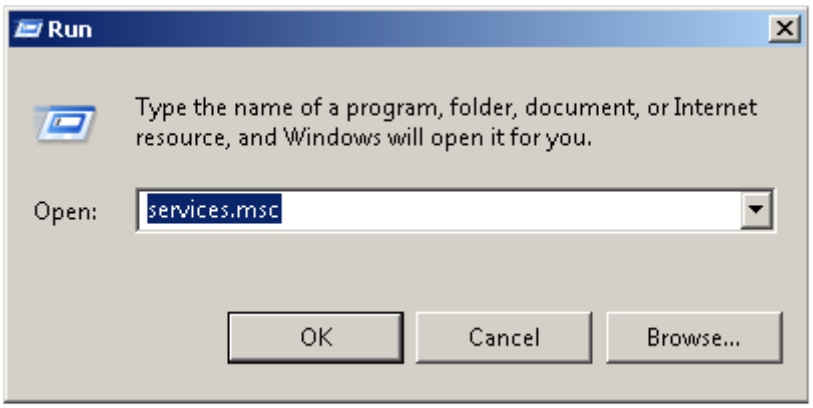


Figure 6.10: Run Windows Services Manager

This will bring up the Windows Services Manager. Here you can see the OMERO.master service running and also stop it. Additionally the *Log On* tab can be accessed here to configure under which user name the service is started (see *OMERO.server binary repository*).

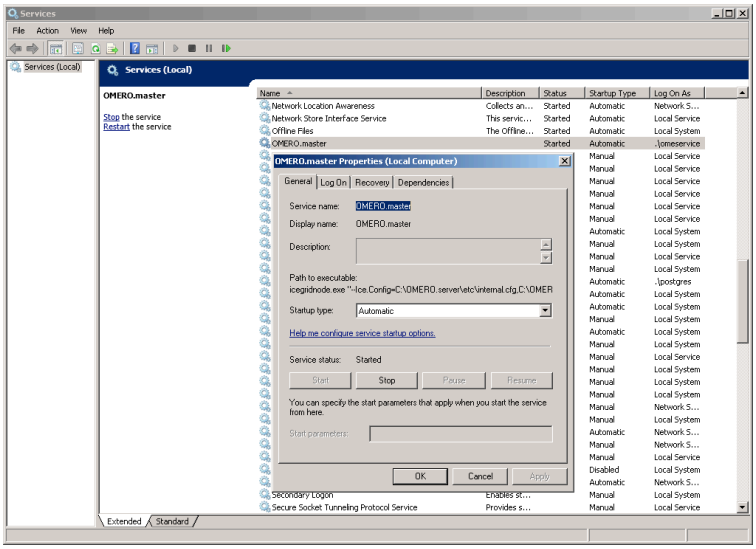


Figure 6.11: OMERO.master Service

It is also possible to change the service start-up type from *Automatic* to *Manual*. The automatic mode guarantees that OMERO.server will start during the Windows boot phase. Manual mode allows the logged in user or administrator to start the service after Windows has finished booting.

Service events

Windows Event Viewer allows for watching events occurring in the OMERO.server service. To start the viewer, follow the same path as for Windows Services Manager, but this time type in `eventvwr.msc` (see *Starting Event viewer*).

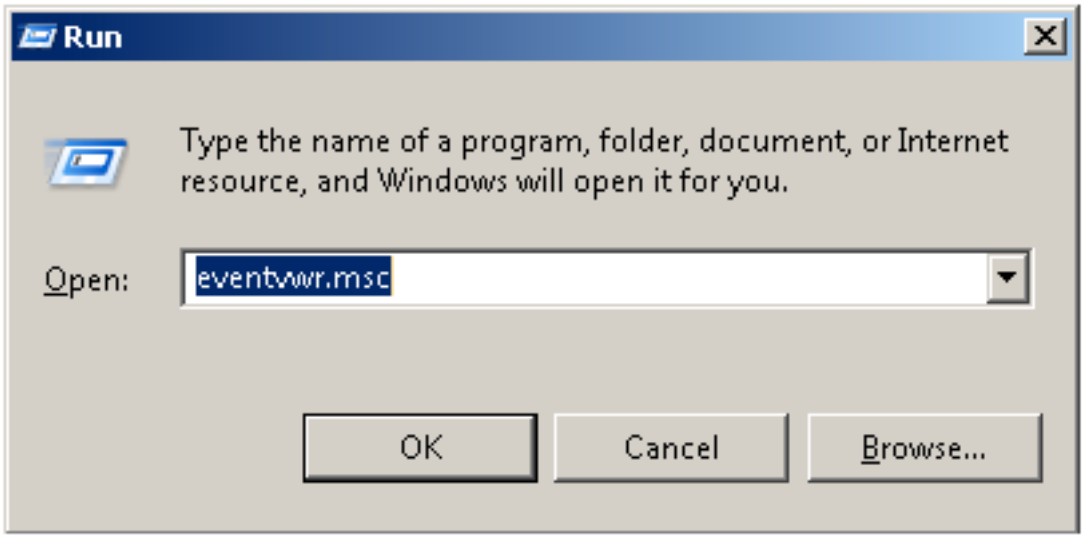


Figure 6.12: Starting Event viewer

The status events from OMERO.master will be registered in the *Application* view (though the log output from the server is in the configured directory).

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

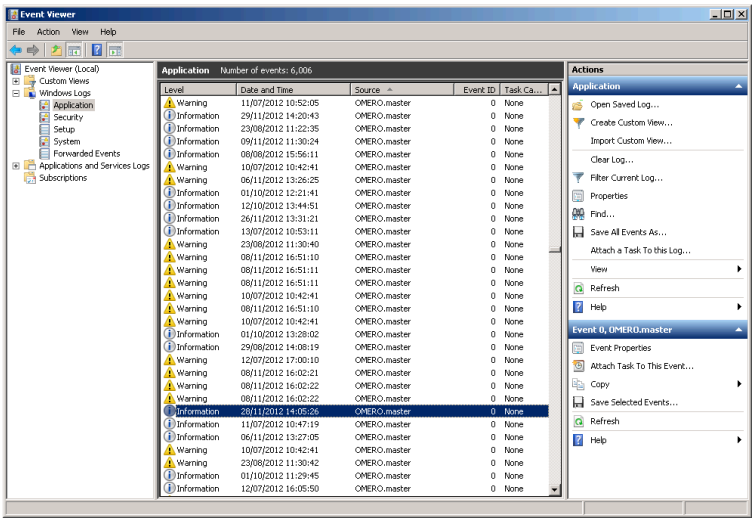


Figure 6.13: OMERO.master Events

6.3 Command Line Interface as an OMERO admin tool

When first beginning to work with the OMERO server, the `omero db`, `omero config`, and `omero admin` commands will be the first you will need.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.3.1 Database tools

Rather than try to provide the functionality of a RDBM tool like `psql`, the `omero db script` command helps to generate SQL scripts for building your database. You can then use those scripts from whatever tool is most comfortable for you:

```
$ bin/omero db script --password secretpassword



Using OMERO5.2 for version
Using 0 for patch
Using password from commandline
Saving to /home/omero/OMERO5.2__0.sql
```

If you do not specify the OMERO root password on the command line you will be prompted to enter it.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.3.2 Server configuration

The `omero config` command is responsible for reading / writing user-specific profiles stored under `etc/grid/config.xml`. To get the current profile, use the `omero config def` command:

```
$ bin/omero config def
default
```

You can then examine the current profile keys using `omero config get` and set key-value pairs using `omero config set`:

```
$ bin/omero config get

$ bin/omero config set example "my first value"

$ bin/omero config get
example=my first value
```

You can use the `OMERO_CONFIG` environment variable to point at a different profile, e.g.:

```
$ OMERO_CONFIG=another bin/omero config def
another

$ OMERO_CONFIG=another bin/omero config get

$ OMERO_CONFIG=another bin/omero config set example "my second value"

$ OMERO_CONFIG=another bin/omero config get
example=my second value
```

The values set via `omero config set` override those compiled into the server jars. The default values which are set can be seen in *Configuration properties glossary*. To add several values to a configuration, you can pipe them via standard in using `omero config load`:

```
$ grep omero.ldap etc/omero.properties | OMERO_CONFIG=ldap bin/omero config load

$ OMERO_CONFIG=ldap bin/omero config get
omero.ldap.attributes=objectClass
omero.ldap.base=ou=example,o=com
omero.ldap.config=false
omero.ldap.groups=
omero.ldap.keyStore=
omero.ldap.keyStorePassword=
omero.ldap.new_user_group=default
omero.ldap.password=
omero.ldap.protocol=
omero.ldap.trustStore=
omero.ldap.trustStorePassword=
omero.ldap.urls=ldap://localhost:389
omero.ldap.username=
omero.ldap.values=person
```

Each of these values can then be modified to suit your local setup. To remove one of the key-value pairs, pass no second argument:

```
$ OMERO_CONFIG=ldap bin/omero config set omero.ldap.trustStore

$ OMERO_CONFIG=ldap bin/omero config set omero.ldap.trustStorePassword

$ OMERO_CONFIG=ldap bin/omero config set omero.ldap.keyStore

$ OMERO_CONFIG=ldap bin/omero config set omero.ldap.keyStorePassword

$ OMERO_CONFIG=ldap bin/omero config get
omero.ldap.attributes=objectClass
omero.ldap.base=ou=example,o=com
omero.ldap.config=false
omero.ldap.groups=
omero.ldap.new_user_group=default
omero.ldap.password=
omero.ldap.protocol=
omero.ldap.urls=ldap://localhost:389
```

```
omero.ldap.username=
omero.ldap.values=person
```

If you will be using a particular profile more frequently you can set it as your default using the `omero config def` command:

```
$ bin/omero config def ldap
```

And finally, if you would like to remove a profile, for example to wipe a given password off of a system, use `omero config drop`:

```
$ bin/omero config drop
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.3.3 Server administration

Server start

Once your database has been properly configured and your config profile is set to use that database, you are ready to start your server using the **omero admin start** command:

```
$ bin/omero admin start
```

This command performs the following operations in order:

1. rewrites the configuration files if *`--force-rewrite`* is passed or the server has never been started
2. checks the server status, i.e. pings the `master` node using the IceGrid administration tool
3. aborts the command if a server is running
4. rewrites the configuration files if it has not been done at step 1
5. starts the server
6. waits until the server is up

Most configuration files under `etc/grid` are generated using the templates under `etc/grid/templates` and the server configuration stored in `etc/grid/config.xml`. The rewriting step updates the JVM memory settings (see *Memory configuration*) and the server ports (see *Ports*) based on the server configuration.

`-h`, `--help`
Display the help for this subcommand.

`--foreground`
This option is particularly useful for debugging and maintenance and allows for starting the server up in the foreground, that is without creating a daemon on UNIX-like systems or service on Windows. During the lifetime of the server, the prompt from which it was launched will be blocked.

`--force-rewrite`
This option forces the server configuration files under `etc/grid` to be rewritten before the status of the server is checked.

Server stop

To stop a running server, you can invoke the **omero admin stop** subcommand:

```
$ bin/omero admin stop
```

This command does the following operations in order:

1. rewrites the server configuration files if `--force-rewrite` is passed
2. checks the server status, i.e. pings the `master` node using the IceGrid administration tool
3. aborts the command if no server is running
4. stops the server
5. waits until the server is down

-h, --help
Display the help for this subcommand.

--force-rewrite
This option forces the configuration files to be rewritten before the server status is checked.

Server restart

To stop and start the server in a single command, you can use the **omero admin restart** command:

```
$ bin/omero admin restart
```

The `restart` subcommand supports the same options as **omero admin start**.

Server diagnostics

To debug a server or inspect the configuration, you can use the **omero admin diagnostics** command:

```
$ bin/omero admin diagnostics
```

The output of this command will report information about:

- the server prerequisites (**psql**, **java**)
- the server environment variables
- the server memory settings and ports
- the status of the binary repository

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.3.4 User/group management

The `omero user` and `omero group` commands provide functionalities to add and manage users and groups on your database.

User creation

New users can be added to the database using the `omero user add` command:

```
$ bin/omero user add -h
```

During the addition of the new user, you will need to specify the first and last name of the new user and their username as well as the groups the user belongs to. To add John Smith as a member of group 2 identified as jsmith, enter:

```
$ bin/omero user add jsmith John Smith 2
```

Additional parameters such as the email address, institution, middle name etc can be passed as optional arguments to the `omero user add` command.

If you are using ldap as an authentication backend, you can create an OMERO user account for jsmith using the `omero ldap create` command, which allows the administrator to add jsmith to an OMERO group, before they have ever logged in to OMERO:

```
$ bin/omero ldap create jsmith
```

Converting non-LDAP users to LDAP authentication

If you want to take an existing (non-LDAP) user and 'upgrade' them to using LDAP you can do so using the `omero ldap setdn` command:

```
$ bin/omero ldap setdn -h
```

The process is also reversible so that the OMERO password for a user rather than the LDAP password will be used. See the caveat in the setdn help output below:

```
usage: bin/omero ldap setdn [-h] [--user-id USER_ID] [--user-name USER_NAME]
                            [--group-id GROUP_ID] [--group-name GROUP_NAME]
                            [-C] [-s SERVER] [-p PORT] [-g GROUP] [-u USER]
                            [-w PASSWORD] [-k KEY] [--sudo ADMINUSER] [-q]
                            choice

Enable LDAP login for user (admins only)

Once LDAP login is enabled for a user, the password set via OMERO is
ignored, and any attempt to change it will result in an error. When
you disable LDAP login, the previous password will be in effect, but if the
user never had a password, one will need to be set!

Positional Arguments:
  choice                            Enable/disable LDAP login (true/false)

Optional Arguments:
  In addition to any higher level options

  -h, --help                        show this help message and exit
  --user-id USER_ID                 ID of the user.
  --user-name USER_NAME             Name of the user.
  --group-id GROUP_ID               ID of the group.
  --group-name GROUP_NAME           Name of the group.

Login arguments:
  Environment variables:

    OMERO_USERDIR     Set the base directory containing the user's files.
                      Default: $HOME/omero
    OMERO_SESSIONDIR  Set the base directory containing local sessions.
                      Default: $OMERO_USERDIR/sessions
    OMERO_TMPDIR      Set the base directory containing temporary files.
                      Default: $OMERO_USERDIR/tmp
```

```
  Optional session arguments:

  -C, --create                      Create a new session regardless of existing ones
  -s SERVER, --server SERVER        OMERO server hostname
  -p PORT, --port PORT              OMERO server port
  -g GROUP, --group GROUP           OMERO server default group
  -u USER, --user USER              OMERO username
  -w PASSWORD, --password PASSWORD  OMERO password
  -k KEY, --key KEY                 OMERO session key (UUID of an active session)
  --sudo ADMINUSER                  Create session as this admin. Changes meaning of password!
  -q, --quiet                       Quiet mode. Causes most warning and diagnostic messages to be suppr
```

Group creation

New groups can be added to the database using the `omero group add` command:

```
$ bin/omero group add -h
```

During the addition of the new group, you need to specify the name of the new group:

```
$ bin/omero group add newgroup
```

The permissions of the group are set to *private* by default. Alternatively you can specify the permissions using `--perms` or `--type` optional arguments:

```
$ bin/omero group add read-only-1 --perms='rwr---'
$ bin/omero group add read-annotate-1 --type=read-annotate
```

See also:

Groups and permissions system Description of the three group permissions levels (private, read-only, read-annotate).

Lists of users/groups on the OMERO server can be queried using the `omero user list` and `omero group list` commands:

```
$ bin/omero user list
$ bin/omero group list
```

Group management

Users can be added to existing groups using the `omero user joingroup` or `omero group adduser` commands. Similarly, users can be removed from existing groups using the `omero user leavegroup` or `omero group removeuser` commands:

```
# Add jsmith to group read-annotate-1
$ bin/omero group adduser jsmith --name=read-annotate-1
# Remove jsmith from group read-annotate-1
$ bin/omero group removeuser jsmith --name=read-annotate-1
# Add jsmith to group read-only-1
$ bin/omero user joingroup read-only-1 --name=jsmith
# Remove jsmith from group read-only-1
$ bin/omero user leavegroup read-only-1 --name=jsmith
```

By passing the `--as-owner` option, these commands can also be used to manage group owners

```
# Add jsmith to the owner list of group read-annotate-1
$ bin/omero group adduser jsmith --name=read-annotate-1 --as-owner
# Remove jsmith from the owner list of group read-annotate-1
$ bin/omero user leavegroup read-annotate-1 --name=jsmith --as-owner
```

Group copy

To create a copy of a group, you must first create a new group using the `omero group add` command:

```
$ bin/omero group add read-only-2 --perms='rwr---'
```

Then you can use the `omero group copyusers` command to copy all group members from one group to another:

```
$ bin/omero group copyusers read-only-1 read-only-2
```

To copy the group owners, use the same command with the *`--as-owner`* optional argument:

```
$ bin/omero group copyusers read-only-1 read-only-2 --as-owner
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.3.5 Repository management

Since 5.0.3 it is possible to list images, filesets and the repositories that contain them. At an administrator-only level it is also possible to move filesets. This functionality is provided by the `omero fs` command. See

```
$ bin/omero fs -h
```

Listing repositories

The `omero fs repos` subcommand lists the repositories used by OMERO. For example

```
bin/omero fs repos
```

```
 # | Id | UUID                                 | Type    | Path
---+----+--------------------------------------+---------+--------------------------
 0 | 1  | 83bf5c68-8236-47ff-ae3e-728674eb0103 | Managed | /OMERO/ManagedRepository
 1 | 2  | ad899754-bff0-4605-a234-acd4da178f3b | Public  | /OMERO
 2 | 3  | ScriptRepo                           | Script  | /dist/lib/scripts
```

The options available to this subcommand are:

`-h`, **`--help`**
: Display the help for this subcommand.

`--style` `<{plain,csv,sql}>`
: This option determines the output style, tabular *sql* being the default as in the previous example. The *csv* style is comma-separated values with an initial header row, *plain* is the same as *csv* but without the header row.

`--managed`
: This option lists only Managed repositories.

For example

```
bin/omero fs repos --managed --style=csv

#,Id,UUID,Type,Path
0,1,83bf5c68-8236-47ff-ae3e-728674eb0103,Managed,/OMERO/ManagedRepository
```

Listing filesets

The `omero fs sets` subcommand lists filesets by various criteria. Filesets are bundles of original data imported into OMERO 5 and above, which represent one or more images. For example

```
bin/omero fs sets

 #  | Id    | Prefix                              | Images | Files | Transfer
----+-------+-------------------------------------+--------+-------+----------
 0  | 79853 | user-3_9/2014-07/22/16-41-04.244/ | 1      | 1     |
 1  | 79852 | user-3_9/2014-07/22/10-44-11.235/ | 1      | 1     |
 2  | 79851 | user-3_9/2014-07/22/10-44-07.300/ | 1      | 1     |
 3  | 79813 | user-3_9/2014-07/21/14-13-02.353/ | 1      | 1     |
 4  | 79812 | user-3_9/2014-07/21/14-13-00.182/ | 1      | 1     |
 5  | 79811 | user-3_9/2014-07/21/14-12-59.212/ | 1      | 1     |
 6  | 79810 | user-3_9/2014-07/21/14-12-57.896/ | 1      | 1     |
 7  | 79809 | user-3_9/2014-07/21/14-10-22.436/ | 3      | 600   |
 ...
 24 | 79772 | user-4_5/2014-07/18/17-14-43.631/ | 1      | 1     |
(25 rows, starting at 0 of approx. 50173)
```

The options available to this subcommand are:

-h, **--help**
: Display the help for this subcommand.

--style <{plain,csv,sql}>
: See *omero fs repos --style*.

--limit <LIMIT>
: This option specifies the maximum number of return values, the default is 25.

--offset <OFFSET>
: This option specifies the number of entries to skip before starting the listing, the default, 0, is to skip no entries.

--order <{newest,oldest,prefix}>
: This option determines the order of the rows returned, *newest* is the default.

--without-images
: This option lists only those filesets without images, these may be corrupt filesets.

--with-transfer <WITH_TRANSFER [WITH_TRANSFER ...]>
: This option lists only those filesets imported using the given in-place import methods.

--check
: This option checks each fileset for validity by recalculating each file's checksum and comparing it with the checksum recorded upon import. This may be slow. **This option is available to administrators only.**

--extended
: With this option more details are provided for each returned value. This may be slow.

For example

```
bin/omero fs sets --order oldest --limit 3 --offset 5 --check

 # | Id | Prefix                              | Images | Files | Transfer | Check
```

```
---+----+-----------------------------------+--------+-------+----------+-------
 0 | 54 | user-3_9/2014-06/09/09-24-28.037/ | 1      | 1     |          | OK
 1 | 55 | user-3_9/2014-06/09/09-24-31.354/ | 1      | 1     |          | OK
 2 | 57 | user-5_4/2014-06/09/11-01-00.557/ | 1      | 1     |          | OK
(3 rows, starting at 5 of approx. 78415)
```

Listing images

The `omero fs images` subcommand lists imported images by various criteria. This subcommand is useful for showing pre-FS (i.e. OMERO 4.4 and before) images which have their original data archived with them. For example

```
bin/omero fs images
```

```
 #   | Image   | Name                                  | FS     | # Files | Size
-----+---------+---------------------------------------+--------+---------+----------
 0   | 102803 | kidney_TFl_1.bmp.ome.tiff             | 79853 | 1        | 435.1 KB
 1   | 102802 | 4kx4k.jpg                              | 79852 | 1        | 1.7 MB
 2   | 102801 | 2kx2k.jpg                              | 79851 | 1        | 486.3 KB
 3   | 102773 | multi-channel.ome.tif                  | 79813 | 1        | 220.3 KB
 4   | 102772 | multi-channel-z-series.ome.tif         | 79812 | 1        | 1.1 MB
 5   | 102771 | multi-channel-time-series.ome.tif      | 79811 | 1        | 1.5 MB
 6   | 102770 | multi-channel-4D-series.ome.tif        | 79810 | 1        | 7.4 MB
 7   | 102769 | 001_001_000_000.tif [Well B6]          | 79809 | 600      | 1.1 GB
...
 24 | 102732 | 00027841.png                           | 79774 | 1        | 235 B
(25 rows, starting at 0 of approx. 117393)
```

The options available to this subcommand are:

-h, **--help**
: Display the help for this subcommand.

--style {plain,csv,sql}
: See *omero fs repos --style*.

--limit <LIMIT>
: See *omero fs sets --limit*.

--offset <OFFSET>
: See *omero fs sets --offset*

--order <{newest,oldest,prefix}>
: See *omero fs sets --order*.

--archived
: With this option the subcommand lists only images with archived data.

--extended
: With this option more details are provided for each returned value. This may be slow.

For example

```
bin/omero fs images --archived --offset 16 --limit 3
```

```
 #  | Image | Name                        | FS | # Files | Size
---+-------+-----------------------------+----+---------+---------
 0 | 15481 | UMD001_ORO.svs [Series 1] |    | 1       | 12.7 MB
 1 | 15478 | biosamplefullframetif.tif |    | 1       | 32.0 MB
 2 | 10018 | 050118.lei [07-13-a]      |    | 4       | 4.8 MB
(3 rows, starting at 16 of approx. 833)
```

Renaming filesets

The `omero fs rename` subcommand moves an existing fileset, specified by its ID, to a new location. **This subcommand is available to administrators only.**

It may be useful to rename an existing fileset after the import template (`omero.fs.repo.path`) has been changed to match the new template. By default the files in the fileset and the accompanying import log are moved. For example, after adding the group name and group ID to template and chnaging the date format

```
$ bin/omero fs rename 9

Renaming Fileset:9 to pg-0_3/user-0_2/2014-07-23/16-48-20.786/
Moving user-0_2/2014-07/23/16-31-51.070/ to pg-0_3/user-0_2/2014-07-23/16-48-20.786/
Moving user-0_2/2014-07/23/16-31-51.070.log to pg-0_3/user-0_2/2014-07-23/16-48-20.786.log
```

The ID can be given as a number or in the form *Fileset:ID*.

The options available to this subcommand are:

-h, --help
Display the help for this subcommand.

--no-move
With this option the files will be left in place to be moved later. Advice will be given as to which files need to be moved to complete the renaming process. Note that if the files are not moved then the renamed filesets will not be accessible until the files have been moved into the new positions.

For example

```
$ bin/omero fs rename Fileset:8 --no-move

Renaming Fileset:8 to pg-0_3/user-0_2/2014-07-23/16-49-23.543/
Done. You will now need to move these files manually:
-----------------------------------------------------
mv /OMERO/ManagedRepository/user-0_2/2014-07/23/16-29-14.809/ /OMERO/ManagedRepository/pg-0_3/user-0_2/
mv /OMERO/ManagedRepository/user-0_2/2014-07/23/16-29-14.809.log /OMERO/ManagedRepository/pg-0_3/user-0
```

Detailing disk usage

The `omero fs usage` subcommand provides details of the underlying disk usage for various types of objects. This subcommand takes optional positional arguments of object types with ids and returns the total disk usage of the specified objects.

For example

```
bin/omero fs usage Image:30001,30051 Plate:1051 --report

Total disk usage: 1064320138 bytes in 436 files
 component    | size (bytes) | files
--------------+--------------+-------
 Thumbnail    | 582030       | 256
 Job          | 1772525      | 2
 Pixels       | 49545216     | 12
 FilesetEntry | 1011947729   | 124
 Annotation   | 472638       | 42
(5 rows)
```

If no positional argument is given then the total usage for the current user across all of that user's groups is returned.

For example

```
bin/omero fs usage --report

Total disk usage: 4526436430274 bytes in 26078 files
 component    | size (bytes)   | files
--------------+----------------+-------
 Pixels       | 14654902013    | 2961
 FilesetEntry | 4510839804505 | 8820
 Thumbnail    | 17337131       | 8110
 Job          | 265665153      | 2792
 OriginalFile | 1757277        | 109
 Annotation   | 13167582976    | 3910
(6 rows)
```

If multiple objects are given and those objects contain common data then that usage will not be counted twice. For example, if two datasets contain the same image then the fileset for that image will not be double-counted in the total disk usage.

The options available to this subcommand are:

-h, **--help**
Display the help for this subcommand.

--style {plain,csv,sql}
See *omero fs repos --style*.

--wait WAIT
Number of seconds to wait for the processing to complete. To wait indefinitely use < 0, for no wait use 0. The default is to wait indefinitely.

--size_only
Print total bytes used, in bytes, with no extra text, this is useful for automated scripting.

--report
Print detailed breakdown of disk usage by types of files. This option is ignored if *–size_only* is used.

--units {K,M,G,T,P}
Units to use for disk usage for the total size using base-2. The default is bytes.

--groups
Print size for all of the current user's groups, this includes the user's own data and the data of other group members visible to the user. This option only applies if no positional arguments are given.

For example

```
bin/omero fs usage --groups --size_only -C -u user-1

4576108188820
```

```
bin/omero fs usage Project:1,2 Dataset:5 --units M --report

Total disk usage: 1432 MiB in 121 files
 component  | size (bytes) | files
------------+--------------+-------
 Thumbnail  | 73710        | 34
 Pixels     | 1499341282   | 34
 Annotation | 3000028      | 53
(3 rows)
```

See also:

Command Line Interface as an OMERO client User documentation for the Command Line Interface

Command Line Interface as an OMERO development tool Developer Documentation for the Command Line Interface

Help for any specific CLI command can be displayed using the *-h* argument. See *Command line help* for more information.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.4 Upgrading and maintenance

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.4.1 OMERO.server backup and restore

Cleaning up your binary repository

The OMERO.server does not remove files from disk until a cleanup task has been run. A script to do this is included in the OMERO.server distribution `lib/python/omero/util/cleanse.py` which can be used so:

```
$ bin/omero admin cleanse /OMERO
```

This can be performed daily using cron with a script such as:

```
#!sh
#!/bin/bash

USERNAME="root"
PASSWORD="root_password"
BINARY_REPOSITORY="/OMERO"
OMERO_PREFIX=/home/omero/OMERO-CURRENT
$OMERO_PREFIX/bin/omero -s localhost -u $USERNAME -w $PASSWORD admin cleanse $BINARY_REPOSITORY
```

Warning: Do not run this script as an operating system user while logged into OMERO as a non-administrative user as this will lead to data loss. Instead, you should always run as an administrative user such as "root". See this announcement[a] for further details.

[a] http://www.openmicroscopy.org/community/viewtopic.php?f=11&t=8060

Managing OMERO.server log files

Your OMERO.server will produce log files that are rotated when they reach 512MB. These directories will look like:

```
omero_dist $ ls var/log
Blitz-0.log     FileServer.log      MonitorServer.log   Processor-0.log     master.out
DropBox.log     Indexer-0.log       OMEROweb.log        master.err
```

Any files with a `.1`, `.2`, `.3` etc. suffix may be compressed or deleted.

OMERO.server log file location

The log file directory may also be relocated to different storage by modifying the `etc/grid/default.xml` file:

```
...
<variable name="OMERO_LOGS"    value="var/log/"/>
...
```

Backing up OMERO

Understanding backup sources

OMERO.server has three main backup sources:

1. PostgreSQL database (assumed to be `omero_database`)
2. OMERO.server binary data store (*UNIX/Mac information page* or *Windows information page*; assumed to be `/OMERO` or `C:\OMERO`)
3. OMERO.server configuration

Note: The lib/scripts directory should also be backed up, but restoring it may pose issues if any of your users have added their own "official scripts". A github repository is now available under https://github.com/ome/scripts which provides help for merging your lib/scripts directories.

You should back up *(1)* and *(2)* regularly.

Warning: Although losing your PostgreSQL database is not as catastrophic for OMERO version 5.0 as it is for 4.4, you still do not want to be in the position of trying to recover your server without a backup of this resource.

You need to back up *(3)* only before you make changes. You can copy it into `/OMERO/backup` to ensure it is kept safe:

```
$ bin/omero config get > /OMERO/backup/omero.config
```

Note: If you have edited `etc/grid/(win)default.xml` directly for any reason then you will also need to copy that file to somewhere safe, such as `/OMERO/backup`.

Backing up your PostgreSQL database

Database backups can be achieved using the PostgreSQL `pg_dump` command. Here is an example backup script that can be placed in `/etc/cron.daily` to perform daily database backups:

```
#!/bin/bash

DATE=`date '+%Y-%m-%d_%H:%M:%S-%Z'`
OUTPUT_DIRECTORY=/OMERO/backup/database
DATABASE="omero_database"
DATABASE_ADMIN="postgres"

mkdir -p $OUTPUT_DIRECTORY
chown -R $DATABASE_ADMIN $OUTPUT_DIRECTORY
su $DATABASE_ADMIN -c "pg_dump -Fc -f $OUTPUT_DIRECTORY/$DATABASE.$DATE.pg_dump $DATABASE"
```

Other database backup configurations are outside the scope of this document but can be researched on the PostgreSQL website[160] *(Chapter 24. Backup and Restore)*.

Note: Regular backups of your PostgreSQL database are crucial; you do not want to be in the position of trying to restore your server without one.

Backing up your binary data store

To simplify backup locations we have, in this document, located all database and configuration backups under `/OMERO`, your *binary data store*. The entire contents of `/OMERO` should be backed up regularly as this will, especially if this document's

[160] http://www.postgresql.org/docs/9.4/interactive/backup.html

conventions are followed, contain all the relevant data to restore your OMERO.server installation in the unlikely event of a system failure, botched upgrade or user malice.

File system backup is often a very personal and controversial topic amongst systems administrators and as such the OMERO project does not make any explicit recommendations about backup software. In the interest of providing a working example we will use open source `rdiff-backup` project and like *Backing up your PostgreSQL database* above, provide a backup script which can be placed in `/etc/cron.daily` to perform daily `/OMERO` backups:

```
#!sh
#!/bin/bash

FROM=/OMERO
TO=/mnt/backup_server

rdiff-backup $FROM $TO
```

`rdiff-backup` can also be used to backup `/OMERO` to a remote machine:

```
#!sh
#!/bin/bash

FROM=/OMERO
TO=backup_server.example.com::/backup/omero

rdiff-backup $FROM $TO
```

More advanced `rdiff-backup` configurations are beyond the scope of this document. If you want to know more you are encouraged to read the documentation available on the `rdiff-backup` website[161].

Restoring OMERO

There are three main steps to OMERO.server restoration in the event of a system failure:

1. OMERO.server `etc` configuration
2. PostgreSQL database (assumed to be `omero`)
3. OMERO.server binary data store (assumed to be `/OMERO`)

Note: It is important that restoration steps are done in this order unless you are absolutely sure what you are doing.

Restoring your configuration

Once you have retrieved an OMERO.server package from the downloads[162] page that **matches** the version you originally had installed, all that is required is to restore your backup preferences by running:

```
$ bin/omero config load /OMERO/backup/omero.config
```

You should then follow the *Reconfiguration* steps of *install*.

Restoring your PostgreSQL database

If you have had a PostgreSQL crash and database users are missing from your configuration, you should follow the first two (*Create a non-superuser database user* and *Create a database for OMERO data to reside in*) steps of *OMERO.server installation*. Once you have ensured that the database user and empty database exist, you can restore the `pg_dump` file as follows:

[161] http://www.nongnu.org/rdiff-backup/docs.html
[162] http://downloads.openmicroscopy.org/latest/omero/

```
$ sudo -u postgres pg_restore -Fc -d omero_database omero.2010-06-05_16:27:29-GMT.pg_dump
```

Restoring your OMERO.server binary data store

All that remains once you have restored your Java preferences and PostgreSQL database is to restore your `/OMERO` *binary data store* backup.

See also:

List of backup software[163] Wikipedia page listing the backup softwares.

PostgreSQL 9.4 Interactive Manual[164] Chapter 24: Backup and Restore

rdiff-backup documentation[165] Online documentation of rdiff-backup project

---

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.4.2 OMERO.server upgrade

The OME team is committed to providing frequent, project-wide upgrades both with bug fixes and new functionality. We try to make the schedule for these releases as public as possible. You may want to take a look at the roadmap[166] for exactly what will go into a release. We always inform our mailing lists[167] of the development status.

See the full details of OMERO 5.2.4 features in the Announcements[168] forum.

This guide aims to be as definitive as possible so please do not be put off by the level of detail; upgrading should be a straightforward process.

Upgrade check list

Check prerequisities

Before starting the upgrade, please ensure that you have reviewed and satisfied all the *system requirements* with *correct versions* for installation. In particular, ensure that you are running a suitable version of PostgreSQL to enable successful upgrading of the database, otherwise the upgrade script aborts with a message saying that your database server version is less than the OMERO prerequisite. If you are upgrading from a version earlier than OMERO 5.0 then first review the 5.0 upgrade notes[169] regarding previous changes in OMERO.

[166] https://trac.openmicroscopy.org/ome/roadmap
[167] http://www.openmicroscopy.org/site/community/
[168] http://www.openmicroscopy.org/community/viewforum.php?f=11
[169] http://www.openmicroscopy.org/site/support/omero5.0/sysadmins/server-upgrade.html

File limits

You may wish to review the open file limits. Please consult the *Too many open file descriptors* section for further details.

Password usage

The passwords and logins used here are examples. Please consult the *Which user account and password do I use where?* section for explanation. In particular, be sure to replace the values of **db_user** and **omero_database** with the actual database user and database name for your installation.

OMERO.web configuration

Check *Deployment (Unix/Linux)* or *Deployment (Windows)*, what is the most recent OMERO.web deployment for the platform. If you generated configuration stanzas using `omero web config` which enables OMERO.web via Apache or Nginx, they will include hard-coded links to your previous version of OMERO. Therefore, you should regenerate your config files when upgrading, remembering to merge in any of your own modifications if necessary. You should carry out this step even for minor version upgrades as there may be fixes which require it.

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[170] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.

OMERO.web dependencies

While upgrading the server it is recommended to keep OMERO.web dependencies up to date to ensure that security updates are applied.

- Nginx on Unix:

```
$ pip install --upgrade -r share/web/requirements-py27-nginx.txt
```

- Apache on Unix:

```
$ pip install --upgrade -r share/web/requirements-py27-apache.txt
```

- Windows:

```
$ pip install --upgrade -r share/web/requirements-py27-win.txt
```

Note: This is mainly for new major releases. If carrying out a minor release upgrade, you should check that updates will not break your set-up before performing this on your production system.

Web plugin updates

OMERO.web plugins are very closely integrated into the webclient. For this reason, it is possible that an update of OMERO will cause issues with an older version of a plugin. It is best when updating the server to also install any available plugin updates according to their own documentation.

[170] https://docs.djangoproject.com/en/1.8/releases/1.8/

Memoization files invalidation

All cached Bio-Formats memoization files created at import time will be invalidated by the server upgrade. This means the very first loading of each image after upgrade will be slower. After re-initialization, a new memoization file will be automatically generated and OMERO will be able to load images in a performant manner again.

These files are stored under `BioFormatsCache` in the OMERO data directory, e.g. `/OMERO/BioFormatsCache`. You may see error messages in your log files when an old memoization file is found; to avoid these messages delete everything under this directory before starting the upgraded server.

Troubleshooting

If you encounter errors during an OMERO upgrade, database upgrade, etc. you should retain as much log information as possible and notify the OMERO.server team via the mailing lists available on the community[171] page.

Upgrade check

All OMERO products check themselves with the OmeroRegistry for update notifications on startup. If you wish to disable this functionality you should do so now as outlined on the *OMERO upgrade checks* page.

Upgrade steps

For all users, the basic workflow for upgrading your OMERO.server is listed below. Please refer to each section for additional details.

- Perform a database backup
- Copy new binaries
- Upgrade your database
- Merge script changes
- Update your environment variables and memory settings
- Update your OMERO.web server configuration
- Restart your server
- Restore a database backup

Perform a database backup

The first thing to do before **any** upgrade activity is to backup your database.

```
$ pg_dump -h localhost -U db_user -Fc -f before_upgrade.db.dump omero_database
```

Copy new binaries

Before copying the new binaries, stop the existing server:

```
$ cd OMERO.server
$ bin/omero web stop
$ bin/omero admin stop
```

Your OMERO configuration is stored using `config.xml` in the `etc/grid` directory under your OMERO.server directory. Assuming you have not made any file changes within your OMERO.server distribution directory, you are safe to follow the following upgrade procedure:

[171] http://www.openmicroscopy.org/site/community/

```
$ cd ..
$ mv OMERO.server OMERO.server-old
$ unzip OMERO.server-5.2.4-ice3x-byy.zip
$ ln -s OMERO.server-5.2.4-ice3x-byy OMERO.server
$ cp OMERO.server-old/etc/grid/config.xml OMERO.server/etc/grid
```

Note: `ice3x` and `byy` **need to be replaced** by the appropriate Ice version and build number of OMERO.server.

Upgrade your database

Warning: This section only concerns users upgrading from a 5.1 or earlier server. If upgrading from a 5.2 server, you do not need to upgrade the database.

Ensure Unicode character encoding Versions of OMERO from 5.1.0 onwards require a Unicode-encoded database; without it, the upgrade script aborts with a message warning how the "OMERO database character encoding must be UTF8". From **psql**:

```
# SELECT datname, pg_encoding_to_char(encoding) FROM pg_database;
  datname   | pg_encoding_to_char
------------+---------------------
 template1  | UTF8
 template0  | UTF8
 postgres   | UTF8
 omero      | UTF8
(4 rows)
```

Alternatively, simply run **psql -l** and check the output. If your OMERO database is not Unicode-encoded with `UTF8` then it must be re-encoded.

If you have the **pg_upgradecluster** command available then its *`--locale`* option can effect the change in encoding. Otherwise, create a Unicode-encoded dump of your database: dump it *as before* but to a different dump file and with an additional *`-E UTF8`* option. Then, create a Unicode-encoded database for OMERO and restore that dump into it with **pg_restore**, similarly to *effecting a rollback*. If required to achieve this, the *`-E UTF8`* option is accepted by both **initdb** and **createdb**.

Run the upgrade script You **must** use the same username and password you have defined during *OMERO.server installation*. For a large production system you should plan for the fact that the upgrade script may take several hours to run.

```
$ cd OMERO.server
$ psql -h localhost -U db_user omero_database < sql/psql/OMERO5.2__0/OMERO5.1__1.sql
Password for user db_user:
...
...
                            status
-------------------------------------------------------------------------
                                                                        +
                                                                        +
                                                                        +
YOU HAVE SUCCESSFULLY UPGRADED YOUR DATABASE TO VERSION OMERO5.2__0      +
                                                                        +
                                                                        +


(1 row)
```

If you are upgrading from a server earlier than 5.1 then it suffices to run the earlier upgrade scripts in sequence before the one above. There is no need to download and run the server from an intermediate major release.

Note: If you perform the database upgrade using *SQL shell*, make sure you are connected to the database using **db_user** before running the script. See this forum thread[172] for more information.

[172] http://www.openmicroscopy.org/community/viewtopic.php?f=5&t=7778

Optimize an upgraded database (optional) After you have run the upgrade script, you may want to optimize your database which can both save disk space and speed up access times.

```
$ psql -h localhost -U db_user omero_database -c 'REINDEX DATABASE ''omero_database'' FORCE;'
$ psql -h localhost -U db_user omero_database -c 'VACUUM FULL VERBOSE ANALYZE;'
```

Merge script changes

If any new official scripts have been added under `lib/scripts` or if you have modified any of the existing ones, then you will need to backup your modifications. Doing this, however, is not as simple as copying the directory over since the core developers will have also improved these scripts. In order to facilitate saving your work, we have turned the scripts into a Git submodule which can be found at https://github.com/ome/scripts.

For further information on managing your scripts, refer to *OMERO.scripts*. If you require help, please contact the OME developers.

Update your environment variables and memory settings

Environment variables If you changed the directory name where the 5.2.4 server code resides, make sure to update any system environment variables. Before restarting the server, make sure your PATH and PYTHONPATH system environment variables are pointing to the new locations.

JVM memory settings Your memory settings should be copied along with `etc/grid/config.xml`, but you can check the current settings by running `omero admin jvmcfg`. See *Memory configuration* for more information.

Update your OMERO.web server configuration

FastCGI support was removed in OMERO 5.2 and OMERO.web can be deployed using WSGI (see *Deployment (Unix/Linux)* for more details). If you have already deployed OMERO.web using WSGI you should regenerate your config files, remembering to merge in any of your own modifications if necessary. **Due to the nature of OMERO.web development for the 5.2.x line, you should carry out this step even for minor version upgrades as there may be fixes which require it.**

If necessary ensure you have set up a regular task to clear out any stale OMERO.web session files as described in *OMERO.web Maintenance (Unix/Linux)* or *OMERO.web Maintenance (Windows)*.

Restart your server

- Following a successful database upgrade, you can start the server.

```
$ cd OMERO.server
$ bin/omero admin start
```

- If anything goes wrong, please send the output of `omero admin diagnostics` to ome-users@lists.openmicroscopy.org.uk[173].
- Start OMERO.web with the following command:

```
$ bin/omero web start
```

[173] ome-users@lists.openmicroscopy.org.uk

Restore a database backup

If the upgraded database or the new server version do not work for you, or you otherwise need to rollback to a previous database backup, you may want to restore a database backup. To do so, create a new database,

```
$ createdb -h localhost -U postgres -E UTF8 -O db_user omero_from_backup
```

restore the previous archive into this new database,

```
$ pg_restore -Fc -d omero_from_backup before_upgrade.db.dump
```

and configure your server to use it.

```
$ bin/omero config set omero.db.name omero_from_backup
```

See also:

Legacy[174] Legacy part of the OME website containing upgrade instructions for previous versions of the OMERO server.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.4.3 OMERO upgrade checks

On each startup the OMERO server checks for available upgrades via the UpgradeCheck class[175]. An HTTP GET call is made to the URL configured in etc/omero.properties[176] as `omero.upgrades.url`, currently http://upgrade.openmicroscopy.org.uk by default (note that viewing that link in your browser will redirect you to this page).

Note: If you have been redirected here by clicking on a link to `http://upgrade.openmicroscopy.org.uk` in an error message or log while trying to run one of the **Bio-Formats command line tools**, please see the Bio-Formats command line tools documentation[177] for assistance.

Actions

Currently the only action taken when an upgrade is necessary is a log statement at WARN level.

```
2011-09-01 12:21:32,070 WARN  [               ome.system.UpgradeCheck] (     main) UP-
GRADE AVAILABLE:Please upgrade to 5.2.4 See http://trac.openmicroscopy.org.uk/omero for the lat-
est version
```

Future versions may also send emails and/or IMs to administrators. In the case of critical upgrades, the server may refuse to start.

Privacy

Currently, the only information which is being transmitted to the server is:

- Java virtual machine version
- operating system details (architecture, version and name)
- current server version
- poll frequency (for determining statistics)
- your IP address (standard HTTP header information)

[175] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/UpgradeCheck.java
[176] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/omero.properties
[177] http://www.openmicroscopy.org/site/support/bio-formats/users/comlinetools/index.html#version-checker

Note: Currently the "poll" property is unused.

If this is a problem for your site, please see *Disabling* below.

Disabling

If you would prefer to have no checks made, the check can be disabled by setting the omero.upgrades.url property to an empty string:

```
omero.upgrades.url=
```

Developers

To use the UpgradeCheck class from your own code, it is necessary to have `common.jar` on your classpath. Then,

```
ResourceBundle bundle = ResourceBundle.getBundle("omero")
String version = bundle.getString("omero.version");
String url = bundle.getString("omero.upgrades.url");
ome.system.UpgradeCheck check = new UpgradeCheck(
  url, version, "insight"); // Or "importer", etc.
check.run();
check.isUpgradeNeeded();
// optionally
check.isExceptionThrown();
```

will connect to the server and check your current version against the latest release.

See also:

OMERO.server installation Instructions for installing OMERO.server on UNIX & UNIX-like platforms

OMERO.server installation Instructions for installing OMERO.server on Windows platforms

OMERO.server upgrade Instructions for upgrading OMERO.server

Server security and firewalls Description of OMERO security practices

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.4.4 Moving the data repository

It may be necessary to move either the whole OMERO data directory or only the Managed Repository to a new location on the file system. This should be done with care following the steps below.

Warning: Before moving OMERO data it is wise to ensure that both the data and the database are fully backed up. See *OMERO.server backup and restore*.

The current location of the data repositories can be found using the `omero fs repos` command:

```
$ bin/omero fs repos

 # | Id | UUID                                 | Type    | Path
---+----+--------------------------------------+---------+-----------------------------------------
 0 | 1  | 309ea513-a23c-48d1-abd2-9ceed1b3ffa4 | Managed | /Users/omero/var/omero/ManagedRepository
 1 | 2  | ScriptRepo                           | Script  | /Users/omero/dist/lib/scripts
```

```
 2 | 3  | 3ec8c878-c776-48a3-b57e-2a11b0c97045 | Public  | /Users/omero/var/omero
(3 rows)
```

Note: This command can be slow, `omero config get` can also be used to determine if `omero.data.dir` or `omero.managed.dir` have non-default values.

Moving the OMERO data directory

If the Managed Repository is within the OMERO data directory and the whole data directory is to be moved then the following steps should be used:

```
bin/omero admin stop
bin/omero config set omero.data.dir NEW
mv OLD NEW
bin/omero admin start
```

Warning: The use of `omero config set` is absolutely necessary here. The steps: `omero admin stop`, `mv`, `omero admin start` without `omero config set` could lead to an unstable situation.

For example, moving the OMERO data directory from `/Users/omero/var/omero` to `/Volumes/omero`:

```
$ bin/omero admin stop
...
$ bin/omero config set omero.data.dir /Volumes/omero
$ mv /Users/omero/var/omero /Volumes/omero
$ bin/omero admin start
...
$ bin/omero fs repos

 # | Id | UUID                                 | Type    | Path
---+----+--------------------------------------+---------+---------------------------------
 0 | 1  | 309ea513-a23c-48d1-abd2-9ceed1b3ffa4 | Managed | /Volumes/omero/ManagedRepository
 1 | 2  | ScriptRepo                           | Script  | /Users/omero/dist/lib/scripts
 2 | 3  | 3ec8c878-c776-48a3-b57e-2a11b0c97045 | Public  | /Volumes/omero
(3 rows)
```

Moving the Managed Repository

If the Managed Repository is in a separate location from the OMERO data directory or only the Managed Repository is to be moved then the following steps should be used:

```
bin/omero admin stop
bin/omero config set omero.managed.dir NEW
mv OLD NEW
bin/omero admin start
```

Warning: The use of `omero config set` is absolutely necessary here. The steps: `omero admin stop`, `mv`, `omero admin start` without `omero config set` could lead to an unstable situation.

For example, moving the Managed Repository from `/Users/omero/var/omero/ManagedRepository` to `/Volumes/imports/ManagedRepository`:

```
$ bin/omero admin stop
...
$ bin/omero config set omero.managed.dir /Volumes/imports/ManagedRepository
$ mv /Users/omero/var/omero/ManagedRepository /Volumes/imports/ManagedRepository
$ bin/omero admin start
...
$ bin/omero fs repos

 # | Id | UUID                                 | Type    | Path
---+----+--------------------------------------+---------+-----------------------------------
 0 | 1  | 309ea513-a23c-48d1-abd2-9ceed1b3ffa4 | Managed | /Volumes/imports/ManagedRepository
 1 | 2  | ScriptRepo                           | Script  | /Users/omero/dist/lib/scripts
 2 | 3  | 3ec8c878-c776-48a3-b57e-2a11b0c97045 | Public  | /Users/omero/var/omero
(3 rows)
```

Note: If `omero.managed.dir` is not set then the location of the Managed Repository will be determined by `omero.data.dir` and the OMERO directory should only be moved as a whole.

If the Managed Repository needs to be moved to a location other than that set by `omero.data.dir`, to a location outside of the OMERO data directory, for example, then `omero.managed.dir` must be set.

If `omero.managed.dir` is set then the Managed Repository and the OMERO data directory should be treated independently and thus be moved separately if necessary.

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.5 Installing additional features

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.5.1 OMERO.grid

To unify the various components of OMERO, OMERO.grid was developed to monitor and control processes over numerous remote systems. Based on ZeroC[178]'s IceGrid framework, OMERO.grid provides management access, distributed background processing, log handling and several other features.

Terminology

Please notice that ZeroC uses a specific naming scheme for IceGrid elements and actors. A *server* in the context of this document is not a host computer - it is a process running inside an IceGrid node, servicing incoming requests. A *host* is a computer on which IceGrid elements get deployed. For more details, see Terminology[179].

Getting started

Requirements

The normal OMERO installation actually makes use of OMERO.grid internally. Note that multi-node OMERO.grid configurations are only tested with Unix-like systems, multi-node configurations on Windows are untested and deprecated, and any remaining support will be dropped in OMERO 5.3. If you have followed the instructions under *OMERO.server installation* you will have everything you need to start working with OMERO.grid.

[178] https://zeroc.com
[179] https://doc.zeroc.com/display/Ice/Terminology

The standard install should also be used to install other hosts in the grid, such as a computation-only host. Some elements can be omitted for a computation-only host such as PostgreSQL, Apache/nginx, etc.

Running OMERO.web and/or starting up the full OMERO.server instance is not required in such a case (only the basic requirements to run `omero node` are needed, i.e. ZeroC Ice and Python modules for OMERO scripts).

IceGrid Tools

If you would like to explore your IceGrid configuration, use

```
bin/omero admin ice
```

It provides full access to the **icegridadmin** console described in the ZeroC manual. Specific commands can also be executed:

```
bin/omero admin ice help
bin/omero admin ice application list
bin/omero admin ice application describe OMERO
bin/omero admin ice server list
```

Further, by running **java -jar ice-gridgui.jar** the GUI provided by ZeroC can be used to administer OMERO.grid. This JAR is provided in the OMERO source code under `lib/repository`.

See also:

icegridadmin Command Line Tool[180] Chapter of the ZeroC[181] manual about the **icegridadmin** CLI

IceGrid Admin Graphical Tool[182] Chapter of the ZeroC[183] manual about the GridGUI tool

OMERO.grid on Windows

Unlike all other supported platforms, the `bin\omero` script and OMERO.grid are not directly responsible for starting and stopping the *OMERO.blitz* server and other processes. Instead, that job is delegated to the native Windows service system. A brief explanation is available under *OMERO.server Windows Service*.

Multi-node deployment is not supported for Windows.

How it works

IceGrid[184] is a location and activation service, which functions as a central registry to manage all your OMERO server processes. OMERO.grid provides server components which use the registry to communicate with one another. Other than a minimal amount of configuration and starting a single daemon on each host machine, OMERO.grid manages the complexity of all your computing resources.

Deployment descriptors

All the resources for a single OMERO site are described by one **application descriptor**. OMERO ships with several example descriptors under `etc/grid`. These descriptors describe what processes will be started on what nodes, identified by simple names. For example the default descriptor[185], used if no other file is specified, defines the `master` node. As you will see, these files are critical both for the correct functioning of your server as well as its security.

The deployment descriptors provided define which server instances are started on which nodes. The default descriptor configures the `master` node to start the *OMERO.blitz* server, the Glacier2 router for firewalling, as well as a single processor - `Processor0`. The master node is also configured via `etc/master.cfg` to host the registry, though this process can be started elsewhere.

[181] https://zeroc.com
[183] https://zeroc.com
[184] https://doc.zeroc.com/display/Ice/IceGrid
[185] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/grid/default.xml

Deployment commands

The `master` node must be started first to provide the registry. This is done via the `omero admin start` command which uses the default descriptor:

```
bin/omero admin start
```

The deploy command looks for any changes to the defined descriptor and restarts only those servers which have modifications:

```
bin/omero admin deploy
```

Both `omero admin start` and `omero admin deploy` can optionally take a path to an application descriptor which must be passed on every invocation:

```
bin/omero admin deploy etc/grid/my-site.xml
```

Two other nodes, then, each provide a single processor, `Processor1` and `Processor2`. These are started via:

To start a node identified by `NAME`, the following command can be used

```
bin/omero node start NAME
```

At this point the node will try and connect to the registry to announce its presence. If a node with the same name is already started, then registration will fail, which is important to prevent unauthorized users.

The configuration of your grid, however, is very much up to you. Based on the example descriptor files (*.xml) and configuration files (*.cfg), it is possible to develop OMERO.grid installations completely tailored to your computing resources.

The whole grid can be shutdown by stopping the master node via: `omero admin stop`. Each individual node can also be shutdown via: `omero node NAME stop` on that particular node.

Deployment examples

Two examples will be presented showing the flexibility of OMERO.grid deployment and identifying files whose modification is critical for the deployment to work.

Nodes on a single host

The first example will focus on changing the deployed nodes/servers on a single host. It should serve as an introduction to the concepts. Unless used for very specific requirements, this type of deployment doesn't yield any performance gains.

The first change that you will want to make to your application descriptor is to add additional processors. Take a look at etc/templates/grid/default.xml[186]. There you can define two new nodes - `node1` and `node2` by simply adding a new XML element below the `master` node definition:

```
<node name="node1">
  <server-instance template="ProcessorTemplate" index="1"/>
</node>

<node name="node2">
  <server-instance template="ProcessorTemplate" index="2"/>
</node>
```

[186] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/grid/default.xml

Remember to change the node name and the index number for each subsequent node definition. The node name and the index number do not need to match. In fact, the index number can be completely ignored, except for the fact that it must be unique. The node name, however, is important for properly starting your new processor.

You will need both a configuration file under `etc/` with the same name, and unless the node name matches the name of your local host, you will need to specify it on the command line:

```
bin/omero node node1 start
```

or with the environment variable `OMERO_NODE`:

```
OMERO_NODE=node1 bin/omero node start
```

After starting up both nodes, you can verify that you now have three processors running by looking at the output of `omero admin diagnostics`.

For more information on using scripts, see the *OMERO.scripts advanced topics*.

Nodes on multiple hosts

Warning: Before attempting this type of deployment, make sure that the hosts can ping each other and that required ports are open and not firewalled.
Windows multi-node configurations are not supported.

A more complex deployment example is running multiple nodes on networked hosts. Initially, the host's loopback IP address (127.0.0.1) is used in the grid configuration files.

For this example, let's presume we have control over two hosts: `omero-master` (IP address 192.168.0.1/24) and `omero-slave` (IP address 192.168. 0.2/24). The goal is to move the processor server onto another host (`omero-slave`) to reduce the load on the host running the `master` node (`omero-master`). The configuration changes required to achieve this are outlined below.

On host `omero-master`:

- `etc/grid/default.xml` - remove or comment out from the `master` node the `server-instance` using the `ProcessorTemplate`. Below the `master` node add an XML element defining a new node:

```
<node name="omero-slave">
  <server-instance template="ProcessorTemplate" index="0" dir=""/>
</node>
```

- `etc/internal.cfg` - change the value of `Ice.Default.Locator` from 127.0.0.1 to 192.168.0.1
- `etc/master.cfg` - change all occurrances of 127.0.0.1 to 192.168.0.1

On host `omero-slave`:

- copy or rename `etc/node1.cfg` to `etc/omero-slave.cfg` and change all `node1` strings to `omero-slave` in `etc/omero-slave.cfg`. Also update the `IceGrid.Node.Endpoints` value to `tcp -h 192.168.0.2`
- `etc/internal.cfg` - change the value of `Ice.Default.Locator` from 127.0.0.1 to 192.168.0.1
- `etc/ice.config` - add the line `Ice.Default.Router=OMERO.Glacier2/router:tcp -p 4063 -h 192.168.0.1`

To apply the changes, start the OMERO instance on the `omero-master` node by using `omero admin start`. After that, start the `omero-slave` node by using `omero node omero-slave start`. Issuing `omero admin diagnostics` on the master node should show a running processor instance and the `omero-slave` node should accept job requests from the master node.

Securing grid resources

More than just making sure no malicious code enters your grid, it is critical to prevent unauthorized access via the application descriptors (*.xml) and configuration (*.cfg) as mentioned above.

Firewall

The simplest and most effective way of preventing unauthorized access is to have all OMERO.grid resources behind a firewall. Only the Glacier2 router has a port visible to machines outside the firewall. If this is possible in your configuration, then you can leave the internal endpoints unsecured.

SSL (Secure Socket Layer)

Though it is probably unnecessary to use transport encryption within a firewall, encryption from clients to the Glacier2 router will often be necessary. For more information on SSL, see *SSL*.

Permissions Verifier

The IceSSL plugin can be used both for encrypting the channel as well as authenticating users. SSL-based authentication, however, can be difficult to configure especially for within the firewall, and so instead you may want to configure a "permissions verifier" to prevent non-trusted users from accessing a system within your firewall. From master.cfg[187]:

```
IceGrid.Registry.AdminPermissionsVerifier=IceGrid/NullPermissionsVerifier
#IceGrid.Registry.AdminCryptPasswords=etc/passwd
```

Here we have defined a "null" permissions verifier which allows anyone to connect to the registry's administrative endpoints. One simple way of securing these endpoints is to use the `AdminCryptPasswords` property, which expects a passwd-formatted file at the given relative or absolute path:

```
mrmypasswordisomero TN7CjkTVoDnb2
msmypasswordisome   jkyZ3t9JXPRRU
```

where these values come from using openssl:

```
$ openssl
OpenSSL> passwd
Password:
Verifying - Password:
TN7CjkTVoDnb2
OpenSSL>
```

Another possibility is to use the *OMERO.blitz* permissions verifier, so that anyone with a proper OMERO account can access the server.

See Controlling Access to IceGrid Sessions[188] of the Ice manual for more information.

Unique node names

Only a limited number of node names are configured in an application descriptor. For an unauthorized user to fill a slot, they must know the name (which **is** discoverable with the right code) and be the first to contact the grid saying "I am Node029", for example. A system administrator need only then be certain that all the node slots are taken up by trusted machines and users.

[187] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/master.cfg
[188] https://doc.zeroc.com/display/Ice/Resource+Allocation+using+IceGrid+Sessions#ResourceAllocationusingIceGridSessions-ControllingAccesstoIceGridSessions

It is also possible to allow "dynamic registration" in which servers are added to the registry after the fact. In some situations this may be quite useful, but is disabled by default. Before enabling it, be sure to have secured your endpoints via one of the methods outlined above.

Absolute paths

Except under Windows, the example application descriptors shipped with OMERO, all use relative paths to make installation easier. Once you are comfortable with configuring OMERO.grid, it would most likely be safer to configure absolute paths. For example, specifying that nodes execute under `/usr/lib/omero` requires that whoever starts the node have access to that directory. Therefore, as long as you control the boxes which can attach to your endpoints (see *Firewall*), then you can be relatively certain that no tampering can occur with the installed binaries.

Technical information and other tips

Processes

It is important to understand just what processes will be running on your servers. When you run `omero admin start`, **icegridnode** is executed which starts a controlling daemon and deploys the proper descriptor. This configuration is persisted under `var/master` and `var/registry`.

Once the application is loaded, the **icegridnode** daemon process starts up all the servers which are configured in the descriptor. If one of the processes fails, it will be restarted. If restart fails, eventually the server will be "disabled". On shutdown, the **icegridnode** process also shutdowns all the server processes.

Targets

In application descriptors, it is possible to surround sections of the description with `<target/>` elements. For example, in templates.xml[189] the section which defines the main *OMERO.blitz* server includes:

```
<server id="Blitz-${index}" exe="${JAVA}" activation="always" pwd="${OMERO_HOME}">
  <target name="debug">
    <option>-Xdebug</option>
    <option>-Xrunjdwp:server=y,transport=dt_socket,address=8787,suspend=y</option>
  </target>
  ...
```

When the application is deployed, if "debug" is added as a target, then the `-Xdebug`, etc. options will be passed to the Java runtime. This will allow remote connection to your server over the configured port.

Multiple targets can be enabled at the same time:

```
bin/omero admin deploy etc/grid/default.xml debug secure someothertarget
```

Ice.MessageSizeMax

Ice imposes an upper limit on all method invocations. This limit, `Ice.MessageSizeMax`, is configured in your application descriptor (e.g. templates.xml[190]) and configuration files (e.g. ice.config[191]). The setting must be applied to all servers which will be handling the invocation. For example, a call to `InteractiveProcessor.execute(omero::RMap inputs)` which passes the inputs all the way down to `processor.py` will need to have a sufficiently large `Ice.MessageSizeMax` for: the client, the Glacier2 router, the *OMERO.blitz* server, and the Processor.

The default is currently set to 65536 kilobytes which is 64MB.

[189] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/grid/templates.xml
[190] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/grid/templates.xml
[191] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/ice.config

Logging

Currently all output from OMERO.grid is stored in `$OMERO_PREFIX/var/log/master.out` with error messages going to `$OMERO_PREFIX/var/log/master.err`. Individual services may also create their own log files.

Shortcuts

If the `bin/omero` script is copied or symlinked to another name, then the script will separate the name on hyphens and execute `bin/omero` with the second and later parts **prepended** to the argument list.

For example,

```
ln -s bin/omero bin/omero-admin
bin/omero-admin start
```

works identically to:

```
bin/omero admin start
```

Symbolic linking

Shortcuts allow the `bin/omero` script to function as an init.d script when named `omero-admin`, and need only be copied to `/etc/init.d/` to function properly. It will resolve its installation directory, and execute from there unless `OMERO_HOME` is set.

For example,

```
ln -s $OMERO_PREFIX/bin/omero /usr/local/bin/omero
omero-admin start
```

The same works for putting `bin/omero` on your path:

```
PATH=$OMERO_PREFIX/bin:$PATH
```

This means that OMERO.grid can be unpacked anywhere, and as long as the user invoking the commands has the proper permissions on the `$OMERO_PREFIX` directory, it will function normally.

Running as root

One exception to this rule is that starting OMERO.grid as root may actually delegate to another user, if the "user" attribute is set on the `<server/>` elements in `etc/grid/templates.xml` (this holds only for Unix-based platforms including Apple OS X. See *OMERO.grid on Windows* for information on changing the server user under Windows).

See also:

OMERO sessions

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.5.2 OMERO.mail

The OMERO server has the ability to send email to any users who have a properly configured email address. OMERO system administrators can then use the `omero admin email` command to contact those users.

In order to activate the subsystem, minimally the `omero.mail.config` property will need to be activated.

Minimum configuration

```
$ bin/omero config set omero.mail.config true
```

By default, this will use "localhost" as the mail server on port 25 and send as the user "omero". Likely you will need to configure OMERO to use your actual mail server.

For example,

```
$ bin/omero config set omero.mail.host smtp.university.example
```

If authentication is required, then also configure:

```
$ bin/omero config set omero.mail.username USER
$ bin/omero config set omero.mail.password PASS
```

Setting email addresses

For the any user to receive email, a valid email address must be configured. By default, the *root* OMERO user will *not* have an email address configured. This can be done from one of the UIs or via the `omero obj` command:

```
$ bin/omero obj update Experimenter:0 email=root@university.example
```

Note: Using a mailing list or an alias for the *root* user can simplify configuration.

Enabling mail notifications

A number of "mail senders" are available for sending notifications of certain events on the server. Those available include:

- *ServerUpMailSender* and *ServerDownMailSender* which mail when the server goes up or down
- *FailedLoginMailSender* which can be configured to send for particular users if a bad password is used
- ***ObjectMailSender* which can be configured to send an email under various conditions. Instances which are configured include**
  - *newUserMailSender* which sends an email every time a user is created
  - *newCommentMailSender* which sends an email every time a user's image is commented on by another user.

To activate the senders, the `etc/blitz/mail-senders.example` can be copied to a file ending with ".xml".

OMERO.web error reporting

OMERO.web will email the users listed in the `omero.web.admins` whenever the application identify broken link (HTTP status code 404) or raises an unhandled exception that results in an internal server error (HTTP status code 500). This gives the administrators immediate notification of any errors. The `omero.web.admins` will get a description of the error, a complete Python traceback, and details about the HTTP request that caused the error.

Note: Reporting errors requires property `omero.web.debug` set to *False* and works together with *OMERO.web error handling*.

Other key properties

Along with `omero.mail.host`, a few general connection properties may be needed for your particular SMTP server:

- `omero.mail.port`
- `omero.mail.smtp.auth`
- `omero.mail.smtp.starttls.enable`
- `omero.mail.from`

Note: `omero.mail.from` may not be necessary but some servers may require it to match username. Regardless, it can be useful to inform users more clearly of who is getting in touch with them.

All properties can be found under the *Mail* section of *Configuration properties glossary*.

Further configuration

Finally, if the above mail configuration properties do not cover your needs, you can add your own implementation as described under *Extending OMERO.server*. The related property is `omero.mail.bean`:

```
$ bin/omero config set omero.mail.bean myMailImplementation
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.5.3 OMERO.movie

A short decription on how to create movies from OMERO.

Creating a movie from OMERO

OMERO provides a script to make Mpeg or Quicktime movies from any image in the server. These movies are created by a script called makemovie.py, this script has a number of options: these include: selecting a range of Z,T planes, the channels to display. The movie can also show information overlayed over the image: z-section, scale bar and timing.

The resulting movie will then be uploaded to the server by the script and become a file attachment to the source image.

Viewing the movie

The make movie script allows you to save the movie in two different formats, a DivX encoded AVI and Quicktime movie. To view the AVI you may need to install a divX codec from DivX[192]. It should be noted that the DivX avi is normally 1/3 to 1/10 the size of the Quicktime movie.

Installing the make movie script

The make movie script currently uses the mencoder[193] utility to encode the movies, this command should be in the path of the computer (icegrid node) running the script.

You can find windows installs for mencoder at http://sourceforge.net/projects/mplayer-win32/files/

We have Mac OSX installs for mencoder[194] which were originally provided here[195]. Unzip and put the mencoder in the PATH available to the server, e.g. /usr/local/bin/ . You may need to restart the server for this to take effect.

[192] http://www.divx.com/
[193] http://www.mplayerhq.hu/design7/dload.html
[194] http://cvs.openmicroscopy.org.uk/snapshots/mencoder/mac/
[195] http://stefpause.com/apple/mac/mplayer-os-x-10rc1-and-mencoder-binaries/

There are also macports, rpms and debs for mencoder.

Make movie also uses Pillow[196] and numpy[197].

Make movie command arguments

A detailed list of the commands accepted by the script are:

- imageId: This id of the image to create the movie from
- output: The name of the output file, sans the extension
- zStart: The starting z-section to create the movie from
- zEnd: The final z-section
- tStart: The starting timepoint to create the movie
- tEnd: The final timepoint.
- channels: The list of channels to use in the movie (index, from 0)
- splitView: Should we show the split view in the movie (not available yet)
- showTime: Show the average time of the aquisition of the channels in the frame.
- showPlaneInfo: Show the time and z-section of the current frame.
- fps: The number of frames per second of the movie
- scalebar: The scalebar size in microns, if <=0 will not show scale bar.
- format: The format of the movie to be created currently supports 'video/mpeg', 'video/quicktime'
- overlayColour: The colour of the overlays, scalebar, time, as int(RGB)
- fileAnnotation: The fileAnnotation id of the uploaded movie. (return value from script)

Platform-specific notes

Windows

For Windows, you can download a "MPlayer-rtm-svm-<version>" bundle from http://sourceforge.net/projects/mplayer-win32/[198]. You will need 7zip[199] to open the bundle. Then you will need to add the directory containing "mencoder.exe" to your system path and restart.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.5.4 OMERO.scripts

OMERO.scripts are the OME version of plugins, allowing you to extend the functionality of OMERO. Official core OMERO.scripts come bundled with every OMERO.server release but you can also add new scripts you have written yourself or found via the new script sharing service[200].

[196] http://pillow.readthedocs.org
[197] http://www.scipy.org/Download
[198] http://sourceforge.net/projects/mplayer-win32/
[199] http://www.7-zip.org/download.html
[200] http://www.openmicroscopy.org/site/community/scripts

Prerequisites

Uploading and managing scripts

OMERO.scripts user guide describes the workflow for developing and uploading scripts as an Admin. **Any scripts you add to the lib/scripts/ directory as a server admin will be considered 'trusted' and automatically detected by OMERO, allowing them to be run on the server from the clients or command line by any of your users.**

Once in the directory, scripts cannot be automatically updated and any additional ones will be lost when you upgrade your server installation. Therefore, we recommend you use a Github repository to manage your scripts. If you are not familiar with using git[201], you can use the GitHub app for your OS[202] (available for Mac and Windows but not Linux). The basic workflow is:

- fork our omero-user-script[203] repository
- clone it in your lib/scripts directory

```
cd lib/scripts;
git clone git@github.com:YOURGITUSERNAME/omero-user-scripts.git YOUR_SCRIPTS
```

- save the scripts you want to use into the appropriate sub-directory in your cloned location lib/scripts/YOUR_SCRIPTS

Then when you upgrade your OMERO.server installation, provided your Github repository is up to date with all your latest script versions (i.e. all your local changes are committed), you just need to repeat the `git clone` step. Those scripts will then be automatically detected by your new server installation and available for use from the clients and command line as before.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.5.5 OMERO.tables

OMERO.tables provide a way to efficiently store large, tabular results within OMERO. If you would like to find out more about the use of the OMERO.tables API, see *OMERO.analysis*

Requirements

If you would like to help test the Tables API, you will need the following installed:

- HDF5[204]
- NumPy[205] points to downloads at http://sourceforge.net/projects/numpy/
- PyTables[206] (Some packages include HDF5)

Unix

PyTables is likely available from the package repository of your Unix-flavor. This includes Mac OS X (homebrew), Debian and Ubuntu (apt-get), CentOS (yum), and SuSE (yast). Here we've shown manual instructions using virtualenv.

Manually

[201] http://www.openmicroscopy.org/site/support/contributing/using-git.html
[202] http://help.github.com/articles/set-up-git
[203] https://github.com/ome/omero-user-scripts
[204] http://www.hdfgroup.org/HDF5/release/obtain5.html
[205] http://numpy.sourceforge.net/numdoc/HTML/numdoc.htm
[206] http://pytables.github.com/downloads.html

```
$ virtualenv $HOME/virtualenv
$ uname -o -p
unknown GNU/Linux
$ gcc --version
gcc-4.8.real (Debian 4.8.1-9) 4.8.1
Copyright (C) 2013 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

$ wget "http://www.hdfgroup.org/ftp/HDF5/current/src/hdf5-1.8.11.tar.gz"
$ tar xzf hdf5-1.8.11.tar.gz
$ cd hdf5-1.8.11
$ ./configure --prefix=$HOME/virtualenv
$ make
$ make install
$ export LD_LIBRARY_PATH=$HOME/virtualenv/lib
$ . $HOME/virtualenv/bin/activate
$ easy_install tables
```

Checking that it works

After that, the following should succeed:

```
% python
Python 2.7.5+ (default, Aug  4 2013, 10:07:17)
[GCC 4.8.1] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import tables
>>> tables.test()
--------------------------------------------------------------------------------
PyTables version:  2.4.0
HDF5 version:      1.8.11
NumPy version:     1.7.1
Numexpr version:   2.0.1 (not using Intel's VML/MKL)
Zlib version:      1.2.8 (in Python interpreter)
LZO version:       2.06 (Aug 12 2011)
BZIP2 version:     1.0.6 (6-Sept-2010)
Blosc version:     1.1.3 (2010-11-16)
Python version:    2.7.5+ (default, Aug  4 2013, 10:07:17)
[GCC 4.8.1]
Platform:          linux2-x86_64
Byte-ordering:     little
Detected cores:    8
…
```

Once the required Python libraries are installed, starting OMERO will automatically start up the OMERO.tables service; there should be no need for further configuration or interaction.

Windows

After installing all the Windows prerequisites OMERO.tables should start up during the OMERO.server startup. It can be verified by looking at the output of `omero admin diagnostics`:

```
(…)
Server:     Tables-0                      active (pid = 3176, enabled)
```

See also:

PostgreSQL (9.4 or higher)

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

6.6 Troubleshooting OMERO

6.6.1 Which user account and password do I use where?

Accounts table, including the example usernames and passwords used in the installation guides:

Account type	Function	Username	Password
System	Administrator/Root		
System	(Database) service account	postgres	
System	(OMERO) service account	omero_user	
Database	Database administrator	postgres	
Database	Database user	db_user	db_password
OMERO	OMERO administrator	root	root_password
OMERO	OMERO users		

Note: These example usernames and passwords are provided to help you follow the installation guide examples. Do not use root_password or db_password; substitute your own passwords.

There are a total of three types of user accounts: system, database and OMERO accounts.

System accounts

These are accounts on your machine or directory server (e.g. LDAP, Active Directory). One account is used for running the OMERO server (either your own or one you created specially for running OMERO, referred to here as "omero_user"). There is also a user called the "administrator-level user" on the *Windows installation page* and "root-level user" on the *UNIX installation page* (which includes Mac OS X). A separate "postgres" user is used for running the database server. The "omero_user" account runs the OMERO server, and owns the files uploaded to OMERO. This account must have permission to write to the */OMERO/* binary repository. Some operations in the install scripts require the root-level/administrator-level privileges in order to use another account to perform particular actions e.g. the "postgres" user to create a database. However **the OMERO.server should never be run as the root-level/administrator-level user or as the system-level "postgres" user**.

Database accounts

The PostgreSQL database system contains user and administrative accounts; these are completely separate from the system accounts, above, existing only inside the database. The database administrative user ("postgres") is the owner of all the database resources, and can create new users internal to the database. A single database account is used at run time by OMERO to talk to your database. Therefore, you must configure the *database* values during installation:

```
$ bin/omero config set omero.db.user db_user
$ bin/omero config set omero.db.pass db_password
```

Note: Do **not** use db_user or db_password here; substitute your own username and password.

A database user may have the same name as an account on your machine, in which case a password might not be necessary.

OMERO accounts

These accounts only exist inside the OMERO system, and are completely separate from both the system and database accounts, above. The first user which you will need to configure is the "root" OMERO user (different from any root-level Unix account). This is done by setting the password in the database script, see *Database tools*.

Other OMERO users can be created via the OMERO.web admin tool. None of the passwords have to be the same, in fact they should be different **unless you are using the LDAP plugin**.

6.6.2 Server fails to start

1. Check that you are able to successfully connect to your PostgreSQL installation as outlined on the PostgreSQL page for your OS (*Windows PostgreSQL page* or *UNIX/Mac PostgreSQL page*).
2. Check the permissions on your `omero.data.dir` (`/OMERO` or `C:OMERO` by default) as outlined on the *OMERO.server installation* page for Unix/Mac users, or the *OMERO.server binary repository* page for Windows users.
3. Are you on a laptop? If you see an error message mentioning "node master couldn't be reached"[207], you may be suffering from a network address swap. Ice does not like to have its network changed as can happen if the server is running on a laptop on wireless. If you lose connectivity to icegridnode, you may have to kill it manually via `kill PID` or `killall icegridnode` (under Unix).
4. If you see an error message mentioning "Freeze::DatabaseException"[208] or "could not lock file: var/registry/__Freeze/lock"[209], your icegrid registry may have become corrupted. This is not a problem, but it will be necessary to stop OMERO and delete the `var/master` directory (e.g. `rm -rf var/master`). When restarting OMERO, the registry will be automatically re-created.
5. If you see an error message mentioning "Protocol family unavailable", you will need to set the `Ice.IPv6` property with `omero config set Ice.IPv6 0`.
6. If you upgraded from a 5.0.2 server or older and copied the entire content of the `etc/grid` directory from the old server to the new server, you will need to revert the changes made to `templates.xml` to generate the new memory settings[210].
7. If OMERO starts up, but fails to respond to connection requests, check *netstat -a* for port 4064. If nothing is listening on 4064, you may need to specify which network interface to use. `omero config set Ice.Default.Host 127.0.0.1`, for example, would force OMERO to only listen on localhost. See Proxy and Endpoint Syntax[211] for more information.

6.6.3 Remote clients cannot connect to OMERO installation

The Admin section of OMERO.web appears to work properly and you may or may not have created some users, but no matter what you do remote clients will not speak to OMERO. OMERO.insight gives you an error message similar to the following despite giving the correct username and password:

This is often due to firewall misconfiguration on the machine that runs your OMERO server, affecting the ability of remote clients to locate it. Please see the *Server security and firewalls* page.

6.6.4 Server crashes with…

- `X11 connection rejected because of wrong authentication`
- `X connection to localhost:10.0 broken (explicit kill or server shutdown).`

[207] https://trac.openmicroscopy.org/ome/ticket/7325
[208] https://trac.openmicroscopy.org/ome/ticket/5576
[209] https://trac.openmicroscopy.org/ome/ticket/7325
[210] https://trac.openmicroscopy.org/ome/ticket/12527
[211] https://doc.zeroc.com/display/Ice/Proxy+and+Endpoint+Syntax#ProxyandEndpointSyntax-address

OMERO uses image scaling and processing techniques that may be interfered with when used with SSH X11-forwarding. You should disable SSH X11-forwarding in your SSH session by using the `-x` flag as follows before you restart the OMERO.server:

```
ssh -x my_server.examples.com
```

6.6.5 OutOfMemoryError / PermGen space errors in OMERO.server logs

Out of memory or permanent generation (PermGen) errors can be caused by many things. You may be asking too much of the server. Or you may require an increase in the maximum Java heap or the permanent generation space. This can be done by modifying the configuration for your OMERO.server. See *Memory configuration*.

Similarly, if you are finding out of memory errors in one of the other process logs (e.g. `Indexer-0.log` or `PixelData-0.log`), you might try optimizing the JVM memory settings.

Furthermore, under certain conditions access of images greater than 4GB can be problematic on 32-bit platforms due to certain bugs within the Java Virtual Machine including Bug ID: 4724038[212]. A 64-bit platform for your OMERO.server is **HIGHLY** recommended.

6.6.6 Import errors

Import error when running bin/omero

```
Traceback (most recent call last):
File "bin/omero", line 67, in ?
    import omero.cli
ImportError: No module named omero.cli
```

If you get any import related errors while running `bin/omero`, the most likely cause is that your PYTHONPATH is not properly set.

- If you installed Ice globally via your package manager, make sure you included ice-python.
- If you installed Ice manually, e.g. under `/opt/Ice-3.5.1` you need to add `/opt/Ice-3.5.1/python` (or similar) to your PYTHONPATH environment variable. See the Ice installation instructions for more information.

Too many open files

This is most often seen as an error during importing and is caused by the number of opened files exceeding the limit imposed by your operating system. It might be due to OMERO leaking file descriptors; if you are not using the latest version, please upgrade, since a number of bugs which could cause this behavior have been fixed. It is also possible for buggy scripts which do not properly release resources to cause this error.

To view the current per-process limit, run

```
ulimit -Hn
```

which will show the hard limit for the maximum number of file descriptors (-Sn will show the soft limit). This limit may be increased. On Linux, see `/etc/security/limits.conf` (global PAM per-user limits configuration); it is also possible to increase the limit in the shell with

```
ulimit -n newlimit
```

providing that you are uid 0 (other users can only increase the soft limit up to the hard limit). To view the system limit, run

[212] http://bugs.sun.com/bugdatabase/view_bug.do?bug_id=4724038

```
cat /proc/sys/fs/file-max
```

We recommend 8K as a minimum number of files limit for production systems, with 16K being reasonable for bigger machines.

On Mac OS X, the standard ulimit will not work properly. There are several different ways of setting the ulimit, depending upon the version of OS X you are using, but the most common are to edit `sysctl.conf` or `launchd.conf` to raise the limit. However, note that both of these methods change the defaults for every process on the system, not just for a single user or service.

Increasing the number of available filehandles via 'ulimit -n'

ValueError: filedescriptor out of range in select() - this is a known issue in Python versions prior to 2.7.0. See #6201[213] and Python Issue #3392[214] for more details.

Windows import errors

See *Failure response on import for new databases*.

Directory exists but is not registered

Import errors of type `Directory exists but is not registered: CheckedPath(username_id)` suggest a server-side issue under the ManagedRepository.

For production servers, this can be caused by a server crash during import or an issue at the file system level (permissions, renaming). If the `ManagedRepository/username_id` folder is empty, you should try removing it before trying another import.

For development servers, this may be caused by the binary directory not being cleaned after the database has been wiped.

See also:

Upload problem: Directory exists but is not registered.[215]

import: Directory exists but is not registered: CheckedPath([216]

[ome-devel] Directory exists but is not registered: CheckedPath(username_id)[217]

6.6.7 DropBox fails to start: failed to get session

If the main server starts but DropBox fails with the following entry in `var/log/DropBox.log`,

```
2011-06-07 03:42:56,775 ERROR [        fsclient.DropBox] (MainThread) Failed to get Session:
```

then it may be that the server is taking a relatively long time to start.

A solution to this is to increase the number of retries and/or the period (seconds) between retries in `etc/grid/templates.xml`

```
<property name="omero.fs.maxRetries"  value="5"/>
<property name="omero.fs.retryInterval"  value="3"/>
```

[213] https://trac.openmicroscopy.org/ome/ticket/6201
[214] http://bugs.python.org/issue3392
[215] http://www.openmicroscopy.org/community/viewtopic.php?f=5&t=7537
[216] http://www.openmicroscopy.org/community/viewtopic.php?f=6&t=7722&p=15264&hilit=CheckedPath#p15264
[217] http://lists.openmicroscopy.org.uk/pipermail/ome-devel/2014-October/003020.html

6.6.8 Search does not return expected results

If searching for a specific term does not return the expected results (e.g. searching for the name of a tag does not return the full list of a user's images annotated with that tag), there are a few things that may have gone wrong. See *Missing search results* for more details.

6.6.9 OMERO.web issues

OMERO.web and Apache

Do not enable mod_python and mod_wsgi in the same apache process. mod_wsgi will deadlock if run in daemon mode while mod_python is enabled

OMERO.web did not start

- If the Apache error logs contain lines of type `Permission denied: access to xxx denied`, you need to check the permissions of the folder and make sure it is readable and executable by the Apache user.

  See also:

  What are your LDAP requirements?[218]

  upgrade 5.0.5 to 5.1.1 omero.web forbidden[219]

OMERO.web running but status says not started

If you upgraded OMERO but forgot to stop OMERO.web, processes will still be running. In order to kill stale processes by hand, run:

```
$ ps aux | grep /home/omero/OMERO.server/var/django.pid
```

Note: As Gunicorn is based on the pre-fork worker model it is enough to kill the master process, the one with the lowest PID.

OMERO.web not available HTTP 404

Consult nginx `error.log` for more details.

The most common problem appears when the default configuration for `location /` is loaded prior to omeroweb.conf

```
2016/01/01 00:00:00 [error] 1234#0: *5 "/usr/share/nginx/html/webclient/login/index.html" is not found
```

OMERO.web not responding/timeout issues

```
[CRITICAL] WORKER TIMEOUT (pid:1234)
```

OMERO.web deployed with Gunicorn relies on the operating system to provide all of the load balancing while handling requests. Adjust the timeout using `omero.web.wsgi_timeout` and scale the number of `omero.web.wsgi_workers` starting with (2 x NUM_CORES) + 1 workers. For more details refer to *Gunicorn default configuration (Unix/Linux)*.

[218] http://www.openmicroscopy.org/community/viewtopic.php?f=5&t=14
[219] http://lists.openmicroscopy.org.uk/pipermail/ome-users/2015-April/005316.html

Issues with downloading data from OMERO.web

An *EXPERIMENTAL: Gunicorn advance configuration (Unix/Linux)* is available for testing with nginx if you are encountering problems with downloads failing. You can also configure OMERO.web to limit downloads - refer to the *OMERO.web deployment* documentation and *Download restrictions* for further details.

OMERO.web piecharts

'Drive space' does not generate pie chart or 'My account' does not show markup picture and crop the picture options.

Error message says: 'Piechart could not be displayed. Please check log file to solve the problem'. Please check `var/log/OMEROweb.log` for more details. There are a few known possibilities:

- 'TclError: no display name and no $DISPLAY environment variable'. Turn off the compilation of TCL support in Matplotlib[220].
- 'ImportError: No module named Image'. Install Pillow[221] (packages should be available for your distribution). Also double check if all of the prerequisites were installed from OMERO.web deployment (*UNIX instructions* or *Windows instructions*).

6.6.10 Troubleshooting performance issues with the clients

If you are having issues with slowdown and timeouts in the clients, there are three things to check:

- your network connection
- if you are running out of memory (processing large datasets can cause problems)
- whether your server's HOME directory is on a network share

In the final case, two issues arise. Firstly, when performing some operations, the clients make use of temporary file storage and log directories, as described in the *Client configuration* section of *System requirements*. If your home directory is stored on a network, possibly NFS mounted (or similar), then these temporary files are being written and read over the network which can slow access down. Secondly, the OMERO.server also accesses the temporary and log folders of the user the server process is running as. As the server makes heavier use of these folders than the clients, if the OMERO.server user directory is stored on a network drive then slow performance can occur.

To resolve this, define the `OMERO_TMPDIR` environment variable to point at a temporary directory located on the local file system (e.g. `/tmp/omero`).

6.6.11 Other issues

Connection problems and TCP window scaling on Linux systems

Later versions of the 2.6 Linux kernel, specifically 2.6.17, have TCP window scaling enabled by default. If you are having initial logins never timeout or problems with connectivity in general you can try turning the feature off as follows:

```
# echo 0 > /proc/sys/net/ipv4/tcp_window_scaling
```

Server or clients print "WARNING: Prefs file removed in background..."

```
Nov 12, 2008 3:02:50 PM java.util.prefs.FileSystemPreferences$7 run
WARNING: Prefs file removed in background /root/.java/.userPrefs/prefs.xml
Nov 12, 2008 3:02:50 PM java.util.prefs.FileSystemPreferences$7 run
WARNING: Prefs file removed in background /usr/lib/jvm/java-1.7.0-icedtea-1.7.0.0/jre/.systemPrefs/prefs
```

[220] http://matplotlib.org/
[221] http://pillow.readthedocs.org

These warnings (also sometimes listed as ERRORS) can be safely ignored, and are solely related to how Java is installed on your system. See http://bugs.sun.com/bugdatabase/view_bug.do?bug_id=4751177 or this ome-users thread[222] on our mailing list for more information.

[222] http://lists.openmicroscopy.org.uk/pipermail/ome-users/2009-March/001465.html

CHAPTER

SEVEN

OPTIMIZING SERVER CONFIGURATION

This chapter discusses the options for configuring OMERO.server for optimum performance and security.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.1 Server security and firewalls

7.1.1 General

OMERO has been built with security in mind. Various standard security practices have been adhered to during the development of the server and client including:

- Encryption of all passwords between client and server via SSL
- Full encryption of all data when requested via SSL
- User and group based access control
- Authentication via LDAP
- Limited visible TCP ports to ease firewalling
- Use of a higher level language (Java or Python) to limit buffer overflows and other security issues associated with native code
- Escaping and bind variable use in all SQL interactions performed via Hibernate

Note: The OMERO team treats the security of all components with care and attention. If you have a security issue to report, please do not hesitate to contact us using our private, secure mailing list as described on the security vulnerabilities[1] page.

7.1.2 Firewall configuration

Securing your OMERO system with so called *firewalling* or *packet filtering* can be done quite easily. By default, OMERO clients only need to connect to two TCP ports for communication with your OMERO.server: 4063 (unsecured) and 4064 (SSL). These are the IANA[2] assigned ports for the Glacier2 router from ZeroC[3]. Both of these values, however, are completely up to you, see *SSL* below.

Important OMERO ports:

- **TCP/4063**
- **TCP/4064**

If you are using OMERO.web, then you will also need to make your HTTP and HTTPS ports available. These are usually 80 and 443.

Important OMERO.web ports:

[1] http://www.openmicroscopy.org/info/vulnerabilities/
[2] http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xml
[3] https://zeroc.com

- **TCP/80**
- **TCP/443**

Example OpenBSD firewall rules

```
block in log on $ext_if from any to <omero_server_ip>
pass in on $ext_if proto tcp from any to <omero_server_ip> port 4063
pass in on $ext_if proto tcp from any to <omero_server_ip> port 4064
pass in on $ext_if proto tcp from any to <omero_server_ip> port 443
pass in on $ext_if proto tcp from any to <omero_server_ip> port 80
```

Example Linux firewall rules

```
iptables -P INPUT drop
iptables -A INPUT -p tcp --dport 4063 -j ACCEPT
iptables -A INPUT -p tcp --dport 4064 -j ACCEPT
iptables -A INPUT -p tcp --dport 443 -j ACCEPT
iptables -A INPUT -p tcp --dport 80 -j ACCEPT
...
```

7.1.3 Passwords

The passwords stored in the `password` table are salted and hashed, so it is impossible to recover a lost one, instead a new one must be set by an admin.

If the password for the root user is lost, the only way to reset it (in the absence of other admin accounts) is to manually update the password table. The `bin/omero` command can generate the required SQL statement for you:

```
$ bin/omero db password
Please enter password for OMERO root user:
Please re-enter password for OMERO root user:
UPDATE password SET hash = 'PJueOtwuTPHB8Nq/1rFVxg==' WHERE experimenter_id  = 0;
```

Current hashed password:

```
$ psql mydatabase -c " select * from password"
 experimenter_id |           hash
-----------------+--------------------------
               0 | Xr4ilOzQ4PCOq3aQ0qbuaQ==
(1 row)
```

Change the password using the generated SQL statement:

```
$ psql mydatabase -c "UPDATE password SET hash = 'PJueOtwuTPHB8Nq/1rFVxg==' WHERE experimenter_id  = 0;
UPDATE 1
```

7.1.4 Java key- and truststores.

If your server is connecting to another server over SSL, you may need to configure a truststore and/or a keystore for the Java process. This happens, for example, when your LDAP server uses SSL. See the *LDAP plugin* for information on how to configure the LDAP URLs. As with all configuration properties, you will need to restart your server after changing them.

To do this, you will need to configure several server properties, similar to the properties you configured during *installation* (*Windows*).

- truststore path

```
bin/omero config set omero.security.trustStore /home/user/.keystore

A truststore is a database of trusted entities and their
associated X.509 certificate chains authenticating the
corresponding public keys. The truststore contains the
Certificate Authority (CA) certificates and the certificate(s) of
the other party to which this entity intends to send encrypted
(confidential) data. This file must contain the public key
certificates of the CA and the client's public key certificate.
```

  If you don't have one you can create it using the following:

```
openssl s_client -connect {{host}}:{{port}} -prexit < /dev/null | openssl x509 -outform PEM | keyt
```

- truststore password

```
bin/omero config set omero.security.trustStorePassword secret
```

- keystore path

```
bin/omero config set omero.security.keyStore /home/user/.mystore

A keystore is a database of private keys and their associated
X.509 certificate chains authenticating the corresponding public
keys.

A keystore is mostly needed if you are doing client-side certificates
for authentication against your LDAP server.
```

- keystore password

```
bin/omero config set omero.security.keyStorePassword secret
```

7.1.5 SSL

Especially if you are going to use LDAP authentication to your server, it is important to encrypt the transport channel between clients and the Glacier2 router to keep your passwords safe.

By default, all logins to OMERO occur over SSL using an anonymous handshake. After the initial connection, communication is un-encrypted to speed up image loading. Clients can still request to have all communications encrypted by clicking on the lock symbol. An unlocked symbol means that non-password related activities (i.e. anything other than login and changing your password) will be unencrypted, and the only critical connection which is passed in the clear is your session id.

Administrators can configure OMERO such that unencrypted connections are not allowed, and the user's choice will be silently ignored. The SSL and non-SSL ports are configured in the `etc/grid/default.xml` and `etc/grid/windefault.xml` files, and as described above, default to 4064 and 4063 respectively, and can be modified using the *Ports* configuration properties. For instance, to prefix all ports with 1, use `omero.ports.prefix`:

```
$ bin/omero config set omero.ports.prefix 1
```

See also:

LDAP authentication

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.2 LDAP authentication

LDAP[4] is an open standard for querying and modifying directory services that is commonly used for authentication, authorization and accounting (AAA). OMERO.server supports the use of an LDAP server to query (but not modify) AAA information for the purposes of automatic user creation.

This allows OMERO users to be automatically created and placed in groups according to your existing institution policies. This can significantly simplify your user administration burden. Note that OMERO has its own concept of "groups" that is quite distinct from LDAP groups.

The OMERO.server LDAP implementation can handle a number of use cases. For example:

- Allow every "inetOrgPerson" under `omero.ldap.base` to login
- but restrict access based upon an arbitrary LDAP filter, e.g.

```
omero.ldap.user_filter=(memberOf=cn=someGoup,ou=Lab,o=College)
```

- and add that user to some number of groups, e.g.

```
omero.ldap.new_user_group=:query:(member=@{dn})
```

7.2.1 How it works

On login, the username provided is searched for in OMERO. If the name does not exist, then the LDAP plugin is queried for a username matching the system-wide user filter. If such an LDAP entry exists and the password matches, a new user with the given username is created, and the user is added to any groups which match the `new_user_group` setting.

On subsequent logins, the user filter and the password are again checked against the LDAP server, and if there is no longer a match, login is refused. If you would prefer to only have the `user_filter` applied during user creation and not on every login, see *Legacy password providers*.

You can take existing non-LDAP users and 'upgrade' them to using LDAP with the OMERO command line tool, see *Converting non-LDAP users to LDAP authentication*. You can also use `omero ldap create` to add an ldap user to OMERO groups without requiring them to log in first, see *User/group management* for details.

7.2.2 LDAP properties

The LDAP plugin is configured via several configuration properties, all starting with `omero.ldap` (see *LDAP*).

Some of the property values are passed directly to the underlying LDAP library (Spring LDAP[5]), which in turn makes use of the Java API. OMERO does not modify the error messages thrown by the library or by Java, so please consult the appropriate documentation to diagnose any low-level problems.

Note: Please remember that once a change has been made, a server restart will be needed.

[4] http://en.wikipedia.org/wiki/Lightweight_Directory_Access_Protocol
[5] http://projects.spring.io/spring-ldap/

Minimum configuration

The following properties are the minimum requirements for logging in to OMERO using LDAP.

```
omero.ldap.config=true
omero.ldap.urls=ldap://localhost:389
omero.ldap.username=
omero.ldap.password=
omero.ldap.base=ou=example,o=com
```

After having configured your connection, you can turn LDAP on and off between restarts by setting `omero.ldap.config` to false. The `base` property determines where in the LDAP tree searches will begin. No users or groups will be found if they are not under the base provided.

User lookup

Two user properties are used to look up users by login name and, if necessary, create new users based on the information in LDAP.

```
omero.ldap.user_filter=(objectClass=person)
omero.ldap.user_mapping=omeName=cn,firstName=givenName,lastName=sn,email=mail,institution=department,mid
```

`omero.ldap.user_filter` will be AND'ed to the username query, and can contain any valid LDAP filter string. The username query is taken from the LDAP attribute which gets mapped to "omeName" by `omero.ldap.user_mapping`. Here, the "cn" is mapped to "omeName", so the username query is `(cn=[login name])`. The final query is `(&(objectClass=person)(cn=[login name]))`, which must return a single result to be considered valid.

Group lookup

Three group properties are all concerned with what groups a user will be placed in on creation.

```
omero.ldap.group_filter=(objectClass=groupOfNames)
omero.ldap.group_mapping=name=cn
omero.ldap.new_user_group=default
```

The group filter and group mapping work just as the user filter and mapping do, in that the group name query will be AND'd with the `group_filter`. In this case, the final query would be `(&(objectClass=groupOfNames)(cn=[group name]))`. However, these properties may not be used depending on the value of `new_user_group`, which can have several different values:

- If not prefixed at all, then the value is simply the name of a group which all users from LDAP should be added to.
- If prefixed with `:ou:`, then a user's last organizational unit (OU) will be used as his or her group. For example, the user with the DN "cn=frank,ou=TheLab,ou=LifeSciences,o=TheCollege" will be placed in the group "TheLab".
- If prefixed with `:attribute:`, then the rest of the string is taken to be an attribute all of whose values will be taken as group names. For example, `omero.ldap.new_user_group=:attribute:memberOf` would add a user to all the groups named by memberOf. You can prefix this value with `filtered_` to have the `group_filter` applied to the attribute values, i.e. `:filtered_attribute:memberOf` will mean that only the values of memberOf which match `group_filter` will be considered. An example value of the `memberOf` attribute would be: `CN=mygroup,OU=My Group,OU=LabUsers, DC=openmicroscopy,DC=org`
- If prefixed with `:dn_attribute:`, then the rest of the string is taken to be an attribute all of whose values will be taken as group distinguished names. For example, `omero.ldap.new_user_group=:dn_attribute:memberOf` would add a user to all the groups named by memberOf, where the name of the group is mapped via `group_mapping`. You can prefix this value with `filtered_` to have the `group_filter` applied to the attribute values, i.e. `:filtered_dn_attribute:memberOf` will mean that only the values of memberOf which match `group_filter` will be considered. An example value of the `memberOf` attribute would be: `CN=mygroup,OU=My Group,OU=LabUsers, DC=openmicroscopy,DC=org`

Note that if an attribute specified in `omero.ldap.group_mapping` does not constitute a part of the Distinguished Name (DN) as determined by your LDAP server then it can only be found by using `:attribute:` or `:filtered_attribute:` instead. Typical attributes that comprise the DN are: DC, CN, OU, O, STREET, L, ST, C and UID.

- If prefixed with `:query:`, then the rest of the value is taken as a query to be AND'ed to the group filter. In the query, values from the user such as "@{cn}", "@{email}", or "@{dn}" can be used as place holders.
- If prefixed with `:bean:`, then the rest of the string is the name of a Spring bean which implements the NewUserGroupBean interface. See the developer documentation *LDAP plugin design* for more info.

Compound Filters

Note: OMERO uses standard RFC 2254 LDAP filters[6], so they must conform to that syntax and are only able to do what those filters can do. You can test the filters via ldapsearch on your OMERO server (assuming you have the OpenLDAP binaries installed).

If you are using OpenLDAP make sure your directory has the `memberOf` attribute correctly configured. Some versions of ApacheDS do not support `memberOf` at all.

Both the `user_filter` and the `group_filter` can contain any valid LDAP filter string. These must be a valid filter in themselves. e.g.

```
omero.ldap.user_filter=(|(ou=Queensland Brain Institute)(ou=Ageing Dementia Research))
```

The "|" operator (read: "OR") above allows members of two organizational units to login to OMERO. Expanding the list allows concentric "rings" of more and more OU's granular access to OMERO.

```
omero.ldap.group_filter=(&(objectClass=groupOfNames)(mail=omero.flag))
```

The "&" operator (read: "AND") produces a filter that will only match groups that have the `mail` attribute set to the value `omero.flag`. When combined with the `group_mapping`, the final query would be `(&(&(objectClass=groupOfNames)(mail=omero.flag))(cn=[group name]))`

This is the same as the query `(&(objectClass=groupOfNames)(mail=omero.flag)(cn=[group name]))` but setting `group_filter` to `(objectClass=groupOfNames)(mail=omero.flag)` is not valid as that is not a valid filter on its own.

To restrict the list of groups to just the ones returned by the above query, the following setting is also required to remove unmatched groups:

```
omero.ldap.new_user_group=:filtered_dn_attribute:memberOf
```

7.2.3 Case sensitivity

By default, the LDAP plugin is case-sensitive i.e. it will treat the usernames JSmith and jsmith as two different users. You can remove case sensitivity using:

```
bin/omero config set omero.security.ignore_case true
```

Warning: Enabling this option will affect all usernames in your OMERO system. It is the system administrator's responsibility to handle any username clashes which may result. Making all usernames lowercase is recommended.

[6] http://www.faqs.org/rfcs/rfc2254.html

7.2.4 LDAP over SSL

If you are connecting to your server over SSL, that is, if your URL is of the form `ldaps://ldap.example.com:636` you may need to configure a key and trust store for Java. See the *Server security and firewalls* page for more information.

7.2.5 Synchronizing LDAP on user login

This feature allows for LDAP to be considered the authority on user/group membership. With the following setting enabled, each time a user logs in to OMERO their LDAP groups will be read from the LDAP server and reflected in OMERO:

```
bin/omero config set omero.ldap.sync_on_login true
```

Admin actions carried out in the clients may not survive this synchronization e.g. if an admin has removed an LDAP user from an LDAP group in the UI, the user will be re-added to the group when logging in again after the synchronization.

Note: This applies to groups created by LDAP in OMERO 5.1.x. Groups created in older versions of OMERO will not be registered as LDAP groups if you have manually altered their membership, even if the membership now matches the LDAP group.

`bin/omero ldap setdn true --group-name $NAME` can be used to make these previous OMERO groups into LDAP groups.

7.2.6 Legacy password providers

The primary component of the LDAP plugin is the LdapPasswordProvider, which is responsible for creating users, checking their passwords, and adding them to or removing them from groups. The default password provider is the `chainedPasswordProvider` which first checks LDAP if LDAP is enabled, and then checks JDBC. This can explicitly be enabled by executing the system admin command:

```
bin/omero config set omero.security.password_provider chainedPasswordProvider
```

When the LDAP password provider implementation changes, previous versions can be configured as necessary.

- `chainedPasswordProviderNoSalt`

  The `chainedPasswordProviderNoSalt` uses the version of the JDBC password provider without password salting support as available in the OMERO 4.4.x series. To enable it, use:

  ```
  bin/omero config set omero.security.password_provider chainedPasswordProviderNoSalt
  ```

- `chainedPasswordProvider431`

  With the 431 password provider, the user filter is only checked on first login and not kept on subsequent logins. This allows for an OMERO admin to change the username of a user in omero to be different than the one kept in LDAP. To enable it, use:

  ```
  bin/omero config set omero.security.password_provider chainedPasswordProvider431
  ```

See also:

OMERO.server installation Installation guide for OMERO.server under UNIX-based platforms

Server security and firewalls Security pages for OMERO.server

LDAP plugin design Developer documentation on extending the LDAP plugin yourself.

What are your LDAP requirements?[7] Forum discussion if you have LDAP requirements that are not covered by the above configuration

JNDI referrals documentation http://docs.oracle.com/javase/jndi/tutorial/ldap/referral/jndi.html

7.2.7 Active Directory

Active Directory[8] (AD) supports a form of LDAP and can be used by OMERO like most other directory services.

In AD, the Domain Services[9] (DS) 'forest' is a complete instance of an Active Directory which contains one or more domains. Querying a particular Domain Service will yield results which are local to that domain only. In an environment with just one domain it is possible to use the default configuration instructions for OMERO LDAP. If there are multiple domains in the forest then it is necessary to query the *Global Catalogue* to enable querying across all of them.

Global Catalogue

In an AD DS forest, a Global Catalogue[10] provides a central repository of all the domain information from all of the domains. This can be queried in the same way as a specific Domain Service using LDAP, but it runs on different ports; 3268 and 3269 (SSL).

- LDAP AD Global Catalogue server URL string

```
bin/omero config set omero.ldap.urls ldap://ldap.example.com:3268
```

Note: A SSL URL above should look like this: ldaps://ldap.example.com:3269

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.3 Performance and monitoring

Once you have your OMERO server running and secured, a second critical step will be tuning various configuration parameters in order to get optimal performance.

7.3.1 Memory configuration

OMERO should automatically configure itself to take advantage of the physical memory installed on a system whilst leaving room for other services. You may wish to override the defaults on a production server, for instance if your machine is solely dedicated to running OMERO you can increase the amount of memory that OMERO will use. You may also need to modify your settings if you are seeing out-of-memory errors when dealing with certain types of images.

A number of configuration properties starting with *omero.jvmcfg* control the calculation of how much memory to allocate to various OMERO services on startup, most importantly:

- blitz
- indexer
- pixeldata

Configuration properties

Configuration properties can either be applied to all three service types at the same time by omitting the service type (e.g. `omero.jvmcfg.strategy`) or to each individually by including it (e.g. *omero.jvmcfg.strategy.blitz*).

For example, the default, PercentStrategy, is equivalent to making the call:

[8] http://en.wikipedia.org/wiki/Active_Directory
[9] http://msdn.microsoft.com/en-us/library/aa362244(v=vs.85).aspx
[10] http://technet.microsoft.com/en-us/library/cc728188(v=ws.10).aspx

```
$ bin/omero config set omero.jvmcfg.strategy percent
```

This could be changed to use the ManualStrategy for all servers:

```
$ bin/omero config set omero.jvmcfg.strategy manual
```

Strategies

A couple of strategies are available for calculating the effective JVM settings from the provided configuration properties.

PercentStrategy Default. Reads the *percent* configuration property which can also be set globally or on a service-type basis. This percentage (0-100) of the system memory is used for the process, subject to minimum and maximum limits which can be changed. `omero.jvmcfg.system_memory`, `omero.jvmcfg.min_system_memory`, and `omero.jvmcfg.max_system_memory` are all used for defining the system memory seen. The default percentages are: blitz and pixeldata 15%, indexer 10%. If `omero.jvmcfg.perm_gen` or `omero.jvmcfg.heap_size` are explicitly set, they will be used directly as with the *ManualStrategy*.

ManualStrategy Simply provides the values given as the JVM settings. If no value is set for a particular configuration property, then the default is used: *heap_size=512m* and *perm_gen=128m* These values are equivalent to the defaults in OMERO 5.0.2 and earlier.

Examples

```
$ bin/omero config set omero.jvmcfg.percent.blitz 50
```

would raise the blitz heap size to 50% of the system memory seen.

```
$ bin/omero config set omero.jvmcfg.system_memory 24000
```

would set the system memory seen to 24GB regardless of the actual amount of memory present in the system. The PercentageStrategy would use this as the basis for setting the Java heap sizes for all services.

```
$ bin/omero config set omero.jvmcfg.max_system_memory 64000
```

would raise the maximum system memory seen by an OMERO installation to 64000MB of system memory. Assuming there was at least 64000MB of memory installed blitz would default to using 9600MB.

```
$ bin/omero config set omero.jvmcfg.strategy.indexer manual
$ bin/omero config set omero.jvmcfg.heap_size.indexer 2000
```

would set the indexer heap size to 2000MB without modifying the settings for the other services.

Tips

View the memory settings that will apply to a newly started server.

```
$ bin/omero admin jvmcfg
```

After modifying any memory settings, be sure to restart your server.

```
$ bin/omero admin restart
```

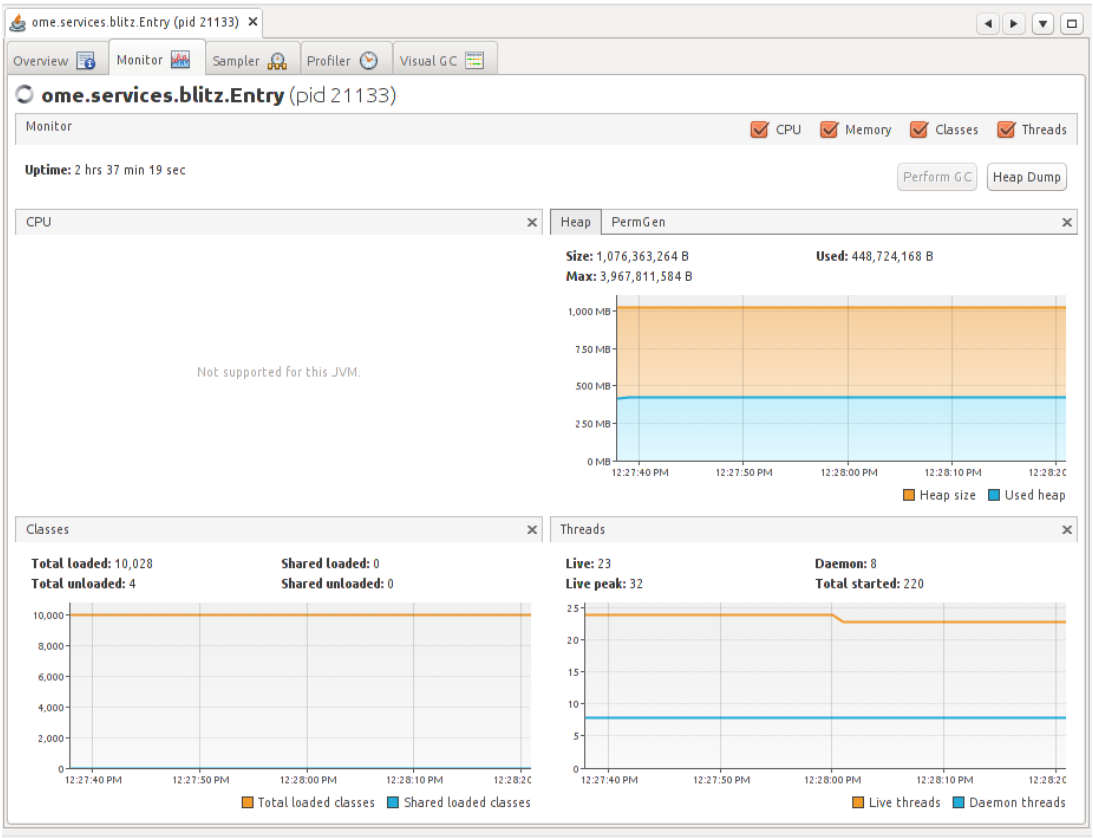
See also:

http://www.openmicroscopy.org/community/viewtopic.php?f=4&t=7400 Forum thread on PixelData JVM (Java Virtual Machine) memory settings

Grid configuration Section of the advanced server configuration documentation describing `etc/grid/templates.xml`.

7.3.2 Monitoring

In addition to watching the OMERO log files, the JVM itself provides a number of tools that you can use to determine the health of your server. JVisualVM[11], for example, can be used to visualize the memory use of each JVM:



You will need to have the PID (process ID) for the service you want to monitor, which will usually be the main Blitz process. You can find the PID either via `omero admin diagnostics` or alternatively via the *jps* command found in the JDK.

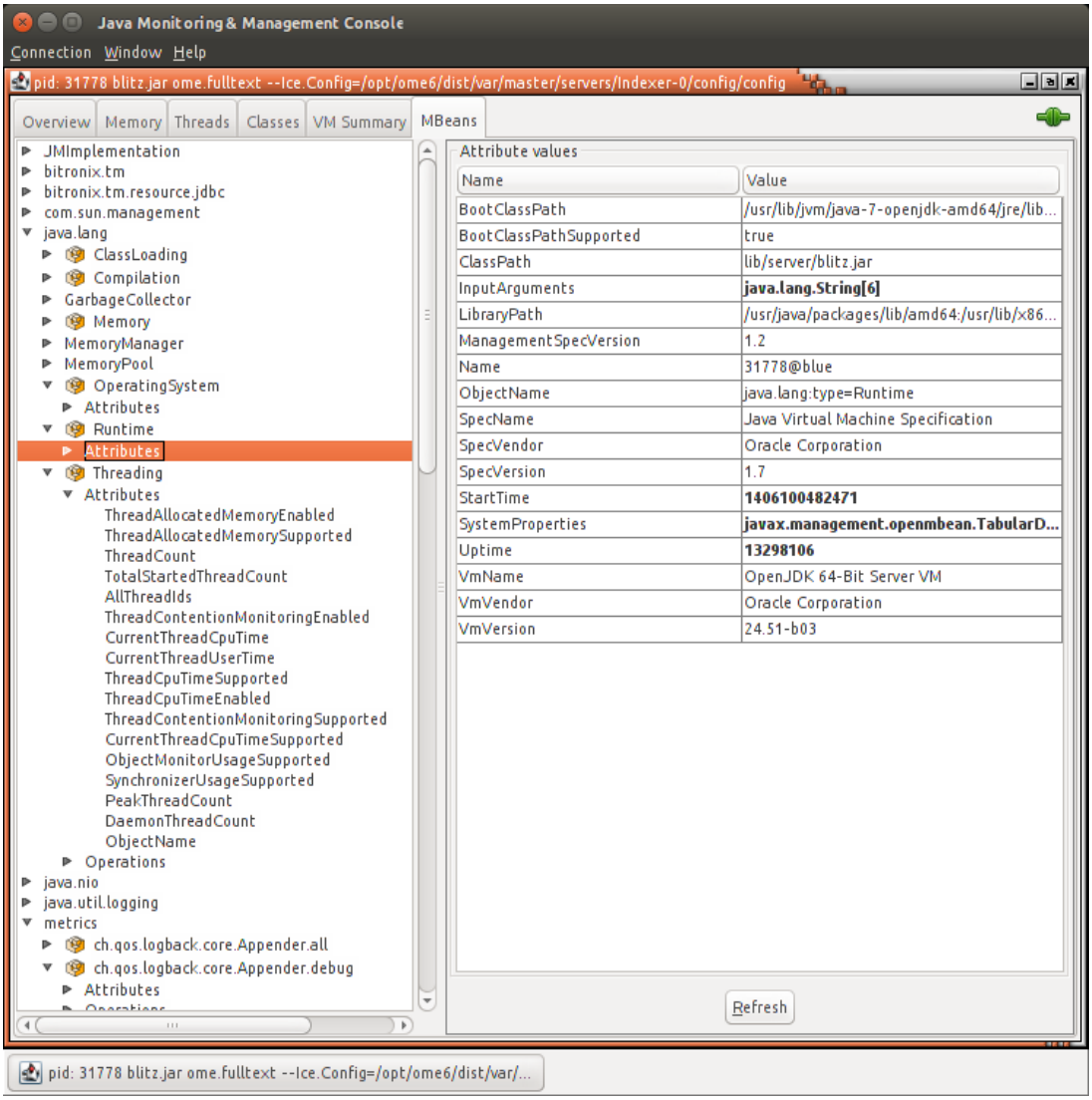
Another tool, JConsole[12], also provides access to the memory statistics for your JVM, but also lists the JMX (Java Management Extensions) management beans which provide extensive information about the running process. Information includes the number of queries that have been run, the number of open file handles, the system properties that were set on startup, and much more. Further, the *ome.system.metrics* package makes use of JMX to expose further properties.

With *further configuration*, JMX properties can also be accessed remotely which can be very useful for monitoring your server with Check_MK[13], Nagios[14], Zenoss[15], or similar. However, care must be taken to protect the exposed ports.

Note: The commands above require the Java JDK (Java Development Kit) as opposed to the JRE (Java Runtime Environment).

---

[11] http://visualvm.java.net/
[12] http://openjdk.java.net/tools/svc/jconsole/
[13] https://mathias-kettner.de/check_mk.html
[14] http://www.nagios.org/
[15] http://www.zenoss.com/



7.3.3 Metrics

Building on top of Coda Hale's Metrics[16] library, OMERO provides the ome.system.metrics package which measures a number of internal events and makes them available both via JMX as described under *Monitoring* but also prints them to the log files.

By default, these values are printed to each of the JVM-based log files (e.g. `var/log/Blitz-0.log`, `var/log/Indexer-0.log`, etc) once per hour. This value can be configured via `omero.metrics.slf4j_minutes`. A typical value might look like:

```
11:28:18,923 INFO  [                    ome.system.metrics] (r-thread-1) type=TIMER, name=ome.service
```

Values include basic statistics (*count*, *min*, *max*, *mean*, etc.) as well as 75th, 90th, 95th, etc percentiles. Further, the rate over the last minute, the last 5 minutes, and the last 15 minutes is provided (*m1*, *m5*, *m15*). For example:

- *count=3601*
- *min=0.41...*
- *max=7.85...*
- *mean=0.94...*
- *stddev=0.31...*
- *median=0.96...*

[16] http://metrics.dropwizard.io

- *p75=1.08...*
- *p95=1.25...*
- *p98=1.35...*
- *p99=1.43...*
- *p999=7.69...*
- *mean_rate=0.50...*
- *m1=0.49...*
- *m5=0.499...*
- *m15=0.49...*
- *rate_unit=events/second*
- *duration_unit=milliseconds*

Useful metrics include:

ch.qos.logback.core.Appender.error The number and rate of errors that have been logged. (All services)

jvm.fileDescriptorCountRatio The ratio of used to available file descriptors. (All services)

ome.services.eventlogs.EventLogQueue.priorityCount The number of items in the queue. (Indexer-only)

ome.io.nio.PixelsService.minmaxTimes Time taken to generate min/max values per plane. (PixelData-only)

ome.io.nio.PixelsService.tileTimes‘ Time taken to generate tiled-pyramids for a big image. (PixelData-only)

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.4 Search and indexing configuration

7.4.1 How Indexing works

Indexing is not driven by the user, but happens automatically in the background and can be controlled by a number of settings listed under *Search*. The indexer runs periodically as defined by `omero.search.cron` and parses the latest batch of new or modified objects in the database.

Upon successful completion, the persistent count in the `configuration` table will be incremented.

```
omero=# select value from configuration where name = 'PersistentEventLogLoader.v2.current_id';
 value
-------
 30983
(1 row)
```

Note: Presence of more than one `PersistentEventLogLoader.*` value in your database indicates that you have run indexing with multiple versions of the server. This is fine. To allow a new server version to force an update, the configuration key may be changed. For example, `PersistentEventLogLoader.current_id` became `PersistentEventLogLoader.v2.current_id` in a5cb64a[17].

7.4.2 Missing search results

If you are having any difficult with search results not appearing timely, first you should start by checking the health of the Indexer-0 process:

[17] https://github.com/openmicroscopy/openmicroscopy/commit/a5cb64a

- Check the server's log directory for a file named `Indexer-0.log` and monitor its progress (e.g. using `tail` or similar). If messages of the format:

```
INFO  [    ome.services.fulltext.FullTextIndexer ] (3-thread-2) INDEXED 2 objects in 1 batch(es) [2
```

  are periodically being appended to the log file, then your indexer process may be running behind. You can either wait for it to catch up, or try increasing the search batch size in order to speed processing. See the section on the `omero.search.batch` setting for more information.

- If there are no updates to the `Indexer-0.log` file even when new images, tags, files, etc. are added to the server, then it is possible that the Indexer process has become stuck. It is possible to force a restart of the indexer using the *IceGrid Tools* like so:

```
> bin/omero admin ice
> omero admin ice
Ice 3.5.1  Copyright (c) 2003-2013 ZeroC, Inc.
>>> server list
Blitz-0
DropBox
FileServer
Indexer-0
...
>>> server stop Indexer-0
```

  You do not need to manually re-start the Indexer, as IceGrid will handle the creation of a new Indexer process automatically.

In case neither of the above seems to be the case, then your indexer is running normally and more likely your index has been corrupted. You will need to *re-index* OMERO. Reasons why this might have occurred include:

- Missing search terms are part of a very large text file. If the indexer's maximum file size limit is reached, a file may not be indexed. See the section on the `omero.search.max_file_size` setting for more information on increasing this limit.
- A bug in Lucene prior to OMERO 5.0.1 caused some documents to be "sealed" in that old search terms would return the document, but newer terms would **not**.

7.4.3 Re-indexing

Background re-indexing

Under most circumstances, you should be able to re-index the database while the server is still running. If you need to make any adjustments to the server configuration or the process heap size, first shut the server down and make these changes before restarting the server. Use the following steps to initiate a re-indexing.

- Disable the search indexer process and stop any currently running indexer processes:

```
$ bin/omero admin reindex --prepare
```

- Remove the existing search Indexes by deleting the contents of the `FullText` subdirectory of your `omero.data.dir`:

```
$ bin/omero admin reindex --wipe
```

- Reset the indexer's progress counter in the database:

```
$ bin/omero admin reindex --reset 0
```

- Re-enable/restart the indexer process:

```
$ bin/omero admin reindex --finish
```

Depending on the size of your database, it may take the indexer some time to finish re-indexing. During this time, your OMERO server will remain available for use, however the search functionality will be degraded until the re-indexing is finished. See *Monitoring re-indexing* for information on how long this should take.

Note: Once you wipe your full-text directory, searches will return fewer or no results until re-indexing is complete.

Off-line re-indexing

It is also possible to re-index the database with the server off-line. First, shutdown the OMERO server as normal and make any adjustments to the configuration that need to be made. Clear the contents of the `FullText` directory and reset the indexing's progress counter as above:

```
$ bin/omero admin reindex --wipe
$ bin/omero admin reindex --reset 0
```

Then run the off-line re-indexing command:

```
$ bin/omero admin reindex --foreground
```

Re-indexing the database in off-line mode will use a 1 GB heap by default, but this can be specified on the command-line with the *--mem* argument:

```
$ bin/omero admin reindex --foreground --mem=2g
```

Other search configuration properties from *Search* can be set for the processing by setting the `JAVA_OPTS` environment variable:

```
$ JAVA_OPTS="-Domero.search.max_partition_size=100000" bin/omero admin reindex --foreground
```

Once foreground indexing is complete, re-enable the background indexer as above:

```
$ bin/omero admin reindex --finish
```

Monitoring re-indexing

During re-indexing, it is possible to estimate the percent indexed using the following SQL command:

```
omero=> select 'At ' ||  current_timestamp(0) || ', Percent indexed: ' || trunc(((select count(*) from
                  ?column?
-----------------------------------------------------
 At 2014-06-14 07:54:37+00, Percent indexed: 70.90%
(1 row)
```

This value is also logged periodically both when re-indexing in the background and the foreground and is available via JMX. See *Metrics* for more information.

The overall re-indexing performance depends significantly on the memory settings and the size of the repository to index. The following table provides estimates of the process duration based on re-indexing of existing production servers of various sizes:

Re-indexing type	Re-indexing duration	Binary repository size	Indexer memory settings
Background [18]	8h	19TB	`-Xmx4800m`
Off-line	6h30	16TB	`--mem 2g`

See also:

OMERO search Section of the developer documentation describing how to perform search queries against the server.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.5 FS configuration options

7.5.1 Background

Users import their image files to the OMERO.fs server. The contents of these files are kept intact by the server and the import process preserves the files' path and name (at least within the rules of `omero.fs.repo.path_rules` below), so that OMERO.fs can become a trusted repository for the master copy of users' data. While the default server configuration from *Configuration properties glossary* should typically suffice, `omero config set` may be used to adjust settings related to file uploads. These settings are explained below.

7.5.2 Repository location

Several properties determine where FS-imported files are stored:

- `omero.data.dir` - singleton property (i.e. once globally) which points to the legacy repository location for OMERO. For OMERO to run on multiple systems, the contents of this directory must be on a shared volume.
- `omero.managed.dir` - singleton property which points to the default `ManagedRepository`. In an OMERO install in which there is only one Blitz server, this will be the only repository. This need not be located under `omero.data.dir` but is by default.
- `omero.repo.dir` (experimental) - value passed to all non-legacy, standalone repositories. This is not actively used, but would allow hosting repositories on multiple physical systems without the need for a shared volume. For example, after running `bin/omero admin start` on the main machine, it would be possible to launch nodes on various machines via `bin/omero node start fs-B`, `bin/omero node start fs-C`, etc. Each of these would pass a different `omero.repo.dir` value to its process.

7.5.3 Template path

When files are uploaded to the managed repository, a parent directory is created to receive the upload. A multi-file image has all its files stored in the same parent directory, though they may be in different subdirectories of that parent to mirror the original directory structure before upload. The `omero.fs.repo.path` setting defines the creation of that parent directory. It is this value which makes the `ManagedRepository` "managed".

Path naming constraints

There is some flexibility in how this parent directory is named. The constraints are:

- The path components (individual directories in the path) must be separated by `/` characters, **even on Windows systems**.
- A path component separator may be written as `//` only if followed by at least one more path component. In this case:
  - The server ensures that the path components preceding the `//` are owned by the `root` user.
  - Any newly created path components following the `//` are **owned by the user** who owns the images.

[18] [ome-users] Re-indexing OMERO's search database (http://lists.openmicroscopy.org.uk/pipermail/ome-users/2015-February/005038.html)

- If no `//` is present then *all* newly created path components are **owned by the user** who owns the images.
- The path must be unique for each import. It is for this reason that the `%time%` term expands to a time with millisecond resolution.
- To avoid confusion with the expansion terms enumerated below, avoid other uses of the `%` character in path components.

In the above, ownership of path components is in the context of OMERO users accessing the OMERO managed repository through its API. It does not relate to operating system users' permissions for the underlying filesystem.

Expansion terms

Special terms may be used within path components: these are replaced with text that depends on the import.

For any directory in the template path

`%userId%` expands to the user's numerical ID

`%user%` expands to the user's name

`%institution%` expands to the user's institution name; this path component is wholly omitted if the user has no institution set

`%institution:default%` expands to the user's institution name, or to the supplied "default" if the user has no institution set; for instance, `%institution:State College of Florida, Manatee-Sarasota%` is permitted

`%groupId%` expands to the OMERO group's numerical ID

`%group%` expands to the OMERO group's name

`%perms%` expands to the group's six-character permissions string, for example `rw----` for a private group

`%year%` expands to the current year number, for example `2014`

`%month%` expands to the current month number, zero-padded, for example `08`

`%monthname%` expands to the current month name, for example `August`

`%day%` expands to the current day number in the month, zero-padded, for example `04`

`%sessionId%` expands to the session's numerical ID

`%session%` expands to the session key (UUID) of the session, for example `6c2dae43-cfad-48ce-af6f-025569f9e6df`

For user-owned directories only

These expansion terms may not precede `//` in the template path.

`%time%` expands to the current time, in hours, minutes, seconds, milliseconds, for example `13-49-07.727`

`%hash%` expands to an eight-digit hexadecimal hash code that is constant for the set of files being imported, for example `0554E3A1`

`%hash:digits%` expands as `%hash%`, where `digits` is a comma-separated list of how many digits of the hash to use in different subdirectories; for example, `hash-%hash:3,3,2%` expands to a form like `hash-123/456/78`

`%increment%` expands to an integer that increases consecutively so as to create the next new directory, for example using `inc-%increment%` with preexisting directories up to `inc-24` would expand to `inc-25`

`%increment:digits%` expands as `%increment%` where `digits` specifies a minimum length to which to zero-pad the integer, for example using `inc-%increment:3%` with preexisting directories up to `inc-024` would expand to `inc-025`

`%subdirs%` expands to nothing until the preceding directory has more than one thousand entries, in which case it expands to an integer that increases consecutively to similarly limit the entry count in subdirectories; applies recursively to extend the number of path components as needed, so, using `example/below-%subdirs%` in the path, with `example/below-000` to `example/below-999` all "full", three-digit subdirectories below those are created, such as `example/below-123/456`

%subdirs:digits% expands as %subdirs% where digits specifies to how many digits %subdirs% may expand for each path component: for example, example/%subdirs:4%-below allows ten thousand directory entries in example before creating example/1234-below and, much later, example/1234-below/5678

No more than one of either %subdirs% or %increment% may be used in any one path component, although they may each be used many times in the whole path.

7.5.4 Legal file names

Although OMERO.fs attempts to preserve file naming, the server's operating system or file system is likely to somehow constrain what file names may be stored by OMERO.fs. This is of particular concern when a user may upload from a more permissive system to a server on a less permissive system, or when it is anticipated that the server itself may be migrated to a less permissive system. The server never accepts Unicode control characters in file names.

The omero.fs.repo.path_rules setting defines the combination of restrictions that the server must apply in accepting file uploads. The restrictions are grouped into named sets:

Windows required prohibits names with the characters ", *, /, :, <, >, ?, \, |, names beginning with $, the names AUX, CLOCK$, CON, NUL, PRN, COM1 to COM9, LPT1 to LPT9, and anything beginning with one of those names followed by .

Windows optional prohibits names ending with . or a space

UNIX required prohibits names with the character /

UNIX optional prohibits names beginning with . or –

These rules are applied to each separate path component of the file name on the client's system. So, for instance, an upload of a file /tmp/myfile.tif from a Linux system would satisfy the UNIX required restrictions because neither of the path components tmp and myfile.tif contains a / character.

Applying the "optional" restrictions does not assist OMERO.fs at all; those restrictions are designed to ease manual maintenance of the directory specified by the omero.managed.dir setting, being where the server stores users' uploaded files.

7.5.5 Checksum algorithm

As the client uploads each file to the server, it calculates a checksum for the file. After the upload is complete the client reports that checksum to the server. The server then calculates the checksum for the corresponding file from its local filesystem and checks that it matches what the client reported. **File integrity** is thus **assured** because corruption during transmission or writing would be revealed by a checksum mismatch.

There are various algorithms by which checksums may be calculated. The list of available algorithms is given by omero.checksum.supported. To calculate comparable checksums the client and server use the same algorithm. The server API permits clients to specify the algorithm, but it is expected that they will typically accept the server default.

The number that suffixes each of the checksum algorithm names specifies the bit width of the resulting checksum. A larger bit width makes it less likely that different files will have the same checksum by coincidence, but lengthens the checksum hex strings that are reported to the user and stored in the hash column of the originalfile table in the database.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.6 Grid configuration

In some cases, the configuration properties will not suffice to fully configure your server. In that case, it may be necessary to make use of IceGrid's XML configuration files. Like the config.xml file mentioned above, these are stored under etc/grid: etc/grid/default.xml is used on Unix systems, etc/grid/windefault.xml is used on Windows systems and both make use of etc/grid/templates.xml.

The default OMERO application descriptor deploys multiple server instances (Blitz-0, FileServer, Indexer-0, PixelData-0, ...) on a single node. Each server instance is defined by a server-template element in etc/grid/templates.xml with its own parameters.

7.6.1 Modifying the application descriptors

When you run `omero admin start` without any other arguments, it looks up the default **application descriptor** for your platform:

```
$ bin/omero admin start
No descriptor given. Using etc/grid/default.xml
Waiting on startup. Use CTRL-C to exit
```

The "start" and "deploy" command, however, take several other parameters:

```
$ bin/omero admin start --help
usage: bin/omero admin start [-h] [-u USER] [file] [targets [targets ...]]

Start icegridnode daemon and waits for required components to come up,
i.e. status == 0

If the first argument can be found as a file, it will be deployed as the
application descriptor rather than etc/grid/default.xml. All other
arguments will be used as targets to enable optional sections of the
descriptor

Positional Arguments:
  file                  Application descriptor. If not provided, a default will be used
  targets                Targets within the application descriptor which should be activated.
```

If a file is passed in as the first argument, then that **application descriptor** as opposed to `etc/grid/default.xml` will be used. You can also modify the default application descriptors in place.

Note: The largest issue with using your own application descriptors or modifying the existing ones is that they tend to change between versions, and there is no facility for automatically merging your local changes. You should be prepared to re-make whatever changes you perform directly on the new files.

7.6.2 Targets

Targets are elements within the application descriptors which can optionally turn on configuration. The target is only applicable until the next invocation of `omero admin start` or `omero admin deploy`

Note: You must remember to always apply the targets on each `omero admin` command. If not, the target will not be removed. Therefore, they are often better used for debugging purposes; however, as opposed to alternative application descriptors, using the pre-existing targets should not require any special effort during upgrades.

Debugging

```
<properties id="PythonServer">
  <property name="Ice.ImplicitContext" value="Shared"/>
  <!-- Default logging settings for Python servers. -->
  <property name="omero.logging.timedlog" value="False"/>
  <property name="omero.logging.logsize" value="5000000"/>
  <property name="omero.logging.lognum" value="9"/>
  <property name="omero.logging.level" value="20"/>
  <target name="debug">
    <property name="omero.logging.level" value="10"/>
  </target>
```

Here, the "debug" target allows increasing the logging output of the Python servers without modifying any files.

JMX configuration

```
<server-template id="BlitzTemplate">
  <parameter name="index"/>
  <parameter name="config" default="default"/>
  <parameter name="jmxhost" default=""/>
  <parameter name="jmxport" default="3001"/>
   …
    <target name="jmx">
        <!-- Be sure to understand the consequences of enabling JMX.
             It allows calling remote methods on your JVM -->
        <option>-Dcom.sun.management.jmxremote=${jmxhost}</option>
        <option>-Dcom.sun.management.jmxremote.port=${jmxport}</option>
        <option>-Dcom.sun.management.jmxremote.authenticate=false</option>
        <option>-Dcom.sun.management.jmxremote.ssl=false</option>
    </target>
```

The JMX target activates the monitoring of the Blitz server via JMX. If you need to modify the "jmxport" or "jmxhost" variables, you will need to do so directly in the application descriptor XML.

7.6.3 Changing ports / multiple servers on a single host

By modifying the default OMERO ports, it is possible to run multiple OMERO servers on the same physical machine. All port numbers can be adjusted using the relevant *configuration properties*.

To run multiple servers on a single host, the easiest approach is to prefix all ports (SSL, TCP, registry) using `omero.ports.prefix`:

```
# First server
cd ~/OMERO.server-1
bin/omero admin start

# Second server
cd ~/OMERO.server-2
bin/omero config set omero.ports.prefix 1
bin/omero admin start

# Third server
cd ~/OMERO.server-3
bin/omero config set omero.ports.prefix 2
bin/omero admin start
```

Clients will need to use the appropriate port (4064, 14064 or 24064) to connect to OMERO.

See also:

SSL Section of the *Server security and firewalls* page.

7.6.4 Extending OMERO

Finally, if configuration does not suffice, there are also options for extending OMERO with your own code. These are described on the development site under *Extending OMERO.server*.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.7 Setting the OMERO_HOME environment variable

Warning: `OMERO_HOME` should be considered strictly *internal* to OMERO and be reserved for development or "power usage".

7.7.1 Rationale

`OMERO_HOME` defines the root deployment directory to be used by OMERO command line tools.

Setting it allows to switch between different versions of applications or libraries during development.

Note: Despite a familiar-sounding name, `OMERO_HOME` does **not** denote the server installation directory.

7.7.2 Caveats

As a "power switch", `OMERO_HOME` will override the directory layout as detected by the *bin/omero* family of utilities.

This could cause hard-to-detect problems at runtime. Environments hosting multiple OMERO versions would be particularly prone to such side effects, as illustrated below.

```
# Installation directory layout:
# /opt
#   +-- OMERO.server-version-4.4.10
#   +-- OMERO.server-version-5.0.0

# OMERO-4 was first installed, and is conveniently referenced through OMERO_HOME
$ echo $OMERO_HOME
> /opt/OMERO.server-version-4.4.10

# Update the configuration for OMERO-4
$ /opt/OMERO.server-version-4.4.10/bin/omero config set omero.db.name 'omero_4_database'
$ /opt/OMERO.server-version-4.4.10/bin/omero config get omero.db.name
> omero_4_database

# Update the configuration for OMERO-5
$ /opt/OMERO.server-version-5.0.0/bin/omero config set omero.db.name 'omero_5_database'
$ /opt/OMERO.server-version-5.0.0/bin/omero config get omero.db.name
> omero_5_database

# Double check the OMERO-4 configuration...
# Using OMERO_HOME has taken precedence over the current directory
# The OMERO-4 server instance has been mistakenly updated to point at
# a version 5 database schema.
# Furthermore, the issue might go unnoticed until the next OMERO-4 restart.
$ /opt/OMERO.server-version-4.4.10/bin/omero config get omero.db.name
> omero_5_database
```

7.7.3 Recommendations

- If you are using an environment variable to define the server installation root, choose a different name, as represented by `OMERO_PREFIX` in this documentation.
- If you are nevertheless using `OMERO_HOME` in your **local** environment, it is worth checking for potentially lingering global definitions (eg. *.bashrc*, *.profile*, */etc/profile.d*).

See also:

OMERO.server installation

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.8 Configuration properties glossary

7.8.1 Introduction

The primary form of configuration is via the use of key/value properties, stored in `etc/grid/config.xml` and read on server startup. Backing up and copying these properties is as easy as copying this file to a new server version.

The etc/omero.properties[19] file of your distribution defines all the default configuration properties used by the server. Changes made to the file are *not* recognized by the server. Instead, configuration options can be set using the `omero config set` command:

```
$ bin/omero config set <parameter> <value>
```

When supplying a value with spaces or multiple elements, use **single quotes**. The quotes will not be saved as part of the value (see below).

To remove a configuration option (to return to default values where mentioned), simply omit the value:

```
$ bin/omero config set <parameter>
```

These options will be stored in a file: `etc/grid/config.xml` which you can read for reference. **DO NOT** edit this file directly.

You can also review all your settings by using:

```
$ bin/omero config get
```

which should return values without quotation marks.

A final useful option of `omero config edit` is:

[19] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/omero.properties

```
$ bin/omero config edit
```

which will allow for editing the configuration in a system-default text editor.

Note: Please use the **escape sequence** `\"` for nesting double quotes (e.g. `"[\"foo\", \"bar\"]"`) or wrap with `'` (e.g. `'["foo", "bar"]'`).

Examples of doing this are on the main *Unix* and *Windows* pages, as well as the *LDAP installation* page.

7.8.2 Mandatory properties

The following properties need to be correctly set for all installations of the OMERO.server. Depending on your set-up, default values may be sufficient.

- `omero.data.dir`
- `omero.db.host`
- `omero.db.name`
- `omero.db.pass`

7.8.3 Binary repository

omero.checksum.supported

Checksum algorithms supported by the server for new file uploads, being any comma-separated non-empty subset of:

- Adler-32
- CRC-32
- MD5-128
- Murmur3-32
- Murmur3-128
- SHA1-160
- File-Size-64

In negotiation with clients, this list is interpreted as being in descending order of preference.

Default: *SHA1-160, MD5-128, Murmur3-128, Murmur3-32, CRC-32, Adler-32, File-Size-64*

omero.data.dir

Default: */OMERO/*

omero.fs.repo.path

Template for FS managed repository paths. Allowable elements are:

```
%user%          bob
%userId%        4
%group%         bobLab
%groupId%       3
%year%          2011
%month%         01
%monthname%     January
```

```
%day%           01
%time%          15-13-54.014
%institution%   University of Dundee
%hash%          0D2D8DB7
%increment%     14
%subdirs%       023/613
%session%       c3fdd5d8-831a-40ff-80f2-0ba5baef448a
%sessionId%     592
%perms%         rw----
/               path separator
//              end of root-owned directories
```

These are described further at *FS configuration options*

The path must be unique per fileset to prevent upload conflicts, which is why %time% includes milliseconds.

A // may be used as a path separator: the directories preceding it are created with root ownership, the remainder are the user's. At least one user-owned directory must be included in the path.

The template path is created below `omero.managed.dir`, e.g. `/OMERO/ManagedRepository/$omero.fs.repo.path/`

Default: *%user%_%userId%//%year%-%month%/%day%/%time%*

omero.fs.repo.path_rules

Rules to apply to judge the acceptability of FS paths for writing into `omero.managed.dir`, being any comma-separated non-empty subset of:

- Windows required
- Windows optional
- UNIX required
- UNIX optional
- local required
- local optional

Minimally, the "required" appropriate for the server is recommended. Also applying "optional" rules may make sysadmin tasks easier, but may be more burdensome for users who name their files oddly. "local" means "Windows" or "UNIX" depending on the local platform, the latter being applied for Linux and Mac OS X.

Default: *Windows required, UNIX required*

omero.managed.dir

Default: *${omero.data.dir}/ManagedRepository*

7.8.4 Client

omero.client.download_as.max_size

Clients disable download as jpg/png/tiff above max pixel count.

Default: *144000000*

omero.client.scripts_to_ignore

Server-side scripts used in IScript service Clients shouldn't display.

Default: */omero/figure_scripts/Movie_Figure.py, /omero/figure_scripts/Split_View_Figure.py, /omero/figure_scripts/Thumbnail_Figure.py, /omero/figure_scripts/ROI_Split_Figure.py, /omero/export_scripts/Make_Movie.py, /omero/setup_scripts/FLIM_initialise.py, /omero/import_scripts/Populate_ROI.py*

omero.client.ui.menu.dropdown.colleagues.enabled

Flag to show/hide colleagues

Default: *true*

omero.client.ui.menu.dropdown.colleagues.label

Client dropdown menu colleagues label.

Default: *${omero.client.ui.menu.dropdown.colleagues}*

omero.client.ui.menu.dropdown.everyone.enabled

Flag to show/hide all users.

Default: *true*

omero.client.ui.menu.dropdown.everyone.label

Client dropdown menu all users label.

Default: *${omero.client.ui.menu.dropdown.everyone}*

omero.client.ui.menu.dropdown.leaders.enabled

Flag to show/hide leader.

Default: *true*

omero.client.ui.menu.dropdown.leaders.label

Client dropdown menu leader label.

Default: *${omero.client.ui.menu.dropdown.leaders}*

omero.client.ui.tree.orphans.description

Description of the "Orphaned images" container.

Default: *This is a virtual container with orphaned images. These images are not linked anywhere. Just drag them to the selected container.*

omero.client.ui.tree.orphans.enabled

Flag to show/hide "Orphaned images" container. Only accept "true" or "false"

Default: *true*

omero.client.ui.tree.orphans.name

Name of the "Orphaned images" container located in client tree data manager.

Default: *Orphaned Images*

omero.client.viewer.initial_zoom_level

Initial client image viewer zoom level for big images

Default: *0*

omero.client.viewer.interpolate_pixels

Client viewers interpolate pixels by default.

Default: *true*

omero.client.viewer.roi_limit

Client viewers roi limit.

Default: *2000*

omero.client.web.host

Absolute omeroweb host http(s)://your_domain/prefix/

Default: *[empty]*

7.8.5 Database

omero.db.authority

The string that will be used as the base for LSIDs in all exported OME objects including OME-XML and OME-TIFF. It's usually not necessary to modify this value since the database UUID (stored in the database) is sufficient to uniquely identify the source.

Default: *export.openmicroscopy.org*

omero.db.dialect

Implementation of the org.hibernate.dialect.Dialect interface which will be used to convert HQL queries and save operations into SQL SELECTs and DML statements.

(PostgreSQL default)

Default: *ome.util.PostgresqlDialect*

omero.db.driver

JDBC driver used to access the database. Other drivers can be configured which wrap this driver to provide logging, monitoring, etc.

(PostgreSQL default)

Default: *org.postgresql.Driver*

omero.db.host

The host name of the machine on which the database server is running. A TCP port must be accessible from the server on which OMERO is running.

Default: *localhost*

omero.db.name

The name of the database instance to which OMERO will connect.

Default: *omero*

omero.db.pass

The password to use to connect to the database server

Default: *omero*

omero.db.patch

The patch version of the database which is in use. This value need not match the patch version of the server that is is being used with. Any changes by developers to the database schema will result in a bump to this value.

Default: *0*

omero.db.poolsize

Sets the number of database server connections which will be used by OMERO. Your database installation will need to be configured to accept *at least* as many, preferably more, connections as this value.

Default: *10*

omero.db.port

TCP port on which the database server is listening for connections. Used by the JDBC driver to access the database. Use of a local UNIX socket is not supported.

(PostgreSQL default)

Default: *5432*

omero.db.prepared_statement_cache_size

Default: *10*

omero.db.profile

Default values for the current profile will be hard-coded into the hibernate.properties file in the *model-*.jar*. By using a different jar, you can modify the defaults.

Note: some other properties are defined in the file `etc/profiles/$omero.db.profile` Especially of importance is `omero.db.port`

Default: *psql*

omero.db.sql_action_class

Implementation of the ome.util.SqlAction interface which will be used to perform all direct SQL actions, i.e. without Hibernate.

(PostgreSQL default)

Default: *ome.util.actions.PostgresSqlAction*

omero.db.statistics

Whether JMX statistics are collected for DB usage (by Hibernate, etc)

Default: *true*

omero.db.user

The username to use to connect to the database server

Default: *omero*

omero.db.version

Version of the database which is in use. This value typically matches the major.minor version of the server that it is being used with. Typically, only developers will change this version to bump to a new major version.

Default: *OMERO5.2*

7.8.6 Grid

omero.cluster.read_only

Default: *false*

omero.cluster.redirector

Default: *nullRedirector*

omero.grid.registry_timeout

registry_timeout is the milliseconds which the registry and other services will wait on remote services to respond.

Default: *5000*

7.8.7 Ice

Ice.IPv6

Disable IPv6 by setting to 0. Only needed in certain situations.

Default: *1*

7.8.8 JVM

omero.jvmcfg.append

Contains other parameters which should be passed to the JVM. The value of "append" is treated as if it were on the command-line and so will be separated on whitespace. For example, '-XX:-PrintGC -XX:+UseCompressedOops' would results in two new arguments.

Default: *[empty]*

omero.jvmcfg.heap_dump

Toggles on or off heap dumps on OOMs. Default is "off". The special value "tmp" will create the heap dumps in your temp directory.

Default: *[empty]*

omero.jvmcfg.heap_size

Explicit value for the *-Xmx* argument, e.g. "1g"

Default: *[empty]*

omero.jvmcfg.max_system_memory

Suggestion for strategies as to the maximum memory that they will use for calculating JVM settings (MB).

Default: *48000*

omero.jvmcfg.min_system_memory

Suggestion for strategies as to the minimum memory that they will use for calculating JVM settings (MB).

Default: *3414*

omero.jvmcfg.percent

Used only by the percent strategy. An integer between 0 and 100 which is the percent of active memory that will be used by the service.

Default: *[empty]*

omero.jvmcfg.perm_gen

Explicit value for the MaxPermSize argument to the JVM, e.g. "500M". Ignored for Java8+

Default: *[empty]*

omero.jvmcfg.strategy

Memory strategy which will be used by default. Options include: percent, manual

Default: *percent*

omero.jvmcfg.system_memory

Manual override of the total system memory that OMERO will *think* is present on the local OS (MB). If unset, an attempt will be made to detect the actual amount: first by using the Python library *psutil* and if that is not installed, by running a Java tool. If neither works, 4.0GB is assumed.

Default: *[empty]*

7.8.9 LDAP

omero.ldap.base

LDAP server base search DN, i.e. the filter that is applied to all users. (can be empty in which case any LDAP user is valid)

Default: *ou=example, o=com*

omero.ldap.config

Enable or disable LDAP (*true* or *false*).

Default: *false*

omero.ldap.group_filter

Default: *(objectClass=groupOfNames)*

omero.ldap.group_mapping

Default: *name=cn*

omero.ldap.new_user_group

Without a prefix the "new_user_group" property specifies the name of a single group which all new users will be added to. Other new_user_group strings are prefixed with `:x:` and specify various lookups which should take place to find one or more target groups for the new user.

`:ou:` uses the final organizational unit of a user's dn as the single OMERO group e.g. `omero.ldap.new_user_group=:ou:`

`:attribute:` uses all the values of the specified attribute as the name of multiple OMERO groups. e.g. `omero.ldap.new_user_group=:attribute:memberOf`

Like `:attribute:`, `:filtered_attribute:` uses all the values of the specified attribute as the name of multiple OMERO groups but the attribute must pass the same filter as `:query:` does. e.g. `omero.ldap.new_user_group=:filtered_attribute:memberOf`

Similar to `:attribute:`, `:dn_attribute:` uses all the values of the specified attribute as the DN of multiple OMERO groups. e.g. `omero.ldap.new_user_group=:dn_attribute:memberOf`

A combination of filtered_attribute and dn_attribute, `:filtered_dn_attribute:` uses all of the values of the specified attribute as the DN of multiple OMERO groups but the attribute must pass the same filter as `:query:` e.g. `omero.ldap.new_user_group=:filtered_dn_attribute:memberOf`

`:query:` performs a query for groups. The "name" property will be taken as defined by omero.ldap.group_mapping and the resulting filter will be AND'ed with the value group_filter (above) e.g. `omero.ldap.new_user_group=:query:(member=@{dn})`

`:bean:` looks in the server's context for a bean with the given name which implements `ome.security.auth.NewUserGroupBean` e.g. `omero.ldap.new_user_group=:bean:myNewUserGroupMapperBean`

Default: *default*

omero.ldap.new_user_group_owner

A query element to check if user who is being created via the new_user_group setting should be made a "manager", i.e. owner, of the queried group. E.g. `omero.ldap.new_user_group_owner=(owner=@{dn})` will use the 'manager' attribute to set the 'owner' flag in the database. This query element is appened to any query used by new_user_group with an AND.

This property is not used by new_user_group type 'default' and only potentially by `:bean:`.

Default: *[empty]*

omero.ldap.password

LDAP server bind password (if required; can be empty)

Default: *[empty]*

omero.ldap.referral

Available referral options are: “ignore”, “follow”, or “throw” as per the JNDI referral documentation.

Default: *ignore*

omero.ldap.sync_on_login

Whether or not values from LDAP will be synchronized to OMERO on each login. This includes not just the username, email, etc, but also the groups that the user is a member of.

Note: Admin actions carried out in the clients may not survive this synchronization e.g. LDAP users removed from an LDAP group in the UI will be re-added to the group when logging in again after the synchronization.

Default: *false*

omero.ldap.urls

Set the URL of the LDAP server. A SSL URL for this property would be of the form: ldaps://ldap.example.com:636

Default: *ldap://localhost:389*

omero.ldap.user_filter

Default: *(objectClass=person)*

omero.ldap.user_mapping

Default: *omeName=cn, firstName=givenName, lastName=sn, email=mail, institution=department, middleName=middleName*

omero.ldap.username

LDAP server bind DN (if required; can be empty)

Default: *[empty]*

7.8.10 Mail

omero.mail.bean

Mail sender properties

Default: *defaultMailSender*

omero.mail.config

Enable or disable mail sender (*true* or *false*).

Default: *false*

omero.mail.from

the email address used for the “from” field

Default: *omero@${omero.mail.host}*

omero.mail.host

the hostname of smtp server

Default: *localhost*

omero.mail.password

the password to connect to the smtp server (if required; can be empty)

Default: *[empty]*

omero.mail.port

the port of smtp server

Default: *25*

omero.mail.smtp.auth

see javax.mail.Session properties

Default: *false*

omero.mail.smtp.connectiontimeout

Default: *60000*

omero.mail.smtp.debug

Default: *false*

omero.mail.smtp.socketFactory.class

Default: *javax.net.SocketFactory*

omero.mail.smtp.socketFactory.fallback

Default: *false*

omero.mail.smtp.socketFactory.port

Default: *${omero.mail.port}*

omero.mail.smtp.starttls.enable

Default: *false*

omero.mail.smtp.timeout

Default: *60000*

omero.mail.transport.protocol

other smtp parameters; see org.springframework.mail.javamail.JavaMailSenderImpl

Default: *smtp*

omero.mail.username

the username to connect to the smtp server (if required; can be empty)

Default: *[empty]*

7.8.11 Metrics

omero.metrics.bean

Which bean to use: nullMetrics does nothing defaultMetrics uses the properties defined below

Default: *defaultMetrics*

omero.metrics.graphite

Address for Metrics to send server data

Default: *[empty]*

omero.metrics.slf4j_minutes

Number of minutes to periodically print to slf4j 0 or lower disables the printout.

Default: *60*

7.8.12 Performance

omero.sessions.maximum

Default: *0*

omero.sessions.sync_force

Default: *1800000*

omero.sessions.sync_interval

Default: *120000*

omero.sessions.timeout

Sets the duration of inactivity in milliseconds after which a login is required.

Default: *600000*

omero.threads.cancel_timeout

Default: *5000*

omero.threads.idle_timeout

Default: *5000*

omero.threads.max_threads

Default: *50*

omero.threads.min_threads

Default: *5*

omero.throttling.method_time.error

Time in milliseconds after which a single method invocation will print a ERROR statement to the server log. If ERRORs are frequently being printed to your logs, you may want to increase this value after checking that no actual problem exists. Values of more than 60000 (1 minute) are not advised.

Default: *20000*

omero.throttling.method_time.error.indexer

Value for the indexer is extended to 1 day

Default: *86400000*

omero.throttling.method_time.warn

Time in milliseconds after which a single method invocation will print a WARN statement to the server log.

Default: *5000*

omero.throttling.method_time.warn.indexer

Value for the indexer is extended to 1 hour

Default: *3600000*

omero.throttling.objects_read_interval

Default: *1000*

omero.throttling.objects_written_interval

Default: *1000*

omero.throttling.servants_per_session

Default: *10000*

7.8.13 Pixeldata

omero.pixeldata.backoff

Name of the spring bean which will be used to calculate the backoff (in ms) that users should wait for an image to be ready to view.

Default: *ome.io.nio.SimpleBackOff*

omero.pixeldata.batch

Number of instances indexed per indexing. (Ignored by pixelDataEventLogQueue)

Default: *50*

omero.pixeldata.cron

Polling frequency of the pixeldata processing. Set empty to disable pixeldata processing.

Cron Format: seconds minutes hours day-of-month month day-of-week year (optional). For example, "0,30 * * * * ?" is equivalent to running every 30 seconds. For more information download the latest *1.x version* of the Quartz Job Scheduler[20] and review `docs/api/org/quartz/CronExpression.html` within the distribution.

Default: **/4 * * * * ?*

omero.pixeldata.dispose

Whether the PixelData.dispose() method should try to clean up ByteBuffer instances which may lead to memory exceptions. See ticket #11675 for more information. Note: the property is set globally for the JVM.

Default: *true*

omero.pixeldata.event_log_loader

EventLogLoader that will be used for loading EventLogs for the action "PIXELDATA". Choices include: pixelDataEventLogQueue and the older pixelDataPersistentEventLogLoader

Default: *pixelDataEventLogQueue*

omero.pixeldata.max_plane_height

Default: *3192*

omero.pixeldata.max_plane_width

Default: *3192*

omero.pixeldata.memoizer_wait

Maximum time in milliseconds that file parsing can take without the parsed metadata being cached to BioFormatsCache.

Default: *0*

[20] http://www.quartz-scheduler.org/downloads/

omero.pixeldata.repetitions

Instead, it is possible to tell the server to run more pixeldata repetitions, each of which gets completely committed before the next. This will only occur when there is a substantial backlog of pixels to process.

(Ignored by pixelDataEventLogQueue; uses threads instead)

Default: *1*

omero.pixeldata.threads

How many pixel pyramids will be generated at a single time. The value should typically not be set to higher than the number of cores on the server machine.

Default: *2*

omero.pixeldata.tile_height

Default: *256*

omero.pixeldata.tile_sizes_bean

Default sizes for tiles are provided by a ome.io.nio.TileSizes implementation. By default the bean ("configuredTileSizes") uses the properties provided here.

Default: *configuredTileSizes*

omero.pixeldata.tile_width

Default: *256*

7.8.14 Policy

omero.policy.bean

Instance of the PolicyService interface which will be responsible for checking certain server actions made by a user.

Default: *defaultPolicyService*

omero.policy.binary_access

Configuration for the policy of whether users can access binary files from disk. Binary access includes all attempts to download a file from the UI.

The individual components of the string include:

- write - whether or not users who have WRITE access to the objects can access the binary. This includes group and system administrators.
- read - whether or not users who have READ access to the objects can access the binary.
- image - whether or not images are to be considered accessible as a rule.
- plate - whether or not plates and contained HCS objects are to be considered accessible as a rule. This includes wells, well samples, and plate runs.

Though the order of the components of the property are not important, the order that they are listed above roughly corresponds to their priority. E.g. a -write value will override +plate.

Example 1: "-read,+write,+image,-plate" only owners of an image and admins can download it.

Example 2: "-read,-write,-image,-plate" no downloading is possible.

Configuration properties of the same name can be applied to individual groups as well. E.g. adding, omero.policy.binary_access=-read to a group, you can prevent group-members from downloading original files.

Configuration is pessimistic: if there is a negative *either* on the group *or* at the server-level, the restriction will be applied. A missing value at the server restricts the setting but allows the server to override.

Default: *+read, +write, +image*

7.8.15 Ports

omero.ports.prefix

The prefix to apply to all port numbers (SSL, TCP, registry) used by the server

Default: *[empty]*

omero.ports.registry

The IceGrid registry port number to use

Default: *4061*

omero.ports.ssl

The Glacier2 SSL port number to use

Default: *4064*

omero.ports.tcp

The Glacier2 TCP port number to use

Default: *4063*

7.8.16 Scripts

omero.launcher.jython

Executable on the PATH which will be used for scripts with the mimetype 'text/x-jython'.

Default: *jython*

omero.launcher.matlab

Executable on the PATH which will be used for scripts with the mimetype 'text/x-matlab'.

Default: *matlab*

omero.launcher.python

Executable on the PATH which will be used for scripts with the mimetype 'text/x-python'.

No value implies use sys.executable

Default: *[empty]*

omero.process.jython

Server implementation which will be used for scripts with the mimetype 'text/x-jython'. Changing this value requires that the appropriate class has been installed on the server.

Default: *omero.processor.ProcessI*

omero.process.matlab

Server implementation which will be used for scripts with the mimetype 'text/x-matlab'. Changing this value requires that the appropriate class has been installed on the server.

Default: *omero.processor.MATLABProcessI*

omero.process.python

Server implementation which will be used for scripts with the mimetype 'text/x-python'. Changing this value requires that the appropriate class has been installed on the server.

Default: *omero.processor.ProcessI*

omero.scripts.cache.cron

Frequency to reload script params. By default, once a day at midnight.

Cron Format: seconds minutes hours day-of-month month day-of-week year (optional). For example, "0,30 * * * * ?" is equivalent to running every 30 seconds. For more information download the latest *1.x version* of the Quartz Job Scheduler[21] and review `docs/api/org/quartz/CronExpression.html` within the distribution.

Default: *0 0 0 * * ?*

omero.scripts.cache.spec

Guava LoadingCache spec for configuring how many script JobParams will be kept in memory for how long.

For more information, see http://google.github.io/guava/releases/17.0/api/docs/com/google/common/cache/CacheBuilderSpec.html

Default: *maximumSize=1000*

omero.scripts.timeout

Default: *3600000*

7.8.17 Search

omero.search.analyzer

Analyzer used both index and to parse queries

Default: *ome.services.fulltext.FullTextAnalyzer*

omero.search.batch

Size of the batches to process events per indexing. Larger batches can speed up indexing, but at the cost of memory.

Default: *5000*

[21] http://www.quartz-scheduler.org/downloads/

omero.search.bridges

Extra bridge classes, comma-separated, to be invoked on each indexing. Bridges are used to parse more information out of the data.

Default: *[empty]*

omero.search.cron

Polling frequency of the indexing. Set empty to disable search indexing.

Cron Format: seconds minutes hours day-of-month month day-of-week year (optional). For example, "0,30 * * * * ?" is equivalent to running every 30 seconds. For more information download the latest *1.x version* of the Quartz Job Scheduler[22] and review `docs/api/org/quartz/CronExpression.html` within the distribution.

Default: **/2 * * * * ?*

omero.search.event_log_loader

Default: *eventLogQueue*

omero.search.excludes

Indexing takes place on all EventLogs as they occur in the database. The types listed here will be skipped if they appear in the "entityType" field of the EventLog table.

Default: *ome.model.annotations.ChannelAnnotationLink, ome.model.core.Channel, ome.model.core.PlaneInfo, ome.model.core.PixelsOriginalFileMap, ome.model.containers.DatasetImageLink, ome.model.containers.ProjectDatasetLink, ome.model.containers.CategoryGroupCategoryLink, ome.model.containers.CategoryImageLink, ome.model.display.ChannelBinding, ome.model.display.QuantumDef, ome.model.display.Thumbnail, ome.model.meta.Share, ome.model.meta.Event, ome.model.meta.EventLog, ome.model.meta.GroupExperimenterMap, ome.model.meta.Node, ome.model.meta.Session, ome.model.annotations.RoiAnnotationLink, ome.model.roi.Roi, ome.model.roi.Shape, ome.model.roi.Text, ome.model.roi.Rectangle, ome.model.roi.Mask, ome.model.roi.Ellipse, ome.model.roi.Point, ome.model.roi.Path, ome.model.roi.Polygon, ome.model.roi.Polyline, ome.model.roi.Line, ome.model.screen.ScreenAcquisitionWellSampleLink, ome.model.screen.ScreenPlateLink, ome.model.screen.WellReagentLink, ome.model.stats.StatsInfo*

omero.search.include_actions

EventLog.action values which will be indexed. Unless custom code is generating other action types, this property should not need to be modified.

Default: *INSERT, UPDATE, REINDEX, DELETE*

omero.search.include_types

Whitelist of object types which will be indexed. All other types will be ignored. This matches the currently available UI options but may need to be expanded for custom search bridges.

Default: *ome.model.core.Image, ome.model.containers.Project, ome.model.containers.Dataset, ome.model.screen.Plate, ome.model.screen.Screen, ome.model.screen.PlateAcquisition*

omero.search.locking_strategy

Default: *native*

[22] http://www.quartz-scheduler.org/downloads/

omero.search.max_file_size

Maximum file size for text indexing (bytes) If a file larger than this is attached, e.g. to an image, the indexer will simply ignore the contents of the file when creating the search index. This should not be set to more than half of the Indexer heap space.

Note: If you set the max file size to greater than 1/2 the size of the indexer's heap (256 MB by default), you may encounter Out of Memory errors in the Indexer process or you may cause the search index to become corrupt. Be sure that you also increase the heap size accordingly (see *OutOfMemoryError / PermGen space errors in OMERO.server logs*).

Default: *131072000*

omero.search.max_partition_size

Number of objects to load in a single indexing window. The larger this value the fewer times a single object will be indexed unnecessarily. Each object uses roughly 100 bytes of memory.

Default: *1000000*

omero.search.maxclause

Maximum number of OR-clauses to which a single search can expand

Default: *4096*

omero.search.merge_factor

Default: *25*

omero.search.ram_buffer_size

Default: *64*

omero.search.repetitions

Instead, it is possible to tell the server to run more indexing repetitions, each of which gets completely committed before the next. This will only occur when there is a substantial backlog of searches to perform. (More than 1 hours worth)

Default: *1*

omero.search.reporting_loops

Periodically the completion percentage will be printed. The calculation can be expensive and so is not done frequently.

Default: *100*

7.8.18 Security

omero.security.chmod_strategy

Default: *groupChmodStrategy*

omero.security.filter.bitand

Default: *(int8and(permissions, %s) = %s)*

omero.security.keyStore

A keystore is a database of private keys and their associated X.509 certificate chains authenticating the corresponding public keys. A keystore is mostly needed if you are doing client-side certificates for authentication against your LDAP server.

Default: *[empty]*

omero.security.keyStorePassword

Sets the password of the keystore

Default: *[empty]*

omero.security.login_failure_throttle_count

Default: *1*

omero.security.login_failure_throttle_time

Default: *3000*

omero.security.password_provider

Implementation of PasswordProvider that will be used to authenticate users. Typically, a chained password provider will be used so that if one form of authentication (e.g. LDAP) does not work, other attempts will be made.

Default: *chainedPasswordProvider*

omero.security.password_required

Controls whether the server will allow creation of user accounts with an empty password. If set to true (default, strict mode), empty passwords are disallowed. This still allows the guest user to interact with the server.

Default: *true*

omero.security.trustStore

A truststore is a database of trusted entities and their associated X.509 certificate chains authenticating the corresponding public keys. The truststore contains the Certificate Authority (CA) certificates and the certificate(s) of the other party to which this entity intends to send encrypted (confidential) data. This file must contain the public key certificates of the CA and the client's public key certificate.

Default: *[empty]*

omero.security.trustStorePassword

Sets the password of the truststore

Default: *[empty]*

7.8.19 Web

omero.web.admins

A list of people who get code error notifications whenever the application identifies a broken link or raises an unhandled exception that results in an internal server error. This gives the administrators immediate notification of any errors, see *OMERO.mail*. Example:`'[["Full Name", "email address"]]'`.

Default: *[]*

omero.web.application_server

OMERO.web is configured to run in Gunicorn as a generic WSGI application by default. If you are using Apache change this to "wsgi" before generating your web server configuration. Available options: "wsgi-tcp" (Gunicorn), "wsgi" (Apache)

Default: *wsgi-tcp*

omero.web.application_server.host

Upstream application host

Default: *127.0.0.1*

omero.web.application_server.max_requests

The maximum number of requests a worker will process before restarting.

Default: *0*

omero.web.application_server.port

Upstream application port

Default: *4080*

omero.web.apps

Add additional Django applications. For example, see *Creating an app*

Default: *[]*

omero.web.caches

OMERO.web offers alternative session backends to automatically delete stale data using the cache session store backend, see Django cached session documentation[23] for more details.

Default: *{"default": {"BACKEND": "django.core.cache.backends.dummy.DummyCache"}}*

omero.web.chunk_size

Size, in bytes, of the "chunk"

Default: *1048576*

omero.web.databases

Default: *{}*

omero.web.debug

A boolean that turns on/off debug mode.

Default: *false*

[23] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#using-cached-sessions

omero.web.index_template

Define template used as an index page `http://your_host/omero/`.If None user is automatically redirected to the login page.For example use 'webclient/index.html'.

Default: *None*

omero.web.logdir

A path to the custom log directory.

Default: */home/omero/OMERO.server/var/log*

omero.web.login_logo

Customize webclient login page with your own logo. Logo images should ideally be 150 pixels high or less and will appear above the OMERO logo. You will need to host the image somewhere else and link to it with `"http://www.openmicroscopy.org/site/logo.jpg"`.

Default: *None*

omero.web.login_redirect

Redirect to the given location after logging in. It only supports arguments for Django reverse function[24]. For example: `'{"redirect": ["webindex"], "viewname": "load_template", "args":["userdata"], "query_string": "experimenter=-1"}'`

Default: *{}*

omero.web.login_view

Default: *weblogin*

omero.web.page_size

Number of images displayed within a dataset or 'orphaned' container to prevent from loading them all at once.

Default: *200*

omero.web.ping_interval

Timeout interval between ping invocations in seconds

Default: *60000*

omero.web.pipeline_css_compressor

Compressor class to be applied to CSS files. If empty or None, CSS files won't be compressed.

Default: *None*

omero.web.pipeline_js_compressor

Compressor class to be applied to JavaScript files. If empty or None, JavaScript files won't be compressed.

Default: *None*

[24] https://docs.djangoproject.com/en/1.8/ref/urlresolvers/#django.core.urlresolvers.reverse

omero.web.pipeline_staticfile_storage

The file storage engine to use when collecting static files with the collectstatic management command. See the documentation[25] for more details.

Default: *pipeline.storage.PipelineStorage*

omero.web.prefix

Used as the value of the SCRIPT_NAME environment variable in any HTTP request.

Default: *None*

omero.web.public.cache.enabled

Default: *false*

omero.web.public.cache.key

Default: *omero.web.public.cache.key*

omero.web.public.cache.timeout

Default: *86400*

omero.web.public.enabled

Enable and disable the OMERO.web public user functionality.

Default: *false*

omero.web.public.password

Password to use during authentication.

Default: *None*

omero.web.public.server_id

Server to authenticate against.

Default: *1*

omero.web.public.url_filter

Set a URL filter for which the OMERO.web public user is allowed to navigate. The idea is that you can create the public pages yourself (see OMERO.web framework since we do not provide public pages.

Default: *^/(?!webadmin)*

omero.web.public.user

Username to use during authentication.

Default: *None*

[25] http://django-pipeline.readthedocs.org/en/latest/storages.html

omero.web.secret_key

A boolean that sets SECRET_KEY for a particular Django installation.

Default: *None*

omero.web.secure_proxy_ssl_header

A tuple representing a HTTP header/value combination that signifies a request is secure. Example `'["HTTP_X_FORWARDED_PROTO_OMERO_WEB", "https"]'`. For more details see secure proxy ssl header[26].

Default: *[]*

omero.web.server_list

A list of servers the Web client can connect to.

Default: *[["localhost", 4064, "omero"]]*

omero.web.session_cookie_age

The age of session cookies, in seconds.

Default: *86400*

omero.web.session_cookie_domain

The domain to use for session cookies

Default: *None*

omero.web.session_cookie_name

The name to use for session cookies

Default: *None*

omero.web.session_engine

Controls where Django stores session data. See Configuring the session engine for more details[27].

Default: *omeroweb.filesessionstore*

omero.web.session_expire_at_browser_close

A boolean that determines whether to expire the session when the user closes their browser. See Django Browser-length sessions vs. persistent sessions documentation[28] for more details.

Default: *true*

omero.web.static_root

The absolute path to the directory where collectstatic will collect static files for deployment. If the staticfiles contrib app is enabled (default) the collectstatic management command will collect static files into this directory.

Default: */home/omero/OMERO.server/lib/python/omeroweb/static*

[26] https://docs.djangoproject.com/en/1.8/ref/settings/#secure-proxy-ssl-header
[27] https://docs.djangoproject.com/en/1.8/ref/settings/#session-engine
[28] https://docs.djangoproject.com/en/1.8/topics/http/sessions/#browser-length-vs-persistent-sessions

omero.web.static_url

URL to use when referring to static files. Example: `'/static/'` or `'http://static.example.com/'`. Used as the base path for asset definitions (the Media class) and the staticfiles app. It must end in a slash if set to a non-empty value.

Default: */static/*

omero.web.staticfile_dirs

Defines the additional locations the staticfiles app will traverse if the FileSystemFinder finder is enabled, e.g. if you use the collectstatic or findstatic management command or use the static file serving view.

Default: *[]*

omero.web.template_dirs

List of locations of the template source files, in search order. Note that these paths should use Unix-style forward slashes, even on Windows.

Default: *[]*

omero.web.ui.center_plugins

Add plugins to the center panels. Plugins are `['Channel overlay', 'webtest/webclient_plugins/center_plugin.ove` `'channel_overlay_panel']`. The javascript loads data into `$('#div_id')`.

Default: *[]*

omero.web.ui.right_plugins

Add plugins to the right-hand panel. Plugins are `['Label', 'include.js', 'div_id']`. The javascript loads data into `$('#div_id')`.

Default: *[["Acquisition", "webclient/data/includes/right_plugin.acquisition.js.html", "metadata_tab"],["Preview", "webclient/data/includes/right_plugin.preview.js.html", "preview_tab"]]*

omero.web.ui.top_links

Add links to the top header: links are `['Link Text', 'link', options]`, where the url is reverse('link') OR simply 'link' (for external urls). E.g. `'[["Webtest", "webtest_index"], ["Homepage", "http://...", {"title": "Homepage", "target": "new"} ]]'`

Default: *[["Data", "webindex", {"title": "Browse Data via Projects, Tags etc"}],["History", "history", {"title": "History"}],["Help", "http://help.openmicroscopy.org/",{"title":"Open OMERO user guide in a new tab", "target":"new"}]]*

omero.web.use_x_forwarded_host

Specifies whether to use the X-Forwarded-Host header in preference to the Host header. This should only be enabled if a proxy which sets this header is in use.

Default: *false*

omero.web.viewer.view

Django view which handles display of, or redirection to, the desired full image viewer.

Default: *omeroweb.webclient.views.image_viewer*

omero.web.webgateway_cache

Default: *None*

omero.web.wsgi_args

A string representing Gunicorn additional arguments. Check Gunicorn Documentation http://docs.gunicorn.org/en/latest/settings.html

Default: *None*

omero.web.wsgi_timeout

Workers silent for more than this many seconds are killed and restarted. Check Gunicorn Documentation http://docs.gunicorn.org/en/stable/settings.html#timeout

Default: *60*

omero.web.wsgi_workers

The number of worker processes for handling requests. Check Gunicorn Documentation http://docs.gunicorn.org/en/stable/settings.html#workers

Default: *5*

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

7.9 Syslog configuration

syslog[29] is a standard for message logging over networks. OMERO.server supports logging to either a local or remote syslog service.

This allows all logs of the OMERO.server to be routed to a central location instead of (or as well as) to a file.

Note: It is important to note that this applies only to the OMERO.server itself, not to components like OMERO.web.

7.9.1 How it works

Whenever a log message is generated, OMERO's logging framework will forward that message to any configured appenders.

By default, OMERO is configured to log everything to files.

Note: OMERO is configured to log a record of events for operations such as import. These are written directly to the Managed Repository. It is very likely that even if replacing file logging with syslog, this aspect should be retained in files. This is easily achieved by not changing any loggers using *SIFT*.

Configuration

To configure OMERO to be able to log to syslog, it is necessary to modify the file `OMERO.server/current/etc/logback.xml`. It is possible to do all the configuration changes in this file alone, but for ease of config management, it is demonstrated here where an additional `OMERO.server/current/etc/logback_syslog.xml` file is used in addition.

The following information is required to configure OMERO to log to syslog.

[29] https://en.wikipedia.org/wiki/Syslog

- The host on which syslog is running: e.g. *localhost*
- The port number on which syslog is running on that host: e.g. *514*
- The facility (RFC 3164[30]) that OMERO should be handled as: e.g. *user* or *local6*

Note: The facility is important because it determines how syslog will handle the messages it receives. It is unlikely that OMERO's log output will be desired in a local systems primary message log for example. On Linux this is often `/var/log/messages`. Remember to configure the syslog configuration to avoid this. This is also where configuration of onward forwarding can be configured (to a service such as splunk[31]). Finally, syslog can be configured to specifically output this facility output to a file such as `/var/log/omero`.

Create the new file `OMERO.server/current/etc/logback_syslog.xml`:

```
<?xml version="1.0" encoding="UTF-8"?>
<included>
  <!-- syslog -->
  <appender name="SYSLOG" class="ch.qos.logback.classic.net.SyslogAppender">

    <!-- Exclude debug level logging from ome.services.blitz.repo.ManagedImportRequestI -->
    <filter class="ch.qos.logback.core.filter.EvaluatorFilter">
      <evaluator> <!-- defaults to type ch.qos.logback.classic.boolex.JaninoEventEvaluator -->
        <expression>return Level.DEBUG.equals(Level.toLevel(level)) &amp;&amp; logger.equals("ome.servi
      </evaluator>
      <OnMismatch>NEUTRAL</OnMismatch>
      <OnMatch>DENY</OnMatch>
    </filter>
    <!-- Exclude debug level logging from omero.* (except allow omero.cmd.*) -->
    <filter class="ch.qos.logback.core.filter.EvaluatorFilter">
      <evaluator> <!-- defaults to type ch.qos.logback.classic.boolex.JaninoEventEvaluator -->
        <expression>return Level.DEBUG.equals(Level.toLevel(level)) &amp;&amp; logger.startsWith("omero
      </evaluator>
      <OnMismatch>NEUTRAL</OnMismatch>
      <OnMatch>DENY</OnMatch>
    </filter>

    <syslogHost>localhost</syslogHost>
    <facility>local6</facility>
    <suffixPattern>OMERO [%level] [%thread] %logger %msg</suffixPattern>
  </appender>

</included>
```

This creates an appender that sends messages to syslog. *syslogHost* is the host on which syslog is running. No port is specified as *514* is the default. The *suffixPattern* is customizable. In this instance it is identical to OMERO's file logger except an added "OMERO" identifier has been added for clarity. The name of the appender has been set to *SYSLOG*. The filters replicate the same behaviour from the default *FILE* appender.

Note: If configuring the appender directly in the `OMERO.server/current/etc/logback.xml` file, then the *included* tag should not be used.

Within the *configuration* tag of `OMERO.server/current/etc/logback.xml` add:

```
<include file="/path/to/OMERO.server/etc/logback_syslog.xml"/>
```

Note: The included file path can be relative, but note that it is NOT relative to the `OMERO.server/current/etc/logback.xml` file, but to the current directory set by OMERO. It is highly recommended to use a full path.

[30] https://tools.ietf.org/html/rfc3164
[31] http://www.splunk.com/

Finally, also within `OMERO.server/current/etc/logback.xml` modify the *root* tag to include a second *appender-ref* (It can also be replaced if the file logs are not desired or syslog will handle writing those to a file on OMERO's behalf):

```
<root level="OFF">
  <appender-ref ref="SYSLOG"/>
  <appender-ref ref="FILE"/>
</root>
```

Note: A restart of OMERO will be necessary before this takes effect.

CHAPTER

EIGHT

OPTIMIZING OMERO AS A DATA REPOSITORY

This chapter explains how to customize the appearance and functionality of OMERO clients to host images for groups or public viewing.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

8.1 Customize OMERO clients

The OMERO clients offer a flexible user interface that can be customized. The sections below describe how to set up these features.

8.1.1 Index page

Create new custom template in /your/path/to/templates/mytemplate/index.html and add the following

Note: Users will no longer be automatically redirected to the login page

```
$ bin/omero config set omero.web.template_dirs '/your/path/to/templates/'
$ bin/omero config set omero.web.index_template 'mytemplate/index.html'
```

8.1.2 Login page

omero.web.login_logo allows you to customize the webclient login page with your own logo. Logo images should ideally be 150 pixels high or less and will appear above the OMERO logo. You will need to host the image somewhere else and link to it with

```
$ bin/omero config set omero.web.login_logo 'http://www.url/to/image.png'
```

8.1.3 Login redirection

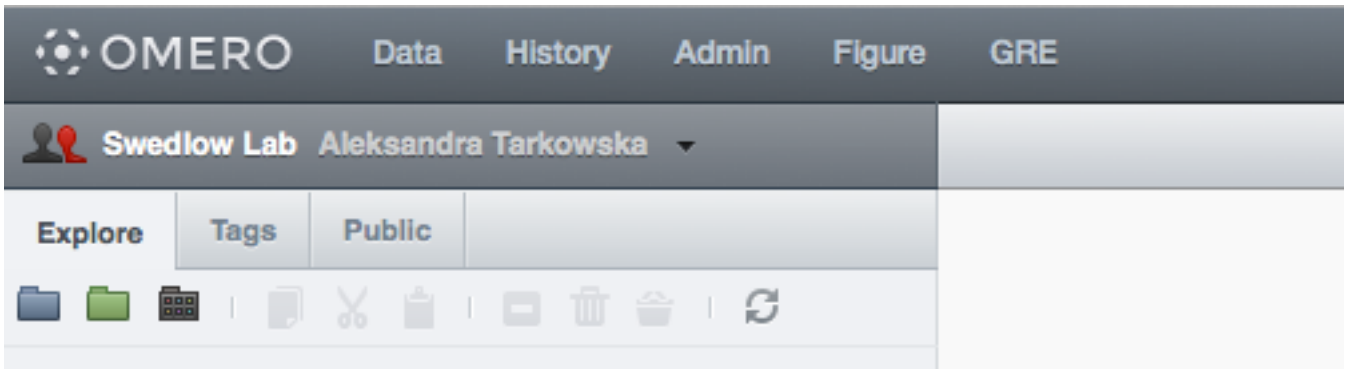
omero.web.login_redirect property redirects to the given location after logging in.

```
$ bin/omero config set omero.web.login_redirect '{"redirect": ["webindex"], "viewname": "load_template",
```

8.1.4 Top links menu

`omero.web.ui.top_links` adds links to the top header.

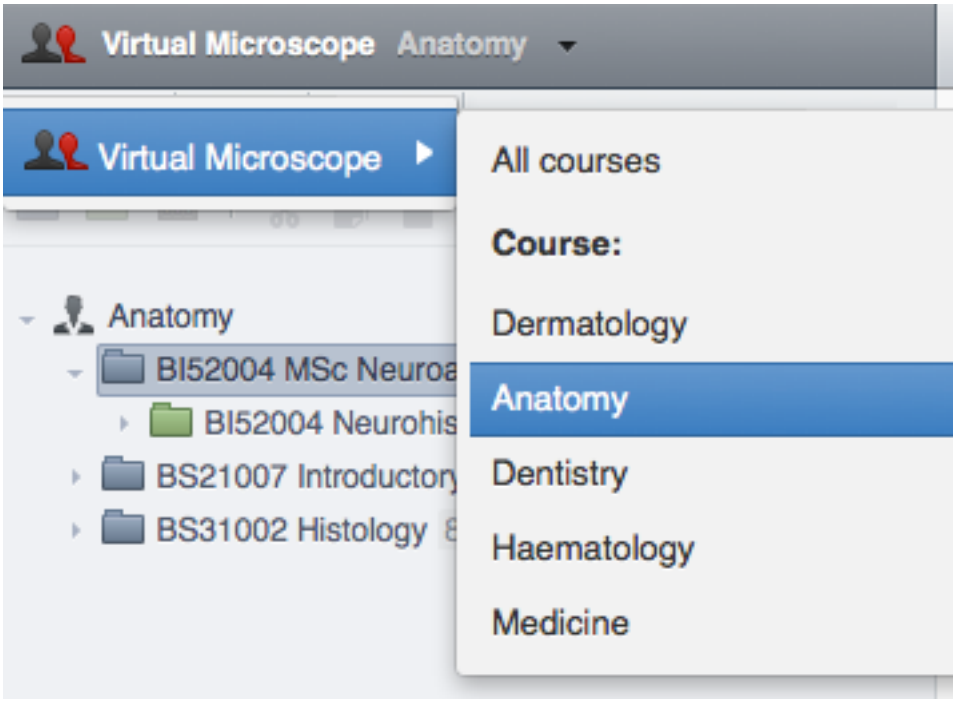
```
$ bin/omero config append omero.web.ui.top_links '["Figure", "webfigure"]'
$ bin/omero config set omero.web.ui.top_links '["GRE", "http://lifesci.dundee.ac.uk/gre"]'
```



8.1.5 Group and Users in dropdown menu

Customize the groups and users dropdown menu by changing the labels or hiding the entire list.

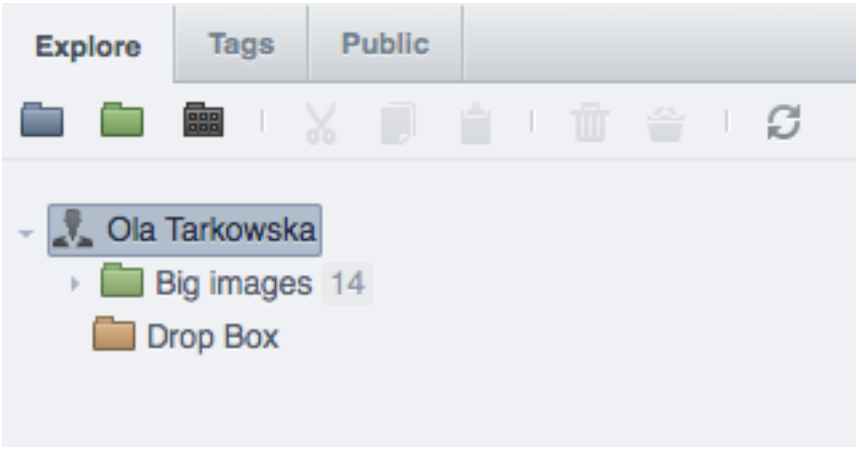
```
$ bin/omero config set omero.client.ui.menu.dropdown.leaders "Owners"
$ bin/omero config set omero.client.ui.menu.dropdown.colleagues.enabled true
$ bin/omero config set omero.client.ui.menu.dropdown.colleagues "Members"
$ bin/omero config set omero.client.ui.menu.dropdown.colleagues.enabled true
$ bin/omero config set omero.client.ui.menu.dropdown.all "All Members"
$ bin/omero config set omero.client.ui.menu.dropdown.colleagues.enabled true
```



8.1.6 Orphaned container

`omero.client.ui.tree.orphans.name` allows you to change the name of the "Orphaned images" container located in the client data manager tree.

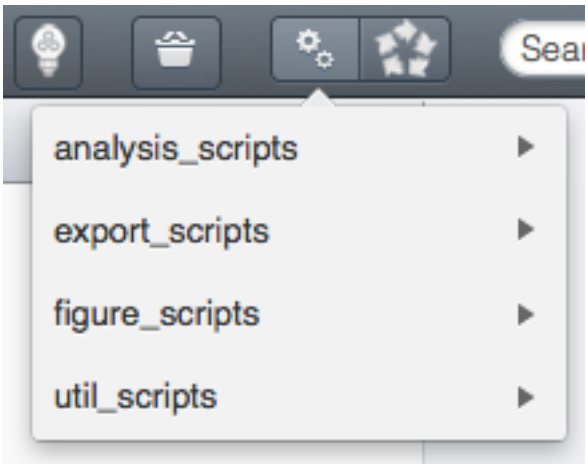
```
$ bin/omero config set omero.client.ui.tree.orphans.name "Orphaned images"
```



8.1.7 Disabling scripts

`omero.client.scripts_to_ignore` hides the scripts that the clients should not display

```
$ bin/omero config append omero.client.scripts_to_ignore "/my_scripts/script.py"
```

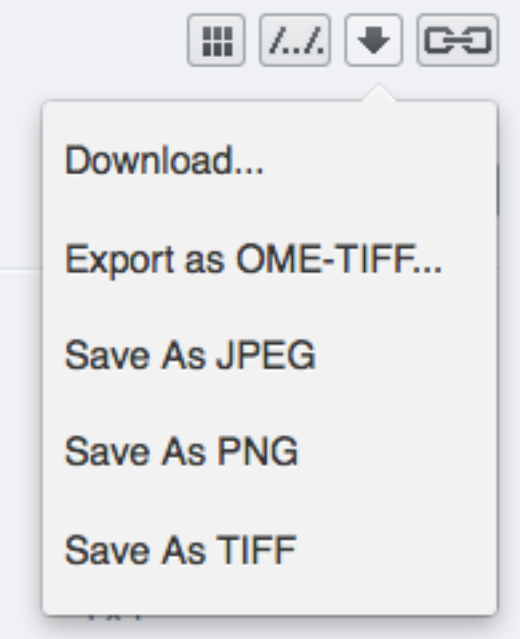


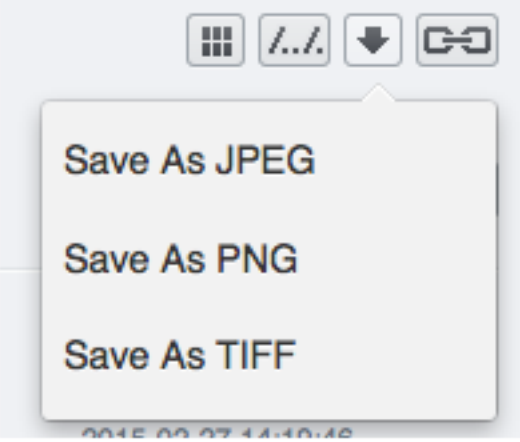
8.1.8 Download restrictions

`omero.policy.binary_access` determines whether users can access binary files from disk. Binary access includes all attempts to download a file from the UI.

```
$ bin/omero config set omero.policy.binary_access "+read,+write,+image"
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.





8.2 Public data in the repository

The OMERO.web framework allows raw data to be published using built-in tools or supplied through webservices to external web pages. Selected datasets can be made visible to a 'public user' using the standard OMERO permissions system, ensuring you always have control over how users can interact with your data.

There are several ways of publishing data using OMERO.web:

- using a URL to launch the web-based Image viewer, as described in *Launching OMERO.web viewer*, which can be accompanied by a thumbnail. For more details of how to load the thumbnail see *URLs from within OMERO.web*
- embedding the image viewport directly into other web pages, for more details see *Customizing the content of the embedded OMERO.web viewport*
- allowing public access to the OMERO.web data manager
- writing your own app to host your public data (see *Creating an app*) and then allowing public access to the chosen URL for that app

The sections below describe how to set up these features.

8.2.1 Public user

The OMERO.web framework supports auto-login for a single username / password. This means that any public visitors to certain OMERO.web pages will be automatically logged in and will be able to access the data available to the defined 'public user'.

To set this up on your OMERO.web installation:

- Create a group with read-only permissions (the name can be anything e.g. "public-data"). We recommend read-only permissions so that the public user will not be able to modify, delete or annotate data belonging to other members.
- Create a member of this group, noting the username and password (you will enter these below). Again, the First Name, Last Name, username and password can be anything you like.

  Note: If you add this member to other groups, all data in these groups will also become publicly accessible for as long as this user remains in the group.

- Enable the `omero.web.public.enabled` property and set `omero.web.public.user` and `omero.web.public.password`:

```
$ bin/omero config set omero.web.public.enabled True

$ bin/omero config set omero.web.public.user '<username>'

$ bin/omero config set omero.web.public.password '<password>'
```

- Set the `omero.web.public.url_filter`. This filter is a regular expression that will allow only matching URLs to be accessed by the public user.

  There are three common use cases for the URL filter:

  – Enable 'webgateway' URLs which includes everything needed for the full image viewer:

  ```
  $ bin/omero config set omero.web.public.url_filter '^/webgateway'
  ```

  without the ability to download data:

  ```
  $ bin/omero config set omero.web.public.url_filter '^/webgateway/(?!archived_files|download_as)'
  ```

  Then you can access public images via the following link *http://your_host/webgateway/img_detail/IMAGE_ID/*.

  – Create your own public pages in a separate app (see *create app*) and allow public access to that app. For example, to allow only URLs that start with '/my_web_public' you would use:

  ```
  $ bin/omero config set omero.web.public.url_filter '/my_web_public'
  ```

  – You can use the full webclient UI for public browsing of images. However, the webclient UI was not designed for public use and allows various actions that create data or are resource intensive. These can be selectively disabled using the following command:

  ```
  $ bin/omero config set omero.web.public.url_filter '^/(webadmin/myphoto/|webclient/(?!(action|lo
  ```

- Set the `omero.web.public.server_id` which the public user will be automatically connected to. Default: 1 (the first server in the `omero.web.server_list`)

```
$ bin/omero config set omero.web.public.server_id 1
```

If you enable public access to the main webclient but still wish registered users to be able to login, the login page can always be accessed using a link of the form *https://your_host/webclient/login/*.

8.2.2 Reusing OMERO session

As an alternative to granting permanent public access to the data, the OMERO.web framework supports password-less, OMERO session key-based authentication. For example a direct link to image will look as follows:

```
https://your_host/webgateway/img_detail/IMAGE_ID/?server=SERVER_ID&bsession=OMERO_SESSION_KEY
```

Note: The *SERVER_ID* should match the index from the list set using `omero.web.server_list` from the server session you created. If your list contains only one server, the index will be 1.

For more details about how to create an OMERO session see *server-side session* or use the *command line interface* to create one.

CHAPTER

NINE

DATA IMPORT AND STORAGE

This chapter contains details of how OMERO.fs allows you to import and store data with OMERO 5.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

9.1 OMERO.dropbox

DropBox was originally designed as the first stage of the file system changes referred to as *OMERO.fs*. It utilizes a file system monitor to find newly uploaded files and run a fully automatic import on those files if possible. This release of OMERO.dropbox runs on the same machine as the OMERO.server and watches designated areas of the local filesystem for new or modified files. If those files are importable, then an automatic import is initiated. OMERO.dropbox is started automatically when the OMERO.server starts and it will run if the prerequisites below are met.

9.1.1 Prerequisites

In addition to the general *System requirements* OMERO.dropbox has the following more specific requirements:

- OMERO.dropbox is built on underlying OS file-notification system, and so is only available for specific versions of certain operating systems. OMERO.dropbox has been tested on the following systems:
  - Linux with kernel 2.6.13 and higher.
  - Mac OS 10.6 and later.
  - Windows XP, Vista, 7, Server 2003, Server 2008 and Server 2008R2, but see note below.
- In addition some platforms require further Python packages to be available:
  - Mac OS systems that use a macports install of Python will need to have FSEvents available in the PYTHONPATH. This will require a path of the form `/System/Library/Frameworks/Python.framework/Versions/2.X/Extras/lib/python/PyObjC/` to be added, according to the version of Python used.
- The filesystem which OMERO.dropbox watches must be local to the given operating system. Watching a network-attached share (NAS) is strictly ***not*** supported.

Note: It is likely, but not guaranteed, that DropBox will run on later versions of Windows, however only tested versions are supported by default. Setting the property `omero.fs.platformCheck` to `False` in `etc/grid/templates.xml` or using `omero config set` and restarting the server will allow DropBox to be started on an untested version of Windows.

If you do successfully run DropBox on an as yet untested version of Windows please do let us know via the forums and mailing lists[1].

[1] http://www.openmicroscopy.org/site/community/

9.1.2 Using DropBox

In its default configuration the monitored area of the file system is a `DropBox` subdirectory of the OmeroBinaryRepository directory. The system administrator should create `DropBox` and then under that a directory for each user, using their omero username. The ownership and permissions should be set so that a user can copy files into their DropBox directory:

```
/OMERO/DropBox/amy
              /emily
              /edgar
              /root
              /zak
```

Experimenters can add subdirectories under their named directory for convenience. Copying or moving a file of an importable file type into a named directory or nested subdirectory will initiate an automatic import of that file for that user. Multi-file formats will be imported after the last required file of a set is copied into the directory. Images and plates will be imported into the group the user was last logged into, with images placed into `Orphaned images`.

Acquisition systems can then be configured to drop a user's images into a given DropBox.

Note:

- The DropBox system is designed for image files to be copied in at normal acquisition rates. Copying many files en masse may result in files failing to import.
- It is also intended as a write-once system. Modifying an image after it has been imported may result in that modified image also being imported depending on the operating system and how the image was modified.
- Once directories are created within DropBox or files are copied or moved into DropBox they should not be moved, renamed or otherwise changed. Images may be imported again or already imported images may become unreadable.

9.1.3 Permissions

Changing the permissions of a directory within DropBox may result in duplicate imports as a newly readable directory appears identical to a new directory. If directories need to be modified it is recommended that the DropBox system is stopped and then restarted around any changes, as below.

```
$ bin/omero admin ice server disable DropBox
$ bin/omero admin ice server stop DropBox
$ bin/omero admin ice server disable MonitorServer
$ bin/omero admin ice server stop MonitorServer

# make any directory changes

$ bin/omero admin ice server enable MonitorServer
$ bin/omero admin ice server enable DropBox
```

Note: Any new files copied into DropBox during this disabled period will not be detected and thus not imported.

9.1.4 Log files

The log files `var/log/FileServer.log`, `var/log/MonitorServer.log` and `var/log/DropBox.log` will indicate success or otherwise of start-up of the two components. Once running, `var/log/MonitorServer.log` will log file events seen within designated file areas and `var/log/DropBox.log` will log the progress of any file imports.

9.1.5 Unicode path and file names

If file or path names contain Unicode characters this can cause DropBox to fail. This can be remedied by the use of a `sitecustomize.py` or `usercustomize.py` file containing the following:

```
import sys
reload(sys)
sys.setdefaultencoding('utf-8')
```

For more details on using customization files in Python see: site — Site-specific configuration hook[2]. For more discussion on this issue within OMERO see the forum post: Dropbox halts on certain unicode characters[3].

Note: If a customization file is used and the OMERO server is upgraded please ensure the file is still available to DropBox after the upgrade.

9.1.6 Advanced use

OMERO.dropbox can be configured in several ways through `etc/grid/templates.xml`. In its default configuration, as detailed above, it monitors the subdirectory `DropBox` of the OMERO data directory for all users.

A number of the properties in `templates.xml` accept a semi-colon separated list of values. This extended configuration allows a site to watch multiple directories, and configure each for a different user, a different type of file, etc. Any value missing from the configuration (e.g. `value="1;;2"`) will be replaced by the default value.

One example alternative configuration would be to watch specific directories for specific users. In the example below two directories are monitored, one for user `amy` and one for `zak`:

```
<property name="omero.fs.importUsers"  value="amy;zak"/>
<property name="omero.fs.watchDir"  value="/home/amy/myData;/home/zak/work/data"/>
```

The remaining properties have been left at their default values for both users.

To limit DropBox to import only files belonging to specific image types the following property can be set,

```
<property name="omero.fs.readers"  value="/home/amy/my_readers.txt;"/>
```

Here only the image types listed in `my_readers.txt` will be imported for the user `amy` while the system-wide `readers.txt` will be used for `zak`.

For a full description of the properties see below.

Properties

Each property takes the form of a single item or a semi-colon separated list of items. Where the item is a list, values within that list should be comma separated.

- importUsers

  The importUsers is either `default` or a list of OMERO user names. In the case of the value being `default`, the same configuration is applied to all users and each subsequent configuration setting should be a single value. In the case of this value being a list of users, each subsequent value should be a list of the same length as the number of users. The default value is `default`.

  ```
  <property name="omero.fs.importUsers"  value="default"/>
  ```

- watchDir

  The absolute directory path of interest for each user. The default is empty.

[2] https://docs.python.org/2.7/library/site.html
[3] https://www.openmicroscopy.org/community/viewtopic.php?f=4&t=7810#p15910

```
<property name="omero.fs.watchDir"  value=""/>
```

- eventTypes

  For automatic import Creation and Modification events are monitored. It is also possible to monitor Deletion events though these are not used by DropBox. The default is Creation,Modification.

  ```
  <property name="omero.fs.eventTypes"  value="Creation,Modification"/>
  ```

- pathMode

  By default existing and newly created subdirectories are monitored. It is possible to restrict monitoring to a single directory ("Flat"), only existing subdirectories ("Recurse"), or all subdirectories ("Follow"). For DropBox to function correctly the mode should be Follow. The default is Follow.

  ```
  <property name="omero.fs.pathMode"  value="Follow"/>
  ```

- whitelist

  A list of file extensions of interest. An empty list implies all file extensions are monitored. The default is an empty list.

  ```
  <property name="omero.fs.whitelist"  value=""/>
  ```

- blacklist

  A list of subdirectories to ignore. Not currently supported.

  ```
  <property name="omero.fs.blacklist"  value=""/>
  ```

- timeout

  This timeout in seconds is used by one-shot monitors. This property is not used by DropBox.

  ```
  property name="omero.fs.timeout"  value="0.0"/>
  ```

- blockSize

  The number of events that should be propagated to DropBox in one go. Zero implies all events possible. The default is zero.

  ```
  <property name="omero.fs.blockSize"  value="0"/>
  ```

- ignoreSysFiles

  If this is True events concerning system files, such as filenames beginning with a dot or default new folder names, are ignored. The exact events ignored will be OS-dependent. The default is True.

  ```
  <property name="omero.fs.ignoreSysFiles"  value="True"/>
  ```

- ignoreDirEvents

  If this is True then the creation and modification of subdirectories is not reported to DropBox. The default is True.

  ```
  <property name="omero.fs.ignoreDirEvents"  value="True"/>
  ```

- dirImportWait

  The time in seconds that DropBox should wait after being notified of a file before starting an import on that file. This allows for companion files or filesets to be copied. If a new file is added to a fileset during this wait period DropBox begins waiting again. The default is 60 seconds.

```
<property name="omero.fs.dirImportWait"  value="60"/>
```

- fileBatch

  The number of files that can be copied in before processing the batch. In cases where there are large numbers of files in a typical file set it may be more efficient to set this value higher. The default is 10.

```
<property name="omero.fs.fileBatch"  value="10"/>
```

- throttleImport

  The time in seconds that DropBox should wait after initiating an import before initiating a second import. If imports are started too close together connection issues can arise. The default is 10 seconds.

```
<property name="omero.fs.throttleImport"  value="10"/>
```

- readers

  A file of readers. If this is a valid file then it is used to filter those events that are of interest. Only files corresponding to a reader in the file will be imported. The default is empty.

```
<property name="omero.fs.readers"  value=""/>
```

- importArgs

  A string of extra arguments supplied to the importer. This could include, for example, an email address to report failed imports to: `--report --email test@example.com`. The default is empty. For details on available extra arguments see *Import images*.

```
<property name="omero.fs.importArgs"  value=""/>
```

Example

Here's a full example of a configuration for two users:

```
<property name="omero.fs.importUsers"     value="amy;zak"/>
<property name="omero.fs.watchDir"        value="/home/amy/myData;/home/zak/work/data"/>
<property name="omero.fs.eventTypes"      value="Creation,Modification;Creation,Modification"/>
<property name="omero.fs.pathMode"        value="Follow;Follow"/>
<property name="omero.fs.whitelist"       value=";"/>
<property name="omero.fs.blacklist"       value=";"/>
<property name="omero.fs.timeout"         value="0.0;0.0"/>
<property name="omero.fs.blockSize"       value="0;0"/>
<property name="omero.fs.ignoreSysFiles"  value="True;True"/>
<property name="omero.fs.ignoreDirEvents" value="True;True"/>
<property name="omero.fs.dirImportWait"   value="60;60"/>
<property name="omero.fs.fileBatch"       value="10;10"/>
<property name="omero.fs.throttleImport"  value="10;10"/>
<property name="omero.fs.readers"         value="/home/amy/my_readers.txt;"/>
<property name="omero.fs.importArgs"      value="--report;--report --email zak@example.com"/>
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

9.2 In-place import

In-place import is a feature added to OMERO 5.0.0 to allow files which are already present on the server machine to be imported into OMERO without the need to copy them. This requires users to have shell (SSH, etc.) access to the server machine, and so there are a number of *limitations* to this implementation. Development of this feature is on-going, with improvements planned to enable a more user-friendly experience. This CLI-based stop-gap is being made available at this stage because for some users, in-place import is essential for their use of OMERO.

This feature is designed to allow imaging facilities to import large datasets into OMERO while keeping them safely stored in a secure repository which is read-only for users. Leaving the data in a user's file system **is very dangerous** as they may forget they need to keep it or move to a different institution. **Under no circumstances should in-place import be used with temporary storage.**

Warning: The instructions below should help you get started but **it is critical that you understand the implications of using this feature.** Please do not just copy commands and hope for the best.

9.2.1 Responsibilities

As a data management platform, OMERO assumes that it is in control of your data in order to help prevent data loss. It assumes that data was copied into the server and only a server administrator or authorized OMERO user would have the rights to do anything destructive to that data.

With in-place import, the data either resides completely outside of OMERO or is shared with other users. This means that the critical, possibly sole, copy of your data must be protected outside of OMERO. **This is your responsibility for the lifetime of the data**.

9.2.2 Limitations

In-place import is only available on the OMERO server system itself. In other words, using SSH or similar, you will need to shell into the server and run the command-line importer directly. If you are uncomfortable with this, you should let someone else handle in-place importing.

Someone wanting to perform an in-place import **MUST** have:

- a regular OMERO account
- an OS-account with access to `bin/omero`
- read access to the location of the data
- **write** access to the *ManagedRepository* or one of its subdirectories

The above means that it may be useful to create a single OS account (e.g. "import_user") which multiple users can log into, and then use their own OMERO accounts to import data. Alternatively, each OMERO user can be given an OS account with access rights to the data storage as well as the managed repository.

At the moment full in-place import functionality is available only under POSIX systems (Unix, Linux, OS X). Under Windows, `ln` and `ln_s` work as expected but `ln_rm` does not automatically remove image files after import.

For soft linking with `--transfer=ln_s` it has been noticed that some plate imports run rather more slowly than usual. Other operations may also be affected. In determining if or how to use in-place import at your high-content screening facility, we thus recommend time profiling with representative data, and alerting us to any significant disappointments.

Also, there is still some data duplication when pyramids are generated. We are hoping to find a work-around for this in the future.

9.2.3 Safety tips

Whether you chose to use the hard- or soft-linking option below, you should take steps to secure files which are in-place imported to OMERO. The best option is making them **read-only** for both the OMERO user and also for the owner of the data. This means the server cannot accidentally modify the files (e.g. if a client mixes up the file IDs and tries to write to the wrong location) and that the files cannot be removed from the system while OMERO is still using them. Files may not be renamed or otherwise altered such that the OMERO server user cannot find them at the expected location.

If possible, **all the files should be added to your regular backup process**. If the files for imported images are later removed or corrupted, the result will probably be that while the images remain in their projects or screens with their annotations and basic metadata, they simply cannot be successfully viewed. However, this behavior is **not guaranteed**, so do *not* assume that the resulting problems will not extend further. Once the problem is noticed, replacing the original image files from backups, in the same place with the same name, is likely but **not guaranteed** to fully restore the images and their associated data in OMERO.

9.2.4 Additional setup requirements

In-place import requires additional user and group setup. As no-one should be allowed to log into the account used to install the server, to permit in-place imports you need to create a different user account, allowing someone to log into the server but not accidentally delete any files. Therefore, you should set up an 'in-place' user and an 'in-place' group and configure a subset of directories under *ManagedRepository* to let members of that group write to them. The example below details how this was done for one of our test servers in Dundee:

```
### STATUS BEFORE

[sysadmin@ome-server omero_system_user]$ umask
0002

[sysadmin@ome-server omero_system_user]$ ls -ltrad ManagedRepository/
drwxrwxr-x 8 omero_system_user omero_system_user 4096 Apr 24 10:13 ManagedRepository/

[sysadmin@ome-server omero_system_user]$ grep inplace /etc/passwd /etc/group
/etc/passwd:inplace_user:x:501:501::/home/inplace_user:/bin/bash
/etc/group:omero_system_user:x:500:inplace_user
/etc/group:inplace_user:x:501:

[sysadmin@ome-server omero_system_user]$ grep omero_system_user /etc/passwd /etc/group
/etc/passwd:omero_system_user:x:500:500::/home/omero_system_user:/bin/bash
/etc/group:omero_system_user:x:500:inplace_user

[sysadmin@ome-server omero_system_user]$ sudo -u inplace_user -i
[inplace_user@ome-server ~]$ umask
0002


### SCRIPT
chgrp inplace_user /repositories/binary-repository/ManagedRepository
chmod g+rws /repositories/binary-repository/ManagedRepository

chmod g+rws /repositories/binary-repository/ManagedRepository/*
chmod g+rws /repositories/binary-repository/ManagedRepository/*/*
chmod g+rws /repositories/binary-repository/ManagedRepository/*/*/*

chgrp inplace_user /repositories/binary-repository/ManagedRepository/*
chgrp inplace_user /repositories/binary-repository/ManagedRepository/*/*
chgrp inplace_user /repositories/binary-repository/ManagedRepository/*/*/*

# With the above, newly created directories should be in the inplace group
# As long as the file is readable by omero_system_user, then it should work fine!



### AFTER SCRIPT
```

```
[root@ome-server omero_system_user]# ls -ltrad ManagedRepository/
drwxrwsr-x 8 omero_system_user inplace_user 4096 Apr 24 10:13 ManagedRepository/

### TEST

# with default umask this likely has to do
[inplace_user@ome-server ~]$ cd /repositories/binary-repository/ManagedRepository/
[inplace_user@ome-server ManagedRepository]$ mkdir inplace.test
[inplace_user@ome-server ManagedRepository]$ ls -ltrad inplace.test/
drwxrwsr-x 2 inplace_user inplace_user 4096 Apr 30 11:35 inplace.test/

[omero_system_user@ome-server omero_system_user]$ cd /repositories/binary-repository/ManagedRepository/
[omero_system_user@ome-server ManagedRepository]$ rmdir inplace.test/
[omero_system_user@ome-server ManagedRepository]$
```

9.2.5 Getting started

From 5.0.0, the command-line import client has a new help menu which explains the available options:

```
$ bin/omero import --advanced-help


ADVANCED OPTIONS:

  These options are not intended for general use. Make sure you have read the
  documentation regarding them. They may change in future releases.

  In-place imports:
  -----------------

    --transfer=ARG                  File transfer method

        General options:
          upload                  # Default
          upload_rm               # Caution! File upload followed by source deletion.
          some.class.Name         # Use a class on the CLASSPATH.

        Server-side options:
          ln                      # Use hard-link.
          ln_s                    # Use soft-link.
          ln_rm                   # Caution! Hard-link followed by source deletion.
          cp                      # Use local copy command.
          cp_rm                   # Caution! Copy followed by source deletion.


  e.g. $ bin/omero import -- --transfer=ln_s foo.tiff
       $ ./importer-cli --transfer=ln bar.tiff
       $ CLASSPATH=mycode.jar ./importer-cli --transfer=com.example.MyTransfer baz.tiff

  Background imports:
  -------------------

    --auto_close                    Close completed imports immediately.

    --minutes_wait=ARG              Choose how long the importer will wait on server-side processing.
                                    ARG > 0 implies the number of minutes to wait.
                                    ARG = 0 exits immediately. Use a *_completed option to clean up.
                                    ARG < 0 waits indefinitely. This is the default.

    --close_completed               Close completed imports.
```

```
    --wait_completed                Wait for all background imports to complete.


  e.g. $ bin/omero import -- --minutes_wait=0 file1.tiff file2.tiff file3.tiff
       $ ./importer-cli --minutes_wait=0 some_directory/
       $ ./importer-cli --wait_completed # Waits on all 3 imports.

  File exclusion:
  ---------------

    --exclude=filename              Exclude files based on filename.

    --exclude=clientpath             Exclude files based on the original path.


  e.g. $ bin/omero import -- --exclude=filename foo.tiff # First-time imports
       $ bin/omero import -- --exclude=filename foo.tiff # Second-time skips

  Import speed:
  -------------

    --checksum-algorithm=ARG        Choose a possibly faster algorithm for detecting file corruption,
                                    e.g. Adler-32 (fast), CRC-32 (fast), File-Size-64 (fast),
                                         MD5-128, Murmur3-32, Murmur3-128,
                                         SHA1-160 (slow, default)

  e.g. $ bin/omero import -- --checksum-algorithm=CRC-32 foo.tiff
       $ ./importer-cli --checksum-algorithm=Murmur3-128 bar.tiff

    --no-stats-info                Disable calculation of minima and maxima when as part of the Bio-For

  e.g. $ bin/omero import -- --no-stats-info foo.tiff
       $ ./importer-cli --no-stats-info bar.tiff

  --no-thumbnails                Do not perform thumbnailing after import

  e.g. $ bin/omero import -- --no-thumbnails foo.tiff
       $ ./importer-cli --no-thumbnails bar.tiff

    --no-upgrade-check                Disable upgrade check for each import
  e.g. $ bin/omero import -- --no-upgrade-check foo.tiff
       $ ./importer-cli --no-upgrade-check bar.tiff


  Feedback:
  ---------

    --qa-baseurl=ARG        Specify the base URL for reporting feedback
  e.g. $ bin/omero import broken_image.tif -- --email EMAIL --report --upload --logs --qa-baseurl=https
       $ ./importer-cli broken_image.tif --email EMAIL --report --upload --logs --qa-baseurl=https://qa

Report bugs to <ome-users@lists.openmicroscopy.org.uk>
```

In versions prior to 5.0.3 this help option is hidden and it can only be accessed using:

```
$ bin/omero import -- --advanced-help
```

The option for performing an in-place transfer is *--transfer*. A new extension point, file transfers allow a choice of which mechanism is used to get a file into OMERO.

```
$ bin/omero import -- --transfer=ln_s my_file.dv


Using session bba923bb-cf0c-4cf0-80c5-a309be523ad8 (root@localhost:4064). Idle timeout: 10.0 min. Curre
...[      main] INFO          ome.formats.importer.ImportConfig - OMERO Version: 5.0.0-rc1-DEV-ice35
...[      main] INFO          ome.formats.importer.ImportConfig - Bioformats version: 5.0.0-rc1-DEV-ice3
...[      main] INFO   formats.importer.cli.CommandLineImporter - Setting transfer to ln_s
...[      main] INFO   formats.importer.cli.CommandLineImporter - Log levels -- Bio-Formats: ERROR OMER
...[      main] INFO      ome.formats.importer.ImportCandidates - Depth: 4 Metadata Level: MINIMUM
...[      main] INFO      ome.formats.importer.ImportCandidates - 1 file(s) parsed into 1 group(s) with
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Attempting initial SSL connection to
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Insecure connection requested, fallin
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Server: 5.0.0
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Client: 5.0.0-rc1-DEV-ice35
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Java Version: 1.7.0_51
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - OS Name: Linux
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - OS Arch: amd64
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - OS Version: 3.8.0-27-generic
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILESET_UPLOAD_PREPARATION
...[      main] INFO          ome.formats.importer.ImportConfig - OMERO Version: 5.0.0-rc1-DEV-ice35
...[      main] INFO          ome.formats.importer.ImportConfig - Bioformats version: 5.0.0-rc1-DEV-ice3
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILESET_UPLOAD_START
...[      main] INFO   s.importer.transfers.SymlinkFileTransfer - Transferring /tmp/a.fake...
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILE_UPLOAD_STARTED: /tmp/a.fake
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILE_UPLOAD_COMPLETE: /tmp/a.fake
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILESET_UPLOAD_END
...[l.Client-1] INFO   ormats.importer.cli.LoggingImportMonitor - METADATA_IMPORTED Step: 1 of 5  Logfil
...[l.Client-0] INFO   ormats.importer.cli.LoggingImportMonitor - PIXELDATA_PROCESSED Step: 2 of 5  Log
...[l.Client-1] INFO   ormats.importer.cli.LoggingImportMonitor - THUMBNAILS_GENERATED Step: 3 of 5  Lo
...[l.Client-0] INFO   ormats.importer.cli.LoggingImportMonitor - METADATA_PROCESSED Step: 4 of 5  Logfi
...[l.Client-1] INFO   ormats.importer.cli.LoggingImportMonitor - OBJECTS_RETURNED Step: 5 of 5  Logfile
...[l.Client-0] INFO   ormats.importer.cli.LoggingImportMonitor - IMPORT_DONE Imported file: /tmp/a.fake
Imported pixels:
5001
Other imported objects:
Fileset:4102
Image:5001
...[l.Client-0] INFO      ome.formats.importer.cli.ErrorHandler - Number of errors: 0
```

The only visible difference here is the line:

```
...formats.importer.cli.CommandLineImporter - Setting transfer to ln_s
```

Rather than uploading via the OMERO API, the command-line importer makes a call to the system *ln* command.

9.2.6 Transfer options

Previously, OMERO only offered the option of uploading via the API. Files were written in blocks via the RawFileStore interface. With in-place import, several options are provided out of the box as well as the ability to use your own.

"ln_s" - soft-linking

The most flexible option is soft-linking. For each file, it executes *ln -s source target* on the local file system. This works across file system boundaries and leaves a clear record of what file was imported:

```
/OMERO/ManagedRepository/root_0/2014-01/24/10-11-14.947$ ls -ltra
total 8
lrwxrwxrwx 1 omero omero   11 Jan 24 10:11 my-file.dv -> /home/demo/my-file.dv
```

Here you can see in the imported file set, a soft-link which belongs to the *omero* user, but which points to a file in the */home/demo* directory.

Deleting the imported images in OMERO will delete the **soft link** but **not** the original file under */home*. This could come as a surprise to users, since the deletion will effectively free no space.

Warning: The deletion of the original files under */home* (or equivalent) **will lead to a complete loss of the data since no copy is held in OMERO**. Therefore, this method should only be used in conjunction with a properly managed and backed-up data repository. If the files are corrupted or deleted, there is no way to use OMERO to retrieve them.

"ln" - hard-linking

The safest option is hard-linking, though it cannot be used across file systems. For each file, it executes *ln source target*. Attempting to hard link across file system boundaries will lead to an error:

```
...[      main] INFO          ome.formats.importer.ImportConfig - OMERO Version: 5.0.0-rc1-DEV-ice35
...[      main] INFO          ome.formats.importer.ImportConfig - Bioformats version: 5.0.0-rc1-DEV-ice3
...[      main] INFO   formats.importer.cli.CommandLineImporter - Setting transfer to ln
...[      main] INFO   formats.importer.cli.CommandLineImporter - Log levels -- Bio-Formats: ERROR OMER
...[      main] INFO      ome.formats.importer.ImportCandidates - Depth: 4 Metadata Level: MINIMUM
...[      main] INFO      ome.formats.importer.ImportCandidates - 1 file(s) parsed into 1 group(s) with
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Attempting initial SSL connection to
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Insecure connection requested, fallin
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Server: 5.0.0
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Client: 5.0.0-rc1-DEV-ice35
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - Java Version: 1.7.0_51
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - OS Name: Linux
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - OS Arch: amd64
...[      main] INFO       ome.formats.OMEROMetadataStoreClient - OS Version: 3.8.0-27-generic
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILESET_UPLOAD_PREPARATION
...[      main] INFO          ome.formats.importer.ImportConfig - OMERO Version: 5.0.0-rc1-DEV-ice35
...[      main] INFO          ome.formats.importer.ImportConfig - Bioformats version: 5.0.0-rc1-DEV-ice3
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILESET_UPLOAD_START
...[      main] INFO   .importer.transfers.HardlinkFileTransfer - Transferring /tmp/a.fake...
...[      main] INFO   ormats.importer.cli.LoggingImportMonitor - FILE_UPLOAD_STARTED: /tmp/a.fake
...[      main] ERROR  .importer.transfers.HardlinkFileTransfer - transfer process returned 1
...[      main] ERROR  .importer.transfers.HardlinkFileTransfer - error in closing raw file store
omero.ResourceError: null
    at sun.reflect.NativeConstructorAccessorImpl.newInstance0(Native Method) ~[na:1.7.0_51]
    at sun.reflect.NativeConstructorAccessorImpl.newInstance(NativeConstructorAccessorImpl.java:57) ~[na
    at sun.reflect.DelegatingConstructorAccessorImpl.newInstance(DelegatingConstructorAccessorImpl.java:
    at java.lang.reflect.Constructor.newInstance(Constructor.java:526) ~[na:1.7.0_51]
    at java.lang.Class.newInstance(Class.java:374) ~[na:1.7.0_51]
    at IceInternal.BasicStream.createUserException(BasicStream.java:2615) ~[ice.jar:na]
    at IceInternal.BasicStream.access$300(BasicStream.java:12) ~[ice.jar:na]
    at IceInternal.BasicStream$EncapsDecoder10.throwException(BasicStream.java:3099) ~[ice.jar:na]
    at IceInternal.BasicStream.throwException(BasicStream.java:2077) ~[ice.jar:na]
    at IceInternal.Outgoing.throwUserException(Outgoing.java:538) ~[ice.jar:na]
    at omero.api._RawFileStoreDelM.close(_RawFileStoreDelM.java:466) ~[blitz.jar:na]
    at omero.api.RawFileStorePrxHelper.close(RawFileStorePrxHelper.java:1739) ~[blitz.jar:na]
    at omero.api.RawFileStorePrxHelper.close(RawFileStorePrxHelper.java:1701) ~[blitz.jar:na]
    at ome.formats.importer.transfers.AbstractFileTransfer.cleanupUpload(AbstractFileTransfer.java:123)
    at ome.formats.importer.transfers.AbstractExecFileTransfer.transfer(AbstractExecFileTransfer.java:6
    at ome.formats.importer.ImportLibrary.uploadFile(ImportLibrary.java:410) [blitz.jar:na]
    at ome.formats.importer.ImportLibrary.importImage(ImportLibrary.java:465) [blitz.jar:na]
    at ome.formats.importer.ImportLibrary.importCandidates(ImportLibrary.java:274) [blitz.jar:na]
    at ome.formats.importer.cli.CommandLineImporter.start(CommandLineImporter.java:218) [blitz.jar:na]
    at ome.formats.importer.cli.CommandLineImporter.main(CommandLineImporter.java:658) [blitz.jar:na]
2014-01-31 12:59:20,338 3152       [      main] ERROR        ome.formats.importer.ImportLibrary - Error
java.lang.RuntimeException: transfer process returned 1
    at ome.formats.importer.transfers.AbstractExecFileTransfer.exec(AbstractExecFileTransfer.java:137)
    at ome.formats.importer.transfers.AbstractExecFileTransfer.transfer(AbstractExecFileTransfer.java:5
```

```
    at ome.formats.importer.ImportLibrary.uploadFile(ImportLibrary.java:410) ~[blitz.jar:na]
    at ome.formats.importer.ImportLibrary.importImage(ImportLibrary.java:465) ~[blitz.jar:na]
    at ome.formats.importer.ImportLibrary.importCandidates(ImportLibrary.java:274) ~[blitz.jar:na]
    at ome.formats.importer.cli.CommandLineImporter.start(CommandLineImporter.java:218) [blitz.jar:na]
    at ome.formats.importer.cli.CommandLineImporter.main(CommandLineImporter.java:658) [blitz.jar:na]
2014-01-31 12:59:20,338 3152       [      main] INFO         ome.formats.importer.ImportLibrary - Exiti
```

The safeness of this method comes from the fact that OMERO *also* has a pointer to the data. Deletion of the original file under */home* would leave data in OMERO in place. Again, this could cause a surprise as the space would not be properly freed, but at least there cannot be an accidental loss.

> **Warning:** The primary concern with this method is **modification** of files. If the original data is *written* by a user, unexpected results could follow in OMERO. See the *Safety tips* section above for ways around this.

If you are unclear about how hard-linking works, please see the Hard link[4] article on Wikipedia.

The semantics of hard-linking have changed recently on Linux systems with the "protected hardlinks" feature, which is enabled by default and is in use on Ubuntu 14.04, CentOS 7 and other contemporary systems. When you create a hard-link to a file, Linux now requires that you are either the *owner* of the file, or that you have *read-write permissions* to the file. Other Unix systems, and older Linux systems, allow a hard-link to be made if you have *search access* to the file (i.e. you have appopriate read and execute permissions on the directory path containing the file), but do not check the file permissions themselves. See the kernel-hardening mailing list post[5] which describes the change in more detail. The implication for in-place import is that the user performing the import must own or have read-write permissions on the data files being imported in-place.

"ln_rm" - moving

Finally, the least favored option is *ln_rm*. It first performs a hard-link like *ln*, but once the import is complete it attempts to delete the original file. This is currently in testing as an option for DropBox but is unlikely to be of use to general users. Although this option is more limited than the *upload_rm* option below it will be much faster.

"upload_rm" - uploading and deleting

This option, available from OMERO 5.0.3, is not strictly an in-place option but is detailed here for convenience. It first performs a file upload like default import, but once the import is complete it attempts to delete the original files. It deletes the original files **if and only if** the import is successful.

"cp" and "cp_rm" variants

New in 5.0.7, the *cp* and *cp_rm* commands provide the same functionality as *ln* and *ln_rm* but perform a copy rather than a link operation. The benefit of a copy is that it works over OS filesystem boundaries while still providing the integrity that *ln_s* cannot. The primary downside of a raw *cp* compared to *ln* is that there is data duplication. *cp_rm* being very similar to *ln_rm usually* works around this downside, except in the case of a failed import. Then the duplicated data will remain in OMERO and an explicit cleanup step will need to be taken.

Your own file transfer

If none of the above options work for you, it is also possible to write your own implementation of the *ome.formats.importer.transfers.FileTransfer* class, likely subclassing *ome.formats.importer.transfers.AbstractFileTransfer* or *ome.formats.importer.transfers.AbstractExecFileTransfer*. If you do so, please let us know how we might improve either the interface or the implementations that we provide.

Once your implementation has been compiled into a jar and placed in the *lib/clients* directory, you can invoke it using:

[4] http://en.wikipedia.org/wiki/Hard_link
[5] http://www.openwall.com/lists/kernel-hardening/2012/02/21/20

```
$ bin/omero import -- --transfer=example.package.ClassName ...
```

9.2.7 Related advanced options

In addition to the *--transfer* option in 5.0.0, a number of other advanced options have been added which may be useful for either tweaking import performance or dealing with complicated situations. However, like *--transfer*, these options should be considered experimental and **may change in subsequent releases**. Comments and suggestions are very welcome.

Checksums

If you think that calculating the checksums for your large files is consuming too much time, you might want to configure the checksum algorithm used. This can be done with the *--checksum_algorithm* property. Available options are printed with the *--advanced-help* option and include Adler-32, CRC-32, MD5-128, Murmur3-32, Murmur3-128, and the default SHA1-160.

DropBox

As described in the scenarios "*DropBox import (automatic delete)*" and "*In-place DropBox import (automatic delete)*", *DropBox* can be configured to use any of the options described above. The configuration property to modify is *omero.fs.importArgs*:

```
$ bin/omero config set -- omero.fs.importArgs "--transfer=upload_rm"
```

This will **move** files into OMERO rather than leaving a copy in the DropBox directory.

```
$ bin/omero config set -- omero.fs.importArgs "--transfer=ln_rm"
```

This will also **move** files into OMERO rather than leaving a copy in the DropBox directory. For this to work, the two directories will need to be on the same file system. This option is much faster than *upload_rm*. Please read *"ln_rm" - moving* carefully to ensure you fully understand the implications of using this option.

Warning: Use at your own risk!

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

9.3 Advanced import scenarios

Increasingly users of OMERO are needing to go beyond the traditional "upload via a GUI"-style import model to more powerful methods.

There is a set of requirements for getting data into OMERO that is common to many institutions. Some of the requirements may be mutually exclusive.

- Users need to get data off microscopes quickly. This likely includes not waiting for import to complete. Users will often move data immediately, or even save remotely during acquisition.
- Users would like direct access to the binary repository file-system to read original files for analysis.
- Users would like to view and begin working with images as soon as possible after acquisition.

Below we explain which options are available to you, and why there is a trade-off between the above requirements.

9.3.1 Import overview

In OMERO 4 and earlier versions, data was uploaded to the binary repository in an opaque form; starting with OMERO 5, files are uploaded to the repository in their original form using Bio-Formats.

The "OMERO binary repository" (or repo) is the directory belonging to the OMERO user where files are imported:

- The *ManagedRepository* directory inside of the repo is where files go during import into OMERO 5. Each user receives a top-level directory inside of "ManagedRepository" which fills with timestamped directories as imports accrue.
- Depending on the permissions of this directory, users may or may not be able to see their imported files. Managing the permissions is the responsibility of the system administrator.

In "normal import", files are copied to the OMERO binary repo via the API and so can work remotely or locally. In *"in-place import"*, files are "linked" into place.

Warning: In-place import is a new, powerful feature - it is critical that you read and understand the *documentation* before you consider using it.

9.3.2 Traditional import

Manual import (GUI)

This is the standard workflow and the one currently used at the University of Dundee. Users dump data to a shared file-system from the acquisition system, and then use the OMERO.insight client from the lab to import.

Advantages

- Users can validate that import worked.
- Failed imports can be repeated and/or reported to QA etc.
- Users do not have to wait for import to be scheduled.
- Import destination is known: Project/Dataset etc.

Disadvantages

- Imports can be slow due to the data transfer from file-system to OMERO via the client.
- Users must remember to delete data from the shared file-system to avoid data duplication.
- Users cannot access the OMERO binary repo directly and must download original data via clients for local analysis.

Manual import (CLI)

Another typical workflow is that rather than using the GUI, users perform the same procedure as under "Manual import" but with the *command-line (CLI) importer*.

Advantages

- With a CLI workflow, it may be easier for users to connect remotely to kick off an import and to leave it running in the background for a long period of time.

Disadvantages

All the same disadvantages apply as under "Manual import (GUI)".

Cronjob import (manual delete)

For importing via cron, users still dump their data to a shared file-system from the acquisition system. They must have permissions to write to "their" directory which is mapped to a user in OMERO.

A cronjob starts a CLI import, possibly at night. The cronjob could be given admin rights in OMERO to perform an "Import As" for a particular user.

Disadvantages

- If a normal import is used, the cronjob would have to manually delete imported files from their original location to avoid duplication.
- Users cannot work with their data in OMERO until some time after acquisition.
- Failed imports are logged within the managed repository but not yet notified. Logs would probably need to be accessed via a sysadmin/cli. The cronjob could capture stdout and stderr and check for failures.

DropBox import (manual delete)

Similar to the cronjob scenario, DropBox importing requires that users drop their data in "their" directory which has special permissions for writing. The DropBox service monitors those directories for modifications and imports the files on a first-come-first-serve basis.

Advantages

- Users should see their data in OMERO quickly.

Disadvantages

- There is a limitation on the rate of new files in monitored locations.
- There is also a limitation on which file systems can be used. A networked file share **cannot** be monitored by DropBox.
- Users must manually delete imported files from their DropBox directory to avoid duplication.
- Failed imports are logged within the managed repository but not yet notified. Logs would probably need to be accessed via a sysadmin or through the CLI and searched by the user and file name.

DropBox import (automatic delete)

One option that exists from OMERO 5.0.3 is to have files removed from DropBox automatically after a successful import. This is achieved by first performing an "upload" import from the DropBox directory to the ManagedRepository and then by deleting the data from DropBox **if and only if** the import was successful. For failed imports, files will remain in the DropBox directories until someone manually deletes them.

Advantages

- For all successful imports, files will be automatically removed from the DropBox directories thus reducing duplication.

9.3.3 In-place import

The following sections outline *in-place* based scenarios to help you judge if the functionality may be useful for you.

Common advantages

- All in-place import scenarios provide non-copying benefit. Data that is too large to exist in multiple places, or which is accessed too frequently in its original form to be renamed, remains where it was originally acquired.

Common disadvantages

- Like the DropBox import scenario above, all in-place imports require the user to have access to the user-based directories under the ManagedRepository. See *limitations* for more details.
- Similarly, all the following scenarios carry the same burden of securing the data externally to OMERO. This is the primary difference between a normal import and an in-place import: **backing up OMERO is no longer sufficient to prevent data loss. The original location must also be secured!** This means that users must not move or alter data once imported.

In-place manual import (CLI)

The in-place version of a CLI manual import is quite similar to the normal CLI import, with the primary difference being that the data is not transferred from the shared file-system where the data is initially stored after acquisition, but instead is just "linked" into place.

Advantages

- Local filesystem in-place import is faster than traditional importing, due to the lack of a data transfer.

Disadvantages

- Requires proper security setup as explained above.

In-place Cronjob import

Assuming all the restrictions are met, the cronjob-based workflow above can carry out an in-place import by adding the in-place transfer flag. The advantages and disadvantages are as above.

In-place DropBox import (manual delete)

Just as with the in-place cronjob import, using in-place import for DropBox is as straight-forward as passing the in-place flag. The common advantages and disadvantages of in-place import apply.

In-place DropBox import (automatic delete)

An option that also exists in the in-place scenario is to have files removed from DropBox automatically after a successful import. This is achieved by first performing a "hardlink in-place import" from the DropBox directory to the ManagedRepository and then by deleting the data from DropBox **if and only if** the import was successful. For failed imports, files will remain in the DropBox directories until someone manually deletes them.

Advantages

- For all successful imports, files will be automatically removed from the DropBox directories.

Disadvantages

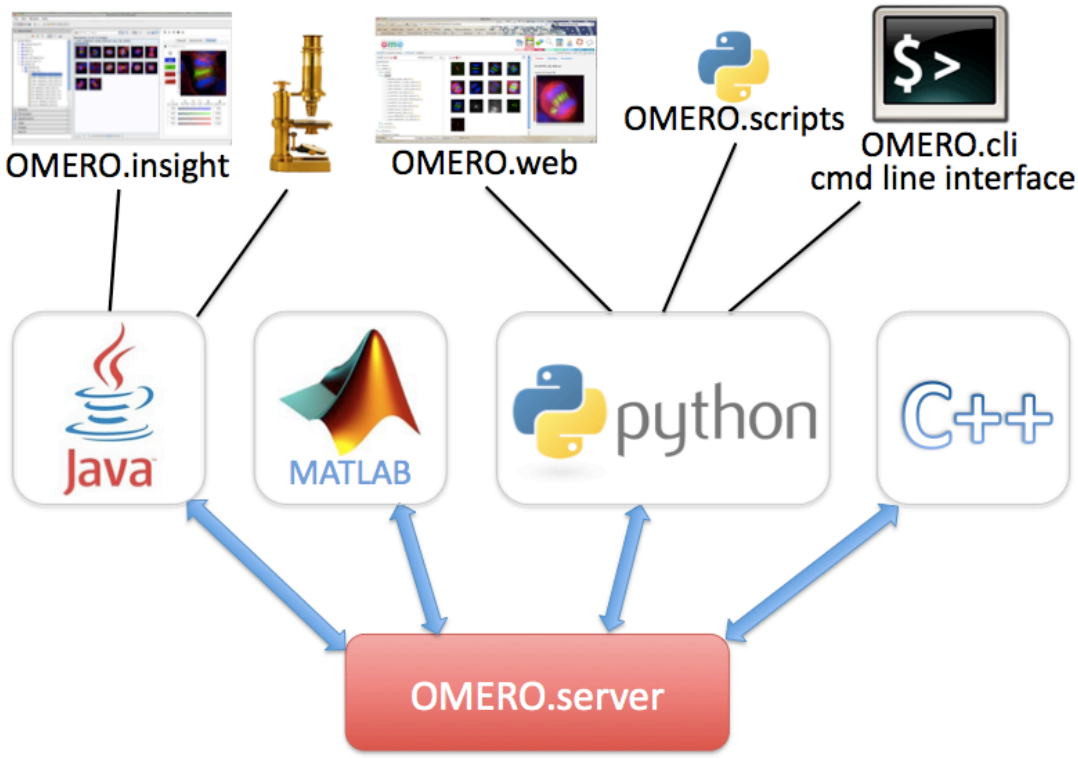
- This option is only available if the filesystem which DropBox watches is the same as the file system which the ManagedRepository lives on. This prevents the use of network file systems and similar remote shares.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

Part III

Developer Documentation

The following documentation is for developers wishing to write OMERO client code or extend the OMERO server. Instructions on downloading[6], installation and administering OMERO can be found under the *System Administrator Documentation* of the main site.



OMERO is an open source client/server system written in Java for visualizing, managing, and annotating microscope images and metadata. The *OMERO Application Programming Interface* allows clients to be written in *Java*, *Python*, *C++* or *MATLAB*. OMERO releases include a Java client OMERO.insight, a Python-based web client OMERO.web and the *Command Line Interface as an OMERO development tool*, which also uses Python. There is also an ImageJ plugin. OMERO can be extended by modifying these clients or by writing your own in any of the supported languages (see figure). OMERO also supports a *Scripting Service* which allows Python scripts to be run on the server and called from any of the other clients.

OMERO is designed, developed and released by the Open Microscopy Environment[7], with contributions from Glencoe Software, Inc.[8] OMERO is released under the GNU General Public License (GPL)[9] with commercial licenses and customization available from Glencoe Software, Inc.[10]. You can read about how OMERO has developed since the project started in the *OMERO version history*.

For help with any aspect of OMERO, see details of our forums and mailing lists[11].

[6] http://downloads.openmicroscopy.org/latest/omero/
[7] http://www.openmicroscopy.org/site
[8] http://www.glencoesoftware.com/
[9] http://www.gnu.org/copyleft/gpl.html
[10] http://www.glencoesoftware.com/
[11] http://www.openmicroscopy.org/site/community/

CHAPTER

TEN

INTRODUCTION TO OMERO

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

10.1 What's new for OMERO 5.2 for developers

- The *Version requirements* section provides extensive details about which operating systems and dependency versions we intend to support for the life of 5.2 and the likely changes to these for the next major release (currently planned to be 5.3). Most notably for development purposes, we have dropped support for Java 1.6.

10.1.1 Breaking changes

OMERO.web

OMERO.web has undergone a major upgrade, updating jsTree to version 3.0.8 and using json for all tree loading to substantially improve performance.

If you have web code that directly works with the jsTree, you will need to update it according to the jsTree docs[1].

A number of new URLs are available in webclient, with the /api/ prefix that provide json data for the jsTree. However, these may soon be moved to a different Django app and should not yet be considered stable.

Graphs

The API's request operations Chmod[2], Chgrp[3], Chown[4], Delete[5], and their superclass GraphModify[6], were deprecated in 5.1 and will be removed in 5.3. They are replaced by Chmod2[7]Chgrp2[8], Chown2[9], Delete2[10], and their superclass GraphModify2[11]. OMERO developers who have not migrated yet should refer to *Using the new 5.1 graph requests* and take action before the deprecated features are removed.

Java Gateway

The Java gateway has undergone a major overhaul which should make the development of Java applications much easier. As part of this, `pojos` has been renamed as `omero.gateway.model`. We do not intend to modify the methods already available but this

[1] https://www.jstree.com/
[2] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chmod.html
[3] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp.html
[4] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chown.html
[5] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Delete.html
[6] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify.html
[7] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chmod2.html
[8] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp2.html
[9] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chown2.html
[10] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Delete2.html
[11] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify2.html

work should still be considered as under development as we move towards the gateway becoming a stable public API. Feedback as always is welcome. See *OMERO Java language bindings* for more information or follow the example in minimal-omero-client[12].

OMERO model

The `Rect` class has been renamed to `Rectangle` to match the OME-XML schema. This requires the corresponding change to be made in client software that uses the OMERO.blitz server API to work with ROIs.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

10.2 Installing OMERO from source

10.2.1 Using the source code

The source code of each release of OMERO is available for download from the Source code[13] section of the OMERO download page.

Note: At the moment, this source code bundle does not contain the version of Bio-Formats. To include this version information, you will need to manually copy the `ant/gitversion.xml` file included in the source code bundle of Bio-Formats for the same release under `components/bioformats/ant`.

10.2.2 Using the Git source repository

To use the Git source repository, you will need to install Git on your system. See the Using Git[14] section of the Contributing documentation for more information on how to install and configure Git.

The main repository for OMERO is available from https://github.com/openmicroscopy/openmicroscopy. Most OME development is currently happening on GitHub, therefore it is highly suggested that you become familiar with how it works, if not create an account for yourself.

Start by cloning the official repository:

```
git clone https://github.com/openmicroscopy/openmicroscopy.git
```

Since the openmicroscopy repository now makes use of submodules, you first need to initialize all the submodules:

```
cd openmicroscopy
git submodule update --init
```

Alternatively, with version 1.6.5 of git and later, you can pass the `--recursive` option to git clone and initialize all submodules:

```
git clone --recursive https://github.com/openmicroscopy/openmicroscopy.git
```

See also:

Using Git[15] Section of the contributing documentation explaining how to use Git for contributing to the source code.

[12] https://github.com/ome/minimal-omero-client
[13] http://downloads.openmicroscopy.org/latest/omero/#code
[14] http://www.openmicroscopy.org/site/support/contributing/using-git.html

10.2.3 Building OMERO

To install the dependencies required to run the OMERO.server on Linux or Mac OS X, take a look at the *OMERO.server installation* page where you will also find links to walk-throughs for specific platforms.

Some environment variables may need to be set up before building the server:

- If the system slice files cannot be found you must set `SLICEPATH` to point to the `slice` directory of the Ice installation.

Once all the dependencies and environment variables are set up, you can build the server using:

```
python build.py
```

or the clients using:

```
python build.py release-clients
```

See also:

Build System Section of the developer documentation detailing the build system

---

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

10.3 Build System

Overview

The page goes into details about how the build system is configured.

OMERO mostly uses an Ant[16]-based build with dependency management provided by Ivy[17]. *C++ code* is built using Cmake and Python uses the traditional distutils/setuptools tools.

10.3.1 Structure of the build

This is an (abbreviated) snapshot of the structure of the filesystem for OMERO:

```
OMERO_SOURCE_PREFIX
|
|-- build.xml ......................... Top-level build file
|
|-- build.py .......................... Python wrapper to handle OS-specific configuration
|
|-- omero.class ....................... Self-contained Ant launcher
|
|--etc ................................ Configuration folder
|   |-- grid .......................... Deployment files folder
|   |-- ivysettings.xml ............... Main Ivy configuration file
|   |-- hibernate.properties
|   |-- build.properties
|   |-- logback.xml
|   |-- omero.properties
|   \-- profiles
|
```

[16] http://ant.apache.org
[17] http://ant.apache.org/ivy

```
|-- examples ........................... User examples
|
\components
  |
  |--<component-name> .................. Each component has this same basic structure.
  |    |-- build.xml ................... Build file
  |    |-- ivy.xml ..................... Jar dependencies
  |    |-- test.xml .................... Test dependencies
  |    |-- src ......................... Source code
  |    |-- resources ................... Other files of interest
  |    |-- test ........................ Test source code and test resources
  |    \-- target ...................... Build output (deleted on clean)
  |
  |  NOTABLE COMPONENTS
  |
  |-- model ............................ The model component is special in that it produces
  |                                      a jar specific to your database choice: model-psql.jar
  |                                      The generated 'ome.model.*' files contain Hibernate
  |                                      annotations for object-relational mapping.
  |
  |-- blitz ............................ The blitz component also performs code generation
  |                                      producing artifacts for Java, Python, and C++.
  |                                      and other build tools.
  |
  |--tools ............................. Other server-components with special build needs.
  |    |--build.xml .................... Build scripts
  |    |
  |    \--<tool-name>
  |         |--build.xml ............... Build file
  |         \--ivy.xml ................. Jar dependencies
  |
  \--antlib ............................ Special component which is not built, but referenced by the bu
      |
      \--resources ..................... Build resources
          |--global.xml ................ Global build properties
          |--hibernate.xml
          |--lifecycle.xml ............. Ivy-related targets
          \--version.xml ............... Version properties
```

Note: User examples are explained under *Working with OMERO*

Unfortunately, just the above snapshot of the code repository omits some of the most important code. Many megabytes of source code is generated both by our own DSLTask[18] as well as by the Ice[19] `slice2java`, `slice2cpp`, and `slice2py` code generators. These take an intermediate representation of the OME-Model[20] and generate our *OME-Remote Objects*. This code is not available in git, but once built, can be found in all the directories named "generated".

10.3.2 Build tools

Ant

`./build.py` is a complete replacement for your local ant install. In many cases, you will be fine running **ant**. If you have any issues (for example `OutOfMemory`) , please use `./build.py` instead. **However, only use one or the other; do not mix calls between the two.**

The main build targets are defined in the top-level `build.xml` file. All available targets can be listed using:

[18] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/dsl
[19] https://zeroc.com
[20] http://www.openmicroscopy.org/site/support/ome-model/ome-xml/

```
./build.py -p
```

Each of the component contains a `build.xml` and can be built directly using:

```
./build.py -f components/server/build.xml
```

This will call the default `dist` target for each component.

Ivy

The build system uses Ivy[21] 2.3.0 as the dependency manager. The general Ivy configuration is defined in a settings file[22] located under etc/ivysettings.xml[23].

In order to determine the transitive closure of all dependencies, Ivy resolves each `ivy.xml` file and stores the resolved artifacts in a cache[24] to speed up other processes. The OMERO build system defines and uses two kinds of caches:

1. the local dependencies cache under `lib/cache` is used by most resolvers
2. Maven resolvers use the Maven cache under `~/.m2/repository`

Note: When the Ivy configuration file or the version number is changed, the cache can become stale. Calling `./build.py clean` from the top-level build will delete the content of the local cache.

Resolvers[25] are key to how Ivy functions. Multiple dependency resolvers can be defined fine-grained enough to resolve an individual jar in order to pick up the latest version of any library from a repository[26], a generic URL[27] or from the local file system[28]. Since OMERO 5.1.3, the remote repository resolvers are set up to resolve transitive dependencies.

The OMERO build system uses by default a chain resolver[29] called `omero-resolver` which resolves the following locations in order:

1. `target/repository` which contains most artifacts published by the build system in the *install* step of the lifecycle
2. the local dependency repository under `lib/repository`
3. the local Maven cache under `~/.m2/repository`
4. the Maven central repository[30]
5. the OME artifactory[31]

Bio-Formats dependencies are resolved using a specific chain resolver[32] called `ome-resolver` which resolves the following locations in order:

1. the local Maven cache under `~/.m2/repository`
2. the OME artifactory[33]

To define its dependencies, each component uses a top-level Ivy file[34], `ivy.xml`, for the build and optionally another Ivy file, `test.xml`, for the tests.

The OMERO build system defines and uses four types of Ivy configurations[35]:

[21] http://ant.apache.org/ivy
[22] http://ant.apache.org/ivy/history/2.3.0/settings.html
[23] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/ivysettings.xml
[24] http://ant.apache.org/ivy/history/2.3.0/settings/caches/cache.html
[25] http://ant.apache.org/ivy/history/2.3.0/settings/resolvers.html
[26] http://ant.apache.org/ivy/history/2.3.0/resolver/ibiblio.html
[27] http://ant.apache.org/ivy/history/2.3.0/resolver/url.html
[28] http://ant.apache.org/ivy/history/2.3.0/resolver/filesystem.html
[29] http://ant.apache.org/ivy/history/2.3.0/resolver/chain.html
[30] http://central.sonatype.org
[31] http://artifacts.openmicroscopy.org
[32] http://ant.apache.org/ivy/history/2.3.0/resolver/chain.html
[33] http://artifacts.openmicroscopy.org
[34] http://ant.apache.org/ivy/history/2.3.0/ivyfile.html
[35] http://ant.apache.org/ivy/history/2.3.0/ivyfile/configurations.html

1. build: defines dependencies to be used for building
2. server: defines dependencies to be bundled under `lib/server`
3. client: defines dependencies to be bundled under `lib/client`
4. test: defines dependencies to be used for running the tests

While building, most Java components follow the same lifecycle define in lifecycle.xml[36]. The default *dist* target for each component calls each of the following steps in order:

1. retrieve: retrieve[37] the resolved dependencies and copy them under `target/libs`
2. prepare: prepare various resources (property files, lib/logback-build.xml[38])
3. generate: copy all resources from the previous step for compilation
4. compile: compile the source files into the destination repository
5. package-extra: package the sources and the Javadoc into Jar files for publication
6. package: package the compiled classes into a Jar file for publication
7. install: convert the component Ivy file into a pom file using makepom[39] and publish[40] the component artifacts

Individual components can override the content of this default lifecycle via their `build.xml`.

OmeroTools

The Ant[41] build alone is not enough to describe all the products which get built. Namely, the builds for the non-Java components stored under components/tools[42] are a bit more complex. Each tools component installs its artifacts to the tools/target directory which is copied **on top of** the `dist` top-level distribution directory.

Jenkins

The OME project currently uses Jenkins[43] as a continuous integration server available here[44], so many binary packages can be downloaded without compiling them yourself. See the Continuous Integration documentation[45] for further details.

10.3.3 Server build

The default ant target (`build-default`) will build the OMERO system and copy the necessary components for a binary distribution to the `dist` directory. Below is a comparison of what is taken from the build, where it is put, and what role it plays in the distribution.

OMERO_SOURCE_PREFIX	OMERO_SOURCE_PREFIX/dist	Comments
components/blitz/target/blitz.jar	`lib/server`	Primary Ice servants
components/blitz/target/server.jar	`lib/server`	Primary server logic
components/tools/OmeroCpp/lib*	`lib/`	Native shared libraries
components/tools/OmeroPy/build/lib	`lib/python`	Python libraries
lib/repository/<some>	`lib/client` & `lib/server`	Libraries needed for the build
etc/	`etc/`	Configuration
`sql/*.sql`	`sql/`	SQL scripts to prepare the database

Note: By default, *OMERO C++ language bindings* are not built. Use `build-all` for that.

These files are then zipped to OMERO.server-<version>.zip via `release-zip`

[36] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/antlib/resources/lifecycle.xml
[37] http://ant.apache.org/ivy/history/2.3.0/use/retrieve.html
[38] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/lib/logback-build.xml
[39] http://ant.apache.org/ivy/history/2.3.0/use/makepom.html
[40] http://ant.apache.org/ivy/history/2.3.0/use/publish.html
[41] http://ant.apache.org
[42] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools
[43] http://jenkins-ci.org
[44] https://ci.openmicroscopy.org/
[45] http://www.openmicroscopy.org/site/support/contributing/ci-omero.html

10.3.4 Coupled development

Since OMERO 5.1.3, Bio-Formats is decoupled from the OMERO build system which consumes Bio-Formats artifacts from the OME Maven repository via Ivy[46].

While this decoupling matches most of the development use cases, it is sometimes necessary to work on coupled Bio-Formats and OMERO branches especially during breaking changes of the OME Data Model or the Bio-Formats API.

The general rule for coupled branches is to build each component in their dependency order and use the local Maven repository under `~/.m2/repository` to share artifacts.

Building Bio-Formats

From the top-level folder of the Bio-Formats repository,

1. adjust the version of Bio-Formats which will be built, installed locally and consumed by OMERO e.g. for 5.2.0-SNAPSHOT:

```
$ ./tools/bump_maven_version.py 5.2.0-SNAPSHOT
```

2. run the Maven command allowing to build and install the artifacts under the local Maven cache:

```
$ mvn clean install
```

Building OMERO

From the top-level folder of the OMERO repository,

1. adjust the `versions.bioformats` property under etc/omero.properties[47] to the version chosen for the Bio-Formats build
2. adjust the `ome.resolver` property under etc/build.properties[48] to be `ome-resolver`
3. run the build system as usual:

```
$ ./build.py build-dev
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

10.4 Working with OMERO

This page describes various tools and resources useful for working with the OMERO API, as well as some tips on setting up your working environment. It should be useful to client developers working in any of the supported languages. For language specific info, see the following links: *OMERO Java language bindings*, *OMERO Python language bindings*, *OMERO C++ language bindings*, *OMERO MATLAB language bindings*.

10.4.1 OMERO.clients

The OMERO model is implemented as a relational PostgreSQL database on the OMERO.server and mapped to code-generated model objects used by the clients in the various supported languages (linked above). The OMERO API consists of a number of

[46] http://ant.apache.org/ivy
[47] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/omero.properties
[48] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/build.properties

services for working with these objects and associated binary data. Typically, clients will use various stateless services to query the OMERO model and then use the stateful services for exchange of binary data or image rendering.

A typical client interaction might have an outline such as:

- Log in to OMERO, obtaining connection and 'service factory'.
- Use the stateless 'Query Service' or 'Container Service' to traverse Projects, Datasets and Images.
- Use the stateful 'Rendering Engine' or 'Thumbnail Service' to view images.
- Use the stateful 'Raw Pixels Service' or 'Raw File Store' to retrieve pixel or file data for analysis.
- Create new Annotations or other objects and save them with the stateless 'Update Service'.
- Close stateful services to free resources and close the connection.

OMERO.clients use a common 'gateway' to communicate with an OMERO.server installation and allow the user to import, display, edit, and manage server data. The OMERO team has developed a suite of clients (see *OMERO clients overview*), but the open source nature of the OMERO project also allows developers to create their own, customized clients. If you are interested in doing this, further information is available on *Developing OMERO clients*.

10.4.2 OMERO server

Although most interactions with OMERO can be achieved remotely, you will generally find it easier to have the server installed on your development machine, particularly if you are going to be doing a lot of OMERO development. This gives you local access to the database, binary repository, logs etc. and means you can work 'off-line'.

Even if the server you are connecting to is remote, you will still want to have the server package available locally, so as to give you the command line tools, Python libraries, etc. It is important that all OMERO server and client libraries you use are the same OMERO version.

You may wish to work with the most recent OMERO release, or alternatively you can use the latest development code. Instructions on how to download or check out the code can be found on the main downloads page[49].

Regular builds of the server are performed by Jenkins[50] including generated Javadocs. See the contributing developer continuous integration[51] documentation for more information.

10.4.3 Environment variables

In addition to the install instructions, you might find it useful to set the following variables:

- OMERO_HOME: should be set to the directory containing the OMERO distribution or build (**note that we do not recommend setting this variable for production servers, it is for development usage only** - see *Setting the OMERO_HOME environment variable*)

```
# E.g. If you built the server yourself
export OMERO_PREFIX=~/Desktop/OMERO/dist
# Or you downloaded a release package
export OMERO_PREFIX=~/Desktop/OMERO.server-5.0.x
```

- Add the /bin/ directory to your PATH - allows you to call the 'omero' command from anywhere

```
export PATH=$PATH:$OMERO_PREFIX/bin/
```

- For Python developers, set your PYTHONPATH as follows

```
export PYTHONPATH=$PYTHONPATH:$OMERO_PREFIX/lib/python/
```

[49] http://downloads.openmicroscopy.org/latest/omero/
[50] http://jenkins-ci.org
[51] http://www.openmicroscopy.org/site/support/contributing/ci-omero.html

Now checkout the CLI.

```
$ omero -h
```

10.4.4 Network hopping for laptops

By default OMERO will bind to all available interfaces. On a laptop this has the undesirable effect of requiring an OMERO restart when changing network connections, e.g. from a home to a work network connection. To avoid this, it is possible to bind only on the localhost interface which will never change IP address.

```
$ omero config set Ice.Default.Host 127.0.0.1
# Restart to activate the new setting
$ omero admin restart
```

Note: Be warned, if doing this, it will no longer be possible to connect to the OMERO server instance from anywhere except the local machine.

10.4.5 Database access

It is useful to be able to directly query or browse the OMERO PostgreSQL database, which can be achieved with a number of tools. E.g.

- psql - this command line tool should already be installed. Depending on your permissions, you may need to connect as the 'postgres' user:

```
$ sudo -u postgres psql omero
Password:       # sudo password
omero=# \d;     # give a complete list of tables and views
omero=# \d annotation;          # list all the columns in a particular table
omero=# select id, discriminator, ns, textValue, file from annotation order by id desc;    # query
```

- pgAdmin[52] is a free, cross platform GUI tool for working with PostgreSQL

10.4.6 OMERO model

You can browse the OMERO model in a number of ways, one of which is by looking at the database itself (see above). Another is via the OMERO model API[53] documentation.

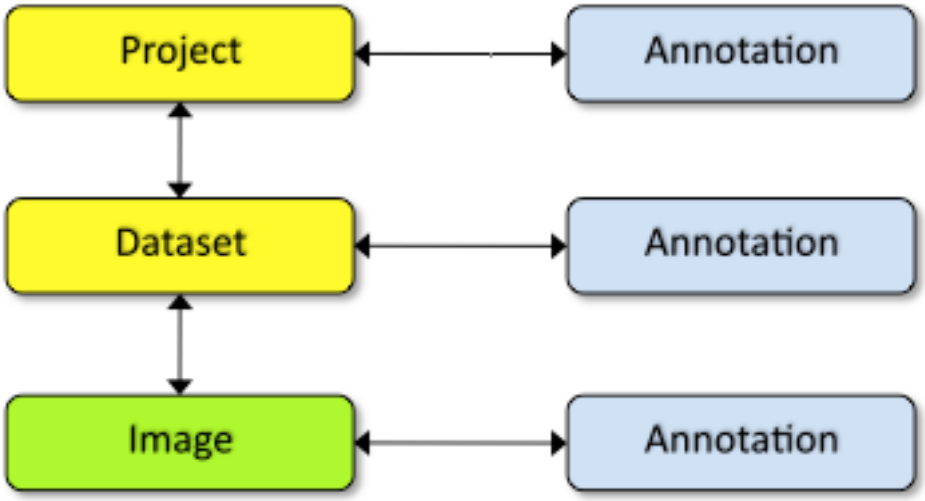
However, due to the complexity of the OMERO model, it is helpful to have some starting points (follow links below to the docs themselves).

Note: These figures show highly simplified outlines of various model objects.

Projects, datasets and images

Projects[54] and Datasets[55] are many-to-many containers for Images[56] (linked by ProjectDatasetLinks[57] and DatasetImageLinks[58] respectively).

[52] http://www.pgadmin.org/
[53] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model.html
[54] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Project.html
[55] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Dataset.html
[56] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Image.html
[57] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/ProjectDatasetLink.html
[58] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/DatasetImageLink.html



Projects, Datasets, Images and a number of other entities can be linked to Annotations (abstract superclass)[59] via specific links (ProjectAnnotationLink[60], DatasetAnnotationLink[61] etc). Annotation subclasses such as CommentAnnotation[62], FileAnnotation[63] etc. are stored in a single database table in OMERO (all Annotations have unique ID).

Images

Images in OMERO are made up of many entities. These include core image components such as Pixels[64] and Channels[65], as well as a large number of additional metadata objects such as Instrument (microscope), Objective, Filters, Light Sources, and Detectors.

10.4.7 Working with the OMERO model objects

For detailed information see *OME-Remote Objects* and *Developing OMERO clients* pages.

Objects that you wish to work with on the client must be loaded from OMERO, with the query defining the extent of any data graph that is "fetched".

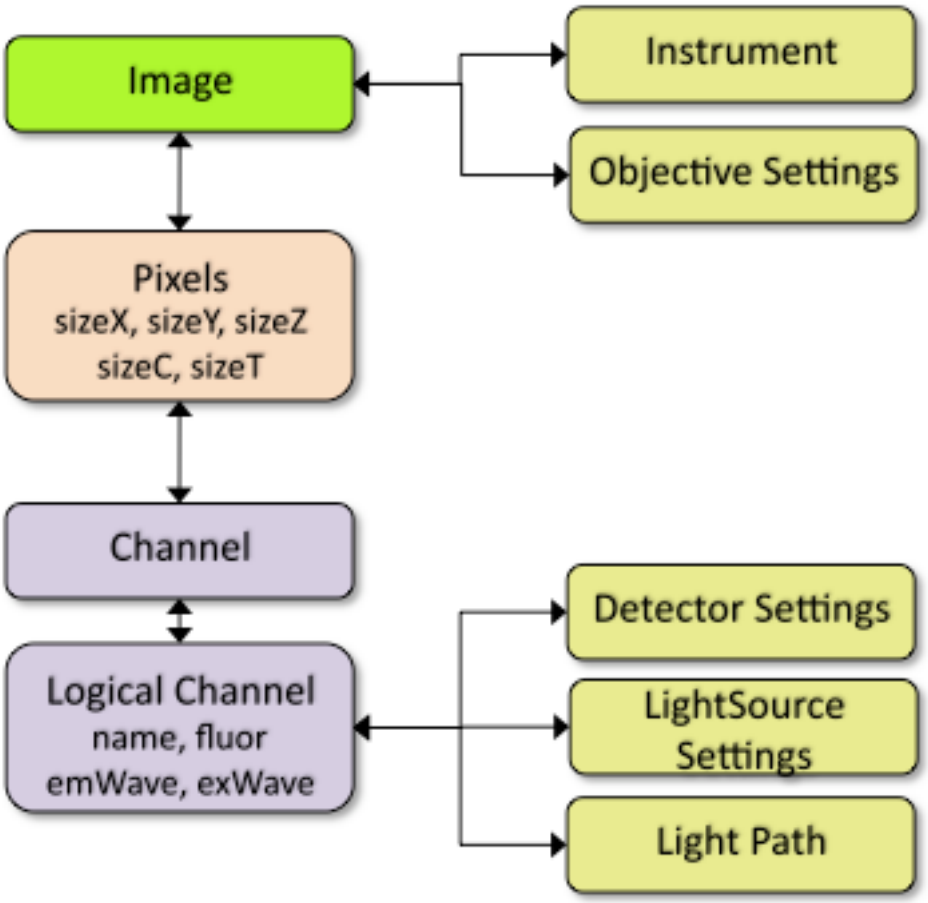
The *OMERO Application Programming Interface* supports two principle ways of querying OMERO and retrieving the objects. You can write SQL-like queries using the query service (uses "HQL") or you can use one of the other services that already has suitable queries. Using the query service is very flexible but it requires detailed knowledge of the OMERO model (see above) and is susceptible to any change in the model.

For example, to load a specific Project and its linked Datasets you could write a query like this:

```
queryService = session.getQueryService()
params = omero.sys.Parameters()
params.map = {"pid": rlong(projectId)}
query = "select p from Project p left outer join fetch p.datasetLinks as links left
           outer join fetch links.child as dataset where p.id=:pid"
project = queryService.findByQuery(query, params)
for dataset in project.linkedDatasetList:
    print dataset.getName().getValue()
```

Or use the Container Service like this:

[59] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Annotation.html
[60] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/ProjectAnnotationLink.html
[61] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/DatasetAnnotationLink.html
[62] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/CommentAnnotation.html
[63] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/FileAnnotation.html
[64] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Pixels.html
[65] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Channel.html




```
containerService = session.getContainerService()
project = containerService.loadContainerHierarchy("Project", [projectId], True)
for dataset in project.linkedDatasetList:
    print dataset.getName().getValue()
```

For a list of the available services, see the *OMERO Application Programming Interface* page.

10.4.8 Examples

HQL examples

HQL is used for Query Service queries (see above). Some examples, coupled with the references for the *OMERO model* and HQL syntax[66] should get you going, along with notes about object loading on the *OME-Remote Objects* page.

Note: If possible, it is advisable to use an existing API method from one of the other services (as for the container service above).

Although it is possible to place query parameters directly into the string, it is preferable (particularly for type-checking) to use the omero.sys.Parameters object:

```
queryService.findByQuery("from PixelsType as p where p.value='%s'" % pType, None)

# better to do
params = omero.sys.Parameters()
```

[66] https://docs.jboss.org/hibernate/orm/3.5/reference/en/html/queryhql.html

```
params.map = {"pType": rstring(pType)}
queryService.findByQuery("from PixelsType as p where p.value=:pType", params)
```

psql queries

Below are a number of example psql database queries:

```
# list any images that do not have pixels:
omero=#select id, name from Image i where i.id not in (select image from Pixels where image is not null

omero=# select id, name, ome_perms(permissions) from experimentergroup;
 id  |                        name                         | ome_perms
-----+-----------------------------------------------------+-----------
   0 | system                                              | -rw----
   1 | user                                                | -rwr-r-
   2 | guest                                               | -rw----
   3 | JRS-private                                         | -rw----
   4 | JRS-read-only                                       | -rwr---

omero=# select id, name, path, owner_id, group_id, ome_perms(permissions) from originalfile order by id
 id |       name                        |          path                                                | owner
----+-----------------------------------+--------------------------------------------------------------+------
 56 | GFP-FRAP.cpe.xml                  | /Users/will/omero/editor/GFP-FRAP.cpe.xml                    |

omero=# \x
Expanded display is on.
omero=# select id, discriminator, ns, textValue, file from annotation where id=369;
-[ RECORD 1 ]-+---------------------------------------------
id            | 369
discriminator | /type/OriginalFile/
ns            | openmicroscopy.org/omero/import/companionFile
textvalue     |
file          | 570

omero=# \x
Expanded display is off.
omero=# select * from joboriginalfilelink where parent = 7;
 id | permissions | version | child | creation_id | external_id | group_id | owner_id | update_id | par
----+-------------+---------+-------+-------------+-------------+----------+----------+-----------+----
 14 |        -103 |         |   110 |         891 |             |      208 |      207 |       891 |
 17 |        -103 |         |   113 |         926 |             |      208 |      207 |       926 |
(2 rows)

omero=# select id, name, path, owner_id, group_id, ome_perms(permissions) from originalfile where id in
 id  |       name        |                              path                                | owner_id | gr
-----+-------------------+------------------------------------------------------------------+----------+---
 113 | stdout            | /Users/will/omero/tmp/omero_will/75270/processuLq8fd.dir/out |      207 |
 110 | imagesFromRois.py | ScriptName061ea79c-f98c-447b-b720-d17003d6a72f                |        0 |
(2 rows)

# find all annotations on Image ID=2
omero=# select * from annotation where id in (select child from imageannotationlink where parent = 2) ;

# trouble-shooting postgres
omero=# select * from pg_stat_activity ;
```

bin/omero hql

You can use the omero `omero hql` command to query a remote OMERO database, entering your login details when requested.

Note: Because you will be querying the database under a particular login, the entries returned will be subject to the permissions of that login.

```
bin/omero hql -q --limit=10 "select name from OriginalFile where id=4106"
bin/omero hql -q --limit=10 "select id, textValue, file from Annotation a order by a.id desc"
bin/omero hql -q --limit=10 "select id, textValue from TagAnnotation a order by a.id desc"
bin/omero hql -q --limit=100 "select id, owner.id, started, userAgent from Session where closed is null
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

10.5 Running and writing tests

The following guidelines apply to tests in both the Java and Python test components. However, some of the presented options apply to only one or the other.

10.5.1 Running tests

Running unit tests

The unit testing framework is fairly simple. Only methods which contain logic written within OMERO are tested. This means that framework functionality like remoting or the Hibernate layer is not tested. This is a part of integration testing (see below).

You can run the unit tests for any component from its directory by entering:

```
./build.py -f components/<component>/build.xml test
```

The same can be done for all components using:

```
./build.py test-unit
```

Note that for tests written in Python the package *pytest* must be installed, see *Writing Python tests*. Also note that some Python tests are excluded by default, see *Using markers in OmeroPy tests* for more details.

Running integration tests

Integration testing is a bit more complex because of the reliance on a database, which is not easily mockable. All Hibernate-related classes are tested in integration mode.

The tests require a fast computer. Running all the integration tests places several restrictions on the environment:

- There must be a running OMERO database.
- An OMERO.server instance must be running.

Integration tests assume that:

- `ICE_CONFIG` has been properly set. The contents of the `etc/ice.config` file should be enough to configure a running server for integration testing. This means that code creating a client connection as outlined in *Developing OMERO clients* should execute without errors.
- An OMERO.server instance is running on the host and port specified in the `ICE_CONFIG` file.

If any of the tests fail with a user authentication exception (or `omero.client` throws an exception), a new `ice.config` file can be created and pointed to by the `ICE_CONFIG` environment variable. Most likely the first settings that will have to be put there will be `omero.user` and `omero.pass`.

Running all tests

To run all the integration tests, use

```
./build.py test-integration
```

Note that some Python tests are excluded by default, see *Using markers in OmeroPy tests* for more details.

Component tests

Running an integration test suite for an individual component can be done explicitly via:

```
./build.py -f components/<component>/build.xml integration
```

Results are placed in `components/<component>/target/reports`.

Individual tests

Alternatively, you can run individual tests which you may currently be working on. This can be done using the `test` target. For example:

```
./build.py -f components/tools/OmeroJava/build.xml test -DTEST=integration/AdminTest
./build.py -f components/tools/OmeroPy/build.xml test -DTEST=test/integration/test_admin.py
```

Running Java tests

Individual test class methods

Individual OmeroJava test class methods (or a comma-separated list of methods) can be run using the *-DMETHODS* parameter together with the `test` target. The test method must be provided in the fully qualified name form (*-Dpackage.class.method*).

```
./build.py -f components/tools/OmeroJava/build.xml test -DMETHODS=integration.chgrp.AnnotationMoveTest.
```

Individual test groups

To run individual OmeroJava test groups (or comma-separated sets of groups) of tests, the *-DGROUPS* parameter can be used together with the `test` target

```
./build.py -f components/tools/OmeroJava/build.xml test -DGROUPS=integration
```

Using Eclipse to run tests

To facilitate importing OMERO components into Eclipse, there are `.project` and `.classpath-template` files stored in each component directory (e.g. common's .classpath[67] and common's .project[68]).

There are also top-level `.classpath` and `.project` files which allow for importing all components as a single project, but this approach requires more memory and does not clearly differentiate the classpaths, and so can lead to confusion.

[67] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/.classpath-template
[68] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4//components/common/.project

Before importing any component as a project into Eclipse, a successful build has to have taken place:

```
./build.py
```

This is for two reasons. Firstly, the Eclipse projects are not configured to perform the code generation needed. The **build.py** command creates the directory:

```
<component>/target
```

which will be missing from any Eclipse project you open before building the source.

Secondly, Ivy is used to copy all the jar dependencies from `OMERO_SOURCE_PREFIX/lib/repository` to `<component>/target/libs`, which is then used in the Eclipse `.classpath` files.

If Eclipse ever gets out of sync after the first build, **./build.py build-eclipse** can be used to quickly synchronize.

A prerequisite of running unit and integration tests in the Eclipse UI is having the TestNG plug-in installed and working (help available on the TestNG site[69]).

Running the unit tests under Eclipse requires no extra settings and is as easy as navigating to the package or class context menu *Run As* or *Debug As*, then selecting *TestNG*.

Integration tests require the `ICE_CONFIG` environment variable to be available for the Eclipse-controlled JVM. This can be done by editing Debug/Run configurations in Eclipse. After navigating to the Debug (or Run) Configurations window, the *Environment* tab needs to be selected. After clicking *New*, `ICE_CONFIG` can be defined as a path to the `ice.config` file. This setting needs to be defined per package, class or method.

By using the "debug" target from templates.xml, it is possible to have OMERO listen on port 8787 for a debugging connection.

```
bin/omero admin stop
bin/omero admin start debug
```

Then in Eclipse, you can create a new "Debug" configuration by clicking on *Remote Java Application*, and setting the port to 8787. These values are arbitrary and can be changed locally.

Keep in mind:

- The server will not start up until you have connected with Eclipse. This is due to the "suspend=y" clause in templates.xml. If you would like the server to start without you connecting, use "suspend=n".
- If you take too much time examining your threads, your calls may throw timeout exceptions.

Running Python tests

Using markers in OmeroPy tests

Tests under OmeroPy can be included or excluded according to markers defined in the tests. This can be done by using the *-DMARK* option. For example, to run all the integration tests marked as `broken`:

```
./build.py -f components/tools/OmeroPy/build.xml integration -DMARK=broken
```

By default tests marked as `long_running` and `broken` are excluded and so the following two builds are equivalent:

```
./build.py -f components/tools/OmeroPy/build.xml integration
./build.py -f components/tools/OmeroPy/build.xml integration -DMARK="not (long_running or broken)"
```

In order to run **all** tests, including `long_running` and `broken`, an empty marker must be used:

[69] http://testng.org/doc/eclipse.html

```
./build.py -f components/tools/OmeroPy/build.xml integration -DMARK=
```

See also:

Marking OmeroPy tests

Running tests directly

When writing tests it can be more convenient, flexible and powerful to run the tests from components/tools/OmeroPy[70] using **setup.py test**. Since Python is interpreted, tests can be written and then run without having to rebuild or restart the server. A few basic options are shown below.

-t <test_path>, **--test-path** <test_path>
: This option specifies the test suite to run. For instance to run a single test file:

```
cd components/tools/OmeroPy
./setup.py test -t test/integration/test_admin.py
```

Or to run all tests under a given folder:

```
cd components/tools/OmeroPy
./setup.py test -t test/integration/clitest
```

-k <string>
: This option will run all integration tests containing the given string in their names. For example, to run all the tests under `test/integration` with *permissions* in their names:

```
./setup.py test -t test/integration -k permissions
```

This option can also be used to run a named test within a test module:

```
./setup.py test -t test/integration/test_admin.py -k testGetGroup
```

-m <marker>
: This option will run integration tests depending on the markers they are decorated with. Available markers can be listed using the *--markers* option. For example, to run all integration tests excluding those decorated with the marker *long_running*:

```
./setup.py test -t test/integration -m "not long_running"
```

--markers
: This option lists available markers for decorating tests:

```
./setup.py test --markers
```

-s
: This option allows the standard output to be shown on the console:

```
./setup.py test -t test/integration/test_admin.py -s
```

-h, **--help**
: This option displays the full list of available options:

[70] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroPy

```
./setup.py test -h
```

To make use of the more advanced options available in *pytest* that are not accessible using **setup.py test**, the **py.test** script can be used directly. To use this `PYTHONPATH` must contain the path to the OMERO Python libraries, see *OMERO Python language bindings* as well as the path to the OMERO Python test library[71]. Alternatively, the *pytest* plugin pytest-pythonpath[72] can be used to add paths to `PYTHONPATH` specifically for *pytest*.

`--repeat` `<number>`
: This option allows to repeat tests for *number* occurences:

```
py.test --repeat 20 test/unit/fstest
```

`-h`, **`--help`**
: This option displays the full list of options:

```
py.test --help
```

and http://pytest.org/latest/usage.html for more help in running tests.

Failing tests

The `test.with.fail` ant property is set to `false` by default, which prevents test failures from failing the build. However, it can instead be set to `true` to allow test failures to fail the build. For example:

```
./build.py -Dtest.with.fail=true integration
```

Some components might provide individual targets for specific tests (e.g. OmeroJava provides the `broken` target for running broken tests). The `build.xml` file is the reference in each component.

10.5.2 Writing tests

Writing Java tests

For more information on writing tests in general see http://testng.org. For a test to be an "integration" test, place it in the "integration" TestNG group. If a test is temporarily broken, add it to the "broken" group:

```
@Test(groups = {"integration", "broken"}
public void testMyStuff() {

}
```

Tests should be of the **Acceptance Test** form. The ticket number for which a test is being written should be added in the TestNG annotation:

```
@Test(groups = "ticket:60")
```

This works at either the method level (see SetsAndLinksTest.java[73]) or the class level (see UniqueResultTest.java[74]).

The tests under components/tools/OmeroJava/test[75] will be the starting point for most Java-client developers coming to OMERO. An example skeleton for an integration test looks similar to

[71] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tests/python
[72] https://pypi.python.org/pypi/pytest-pythonpath
[73] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/test/ome/model/utests/SetsAndLinksTest.java
[74] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/test/ome/server/itests/query/UniqueResultTest.java
[75] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroJava/test

```
@Test(groups = "integration")
public class MyTest {

  omero.client client;

  @BeforeClass
  protected void setup() throws Exception {
    client = new omero.client();
    client.createSession();
  }

  @AfterClass
  protected void tearDown() throws Exception {
    client.closeSession();
  }

  @Test
  public void testSimple() throws Exception {
    client.getSession().getAdminService().getEventContext();
  }

}
```

Writing Python tests

To write and run Python tests you first need to install *pytest*:

```
pip install pytest
```

For more information on writing tests in general see http://pytest.org.

Similar to the OmeroJava tests, the tests under components/tools/OmeroPy/test[76], components/tools/OmeroFS/test[77] and components/tools/OmeroWeb/test[78] will be the starting point for most Python-client developers coming to OMERO. Integration tests should be placed under the `integration` subfolders. The file names must begin with *test_* for the tests to be found by *pytest*.

```
import omero

class TestExample(object)

  def setup_method(self, method):
    client = new omero.client()
    client.createSession()

  def teardown_method(self, method):
    client.closeSession()

  def testSimple():
    ec = client.getSession().getAdminService().getEventContext()
    assert ec, "No EventContext!"
```

Marking OmeroPy tests

Methods, classes and functions can be decorated with *pytest* markers to allow for the selection of tests. *pytest* provides some predefined markers and markers can be simply defined as they are used. However, to centralize the use of custom markers they

[76] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroPy/test
[77] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroFS/test
[78] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroWeb/test

should be defined in components/tools/pytest.ini[79].

To view all available markers the `--markers` option can be used with **setup.py test** or **py.test** as detailed in *Running tests directly*.

There are a small number of custom markers defined:

long_running Used to mark tests as long running. These are tests that typically take 10 minutes or more and are excluded from the daily integration builds.

broken Used to mark broken tests. These are tests that fail consistently with no obvious quick fix. Broken tests are excluded from the main integration builds and instead are run in a separate daily build. *broken* markers should have a reason, an associated Trac ticket number or both. If there are multiple associated tickets then a comma-separated list should be used.

intermittent Used to mark tests that fail intermittently. *intermittent* markers should have a reason, an associated Trac ticket number or both. If there are multiple associated tickets then a comma-separated list should be used. Tests marked as intermittent are included in the daily integration builds.

```
import pytest

class TestExample2(object):

    @pytest.mark.broken(reason="Asserting false", ticket="12345,67890")
    def testBroken():
        assert False, "Bound to fail"

    @pytest.mark.long_running
    def testLongRunning():
        self.somePotentiallyLongCall()

    @pytest.mark.intermittent(reason="Occasionally times out", ticket="98765")
    def testIntermittent():
        self.somePotentiallyIntermittentCall()
```

Using the Python test library

The OMERO Python test library[80] defines an abstract `ITest` class that implements the connection set up as well as many methods shared amongst all Python integration tests.

Each concrete instance of the `ITest` will initiate a connection to the server specified by the `ICE_CONFIG` environment variable at the `setup_class()` level. The following objects are created by `ITest.setup_class()` and shared by all test methods of this class:

- `self.root` is a client for the root user
- `self.group` is a new group which permissions are set to `ITest.DEFAULT_PERMS` by default. Overriding `DEFAULTS_PERMS` in a subclass of `ITest` means the group will be created with the new permissions.
- `self.user` is a new user and member of `self.group`
- `self.client` is a client for the `self.user` created at class setup.

Additionally, for the `self.client` object, different shortcuts are available:

- `self.sf` is the non-root client session
- `self.update` is the update service for the non-root client session
- `self.query` is the query service for the non-root client session
- `self.ctx` is the event context for the non-root client session. Note this corresponds to the context at creation time and should be refreshed if the context is modified.

The example below inherits the `ITest` class and would create a read-write group by default

[79] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/pytest.ini
[80] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tests/python/library/__init__.py

```
from library import ITest

class TestExample(ITest):

    DEFAULT_PERMS = 'rwrw--'  # Override default permissions
    def test1():
        doAction(self.sf)
```

New user and groups can be instantiated by individual tests using the `ITest.new_user()` and `ITest.new_group()` methods:

```
def testNewGroupOwner():
    new_group = self.new_group(perms='rwa---')
    new_owner = self.new_use(group=new_group, owner=True)
    assert new_owner.id.val, "No EventContext!"
```

New clients can be instantiated by individual tests using the `ITest.new_client()` or `ITest.new_client_and_user()` methods:

```
def testNewClient():
    new_client = self.new_user_and_client()
    ec = new_client.getSession().getAdminService().getEventContext()
    assert ec, "No EventContext!"
```

Images can be imported using the `ITest.importSingleImage()` or `ITest.importSingleImageWithCompanion()` or `ITest.importMIF()` methods:

```
def testImportMIF():
    images = self.importMIF(2)
    assert len(images) == 2
```

Writing OMERO.web tests

For OMERO.web integration tests, the OMERO.web test library[81] defines an abstract `IWebTest` class that inherits from `ITest` and also implements Django clients at the class setup using the Django testing tools[82].

On top of the elements created by `ITest.setup_class()`, the `IWebTest` class creates:

- `self.django_root_client` is a Django test client for the root user
- `self.django_client` is a client for the new user created at the class setup.

```
from weblibrary import IWebTest

class TestExample(IWebTest):
    def testSimple():
        self.django_client.post('/login/', {'username': 'john'})
```

New Django test clients can be instantiated by individual tests using the `IWebTest.new_django_client()` method:

```
def testNewDjangoClient():
    new_user = self.new_user()
    omeName = new_user.omeName.val
    new_django_client = self.new_django_client(omeName, omeName)
```

[81] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroWeb/test/integration/weblibrary.py
[82] https://docs.djangoproject.com/en/1.8/topics/testing/tools

See also:

test_simple.py[83] Example test class using the OMERO.web test library methods

CHAPTER

ELEVEN

USING THE OMERO API

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.1 OMERO Python language bindings

MOVIE: introduction to Blitz Gateway[1]

In addition to the auto-generated Python libraries of the core *OMERO Application Programming Interface*, we have developed a more user-friendly Python module 'Blitz Gateway' that facilitates several aspects of working with the Python API, such as connection handling, object graph traversal and lazy loading.

This page gives you a large number of code samples to get you started. Then we describe a bit more about *Blitz Gateway documentation*.

The Python libraries are part of the server build and can be found under OMERO_HOME/lib/python. These include the core omero.model objects and services as well as the Blitz Gateway code (at OMERO_HOME/lib/python/omero/gateway/__init__.py).

To use OmeroPy, you will need to download the libraries (e.g. as part of the server package) and setup your `PYTHONPATH` to include them:

```
export OMERO_PREFIX=~/Desktop/OMERO.server-5.2.4-ice3x-byy       # for example
export PYTHONPATH=$PYTHONPATH:$OMERO_PREFIX/lib/python
```

You will also need Ice libraries as described in the *OMERO.server installation* and an OMERO server to connect to, which must be the same major version, i.e. 5.2.x.

All the code examples below can be found at examples/Training/python[2].

If you want to run the examples, you will need to download and configure them to connect to your own server. E.g. `HOST = "localhost"` You can edit `HOST, PORT, USERNAME and PASSWORD` in the `Parse_OMERO_Properties.py` file and these values will be imported into the other scripts.

Then you can run the scripts:

```
$ python Connect_To_OMERO.py
```

If all goes well, you should be connected to your OMERO server and see some details of your session printed out.

All the following code examples can be downloaded and run in the same way. Some scripts will also need editing of other parameters, usually IDs from Projects, Datasets, Images etc. You can use the OMERO.insight or OMERO.web client to choose suitable data IDs before editing and running the code samples.

[1] http://cvs.openmicroscopy.org.uk/snapshots/movies/omero-4-3/mov/BlitzGatewayIntro-4.3.mov
[2] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/examples/Training/python

11.1.1 Code samples

Connect to OMERO

```
# Connect to the Python Blitz Gateway
# ============================================================
# Make a simple connection to OMERO, printing details of the
# connection. See OmeroPy/Gateway for more info
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
connected = conn.connect()



# Check if you are connected.
# ============================================================
if not connected:
    import sys
    sys.stderr.write(
        "Error: Connection not available, please check your user name and"
        " password.\n")
    sys.exit(1)



# Using secure connection.
# ============================================================
# By default, once we have logged in, data transfer is not encrypted
# (faster)
# To use a secure connection, call setSecure(True):



# conn.setSecure(True)          # <--------- Uncomment this



# Current session details
# ============================================================
# By default, you will have logged into your 'current' group in OMERO. This
# can be changed by switching group in the OMERO.insight or OMERO.web clients.



user = conn.getUser()
print "Current user:"
print "   ID:", user.getId()
print "   Username:", user.getName()
print "   Full Name:", user.getFullName()



print "Member of:"
for g in conn.getGroupsMemberOf():
    print "   ID:", g.getName(), " Name:", g.getId()
group = conn.getGroupFromContext()
print "Current group: ", group.getName()



# List the group owners and other members
owners, members = group.groupSummary()
print "   Group owners:"
for o in owners:
    print "     ID: %s %s Name: %s" % (
        o.getId(), o.getOmeName(), o.getFullName())
print "   Group members:"
```

```
for m in members:
    print "      ID: %s %s Name: %s" % (
        m.getId(), m.getOmeName(), m.getFullName())



print "Owner of:"
for g in conn.listOwnedGroups():
    print "    ID: ", g.getName(), " Name:", g.getId()



# Added in OMERO 5.0
print "Admins:"
for exp in conn.getAdministrators():
    print "    ID: %s %s Name: %s" % (
        exp.getId(), exp.getOmeName(), exp.getFullName())



# The 'context' of our current session
ctx = conn.getEventContext()
# print ctx     # for more info



# Close connection:
# ====================================================================
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Read data

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
imageId = 1
datasetId = 2
plateId = -1         # Don't need to set this



def print_obj(obj, indent=0):
    """
    Helper method to display info about OMERO objects.
    Not all objects will have a "name" or owner field.
    """
    print """%s%s:%s  Name:"%s" (owner=%s)""" % (
        " " * indent,
        obj.OMERO_CLASS,
        obj.getId(),
        obj.getName(),
        obj.getOwnerOmeName())
```

- **List all Projects available to me, and their Datasets and Images:**

```
# The only_owned=True parameter limits the Projects which are returned.
# If the parameter is omitted or the value is False, then all Projects
# visible in the current group are returned.
print "\nList Projects:"
print "=" * 50
my_expId = conn.getUser().getId()
for project in conn.listProjects(my_expId):
    print_obj(project)
    for dataset in project.listChildren():
        print_obj(dataset, 2)
        for image in dataset.listChildren():
            print_obj(image, 4)
```

- **Retrieve the datasets owned by the user currently logged in:**

```
# Here we create an omero.sys.ParametersI instance which we
# can use to filter the results that are returned. If we did
# not pass the params argument to getObjects, then all Datasets
# in the current group would be returned.
print "\nList Datasets:"
print "=" * 50



params = omero.sys.ParametersI()
params.exp(conn.getUser().getId())  # only show current user's Datasets



datasets = conn.getObjects("Dataset", params=params)
for dataset in datasets:
    print_obj(dataset)
```

- **Retrieve the images contained in a dataset:**

```
print "\nDataset:%s" % datasetId
print "=" * 50
dataset = conn.getObject("Dataset", datasetId)
print "\nImages in Dataset:", dataset.getName()
for image in dataset.listChildren():
    print_obj(image)
```

- **Retrieve an image by Image ID:**

```
image = conn.getObject("Image", imageId)
print "\nImage:%s" % imageId
print "=" * 50
print image.getName(), image.getDescription()
# Retrieve information about an image.
print " X:", image.getSizeX()
print " Y:", image.getSizeY()
print " Z:", image.getSizeZ()
print " C:", image.getSizeC()
print " T:", image.getSizeT()
# render the first timepoint, mid Z section
z = image.getSizeZ() / 2
t = 0
renderedImage = image.renderImage(z, t)
# renderedImage.show()                # popup (use for debug only)
# renderedImage.save("test.jpg")      # save in the current folder
```

- **Get Pixel Sizes for the above Image:**

```
sizeX = image.getPixelSizeX()       # E.g. 0.132
print " Pixel Size X:", sizeX
# Units support, new in OMERO 5.1.0
sizeXobj = image.getPixelSizeX(units=True)
print " Pixel Size X:", sizeXobj.getValue(), "(%s)" % sizeXobj.getSymbol()
# To get the size with different units, E.g. Angstroms
sizeXang = image.getPixelSizeX(units="ANGSTROM")
print " Pixel Size X:", sizeXang.getValue(), "(%s)" % sizeXang.getSymbol()
```

- **Retrieve Screening data:**

```
print "\nList Screens:"
print "=" * 50
for screen in conn.getObjects("Screen"):
    print_obj(screen)
    for plate in screen.listChildren():
        print_obj(plate, 2)
        plateId = plate.getId()
```

- **Retrieve Wells and Images within a Plate:**

```
if plateId >= 0:
    print "\nPlate:%s" % plateId
    print "=" * 50
    plate = conn.getObject("Plate", plateId)
    print "\nNumber of fields:", plate.getNumberOfFields()
    print "\nGrid size:", plate.getGridSize()
    print "\nWells in Plate:", plate.getName()
    for well in plate.listChildren():
        index = well.countWellSample()
        print "  Well: ", well.row, well.column, " Fields:", index
        for index in xrange(0, index):
            print "    Image: ", \
                well.getImage(index).getName(),\
                well.getImage(index).getId()
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Groups and permissions

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
imageId = 1
```

- **We are logged in to our 'default' group**

```
group = conn.getGroupFromContext()
print "Current group: ", group.getName()
```

- **Each group has defined Permissions set**

```
group_perms = group.getDetails().getPermissions()
perm_string = str(group_perms)
permission_names = {
    'rw----': 'PRIVATE',
    'rwr---': 'READ-ONLY',
    'rwra--': 'READ-ANNOTATE',
    'rwrw--': 'READ-WRITE'}  # Not exposed in clients
print "Permissions: %s (%s)" % (permission_names[perm_string], perm_string)
```

- **By default, any query applies to ALL data that we can access in our Current group.**

This will be determined by group permissions e.g. in Read-Only or Read-Annotate groups, this will include other users' data - see *Groups and permissions system*.

```
projects = conn.listProjects()      # may include other users' data
for p in projects:
    print p.getName(), "Owner: ", p.getDetails().getOwner().getFullName()



# Will return None if Image is not in current group
image = conn.getObject("Image", imageId)
print "Image: ", image
```

- **In OMERO-4.4, we added 'cross-group' querying, use '-1'**

```
conn.SERVICE_OPTS.setOmeroGroup('-1')
image = conn.getObject("Image", imageId)     # Will query across all my groups
print "Image: ", image,
if image is not None:
    print "Group: ", image.getDetails().getGroup().getName(),
    print image.details.group.id.val    # access groupId without loading group
```

- **To query only a single group (not necessarily your 'current' group)**

```
groupId = image.details.group.id.val
# This is how we 'switch group' in webclient
conn.SERVICE_OPTS.setOmeroGroup(groupId)
projects = conn.listProjects()
image = conn.getObject("Image", imageId)
print "Image: ", image,
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Raw data access

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
imageId = 27544
```

- **Retrieve a given plane**

```
# Use the pixelswrapper to retrieve the plane as
# a 2D numpy array. See [http://www.scipy.org/Tentative_NumPy_Tutorial]
#
# Numpy array can be used for various analysis routines
#
image = conn.getObject("Image", imageId)
sizeZ = image.getSizeZ()
sizeC = image.getSizeC()
sizeT = image.getSizeT()
z, t, c = 0, 0, 0                       # first plane of the image
pixels = image.getPrimaryPixels()
plane = pixels.getPlane(z, c, t)        # get a numpy array.
print "\nPlane at zct: ", z, c, t
print plane
print "shape: ", plane.shape
print "min:", plane.min(), " max:", plane.max(),\
    "pixel type:", plane.dtype.name
```

- **Retrieve a given stack**

```
# Get a Z-stack of tiles. Using getTiles or getPlanes (see below) returns
# a generator of data (not all the data in hand) The RawPixelsStore is
# only opened once (not closed after each plane) Alternative is to use
# getPlane() or getTile() multiple times - slightly slower.
c, t = 0, 0                 # First channel and timepoint
tile = (50, 50, 10, 10)     # x, y, width, height of tile



# list of [ (0,0,0,(x,y,w,h)), (1,0,0,(x,y,w,h)), (2,0,0,(x,y,w,h))... ]
zctList = [(iz, c, t, tile) for iz in range(sizeZ)]
print "\nZ stack of tiles:"
planes = pixels.getTiles(zctList)
for i, p in enumerate(planes):
    print "Tile:", zctList[i], " min:", p.min(),\
        " max:", p.max(), " sum:", p.sum()
```

- **Retrieve a given hypercube**

```
zctList = []
for z in range(sizeZ / 2, sizeZ):     # get the top half of the Z-stack
    for c in range(sizeC):          # all channels
        for t in range(sizeT):      # all time-points
            zctList.append((z, c, t))
print "\nHyper stack of planes:"
planes = pixels.getPlanes(zctList)
for i, p in enumerate(planes):
    print "plane zct:", zctList[i], " min:", p.min(), " max:", p.max()
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Write data

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
projectId = 2
# Specify a local file. E.g. could be result of some analysis
fileToUpload = "README.txt"   # This file should already exist
```

- **Create a new Dataset**

```
datasetObj = omero.model.DatasetI()
datasetObj.setName(rstring("New Dataset"))
datasetObj = conn.getUpdateService().saveAndReturnObject(datasetObj)
datasetId = datasetObj.getId().getValue()
print "New dataset, Id:", datasetId
```

- **Link to Project**

```
project = conn.getObject("Project", projectId)
if project is None:
    import sys
    sys.stderr.write("Error: Object does not exist.\n")
    sys.exit(1)
link = omero.model.ProjectDatasetLinkI()
link.setParent(omero.model.ProjectI(project.getId(), False))
link.setChild(datasetObj)
conn.getUpdateService().saveObject(link)
```

- **Annotate Project with a new 'tag'**

```
tagAnn = omero.gateway.TagAnnotationWrapper(conn)
tagAnn.setValue("New Tag")
tagAnn.save()
project = conn.getObject("Project", projectId)
project.linkAnnotation(tagAnn)
```

- **Added in OMERO 5.1: 'Map' annotations (list of key: value pairs)**

```
keyValueData = [["Drug Name", "Monastrol"],
                ["Concentration", "5 mg/ml"]]
mapAnn = omero.gateway.MapAnnotationWrapper(conn)
# Use 'client' namespace to allow editing in Insight & web
namespace = omero.constants.metadata.NSCLIENTMAPANNOTATION
mapAnn.setNs(namespace)
mapAnn.setValue(keyValueData)
mapAnn.save()
```

```
project = conn.getObject("Project", projectId)
# NB: only link a client map annotation to a single object
project.linkAnnotation(mapAnn)
```

- **How to create a file annotation and link to a Dataset**

```
dataset = conn.getObject("Dataset", datasetId)
# create the original file and file annotation (uploads the file etc.)
namespace = "imperial.training.demo"
print "\nCreating an OriginalFile and FileAnnotation"
fileAnn = conn.createFileAnnfromLocalFile(
    fileToUpload, mimetype="text/plain", ns=namespace, desc=None)
print "Attaching FileAnnotation to Dataset: ", "File ID:", fileAnn.getId(), \
    ",", fileAnn.getFile().getName(), "Size:", fileAnn.getFile().getSize()
dataset.linkAnnotation(fileAnn)      # link it to dataset.
```

- **Download a file annotation linked to a Dataset**

```
# make a location to download the file. "download" folder.
path = os.path.join(os.path.dirname(__file__), "download")
if not os.path.exists(path):
    os.makedirs(path)



# Go through all the annotations on the Dataset. Download any file annotations
# we find.
print "\nAnnotations on Dataset:", dataset.getName()
for ann in dataset.listAnnotations():
    if isinstance(ann, omero.gateway.FileAnnotationWrapper):
        print "File ID:", ann.getFile().getId(), ann.getFile().getName(), \
            "Size:", ann.getFile().getSize()



file_path = os.path.join(path, ann.getFile().getName())



f = open(str(file_path), 'w')
print "\nDownloading file to", file_path, "..."
try:
    for chunk in ann.getFileInChunks():
        f.write(chunk)
finally:
    f.close()
    print "File downloaded!"
```

- **Load all the file annotations with a given namespace**

```
nsToInclude = [namespace]
nsToExclude = []
metadataService = conn.getMetadataService()
annotations = metadataService.loadSpecifiedAnnotations(
    'omero.model.FileAnnotation', nsToInclude, nsToExclude, None)
for ann in annotations:
    print ann.getId().getValue(), ann.file.name.val
```

- **Get first annotation with specified namespace**

```
ann = dataset.getAnnotation(namespace)
print "Found Annotation with namespace: ", ann.getNs()
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

OMERO tables

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
datasetId = 33
```

- **Create a name for the Original File (should be unique)**

```
from random import random
tablename = "TablesDemo:%s" % str(random())



col1 = omero.grid.LongColumn('Uid', 'testLong', [])
col2 = omero.grid.StringColumn('MyStringColumnInit', '', 64, [])



columns = [col1, col2]
```

- **Create and initialize a new table.**

```
repositoryId = 1
table = conn.c.sf.sharedResources().newTable(repositoryId, tablename)
table.initialize(columns)
```

- **Add data to the table.**

```
ids = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
strings = ["one", "two", "three", "four", "five",
           "six", "seven", "eight", "nine", "ten"]
data1 = omero.grid.LongColumn('Uid', 'test Long', ids)
data2 = omero.grid.StringColumn('MyStringColumn', '', 64, strings)
data = [data1, data2]
table.addData(data)
table.close()           # when we are done, close.
```

- **Get the table as an original file...**

```
orig_file = table.getOriginalFile()
orig_file_id = orig_file.id.val
# ...so you can attach this data to an object. E.g. Dataset
fileAnn = omero.model.FileAnnotationI()
# use unloaded OriginalFileI
fileAnn.setFile(omero.model.OriginalFileI(orig_file_id, False))
fileAnn = conn.getUpdateService().saveAndReturnObject(fileAnn)
link = omero.model.DatasetAnnotationLinkI()
link.setParent(omero.model.DatasetI(datasetId, False))
link.setChild(omero.model.FileAnnotationI(fileAnn.id.val, False))
conn.getUpdateService().saveAndReturnObject(link)
```

- **Table API**

See also:

OMERO Tables[3]

```
openTable = conn.c.sf.sharedResources().openTable(orig_file)



print "Table Columns:"
for col in openTable.getHeaders():
    print "    ", col.name
rowCount = openTable.getNumberOfRows()
print "Row count:", rowCount
```

- **Get data from every column of the specified rows**

```
rowNumbers = [3, 5, 7]
print "\nGet All Data for rows: ", rowNumbers
data = openTable.readCoordinates(range(rowCount))
for col in data.columns:
    print "Data for Column: ", col.name
    for v in col.values:
        print "    ", v
```

- **Get data from specified columns of specified rows**

```
colNumbers = [1]
start = 3
stop = 7
print "\nGet Data for cols: ", colNumbers,\
    " and between rows: ", start, "-", stop



data = openTable.read(colNumbers, start, stop)
for col in data.columns:
    print "Data for Column: ", col.name
    for v in col.values:
        print "    ", v
```

- **Query the table for rows where the 'Uid' is in a particular range**

```
queryRows = openTable.getWhereList(
    "(Uid > 2) & (Uid <= 8)", variables={}, start=0, stop=rowCount, step=0)
```

[3] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/grid/Table.html

```
data = openTable.readCoordinates(queryRows)
for col in data.columns:
    print "Query Results for Column: ", col.name
    for v in col.values:
        print "   ", v
openTable.close()           # we're done
```

- **In future, to get the table back from Original File**

```
orig_table_file = conn.getObject(
    "OriginalFile", attributes={'name': tablename})     # if name is unique
savedTable = conn.c.sf.sharedResources().openTable(orig_table_file._obj)
print "Opened table with row-count:", savedTable.getNumberOfRows()
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

ROIs

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
updateService = conn.getUpdateService()
```

- **Create ROI.**

```
# We are using the core Python API and omero.model objects here, since ROIs
# are not yet supported in the Python Blitz Gateway.
#
# First we load our image and pick some parameters for shapes
x = 50
y = 200
width = 100
height = 50
image = conn.getObject("Image", imageId)
theZ = image.getSizeZ() / 2
theT = 0


# We have a helper function for creating an ROI and linking it to new shapes
def createROI(img, shapes):
    # create an ROI, link it to Image
    roi = omero.model.RoiI()
    # use the omero.model.ImageI that underlies the 'image' wrapper
    roi.setImage(img._obj)
    for shape in shapes:
        roi.addShape(shape)
    # Save the ROI (saves any linked shapes too)
    updateService.saveObject(roi)


# Another helper for generating the color integers for shapes
def rgbaToInt(red, green, blue, alpha=255):
```

```
    """ Convert an R,G,B,A value to an int """
    RGBAInt = (alpha << 24) + (red << 16) + (green << 8) + blue
    if (RGBAInt > (2**31-1)):       # convert to signed 32-bit int
        RGBAInt = RGBAInt - 2**32
    return int(RGBAInt)


# create a rectangle shape (added to ROI below)
print ("Adding a rectangle at theZ: %s, theT: %s, X: %s, Y: %s, width: %s,"
       " height: %s" % (theZ, theT, x, y, width, height))
rect = omero.model.RectangleI()
rect.x = rdouble(x)
rect.y = rdouble(y)
rect.width = rdouble(width)
rect.height = rdouble(height)
rect.theZ = rint(theZ)
rect.theT = rint(theT)
rect.textValue = rstring("test-Rectangle")


# create an Ellipse shape (added to ROI below)
ellipse = omero.model.EllipseI()
ellipse.cx = rdouble(y)
ellipse.cy = rdouble(x)
ellipse.rx = rdouble(width)
ellipse.ry = rdouble(height)
ellipse.theZ = rint(theZ)
ellipse.theT = rint(theT)
ellipse.textValue = rstring("test-Ellipse")


# Create an ROI containing 2 shapes on same plane
# NB: OMERO.insight client doesn't support display
# of multiple shapes on a single plane.
# Therefore the ellipse is removed later (see below)
createROI(image, [rect, ellipse])


# create an ROI with single line shape
line = omero.model.LineI()
line.x1 = rdouble(x)
line.x2 = rdouble(x+width)
line.y1 = rdouble(y)
line.y2 = rdouble(y+height)
line.theZ = rint(theZ)
line.theT = rint(theT)
line.textValue = rstring("test-Line")
createROI(image, [line])


def create_mask(mask_bytes, bytes_per_pixel=1):
    if bytes_per_pixel == 2:
        divider = 16.0
        format_string = "H"  # Unsigned short
        byte_factor = 0.5
    elif bytes_per_pixel == 1:
        divider = 8.0
        format_string = "B"  # Unsiged char
        byte_factor = 1
    else:
        message = "Format %s not supported"
```

```
        raise ValueError(message)
    steps = math.ceil(len(mask_bytes) / divider)
    mask = []
    for i in range(long(steps)):
        binary = mask_bytes[
            i * int(divider):i * int(divider) + int(divider)]
        format = str(int(byte_factor * len(binary))) + format_string
        binary = struct.unpack(format, binary)
        s = ""
        for bit in binary:
            s += str(bit)
        mask.append(int(s, 2))
    return bytearray(mask)


mask_x = 50
mask_y = 50
mask_h = 100
mask_w = 100
# Create [0, 1] mask
mask_array = numpy.fromfunction(
    lambda x, y: (x * y) % 2, (mask_w, mask_h))
# Set correct number of bytes per value
mask_array = mask_array.astype(numpy.uint8)
# Convert the mask to bytes
mask_array = mask_array.tostring()
# Pack the bytes to a bit mask
mask_packed = create_mask(mask_array, 1)


# Define mask's fill color
mask_color = ColorHolder()
mask_color.setRed(255)
mask_color.setBlue(0)
mask_color.setGreen(0)
mask_color.setAlpha(100)


# create an ROI with a single mask
mask = omero.model.MaskI()
mask.setTheC(rint(0))
mask.setTheZ(rint(0))
mask.setTheT(rint(0))
mask.setX(rdouble(mask_x))
mask.setY(rdouble(mask_y))
mask.setWidth(rdouble(mask_w))
mask.setHeight(rdouble(mask_h))
mask.setFillColor(rint(mask_color.getInt()))
mask.setTextValue(rstring("test-Mask"))
mask.setBytes(mask_packed)
createROI(image, [mask])


# create an ROI with single point shape
point = omero.model.PointI()
point.cx = rdouble(x)
point.cy = rdouble(y)
point.theZ = rint(theZ)
point.theT = rint(theT)
point.textValue = rstring("test-Point")
createROI(image, [point])
```

```
def pointsToString(points):
    """ Returns legacy format supported by Insight """
    points = ["%s,%s" % (p[0], p[1]) for p in points]
    csv = ", ".join(points)
    return "points[%s] points1[%s] points2[%s]" % (csv, csv, csv)
# create an ROI with a single polygon, setting colors and lineWidth
polygon = omero.model.PolygonI()
polygon.theZ = rint(theZ)
polygon.theT = rint(theT)
polygon.fillColor = rint(rgbaToInt(255, 0, 255, 50))
polygon.strokeColor = rint(rgbaToInt(255, 255, 0))
polygon.strokeWidth = omero.model.LengthI(10, UnitsLength.PIXEL)
points = [[10, 20], [50, 150], [200, 200], [250, 75]]
polygon.points = rstring(pointsToString(points))
createROI(image, [polygon])
```

- **Retrieve ROIs linked to an Image.**

```
roiService = conn.getRoiService()
result = roiService.findByImage(imageId, None)
for roi in result.rois:
    print "ROI:  ID:", roi.getId().getValue()
    for s in roi.copyShapes():
        shape = {}
        shape['id'] = s.getId().getValue()
        shape['theT'] = s.getTheT().getValue()
        shape['theZ'] = s.getTheZ().getValue()
        if s.getTextValue():
            shape['textValue'] = s.getTextValue().getValue()
        if type(s) == omero.model.RectangleI:
            shape['type'] = 'Rectangle'
            shape['x'] = s.getX().getValue()
            shape['y'] = s.getY().getValue()
            shape['width'] = s.getWidth().getValue()
            shape['height'] = s.getHeight().getValue()
        elif type(s) == omero.model.EllipseI:
            shape['type'] = 'Ellipse'
            shape['cx'] = s.getCx().getValue()
            shape['cy'] = s.getCy().getValue()
            shape['rx'] = s.getRx().getValue()
            shape['ry'] = s.getRy().getValue()
        elif type(s) == omero.model.PointI:
            shape['type'] = 'Point'
            shape['cx'] = s.getCx().getValue()
            shape['cy'] = s.getCy().getValue()
        elif type(s) == omero.model.LineI:
            shape['type'] = 'Line'
            shape['x1'] = s.getX1().getValue()
            shape['x2'] = s.getX2().getValue()
            shape['y1'] = s.getY1().getValue()
            shape['y2'] = s.getY2().getValue()
        elif type(s) == omero.model.MaskI:
            shape['type'] = 'Mask'
            shape['x'] = s.getX().getValue()
            shape['y'] = s.getY().getValue()
            shape['width'] = s.getWidth().getValue()
            shape['height'] = s.getHeight().getValue()
        elif type(s) in (
                omero.model.LabelI, omero.model.PolygonI):
            print type(s), " Not supported by this code"
        # Do some processing here, or just print:
        print "   Shape:",
        for key, value in shape.items():
```

```
            print "  ", key, value,
        print ""
```

- **Remove shape from ROI**

```
result = roiService.findByImage(imageId, None)
for roi in result.rois:
    for s in roi.copyShapes():
        # Find and remove the Shape we added above
        if s.getTextValue() and s.getTextValue().getValue() == "test-Ellipse":
            print "Removing Shape from ROI..."
            roi.removeShape(s)
            roi = updateService.saveAndReturnObject(roi)
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Delete data

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
projectId = 507         # NB: This will be deleted!
```

- **Load the Project**

```
project = conn.getObject("Project", projectId)
if project is None:
    import sys
    sys.stderr.write("Error: Object does not exist.\n")
    sys.exit(1)


print "\nProject:", project.getName()
```

- **Delete Project**

```
# You can delete a number of objects of the same type at the same
# time. In this case 'Project'. Use deleteChildren=True if you are
# deleting a Project and you want to delete Datasets and Images.
obj_ids = [projectId]
deleteChildren = False
handle = conn.deleteObjects(
    "Project", obj_ids, deleteAnns=True, deleteChildren=deleteChildren)
```

- **Retrieve callback and wait until delete completes**

```
# This is not necessary for the Delete to complete. Can be used
# if you want to know when delete is finished or if there were any errors
cb = omero.callbacks.CmdCallbackI(conn.c, handle)
print "Deleting, please wait."
while not cb.block(500):
    print "."
err = isinstance(cb.getResponse(), omero.cmd.ERR)
print "Error?", err
if err:
    print cb.getResponse()
cb.close(True)      # close handle too
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Render Images

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
imageId = 27544
```

- **Get thumbnail**

```
# Thumbnail is created using the current rendering settings on the image
image = conn.getObject("Image", imageId)
img_data = image.getThumbnail()
renderedThumb = Image.open(StringIO(img_data))
# renderedThumb.show()            # shows a pop-up
renderedThumb.save("thumbnail.jpg")
```

- **Get current settings**

```
print "Channel rendering settings:"
for ch in image.getChannels():
    # if no name, get emission wavelength or index
    print "Name: ", ch.getLabel()
    print "  Color:", ch.getColor().getHtml()
    print "  Active:", ch.isActive()
    print "  Levels:", ch.getWindowStart(), "-", ch.getWindowEnd()
print "isGreyscaleRenderingModel:", image.isGreyscaleRenderingModel()
print "Default Z/T positions:"
print "    Z = %s, T = %s" % (image.getDefaultZ(), image.getDefaultT())
```

- **Show the saved rendering settings on this image**

```
print "Rendering Defs on Image:"
for rdef in image.getAllRenderingDefs():
```

```
    img_data = image.getThumbnail(rdefId=rdef['id'])
    print "   ID: %s (owner: %s %s)" % (
        rdef['id'], rdef['owner']['firstName'], rdef['owner']['lastName'])
```

- **Render each channel as a separate greyscale image**

```
image.setGreyscaleRenderingModel()
sizeC = image.getSizeC()
z = image.getSizeZ() / 2
t = 0
for c in range(1, sizeC + 1):       # Channel index starts at 1
    channels = [c]                  # Turn on a single channel at a time
    image.setActiveChannels(channels)
    renderedImage = image.renderImage(z, t)
    # renderedImage.show()                          # popup (use for debug only)
    renderedImage.save("channel%s.jpg" % c)     # save in the current folder
```

- **Turn 3 channels on, setting their colors**

```
image.setColorRenderingModel()
channels = [1, 2, 3]
colorList = ['F00', None, 'FFFF00']  # do not change color of 2nd channel
image.setActiveChannels(channels, colors=colorList)
# max intensity projection 'intmean' for mean-intensity
image.setProjection('intmax')
renderedImage = image.renderImage(z, t)  # z and t are ignored for projections
# renderedImage.show()
renderedImage.save("all_channels.jpg")
image.setProjection('normal')               # turn off projection
```

- **Turn 2 channels on, setting levels of the first one**

```
channels = [1, 2]
rangeList = [[100.0, 120.2], [None, None]]
image.setActiveChannels(channels, windows=rangeList)
# Set default Z & T. These will be used as defaults for further rendering
image.setDefaultZ(0)
image.setDefaultT(0)
# default compression is 0.9
renderedImage = image.renderImage(z=None, t=None, compression=0.5)
renderedImage.show()
renderedImage.save("two_channels.jpg")
```

- **Save the current rendering settings & default Z/T**

```
image.saveDefaults()
```

- **Reset to settings at import time, and optionally save**

```
image.resetDefaults(save=True)
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Create Image

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
imageId = 27544     # This image must have at least 2 channels
```

- **Create an image from scratch**

```
# This example demonstrates the usage of the convenience method
# createImageFromNumpySeq() Here we create a multi-dimensional image from a
# hard-coded array of data.
from numpy import array, int8
import omero
sizeX, sizeY, sizeZ, sizeC, sizeT = 5, 4, 1, 2, 1
plane1 = array(
    [[0, 1, 2, 3, 4], [5, 6, 7, 8, 9], [0, 1, 2, 3, 4], [5, 6, 7, 8, 9]],
    dtype=int8)
plane2 = array(
    [[5, 6, 7, 8, 9], [0, 1, 2, 3, 4], [5, 6, 7, 8, 9], [0, 1, 2, 3, 4]],
    dtype=int8)
planes = [plane1, plane2]



def planeGen():
    """generator will yield planes"""
    for p in planes:
        yield p



desc = "Image created from a hard-coded arrays"
i = conn.createImageFromNumpySeq(
    planeGen(), "numpy image", sizeZ, sizeC, sizeT, description=desc,
    dataset=None)



print 'Created new Image:%s Name:"%s"' % (i.getId(), i.getName())
```

- **Set the pixel size using units (added in 5.1.0)**

Lengths are specified by value and a unit enumeration Here we set the pixel size X and Y to be 9.8 Angstroms

```
from omero.model.enums import UnitsLength
# Re-load the image to avoid update conflicts
i = conn.getObject("Image", i.getId())
u = omero.model.LengthI(9.8, UnitsLength.ANGSTROM)
p = i.getPrimaryPixels()._obj
p.setPhysicalSizeX(u)
p.setPhysicalSizeY(u)
conn.getUpdateService().saveObject(p)
```

- **Create an Image from an existing image**

```
# We are going to create a new image by passing the method a 'generator' of 2D
# planes This will come from an existing image, by taking the average of 2
# channels.
zctList = []
image = conn.getObject('Image', imageId)
sizeZ, sizeC, sizeT = image.getSizeZ(), image.getSizeC(), image.getSizeT()
dataset = image.getParent()
pixels = image.getPrimaryPixels()
newSizeC = 1


def planeGen():
    """
    set up a generator of 2D numpy arrays.


The createImage method below expects planes in the order specified here
(for z.. for c.. for t..)
"""
for z in range(sizeZ):              # all Z sections
    # Illustrative purposes only, since we only have 1 channel
    for c in range(newSizeC):
        for t in range(sizeT):      # all time-points
            channel0 = pixels.getPlane(z, 0, t)
            channel1 = pixels.getPlane(z, 1, t)
            # Here we can manipulate the data in many different ways. As
            # an example we are doing "average"
            # average of 2 channels
            newPlane = (channel0 + channel1) / 2
            print "newPlane for z,t:", z, t, newPlane.dtype, \
                newPlane.min(), newPlane.max()
            yield newPlane


desc = ("Image created from Image ID: %s by averaging Channel 1 and Channel 2"
        % imageId)
i = conn.createImageFromNumpySeq(
    planeGen(), "new image", sizeZ, newSizeC, sizeT, description=desc,
    dataset=dataset)
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Filesets - added in OMERO 5.0

- **Create a connection**

```
conn = BlitzGateway(USERNAME, PASSWORD, host=HOST, port=PORT)
conn.connect()
```

- **Configuration**

```
imageId = 101
```

- **Get the 'Fileset' for an Image**

```
# A Fileset is a collection of the original files imported to
# create an image or set of images in OMERO.
image = conn.getObject("Image", imageId)
fileset = image.getFileset()       # will be None for pre-FS images
fsId = fileset.getId()
# List all images that are in this fileset
for fsImage in fileset.copyImages():
    print fsImage.getId(), fsImage.getName()
# List original imported files
for origFile in fileset.listFiles():
    name = origFile.getName()
    path = origFile.getPath()
    print path, name
```

- **Get Original Imported Files directly from the image**

```
# this will include pre-FS data IF images were archived on import
print image.countImportedImageFiles()
# specifically count Fileset files
fileCount = image.countFilesetFiles()
# list files
if fileCount > 0:
    for origFile in image.getImportedImageFiles():
        name = origFile.getName()
        path = origFile.getPath()
        print path, name
```

- **Can get the Fileset using conn.getObject()**

```
fileset = conn.getObject("Fileset", fsId)
```

- **Close connection:**

```
# When you are done, close the session to free up server resources.
conn._closeSession()
```

Python OMERO.scripts

It is relatively straightforward to take the code samples above and re-use them in OMERO.scripts. This allows the code to be run on the OMERO server and called from either the OMERO.insight client or OMERO.web by any users of the server. See *OMERO.scripts user guide*.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.2 Blitz Gateway documentation

The Sphinx-generated documentation of methods provided by OMERO Gateway is available showing wrapper classes[4].

Specifically, the API for the 'conn' connection wrapper created above is here[5].

[4] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html
[5] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html#omero.gateway.BlitzGateway

When working with OMERO model objects[6] (omero.model.Image etc) the Gateway will wrap these objects in classes such as omero.gateway.ImageWrapper[7] to handle object loading and hierarchy traversal. For example:

```
>>> for p in conn.listProjects():          # Initially we just load Projects
...     print p.getName()
...     for dataset in p.listChildren():      # lazy-loading of Datasets here
...             print "  ", dataset.getName()
...
TestProject
   Aurora-B
tiff stacks
   newTimeStack
   test
siRNAi
   CENP
   live-cell
   survivin
```

11.2.1 Access to the OMERO API services

If you need access to API methods that are not provided by the gateway library, you can get hold of the *OMERO Application Programming Interface*.

Note: These services will always work with omero.model objects and not the gateway wrapper objects.

The gateway handles creation and reuse of the API services, so that new ones are not created unnecessarily. Services can be accessed using the methods of the underlying Service Factory[8] with the Gateway handling reuse as needed. Stateless services (those retrieved with get… methods e.g. getQueryService[9]) are always reused for each call, e.g. blitzon.getQueryService() whereas stateful services e.g. createRenderingEngine[10] may be created each time.

Not all methods of the service factory are currently supported in the gateway. You can get an idea of the currently supported services by looking at the source code under the _createProxies[11] method.

Example: ContainerService can load Projects and Datasets in a single call to server (no lazy loading)

```
cs = conn.getContainerService()
projects = cs.loadContainerHierarchy("Project", None, None)
for p in projects:                  # omero.model.ProjectI
    print p.getName().getValue()      # need to 'unwrap' rstring
    for d in p.linkedDatasetList():
        print d.getName().getValue()
```

11.2.2 Stateful services, reconnection, error handling etc

The Blitz gateway was designed for use in the *OMERO.web framework* framework and it is not expected that stateful services will be maintained on the client for significant time. There is various error-handling functionality in the Blitz gateway that will close existing services and recreate them in order to maintain a working connection. If this happens then any stateful services that you have on the client-side will become stale. We will attempt to document this a little better in due course, but our general advice is to create, use and close the stateful services in the shortest practicable time.

[6] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model.html
[7] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html#omero.gateway.ImageWrapper
[8] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ServiceFactory.html
[9] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ServiceFactory.html#getQueryService
[10] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ServiceFactory.html#createRenderingEngine
[11] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html#omero.gateway._BlitzGateway._createProxies

11.2.3 Overwriting and extending omero.gateway classes

When working with omero.gateway[12] or wrapper classes such as omero.gateway.ImageWrapper[13] you might want to add your own functionality or customize an existing one. NB: Note the call to `omero.gateway.refreshWrappers()` to ensure that your subclasses are returned by calls to getObjects() For example:

```
class MyBlitzGateway (omero.gateway.BlitzGateway):

    def __init__ (self, *args, **kwargs):
        super(MyBlitzGateway, self).__init__(*args, **kwargs)

        ...do something, e.g. add new field...
        self.new_field = 'foo'

    def connect (self, *args, **kwargs):

        rv = super(MyBlitzGateway, self).connect(*args,**kwargs)
        if rv:
            ...do something, e.g. modify new field...
            self.new_field = 'bla'

        return rv

omero.gateway.BlitzGateway = MyBlitzGateway

class MyBlitzObjectWrapper (object):

    annotation_counter = None

    def countAnnotations (self):
        """
        Count on annotations linked to the object and set the value
        on the custom field 'annotation_counter'.

        @return     Counter
        """

        if self.annotation_counter is not None:
            return self.annotation_counter
        else:
            container = self._conn.getContainerService()
            m = container.getCollectionCount(self._obj.__class__.__name__, type(self._obj).ANNOTATIONLI
            if m[self._oid] > 0:
                self.annotation_counter = m[self._oid]
                return self.annotation_counter
            else:
                return None

class ImageWrapper (MyBlitzObjectWrapper, omero.gateway.ImageWrapper):
    """
    omero_model_ImageI class wrapper overwrite omero.gateway.ImageWrapper
    and extends MyBlitzObjectWrapper.
    """

    def __prepare__ (self, **kwargs):
        if kwargs.has_key('annotation_counter'):
            self.annotation_counter = kwargs['annotation_counter']

omero.gateway.ImageWrapper = ImageWrapper

# IMPORTANT to update the map of wrappers for 'Image' etc. returned by getObjects("Image")
omero.gateway.refreshWrappers()
```

[12] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html
[13] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html#omero.gateway.ImageWrapper

This page provides some background information on the OMERO Python client 'gateway' (omero.gateway module) and describes work to improve the API.

The Blitz Gateway is a Python client-side library that facilitates working with the OMERO API, handling connection to the server, loading of data objects and providing convenience methods to access the data. It was originally designed as part of the *OMERO.web framework* framework, to provide connection and data retrieval services to various web clients. However, we have now decided to encourage its use for all access to the OMERO Python API.

11.2.4 Wrapper objects

The Gateway consists of a number of wrapper objects:

Connection wrapper

The BlitzGateway class (see API of development code[14]) is a wrapper for the OMERO client and session objects. It provides various methods for connecting to the OMERO server, querying the status or context of the current connection and as a starting point for retrieving data objects from OMERO.

```
from omero.gateway import *

conn = BlitzGateway("username", "password", host="localhost", port=4064)
conn.connect()

for p in conn.listProjects():
    print p.name
```

Model object wrappers

OMERO model objects, e.g. omero.model.Project, omero.model.Pixels etc. (see full list[15]) are code-generated and mapped to the OMERO database schema. They are language agnostic and their data is in the form of omero.rtypes as described in *about model objects*).

```
import omero
from omero.model import *
from omero.rtypes import rstring
p = omero.model.ProjectI()
p.name = rstring("My Project")    # attributes are all rtypes
print p.getName().getValue()      # getValue() to unwrap the rtype
print p.name.val                  # short-hand
```

To facilitate work in Python, particularly in web page templates, these Python model objects are wrapped in Blitz Object Wrappers. This hides the use of rtypes.

```
import omero
from omero.model import *
from omero.rtypes import rstring
p = omero.model.ProjectI()
p.setName(rstring("Omero Model Project"))    # attributes are all rtypes
print p.getName().getValue()                 # getValue() to unwrap the rtype
print p.name.val                             # short-hand
```

[14] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html#omero.gateway._BlitzGateway
[15] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model.html

```
from omero.gateway import *
project = ProjectWrapper(obj=p)              # wrap the model.object
project.setName("Project Wrapper")           # Don't need to use rtypes
print project.getName()
print project.name

print project._obj                  # access the wrapped object with ._obj
```

These wrappers also have a reference to the BlitzGateway connection wrapper, so they can make calls to the server and load more data when needed (lazy loading).

E.g.

```
# connect as above
for p in conn.listProjects():
    print p.name
    for dataset in p.listChildren():    # lazy loading of datasets, wrapped in DatasetWrapper
        print "Dataset", d.name
```

Wrapper coverage

The OMERO data model has a large number of objects, not all of which are used by the *OMERO.web framework*. Therefore, the Blitz gateway (which was originally built for this framework) has not yet been extended to wrap every omero.model object with a specific Blitz Object Wrapper. The current list of object wrappers can be found in the omero.gateway module API[16]. As more functionality is provided by the Blitz Gateway, the coverage of object wrappers will increase accordingly.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.3 Command Line Interface as an OMERO development tool

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.3.1 Working with objects

The `omero obj` command allows to create and update OMERO objects. More information can be displayed using `bin/omero obj -h`.

Object creation

The `omero obj new` subcommand allows to create new objects:

```
$ bin/omero obj new Object field=value
```

where *Object* is the type of object to create, e.g. *Dataset* or *ProjectDatasetLink* and *field*/*value* is a valid key/value pair for the type of object. For example, the following command creates a new screen with a name and a description:

```
$ bin/omero obj new Screen name=Screen001 description="screen description"
```

[16] http://downloads.openmicroscopy.org/latest/omero/api/python/omero/omero.gateway.html

Object update

The `omero obj update` subcommand allows to update existing objects:

```
$ bin/omero obj update Object:ID field=value
```

where *Object:ID* is the type and the ID of object to update, e.g. *Image:1* or *PlateDatasetLink:10* and *field/value* is a valid key/value pair to update for the specified object.

For example, the following command updates the existing screen of ID 2 with a name and a description:

```
$ bin/omero obj update Screen:2 name=Screen001 description="screen description"
```

Piping output

The output of each `omero obj` command is formatted as *Object:ID* so that the CLI commands can be redirected and piped together. For example, the following set of commands creates a dataset and a project and links them together:

```
$ dataset=$(bin/omero obj new Dataset name=dataset-1)
$ project=$(bin/omero obj new Project name=plate-1)
$ bin/omero obj new ProjectDatasetLink parent=$project child=$dataset
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.3.2 Extensions

Plugins can be written and put in the `lib/python/omero/plugins` directory. On execution, all plugins in that directory are registered with the CLI. Alternatively, the `--path` argument can be used to point to other plugin files or directories.

Thread-safety

The `omero.cli.CLI` should be considered not thread-safe. A single connection object is accessible from all plugins via `self.ctx.conn(args)`, and it is assumed that changes to this object will only take place in the current thread. The CLI instance itself, however, can be passed between multiple threads, as long as only one accesses it sequentially, possibly via locking.

See also:

Extending OMERO.server Other extensions to OMERO

See also:

Command Line Interface as an OMERO client User documentation on the Command Line Interface

Command Line Interface as an OMERO admin tool System Administrator documentation for the Command Line Interface

Help for any specific CLI command can be displayed using the `-h` argument. See *Command line help* for more information.

11.3.3 General notes

- `bin/omero` will find its installation. Therefore, to install OMERO it is only necessary to unpack the bundle, and put `bin/omero` somewhere on your path.
- Any command can be produced by symlinking `bin/omero` to a file of the form "omero-command-arg1-arg2". This is useful under `/etc/rc.d` to have a startup script.
- All commands respond to `omero help`.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.4 OMERO Java language bindings

Using the Ice Java language mapping[17] from ZeroC[18], OMERO provides access to your data within an *OMERO.blitz* server from Java code.

11.4.1 Writing client apps

To make use of the OMERO Java API and interact with *OMERO.blitz* from your code, a client application needs the Java bindings available on the classpath.

The required `.jar` files can be obtained in a number of ways:

- manually from the OME artifactory[19]. All available artifacts and their POM files can be browsed using the Maven repository[20].
- using the `OMERO.java` ZIP file downloaded from the Java[21] section of the OMERO download page. The `libs` directory can then be used on the Java classpath (or attached to a project in Eclipse).
- following the example in minimal-omero-client[22]. Please make sure you are using the proper branch of the repository, as that influences the versions of dependencies defined in the Maven POM file.

11.4.2 Extended classpath

To access all the functionality available in omero_client.jar or to use the importer, you will need more jar files. To see all the current requirements, take a look at the builds on jenkins[23], or alternatively examine the dependencies in the ivy.xml files (e.g. components/insight/ivy.xml[24])

11.4.3 Connect to OMERO

- **Connect to the server**. Remember to close the session.

```
LoginCredentials cred = new LoginCredentials(userName, password, host, port);

// Alternative using args array:
// args = new String[] { "--omero.host=" + hostName, "--omero.port=" + port,
//                 "--omero.user=" + userName, "--omero.pass=" + password };
// LoginCredentials cred = new LoginCredentials(args);

//Create a simple Logger object which just writes
//to System.out or System.err
Logger simpleLogger = new SimpleLogger();

Gateway gateway = new Gateway(simpleLogger);
ExperimenterData user = gateway.connect(cred);

//for every subsequent call to the server you'll need the
```

[17] https://doc.zeroc.com/display/Ice/Hello+World+Application
[18] https://zeroc.com
[19] http://artifacts.openmicroscopy.org
[20] http://artifacts.openmicroscopy.org/artifactory/maven/
[21] http://downloads.openmicroscopy.org/latest/omero/#java
[22] https://github.com/ome/minimal-omero-client
[23] https://ci.openmicroscopy.org/
[24] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/insight/ivy.xml

```
//SecurityContext for a certain group; in this case create
//a SecurityContext for the user's default group.
SecurityContext ctx = new SecurityContext(user.getGroupId());
```

- **Close connection**. **IMPORTANT**

```
gateway.disconnect();
```

11.4.4 Read data

The BrowseFacility offers methods for browsing within the data hierarchy. A list of examples follows, indicating how to load Project, Dataset, Screen, etc.

- **Retrieve the projects** owned by the user currently logged in.

If a Project contains Datasets, the Datasets will automatically be loaded.

```
BrowseFacility browse = gateway.getFacility(BrowseFacility.class);

Collection<ProjectData> projects = browse.getProjects(ctx);

Iterator<ProjectData> i = projects.iterator();
ProjectData project;
Set<DatasetData> datasets;
Iterator<DatasetData> j;
DatasetData dataset;
while (i.hasNext()) {
    project = i.next();
    String name = projet.getName();
    long id = project.getId();
    datasets = project.getDatasets();
    j = datasets.iterator();
    while (j.hasNext()) {
        dataset = j.next();
        // Do something here
        // If images loaded.
        // dataset.getImages();
    }
}
```

- **Retrieve the Datasets** owned by the user currently logged in.

```
BrowseFacility browse = gateway.getFacility(BrowseFacility.class);
Collection<DatasetData> datasets = browse.getDatasets(ctx);

Iterator<DatasetData> i = datasets.iterator();
DatasetData dataset;
Set<ImageData> images;
Iterator<ImageData> j;
ImageData image;
while (i.hasNext()) {
    dataset = i.next();
    images = dataset.getImages();
    j = images.iterator();
    while (j.hasNext()) {
        image = j.next();
        //Do something
    }
}
```

- **Retrieve the Images** contained in a Dataset.

```
BrowseFacility browse = gateway.getFacility(BrowseFacility.class);
Collection<ImageData> images = browse.getImagesForDatasets(ctx, Arrays.asList(datasetId));

Iterator<ImageData> j = images.iterator();
ImageData image;
while (j.hasNext()) {
    image = j.next();
    // Do something
}
```

- **Retrieve an Image** if the identifier is known.

```
BrowseFacility browse = gateway.getFacility(BrowseFacility.class);
ImageData image = browse.getImage(ctx, imageId);
```

- **Access information about the image** for example to draw it.

The model is as follows: Image-Pixels i.e. to access valuable data about the image you need to use the pixels object. We now only support one set of pixels per image (it used to be more!).

```
PixelsData pixels = image.getDefaultPixels();
int sizeZ = pixels.getSizeZ(); // The number of z-sections.
int sizeT = pixels.getSizeT(); // The number of timepoints.
int sizeC = pixels.getSizeC(); // The number of channels.
int sizeX = pixels.getSizeX(); // The number of pixels along the X-axis.
int sizeY = pixels.getSizeY(); // The number of pixels along the Y-axis.
```

- **Retrieve Screening data** owned by the user currently logged in**.**

Note that the wells are not loaded.

```
BrowseFacility browse = gateway.getFacility(BrowseFacility.class);
Collection<ScreenData> screens = browse.getScreens(ctx);

Iterator<ScreenData> i = screens.iterator();
ScreenData screen;
Set<PlateData> plates;
Iterator<PlateData> j;
PlateData plate;
while (i.hasNext()) {
    screen = i.next();
    plates = screen.getPlates();
    j = plates.iterator();
    while (j.hasNext()) {
        plate = j.next();
    }
}
```

- **Retrieve Wells within a Plate.**

Given a plate ID, load the wells.

```
BrowseFacility browse = gateway.getFacility(BrowseFacility.class);
Collection<WellData> wells = browse.getWells(ctx, plateId);

Iterator<WellData> i = wells.iterator();
WellData well;
while (i.hasNext()) {
```

```
    well = i.next();
    //Do something
}
```

11.4.5 Raw data access

- **Retrieve a given plane.**

This is useful when you need for example the pixels intensity.

```
RawDataFacility rdf = gateway.getFacility(RawDataFacility.class);
PixelsData pixels = image.getDefaultPixels();
int sizeZ = pixels.getSizeZ();
int sizeT = pixels.getSizeT();
int sizeC = pixels.getSizeC();

Plane2D p;
for (int z = 0; z < sizeZ; z++)
    for (int t = 0; t < sizeT; t++)
        for (int c = 0; c < sizeC; c++) {
            p = rdf.getPlane(ctx, pixels, z, t, c);
        }
```

- **Retrieve a given tile.**

```
RawDataFacility rdf = gateway.getFacility(RawDataFacility.class);

PixelsData pixels = image.getDefaultPixels();
int sizeZ = pixels.getSizeZ();
int sizeT = pixels.getSizeT();
int sizeC = pixels.getSizeC();
int x = 0;
int y = 0;
int width = pixels.getSizeX()/2;
int height = pixels.getSizeY()/2;
Plane2D p;
for (int z = 0; z < sizeZ; z++) {
    for (int t = 0; t < sizeT; t++) {
        for (int c = 0; c < sizeC; c++) {
            p = rdf.getTile(ctx, pixels, z, t, c, x, y, width, height);
        }
    }
}
```

- **Retrieve a given stack.**

This is useful when you need the pixels intensity.

```
PixelsData pixels = image.getDefaultPixels();
int sizeT = pixels.getSizeT();
int sizeC = pixels.getSizeC();
long pixelsId = pixels.getId();
RawPixelsStorePrx store = gateway.getPixelsStore(ctx);
store.setPixelsId(pixelsId, false);
for (int t = 0; t < sizeT; t++) {
    for (int c = 0; c < sizeC; c++) {
        byte[] plane = store.getStack(c, t);
        //Do something
    }
```

```
}
store.close();
```

- **Retrieve a given hypercube.**

This is useful when you need the pixels intensity.

```
PixelsData pixels = image.getDefaultPixels();
long pixelsId = pixels.getId();
//offset values in each dimension XYZCT
List<Integer> offset = new ArrayList<Integer>();
int n = 5;
for (int i = 0; i < n; i++) {
    offset.add(i, 0);
}

List<Integer> size = new ArrayList<Integer>();
size.add(pixels.getSizeX());
size.add(pixels.getSizeY());
size.add(pixels.getSizeZ());
size.add(pixels.getSizeC());
size.add(pixels.getSizeT());

//indicate the step in each direction, step = 1,
//will return values at index 0, 1, 2.
//step = 2, values at index 0, 2, 4 etc.
List<Integer> step = new ArrayList<Integer>();
for (int i = 0; i < n; i++) {
    step.add(i, 1);
}
RawPixelsStorePrx store = gateway.getPixelsStore(ctx);
store.setPixelsId(pixelsId, false);
byte[] values = store.getHypercube(offset, size, step);
//Do something
store.close();
```

11.4.6 Write data

- **Create a dataset and link it to an existing project.**

```
DataManagerFacility dm = gateway.getFacility(DataManagerFacility.class);

//Using IObject directly
Dataset dataset = new DatasetI();
dataset.setName(omero.rtypes.rstring("new Name 1"));
dataset.setDescription(omero.rtypes.rstring("new description 1"));

//Using the model object (recommended)
DatasetData datasetData = new DatasetData();
datasetData.setName("new Name 2");
datasetData.setDescription("new description 2");


ProjectDatasetLink link = new ProjectDatasetLinkI();
link.setChild(dataset);
link.setParent(new ProjectI(info.getProjectId(), false));
IObject r = dm.saveAndReturnObject(ctx, link);
//With model object
link = new ProjectDatasetLinkI();
link.setChild(datasetData.asDataset());
```

```
link.setParent(new ProjectI(info.getProjectId(), false));
r = dm.saveAndReturnObject(ctx, link);
```

- **Import images into a dataset.**

Using the Gateway:

```
ImportCallback cb = new ImportCallback();
TransferFacility tf = gateway.getFacility(TransferFacility.class);

// the uploadImage method will automatically create a dataset with
// the same name as the directory, the image file is located in
tf.uploadImage(ctx, new File("/pathTo/image.dv"), cb);

//wait for the upload to finish
while (!cb.isFinished()) {
    try {
        Thread.sleep(250);
    } catch (InterruptedException e) {}
}
```

Using the Java API directly:

```
String paths = new String[] {"/pathTo/image1.dv", "/pathTo/image2.dv"};

ImportConfig config = new ome.formats.importer.ImportConfig();

config.email.set("");
config.sendFiles.set(true);
config.sendReport.set(false);
config.contOnError.set(false);
config.debug.set(false);

config.hostname.set("localhost");
config.port.set(4064);
config.username.set("root");
config.password.set("omero");

// the imported image will go into 'orphaned images' unless
// you specify a particular existing dataset like this:
// config.targetClass.set("omero.model.Dataset");
// config.targetId.set(1L);

OMEROMetadataStoreClient store;
try {
    store = config.createStore();
    store.logVersionInfo(config.getIniVersionNumber());
    OMEROWrapper reader = new OMEROWrapper(config);
    ImportLibrary library = new ImportLibrary(store, reader);

    ErrorHandler handler = new ErrorHandler(config);
    library.addObserver(new LoggingImportMonitor());

    ImportCandidates candidates = new ImportCandidates(reader, paths, handler);
    reader.setMetadataOptions(new DefaultMetadataOptions(MetadataLevel.ALL));
    library.importCandidates(config, candidates);

    store.logout();

} catch (Exception e) {
    e.printStackTrace();
}
```

- **Create a tag (tag annotation) and link it to an existing project.**

```
DataManagerFacility dm = gateway.getFacility(DataManagerFacility.class);

TagAnnotation tag = new TagAnnotationI();
tag.setTextValue(omero.rtypes.rstring("new tag 1"));
tag.setDescription(omero.rtypes.rstring("new tag 1"));

//Using the model object (recommended)
TagAnnotationData tagData = new TagAnnotationData("new tag 2");
tagData.setTagDescription("new tag 2");

ProjectAnnotationLink link = new ProjectAnnotationLinkI();
link.setChild(tag);
link.setParent(new ProjectI(info.getProjectId(), false));
IObject r = dm.saveAndReturnObject(ctx, link);
//With model object
link = new ProjectAnnotationLinkI();
link.setChild(tagData.asAnnotation());
link.setParent(new ProjectI(info.getProjectId(), false));
r = dm.saveAndReturnObject(ctx, link);
```

- **Create a file annotation and link to an image.**

To attach a file to an object e.g. an image, few objects need to be created:

1. an `OriginalFile`
2. a `FileAnnotation`
3. a link between the `Image` and the `FileAnnotation`.

```
int INC = 262144;
DataManagerFacility dm = gateway.getFacility(DataManagerFacility.class);

//To retrieve the image see above.
File file = File.createTempFile("temp-file-name_", ".tmp");
String name = file.getName();
String absolutePath = file.getAbsolutePath();
String path = absolutePath.substring(0,
        absolutePath.length()-name.length());

//create the original file object.
OriginalFile originalFile = new OriginalFileI();
originalFile.setName(omero.rtypes.rstring(name));
originalFile.setPath(omero.rtypes.rstring(path));
originalFile.setSize(omero.rtypes.rlong(file.length()));
final ChecksumAlgorithm checksumAlgorithm = new ChecksumAlgorithmI();
checksumAlgorithm.setValue(omero.rtypes.rstring(ChecksumAlgorithmSHA1160.value));
originalFile.setHasher(checksumAlgorithm);
originalFile.setMimetype(omero.rtypes.rstring(fileMimeType)); // or "application/octet-stream"
//Now we save the originalFile object
originalFile = (OriginalFile) dm.saveAndReturnObject(ctx, originalFile);

//Initialize the service to load the raw data
RawFileStorePrx rawFileStore = gateway.getRawFileService(ctx);
rawFileStore.setFileId(originalFile.getId().getValue());
//Open file and read stream.
FileInputStream stream = new FileInputStream(file);
long pos = 0;
int rlen;
byte[] buf = new byte[INC];
ByteBuffer bbuf;
while ((rlen = stream.read(buf)) > 0) {
    rawFileStore.write(buf, pos, rlen);
```

```
    pos += rlen;
    bbuf = ByteBuffer.wrap(buf);
    bbuf.limit(rlen);
}
stream.close();
originalFile = rawFileStore.save();
rawFileStore.close();

//now we have an original File in DB and raw data uploaded.
//We now need to link the Original file to the image using
//the File annotation object. That's the way to do it.
FileAnnotation fa = new FileAnnotationI();
fa.setFile(originalFile);
fa.setDescription(omero.rtypes.rstring(description)); // The description set above e.g. PointsModel
fa.setNs(omero.rtypes.rstring(NAME_SPACE_TO_SET)); // The name space you have set to identify the file a

//save the file annotation.
fa = (FileAnnotation) dm.saveAndReturnObject(ctx, fa);

//now link the image and the annotation
ImageAnnotationLink link = new ImageAnnotationLinkI();
link.setChild(fa);
link.setParent(image.asImage());
//save the link back to the server.
link = (ImageAnnotationLink) dm.saveAndReturnObject(ctx, link);
// o attach to a Dataset use DatasetAnnotationLink;
```

- **Load all the file annotations with a given namespace.**

```
long userId = gateway.getLoggedInUser().getId();
List<String> nsToInclude = new ArrayList<String>();
nsToInclude.add(NAME_SPACE_TO_SET);
List<String> nsToExclude = new ArrayList<String>();
ParametersI param = new ParametersI();
param.exp(omero.rtypes.rlong(userId)); //load the annotation for a given user.
IMetadataPrx proxy = gateway.getMetadataService(ctx);
List<Annotation> annotations = proxy.loadSpecifiedAnnotations(
        FileAnnotation.class.getName(), nsToInclude, nsToExclude, param);
//Do something with annotations.
```

- **Read the attachment.**

First load the annotations, cf. above.

```
Iterator<Annotation> j = annotations.iterator();
Annotation annotation;
FileAnnotationData fa;
RawFileStorePrx store = null;
File file = File.createTempFile("temp-file-name_", ".tmp");
store = gateway.getRawFileService(ctx);
int index = 0;
FileOutputStream stream = new FileOutputStream(file);
OriginalFile of;
while (j.hasNext()) {
    annotation = j.next();
    if (annotation instanceof FileAnnotation && index == 0) {
        fa = new FileAnnotationData((FileAnnotation) annotation);
        //The id of the original file
        of = getOriginalFile(fa.getFileID());
        store.setFileId(fa.getFileID());
        int offset = 0;
        long size = of.getSize().getValue();
```

```
        //name of the file
        String fileName = of.getName().getValue();
        try {
            for (offset = 0; (offset+INC) < size;) {
                stream.write(store.read(offset, INC));
                offset += INC;
            }
        } finally {
            stream.write(store.read(offset, (int) (size-offset)));
            stream.close();
        }
        index++;
    }
}
store.close();
```

11.4.7 How to use OMERO tables

- **Create a table.**

In the following example, we create a table with 2 columns.

```
/**
 * Creates a number of empty rows.
 *
 * @param rows The number of rows.
 * @return See above.
 */
private Column[] createColumns(int rows)
{
  Column[] newColumns = new Column[2];
  newColumns[0] = new LongColumn("Uid", "", new long[rows]);
  newColumns[1] = new LongColumn("MyLongColumn", "",
                new long[rows]);
  return newColumns;
}

int rows = 1;
String name = UUID.randomUUID().toString();
Column[] columns = createColumns(rows);

//create a new table.
SharedResourcesPrx store = gateway.getSharedResources(ctx);
TablePrx table = store.newTable(1, name);

//initialize the table
table.initialize(columns);
//add data to the table.
rows = 2;
Column[] newRow = createColumns(rows);

LongColumn uids = (LongColumn) newRow[0];
LongColumn myLongs = (LongColumn) newRow[1];
for (int i = 0; i < rows; i++) {
    uids.values[i] = i;
    myLongs.values[i] = i;
}

table.addData(newRow);

OriginalFile file = table.getOriginalFile(); //if you need to interact with the table
```

- **Read the contents of the table.**

```
file = new OriginalFileI(file.getId(), false);
table = store.openTable(file);

//read headers
Column[] cols = table.getHeaders();

for (int i = 0; i < cols.length; i++) {
  String colName = cols[i].name;
}

//Depending on size of table, you may only want to read some blocks.
long[] columnsToRead = new long[cols.length];
for (int i = 0; i < cols.length; i++) {
  columnsToRead[i] = i;
}

//The number of columns we wish to read.
long[] rowSubset = new long[(int) (table.getNumberOfRows()-1)];
for (int j = 0; j < rowSubset.length; j++) {
  rowSubset[j] = j;
}
Data data = table.slice(columnsToRead, rowSubset); // read the data.
cols = data.columns;
for (int j = 0; j < cols.length; j++) {
  Column c = cols[j];
}
table.close();
```

11.4.8 ROIs

To learn about the model see the ROI Model documentation[25]. Note that annotations can be linked to ROI or shape.

- **Create ROI.**

In this example, we create an ROI with a rectangular shape and attach it to an image.

```
DataManagerFacility dm = gateway.getFacility(DataManagerFacility.class);
ROIFacility roifac = gateway.getFacility(ROIFacility.class);

//To retrieve the image see above.

ROIData data = new ROIData();
data.setImage(image);
//Create a rectangle.
RectangleData rectangle = new RectangleData(10, 10, 10, 10);
rectangle.setZ(0);
rectangle.setT(0);
data.addShapeData(rectangle);

//Create an ellipse.
EllipseData ellipse = new Ellipse(10, 10, 10, 10);
ellipse.setZ(0);
ellipse.setT(0);
ellipse.setText("ellipse text");
data.addShapeData(ellipse);

// Save ROI and shape
ROIData roiData = roifac.saveROIs(ctx, image.getId(), Arrays.asList(data)).iterator().next();
```

[25] http://www.openmicroscopy.org/site/support/ome-model/developers/roi.html

```
//now check that the shape has been added.
//Retrieve the shape on plane (z, t) = (0, 0)
List<ShapeData> shapes = roiData.getShapes(0, 0);
Iterator<ShapeData> i = shapes.iterator();
while (i.hasNext()) {
  ShapeData shape = i.next();
  // plane info
  int z = shape.getZ();
  int t = shape.getT();
  long id = shape.getId();
  if (shape instanceof RectangleData) {
    RectangleData rectData = (RectangleData) shape;
    // Handle rectangle
  } else if (shape instanceof EllipseData) {
    EllipseData ellipseData = (EllipseData) shape;
    // Handle ellipse
  } else if (shape instanceof LineData) {
    LineData lineData = (LineData) shape;
    // Handle line
  } else if (shape instanceof PointData) {
    PointData pointData = (PointData) shape;
    // Handle point
  }
}
```

- **Retrieve ROIs linked to an Image.**

```
ROIFacility roifac = gateway.getFacility(ROIFacility.class);

//Retrieve the roi linked to an image
List<ROIResult> roiresults = roifac.loadROIs(ctx, image.getId());
ROIResult r = roiresults.iterator().next();
if (r == null) return;
List<Roi> rois = r.rois;
List<Shape> list;
Iterator<Roi> j = rois.iterator();
while (j.hasNext()) {
  roi = j.next();
  list = roi.copyShapes();
  // Do something
}
```

- **Remove a shape from ROI.**

```
DataManagerFacility dm = gateway.getFacility(DataManagerFacility.class);
ROIFacility roifac = gateway.getFacility(ROIFacility.class);

//Retrieve the roi linked to an image
List<ROIResult> roiresults = roifac.loadROIs(ctx, image.getId());
ROIResult r = roiresults.iterator().next();
List<Roi> rois = r.rois;
List<Shape> list;
Iterator<Roi> j = rois.iterator();
while (j.hasNext()) {
  roi = j.next();
  list = roi.copyShapes();
  // remove the first shape.
  if (list.size() > 0) {
    roi.removeShape(list.get(0));
    // update the roi.
    dm.saveAndReturnObject(ctx, roi).saveAndReturnObject(roi);
```

```
  }
}
```

11.4.9 Delete data

It is possible to delete Projects, datasets, images, ROIs etc. and objects linked to them depending on the specified options (see *Deleting in OMERO*).

- **Delete Image.**

In the following example, we create an image and delete it.

```
DataManagerFacility dm = gateway.getFacility(DataManagerFacility.class);

//First create an image.
ImageData image = new ImageData();
image.setName("image1");
image.setDescription("descriptionImage1");
IObject object = dm.saveAndReturnObject(ctx, image.asIObject());

Response rsp = dm.deleteObject(ctx, object);
```

11.4.10 Render Images

- **Initialize the rendering engine and render an image.**

```
PixelsData pixels = image.getDefaultPixels();
long pixelsId = pixels.getId();
RenderingEnginePrx proxy = null;
proxy = gateway.getRenderingService(ctx, pixelsId);
proxy.lookupPixels(pixelsId);
if (!(proxy.lookupRenderingDef(pixelsId))) {
    proxy.resetDefaultSettings(true);
    proxy.lookupRenderingDef(pixelsId);
}
proxy.load();
//Now can interact with the rendering engine.
proxy.setActive(0, Boolean.valueOf(false));
PlaneDef pDef = new PlaneDef();
pDef.z = 0;
pDef.t = 0;
pDef.slice = omero.romio.XY.value;
//render the data uncompressed.
int[] uncompressed = proxy.renderAsPackedInt(pDef);
byte[] compressed = proxy.renderCompressed(pDef);
//Create a buffered image
ByteArrayInputStream stream = new ByteArrayInputStream(compressed);
BufferedImage image = ImageIO.read(stream);
proxy.close();
```

- **Retrieve thumbnails.**

```
ThumbnailStorePrx store = gateway.getThumbnailService(ctx);
PixelsData pixels = image.getDefaultPixels();
store.setPixelsId(pixels.getId())
//retrieve a 96x96 thumbnail.
byte[] array = store.getThumbnail(
```

```
        omero.rtypes.rint(96), omero.rtypes.rint(96));
ByteArrayInputStream stream = new ByteArrayInputStream(array);
//Create a buffered image to display
ImageIO.read(stream);
store.close();
```

11.4.11 Create Image

The following example shows how to create an Image from an Image already in OMERO. Similar approach can be applied when uploading an image.

```
//See above how to load an image.
PixelsData pixels = image.getDefaultPixels();
int sizeZ = pixels.getSizeZ();
int sizeT = pixels.getSizeT();
int sizeC = pixels.getSizeC();
int sizeX = pixels.getSizeX();
int sizeY = pixels.getSizeY();
long pixelsId = pixels.getId();

//Read the pixels from the source image.
RawPixelsStorePrx store = gateway.getPixelsStore(ctx);
store.setPixelsId(pixelsId, false);

List<byte[]> planes = new ArrayList<byte[]>();

for (int z = 0; z < sizeZ; z++) {
    for (int t = 0; t < sizeT; t++) {
        planes.add(store.getPlane(z, 0, t));
    }
}

//Better to close to free space.
store.close();

//Now we are going to create the new image.
IPixelsPrx proxy = gateway.getPixelsService(ctx);

//Search for PixelsType object matching the source image.
List<IObject> l = proxy.getAllEnumerations(PixelsType.class.getName());
Iterator<IObject> i = l.iterator();
PixelsType type = null;
String original = pixels.getPixelType();
while (i.hasNext()) {
    PixelsType o =  (PixelsType) i.next();
    String value = o.getValue().getValue();
    if (value.equals(original)) {
        type = o;
        break;
    }
}
if (type == null)
    throw new Exception("Pixels Type not valid.");

//Create new image.
String name = "newImageFrom"+image.getId();
RLong idNew = proxy.createImage(sizeX, sizeY, sizeZ, sizeT, Arrays.asList(0), type, name,
        "From Image ID: "+image.getId());
if (idNew == null)
    throw new Exception("New image could not be created.");
IContainerPrx proxyCS = entryUnencrypted.getContainerService();
```

```
List<Image> results = proxyCS.getImages(Image.class.getName(),
                Arrays.asList(idNew.getValue()), new ParametersI());
ImageData newImage = new ImageData(results.get(0));

//Link the new image and the dataset hosting the source image.
DatasetImageLink link = new DatasetImageLinkI();
link.setParent(new DatasetI(datasetId, false));
link.setChild(new ImageI(newImage.getId(), false));
gateway.getUpdateService(ctx).saveAndReturnObject(link);

//Write the data.
store = gateway.getPixelsStore(ctx);
store.setPixelsId(newImage.getDefaultPixels().getId(), false);
int index = 0;
for (int z = 0; z < sizeZ; z++) {
    for (int t = 0; t < sizeT; t++) {
        store.setPlane(planes.get(index++), z, 0, t);
    }
}

//Save the data.
store.save();

store.close();
```

11.4.12 Further information

For the details behind writing, configuring, and executing a client, please see *Working with OMERO*.

See also:

ZeroC[26], *OMERO.grid*, *OmeroTools*, *OMERO Application Programming Interface*

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.5 OMERO MATLAB language bindings

See *Developing OMERO clients* and *OME-Remote Objects*, for an introduction to **Object**.

11.5.1 Installing the OMERO.matlab toolbox

- Download the latest released version from the download page[27].
- Unzip the directory anywhere on your system.
- In MATLAB, move to the newly unzipped directory and run `loadOmero;`.
- The MATLAB files are now on your path, and the necessary jars are on your Java classpath. You can change directories and still have access to OMERO.

Once OMERO.matlab is installed, the typical workflow is:

1. *Creating a connection*
2. *Keeping your session alive*

[26] https://zeroc.com
[27] http://downloads.openmicroscopy.org/latest/omero/

3. *Creating an unencrypted session* (optional)
4. Do some work (load objects, work with them, upload to the server…)
5. *Closing your connection*
6. *Unloading OMERO* (optional)

As a quickstart example, the following lines create a secure connection to a server, read a series of images and close the connection.

```
client = loadOmero(servername, port);
session = client.createSession(user, password);
client.enableKeepAlive(60);
images = getImages(session, ids);
client.closeSession();
```

Examples of usage of the OMERO.matlab toolbox are provided in the training examples[28] directory.

11.5.2 Configuring the OMERO.matlab connection

Creating a connection

As described under *Working with OMERO*, there are several ways to configure your connection to an OMERO server. OMERO.matlab comes with a few conveniences for making this work.

If you run `client = loadOmero();` (i.e. loadOmero with an output argument), then OMERO.matlab will try to configure the `omero.client` object for you. First, it checks the `ICE_CONFIG` environment variable. If set, it will let the `omero.client` constructor initialize itself. Otherwise, it looks for the file `ice.config` in the current directory. The OMERO.matlab toolbox comes with a default `ice.config` file pointing at `localhost`. To use this configuration file, you should replace `localhost` by your server address.

Alternatively, you can pass the same parameters to `loadOmero;` that you would pass to `omero.client`:

```
>> omero_client_1 = loadOmero('localhost');
>> omero_client_2 = omero.client('localhost');
```

Or, if you want a session created directly, the following are equivalent:

```
>> [client1, session1] = loadOmero('localhost');
>> client2 = loadOmero('localhost');
>> session2 = client2.createSession()
```

Keeping your session alive

For executing any long running task, you will need a background thread which keeps your session alive. If you are familiar with MATLAB `Timers` you can use omeroKeepAlive.m[29] directly or modify it to your liking.

```
>> [c,s] = loadOmero;
>> t = omeroKeepAlive(c); % Create a 60-second timer and starts it
>> …
>> delete(t);             % Disable the keep-alive
```

Alternatively, you can use the Java-based `enableKeepAlive` method, but it is not configurable from within MATLAB:

[28] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/examples/Training/matlab
[29] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/omeroKeepAlive.m

```
c.enableKeepAlive(60); % Call session.keepAlive() every 60 seconds
c.closeSession();      % Close session to end the keep-alive
```

Working in a different group

Each session is created within a given context, defining not only the session user but also the session group. The session context can be retrieved using the administration service:

```
eventContext = s.getAdminService().getEventContext();
groupId = eventContext.groupId;
```

Most read and write operations described below are performed in the context of the session group when using the default parameters. Since OMERO 5.1.4, it is possible to specify a different context than the session group for reading and writing data using the `group` parameter/key value in the OMERO.matlab functions. Retrieving objects by identifiers is also done across all groups by default.

See also:

OMERO permissions history, querying and usage Developer documentation about the OMERO permissions system

Creating an unencrypted session

Once a session has been created, if you want to speed up the data transfer, you can create and use an unencrypted session as:

```
unsecureClient = client.createClient(false);
sessionUnencrypted = unsecureClient.getSession();
```

Closing your connection

When you are done with OMERO, it is critical that you close your connection to save resources:

```
client.closeSession();
clear client1;
clear session1;
```

If you created an unencrypted session, you will need to close the unsecure session as well:

```
client.closeSession();
unsecureClient.closeSession();
```

Unloading OMERO

Then if you would like, you can unload OMERO as well:

```
unloadOmero();
```

You may see the following warning when unloading OMERO:

```
>> unloadOmero()
Warning: Objects of omero/client class exist - not clearing java
> In javaclasspath>doclear at 377
  In javaclasspath>local_javapath at 194
  In javaclasspath at 105
  In javarmpath at 48
  In unloadOmero at 75

================================================================
While unloading OMERO, found java objects left in workspace.
Please remove with 'clear <name>' and then run 'unloadOmero'
again.  Printing all objects...
================================================================

  Name      Size            Bytes  Class           Attributes

  c         1x1                    omero.client

Closing session(s) for 1 found client(s): c
```

This means that there is still an OMERO.matlab object in your workspace. If not listed, use `whos` to find such objects, and `clear` to remove them. After that, run `unloadOmero()` again:

```
>> clear c
>> unloadOmero()
```

Warning: You should also unload OMERO before installing a new version of OMERO.matlab or calling `loadOmero` again.

If you need to create another session without unloading/loading OMERO again, use the `omero.client` object directly:

```
>> [c,s] = loadOmero(arg1,arg2);
>> c = omero.client(arg3,arg4);
>> s = c.createSession();
```

11.5.3 Reading data

The `IContainer` service provides methods to load the data management hierarchy in OMERO – projects, datasets… A list of examples follows indicating how to load projects, datasets, screens…

- **Projects**

The projects owned by the session user in the context of the session group can be retrieved using the getProjects[30] function:

```
projects = getProjects(session)
```

If the project identifiers are known, they can be retrieved independently of their owner or group using:

```
projects = getProjects(session, ids)
```

If the projects contain datasets, the datasets will automatically be loaded:

[30] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getProjects.m

```
for j = 1 : numel(projects)
    datasetsList = projects(j).linkedDatasetList;
    for i = 0:datasetsList.size()-1,
        d = datasetsList.get(i);
    end
end
```

If the datasets contain images, the images are not automatically loaded. To load the whole graph (projects, datasets, images), pass *true* as an optional argument:

```
myLoadedProjects = getProjects(session, true)
loadedProjects = getProjects(session, ids, true)
imageList = loadedProjects(1).linkedDatasetList.get(0).linkedImageList;
```

Warning: Loading the entire projects/datasets/images graph can be time-consuming and memory-consuming depending on the amount of data.

To return the orphaned datasets as well as the projects, you can query the second output argument of getProjects[31]:

```
[projects, orphanedDatasets] = getProjects(session)
```

To filter projects by owner, use the `owner` parameter/key value. A value of -1 means projects are retrieved independently of their owner:

```
% Returns all projects owned by the specified user in the context of the
% session group
projects = getProjects(session, 'owner', ownerId);
% Returns all projects with the input identifiers owned by the specified
% user
projects = getProjects(session, ids, 'owner', ownerId);
% Returns all projects owned by any user in the context of the session
% group
projects = getProjects(session, 'owner', -1);
```

To filter projects by group, use the `group` parameter/key value. A value of -1 means projects are retrieved independently of their group:

```
% Returns all projects owned by the session user in the specified group
projects = getProjects(session, 'group', groupId);
% Returns all projects with the input identifiers in the specified group
projects = getProjects(session, ids, 'group', groupId);
% Returns all projects owned by the session user across groups
projects = getProjects(session, 'group', -1);
```

- **Datasets**

The datasets owned by the session user in the context of the session group can be retrieved using the getDatasets[32] function:

```
datasets = getDatasets(session)
```

If the dataset identifiers are known, they can be retrieved independently of their owner or group using:

[31] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getProjects.m
[32] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getDatasets.m

```
datasets = getDatasets(session, ids)
```

If the datasets contain images, the images are not automatically loaded. To load the whole graph (datasets, images), pass *true* as an optional argument:

```
loadedDatasets = getDatasets(session, ids, true);
imageList = loadedDatasets(1).linkedImageList;
```

Warning: Loading the entire datasets/images graph can be time-consuming and memory-consuming depending on the amount of data.

To filter datasets by owner, use the `owner` parameter/key value. A value of -1 means datasets are retrieved independently of their owner:

```
% Returns all datasets owned by the specified user in the context of the
% session group
datasets = getDatasets(session, 'owner', ownerId);
% Returns all datasets with the input identifiers owned by the specified
% user
datasets = getDatasets(session, ids, 'owner', ownerId);
% Returns all datasets owned by any user in the context of the session
% group
datasets = getDatasets(session, 'owner', -1);
```

To filter datasets by group, use the `group` parameter/key value. A value of -1 means datasets are retrieved independently of their group:

```
% Returns all datasets owned by the session user in the specified group
datasets = getDatasets(session, 'group', groupId);
% Returns all datasets with the input identifiers in the specified group
datasets = getDatasets(session, ids, 'group', groupId);
% Returns all datasets owned by the session user across groups
datasets = getDatasets(session, 'group', -1);
```

- **Images**

The images owned by the session user in the context of the session group can be retrieved using the getImages[33] function:

```
images = getImages(session)
```

If the image identifiers are known, they can be retrieved independently of their owner or group using:

```
images = getImages(session, ids)
```

All the images contained in a subset of datasets of known identifiers `datasetsIds` can be returned independently of their owner or group using:

```
datasetImages = getImages(session, 'dataset', datasetsIds)
```

All the images contained in all the datasets under a subset of projects of known identifiers `projectIds` can be returned independently of their owner or group using:

[33] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getImages.m

```
projectImages = getImages(session, 'project', projectIds)
```

To filter images by owner, use the `owner` parameter/key value. A value of -1 means images are retrieved independently of their owner:

```
% Returns all images owned by the specified user in the context of the
% session group
images = getImages(session, 'owner', ownerId);
% Returns all images with the input identifiers owned by the specified user
images = getImages(session, ids, 'owner', ownerId);
% Returns all images owned by any user in the context of the session
% group
images = getImages(session, 'owner', -1);
```

To filter images by group, use the `group` parameter/key value. A value of -1 means images are retrieved independently of their group:

```
% Returns all images owned by the session user in the specified group
images = getImages(session, 'group', groupId);
% Returns all images with the input identifiers in the specified group
images = getImages(session, ids, 'group', groupId);
% Returns all images owned by the session user across groups
images = getImages(session, 'group', -1);
```

The `Image-Pixels` model implies you need to use the `Pixels` objects to access valuable data about the `Image`:

```
pixels = image.getPrimaryPixels();
sizeZ = pixels.getSizeZ().getValue(); % The number of z-sections.
sizeT = pixels.getSizeT().getValue(); % The number of timepoints.
sizeC = pixels.getSizeC().getValue(); % The number of channels.
sizeX = pixels.getSizeX().getValue(); % The number of pixels along the X-axis.
sizeY = pixels.getSizeY().getValue(); % The number of pixels along the Y-axis.
```

- **Screens**

The screens owned by the session user in the context of the session group can be retrieved using the getScreens[34] function:

```
screens = getScreens(session)
```

If the screen identifiers are known, they can be retrieved independently of their owner or group using:

```
screens = getScreens(session, ids)
```

Note that the wells are not loaded. The plate objects can be accessed using:

```
for j = 1 : numel(screens),
platesList = screens(j).linkedPlateList;
for i = 0:platesList.size()-1,
    plate = platesList.get(i);
    plateAcquisitionList = plate.copyPlateAcquisitions();
    for k = 0:plateAcquisitionList.size()-1,
        pa = plateAcquisitionList.get(i);
    end
end
```

[34] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getScreens.m

To return the orphaned plates as well as the screens, you can query the second output argument of getScreens[35]:

```
[screens, orphanedPlates] = getScreens(session)
```

To filter screens by owner, use the `owner` parameter/key value. A value of -1 means screens are retrieved independently of their owner:

```
% Returns all screens owned by the specified user in the context of the
% session group
screens = getScreens(session, 'owner', ownerId);
% Returns all screens with the input identifiers owned by the specified
% user
screens = getScreens(session, ids, 'owner', ownerId);
% Returns all screens owned by any user in the context of the session
% group
screens = getScreens(session, 'owner', -1);
```

To filter screens by group, use the `group` parameter/key value. A value of -1 means screens are retrieved independently of their group:

```
% Returns all screens owned by the session user in the specified group
screens = getScreens(session, 'group', groupId);
% Returns all screens with the input identifiers in the specified group
screens = getScreens(session, ids, 'group', groupId);
% Returns all screens owned by the session user across groups
screens = getScreens(session, 'group', -1);
```

- **Plates**

The screens owned by the session user in the context of the session group can be retrieved using the getPlates[36] function:

```
plates = getPlates(session)
```

If the plate identifiers are known, they can be retrieved independently of their owner or group using:

```
plates = getPlates(session, ids)
```

To filter plates by owner, use the `owner` parameter/key value. A value of -1 means plates are retrieved independently of their owner:

```
% Returns all plates owned by the specified user in the context of the
% session group
plates = getPlates(session, 'owner', ownerId);
% Returns all plates with the input identifiers owned by the specified user
plates = getPlates(session, ids, 'owner', ownerId);
% Returns all plates owned by any user in the context of the session
% group
plates = getPlates(session, 'owner', -1);
```

To filter plates by group, use the `group` parameter/key value. A value of -1 means plates are retrieved independently of their group:

```
% Returns all plates owned by the session user in the specified group
plates = getPlates(session, 'group', groupId);
```

[35] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getScreens.m
[36] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/getPlates.m

```
% Returns all plates with the input identifiers in the specified group
plates = getPlates(session, ids, 'group', groupId);
% Returns all plates owned by the session user across groups
plates = getPlates(session, 'group', -1);
```

- **Wells**

Given a plate identifier, the wells can be loaded using the `findAllByQuery` method:

```
wellList = session.getQueryService().findAllByQuery(
['select well from Well as well '...
'left outer join fetch well.plate as pt '...
'left outer join fetch well.wellSamples as ws '...
'left outer join fetch ws.plateAcquisition as pa '...
'left outer join fetch ws.image as img '...
'left outer join fetch img.pixels as pix '...
'left outer join fetch pix.pixelsType as pt '...
'where well.plate.id = ', num2str(plateId)], []);
for j = 0:wellList.size()-1,
    well = wellList.get(j);
    wellsSampleList = well.copyWellSamples();
    well.getId().getValue()
    for i = 0:wellsSampleList.size()-1,
        ws = wellsSampleList.get(i);
        ws.getId().getValue()
        pa = ws.getPlateAcquisition();
    end
end
```

11.5.4 Raw data access

You can retrieve data, plane by plane or retrieve a stack.

- **Plane**

The plane of an input image at coordinates (z, c, t) can be retrieved using the getPlane[37] function:

```
plane = getPlane(session, image, z, c, t);
```

Alternatively, the image identifier can be passed to the function:

```
plane = getPlane(session, imageID, z, c, t);
```

- **Tile**

The tile of an input image at coordinates (z, c, t) originated at (x, y) and of dimensions (w, h) can be retrieved using the getTile[38] function:

```
tile = getTile(session, image, z, c, t, x, y, w, h);
```

Alternatively, the image identifier can be passed to the function:

```
tile = getTile(session, imageID, z, c, t, x, y, w, h);
```

- **Stack**

[37] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/image/getPlane.m
[38] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/image/getTile.m

The stack of an input image at coordinates (c, t) can be retrieved using the getStack[39] function:

```
stack = getStack(session, image, c, t);
```

Alternatively, the image identifier can be passed to the function:

```
stack = getStack(session, imageID, c, t);
```

All the methods described above will internally initialize a raw pixels store to retrieve the pixels data and close this store at the end of the call. This is inefficient when multiple planes/tiles/stacks need to be retrieved. For each function, it is possible to initialize a pixels store and pass this store directly to the pixel retrieval function, e.g.:

```
[store, pixels] = getRawPixelsStore(session, image);
for z = 0 : sizeZ - 1
  for c = 0 : sizeC - 1
    for t = 0 : sizeT - 1
      plane = getPlane(pixels, store, z, c, t);
    end
  end
end
store.close();
```

- **Hypercube**

This is useful when you need the `Pixels` intensity.

```
% Create the store to load the stack. No access via the gateway
store = session.createRawPixelsStore();
% Indicate the pixels set you are working on
store.setPixelsId(pixelsId, false);

% Offset values in each dimension XYZCT
offset = java.util.ArrayList;
offset.add(java.lang.Integer(0));
offset.add(java.lang.Integer(0));
offset.add(java.lang.Integer(0));
offset.add(java.lang.Integer(0));
offset.add(java.lang.Integer(0));

size = java.util.ArrayList;
size.add(java.lang.Integer(sizeX));
size.add(java.lang.Integer(sizeY));
size.add(java.lang.Integer(sizeZ));
size.add(java.lang.Integer(sizeC));
size.add(java.lang.Integer(sizeT));

% Indicate the step in each direction,
% step = 1, will return values at index 0, 1, 2.
% step = 2, values at index 0, 2, 4…
step = java.util.ArrayList;
step.add(java.lang.Integer(1));
step.add(java.lang.Integer(1));
step.add(java.lang.Integer(1));
step.add(java.lang.Integer(1));
step.add(java.lang.Integer(1));
% Retrieve the data
store.getHypercube(offset, size, step);
% Close the store
store.close();
```

[39] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/image/getStack.m

See also:

RawDataAccess.m[40] Example script showing methods to retrieve the pixel data from an image

11.5.5 Annotations

- **Reading annotations by ID**

If the identifier of the annotation of a given type is known, the annotation can be retrieved from the server using the generic getAnnotations[41] function:

```
tagAnnotations = getAnnotations(session, 'tag', tagIds);
```

Shortcut functions are available for the main object and annotation types, e.g. to retrieve tag annotations:

```
tagAnnotations = getTagAnnotations(session, tagIds);
```

- **Reading annotations linked to an object**

The annotations of a given type linked to a given object can be retrieved using the generic getObjectAnnotations[42] function:

```
tagAnnotations = getObjectAnnotations(session, 'tag', 'image', imageIds);
```

Shortcut functions are available for the main object and annotation types, e.g. to retrieve the tag annotations linked to images:

```
tagAnnotations = getImageTagAnnotations(session, imageIds);
```

Annotations can be filtered by namespace. To include only annotations with a given namespace `ns`, use the `include` parameter/key value:

```
tagAnnotations = getImageTagAnnotations(session, imageIds, 'include', ns);
```

To exclude all annotations with a given namespace `ns`, use the `exclude` parameter/key value:

```
tagAnnotations = getImageTagAnnotations(session, imageIds, 'exclude', ns);
```

By default, only the annotations owned by the session owner are returned. To specify the owner of the annotations, use the `owner` paramter/key value pair. For instance to return all tag annotations owned by user 5:

```
tagAnnotations = getImageTagAnnotations(session, imageIds, 'owner', 5);
```

To retrieve all annotations independently of their owner, use -1 as the owner identifier:

```
tagAnnotations = getImageTagAnnotations(session, imageIds, 'owner', -1);
```

- **Reading file annotations**

The content of a file annotation can be downloaded to local disk using the getFileAnnotationContent[43] function. If the file annotation has been retrieved from the server as `fileAnnotation`, then the content of its `OriginalFile` can be downloaded under `target_file` using:

[41] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/annotations/getAnnotations.m
[42] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/annotations/getObjectAnnotations.m
[43] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/annotations/getFileAnnotationContent.m

```
getFileAnnotationContent(session, fileAnnotation, target_file);
```

Alternatively, if only the identifier of the file annotation `faId` is known:

```
getFileAnnotationContent(session, faId, target_file);
```

- **Writing and linking annotations**

New annotations can be created using the corresponding `write*Annotation` function:

```
% Create a comment annotation
commentAnnotation = writeCommentAnnotation(session, 'comment');
% Create a double annotation
doubleAnnotation = writeDoubleAnnotation(session, .5);
% Create a map annotation
mapAnnotation = writeMapAnnotation(session, 'key', value);
% Create a tag annotation
tagAnnotation = writeTagAnnotation(session, 'tag name');
% Create a timestamp annotation
timestampAnnotation = writeTimestampAnnotation(session, now);
% Create an XML annotation
xmlAnnotation = writeXmlAnnotation(session, xmlString);
```

File annotations can also be created from the content of a `local_file_path`:

```
fileAnnotation = writeFileAnnotation(session, local_file_path);
```

Each annotation creation function uses the context of the session group by default. To create the annotation in a different group, use the `group` key/value pair:

```
commentAnnotation = writeCommentAnnotation(session, 'comment', 'group', groupId);
doubleAnnotation = writeDoubleAnnotation(session, .5, 'group', groupId);
mapAnnotation = writeMapAnnotation(session, 'key', value, 'group', groupId);
tagAnnotation = writeTagAnnotation(session, 'tag name', 'group', groupId);
timestampAnnotation = writeTimestampAnnotation(session, now, 'group', groupId);
xmlAnnotation = writeXmlAnnotation(session, xmlString, 'group', groupId);
fileAnnotation = writeFileAnnotation(session, local_file_path, 'group', groupId);
```

Existing annotations can be linked to existing objects on the server using the linkAnnotation[44] function. For example, to link a tag annotation and a file annotation to the image `image_id`:

```
link1 = linkAnnotation(session, tagAnnotation, 'image', image_id);
link2 = linkAnnotation(session, fileAnnotation, 'image', image_id);
```

For existing file annotations, it is possible to replace the content of the original file without having to recreate a new file annotation using the updateFileAnnotation[45] function. If the file annotation has been retrieved from the server as `fileAnnotation`, then the content of its `OriginalFile` can be replaced by the content of `local_file_path` using:

```
updateFileAnnotation(session, fileAnnotation, local_file_path);
```

See also:

WriteData.m[46] Example script showing methods to write, link and retrieve annotations

[44] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/annotations/linkAnnotation.m
[45] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/annotations/updateFileAnnotation.m

11.5.6 Writing data

- **Projects/Datasets**

Projects and datasets can be created in the context of the session group using the createProject[47] and createDataset[48] functions:

```
% Create a new project in the context of the session group
newproject = createProject(session, 'project name');
% Create a new dataset in the context of the session group
newdataset = createDataset(session, 'dataset name');
```

Writing projects/datasets in a different context than the session group can be achieved by passing the group identifier using the *group* parameter:

```
% Create a new project in the specified group
newproject = createProject(session, 'project name', 'group', groupId);
% Create a new dataset in the specified group
newdataset = createDataset(session, 'dataset name', 'group', groupId);
```

When creating a dataset, it is possible to link it to an existing project using either the project object or its identifier. In this case, the group context is determined by the parent project:

```
% Create two new projects in different groups
project1 = createProject(session, 'project name');
project2 = createProject(session, 'project name', 'group', groupId);
% Create new datasets linked to each project
dataset1 = createDataset(session, 'dataset name', project1);
dataset2 = createDataset(session, 'dataset name', project2.getId().getValue());
```

- **Screens/Plates**

Screens and plates can be created in the context of the session group using the createScreen[49] and createPlate[50] functions:

```
% Create a new screen in the context of the session group
newscreen = createScreen(session, 'screen name');
% Create a new plate in the context of the session group
newplate = createPlate(session, 'plate name');
```

Writing screens/plates in a different context than the session group can be achieved by passing the group identifier using the *group* parameter:

```
% Create a new screen in the specified group
newscreen = createScreen(session, 'screen name', 'group', groupId);
% Create a new plate in the specified group
newplate = createPlate(session, 'plate name', 'group', groupId);
```

When creating a plate, it is possible to link it to an existing screen using either the screen object or its identifier. In this case, the group context is determined by the parent screen:

```
% Create two new projects in different groups
screen1 = createScreen(session, 'screen name');
screen2 = createScreen(session, 'screen name', 'group', groupId
% Create new datasets linked to each project
```

[47] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/createProject.m
[48] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/createDataset.m
[49] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/createScreen.m
[50] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/io/createPlate.m

```
plate1 = createPlate(session, 'plate name', screen1);
plate2 = createPlate(session, 'plate name', screen2.getId().getValue());
```

See also:

WriteData.m[51] Example script showing methods to create projects, datasets, plates and screens

11.5.7 How to use OMERO tables

- **Create a table**. In the following example, a table is created with 2 columns.

```
name = char(java.util.UUID.randomUUID());
columns = javaArray('omero.grid.Column', 2)
columns(1) = omero.grid.LongColumn('Uid', 'testLong', []);
valuesString = javaArray('java.lang.String', 1);
columns(2) = omero.grid.StringColumn('MyStringColumn', '', 64, valuesString);

% Create a new table.
table = session.sharedResources().newTable(1, name);

% Initialize the table
table.initialize(columns);
% Add data to the table.
data = javaArray('omero.grid.Column', 2);
data(1) = omero.grid.LongColumn('Uid', 'test Long', [2]);
valuesString = javaArray('java.lang.String', 1);
valuesString(1) = java.lang.String('add');
data(2) = omero.grid.StringColumn('MyStringColumn', '', 64, valuesString);
table.addData(data);
file = table.getOriginalFile(); % if you need to interact with the table
```

- **Read the contents of the table**.

```
of = omero.model.OriginalFileI(file.getId(), false);
tablePrx = session.sharedResources().openTable(of);

% Read headers
headers = tablePrx.getHeaders();
for i=1:size(headers, 1),
    headers(i).name; % name of the header
    % Do something
end

% Depending on the size of table, you may only want to read some blocks.
cols = [0:size(headers, 1)-1]; % The number of columns you wish to read.
rows = [0:tablePrx.getNumberOfRows()-1]; % The number of rows you wish to read.
data = tablePrx.slice(cols, rows); % Read the data.
c = data.columns;
for i=1:size(c),
    column = c(i);
    % Do something
end
tablePrx.close(); % Important to close when done.
```

11.5.8 ROIs

To learn about the model, see the developers guide to the ROI model[52]. Note that annotations can be linked to ROI.

[52] http://www.openmicroscopy.org/site/support/ome-model/developers/roi.html

- **Creating ROI**

This example creates a ROI with two shapes, a rectangle and an ellipse, and attaches it to an image:

```
% First create a rectangular shape.
rectangle = createRectangle(0, 0, 10, 20);
% Indicate on which plane to attach the shape
setShapeCoordinates(rectangle, 0, 0, 0);

% First create an ellipse shape.
ellipse = createEllipse(0, 0, 10, 20);
% Indicate on which plane to attach the shape
setShapeCoordinates(ellipse, 0, 0, 0);

% Create the roi.
roi = omero.model.RoiI;
% Attach the shapes to the roi, several shapes can be added.
roi.addShape(rectangle);
roi.addShape(ellipse);

% Link the roi and the image
roi.setImage(omero.model.ImageI(imageId, false));
% Save
iUpdate = session.getUpdateService();
roi = iUpdate.saveAndReturnObject(roi);
% Check that the shape has been added.
numShapes = roi.sizeOfShapes;
for ns = 1:numShapes
   shape = roi.getShape(ns-1);
end
```

See also:

ROI utility functions[53] OMERO.matlab functions for creating and managing Shape and ROI objects.

- **Retrieving ROIs linked to an image**

```
service = session.getRoiService();
roiResult = service.findByImage(imageId, []);
rois = roiResult.rois;
n = rois.size;
shapeType = '';
for thisROI  = 1:n
    roi = rois.get(thisROI-1);
    numShapes = roi.sizeOfShapes;
    for ns = 1:numShapes
        shape = roi.getShape(ns-1);
        if (isa(shape, 'omero.model.Rectangle'))
           rectangle = shape;
           rectangle.getX().getValue()
        elseif (isa(shape, 'omero.model.Ellipse'))
           ellipse = shape;
           ellipse.getCx().getValue()
        elseif (isa(shape, 'omero.model.Point'))
           point = shape;
           point.getX().getValue();
        elseif (isa(shape, 'omero.model.Line'))
           line = shape;
           line.getX1().getValue();
        end
    end
end
```

- **Removing a shape from ROI**

```
// Retrieve the roi linked to an image
service = session.getRoiService();
roiResult = service.findByImage(imageId, []);
n = rois.size;
for thisROI  = 1:n
    roi = rois.get(thisROI-1);
    numShapes = roi.sizeOfShapes;
    for ns = 1:numShapes
        shape = roi.getShape(ns-1);
        % Remove the shape
        roi.removeShape(shape);
    end
    % Update the roi.
    roi = iUpdate.saveAndReturnObject(roi);
end
```

11.5.9 Deleting data

It is possible to delete projects, datasets, images, ROIs… and objects linked to them depending on the specified options (see *Deleting in OMERO*). For example, images of known identifiers can be deleted from the server using the deleteImages[54] function:

```
deleteImages(session, imageIds);
```

See also:

deleteProjects[55], **deleteDatasets**[56], **deleteScreens**[57], **deletePlates**[58] Utility functions to delete objects

11.5.10 Rendering images

The RenderImages.m[59] example script shows how to initialize the rendering engine and render an image.

11.5.11 Creating Image

The CreateImage.m[60] example script shows how to create an image in OMERO. A similar approach can be applied when uploading an image. To upload individual planes onto the server, the data must be converted into a byte (int8) array first. If the `Pixels` object has been created, this conversion can done using the toByteArray[61] function.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

11.6 OMERO C++ language bindings

Using the Ice C++ language mapping[62] from ZeroC[63], OMERO provides native access to your data from C++ code. CMake[64] is used for building the C++ bindings.

Binaries are not provided, therefore it will be necessary for you to compile your own.

[54] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/delete/deleteImages.m
[59] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/Training/matlab/RenderImages.m
[60] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/Training/matlab/CreateImage.m
[61] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroM/src/helper/toByteArray.m
[62] https://doc.zeroc.com/display/Ice/Hello+World+Application
[63] https://zeroc.com
[64] http://www.cmake.org/

11.6.1 Prerequisites

- The OMERO source code
- A C++ compiler
  - GCC is recommended for Linux and MacOS X
  - **Visual Studio** or the **Platform SDK** for Windows
- The ZeroC **Ice** libraries, headers and slice definitions
- **cmake**
- Google Test (optional; needed to build the unit and integration tests)

11.6.2 Restrictions

If you are restricted to a specific version of GCC or Ice, you may need to obtain or build a compatible version of Ice or GCC, respectively.

11.6.3 Preparing to build

Begin by following the instructions under *Installing OMERO from source* to acquire the source code. Be **sure** that the git branch you are using matches the version of your server!

The location of your Ice installation should be automatically detected if installed into a standard location. If this is not the case, set the location of your Ice installation using the `ICE_HOME` environment variable or the *-DICE_HOME* or *-DIce_SLICE_DIR* **cmake** options for your Ice installation (see below). Some possible locations for the 3.5.1 version of Ice follow. Note these are just examples; you need to adjust them for the Ice installation path and version in use on your system.

- Ice built from source and installed into `/opt`:

  ```
  export ICE_HOME=/opt/Ice-3.5.1
  ```

- Ice installed on Linux using RPM packages:

  ```
  export ICE_HOME=/usr/share/Ice-3.5.1
  ```

- MacOS X with homebrew:

  ```
  export ICE_HOME=/usr/local/Cellar/ice/3.5.1
  ```

- Windows using **Visual Studio**:

  ```
  set ICE_HOME=C:\Program Files (x86)\ZeroC\Ice-3.5.1
  ```

Note: If the Ice headers and libraries are not automatically discovered, these will need to be specified using appropriate **cmake** options (see below).

11.6.4 Building the library

For all build methods, the shared library and examples are always built by default. The unit and integration tests are built if Google test (gtest) is detected.

Building with build.py or ant

```
export GTEST_ROOT=/path/to/gtest
cd /path/to/openmicroscopy
./build.py build-default
./build.py build-cpp [-Dcmake.args="cmake options"]
```

Set any needed **cmake** options using the **ant** `cmake.args` property, plus any needed environment variables.

For example:

```
./build.py -Dcmake.args="'-DCMAKE_CXX_FLAGS=$CMAKE_CXX_FLAGS' \
'-DCMAKE_EXE_LINKER_FLAGS=$CMAKE_LD_FLAGS' \
'-DCMAKE_MODULE_LINKER_FLAGS=$CMAKE_LD_FLAGS' \
'-DCMAKE_SHARED_LINKER_FLAGS=$CMAKE_LD_FLAGS' \
-DCMAKE_VERBOSE_MAKEFILE:BOOL=ON"
```

This method is present for backward compatibility with the previous **scons** build system. While it is possible to customize the build somewhat, some behavior is hardcoded and so this will not be suitable for all situations and is not recommended. Parallel building is also not supported. If you wish to have full control over the C++ build or wish to use a **cmake** generator to build within an IDE, then running **cmake** directly is recommended.

Building with cmake directly

On Linux, Unix or MacOS X with **make**:

```
export GTEST_ROOT=/path/to/gtest
mkdir omero-build
cd omero-build
cmake [-Dtest=(TRUE|FALSE)] [cmake options] /path/to/openmicroscopy
make
```

For example:

```
cmake "-DCMAKE_CXX_FLAGS=$CMAKE_CXX_FLAGS" \
"-DCMAKE_EXE_LINKER_FLAGS=$CMAKE_LD_FLAGS" \
"-DCMAKE_MODULE_LINKER_FLAGS=$CMAKE_LD_FLAGS" \
"-DCMAKE_SHARED_LINKER_FLAGS=$CMAKE_LD_FLAGS" \
-DCMAKE_VERBOSE_MAKEFILE:BOOL=ON /path/to/openmicroscopy
make -j8
```

Running **cmake** directly allows full use of all command-line options and provides complete flexibility for building, e.g. to enable parallel building as shown above or to use an IDE of choice with an appropriate generator.

If you would like to build the C++ tests, run the above with the `GTEST_ROOT` environment variable set.

Note: When **cmake** is run, it will run `./build.py build-default` in the openmicroscopy source tree to generate some of the C++ and Ice sources. If you have previously done a build by running `./build.py`, this step will be skipped. However, if you have recently switched branches *without cleaning the source tree*, please run `./build.py clean` in the source tree to clean up all the generated files prior to running **cmake**.

If the build fails with errors such as

```
/usr/include/Ice/ProxyHandle.h:176:13: error: 'upCast' was not declared in this scope,
and no declarations were found by argument-dependent lookup at the point of
instantiation
```

this is caused by the Ice headers being buggy, and newer versions of GCC rejecting the invalid code. To compile in this situation, add `-fpermissive` to `CXXFLAGS` to allow the invalid code to be accepted, but do note that this may also mask other problems so should not be used unless strictly needed.

11.6.5 cmake build configuration

cmake supports configuration of the build using many different environment variables and options; for a full list, see the cmake reference documentation[65]. The following environment variables are commonly needed:

CMAKE_INCLUDE_PATH Directories to be searched for include files, for example

```
/opt/Ice-3.5.1/include
```

A `:` or `;` separator character is used to separate directories, depending on the platform. Note these are used only for feature tests, not for passing to the compiler when building, for which `CMAKE_CXX_FLAGS` is needed.

CMAKE_LIBRARY_PATH Directories to be searched for libraries, for example

```
/opt/Ice-3.5.1/lib
```

Directories are separated by `:` or `;` as with `CMAKE_INCLUDE_PATH`. Note these are used only for feature tests and finding libraries, not for passing to the linker when building, for which `CMAKE_*_LINKER_FLAGS` is needed.

CXX C++ compiler executable. Useful with ccache[66].

CXXFLAGS C++ compiler flags. Use of `CMAKE_CXX_FLAGS` is preferred.

ICE_HOME The location of the Ice installation. If this is not sufficient to discover the correct binary and library directories, they may otherwise be manually specified with the options below. Likewise for the `include` and `slice` directories. This may also be set as a **cmake** cache variable (see below).

VERBOSE If set to *1*, show the actual build commands rather than the pretty "Compiling XYZ..." statements.

In addition, **cmake** options may be defined directly when running **cmake**. Commonly needed options include:

-DCMAKE_PREFIX_PATH Search this location when searching for programs, headers and libraries. Use to search `/usr/local` or `/opt/Ice`, for example. More specific search locations may be specified using *-DCMAKE_INCLUDE_PATH*, *-DCMAKE_LIBRARY_PATH* and *-DCMAKE_PROGRAM_PATH* separately, if required.

-DCMAKE_INCLUDE_PATH Search this location when searching for headers. Use to include `/usr/local/include` or `/opt/Ice/include`, for example.

-DCMAKE_LIBRARY_PATH Search this location when searching for libraries. Use to include `/usr/local/lib` or `/opt/Ice/lib`, for example.

-DCMAKE_PROGRAM_PATH Search this location when searching for programs. Use to include `/usr/local/bin` or `/opt/Ice/bin`, for example.

-DCMAKE_CXX_FLAGS C++ compiler flags. Use to set any additional linker flags desired.

-DCMAKE_EXE_LINKER_FLAGS Executable linker flags. Use to set any additional linker flags desired.

-DCMAKE_MODULE_LINKER_FLAGS Loadable module linker flags. Use to set any additional linker flags desired.

-DCMAKE_SHARED_LINKER_FLAGS Shared library linker flags. Use to set any additional linker flags desired.

-DCMAKE_VERBOSE_MAKEFILE Default to printing all commands executed by make. This may be overridden with the make `VERBOSE` variable.

-DIce_HOME The location of the Ice installation. If this is not sufficient to discover the correct binary and library directories, they may otherwise be manually specified with the options below. Likewise for the `include` and `slice` directories.

-DIce_SLICE2XXX_EXECUTABLE Specific location of individual Ice `slice2xxx` programs, e.g. `Ice_SLICE2CPP_EXECUTABLE` for **slice2cpp** or `Ice_SLICE2JAVA_EXECUTABLE` for **slice2java**. These are typically found in `${ICE_HOME}/bin` or on the default `PATH`. These will not normally require setting.

-DIce_INCLUDE_DIR Location of Ice headers. This is typically `${ICE_HOME}/include` or on the default include search path. This will not normally require setting.

-DIce_SLICE_DIR Location of Ice slice interface definitions. This is typically `${ICE_HOME}/slice`. Use for installations where *-DICE_HOME* does not contain `slice` or situations where you wish to build without setting *-DICE_HOME*. Note that when building using **build.py**, rather than building directly with **cmake**, the `SLICEPATH` environment variable should be used instead (the **ant** build can't use the **cmake** variables since it only runs **cmake** after a full build of the Java server).

[65] http://www.cmake.org/cmake/help/documentation.html
[66] http://ccache.samba.org/

-DIce_<C>_LIBRARIES Specific libraries for Ice component `<C>`, where `<C>` is the uppercased name of the Ice component, e.g. `ICE` for the `Ice` component, `ICEUTIL` for the `IceUtil` component or `GLACIER2` for the `Glacier2` component. These libraries are typically found in `${ICE_HOME}/lib` or on the default library search path. These will not normally require setting.

-DIce_DEBUG Set to ON to print detailed diagnostics about the detected Ice installation. Use if there are any problems finding Ice.

cmake offers many additional options. Please refer to the documentation[67] for further details, in particular to the variables which change the behavior[68] of the build.

11.6.6 Visual Studio configuration

Warning: OMERO.cpp will not currently build on Windows due to exceeding DLL symbol limits on this platform, leading to a failure when linking the DLL. It is hoped that this platform limitation can be worked around in a future OMERO release.

cmake has full support for **Visual Studio**. Use the **cmake** *-G* option to set the generator for your Visual Studio version, with a `Win64` suffix for an x64 build. The correct Ice programs and libraries for your Ice installation should be automatically discovered.

```
cmake -G "Visual Studio 10 Win64" [cmake options] /path/to/openmicroscopy
```

This is for a 64-bit **Visual Studio 2010** build. Modify appropriately for other versions and compilers. Running

```
cmake --help
```

will list the available generators for your platform (without the `Win64` suffix).

Once **cmake** has finished running, the generated project and solution files may be then opened in **Visual Studio**, or built directly using the **msbuild** command-line tool (make sure that the **Visual Studio** command prompt matches the generator chosen) or by running:

```
cmake --build .
```

As for the Unix build, above, it is also possible to build on Windows using **build.py** or **ant**, providing that you configure the generator appropriately using the correct **cmake** options. However, this will not work for all generators reliably, and the Windows shell quoting makes passing nested quotes to ant quite tricky, so running **cmake** by hand is recommended.

Note: It may be necessary to specify `/Zm1000` as an additional compiler setting.

11.6.7 Installing the library

If using **make**, run:

```
make [DESTDIR=/path/to/staging/directory] install
```

If using another build system, please invoke the equivalent install target for that system.

11.6.8 Using the library

To use *OMERO C++ language bindings* it is necessary to point your compiler and linker at the mentioned directories above. A simple GNU **make** `Makefile` might look like this:

[67] http://www.cmake.org/cmake/help/v3.0/
[68] http://www.cmake.org/cmake/help/v3.0/manual/cmake-variables.7.html#variables-that-change-behavior

```
#
# MAKEFILE:
#
# Where the OMERO distribution was installed
OMERO_DIST ?= /opt/omero

# Where the Ice lib/ and include/ directories are to be found
ICE_HOME ?= /usr/share/Ice

INCLUDES=-I$(OMERO_DIST)/include -I$(ICE_HOME)/include

LIBS = -L$(OMERO_DIST)/lib -L$(ICE_HOME)/lib -L$(ICE_HOME)/lib64 \
       -lIce -lIceUtil -lGlacier2 -lomero-client

LIBPATH = $(LD_LIBRARY_PATH):$(ICE_HOME)/lib:$(ICE_HOME)/lib64:$(OMERO_DIST)/lib

.PHONY: clean run

yourcode.o: yourcode.cpp
        $(CXX) $(CXXFLAGS) -c -o $@ $< $(INCLUDES)

yourcode: yourcode.o
        $(CXX) -o $@ $^ $(LIBS)

run:  yourcode
        LD_LIBRARY_PATH="$(LIBPATH)" ./yourcode --Ice.Config=../etc/ice.config

clean:
        rm -f yourcode *.o *~ core
```

11.6.9 A trivial example: `yourcode.cpp`

A simple example might look something like the following:

```
//
// yourcode.cpp:
//

// Domain
#include <omero/client.h>
#include <omero/api/IAdmin.h>
// Std
#include <iostream>
#include <cassert>
#include <vector>
#include <time.h>
#include <map>

using namespace std;

/*
 * Pass "--Ice.Config=your_config_file" to the executable, or
 * set the ICE_CONFIG environment variable.
 */
int main(int argc, char* argv[])
{
    omero::client_ptr omero = new omero::client(argc, argv);
    omero::api::ServiceFactoryPrx sf = omero->createSession();
    sf->closeOnDestroy();

    // IAdmin is responsible for all user/group creation, password changing, etc.
```

```
28      omero::api::IAdminPrx  admin  = sf->getAdminService();
29
30      // Who you are logged in as.
31      cout << admin->getEventContext()->userName << endl;
32
33      // These two services are used for database access
34      omero::api::IQueryPrx  query  = sf->getQueryService();
35      omero::api::IUpdatePrx update = sf->getUpdateService();
36
37      return 0;
38  }
```

This code does not do much. It creates a server session, loads a few services, and prints the user's name. For serious examples, see *Working with OMERO*.

11.6.10 Compiling and running your code

To compile and run **yourcode**, download the two files above (`Makefile` and `yourcode.cpp`) and then in a shell:

```
make OMERO_DIST=dist yourcode
LD_LIBRARY_PATH=dist/lib ./yourcode --Ice.Config=dist/etc/ice.config
```

where you have edited `dist/etc/ice.config` to contain the values:

```
omero.host=localhost
omero.user=your_name
omero.pass=your_password
```

Alternatively, you can pass these on the command-line:

```
LD_LIBRARY_PATH=dist/lib ./yourcode omero.host=localhost --omero.user=foo --omero.pass=bar
```

Note: This example explains how to run on Linux only. For doing the same on MacOS X, change all instances of `LD_LIBRARY_PATH` to `DYLD_LIBRARY_PATH`.

11.6.11 Further information

For the details behind writing, configuring, and executing a client, please see *Working with OMERO*.

See also:

Ice[69], *OMERO.grid*, *OMERO Application Programming Interface*, *Build System*, #1596[70] which added 64-bit support

[69] https://zeroc.com
[70] https://trac.openmicroscopy.org/ome/ticket/1596

CHAPTER

TWELVE

ANALYSIS

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

12.1 Local analysis

If you are interested in running your analysis locally and storing the results to the server, then your first step is to become familiar with the developer documentation.

- The *Working with OMERO* guide provides numerous examples in each language with explanations and tries to be a starting point for anyone who wants to write code which talks to the OMERO server.
- Most of the *OMERO Application Programming Interface* is covered by the Javadocs[1].
- Each of the languages has extra information on its own page:
  - *OMERO C++ language bindings*
  - *OMERO Java language bindings*
  - *OMERO MATLAB language bindings*
  - *OMERO Python language bindings*

Once you have your local analysis working, you can push it onto the server for background processing using the *OMERO scripting service*.

12.2 Storing external data in OMERO

There are several options for storing external or schema-less data in OMERO, including *StructuredAnnotations* for small quantities of data, or extending the OME model, but this risks interoperability issues. (See *ExtendingOmero*).

For larger volumes of data, or data which needs to be queried, *OMERO.tables* provides a unified solution for the storage of columnar data from various sources, such as automated analysis results or script-based processing, and makes them available within OMERO.

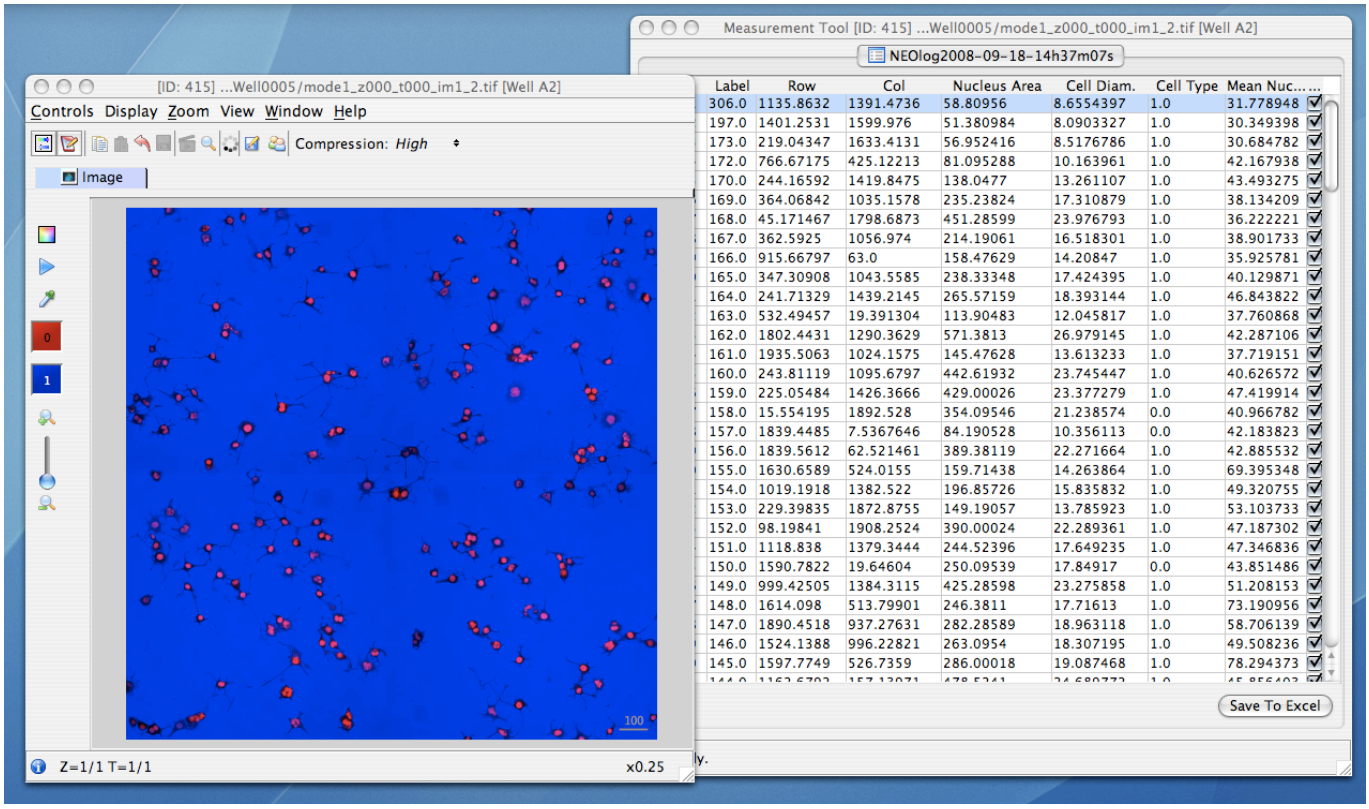
12.2.1 Third-party analysis and OMERO.tables

Support has been added for some third-party analysis data, which gets converted in OMERO into a common format. These formats include:

- MIAS data, measurements, and overlays
- InCell data and measurements
- Flex data with Acapella results (screencast[2]). In the Flex case, additional configuration may be necessary for accessing both the raw data and the analysis results. Watch the configuration screencast[3] for more information.

[1] http://downloads.openmicroscopy.org/latest/omero/api/
[2] http://cvs.openmicroscopy.org.uk/snapshots/movies/omero-4-1/mov/FlexPreview4.1-import.mov
[3] http://cvs.openmicroscopy.org.uk/snapshots/movies/omero-4-1/mov/FlexPreview4.1-configuration.mov

The analysis results which are parsed out of the formats listed above are converted to HDF by the OMERO.tables API. This facility can then be used by clients to visualize the parsed measurements, and in the case of regions of interest, see their location overlayed on the associated image:



12.2.2 Other high-content screening (HCS) data

In addition to the Flex, Mias, and InCell 100 file formats, BD Pathway, Olympus ScanR, and native OME-XML/TIFF files can all be imported as HCS data, though without support for any external analysis data which may be attached. If you are interested in having other analysis formats supported, contact either the *open source community* or Glencoe Software, Inc.[4] depending on your needs.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

12.3 OMERO.tables

The OMERO.tables API unifies the storage of columnar data from various sources, such as automated analysis results or script-based processing, and makes them available within OMERO.

Large and small volumes of tabular data can be stored via named columns, and retrieved in bulk or via paging. A limited query language provides basic filtering and selecting.

For installation instructions, see *OMERO.tables*

12.3.1 The interface

The slice definition file[5] for the OMERO.tables API primarily defines two service interfaces and a type hierarchy.

class `omero.grid.Table` The central service for dealing with tabular data, described *below*.

[4] http://www.glencoesoftware.com/
[5] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/Tables.ice

class omero.grid.**Tables**
An internal service used for managing table services, and can be ignored for almost all purposes.

class omero.grid.**Column**
The base class for column types which permit returning arrays of columnar values (Ice[6] doesn't provide an `Any` type, so it is necessary to group values of the same type). All columns in a table must have the same number of rows.

Note: Attribute names (including column names) beginning with __ (double underscore) are reserved for internal use. This restriction was introduced in OMERO 5.1, Tables created by older versions should continue to work.

Single value columns

These columns store a single value in each row.

class omero.grid.**FileColumn** (*name*, *description*[, *values*])
class omero.grid.**ImageColumn** (*name*, *description*[, *values*])
class omero.grid.**RoiColumn** (*name*, *description*[, *values*])
class omero.grid.**WellColumn** (*name*, *description*[, *values*])
class omero.grid.**PlateColumn** (*name*, *description*[, *values*])
Id-based (*long*) columns which reference `omero.model.File`, `Image`, `Roi`, `Well` and `Plate` instances respectively.

class omero.grid.**BoolColumn** (*name*, *description*[, *values*])
A value column with *bool* (non-null) values.

class omero.grid.**LongColumn** (*name*, *description*[, *values*])
A value column with *long* (non-null, 64-bit) values.

class omero.grid.**DoubleColumn** (*name*, *description*[, *values*])
A value column with *double* (non-null, 64-bit) values.

Parameters

- **name** (*string*) – The name of the column, each column in a table must have a unique name.
- **description** (*string*) – The column description, may be empty.
- **values** (*[]*) – A list of values (one value per row) used to initialize a column (optional).

values
A class member holding the list of values stored in the column.

class omero.grid.**StringColumn** (*name*, *description*, *size*[, *values*])
A value column which holds strings

Parameters

- **name** (*string*) – The column name.
- **description** (*string*) – The column description.
- **size** (*long*) – The maximum string length that can be stored in this column, >= *1*
- **values** (*string[]*) – A list of strings (optional).

Array value columns

These columns store an array in each row.

class omero.grid.**FloatArrayColumn** (*name*, *description*, *size*[, *values*])
A value column with fixed-width arrays of *float* (32 bit) values.

class omero.grid.**DoubleArrayColumn** (*name*, *description*, *size*[, *values*])
A value column with fixed-width arrays of *double* (64 bit) values.

class omero.grid.**LongArrayColumn** (*name*, *description*, *size*[, *values*])
A value column with fixed-width arrays of *long* (64 bit) values.

[6] https://zeroc.com

Parameters

- **name** (*string*) – The column name.
- **description** (*string*) – The column description.
- **size** (*long*) – The width of the array, >= *1*
- **values** (*[][]*) – A list of arrays, each of length `size` (optional).

Warning: The OMERO.tables service currently does limited validation of string and array lengths. When adding or modifying data it is essential that the `size` parameter of a column matches that of the underlying table.

Warning: Array value columns should be considered experimental for now.

Main methods

class `omero.grid.`**`Data`**
Holds the data retrieved from a table, also used to update a table.

`lastModification`
The timestamp of the last update to the table.

`rowNumbers`
The row indices of the values retrieved from the table.

`columns`
A list of columns

class `omero.grid.`**`Table`**
The main interface to the Tables service.

`getHeaders``()`

Returns An empty list of columns describing the table. Fill in the `values` of these columns to add a new row to the table.

`getNumberOfRows``()`

Returns The number of rows in the table.

`readCoordinates`(*rowNumbers*)
Read a set of entire rows in the table.

Parameters **rowNumbers** (*long[]*) – A list of row indices to be retrieved from the table.

Returns The requested rows as a `Data` object.

`read`(*colNumbers*, *start*, *stop*)
Read a subset of columns and consecutive rows from a table.

Parameters

- **colNumber** (*long[]*) – A list of column indices to be retrieved from the table (may be non-consecutive).
- **start** (*long*) – The index of the first row to retrieve.
- **stop** (*long*) – The index of the *last+1* row to retrieve (uses similar semantics to `range()`).

Returns The requested columns and rows as a `Data` object.

Note: *start=0, stop=0* currently returns the first row instead of empty as would be expected using the normal Python range semantics. This may change in future.

`slice`(*colNumbers*, *rowNumbers*)
Read a subset of columns and rows (may be non-consecutive) from a table.

Parameters

- **colNumbers** (*long[]*) – A list of column indices to be retrieved. The results will be returned in the same order as these indices.
- **rowNumbers** (*long[]*) – A list of row indices to be retrieved. The results will be returned in the same order as these indices.

Returns The requested columns and rows as a `Data` object.

`getWhereList` (*condition*, *variables*, *start*, *stop*, *step*)
Run a query on a table, see *Query language*.

Parameters

- **condition** (*string*) – The query string
- **variables** – A mapping of strings and variable values to be substituted into *condition*. This can often be left empty.
- **start** (*long*) – The index of the *first* row to consider.
- **stop** (*long*) – The index of the *last+1* row to consider.
- **step** (*long*) – The stepping interval between the *start* and *stop* rows to consider, using the same semantics as `range()`. Set to *0* to disable stepping.

Returns A list of row indices matching the condition which can be passed as the first parameter of `readCoordinates()` or `read()`.

Note: *variables* seems to add unnecessary complexity, should it be removed?

`initialize` (*columns*)
Initialize a new table. Any column values are ignored, use `addData()` to add these values.

Parameters **columns** (*Column[]*) – A list of columns whose names and types are used to setup the table.

`addData` (*columns*)
Append one or more full rows to the table.

Parameters **columns** (*Column[]*) – A list of columns, such as those returned by `getHeaders()`, whose values are the rows to be added to the table.

`update` (*data*)
Modify one or more columns and/or rows in a table.

Parameters **data** (*Data*) – A `Data` object previously obtained using `read()` or `readCoordinates()` with column values to be updated.

`setMetadata` (*key*, *value*)
Store additional properties associated with a Table.

Parameters

- **key** (*string*) – A key name.
- **value** (*string/int/float/long*) – The value of the property.

`setAllMetadata` (*keyvalues*)
Store multiple additional properties associated with a Table. See `setMetadata()`.

Parameters **keyvalues** (*dict*) – A dictionary of key-value pairs.

`getMetadata` (*key*)
Get the value of a property.

Parameters **key** (*string*) – The property name.

Returns A property.

`getAllMetadata` ()
Get all additional properties. See `getMetadata()`.

Returns All key-value properties.

You many find the *Python* and *Java* annotated code samples helpful, in addition to the *examples* and documentation on the API[7]. These are only an introduction to using OMERO.tables and do not show its full potential, see *Going forward* for some inspiration.

12.3.2 Examples

- Hello World: examples/OmeroTables/first.py[8]
- Creating a Measurement Table: examples/OmeroTables/MeasurementTable.java[9]
- Querying a Table: examples/OmeroTables/FindMeasurements.java[10]

12.3.3 The implementation

Currently, each table is backed by a single HDF table. Since PyTables (and HDF in the general case) do not support concurrent access, OMERO.tables provides a global locking mechanism which permits multiple views of the same data. Each *OMERO.tables* file (registered as an `OriginalFile` in the database), is composed of a single HDF table with any number of certain limited column types.

12.3.4 Query language

The query language mentioned above is *currently* the PyTables condition syntax[11]. Columns are referenced by name. The following operators are supported:

- Logical operators: `&, |, ~`
- Comparison operators: `<, <=, ==, !=, >=, >`
- Unary arithmetic operators: `-`
- Binary arithmetic operators: `+, -, *, /, **, %`

and the following functions:

- `where(bool, number1, number2)`: number — number1 if the bool condition is true, number2 otherwise.
- `{sin,cos,tan}(float|complex)`: float|complex — trigonometric sine, cosine or tangent.
- `{arcsin,arccos,arctan}(float|complex)`: float|complex — trigonometric inverse sine, cosine or tangent.
- `arctan2(float1, float2)`: float — trigonometric inverse tangent of float1/float2.
- `{sinh,cosh,tanh}(float|complex)`: float|complex — hyperbolic sine, cosine or tangent.
- `{arcsinh,arccosh,arctanh}(float|complex)`: float|complex — hyperbolic inverse sine, cosine or tangent.
- `{log,log10,log1p}(float|complex)`: float|complex — natural, base-10 and log(1+x) logarithms.
- `{exp,expm1}(float|complex)`: float|complex — exponential and exponential minus one.
- `sqrt(float|complex)`: float|complex — square root.
- `{real,imag}(complex)`: float — real or imaginary part of complex.
- `complex(float, float)`: complex — complex from real and imaginary parts.

for example, if *id* is the name of a `LongColumn`

```
table.getWhereList(condition='(id>x)', variables={'x':omero.rtypes.rint(5)},
    start=2, stop=10, step=3)
```

will extract a subset of rows (2, 5, 8) as indicated by *start*, *stop* and *step*, substitute *5* in place of *x* in the *condition*, and evaluate *condition* so as to return the indices of rows where column *id* is greater than *5*.

[7] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/grid/Table.html
[8] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroTables/first.py
[9] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroTables/MeasurementTable.java
[10] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroTables/FindMeasurements.java
[11] http://pytables.github.com/usersguide/condition_syntax.html

12.3.5 Going forward

The Tables API itself provides little more than a remotely accessible store, think of it as a server for Excel-like spreadsheets. We are currently looking into the facilities that can be built on top of it, and are **very** open to suggestions. For example, the IRoi interface[12] has been extended to filter ROIs by a given measurement. This allows seeing only those results from a particular analysis run. The following example shows how to set up such a measurement and retrieve its results:

iroi.py[13]

For an example of production code that parses out such measurements, see populate_roi.py[14].

The *IRoi* interface has been integrated into OMERO.insight, allowing for the visualization and export of OMERO.tables:

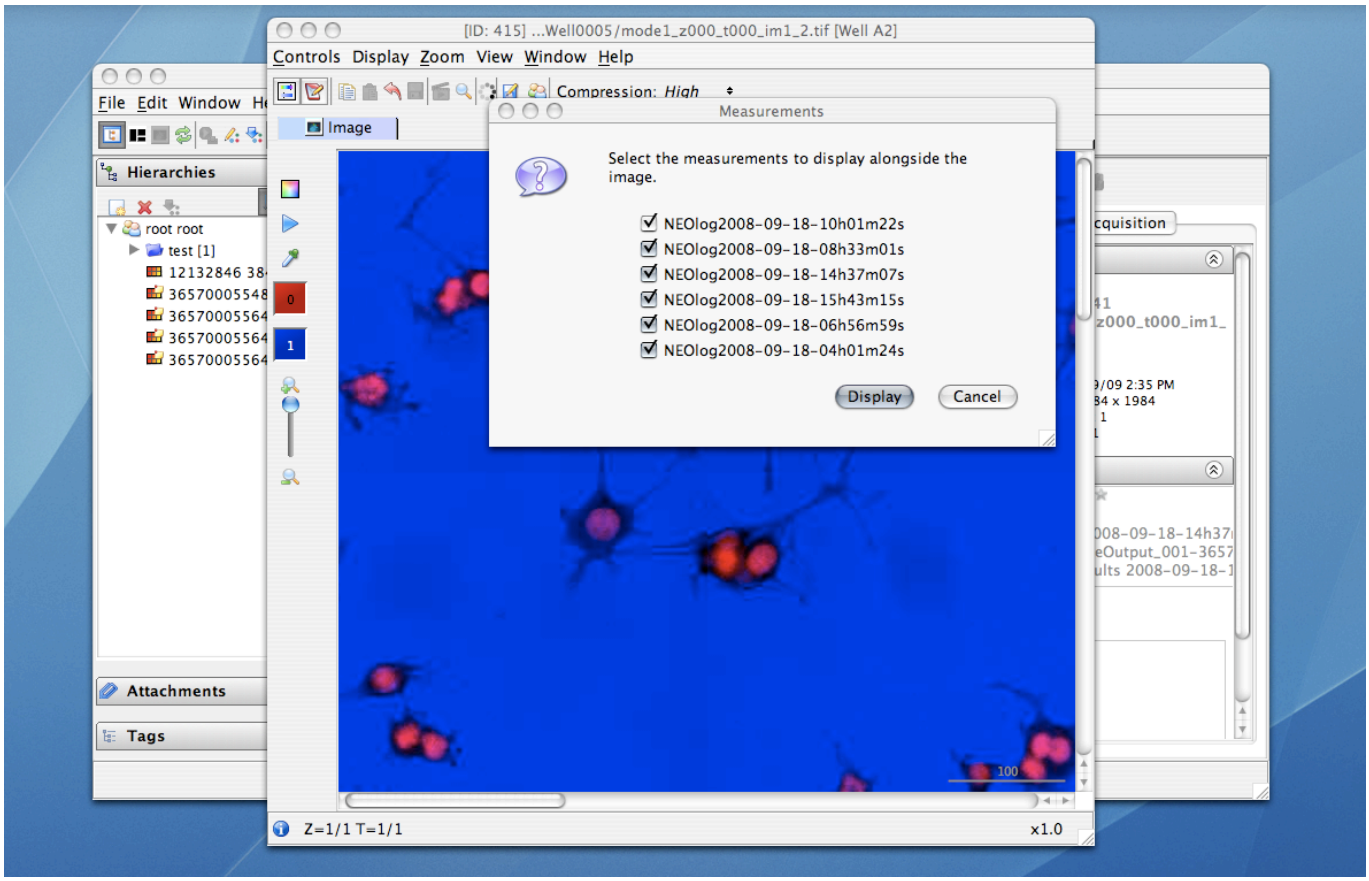


Figure 12.1: Choice between multiple measurements

We are also looking into a NoSQL-style storage mechanism for OMERO, either as an alternative back-end to OMERO.tables or as an additional key-value type store. Any suggestions or ideas would be *very welcome*.

See also:

PyTables[15] Software on which OMERO.tables is built.

Condition Syntax[16] The PyTables condition syntax.

Tables.ice[17] The API definition for OMERO.tables

The Tables test suite[18] The testsuite for OMERO.tables

OMERO.tables Installation requirements for install OMERO.tables

[12] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IRoi.html
[13] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroTables/iroi.py
[14] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroPy/src/omero/util/populate_roi.py

CHAPTER

THIRTEEN

SCRIPTS - PLUGINS FOR OMERO

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

13.1 Introduction to OMERO.scripts

OMERO.scripts are the OME version of plugins, allowing you to extend the functionality of your OMERO installation.

The OMERO scripting service allows scripts to be uploaded to the server so that image processing and analysis, and other functionality, can be carried out there rather than on your local machine. Scripts are generally written in Python, but other languages are also supported, like Jython. MATLAB scripts are supported natively as well as via a Python wrapper as described in *MATLAB and Python*.

Scripts can be run from the OMERO clients, using a UI generated from the script and the results should also be handled where relevant e.g. allowing users to view OMERO Images or Datasets created by the script, or download files or images.

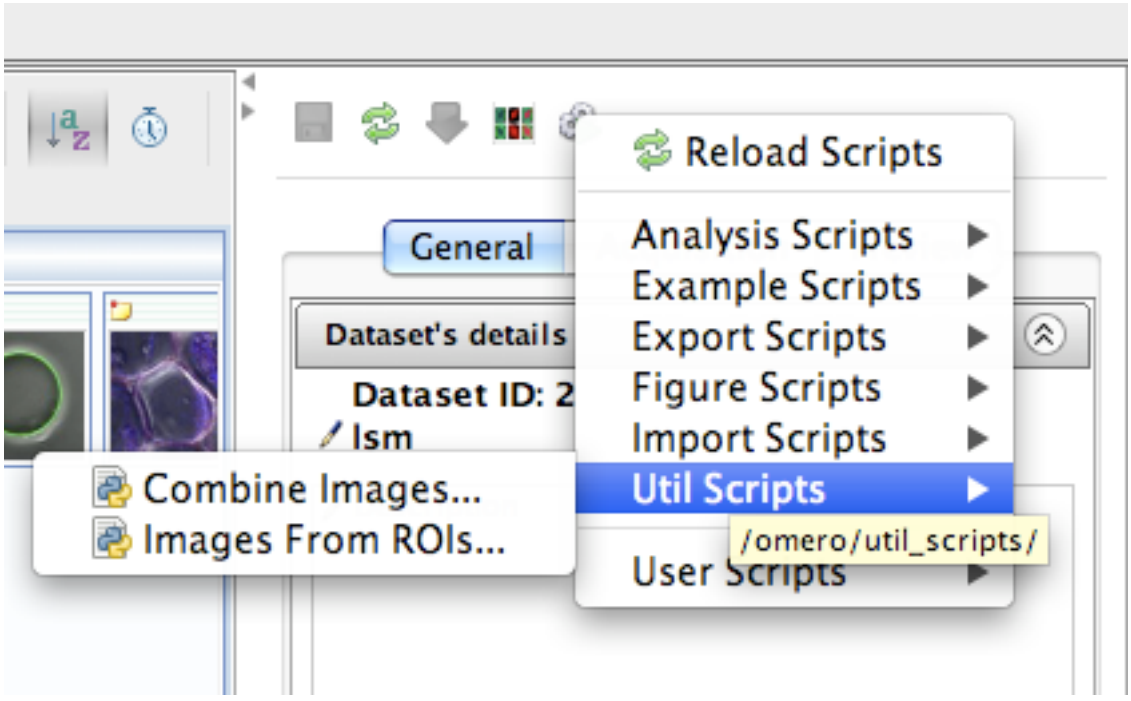


Figure 13.1: Scripts menu in OMERO.insight

13.1.1 Finding scripts

Core scripts[1] are bundled with every OMERO.server release and automatically available to all users. You can find additional

[1] https://github.com/ome/scripts

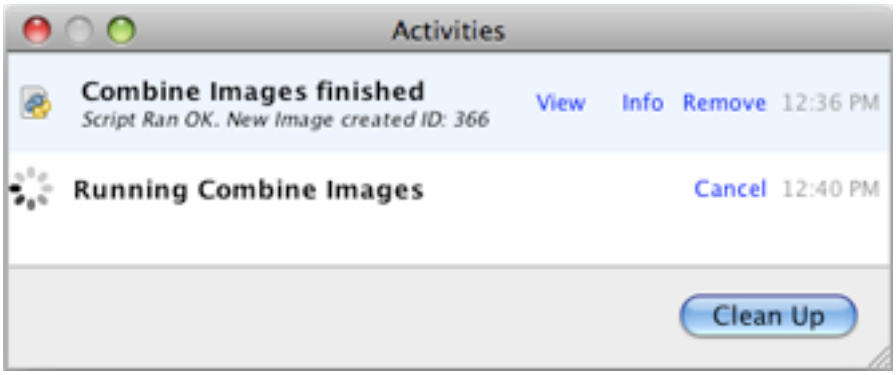


Figure 13.2: Running a script from an OMERO client

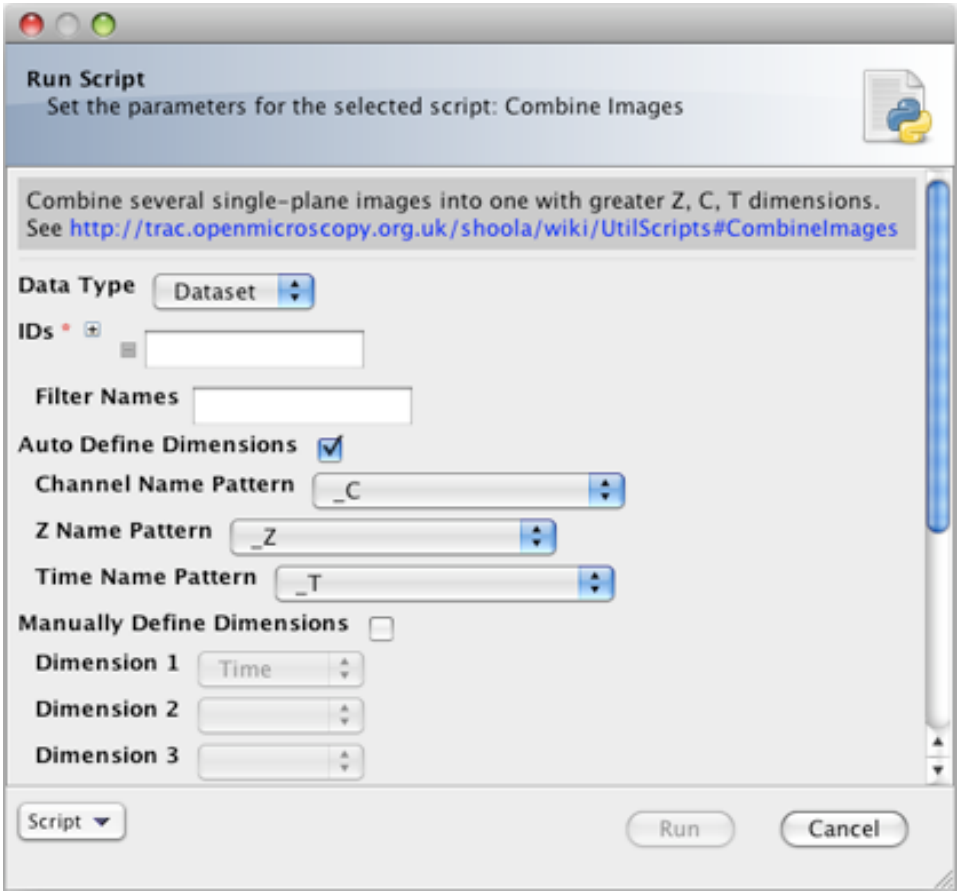


Figure 13.3: A script user interface

scripts via the new script sharing[2] page.

13.1.2 Installing and running scripts

The easiest way to make use of scripts is for someone with admin rights to upload them to the OMERO.server as described in the *OMERO.scripts user guide*. Once a script has been added under the lib/scripts directory, you can run them from the OMERO clients or the command line.

13.1.3 Writing scripts

OMERO.scripts user guide describes the workflows for developing and running your own scripts. You should use the *Guidelines for writing OMERO.scripts* to ensure your script interacts with the OMERO clients in a usable way.

[2] http://www.openmicroscopy.org/site/community/scripts

If you are a biologist with no previous coding experience, you may find the Python for Biologists[3] free online course helpful.

13.1.4 Managing scripts

To keep your scripts up to date, we recommend you use a Github repository to manage your scripts. If you are not familiar with using git[4], you can use the GitHub app for your OS[5] (available for Mac and Windows but not Linux). The basic workflow is:

- fork our omero-user-script[6] repository
- clone it in your lib/scripts directory

```
cd lib/scripts;
git clone git@github.com:YOURGITUSERNAME/omero-user-scripts.git YOUR_SCRIPTS
```

- save the scripts you want to use into the appropriate sub-directory in your cloned location lib/scripts/YOUR_SCRIPTS

Your new scripts will then show up in the script menu in the clients, alongside the core 'omero' scripts which are shipped with each release. This means you should try to pick unique names to avoid future clashes e.g. Custom_Scripts/Search_Scripts/original_metadata_search.py:

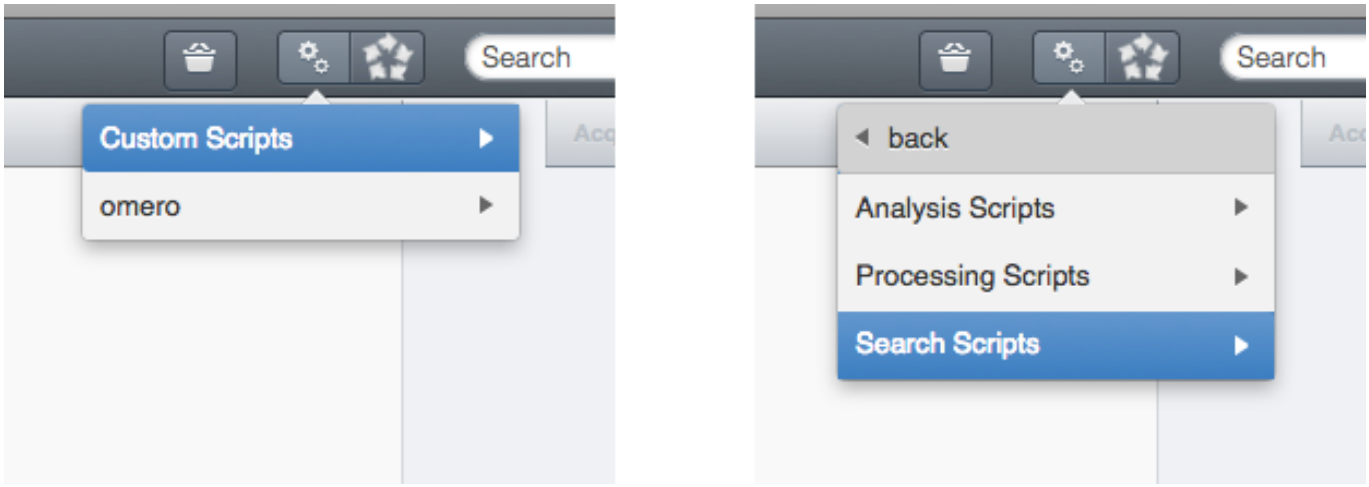


Figure 13.4: Custom scripts in OMERO.web menu

The OME developers use Github to co-ordinate all our development work so joining the network will help you access help and support, and see what other people are doing with scripts. Cloning our repository also means you have an example script to get you started with developing your own.

13.1.5 Contributing back to the community

If you have modified one of the core scripts or developed your own that you would like to contribute back to the community, please get in touch. We can either add your repository to the list on the script sharing[7] page so people can find it, or if the script is likely to have wide appeal, we can look into adding it to the core scripts that are distributed with an OMERO release.

See also:

OMERO.scripts user guide, *Guidelines for writing OMERO.scripts*, *OMERO.scripts advanced topics* and *MATLAB and Python*

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

[3] http://pythonforbiologists.com/index.php/introduction-to-python-for-biologists/
[4] http://www.openmicroscopy.org/site/support/contributing/using-git.html
[5] http://help.github.com/articles/set-up-git
[6] https://github.com/ome/omero-user-scripts
[7] http://www.openmicroscopy.org/site/community/scripts

13.2 OMERO.scripts user guide

OMERO.blitz provides a service to run scripts on the server. The scripts are then passed on to a grid of processors called OMERO.grid that executes the script and returns the result to the server which in turn passes the result onto the caller. All scripts are of the form:

```
# import the omero package and the omero.scripts package.
import omero, omero.scripts as script

'''
This method creates the client script object, with name SCRIPTNAME and SCRIPTDESCRIPTION.
The script then supplies a number of variables that are both inputs and outputs to the
script. The types allowed are defined in the script package, with the qualifier after the
variable of in, out or inout depending on whether the variable if for input, output or input
and output.
'''
client = script.client("SCRIPTNAME", "SCRIPTDESCRIPTION",
         script.TYPE("VARIABLENAME").[in()|out()|inout()], …)
# create a session on the server.
client.createSession()

# All variables are stored in a map accessed by getInput and setOutput via the client object.
VARIABLENAME = client.getInput("VARIABLENAME");
client.setOutput("VARIABLENAME", value);
```

This is a guide to getting started with the scripting service, without going into the 'behind the scenes' details. More technical details can be found on the *OMERO.scripts advanced topics* page. In addition to this guide, you may find the following pages useful for more information on using the OMERO Python API: *Working with OMERO*, *OMERO Python language bindings*.

13.2.1 Sample scripts

Below are two sample scripts. You can find the core scripts that are distributed with the OMERO.server under the scripts repository[8] or download them from OMERO.insight (from the bottom-left of any run-script dialog), or use the script sharing[9] page to find scripts written by other users.

Ping script

This script echoes the input parameters as outputs.

```
import omero, omero.scripts as script
client = script.client("ping.py", "simple ping script",
         script.Long("a"), script.String("b"))
client.createSession()

keys = client.getInputKeys()
print "Keys found:"
print keys
for key in keys:
      client.setOutput(key, client.getInput(key))
```

Accessing an Image and Channels on the server

This example shows usage of the Python Blitz Gateway to access an Image, using its ID. We then list the Channel names and the script returns them as outputs.

[8] https://github.com/ome/scripts
[9] http://www.openmicroscopy.org/site/community/scripts

```
import omero, omero.scripts as scripts
from omero.gateway import BlitzGateway
from omero.rtypes import wrap

# Define the script name & description, and a single 'required' parameter
client = scripts.client("Get_Channels.py", "Get channel names for an image",
    scripts.Long("imageId", optional=False))

# get the Image Id from the parameters.
imageId = client.getInput("imageId", unwrap=True)    # unwrap the rtype

# Use the Python Blitz Gateway for convenience
conn = BlitzGateway(client_obj=client)

# get the Image, print its name
image = conn.getObject("Image", imageId)
print image.getName()

# Print each channel 'label' (Name or Excitation wavelength)
for i, ch in enumerate(image.getChannels()):
    print ch.getLabel()
    # Return as output. Key is string, value is rtype
    client.setOutput("Channel%s" % i, wrap(str(ch.getLabel())))

# Cleanup
client.closeSession()
```

Dynamic arguments

In general, script parameters are processed on server startup and cached for later use. If you have a script which should recalculate its arguments on each invocation, use the *NSDYNAMIC* namespace:

```
# A list of datasets will be dynamically generated and used to populate the
# script parameters every time the script is called

import omero
import omero.gateway
from omero import scripts
from omero.rtypes import rstring


def get_params():
    try:
        client = omero.client()
        client.createSession()
        conn = omero.gateway.BlitzGateway(client_obj=client)
        conn.SERVICE_OPTS.setOmeroGroup(-1)
        objparams = [rstring('Dataset:%d %s' % (d.id, d.getName()))
                     for d in conn.getObjects('Dataset')]
        if not objparams:
            objparams = [rstring('<No objects found>')]
        return objparams
    except Exception as e:
        return ['Exception: %s' % e]
    finally:
        client.closeSession()


def runScript():
    """
    The main entry point of the script
```

```
    """

    objparams = get_params()

    client = scripts.client(
        'Example Dynamic Test', 'Example script using dynamic parameters',

        scripts.String(
            'Dataset', optional=False, grouping='1',
            description='Select a dataset', values=objparams),

        namespaces=[omero.constants.namespaces.NSDYNAMIC],
    )

    try:
        scriptParams = client.getInputs(unwrap=True)
        message = 'Params: %s\n' % scriptParams
        print message
        client.setOutput('Message', rstring(str(message)))

    finally:
        client.closeSession()

if __name__ == '__main__':
    runScript()
```

Example_Dynamic_Script.py

13.2.2 Script writing as 'Admin'

The basic steps in a script-writing workflow are:

- Write a script using your favorite text editor, save locally
- Use command line (or OMERO.insight) to upload script to server
- Use command line (or OMERO.insight or web clients) to run script on the server (results will be displayed)
- Edit script and replace copy on server and run again, etc.

Working with scripts is far more straightforward if you have admin access to your OMERO.server installation - this is the preferred workflow. It is possible to work with scripts as a regular user (see *OMERO.scripts advanced topics*) but the software you would be required to install means it is easier to install a server on your local machine so you have admin rights.

It is assumed that scripts written by a server admin are "trusted" to run on the server without causing any disruption or security risks. Once uploaded these scripts are available to all regular users of the server alongside the official scripts included in each OMERO release.

Download / Edit script

The easiest way to get started is to take an existing script and edit it for your needs. An example created for the purpose of this tutorial can be found at Edit_Descriptions.py[10]. You should organize your scripts on your local machine in a way that makes sense to users, since your local file paths will be mimicked on the server and used to organize script menus in OMERO.insight (see screen-shot above).

```
# Save the script to a suitable location. The tutorial will use this location:
# Desktop/scripts/demo_tutorial/Edit_Descriptions.py
```

[10] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/ScriptingService/Edit_Descriptions.py

The action of this script (editing Image descriptions) is trivial but it demonstrates a number of features that you may find useful, including conventions for inputs and outputs to improve interaction with OMERO.insight (as discussed on the *Guidelines for writing OMERO.scripts*).

The script is well documented and should get you started. A few points to note:

Since the OMERO 4.3 release, if you are using the 'Blitz Gateway', you can get a connection wrapper like this:

```
from omero.gateway import BlitzGateway

conn = BlitzGateway(client_obj=client)
# now you can do E.g. conn.getObject("Image", imageId) etc.
```

Alternatively, if you are working directly with the OMERO services, you can get a service factory like this:

```
session = client.getSession()
# now you can do E.g. session.getQueryService() etc.
```

More example scripts

Several official scripts are included in the release of OMERO and can be found under the lib/scripts/omero/ directory of the server package. Any script can also be download from the OMERO.insight client (bottom-left of the run-script dialog).

Warning: If you wish to edit the official scripts that are part of the OMERO release, you should be prepared to apply the same changes to future releases of these scripts from OMERO. If you think that your changes should be included as part of future released scripts, please let us know.

Upload script

You can use the command line, OMERO.insight or the server file system to upload scripts. The `script` command line tool is discussed in more detail below.

You may find it useful to add the OMERO.server/bin/ folder to your PATH so you can call `bin/omero` commands when working in the scripts folder. E.g:

```
export PATH=$PATH:/Users/will/Desktop/OMERO.server-5.2.4/bin/
```

Upload the script we saved earlier, specifying it as 'official' (trusted to run on the server processor). You will need to log in the first time you use the `omero script` command. The new script ID will be printed out:

```
$ cd Desktop/scripts/
$ omero script upload demo_tutorial/Edit_Descriptions.py --official
Previously logged in to localhost:4064 as root
Server: [localhost]          # hit 'enter' to accept default login details
Username: [root]
Password:
Created session 09fcf689-cc85-409d-91ac-f9865dbfd650 (root@localhost:4064). Idle timeout: 10.0 min. Cur
Uploaded official script as original file #301
```

You can add, remove and edit scripts directly in the OMERO_HOME/lib/scripts/omero/ folder. Any changes made here will be detected by OMERO. Official scripts are uniquely identified on the OMERO server by their 'path' and 'name'.

Any folders in the script path are created on the server under /lib/scripts/ E.g. the above example will be stored at /lib/scripts/examples/Edit_Descriptions.py

The ID of the script is printed after upload and can also be determined by listing scripts (see below).

Run script

You can run the script from OMERO.insight by browsing the scripts (see screen-shot above). A UI will be generated from the chosen script and the currently selected images or datasets will be populated if the script supports this (see *Guidelines for writing OMERO.scripts*).

Or launch the script from the command line, specifying the script ID. You will be asked to provide input for any non-optional parameters that do not have default values specified. Any stdout and stderr will be displayed as well as any outputs that the script has returned.

```
wjm:examples will$ omero script launch 301  # script ID
Using session 1202acc0-4424-4fa2-84fe-7c9e069d3563 (root@localhost:4064). Idle timeout: 10.0 min. Curre
Enter value for "IDs": 1201
Job 1464 ready
Waiting....
Callback received: FINISHED

    *** start stdout ***
    * {'IDs': [1201L], 'Data_Type': 'Dataset'}
    * Processing Images from Dataset: LSM - .mdb
    * Editing images with this description:
    * No description specified
    *
    *    Editing image ID: 15651 Name: sample files.mdb [XY-ch-02]
    *    Editing image ID: 15652 Name: sample files.mdb [XY-ch-03]
    *    Editing image ID: 15653 Name: sample files.mdb [XY-ch]
    *    Editing image ID: 15654 Name: sample files.mdb [XYT]
    *    Editing image ID: 15655 Name: sample files.mdb [XYZ-ch-20x]
    *    Editing image ID: 15656 Name: sample files.mdb [XYZ-ch-zoom]
    *    Editing image ID: 15658 Name: sample files.mdb [XYZ-ch0]
    *    Editing image ID: 15657 Name: sample files.mdb [XYZ-ch]
    *
    *** end stdout ***


    *** out parameters ***
    * Message=8 Images edited
    ***  done ***
```

Parameter values can also be specified in the command.

```
# simply specify the required parameters that don't have defaults
$ omero script launch 301 IDs=1201

# can also specify additional parameters
$ omero script launch 301 Data_Type='Image' IDs=15652,15653 New_Description="Adding description from sc
```

Edit and replace

Edit the script and upload it to replace the previous copy, specifying the ID of the file to replace.

```
$ omero script replace 301 examples/Edit_Descriptions.py
```

Finally, you can upload and run your scripts from OMERO.insight.

Other script commands

Start by printing help for the script command:

```
$ omero script -h
usage: /Users/will/Documents/workspace/Omero/dist/bin/omero script
       [-h] <subcommand> ...

Support for launching, uploading and otherwise managing OMERO.scripts

Optional Arguments:
  In addition to any higher level options

  -h, --help          show this help message and exit

Subcommands:
  Use /Users/will/Documents/workspace/Omero/dist/bin/omero script <subcommand> -h for more information.

  <subcommand>
    demo              Runs a short demo of the scripting system
    list              List files for user or group
    cat               Prints a script to standard out
    edit              Opens a script in $EDITOR and saves it back to the server
    params            Print the parameters for a given script
    launch            Launch a script with parameters
    disable           Makes script non-executable by setting the mimetype
    enable            Makes a script executable (sets mimetype to text/x-python)
    jobs              List current jobs for user or group
    serve             Start a usermode processor for scripts
    upload            Upload a script
    replace           Replace an existing script with a new value
    run               Run a script with the OMERO libraries loaded and current login
```

To list scripts on the server:

```
$ omero script list
Using session 09fcf689-cc85-409d-91ac-f9865dbfd650 (root@localhost:4064). Idle timeout: 10.0 min. Curre
 id  | Official scripts
-----+-----------------------------------------
 201 | /omero/analysis_scripts/flim-omero.py
 1   | /omero/analysis_scripts/FLIM.py
 202 | /omero/export_scripts/Batch_Image_Export.py
 203 | /omero/export_scripts/Make_Movie.py
 204 | /omero/figure_scripts/Movie_Figure.py
 205 | /omero/figure_scripts/Movie_ROI_Figure.py
 206 | /omero/figure_scripts/ROI_Split_Figure.py
 207 | /omero/figure_scripts/Split_View_Figure.py
 208 | /omero/figure_scripts/Thumbnail_Figure.py
 8   | /omero/import_scripts/Populate_ROI.py
 9   | /omero/setup_scripts/FLIM_initialise.py
 209 | /omero/util_scripts/Channel_Offsets.py
 210 | /omero/util_scripts/Combine_Images.py
 211 | /omero/util_scripts/Images_From_ROIs.py
(14 rows)
```

If you want to know the parameters for a particular script you can use the params command. This prints out the details of the script, including the inputs.

```
$ wjm:examples will$ omero script params 301
Using session 1202acc0-4424-4fa2-84fe-7c9e069d3563 (root@localhost:4064). Idle timeout: 10.0 min. Curre

id:  301
name:  Edit_Descriptions.py
version:
authors:
```

```
institutions:
description:  Edits the descriptions of multiple Images,
either specified via Image IDs or by the Dataset IDs.
See http://www.openmicroscopy.org/site/support/omero4/developers/scripts/user-guide.html for the tutori
namespaces:
stdout:  text/plain
stderr:  text/plain
inputs:
  New_Description - The new description to set for each Image in the Dataset
    Optional: True
    Type: ::omero::RString
    Min:
    Max:
    Values:
  IDs - List of Dataset IDs or Image IDs
    Optional: False
    Type: ::omero::RList
    Subtype: ::omero::RLong
    Min:
    Max:
    Values:
  Data_Type - The data you want to work with.
    Optional: False
    Type: ::omero::RString
    Min:
    Max:
    Values: Dataset, Image
outputs:
```

13.2.3 Debugging scripts

The stderr and stdout from running a script should always be returned to you, either when running scripts from the command line, via OMERO.insight or using the scripts API. This should allow you to debug any problems you have.

You can also look at the output from the script in the OriginalFile directory, commonly stored in /OMERO/File/. The script file when executed is uploaded as a new OriginalFile, and the standard error, standard out are saved as the next two OriginalFiles after that. These files can be opened in a text editor to examine contents.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

13.3 Guidelines for writing OMERO.scripts

These guidelines for writing OMERO scripts are designed to improve the interaction of the scripts with OMERO clients so that they can:

- generate a nice, usable UI for the script
- handle the script results appropriately

If you want instructions on how to get started with OMERO scripts, see the link above or the *OMERO.scripts user guide*.

Most of the points below are implemented in the example Edit_Descriptions.py[11].

13.3.1 Script naming and file path

- Script Name should be in the form 'Script_Name.py'. OMERO.insight will replace underscores with spaces in the script selection menu.

[11] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/ScriptingService/Edit_Descriptions.py

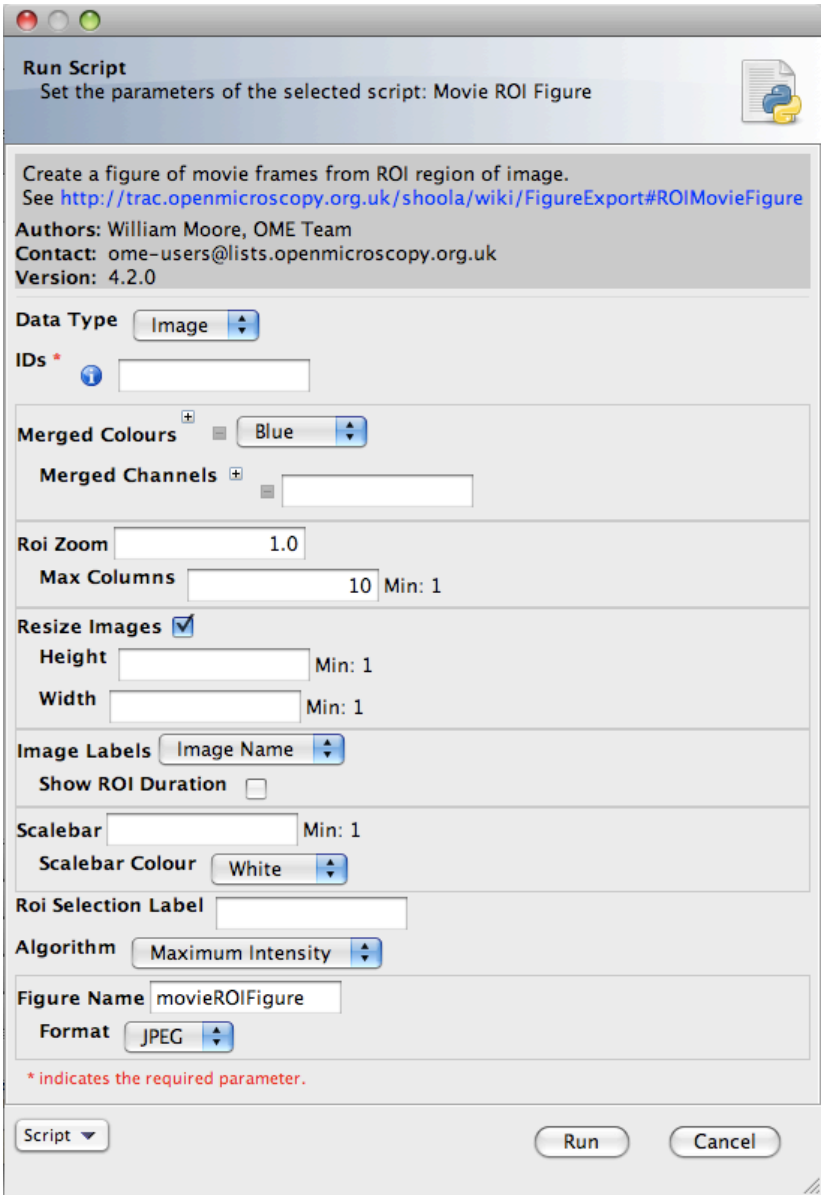


Figure 13.5: Movie ROI figure script UI

- File paths - OMERO.insight will use the parent folder to build a scripts menu, capitalising and removing underscores. For example, a script uploaded from /omero/export_scripts/Batch_Image_Export.py will be displayed in OMERO.insight under "Export Scripts".
- Script Descriptions should give a brief summary of what the script does. If a longer description or instructions for using the script are desired, it is suggested that a URL is included. The description will be displayed in the script UI and any URLs will be 'clickable' to launch a browser.

13.3.2 Parameters

- Parameter Names should be in the form 'Parameter_Name'. Underscores will be replaced by spaces in the UI generated in OMERO.insight.
- Where applicable, Parameters should be supplied with a list of options. For example:

```
scripts.String("Algorithm", values=[rstring('Maximum_Intensity'),rstring('Mean_Intensity')] )
```

- Where possible, parameters should be supplied with default values. These will be used to populate fields in the OMERO.insight script UI and will be used by default when launching the script from the command line.

```
scripts.String("Folder_Name", description="Name of folder to store images", default='Batch_Image_E
```

- Where applicable, Parameters should have min and max values, E.g:

```
scripts.Int("Size_Z", description="Number of Z planes in new image", min=1),
```

13.3.3 Parameter grouping / ordering

Parameters are not ordered by default. They can be ordered and grouped by adding a "grouping" attribute, which is a string, where 'groups' are separated by a '.' E.g. "01.A". Parameters will be ordered by the lexographic sorting of this string and groups indicated in the UI. In most cases this will simply be a common indentation of parameters in the same group. In addition, if the 'parent' parameter of a group is a boolean, then un-checking the check-box in the UI will disable the child parameters. For example a UI generated from the code below will have a 'Show Scalebar' option. If this is un-checked, then the Size and Colour parameters will be disabled and will not be passed to the script.

```
scripts.Bool("Show_Scalebar", grouping="10", default=True),
scripts.Int("Scalebar_Size", grouping="10.1"),
scripts.String("Scalebar_Colour", grouping="10.2"),
```

13.3.4 Pick selected Images, Datasets or Projects from OMERO clients

Both OMERO.insight and OMERO.web recognize and populate a pair of fields named 'Data_Type' (string) and 'IDs' (Long list) with the objects currently selected in the client UI when the script is launched. You should specify the 'Data_Type' options that your script should accept. E.g.

```
dataTypes = [rstring('Dataset'),rstring('Image')]

client = scripts.client('Thumbnail_Figure.py', "Export a figure of thumbnails",
    scripts.String("Data_Type", optional=False, grouping="01", values=dataTypes, default="Dataset"),
    scripts.List("IDs", optional=False, grouping="02").ofType(rlong(0))
    )
```

13.3.5 Script outputs

- Scripts may return a short message to report success or failure. This should use the key: 'Message' in the output map. This will be displayed in OMERO.insight when the script completes.

```
client.setOutput("Message", rstring("Script generated new Image"))
```

- Scripts that generate an Image should return the ImageI object. OMERO.insight will provide a link to view the Image. The key that is used ("Image" in this example) is not important for this to work, but 'image' should be an omero.model.ImageI object.

```
client.setOutput("Image",robject(image))
```

- Scripts that generate a File Annotation or Original File should return these objects. OMERO.insight will give users the option of downloading the File, and may also allow viewing of the file if it is of a suitable type. This should be set as the mimetype of the File Annotation (E.g. 'plain/text', 'image/jpeg' etc). In this example, fileAnnotation should be an omero.model.FileAnnotationI object, but could also be an omero.model.OriginalFileI object.

```
client.setOutput("File_Annotation",robject(fileAnnotation))
```

13.3.6 More tips

- Use the 'unwrap()' function from omero.rtypes to unwrap rtypes from the script parameters since this function will iteratively unwrap lists, maps etc.

```
from omero.rtypes import *
scriptParams = {}
for key in client.getInputKeys():
    if client.getInput(key):
        scriptParams[key] = unwrap(client.getInput(key))

print scriptParams    # stdout will be returned - useful for bug fixing etc.
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

13.4 MATLAB and Python

MATLAB functionality can be mixed into Python scripts via the Python package Mlabwrap[12].

13.4.1 Installing Mlabwrap

To install MlabWrap follow the installation guide[13] and make sure that the paths are set for the environment variables:

```
LD_LIBRARY_PATH=$MATLABROOT/bin/Platform
MLABRAW_CMD_STR=$MATLABROOT/bin/matlab
```

13.4.2 Example MATLAB scripts

Below are some sample scripts showing MATLAB being launched from OMERO.scripts. MATLAB functions can also call the *OMERO Java language bindings* interface to access the server from the MATLAB functions.

Calling a simple MATLAB function

```
import omero, omero.scripts as script
# import mlabwrap to launch matlab.
from mlabwrap import matlab;
client = script.client("rand.py", "Get matrix of random numbers drawn from a uniform distribution",
                       script.Long("x").inout(), script.Long("y").inout())
client.createSession()

x = client.getInput("x").val
y  = client.getInput("y").val

# call the matlab rand function via mlabwrap will automatically launch matlab
```

[12] http://mlabwrap.sourceforge.net
[13] http://mlabwrap.sourceforge.net/#installation

```
# if it is not already running on the system and call the rand method.
val = matlab.rand(x,y);
print val
```

Using the OMERO interface inside MATLAB

This example shows the MATLAB script being called, passed to the client object and accessing the same client instance as the script.

```
import omero, omero.scripts as script
# import mlabwrap to launch matlab.
from mlabwrap import matlab;
client = script.client("projection.py", "Call the matlab projection code",
                        script.String("iceConfig").in(), script.String("user").in(),
                        script.String("password"),
                        script.Long("pixelsId").inout(), script.String("method").inout()
                        script.Long("stack").inout())
client.createSession()

iceConfig = client.getInput("pixelsId").val
user = client.getInput("pixelsId").val
password = client.getInput("pixelsId").val
method  = client.getInput("method").val
stack = client.getInput("stack").val;

image = matlab.performProjection(iceConfig, username, password, pixelsId, stack, method);
```

The MATLAB projection method

```
function performProjection(iceConfig, username, password, pixelsId, zSection, method)

omerojavaService = createOmeroJavaService(iceConfig, username, password);
pixels = getPixels(omerojavaService, pixelsId);
stack = getPlaneStack(omerojavaService, pixelsId, zSection);
projectedImage = ProjectionOnStack(stack, method);



function [resultImage] = ProjectionOnStack(imageStack,type)

[zSections, X, Y] = size(imageStack);

if(strcmp(type,'mean') || strcmp(type, 'sum'))
    resultImage = squeeze(sum(imageStack));
    if(strcmp(type,'mean'))
        resultImage = resultImage./zSections;
    end
end
if(strcmp(type,'max'))
    resultImage = squeeze(max(imageStack,[],1));
end
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

13.5 OMERO.scripts advanced topics

13.5.1 Regular user (non-admin) workflow

If you are using a server for which you do not have admin access, you must upload scripts as 'user' scripts, which are not trusted to run on the server machine. The OMERO scripting service will still execute these scripts in a similar manner to official 'trusted' scripts but behind the scenes it uses the client machine to execute the script. This means that any package imports required by the script should be available on the client machine.

The first step is to connect to the server and set up the processor on the client (see diagram, below).

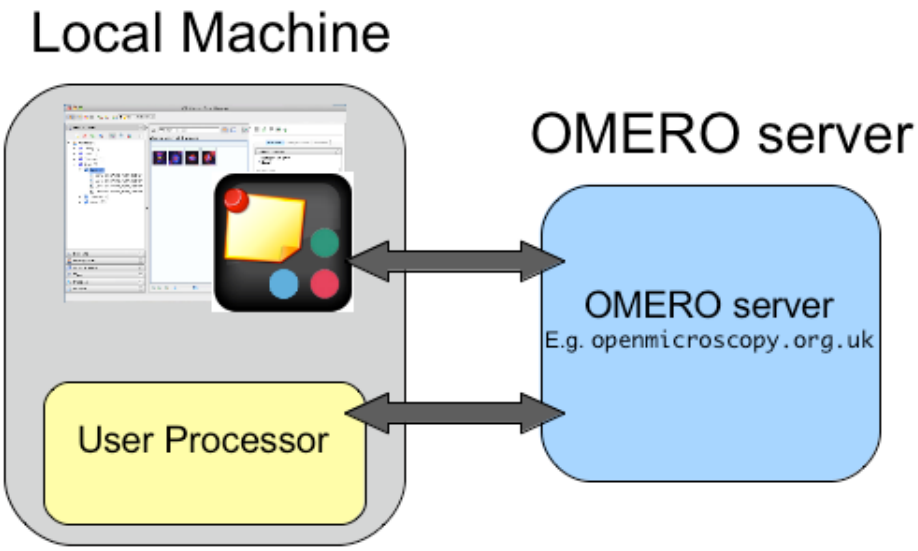


Figure 13.6: OMERO scripting workflow

- You need to download 'Ice' from ZeroC and set the environment variables, as described in the server installation page (see *Unix* and *Windows* versions).
- You also need the OMERO server download. Go to the OMERO downloads[14] page and get the appropriate server package (version must match the server you are connecting to). Unzip the package in a suitable location.

In a command line terminal, change into the unzipped OMERO package, connect to the server and start user processor. For example for host: openmicroscopy.org.uk and user: will

```
$ cd Desktop/OMERO.server-Beta-4.2/
$ bin/omero -s openmicroscopy.org.uk -u will script serve user
$ password: ......
```

If you want to run scripts belonging to another user in the same collaborative group you need to set up your local user processor to accept scripts from that user. First, find the ID of the user, then start the user processor and give it the user's ID:

```
$ cd Desktop/OMERO.server-Beta-4.2/
$ bin/omero -s openmicroscopy.org.uk -u will user list
$ bin/omero -s openmicroscopy.org.uk -u will script serve user=5
```

From this point on, the user and admin workflows are the same, except for a couple of options that are not available to regular users. Also see below.

Note: Because non-official scripts do not have a unique path name, you will be able to run the upload command multiple times on the same file. This will create multiple copies of a file in OMERO and then you will have to choose the most recent one (highest ID) if you want to run the latest script. It is best to avoid this and use the 'replace' command as for official scripts.

[14] http://downloads.openmicroscopy.org/latest/omero/

To list user scripts:

```
$ omero -s openmicroscopy -u will script list user      # lists user scripts
 id  | Scripts for user
    -----+-------------------------------------------------------------------------------------------
 151 | examples/HelloWorld.py
 251 | examples/Edit_Descriptions.py
```

You can list scripts belonging to another user that are available for you (e.g. you are both in the same collaborative group) by using the user ID as described above:

```
$ omero user list
$ omero script list user=5
```

User scripts can be run from OMERO.insight. They will be found under 'User Scripts' in the scripts menu. Remember, for user scripts you will need to have the User-Processor running.

13.5.2 The iScript service

The OMERO.blitz server provides a service called iScript[15] that includes methods to upload, delete, query and run scripts. To access these methods a session needs to be created and the script service started. However, you may find it more convenient to use the command line `bin/omero script` or the OMERO.insight client to work with scripts as described on the *OMERO.scripts user guide*.

13.5.3 Scripting service API

The recommended way of working with the scripting service is via the command line as described on the *OMERO.scripts user guide* page. The information on this page is only useful if you want to access the Scripting service from your own client-side Python code.

OMERO clients can upload, edit, list and run scripts on the OMERO server using the Scripting Service API.

These methods (discussed below) are implemented in examples/ScriptingService/adminWorkflow.py[16]. This sample script allows these functions to be called from the command line and can be used as an example for writing your own clients.

Most functions of the adminWorkflow.py script are also implemented in the OMERO CLI described on the *OMERO.scripts user guide*, which is the preferred way of accessing the scripting service for script writers.

Having downloaded examples/ScriptingService/adminWorkflow.py[17], you can get some instructions for using the script by typing:

```
$ python adminWorkflow.py help
```

To upload 'official' scripts, use the uploadOfficialScript method of the scripting service or use the upload command from adminWorkflow.py (you can omit password and enter it later if you do not want it showing in your console):

```
$ python adminWorkflow.py -s server -u username -p password -f script/file/to/upload.py upload
```

Official scripts must have unique paths. Therefore, the uploadOfficialScript method will not allow you to overwrite and existing script. However, the adminWorkflow.py upload command will automatically use `scriptService.editScript()` if the file exists. If you want to change this behavior, edit the adminWorkflow.py script accordingly.

To get the official scripts available to run, use the `getScripts()` method, which returns a list of Original Files (scripts). This code will produce a list of scripts like the one above.

[15] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IScript.html
[16] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/ScriptingService/adminWorkflow.py
[17] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/ScriptingService/adminWorkflow.py

```
scripts = scriptService.getScripts()
for s in scripts:
    print s.id.val, s.path.val + s.name.val
```

This can be called from adminWorkflow.py with this command:

```
$ python adminWorkflow.py -s server -u username -p password list
```

The script can then be run, using the script ID and passing the script a map of the input parameters. The adminWorkflow.py script has a 'run' command that can be used to identify a script by its ID or path/name and run it. The 'run' command will ask for parameter inputs at the command line.

```
$ python adminWorkflow.py -s localhost -u root -p omero -f scriptID run
```

or

```
$ python adminWorkflow.py -s localhost -u root -p omero -f omero/figure_scripts/Roi_Figure.py run
```

You can combine the latter form of this command with the 'upload' option to upload and run a script at once, useful for script writing and testing.

```
$ python adminWorkflow.py -s localhost -u root -p omero -f omero/figure_scripts/Roi_Figure.py upload run
```

Alternatively, you could edit adminWorkflow.py to 'hard-code' a set of input parameters for a particular script (this strategy is used by examples/ScriptingService/runHelloWorld.py[18]. The code below shows a more complex example parameter map. This strategy might save you time if you want to be able to rapidly run and re-run a script you are working on. Of course, it is also possible to run scripts from OMERO.insight!

```
cNamesMap = omero.rtypes.rmap({'0':omero.rtypes.rstring("DAPI"),
    '1':omero.rtypes.rstring("GFP"),
    '2':omero.rtypes.rstring("Red"),
    '3':omero.rtypes.rstring("ACA")})
blue = omero.rtypes.rstring('Blue')
red = omero.rtypes.rstring('Red')
mrgdColoursMap = omero.rtypes.rmap({'0':blue, '1':blue, '3':red})
map = {
   "Image_IDs": omero.rtypes.rlist(imageIds),
   "Channel_Names": cNamesMap,
   "Split_Indexes": omero.rtypes.rlist([omero.rtypes.rlong(1),omero.rtypes.rlong(2)]),
   "Split_Panels_Grey": omero.rtypes.rbool(True),
   "Merged_Colours": mrgdColoursMap,
   "Merged_Names": omero.rtypes.rbool(True),
   "Width": omero.rtypes.rint(200),
   "Height": omero.rtypes.rint(200),
   "Image_Labels": omero.rtypes.rstring("Datasets"),
   "Algorithm": omero.rtypes.rstring("Mean_Intensity"),
   "Stepping": omero.rtypes.rint(1),
   "Scalebar": omero.rtypes.rint(10), # will be ignored since no pixelsize set
   "Format": omero.rtypes.rstring("PNG"),
   "Figure_Name": omero.rtypes.rstring("splitViewTest"),
   "Overlay_Colour": omero.rtypes.rstring("Red"),
   "ROI_Zoom":omero.rtypes.rfloat(3),
   "ROI_Label":omero.rtypes.rstring("fakeTest"), # won't be found - but should still work
}
```

[18] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/ScriptingService/runHelloWorld.py

The results returned from running the script can be queried for script outputs, including stdout and stderr. The following code queries the results for an output named 'Message' (also displayed by OMERO.insight)

```
print results.keys()
if 'Message' in results:
    print results['Output_Message'].getValue()
if 'stdout' in results:
    origFile = results['stdout'].getValue()
    print "Script generated StdOut in file:" , origFile.getId().getValue()
if 'stderr' in results:
    origFile = results['stderr'].getValue()
    print "Script generated StdErr in file:" , origFile.getId().getValue()
```

This code has been extended in adminWorkflow.py to display any `StdErr` and `StdOut` generated by the script when it is run.

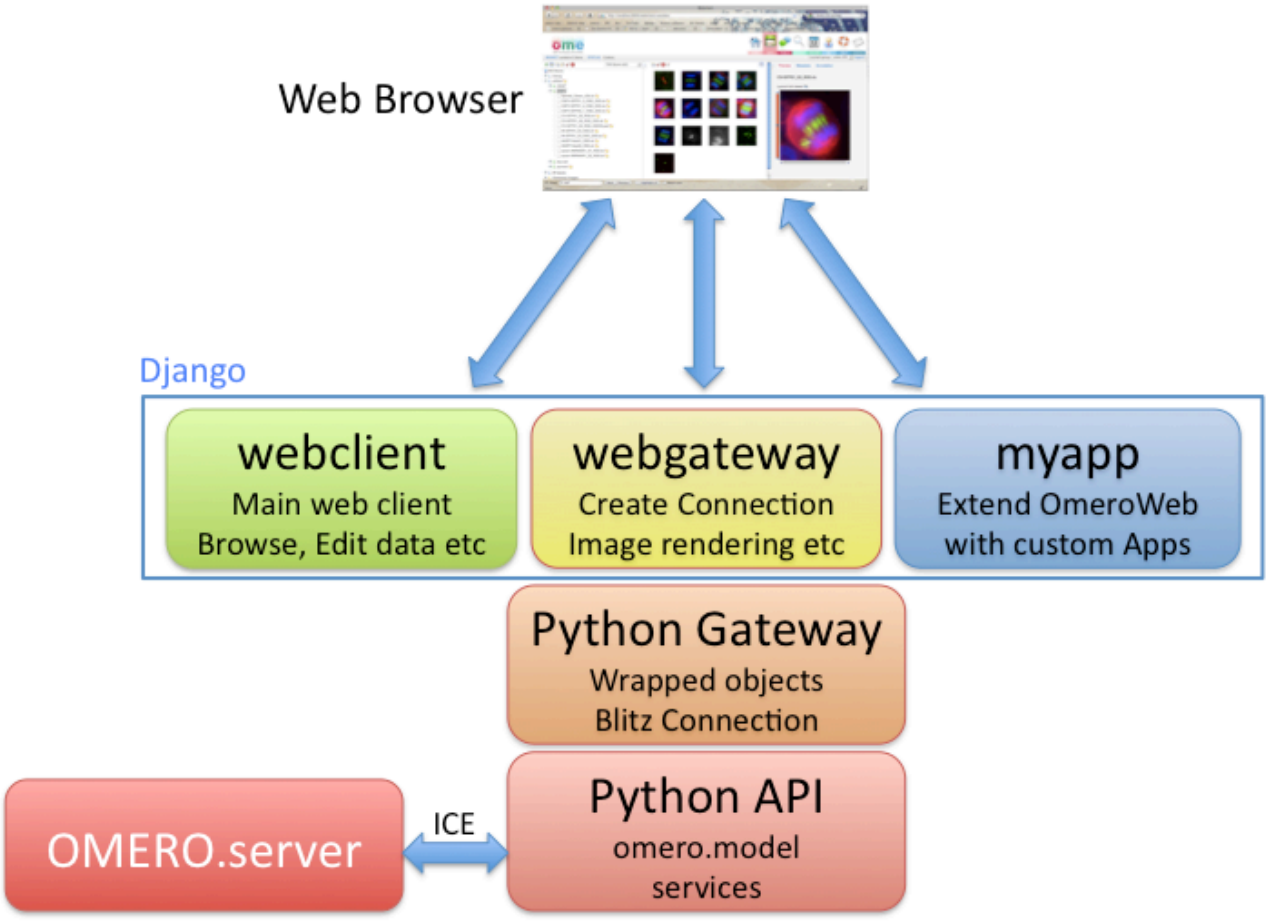
CHAPTER

FOURTEEN

WEB

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.1 OMERO.web framework



OMERO.web is a framework for building web applications for OMERO. It uses Django[1] to generate HTML pages from data retrieved from the OMERO server. OMERO.web acts as a Python client of the OMERO server using the OMERO API, as well as being a web server itself (see 'infrastructure' info below). It uses Django 'apps' to provide modular web tools, such as the webclient (working with image data, administrator management). This modular framework makes it possible to extend OMERO.web with your own apps.

[1] https://www.djangoproject.com/

One of the apps, *WebGateway*, provides utility methods for accessing data and rendering images, as well as handling the connection to OMERO server.

14.1.1 OMERO.web infrastructure

OMERO Python API

The OMERO.web framework is all based on the OMERO Python API, using the Blitz Gateway (see *OMERO Python language bindings*). The OMERO.web framework provides functionality for creating and retrieving connections to OMERO (see example below and *Writing OMERO.web views* for more details)

Web gateway

The webgateway is a Django app that provides utility functionality for the other web components. This includes a full image viewer, as well as methods for rendering images etc. You can browse the webgateway URLs[2], or see the *WebGateway* page for more info.

Web apps

The OMERO.web framework consists of several Django apps denoted by folders named 'web....'. These include webgateway, as discussed above, as well as released tools (webclient) and other apps in development:

webclient Main web client for viewing images, annotating, administration of user and group settings etc. More information available under *OMERO.web*.

webgateway A web services interface, providing rendered images and data. See *WebGateway*.

Note: Although it is possible to access functionality from any installed app, **ONLY webgateway** should be considered as a stable public API. URLs and methods within other web apps are purely designed to provide internal functionality for the app itself and may change in minor releases without warning.

Additional apps can be easily added to your OMERO.web deployment. One example is the webtest app[3] that contains several code samples mentioned in the following pages. You will find install instructions on the webtest app page itself.

14.1.2 Getting started

The preferred workflow for extending OMERO.web is to create a new Django app. Django apps provide a nice way for you to keep all your code in one place and make it much easier to port your app to new OMERO releases or share it with other users. To get started, see *Creating an app*. Further documentation on editing the core OMERO.web code is at *Editing OMERO.web*. If you want to have a quick look at some example code, see below.

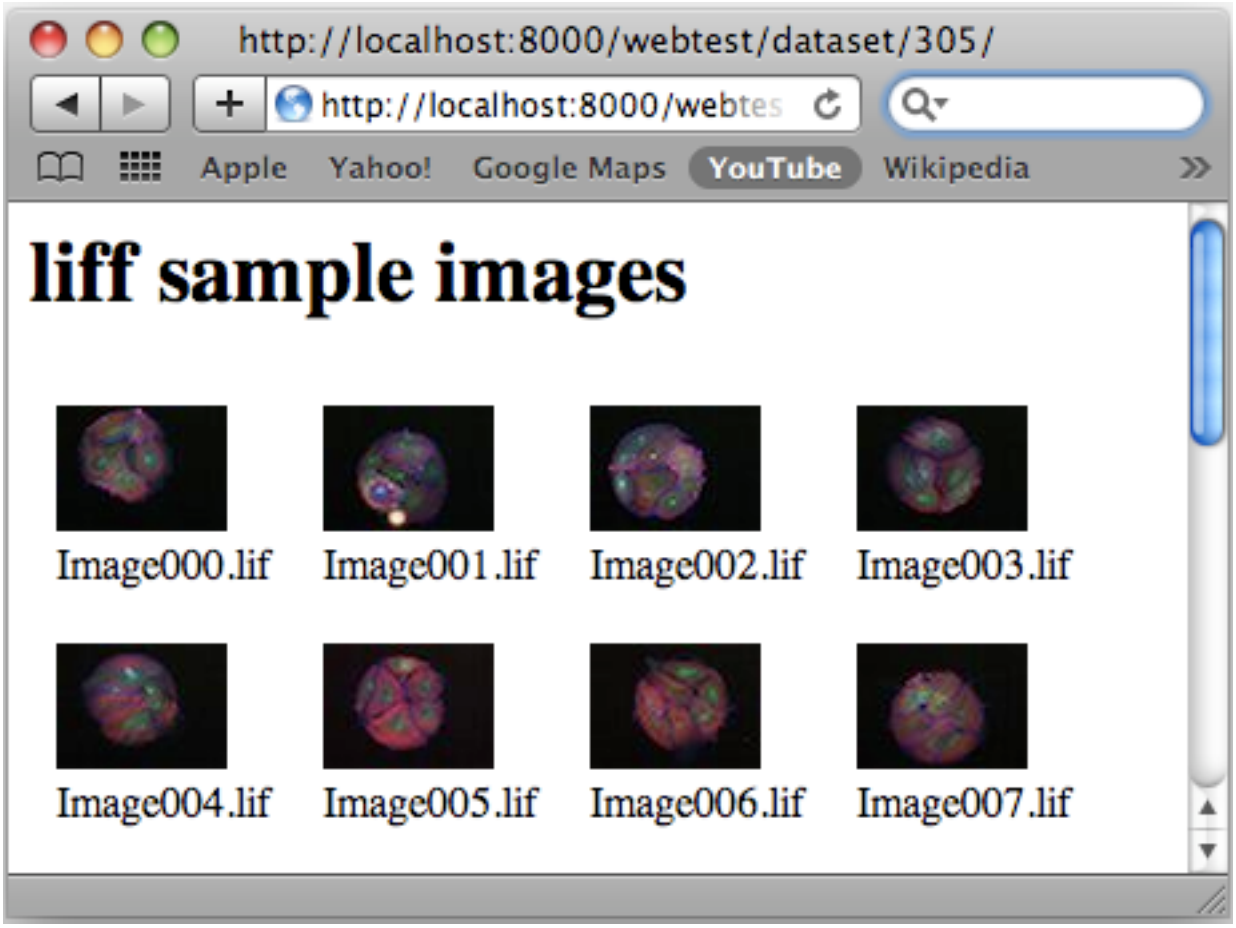
Quick example - webtest

This tiny example gives you a feel for how the OMERO.web framework gets data from OMERO and displays it on a web page. You can find this and other examples in the webtest[4] app.

There are 3 parts to each page: url, view and template. For example, this code below is for generating an HTML page of a Dataset (see screen-shot). If you have OMERO.web running, you can view the page under *http://servername.example.org/webtest/dataset/<datasetId>*.

- **url** goes in omeroweb/webtest/urls.py This maps the URL 'webtest/dataset/<datasetId>/' to the View function 'dataset', passing it the datasetId.

[2] http://downloads.openmicroscopy.org/latest/omero/api/python/omeroweb/omeroweb.webgateway.html#module-omeroweb.webgateway.urls
[3] https://github.com/openmicroscopy/webtest/
[4] https://github.com/openmicroscopy/webtest/




```
url( r'^dataset/(?P<datasetId>[0-9]+)/$', views.dataset ),
```

- **View** function, in omeroweb/webtest/views.py. NB: @login_required decorator retrieves connection to OMERO as 'conn' passed in args to method. See *Writing OMERO.web views* for more details.

```
from omeroweb.webclient.decorators import login_required
# handles login (or redirects). Was @isUserConnected before OMERO 4.4
@login_required()
def dataset(request, datasetId, conn=None, **kwargs):
    ds = conn.getObject("Dataset", datasetId)
    # generate html from template
    return render(request, 'webtest/dataset.html', {'dataset': ds})
```

- **Template:** The template web page, in omeroweb/webtest/templates/webtest/dataset.html

```
<html><body>

<h1>{{ dataset.getName }}</h1>

{% for i in dataset.listChildren %}
    <div style="float:left; padding:10px">
        <img src="{% url 'webgateway.views.render_thumbnail' i.id %}" />
        <br />
        {{ i.getName }}
    </div>
{% endfor %}

</body></html>
```

- Next: Get started by *OMERO.web deployment for developers*....

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.2 OMERO.web deployment for developers

14.2.1 Getting set up

You will need to have an OMERO server running that you can connect to. This will typically be on your own machine, although you can also connect to an external OMERO server. You can add the server to the `omero.web.server_list` and choose that server when you log in. You should enable `omero.web.debug` and start a lightweight development Web server on your local machine.

Note: Since OMERO 5.2, the OMERO.web framework no longer bundles a copy of the Django package, instead manual installation of the Django dependency is required. It is highly recommended to use Django 1.8[5] (LTS) which requires Python 2.7. For more information see *Python* on the *Version requirements* page.

14.2.2 Using the lightweight development server on Unix

All that is required to use the Django lightweight development server is to set the `omero.web.application_server` configuration option, turn `omero.web.debug` on and start the server up:

```
$ bin/omero config set omero.web.application_server development
$ bin/omero config set omero.web.debug True
$ bin/omero web start
INFO:__main__:Application Starting...
INFO:root:Processing custom settings for module omeroweb.settings
...
Validating models...

0 errors found
Django version 1.8, using settings 'omeroweb.settings'
Starting development server at http://127.0.0.1:4080/
Quit the server with CONTROL-C.
```

14.2.3 Using the lightweight development server on Windows

All that is required to use the Django lightweight development server is to set the `omero.web.application_server` configuration option, turn Debugging on and start the server up:

```
C:\omero_dist>bin\omero config set omero.web.application_server development
C:\omero_dist>bin\omero config set omero.web.debug True
C:\omero_dist>bin\omero web start
INFO:__main__:Application Starting...
INFO:root:Processing custom settings for module omeroweb.settings
...
Validating models...

0 errors found
Django version 1.8, using settings 'omeroweb.settings'
Starting development server at http://127.0.0.1:4080/
Quit the server with CTRL-BREAK.
```

[5] https://docs.djangoproject.com/en/1.8/releases/1.8/

14.2.4 Using WSGI (Unix/Linux)

For convenience you may wish to run a web server under your local user account instead of using a system server for testing. Install Nginx and Gunicorn (See *OMERO.web deployment*) but generate a configuration file using the following commands:

```
$ bin/omero config set omero.web.application_server 'wsgi-tcp'
$ bin/omero web config nginx-development > nginx-development.conf
```

Start Nginx and the Gunicorn worker processes running one thread listening on 127.0.0.1:4080 that will autoreload on source change:

```
$ nginx -c $PWD/nginx-development.conf
$ bin/omero config set omero.web.application_server.max_requests 1
$ bin/omero config set omero.web.wsgi_args -- "--reload"
$ bin/omero web start
```

Next: Get started by *Creating an app*....

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.3 Creating an app

The Django web site has a very good tutorial[6] to get you familiar with the Django framework. The more you know about Django, the easier you will find it working with the OmeroWeb framework. One major feature of Django that we do not use in OmeroWeb is the Django database mapping, since all data comes from the OMERO server and is saved back there. You will notice that the models.py files in each app are empty.

14.3.1 Getting set up

In order to deploy OMERO.web in a development or testing environment please follow the instructions under *OMERO.web deployment for developers*.

You should make sure that you can access the webclient on your local machine before starting to develop your own code. Be sure to use the correct port number, e.g.:

- http://localhost:4080/webclient/

When you edit and save your app, Django will automatically detect this and you only need to refresh your browser to see the changes.

If you want to make changes to the OMERO.web code itself, you should see *Editing OMERO.web*.

You can place your app anywhere on your `PYTHONPATH`, as long as it can be imported by OMERO.web.

14.3.2 Creating an app

We suggest you use GitHub[7] (as we do) since it is much easier for us to help you with any problems you have if we can see your code. The steps below describe how to create a stand-alone git repository for your app, similar to webtagging[8]. If you do not want to use GitHub, simply ignore the steps related to GitHub.

The steps below describe how to set up a new app. You should choose an appropriate name for your app and use it in place of <your-app>:

[6] https://docs.djangoproject.com/en/1.8/intro/tutorial01/
[7] https://github.com/
[8] https://github.com/MicronOxford/webtagging

Add your app to your PYTHONPATH

Your app needs to be within a directory that is on your `PYTHONPATH`. We usually create a new container for a new app, and add it to the `PYTHONPATH`.

```
$ mkdir PARENT-APP-DIR
$ cd PARENT-APP-DIR
$ export PYTHONPATH=$PYTHONPATH:/path/to/PARENT-APP-DIR
```

OR you could simply choose an existing location:

```
$ cd /somewhere/on/your/pythonpath/
```

Create and check out a new GitHub repository OR manually create a new directory

- Login to your GitHub account homepage (e.g. https://github.com/<your-name>/) and click "New repository"
- Enter the name of <your-app>, add a description and choose to add a README.
- Check out your new repository (into a new directory)

  ```
  $ git clone git@github.com:<your-name>/<your-app>.git
  ```

- OR: If you have not used git to create your app directory above, then

  ```
  $ mkdir <your-app>
  ```

- In either case, you should now have a directory called `your-app` within a directory that is on your `PYTHONPATH`.

Add the essential files to your app

- Create an empty file `<your-app>/__init__.py` (NB: both double underscores)
- Create `urls.py`

  ```
  from django.conf.urls import *
  from <your-app> import views

  urlpatterns = patterns('django.views.generic.simple',

       # index 'home page' of the <your-app> app
       url( r'^$', views.index, name='<your-app>_index' ),

   )
  ```

- Create `views.py`

  ```
  from django.http import HttpResponse

  def index(request):
      """
      Just a place-holder while we get started
      """
      return HttpResponse("Welcome to your app home-page!")
  ```

For more details on how to write views, forms, using templates, etc. check the Django documentation[9].

Add your app to OMERO.web

`omero.web.apps` adds your custom application to the `INSTALLED_APPS`, so that URLs are registered etc.

Note: Here we use single quotes around double quotes, since we are passing a double-quoted string as a json object.

```
$ bin/omero config append omero.web.apps '"<your-app>"'
```

Now you can view the home-page we created above (NB: you will need to restart the OMERO.web server for the config settings to take effect).

```
$ bin/omero web stop
$ bin/omero web start
```

Go to http://localhost:4080/<your-app>/ OR http://localhost:8000/<your-app>/ and you should see 'Welcome'.

Commit your code and push to GitHub

```
$ git status (see new files, plus .pyc files)
$ echo "*.pyc" > .gitignore          # ignore .pyc files
$ echo ".gitignore" >> .gitignore    # ALSO ignore .gitignore

$ git add ./
$ git commit -m "Initial commit of bare-bones OMERO.web app"
$ git push origin master
```

Connect to OMERO: example

We have got our new app working, but it is not connecting to OMERO yet. Let us create a simple "stack preview" for an Image with multiple Z-sections. We are going to display the image name and 5 planes evenly spaced across the Z-stack. You should be able to add the appropriate code to `urls.py`, `views.py` that you created above, and add a template under /omeroweb/<your-app>/templates/<your-app>/

Note: note that /<your-app>/ appears twice in that path (need an extra folder under templates).

The following example can be found in the webtest[10] app.

- **urls.py**

```
url( r'^stack_preview/(?P<imageId>[0-9]+)/$', views.stack_preview,
     name="<your-app>_stack_preview" ),
```

- **views.py** Here we are using the `@login_required` decorator to retrieve a connection to OMERO from the session key in the HTTP request (or provide a login page and redirect here). `conn` is passed to the method arguments. NB: Note a couple of new imports to add at the top of your page.

[9] https://docs.djangoproject.com/en/1.8/intro/tutorial03/#write-your-first-view
[10] https://github.com/openmicroscopy/webtest/

```
from omeroweb.webclient.decorators import login_required
from django.shortcuts import render


@login_required()
def stack_preview (request, imageId, conn=None, **kwargs):
    """ Shows a subset of Z-planes for an image """
    image = conn.getObject("Image", imageId)        # Get Image from OMERO
    image_name = image.getName()
    sizeZ = image.getSizeZ()                         # get the Z size
    # 5 Z-planes
    z_indexes = [0, int(sizeZ*0.25),
             int(sizeZ*0.5), int(sizeZ*0.75), sizeZ-1]
    return render(request, 'webtest/stack_preview.html',
         {'imageId':imageId,
         'image_name':image_name,
         'z_indexes':z_indexes})
```

- **<your-app>/templates/<your-app>/stack_preview.html**

```
<html>
<head>
     <title>Stack Preview</title>
</head>
<body>
     <h1>{{ image_name }}</h1>

     {% for z in z_indexes %}
         <img src="{% url 'webgateway.views.render_image' imageId z 0 %}"
             style="max-width: 200px; max-height:200px"/>
     {% endfor %}
</body>
</html>
```

Viewing the page at http://localhost:4080/<your-app>/stack_preview/<image-id>/ should give you the image name and 5 planes from the Z stack. You will notice that we are using the `webgateway` to handle the image rendering using a URL auto-generated by Django - see *WebGateway*.

14.3.3 Resources for writing your own code

The webtest[11] app has a number of examples. Once installed, you can go to the webtest homepage e.g. http://localhost:4080/webtest and you will see an introduction to some of them. This page tries to find random images and datasets from your OMERO server to use in the webtest examples.

Using jQuery and jQuery UI from OMERO.web

OMERO.web uses the jQuery[12] and jQuery UI[13] javascript libraries extensively. If you need these libraries, you can include the OMERO.web versions of these libraries in your own pages. The alternative is to provide a specific version of jQuery or jQuery UI in your own app if, for example, you think that a version change may cause problems in your code. If you need to make use of these resources in your own pages, you can add the following statements to the `<head>` of your page templates:

```
<!-- jQuery -->
{% include "webgateway/base/includes/script_src_jquery.html" %}
```

[11] https://github.com/openmicroscopy/webtest/
[12] https://jquery.com/
[13] https://jqueryui.com/

```
<!-- jQuery UI - includes js and css -->
{% include "webgateway/base/includes/jquery-ui.html" %}
```

The OMERO 5.1.0 release included an upgrade to jQuery 1.11.1 and jQuery UI 1.10.4. We have added jQuery-migrate library (1.2.1) to reduce the effects of this upgrade. You should inspect the javascript console during development to observe any warning messages.

Extending templates

We provide several HTML templates in webgateway/templates/webgateway/base. This is a nice way of giving users the feeling that they have not left the webclient, if you are providing additional functionality for webclient users. You may choose not to use this if you are building a 'stand-alone' web application. In either case, it is good practice to create your own templates with common components (links, logout etc.), so you can make changes to all your pages at once. See *Writing page templates in OMERO.web* for more info.

14.3.4 App settings

You can add settings to your app that allow configuration via the command line in the same way as for the base OMERO.web. The list of `CUSTOM_SETTINGS_MAPPINGS` in components/tools/OmeroWeb/omeroweb/settings.py[14] is a good source for examples of the different data types and parsers you can use.

For example, if you want to create a user-defined setting yourapp.foo, that contains a dictionary of key-value pairs, you can add to `CUSTOM_SETTINGS_MAPPINGS` in `yourapp/settings.py`:

```
import json
CUSTOM_SETTINGS_MAPPINGS = {
    "omero.web.yourapp.foo": ["FOO", '{"key": "val"}', json.loads]
}
```

From somewhere else in your app, you can then access the settings:

```
from yourapp import settings

print settings.FOO
```

Users can then configure this on the command line as follows:

```
$ bin/omero config set omero.web.yourapp.foo '{"userkey": "userval"}'
```

OMERO.web top links

You can configure `omero.web.ui.top_links` to add links to the list of links at the top of the webclient main pages.

- **Name your URL in urls.py** (optional). Preferably we use URL names to refer to URLs. For example, the homepage of your app might be named like this in yourapp/urls.py.

  ```
  url( r'^$', views.index, name='figure_index' ),
  ```

  You can then refer to the link defined above using this `name`, or you can simply use a full URL for external links.

- **Update configuration** Use the OMERO command line interface to append the link to the `top_links` list.

  Links use the format `["Label", "URL_name"]` or you can follow this example:

[14] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroWeb/omeroweb/settings.py

```
$ bin/omero config append omero.web.ui.top_links '["Figure", "figure_index"]'
```

From OMERO 5.1, you can add additional attributes to links using the format `['Link Text', 'link', attrs]`. This can be used to add tool-tips and to open the link in a new "target" tab. For example:

```
$ bin/omero config append omero.web.ui.top_links '["Homepage", "http://myhome.com", {"title": "Home
```

Custom image viewer

If you have created your own image viewer and would like to have it replace the existing image viewer in the webclient, this can be configured using `omero.web.viewer.view`.

You will need your `views.py` method to take an Image ID with a parameter named `iid`. For example, see `channel_overlay_viewer` from the webtest[15] app:

```
@login_required()
def channel_overlay_viewer(request, iid, conn=None, **kwargs):
```

You can then configure the webclient to use this viewer by providing the full path name to this view method. For example, if you have webtest installed you can use the `channel_overlay_viewer`:

```
$ bin/omero config set omero.web.viewer.view webtest.views.channel_overlay_viewer
```

This will now direct the image viewer url at `webclient/img_detail/<iid>/` to this viewer. However, the existing viewer will still be available under webgateway at `webgateway/img_detail/<iid>/`.

If you want to use a different viewer for different images, you can conditionally redirect to the webgateway viewer or elsewhere. For example:

```
if image.getSizeC() == 1:
    return HttpResponseRedirect(reverse("webgateway.views.full_viewer", args=(iid,)))
```

14.3.5 OMERO.web plugins

If you want to display content from your app within the webclient UI, please see *Webclient Plugins*.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.4 Webclient Plugins

The webclient UI can be configured to include content from other web apps. This allows you to extend the webclient UI with your own functionality. This is used by the webtagging app[16] and there are also some examples in the webtest[17] app.

Currently you can add content in the following locations:

- **Center Panel** Adding a panel to the center of the webclient will display a drop-down menu to the top right of the center panel, allowing users to choose your plugin.

[15] https://github.com/openmicroscopy/webtest/
[16] http://www.openmicroscopy.org/site/products/partner/omero.webtagging
[17] https://github.com/openmicroscopy/webtest/

- **Right Panel** You can add additional tabs to the right panel. These will be available in the main webclient page as well as history and search result pages.

14.4.1 Overview

To begin with, you need to prepare your plugin pages in your own app, with their own URLs, views and templates. Then you can display these pages within the webclient UI, using the plugin framework.

Note: When you embed your pages in the webclient, there is potential for conflicts between JavaScript and CSS in the host page and your own code. Care must be taken not to overwrite global JavaScript functions (such as jQuery or the 'OME' namespace) or to add CSS codes that may affect host elements.

The webclient plugins work by adding some custom JavaScript snippets into the main pages of the webclient and adding HTML elements to specified locations in the webclient. These snippets of JavaScript can be used to load content into these HTML elements. Usually you will want to do this dynamically, to display data based on the currently selected objects (although this is optional). Helpers can be used to respond to changes in the selected objects and the selected tab, so you can load or refresh your plugin only when necessary.

14.4.2 App URLs

To display content based on currently selected data, such as Projects, Datasets and Images, your app pages will need to have these defined in their URLs. For example:

```
# Webtagging: Tag images within the selected dataset
url( r'^auto_tag/dataset/(?P<datasetId>[0-9]+)/$', views.auto_tag ),

# Webtest: Show a panel of ROI thumbnails for an image
url( r'^image_rois/(?P<imageId>[0-9]+)/', views.image_rois ),
```

These URLs should simply display the content that you want to show in the webclient. NB: when these pages load in the webclient, they will have all the webclient CSS and JavaScript (such as jQuery) available so you do not need to include these in your page.

14.4.3 Configuring the plugin

Choose an element ID

You will need to specify an ID for the <*div*> element that is added to the webclient, so that you can refer to this element in the JavaScript. For example, "image_roi_tab" or "auto_tag_panel".

Create a JavaScript file

This will contain the JavaScript snippet that is injected into the main webclient page <*head*> when the page is generated. This is added using Django's templates, so it should be placed within your app's */templates/<app-name>/* directory and named *.html*, e.g. /templates/<app-name>/webclient_plugins/right_plugin_rois.html. All the JavaScript should be within <*script*> and <*/script*> tags. Your plugin initialization should happen after the page has loaded, so you use the jQuery on-ready function.

You use custom jQuery functions, called 'omeroweb_right_plugin' or 'omeroweb_center_plugin', to initialize the webclient plugin. These will handle all the selection change events. You simply need to specify how the panel is loaded, based on the selected object(s) and what objects are supported. The plugin will be disabled when non-supported objects are selected.

Below is a simple example of their usage. More detailed documentation available in the *plugin options section* below.

Center Panel Plugin

```
<script>
$(function() {

    // Initialise the center panel plugin, on our specified element
    $("#auto_tag_panel").omeroweb_center_plugin({

        // To support single item selection, we can specify the types like this.
        // Tab will only be enabled when a single dataset is selected
        supported_obj_types: ['dataset'],

        load_plugin_content: function(selected, dtype, oid){

            // since we currently limit our dtype to 'dataset', oid will be dataset ID
            // Use the 'index' of your app as base for your URL
            var auto_tag_url = '{% url 'webtagging_index' %}auto_tag/dataset/'+oid+'/';
            $(this).load(auto_tag_url);
        }
    });
});
</script>
```

Right Tab Plugin

```
<script>
$(function() {

   // Initialise the right tab plugin, on our specified tab element
   $("#image_roi_tab").omeroweb_right_plugin({

       // Tab will only be enabled when a single image is selected
       supported_obj_types: ['image'],

       // This will get called when tab is displayed or selected objects change
       load_plugin_content: function(selected, obj_dtype, obj_id) {

           // since we only support single images, the obj_id will be an image ID
           // Generate url based on a template-generated url
           var url = '{% url 'webtest_index' %}image_rois/' + obj_id + '/';

           // Simply load the tab
           $(this).load(url);
       },

   });

});
</script>
```

14.4.4 Plugin installation

Now you need to add your plugin to the appropriate plugin list, stating the displayed name of the plugin, the path/to/js_snippet.html and the ID of the plugin element. Plugin lists are:

- omero.web.ui.center_plugins
- omero.web.ui.right_plugins

Use the OMERO command line interface to add the plugin to the appropriate list.

```
$ bin/omero config append omero.web.ui.center_plugins
    '["Auto Tag", "webtagging/auto_tag_init.js.html", "auto_tag_panel"]'
```

The right_plugins list includes the *Acquisition* tab and *Preview* tab by default. If you want to append the webtest ROI plugin or your own plugin to the list, you can simply do:

```
$ bin/omero config append omero.web.ui.right_plugins
    '["ROIs", "webtest/webclient_plugins/right_plugin.rois.js.html", "image_roi_tab"]'
```

If you want to replace existing plugins and display only your own single plugin, you can simply do:

```
$ bin/omero config set omero.web.ui.right_plugins
    '[["ROIs", "webtest/webclient_plugins/right_plugin.rois.js.html", "image_roi_tab"]]'
```

Restart Web

Stop and restart your web server, then refresh the webclient UI. You should see your plugin appear in the webclient UI in the specified location. You should only be able to select the plugin from the drop-down menu or tab **if** the supported data type is selected, e.g. 'image'. When you select your plugin, the load content method you specified above will be called and you should see your plugin loaded.

Refreshing content

If you now edit the `views.py` or HTML template for your plugin and want to refresh the plugin within the webclient, all you need to do is to select a different object (e.g. dataset, image etc). If you select an object that is not supported by your plugin, then nothing will be displayed, and for the right-tab plugin, the tab selection will change to the first tab.

14.4.5 Plugin options

- **supported_obj_types**: If your plugin displays data from single objects, such as a single Image or Dataset, you can specify that here, using a list of types:

  ```
  supported_obj_types: ['dataset', 'image'],
  ```

  This will ensure that the plugin is only enabled when a single Dataset or Image is selected. To support multiple objects, see 'tab_enabled'.

- **plugin_enabled**: This function allows you to specify whether a plugin is enabled or not when specified objects are selected. It is only used if you have NOT defined 'supported_obj_types'. The function is passed a single argument:
  - selected: This is a list of the selected objects e.g. *[{'id':'image-123'}, {'id':'image-456'}]*

  The function should return true if the plugin should be enabled. For example, if you want the center plugin to support multiple images, or a single dataset:

  ```
  plugin_enabled: function(selected){
      if (selected.length == 0) return false;
      var dtype = selected[0]['id'].split('-')[0];
       if (selected.length > 1) {
          return (dtype == "image");
      } else {
          return ($.inArray(dtype, ["image", "dataset"]) > -1);
      }
  }
  ```

- **load_plugin_content / load_tab_content**: This function will be called when the plugin/tab content needs to be refreshed, either because the plugin is displayed for the first time, or because the selected object changes. The function will be passed 3 arguments:
  - selected: This is a list of the selected objects e.g. *[{'id':'image-123'}, {'id':'image-456'}]*
  - obj_dtype: This is the data-type of the first selected object, e.g. 'image'
  - obj_id: This is the ID of the first selected object, e.g. 123

14.4.6 OMERO 4.4.x backwards compatibility

If an OMERO 5 plugin also needs to work for OMERO 4.4.x installations, there are three things to consider:

URLs in templates

The url tag[18] has changed in Django 1.8[19] from *{% url myview %}* to *{% url 'myview' %}*. In order for your OMERO 4.4.x install to understand the new syntax, it is simply a matter of adding *{% load url from future %}* to the top of the template file. By using the new-style syntax and the *{% load url from future %}* the template will be valid in both OMERO 4.4.x and OMERO 5. The *{% load url from future %}* line does no harm when used on Django 1.8[20].

URL imports

The import statement required to get the URL and patterns objects in the plugin's `urls.py` has changed as well. The following import can be used to import from the correct place depending on which Django version is present.

```
import django
if django.VERSION < (1, 6):
    from django.conf.urls.defaults import *
else:
    from django.conf.urls import *
```

Plugin settings

In OMERO 4.4.x (with the older Django) it was possible to manipulate settings in the plugin's `settings.py` like so:

```
from django.conf import settings

# We can directly manipulate the settings
# E.g. add plugins to CENTER_PLUGINS list
settings.CENTER_PLUGINS.append(
    ["Auto Tag", "webtagging/auto_tag_init.js.html", "auto_tag_panel"]
)
```

This is no longer possible in OMERO 5 with Django 1.8[21] and it is necessary to use `omero config set` to change this setting as documented here: *Plugin Installation*.

In order to preserve the old functionality on OMERO 4.4.x servers, the plugin's `settings.py` can be changed to:

```
import django

if django.VERSION < (1, 6):
    from django.conf import settings
```

[18] https://docs.djangoproject.com/en/1.8/ref/templates/builtins/#url
[19] https://docs.djangoproject.com/en/1.8/releases/1.8/
[20] https://docs.djangoproject.com/en/1.8/releases/1.8/
[21] https://docs.djangoproject.com/en/1.8/releases/1.8/

```
# We can directly manipulate the settings
# E.g. add plugins to CENTER_PLUGINS list
settings.CENTER_PLUGINS.append(
    ["Auto Tag", "webtagging/auto_tag_init.js.html", "auto_tag_panel"]
)
```

This will only take effect on OMERO 4.4.x servers so remember to document that with OMERO 5 the config will need to be modified by the person doing the installation.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.5 Editing OMERO.web

If you need to make changes to OMERO.web itself, then you will want to check out the OMERO source code. You can directly edit and run the OMERO.web code. This means that you benefit from the convenience of editing, saving and refreshing your browser without any build step.

However, you will still need to build OMERO (or download the release build) and set up your `PYTHONPATH` as described in the install documentation in order that you have the various dependencies such as Django.

You will then have 2 copies of the OMERO.web code - source code under components/tools/OmeroWeb/omeroweb and the server build under dist/lib/python/omeroweb.

To set up and run OMERO.web from the source code, you need to follow a few steps (commands are shown below):

- Set `OMERO_HOME`, so that OMERO.web knows where to find config, write logs etc.

  Warning: You should not set `OMERO_HOME` on production servers.
  The examples below assume a *developer* environment, making appropriate use of OMERO internals. See *Setting the OMERO_HOME environment variable* for details.

- Make sure that the Django libraries that are under the build: dist/lib/python/django are on your `PYTHONPATH`.
- Make sure the OmeroWeb folder: components/tools/OmeroWeb is on your `PYTHONPATH`.
- Remove the built omeroweb folder, otherwise this will get used instead of the source omeroweb

  Note: You have to do this again if you build the server

- From the source omeroweb/ folder, manually run the Django development server

```
# Example path to build target or downloaded directory
$ export OMERO_HOME = ~/Desktop/OMERO/dist

# Make sure the Django code etc can be imported
$ export PYTHONPATH=$OMERO_HOME/lib/python/:$OMERO_HOME/../components/tools/OmeroWeb:$PYTHONPATH
$ cd $OMERO_HOME
# need to remove the built omeroweb code so it doesn't get imported
$ rm -rf lib/python/omeroweb/

$ cd ../components/tools/OmeroWeb
$ python omeroweb/manage.py runserver
Validating models...

0 errors found
December 05, 2013 - 13:39:26
Django version 1.8, using settings 'omeroweb.settings'
```

```
Starting development server at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

Note: Default port number is 8000. To specify port, use E.g: $ python manage.py runserver 0.0.0.0:4080

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.6 WebGateway

WebGateway is a Django app within the *OMERO.web framework*. It provides a web API for rendering images and accessing data on the OMERO server via URLs.

Note: The OMERO.web client also supports URLs linking to specified data in OMERO. See the OMERO.web user guides[22] for more details.

14.6.1 Web services

This list of URLs below may be incomplete or out of date. For a complete list of URLs, see the latest API[23] and try the URLs out for yourself!

The HTTP request will need to include login details for creating or using a current server connection. This will be true for any request made after logging in to the server, e.g. login using the webclient login page then go to `webgateway/...` or if you have logged in to a server at `http://ome.example.com/webclient` then go to, for example, `http://ome.example.com/webgateway/render_image/<imageid>/<z>/<t>/`

Figure 14.1: Rendered thumbnail

URLs from within OMERO.web

Images rendered within OMERO.web templates should use Django's `{% url %}` tag to generate URLs for webgateway, passing in the ID of the image. This is shown for each of the URLs below:

Image viewer

- Provides a full image viewer, with controls for scrolling Z and T, editing rendering settings etc.

```
URL: https://your_host/webgateway/img_detail/<imageid>/

Template tag: {% url 'webgateway.views.full_viewer' image_id %}
```

[22] http://help.openmicroscopy.org/
[23] http://downloads.openmicroscopy.org/latest/omero/api/python/omeroweb/omeroweb.webgateway.html#module-omeroweb.webgateway.urls

Images

- Returns a jpeg of the specified plane with current rendering settings

```
URL: https://your_host/webgateway/render_image/<imageid>/<z>/<t>/

Template tag: {% url 'webgateway.views.render_image' image_id theZ theT %}
```

  From OMERO 4.4.4, omitting Z and T will use the default values:

```
URL: https://your_host/webgateway/render_image/<imageid>/

Template tag: {% url 'webgateway.views.render_image' image_id %}
```

- Makes a jpeg laying out each active channel in a separate panel

```
URL: https://your_host/webgateway/render_split_channel/<imageId>/<z>/<t>/

Template tag: {% url 'webgateway.views.render_split_channel' image_id theZ theT %}
```

- Plots the intensity of a row of pixels in an image. w is line width

```
URL: https://your_host/webgateway/render_row_plot/<imageId>/<z>/<t>/<y>/<w>

Template tag: {% url 'webgateway.views.render_row_plot' image_id theZ theT yPos width %}
```

- Plots the intensity of a column of pixels in an image.

```
URL: https://your_host/webgateway/render_col_plot/<imageId>/<z>/<t>/<x>/<w>/

Template tag: {% url 'webgateway.views.render_col_plot' image_id theZ theT xPos width %}
```

- Returns a jpeg of a thumbnail for an image. w and h are optional (default is 64). Specify just one to retain aspect ratio. Since OMERO 5.1 it is also possible to specify Z and T indices in the query string.

```
URL: https://your_host/webgateway/render_thumbnail/<imageId>/?z=10

Template tag: {% url 'webgateway.views.render_thumbnail' image_id %}?z=10    # default size, z=10

URL: https://your_host/webgateway/render_thumbnail/<imageId>/<w>/<h>

Template tag: {% url 'webgateway.views.render_thumbnail' image_id 100 %}     # size 100
```

Rendering settings

If no rendering settings are specified (as above), then the current rendering settings will be used. To apply different settings to images returned by the `render_image` and `render_split_channels` URLs, parameters can be specified in the request. N.B. These settings are only applied to the rendered image and will not be saved unless specified.

Individual parameters are:

- **Channels on/off** e.g. for a 4 channel image, to turn on all channels except 2:

```
?c=1,-2,3,4

# From OMERO 4.4.4 you can simply specify the active channels
?c=3          # only Channel 3 is active
?c=3,4        # Channels 3 and 4 are active
```

- **Channel colour** e.g. to set the colours for channels 1 to red and 2 to green and 3 to blue:

```
?c=1|$FF0000,2|$00FF00,3|$0000FF
```

- **Rendering levels** e.g. to set the cut-in and cut-out values for a 3 Channel image.

```
?c=1|400:505,2|463:2409,3|620:3879
?c=-1|400:505,2|463:2409,3|620:3879      # First channel inactive "-1"
?c=2|463:2409,3|620:3879     # OMERO 4.4.4 only: inactive channels can be omitted
```

- **Z-projection**: Maximum intensity, Mean intensity or None (normal). By default we use all z-sections, but a range can be specified.

```
?p=intmax
?p=intmax|0:10       # Use z-sections 0-10 inclusive
?p=intmean
?p=normal
```

- **Rendering 'Mode'**: greyscale or colour.

```
?m=g    # greyscale (only the first active channel will be shown in grey)
?m=c    # colour
```

- Parameters can be combined, e.g.

```
https://your_host/webgateway/render_image/2602/10/0/?c=1|100:505$0000FF,2|463:2409$00FF00,3|620:38
```

JSON methods

- List of projects: `webgateway/proj/list/`

```
[{"description": "", "id": 269, "name": "Aurora"},
{"description": "", "id": 269, "name": "Drugs"} ]
```

- Project info: `webgateway/proj/<projectId>/detail/`

```
{"description": "", "type": "Project", "id": 269, "name": "CenpA"}
```

- List of Datasets in a Project: `webgateway/proj/<projectId>/children/`

```
[{"child\_count": 9, "description": "", "type": "Dataset", "id": 270,
     "name": "Control"}, ]
```

- Dataset, same as for Project: `webgateway/dataset/<datasetId>/detail/`
- Details of Images in the dataset: `webgateway/dataset/<datasetId>/children/`

- Lots of metadata for the image. See below: `webgateway/imgData/<imageId>/`

Saving etc

- `webgateway/saveImgRDef/<imageId>/`
- `webgateway/compatImgRDef/<imageId>/`
- `webgateway/copyImgRDef/`

ImgData

The following is sample JSON data generated by `/webgateway/imgData/<imageId>/`


```
{
"split_channel": {
    "c": {"width": 1448, "gridy": 2, "border": 2, "gridx": 3, "height": 966},
    "g": {"width": 966, "gridy": 2, "border": 2, "gridx": 2, "height": 966}
    },
"rdefs": {"defaultT": 0, "model": "color",
           "projection": "normal", "defaultZ": 15},
"pixel_range": [-32768, 32767],
"channels": [
    {"color": "0000FF", "active": true,
        "window": {"max": 449.0, "end": 314, "start": 70, "min": 51.0},
        "emissionWave": "DAPI",
        "label": "DAPI"},
    {"color": "00FF00", "active": true,
        "window": {"max": 7226.0, "end": 1564, "start": 396, "min": 37.0},
        "emissionWave": "FITC",
        "label": "FITC"}
    ],
"meta": {
    "projectDescription": "",
    "datasetName": "survivin",
    "projectId": 2,
    "imageDescription": "",
    "imageTimestamp": 1277977808.0,
    "imageId": 12,
    "imageAuthor": "Will Moore",
    "imageName": "CSFV-siRNAi02_R3D_D3D.dv",
    "datasetDescription": "",
    "projectName": "siRNAi",
    "datasetId": 3
},
"id": 12,
"pixel_size": {"y": 0.0663, "x": 0.0663, "z": 0.2},
"size": {
    "width": 480,
    "c": 4,
    "z": 31,
    "t": 1,
    "height": 480
},
"tiles": false
}
```


For large tiled images, the following data is also included:


```
{
"tiles": true,
```

```
"tile_size": {
    width: 256,
    height: 256
},
"levels": 5,
"zoomLevelScaling": {
    0: 1,
    1: 0.25,
    2: 0.0625,
    3: 0.0312,
    4: 0.0150
},
}
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.7 Embedding an OMERO.web viewport in a web page

Note: These example are intended to be used with images that have been added to the PUBLIC group with a Public member in OMERO, making them publicly available. To see how to configure public URL filters, see the *Public data in the repository* section..

14.7.1 OMERO.web viewer in iframe

Insert the following:

```
<div id="omeroviewport"><iframe width="850" height="600" src="http://localhost:8000/webclient/img_detai
```

14.7.2 Launching OMERO.web viewer

Use the following code to reference the scripts.

```
<script type="text/javascript">

    function openPopup(url) {
        owindow = window.open(url, 'anew', config='height=600,width=850,left=50,top=50,toolbar=no,menuba
        if(!owindow.closed) owindow.focus();
        return false;
    }

</script>
```

Then in `<BODY>` insert the following:

```
<a href="#" onclick="return openPopup('http://localhost:8000/webclient/img_detail/IMAGE_ID/')">Open vie
```

14.7.3 Customizing the content of the embedded OMERO.web viewport

This section demonstrates how to embed an OMERO.web image viewer in any HTML page, allowing use of resources directly from an OMERO server.

```
$ bin/omero config set omero.web.public.url_filter '^/webgateway'
```

Provided the image corresponding to `IMAGE_ID` is in the PUBLIC group, it can be accessed via the link: *http://your_host/webgateway/img_detail/IMAGE_ID/*. Please remember that public images must be in a public group where a public user can access them.

Use the following code to load stylesheets and scripts.

```
<link rel="stylesheet" type="text/css" href="http://your_host/static/omeroweb.viewer.min.css">
<script type="text/javascript" src="http://your_host/static/omeroweb.viewer.min.js"></script>
```

Then create the small JavaScript with associated stylesheet which allows you to view particular image defined by **IMAGE_ID**.

```
<style type="text/css">
    .viewport {
        height: 500px;
        width: 800px;
        padding: 10px;
    }
</style>

<script type="text/javascript">
    $(document).ready(function () {

        /* Prepare the viewport */
        viewport = $.WeblitzViewport($("#viewport"), "http://your_host/webgateway/", {
            'mediaroot': "http://your_host/static/"
        });

        /* Load the selected image into the viewport */
        viewport.load(IMAGE_ID);

    });
</script>
```

Then in `<BODY>` insert the following:

```
<div id="viewport" class="viewport"></div>
```

The viewport can be made more interactive by adding buttons or links to allow display of scalebars, ROIs, zooming and selection of channels. Full examples of how to embed microscopy or Whole Slide Image are available in the Webtest Github repository[24].

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.8 Writing OMERO.web views

This page contains info on how to write your own views.py code, including documentation on the `webclient/views.py` and `webgateway/views.py` code. Although we aim to provide some useful notes and examples here, you will find the best source of examples is the code itself[25].

[24] https://github.com/openmicroscopy/webtest/tree/master/templates/webtest/examples
[25] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroWeb/omeroweb/webclient/views.py

14.8.1 @Decorators

Decorators in Python are functions that 'wrap' other functions to provide additional functionality. They are added above a method using the @ notation. We use them in the OMERO.web framework to handle common tasks such as login (getting connection to OMERO server) etc.

@login_required()

The login_required decorator uses parameters in the 'request' object to retrieve an existing connection to OMERO. In the case where the user is not logged in, they are redirected to a login page. Upon login, they will be redirected back to the page that they originally tried to view. The method that is wrapped by this decorator will be passed a 'conn' Blitz Gateway connection to OMERO.

Note: login_required is a class-based decorator with several methods that can be overwritten to customize its functionality (see below). This means that the decorator **MUST** be instantiated when used with the @ notation, i.e.

```
@login_required()     NOT  @login_required    # this will give you strange error messages
```

A simple example of @login_required() usage (in webtest/views.py[26]). Note the Blitz Gateway connection "conn" retrieved by @login_required() is passed to the function via the optional parameter `conn=None`.

```
from omeroweb.decorators import login_required

@login_required()
def dataset(request, datasetId, conn=None, **kwargs):
    ds = conn.getObject("Dataset", datasetId)
    return render(request, 'webtest/dataset.html', {'dataset': ds})
```

or

```
from omeroweb.decorators import login_required, render_response

@login_required()
@render_response()
def dataset(request, datasetId, conn=None, **kwargs):
    ds = conn.getObject("Dataset", datasetId)
    context['template'] = 'webtest/dataset.html'
    context['dataset'] = ds
    return context
```

login_required logic

The login_required decorator has some complex connection handling code, to retrieve or create connections to OMERO. Although it is not necessary to study the code itself, you may find it useful to understand the logic that is used (see Flow Diagram). As mentioned above, we start with a HTTP request (top left) and either a connection is returned (bottom left) OR we are redirected to login page (right).

Note: Options to configure a "public user" are described in the *Public data in the repository* documentation.

Extending login_required

The base login_required class can be found in `omeroweb/decorators.py`. It has a number of methods that can be overwritten to customize or extend its functionality. Again, it is best to look at an example of this. See `webclient/decorators.py`

[26] https://github.com/openmicroscopy/webtest/blob/master/views.py

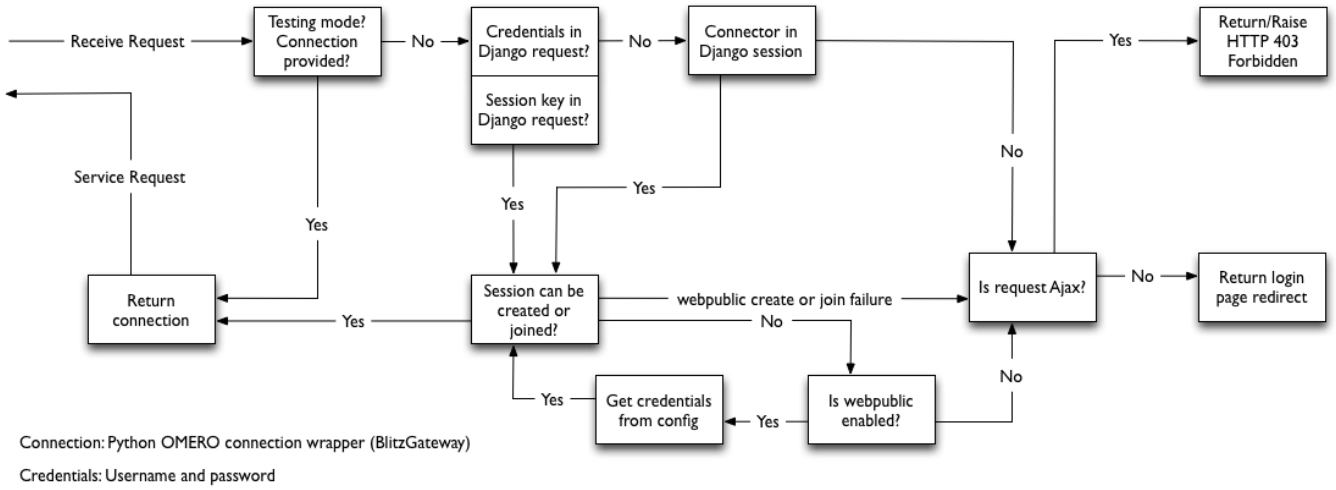


Figure 14.2: Logic flow for retrieving Blitz Gateway connection from HTTP request.

to see how the base omeroweb.decorators.login_required has been extended to configure the conn connection upon login, handle login failure differently etc.

render_response

This decorator handles the rendering of view methods to HttpResponse. It expects that wrapped view methods return a dict. This allows:

- the template to be specified in the method arguments OR within the view method itself
- the dict to be returned as json if required
- the request is passed to the template context, as required by some tags etc
- a hook is provided for adding additional data to the context, from the *Blitz Gateway documentation* or from the request.

Note: Using `@render\_response` guarantees using special RequestContext class[27] which always uses `django.template.context_processors.csrf` (no matter what template context processors are configured in the TEMPLATES setting). For more details see *CSRF*.

Extending render_response

The base render_response class can be found in `omeroweb/decorators.py`. It has a number of methods that can be overwritten to customize or extend its functionality. Again, it is best to look at an example of this. See `webclient/decorators.py` to see how the base omeroweb.decorators.render_response has been extended to configure HttpResponse and its subclasses.

14.8.2 Style guides

Tips on good practice in `views.py` methods and their corresponding URLs.

- Include any required arguments in the function parameter list. Although many `views.py` methods use the **kwargs parameter to accept additional arguments, it is best not to use this for arguments that are absolutely required by the method.**
- Specify default parameters where possible. This makes it easier to reuse the method in other ways.
- Use keyword arguments in URL regular expressions. This makes them less brittle to changes in parameter ordering in the views.
- Similarly, use keyword arguments for URLs in templates

[27] https://docs.djangoproject.com/en/1.8/ref/templates/api/#subclassing-context-requestcontext

```
{% url 'url_name' object_id=obj.id %}
```

and reverse function:

```
>>> from django.core.urlresolvers import reverse
>>> reverse('url_name', kwargs={'object_id': 1})
```

14.8.3 OMERO.web error handling

Django comes with some nice error handling functionality. We have customized this and also provided some client-side error handling in JavaScript to deal with errors in AJAX requests. This JavaScript can be included in all pages that require this functionality. Errors are handled as follows:

- **404** - simply displays a 404 message to the user
- **403** - this is 'permission denied' which probably means the user needs to login to the server (e.g. session may have timed out). The page is refreshed which will redirect the user to login page.
- **500** - server error. We display a feedback form for the user to submit details of the error to our QA system - POSTs to "qa.openmicroscopy.org.uk:80". This URL is configurable in `settings.py`.

In general, you should not have to write your own error handling code in `views.py` or client side. The default behavior is as follows:

With Debug: True (during development)

Django will return an HTML page describing the error, with various parameters, stack trace etc. If the request was AJAX, and you have our JavaScript code on your page then the error will be handled as described (see above). NB: with Debug True, 500 errors will be returned as HTML pages by Django but these will not be rendered as HTML in our feedback form. You can use developer tools on your browser (e.g. Firebug on Firefox) to see various errors and open the request in a new tab to display the full debug info as HTML.

With Debug: False (in production)

Django will use its internal error handling to produce standard 404, 500 error pages. We have customized this behavior to display our own error pages. The 500 error page allows you to submit the error as feedback to our QA system. If the request is AJAX, we return the stack trace is displayed in a dialog which also allows the error to be submitted to QA.

Custom error handling

If you want to handle certain exceptions in particular ways you should use appropriate try/except statements.

This is only advised for trivial errors, where you can give the user a simple message, e.g. "No Objects selected, please try again", or if the error is well understood and you can recover from the error in a reasonable way.

For 'unexpected' server errors, it is best to allow the exception to be handled by Django since this will provide a lot more info to the user (request details etc.) and format HTML (both with Debug True or False).

If you still want to handle the exception yourself, you can provide stack trace alongside a message for the user. If the request is AJAX, do not return HTML, since the response text will be displayed in a dialog box for the user (not rendered as HTML).

```
try:
    # something bad happens
except:
    # log the stack trace
    logger.error(traceback.format_exc())
    # message AND stack trace
```

```
err_msg = "Something bad happened! \n \n%s" % traceback.format_exc()
if request.is_ajax():
    return HttpResponseServerError(err_msg)
else:
    ...   # render err_msg with a custom template
    return HttpResponseServerError(content)
```

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.9 Writing page templates in OMERO.web

This page documents the various base templates that are used by the webclient and describes how to extend these to create your own pages with the OMERO.web look and feel.

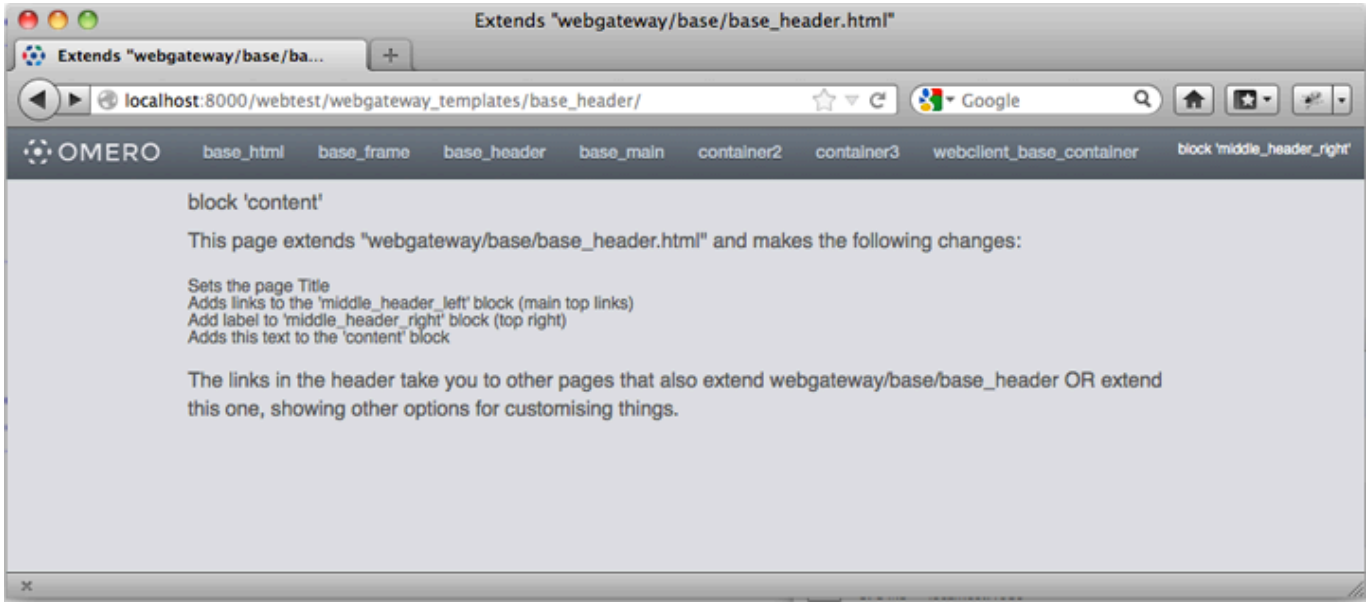


Figure 14.3: The `base_header.html` template extended in webtest with dummy content

You can use these templates in a number of ways, but there are 2 general scenarios that are detailed below:

- You want a page header to look like the webclient, but you do not need any data or connection to an OMERO server.
- You want a page that looks and behaves like it is part of the webclient application, including data from the OMERO server.

14.9.1 Django templates

We use Django templates for the OMERO.web pages. See docs here: templates[28]. We have designed a number of OMERO.web base templates that you can extend. The base templates live in the 'webgateway' app under omeroweb/webgateway/templates/webgateway/base. You can use these to make pages that do not require an OMERO login (e.g. public home page) etc.

If you want your pages to extend the webclient application, you can use templates from omeroweb/webclient/templates/webclient/base[29].

These templates are described in more detail below.

[28] https://docs.djangoproject.com/en/1.8/ref/templates/
[29] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/tools/OmeroWeb/omeroweb/webclient/templates/webclient/base

14.9.2 Getting Started

Within your *OMERO.web app*, create a new page template and add this line at the top:

```
{% extends "webgateway/base/base_header.html" %}
```

Now add the page content in a 'content' block like this:

```
{% block content %}
    Your page content goes here
{% endblock %}
```

You can now save this template and view the page. It should look something like the screen-shot above. You could add a 'title' block to set the page <title>

```
{% block title %}
    My OMERO.web app page
{% endblock %}
```

Additional blocks can be used to customize the page further. See below for more details.

14.9.3 Using Webclient templates

Webclient templates can be used in exactly the same way, for example try using this at the top of the page you created above:

```
{% extends "webclient/base/base_container.html" %}
```

However, this template will need various pieces of data to be in the page context that Django uses to render the page. You will need to use the `@login_required()` and `@render_response()` decorators on your views.py methods in order to retrieve this info and pass it to the template. See *Writing OMERO.web views* for more details.

If you have used the 'content' block on this page (as described above) you will see that your page content fills the whole area under the header. However, if you want to use the same 3 column layout as the webclient, you can replace your 'content' block with:

```
{% block left %}
    Left column content
{% endblock %}

{% block center %}
    Center content
{% endblock %}

{% block right %}
    Right column content
{% endblock %}
```

This should give you something like the screen-shot below.

14.9.4 Extending templates

You should aim to create a small number of your own base templates, extending the OMERO.web webgateway or webclient templates as required. If you extend all of your own pages from a small number of your own base templates, then you will find it easier to change things in future. For example, any changes in our 'webgateway' templates will only require you to edit your own base templates.

Here is a full list of the templates under `omeroweb/webgateway/templates/webgateway/base` with more details below:

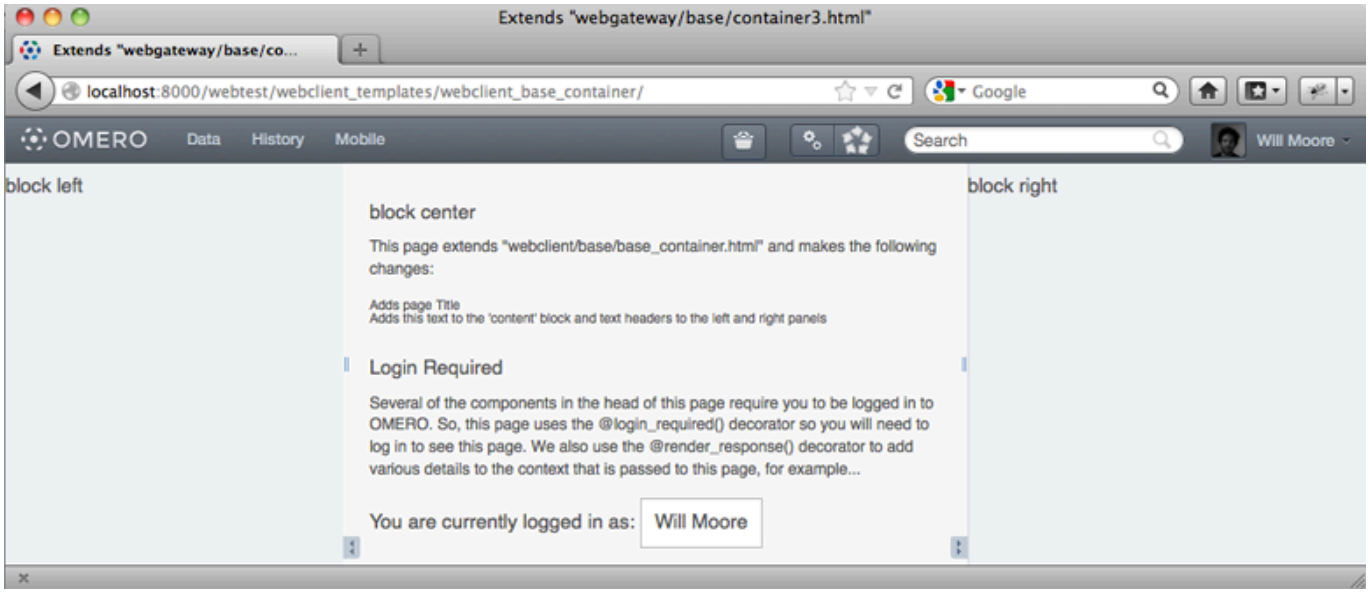


Figure 14.4: The `webclient/base/base_container.html` template extended in webtest with dummy content

- **base_html.html** - This provides the base <html> template with blocks for 'link'(for CSS) 'title' 'script' and 'body'. It is extended by every other template. Usage: `{% extends "webgateway/base/base_html.html" %}`
- **base_frame.html** - This adds jQuery and jQuery-ui libraries to a blank page. Used for popup windows etc. Usage: `{% extends "webgateway/base/base_frame.html" %}`
- **base_header.html** - This also extends base_html.html adding all the header and footer components that are used by the webclient. See screen-shot above. More details below.
- **base_main.html** - This adds jQuery and jQuery-ui libraries to the base_header.html template. Used for popup windows etc. Usage: `{% extends "webgateway/base/base_main.html" %}`
- **container2.html, container3.html** - These templates extend the base_header.html template, adding a 2 or 3 column layout in the main body of the page. container3.html is used by the webclient for the base_container example above.

Webtest examples

You can find examples of how to extend the base templates in the webtest[30] application within the `webtest/templates/webtest/webgateway` directory. If you install the webtest app, you can view the template examples live at <your-server-name>/webtest/webgateway_templates/base_header/>

The link is to an example that extends base_header.html and contains links to all the other webtest examples. These pages indicate the names of the various template "blocks" that have been used to add content to different parts of the page (also see below for block names).

14.9.5 Content blocks

These blocks can be used to add content to specific points in the page.

Note: It is important to consider using `{{ block.super }}` if you want to include the content from the parent template. This is critical for the "link" and "script" blocks, which are used to add <link> and <script> elements to the head of the page. If you forget to use '' {{ block.super }} '' then you will remove all the CSS and JavaScript links required by the parent template.

See base_header.html[31] for full template details.

- link: used to add CSS with <link> blocks to the page head e.g.

[30] https://github.com/openmicroscopy/webtest/
[31] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroWeb/omeroweb/webgateway/templates/webgateway/base/base_header.html

```
{% block link %}
    {{ block.super }}
    <link rel="stylesheet" type="text/css"
          href="{% static "webgateway/css/ome.body.css" %}"/>
{% endblock %}
```

- script - used to add JavaScript with <script> blocks to the page head
- title - add text here for the page <title>.
- head - another block for any extra head elements
- middle_header_right - add content to the right of the main header
- middle_header_left - add content to the left of the main header
- content - main page content.

container2.html, container3.html

These templates have all the same blocks as base_header.html since they extent it (see above). In addition, they also add the following blocks:

- left: The left column (NOT in container2.html)
- center: The middle column
- right: The right column

See container3.html[32] for full template details.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.10 Cross Site Request Forgery protection

CSRF is an attack which forces an end user to execute unwanted actions on a web application in which they are currently authenticated. For more details see Cross-Site Request Forgery[33].

OMERO.web provides easy-to-use protection against Cross Site Request Forgeries, for more information see Django documentation[34].

The first defense against CSRF attacks is to ensure that GET requests (and other 'safe' methods, as defined by 9.1.1 Safe Methods, HTTP 1.1, RFC 2616[35]) are only reading data from the server.

Requests that write data to the server should only use methods such as POST, PUT and DELETE. These requests can then be protected as follows:

- By default OMERO.web has the middleware `django.middleware.csrf.CsrfViewMiddleware` added to the list of middleware classes.
- In any template that uses a POST form, use the `csrf_token` tag inside the `<form>` element if the form is for an internal URL, e.g.:

```
<form action="." method="post">{% csrf_token %}
```

[32] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroWeb/omeroweb/webgateway/templates/webgateway/base/container3.html
[33] https://www.owasp.org/index.php/Cross-Site_Request_Forgery_(CSRF)
[34] https://docs.djangoproject.com/en/1.8/ref/csrf/
[35] http://tools.ietf.org/html/rfc2616.html#section-9.1.1

Note: This should not be done for POST forms that target external URLs, since that would cause the CSRF token to be leaked, leading to a vulnerability.

- On each XMLHttpRequest set a custom X-CSRFToken header to the value of the CSRF token and pass the CSRF token in data with every AJAX POST request. If your custom template already benefits from *loading built-in jQuery* template you do not need to do anything as it already loads `webgateway/js/ome.csrf.js`. Otherwise simply import the script as follows:

```
<script type="text/javascript" src="{% static "webgateway/js/ome.csrf.js" %}"></script>
```

  For more details see CSRF for ajax[36].

The Django framework also offers decorator methods that can help you protect your view methods and restrict access to views based on the request method. For more details see Django decorators[37].

By default OMERO.web provides a built-in view that handles all unsafe incoming requests failing with **403 Forbidden** response if the CSRF token has not been included with a POST form.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

14.11 The OMERO.web client application

The webclient Django app provides the main OMERO.web client UI.

Data is retrieved from OMERO using the *OMERO Python language bindings* and is rendered to HTML using Django templates[38] before being sent to the browser. Additional javascript (jQuery-based) functionality in the browser is used to update the UI in response to user interactions such as browsing or modifying the data. This will often involve AJAX calls to load more data as HTML or JSON objects.

Note: The webclient should **NOT** be considered as a stable public API. URLs and methods within the app are purely designed to provide internal functionality for the webclient itself and may change in minor releases without warning.

14.11.1 Top level pages

There are a small number of top level HTML pages that the user will start at. These are all handled by the load_template view:

- / (homepage delegates to /userdata)
- /userdata
- /usertags
- /public
- /history
- /search

These pages contain many different jQuery scripts that run when the page loads, to setup event listeners and to load additional data.

Additional top-level pages are used in popup windows for running scripts and downloading data.

[36] https://docs.djangoproject.com/en/1.8/ref/csrf/#ajax
[37] https://docs.djangoproject.com/en/1.8/topics/http/decorators/
[38] https://docs.djangoproject.com/en/1.8/topics/templates/

14.11.2 JsTree

A jsTree is used by the userdata, usertags and public pages to browse hierarchical data. Each time a node is expanded, it uses appropriate AJAX calls to load children as json data. Further POST or DELETE AJAX calls are made to modify the data hierachy by creating or deleting links between objects.

Selection changes in the jsTree and centre panel thumbnails cause events to be triggered by jQuery on the `$("body")` element of the page, allowing other scripts to listen for these events. These are used to load selected data into the centre and right panels. The HTML for these panels contains additional scripts that also run when they load to setup their own event listeners.

There is also a global `update_thumbnails_panel` function that can be called by any script that needs to refresh the centre panel. For example, when the jsTree is used to add or remove Images from a selected Dataset.

14.11.3 Switching Groups and Users

The current group and user are stored in the HTTP session[39] as `request.session['active_group']` and `request.session['user_id']`. These are used to define the data that is loaded in the main `userdata` and `usertags` pages.

The group and user are switched by the Groups and Users menu, which updates the session and reloads the page.

14.11.4 Show queries

Data in OMERO can be linked from the webclient with URLs of the form `/webclient/?show=image-23|image-34`

In the load_template view, the first object is queried from OMERO and its parent containers are also loaded. The owner and group of the top container is used to set the `active_group` and `user_id` so that the main page loads the appropriate data hierarchy.

The jsTree does its own lookup from the query string, retrieving json data and using this to expand the appropriate nodes to show the specified objects.

14.11.5 Javascript code

The majority of javascript code is jQuery-based code that is embedded within the HTML templates and is run when the page loads.

Additional code is in static scripts, with functions generally name-spaced under an `OME` module.

[39] https://docs.djangoproject.com/en/1.8/topics/http/sessions/

CHAPTER

FIFTEEN

INSIGHT

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.1 Architecture

15.1.1 Logical view

OMERO.insight is logically organized in two layers

The **Agents** layer contains the logic to manage user interaction. It contains coarse grained components which we call **agents**, that are each responsible for a specific aspect of the application's functionality:

- The Data Manager provides the user with the GUI functionality to access their data, metadata and visualize large image sets.
- The Viewer is a tool to visualize and tune 5D images.
- The Measurement Tool is a tool to perform basic measurement.

Note: If you want to add a new agent, go to *How to build an agent*.

These agents are internally organized according to the MVC (Model-View-Controller[1]) pattern, PAC (Presentation-Abstraction-Control[2]) pattern, or a combination of the two. They rely on the services provided by the bottom layer, the **Container**, to accomplish their tasks.

The **Container** layer manages the agents life-cycle and provides them with services to:

- Communicate without having to know each other (*Event bus*).
- Access the OMERO Server (data management and image services).
- Transform entries in configuration files into objects and then access them (*Configuration*).
- Log messages (log service) and notify the user (user notification service) of runtime errors.
- Cache data (cache service).
- Provide a common top level window to plug their GUI's (*Taskbar*).

15.1.2 Initialization of Agents

Agents let the container create them and then manage their life-cycle. This is achieved through the use of a common interface, `Agent`, that all agents have to implement and by requiring every agent to have a public no-arguments constructor. The Agent interface plays the role of a Separated Interface (Fow[3]), decoupling the container from knowledge of concrete agents. This way, new agents can be plugged in.

[1] http://en.wikipedia.org/wiki/Model-view-controller
[2] http://en.wikipedia.org/wiki/Presentation-abstraction-control
[3] http://martinfowler.com/books

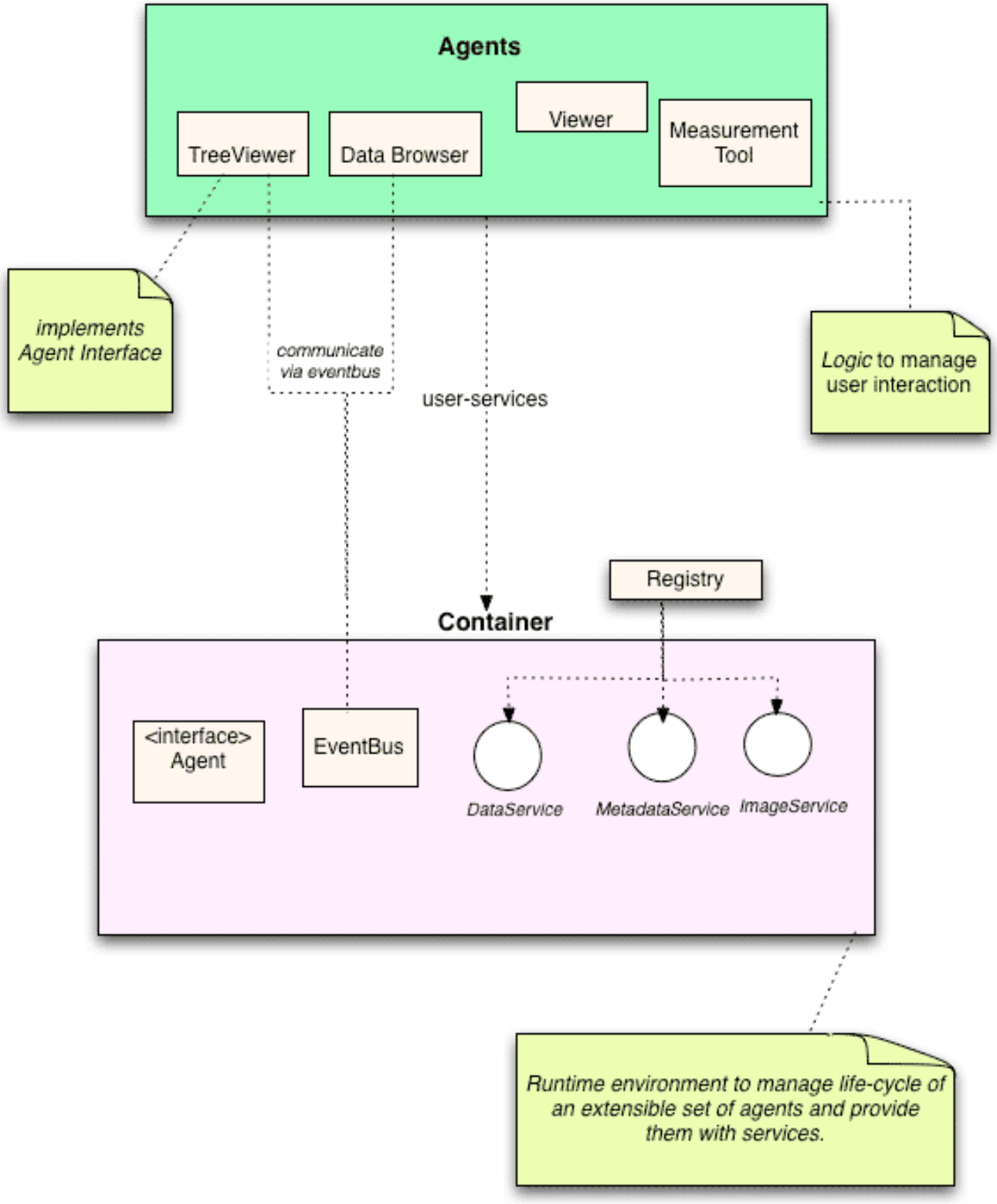


Figure 15.1: OMERO.insight agents and containers

At start-up the container finds out which are the agents' implementation classes from its configuration file, instantiates every agent by reflection (using the no-arguments constructor) and then reads each agent's configuration file (Fow[4]). The configuration entries in this file are turned into objects and collected into a map-like object, which is then passed to the agent. This map object also contains pointers to the container's services. We can think of this object as a Registry (Fow[5]).

[4] http://martinfowler.com/books
[5] http://martinfowler.com/books

There is one Registry containing pointers to the container's services for each agent, so configuration entries are private to each agent - container's services are shared among all agents though. Agents access the Registry object through the Registry interface.

The life-cycle of an agent is as follow:

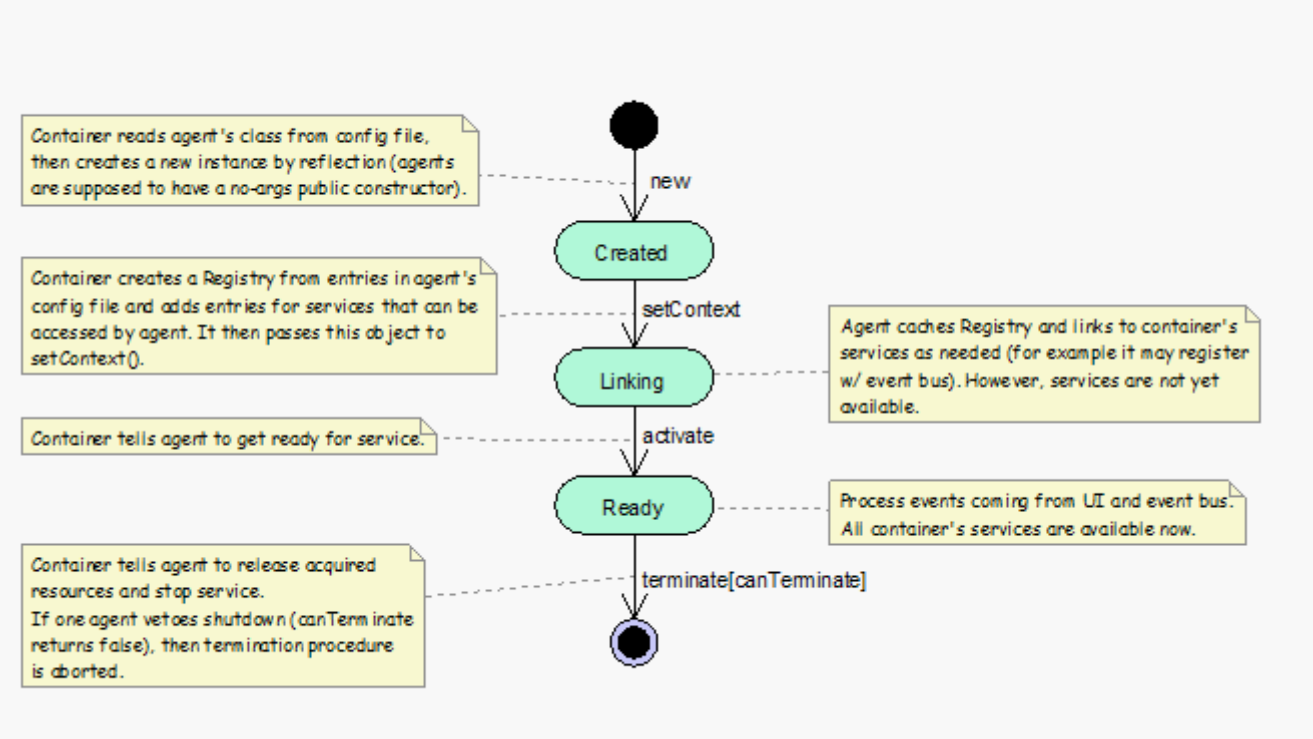


Figure 15.2: OMERO.insight agent lifecycle

15.1.3 Interaction among Agents

Interactions among agents are event-driven. Agents communicate by using a shared *Event bus* provided by the container. The event bus is an event propagation mechanism loosely based on the Publisher-Subscriber[6] pattern and can be regarded as a time-ordered event queue - if event A is posted on the bus before event B, then event A is also delivered before event B.

15.1.4 Process view

All agents run synchronously within the *Swing* dispatching thread. All container's services are called within Swing event handlers and thus run within the *Swing* dispatching thread. To see how to retrieve data from an OMERO server, go to the *Retrieve data from server* page.

See also:

Organization, *Event bus*

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15.2 Configuration

The container provides a flexible and extensible configuration mechanism. Each agent has its own configuration file which is parsed at start-up by the container. The configuration entries in this file are turned into objects and collected into a map-like object, which is then passed to the agent. This map object also contains pointers to the container's services. Thus, we can think of

[6] http://en.wikipedia.org/wiki/Publish/subscribe

this object as a *Registry*. There is one `Registry` for each agent, so configuration entries are private to each agent - container's services are shared among all agents though. The container also has its own configuration file and `Registry`.

The container maintains a set of predefined bindings that are used to convert a configuration entry into an object - such as a `String`, `Integer`, `Font`, `IconFactory`, etc. However, agents can specify custom handlers for converting a configuration entry into an object.

15.2.1 Structure

Configuration files are XML files which declares only two elements:

```
<element name="entry" minOccurs="0" maxOccurs="unbounded">
  <complexType>
    <simpleContent >
      <extension base="string">
        <attribute name="name" type="string" use="required"/>
        <attribute name="type" type="string" default="string"/>
        <simpleType>
          <restriction base="string">
            <enumeration value="string"/>
            <enumeration value="integer"/>
            <enumeration value="float"/>
            <enumeration value="double"/>
            <enumeration value="boolean"/>
          </restriction>
. . . close all tags
<element name="structuredEntry" minOccurs="0" maxOccurs="unbounded">
  <complexType>
    <sequence>
      <any maxOccurs="unbounded"/>
    </sequence>
    <attribute name="name" type="string" use="required"/>
    <attribute name="type" type="string" default="map"/>
  </complexType>
</element>
```

The *entry* and *structuredEntry* elements are used to specify name-value pairs in the actual configuration files. Both elements have a required name attribute whose content is used as a key for accessing the entry value from within the application. In the case of the entry element, the value is a string – this element can thus be used for "classic" name-value style, such as:

```
<entry name="ITEM">The item's value</entry>
```

On the other hand, the value of *structuredEntry* can be made up by any arbitrary sequence of tags.

In both cases (*entry* and *structuredEntry*), the entry value is returned to the application as an object and the type attribute dictates how the entry value is turned into an object. Only "string", "integer", "float", "double" and "boolean" may be used for the type attribute within the entry element, whose content is parsed into a Java `String`, `Integer`, `Float`, `Double` or `Boolean` object according to the content of the type attribute – if this attribute is missing, then "string" is assumed. For example, say you write the following into an agent's configuration file:

```
<entry name="/some/name" type="boolean">true</entry>
```

This will make a `Boolean` object (set to hold *true*) available to the agent – the key for accessing the object will be the string "/some/name".

Things work similarly for the *structuredEntry* element. In this case, the content of the type attribute can be specified to be the fully qualified name of the class that will handle the transformation of the entry value into an object. This is provided so that agents may specify custom handlers for custom configuration entries. For example, an agent's configuration file could contain the entry:

```
<structuredEntry name="/some/name" type="some.pkg.SomeHandler">
  <tag_1>aValue</tag_1>
  <tag_2>anotherValue</tag_2>
</structuredEntry>
```

In this case, an instance of `some.pkg.SomeHandler` will be created to transform the contents of the entry (that is *tag_1* and *tag_2*) into a custom object. Obviously enough, the tags contained within a *structuredEntry* have to be exactly the tags that the handler expects.

If no type attribute is specified, then it is assumed *type = "map"*, which results in the entry's contents being parsed into a `Map` object. Each child tag is assumed to be a simple tag with a string content, like in the following example:

```
<structuredEntry name="/some/name">
  <key_1>value_1</key_1>
  <key_2>value_2</key_2>
</structuredEntry>
```

Each child tag's name is a key in the map and the tag's content is its value – the above would generate the map: `(key_1, value_1), (key_2, value_2)`.

Some predefined structured entries are supplied by the container for common cases (icons and font entries) and for use by the container only (OMERO and agents entries). Here's an excerpt from the container's configuration file:

```
<container>
  <services>
    <structuredEntry name="/services/OMERODS" type="OMERODS">
      <port>1099</port>
    </structuredEntry>
  </services>
  <agents>
    <structuredEntry name="/agents" type="agents">
      <agent>
        <name>Viewer</name>
        <!-- The class tag specifies the FQN of the agent's class. -->
          <class>org.openmiscroscopy.shoola.agents.viewer.Viewer</class>
          <!-- The config tag specifies the name of the agent's configuration file.
               This file has to be placed in the config directory under the
               installation directory. -->
          <config>viewer.xml<config>
        </agent>
 . . . a similar entry for every other agent
    </structuredEntry>
  </agents>
  <resources>
    <iconFactories>
      <!-- This entry can be used in agents' configuration files as well.
       It is turned into an instance of:
       org.openmicroscopy.shoola.env.config.IconFactory
       This object can then be used to retrieve any image file within
       the directory pointed by the location tag. -->
      <structuredEntry name="/resources/icons/DefaultFactory" type="icons">
       <!-- The location tag specifies the FQN of the package that contains the icon files. -->
        <location>org.openmicroscopy.shoola.env.ui.graphx</location>
    </structuredEntry>
 . . . more similar entries
    </iconFactories>
    <fonts>
      <!-- This entry can be used in agents' configuration files as well.
           It is turned into an instance of java.awt.Font. -->
      <structuredEntry name="/resources/fonts/Titles" type="font">
        <family>SansSerif</family>
```

```
        <size>12</size>
        <style>bold</style>
      </structuredEntry>
 . . . more similar entries
    </fonts>
    </resources>
</container>
```

The configuration parser only takes the *entry* and *structuredEntry* tags into account and ignores all the others. It may be useful to group sets of related entries together, as shown above.

The classes that encompass the machinery for parsing configuration files and building registries are depicted by the following UML class diagram.

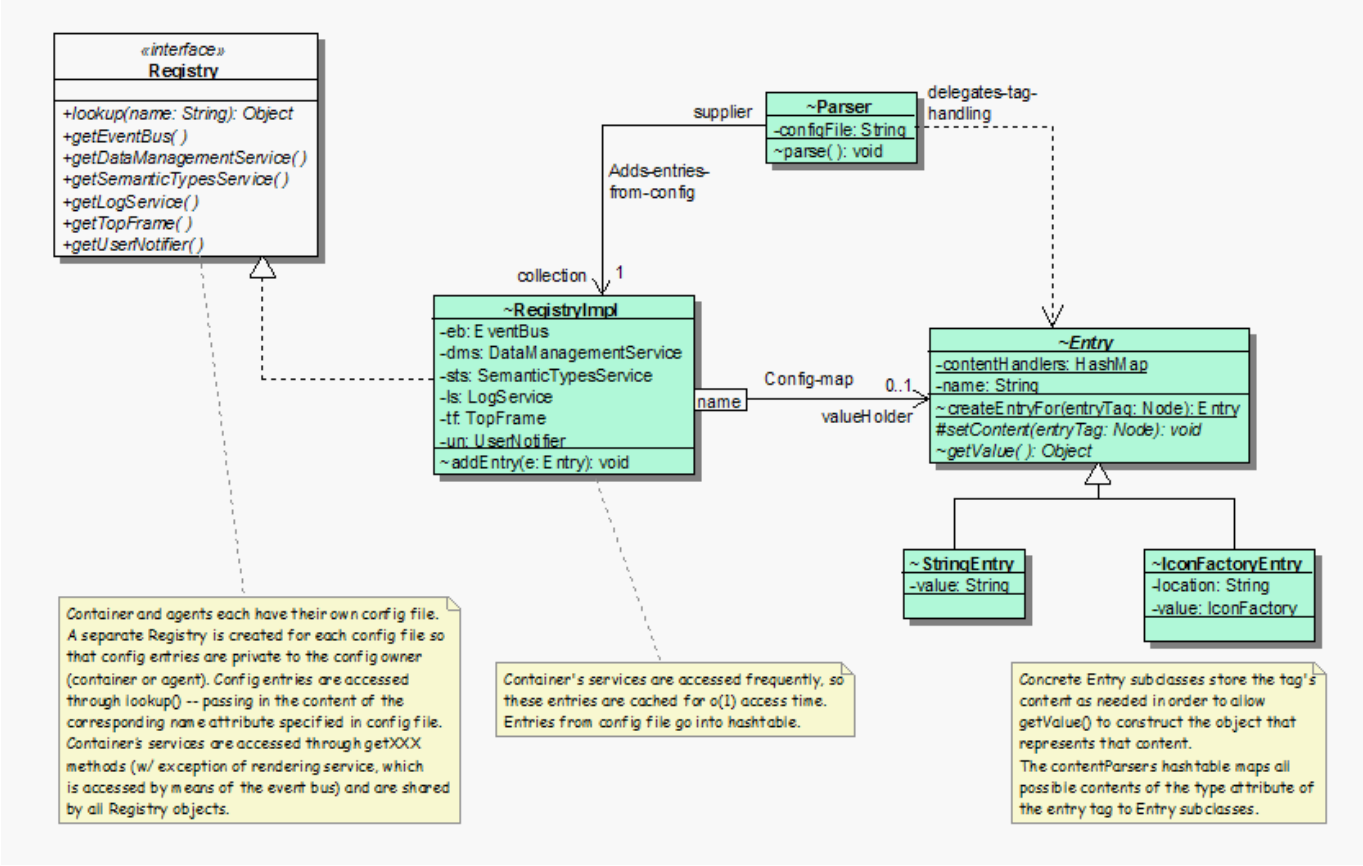

Figure 15.3: OMERO.insight configuration

The `Entry` abstract class sits at the base of a hierarchy of classes that represent entries in configuration files. It represents a name-value pair, where the name is the content of the *name* attribute of a configuration entry (which is stored by the `name` field) and the value is the object representing the entry's content. As the logic for building an object from the entry's content depends on what is specified by the *type* attribute, this class declares an abstract `getValue` method which subclasses implement to return the desired object – we use polymorphism to avoid conditional logic. So we have subclasses (`StringEntry`, `IntegerEntry`, `IconFactoryEntry`, etc.) to handle the content of an entry tag (either *entry* or *structuredEntry*) in correspondence of each predefined value of the type attribute ("string", "integer", "icons", and so on). Given an entry tag, the `createEntryFor` static method (which can be considered a Factory Method) creates a concrete `Entry` object to handle the conversion of that tag's content into an object. Subclasses of `Entry` implement the `setContent` method to grab the tag's content, which is then used for building the object returned by the implementation of `getValue()`.

The `Registry` Interface declares the operations to be used to access configuration entries and container's services.

The `RegistryImpl` class implements the `Registry` interface. It maintains a map of `Entry` objects, which are keyed by their name attribute and represent entries in the configuration file. It also maintains references to the container's services into member fields – as services are accessed frequently, this ensures *o(1)* access time.

The `Parser` class is in charge of parsing a configuration file, extracting entries (only *entry* and *structuredEntry* tags are taken into account), obtain an `Entry` object to represent each of those entries and add these objects to a given `RegistryImpl` object.

15.2.2 Dynamics

How a configuration file is parsed and the corresponding Registry is built:

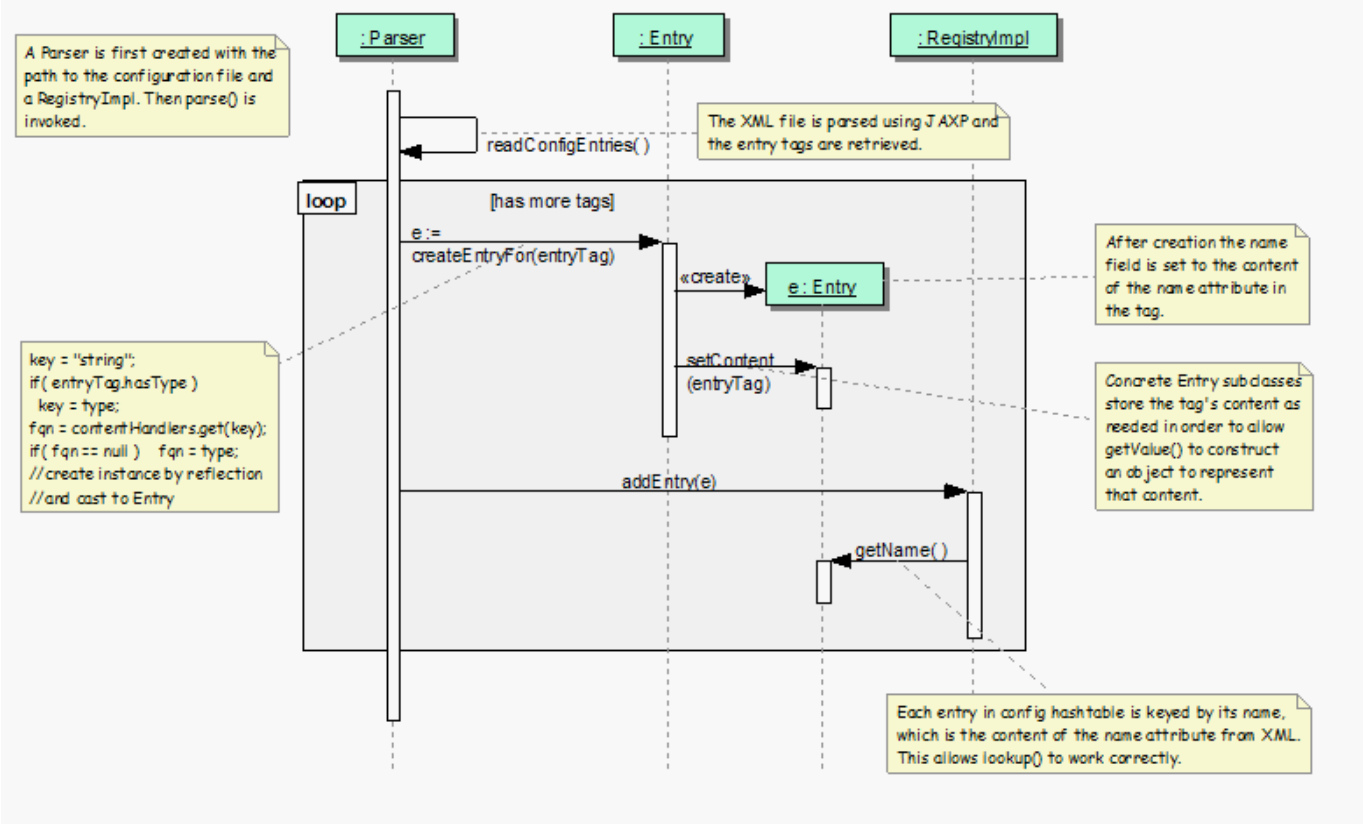

Figure 15.4: Parsing configuration files

A `RegistryImpl` object is created with an empty map. Then a `Parser` object is created passing the path to the configuration file and the `RegistryImpl` object. At this point `parse()` is invoked on the `Parser` object. The configuration file is read (the XML parsing is handled by built-in JAXP libraries) and, for each configuration entry (that is, either *entry* or *struturedEntry* tag), `createEntryFor()` is called to obtain a concrete `Entry` object, which will handle the conversion of the tag's content into an object. This `Entry` object is then added to the map kept by the `RegistryImpl` object.

In order to find out which class is in charge of handling a given tag, the `Entry` class maintains a map, `contentHandlers`, whose keys are the predefined values used for the type attribute ("string", "integer", "icons", etc.) and values are the fully qualified names of the handler classes. Given a tag, `createEntryFor()` uses the content of the type attribute (or "string" if this attribute is missing) to look up the class name in the map and then creates an instance by reflection - all `Entry`'s subclasses are supposed to have a no-args constructor. If the class name is not found in the map, then the content of the type attribute is assumed to be a valid fully qualified name of an `Entry`'s subclass. This allows for agents to specify custom handlers – as long as the handler extends `Entry` and has a public no-args constructor.

Notice that the `RegistryImpl` object adds the couple `(e.getName(), e)` to its map. Because the `Entry` class takes care of setting the name field to the content of the name attribute within the entry tag, the application code can subsequently access e by specifying the value of the name attribute to `lookup()`. The above outlined process is repeated for each configuration file so that the configuration entries of each agent (and the container) are kept in separate objects – a `RegistryImpl` is created every time. Because every agent is then provided with its own `RegistryImpl` object, the configuration entries are private to each agent. However, the container configures all `RegistryImpl` objects with the same references to its services.

See also:

Directory contents

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event

of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.3 Contributing to OMERO.insight

Note: See the Contributing Developer[7] documentation for more information about contributing to OME projects in general.

15.3.1 Getting started with OMERO.insight

Getting started with OMERO.insight entails that you have an *OMERO.server* already deployed.

15.3.2 Installing from source

Since January 2011, the OMERO.insight code base is part of the OMERO code base. See *Installing OMERO from source*, to check out code using http://git.openmicroscopy.org.

Requirements

- Install a Java 7+ Development Kit (JDK), available from Java SE Downloads[8] and required for both the OMERO server and client code. Set the `JAVA_HOME` environment variable to your JDK installation.

Running code

It is helpful to set up the project in Eclipse[9]. Because the OMERO Java and Python source files are encoded in UTF-8, ensure that the encoding in Eclipse (*Preferences* → *General* → *Workspace* → *Text file encoding*) is also set to UTF-8.

Build system

See *Build System* for details.

The OME project currently uses Jenkins[10] (formerly known as hudson) as a continuous integration server available here[11]. OMERO.insight is built as part of the "OMERO" jobs. See the contributing developer continuous integration[12] documentation for full details.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.4 Directory contents

The repository of the software artifacts is organized as follows:

- `build`: This directory contains the tools to compile, run, test, and deliver the application.
- `config`: Various configuration files required by the application to run.

[7] http://www.openmicroscopy.org/site/support/contributing/
[8] http://www.oracle.com/technetwork/java/javase/downloads/index.html
[9] http://www.eclipse.org
[10] http://jenkins-ci.org
[11] https://ci.openmicroscopy.org/
[12] http://www.openmicroscopy.org/site/support/contributing//ci-omero.html

- `docgen`: Documentation artifacts that are used to build actual documents. These are organized in two sub-directories: javadoc and xdocs. The former only contains resources (like CSS files) to generate programmer's documentation – the actual documentation contents are obtained from the source code. The latter contains both resources (like stylesheets and DHTML code) to generate all other kinds of documentation (like design and users documents) and the actual documentation contents in the form of XML/HTML files.
- `launch`: Launcher scripts and installation instructions bundled with the default application distribution file. Its sub-dirs contain further resources to build platform-specific distributions.
- `SRC`: Contains the application source files.
- `TEST`: The test code.
- `README`: The README file.

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15.5 Event bus

Interactions among agents are event-driven. Agents communicate by using a shared event bus provided by the container. The event bus is an event propagation mechanism loosely based on the Publisher-Subscriber[13] pattern and can be regarded as a time-ordered event queue - if event A is posted on the bus before event B, then event A is also delivered before event B.

Events are fired by creating an instance of a subclass of *AgentEvent* and by posting it on the event bus. Agents interested in receiving notification of *AgentEvent* occurrences implement the *AgentEventListener* interface and register with the event bus. This interface has a callback method, `eventFired`, that the event bus invokes in order to dispatch an event. A listener typically registers interest only for some given events - by specifying a list of *AgentEvent* subclasses when registering with the event bus. The event bus will then take care of event de-multiplexing - an event is eventually dispatched to a listener only if the listener registered for that kind of event.

15.5.1 Structure

EventBus

- Defines how client classes access the event bus service.
- A client object (subscriber) makes/cancels a subscription by calling `register()`/`remove()`.
- A client object (publisher) fires an event by calling `postEvent()`.

AgentEvent

- Ancestor of all classes that represent events.
- Source field is meant to be a reference to the publisher that fired the event.
- An event is "published" by adding its class to the events package within the agents package.

AgentEventListener

- Represents a subscriber to the event bus.
- Defines a callback method, `eventFired`, that the event bus invokes in order to dispatch an event.

EventBusListener

- Concrete implementation of the event bus.
- Maintains a de-multiplex table to keep track of what events have to be dispatched to which subscribers.

[13] http://en.wikipedia.org/wiki/Publish/subscribe

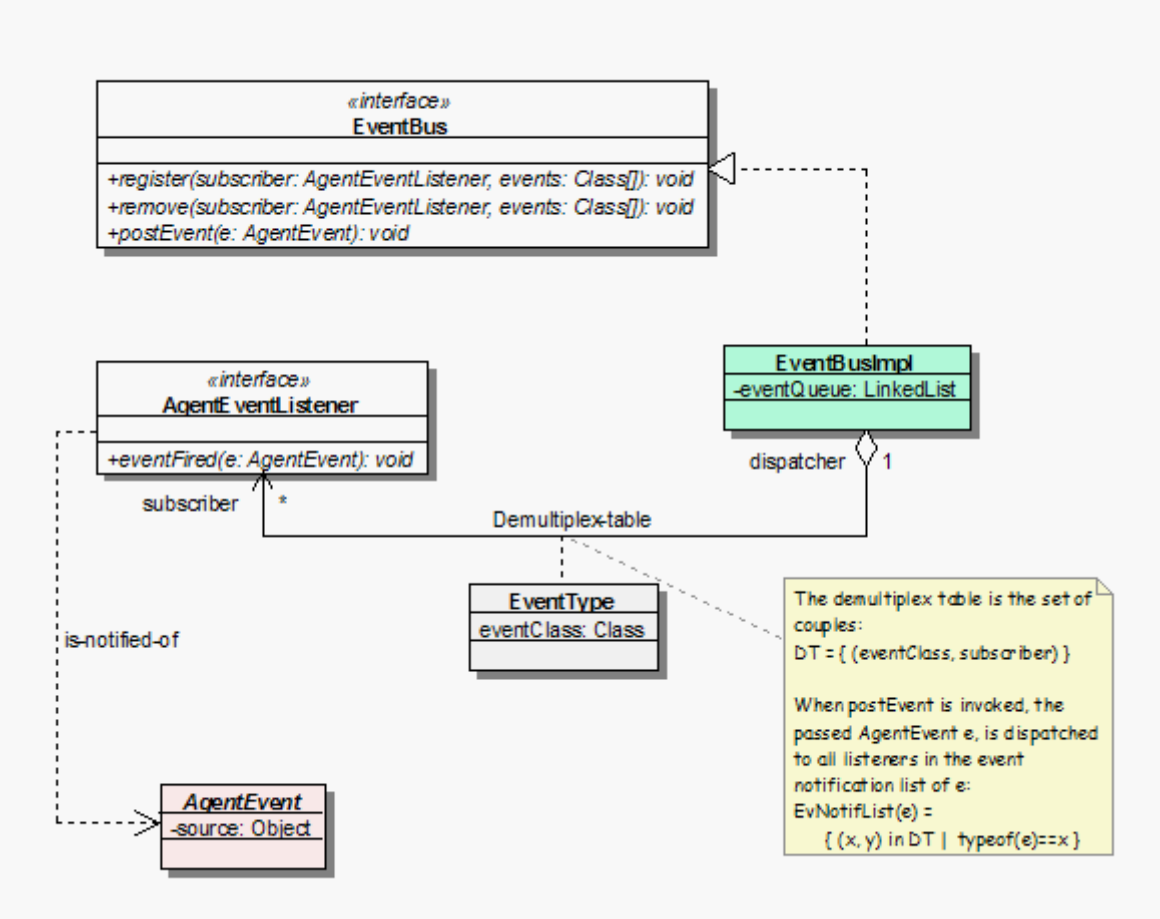

Figure 15.5: OMERO.insight event bus

15.5.2 In action

- When a subscriber invokes the register or remove method, the de-multiplex table is updated accordingly and then the event bus returns to idle.
- When a publisher invokes `postEvent()`, the event bus enters into its dispatching loop and delivers the event to all subscribers in the event notification list.
- Time-ordered event queue - if event A is posted on the bus before event B, then event A is also delivered before event B.
- Dispatching loop runs within same thread that runs the agents (*Swing* dispatching thread).

15.6 Event

15.6.1 Structure

We devise two common categories of events:

- Events that serve as a notification of state change. Usually events posted by agent to notify other agents of a change in its internal state.
- Events that represent invocation requests and completion of asynchronous operations between agents and some services.

In the first category fall those events that an agent posts on the event bus to notify other agents of a change in its internal state. Events in the second category are meant to support asynchronous communication between agents and internal engine. The *AgentEvent* class, which represents the generic event type, is sub-classed in order to create a hierarchy that represents the above categories. Thus, on one hand we have an abstract *StateChangeEvent* class from which agents derive concrete classes to represent state change notifications. On the other hand, the *RequestEvent* and *ResponseEvent* abstract classes are sub-classed by the container in order to define, respectively, how to request the asynchronous execution of an operation and how to represent its completion. We use the

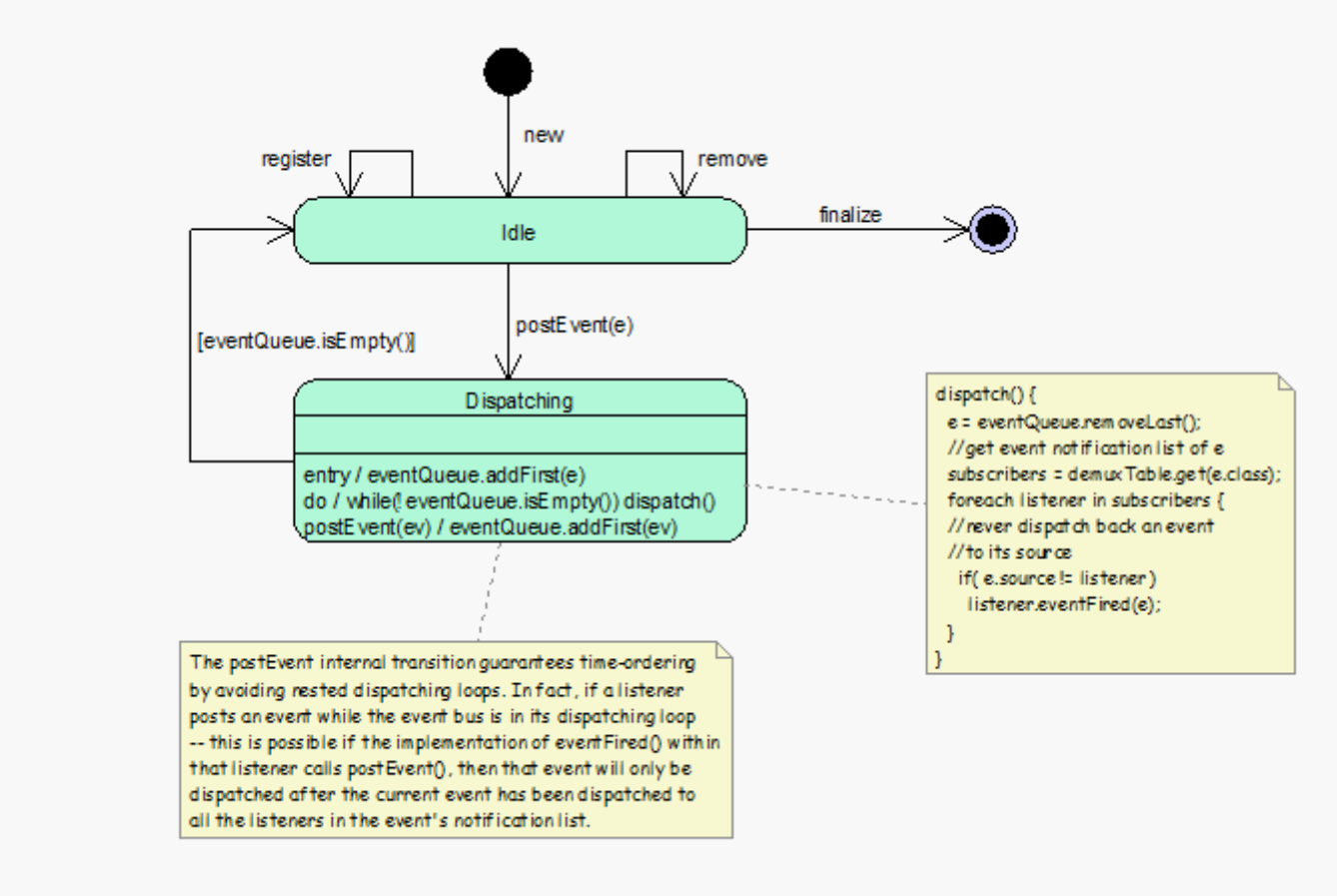

Figure 15.6: OMERO.insight event dispatching

Asynchronous Completion Token pattern to dispatch processing actions in response to the completion of asynchronous operations.

StateChangeEvent

- Ancestor of all classes that represent state change notifications.
- Its state field can be used to carry all state-change information.

RequestEvent

- Abstractly represents a request to execute an asynchronous operation.
- A concrete subclass encapsulates the actual request.
- Knows how and which processing action to dispatch upon completion of the asynchronous operation.

CompletionHandler

- Represents a processing action.
- Allows for all processing action to be treated uniformly.

ResponseEvent

- Abstractly represents the completion of an asynchronous operation.
- A concrete subclass encapsulates the result of the operation, if any.
- Knows the *RequestEvent* object that originated it.
- Knows how to activate the de-multiplexing of a completion event to the processing action.

15.6.2 In action

Follow a concrete example:

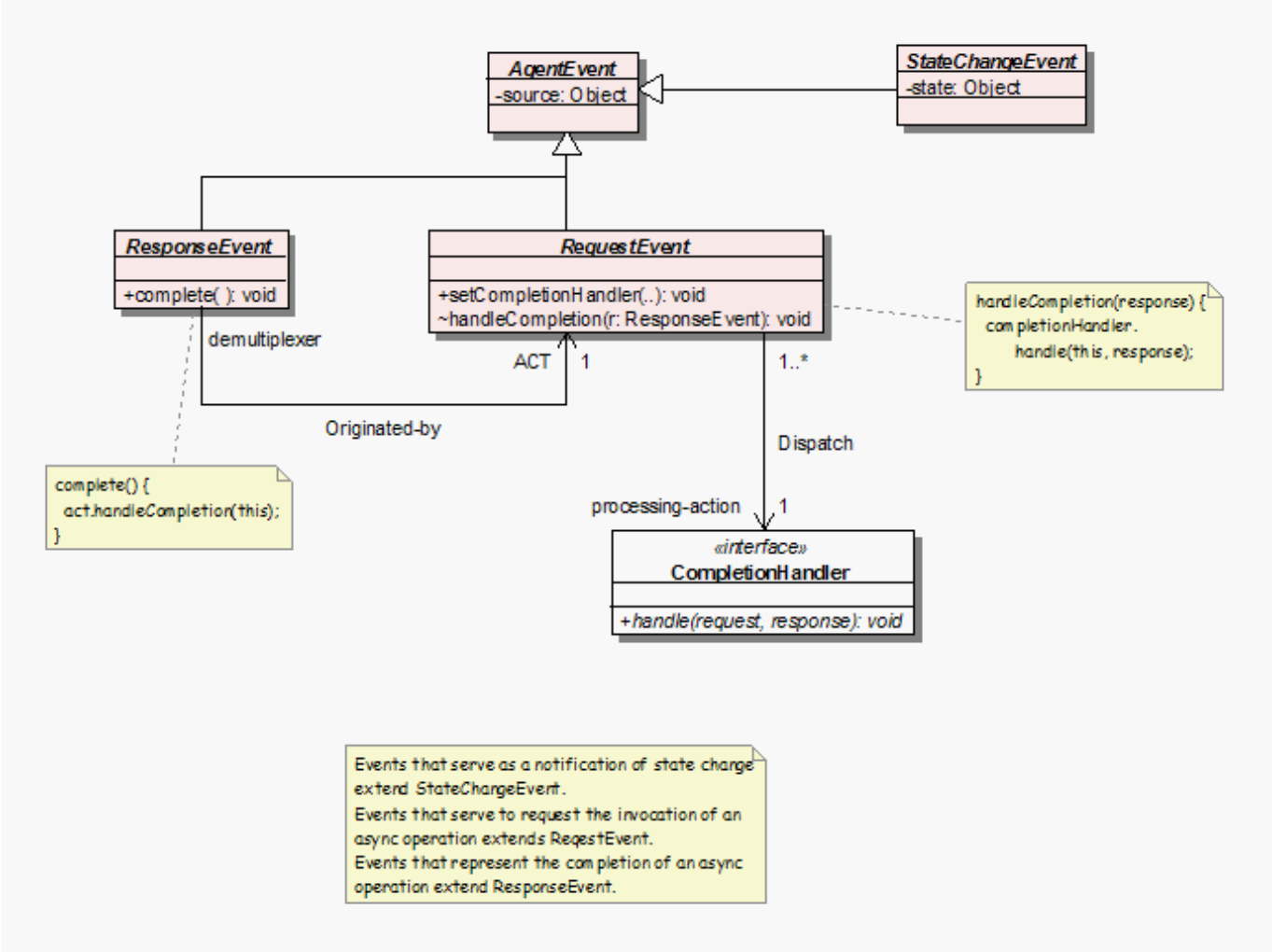

Figure 15.7: OMERO.insight events

```
//Somewhere in the Data Manager
//Request to View an image

EventRequest req = new ViewImage((ImageData) image, null)
//Request the execution of the view call.
eventBus.postEvent(req);


//Somewhere in the Viewer Agent
public void eventFired(AgentEvent e)
{
    if (e instanceof ViewImage) handleViewImage((ViewImage) e);
}
```

A concrete *RequestEvent* encapsulates a request to execute an asynchronous operation. Asynchrony involves a separation in space and time between invocation and processing of the result of an operation: we request the execution of the operation at some point in time within a given call stack (say in `methodX` we make a new request and we post it on the event bus). Then, at a later point in time and within another call stack (`eventFired` method), we receive a notification that the execution has completed and we have to handle this completion event - which mainly boils down to doing something with the result, if any, of the operation. Recall that the *ResponseEvent* class is used for representing a completion event and a concrete subclass carries the result of the operation, if any. After the operation has completed, a concrete *ResponseEvent* is put on the event bus so that the object which initially made the request (often an agent, but, in this context, we will refer to it as the initiator, which is obviously required to implement the *AgentEventListener* interface and register with the event bus) can be notified that execution has completed and possibly handle the result. Thus, at some point in time the initiator's eventFired method is called passing in the response object.

Now the initiator has to find out which processing action has to be dispatched to handle the response. Moreover, the processing action often needs to know about the original invocation context - unfortunately, we cannot relinquish the original call stack (`methodX` is gone). The solution is to require that a response be linked to the original request and that the initiator link a request to a completion handler (which encapsulates the processing action) before posting it on the event bus (this explains the fancy arrangement of the *RequestEvent*, *ResponseEvent* and *CompletionHandler*).

This way de-multiplexing matters are made very easy for the initiator. Upon reception of a completion event notification, all what the initiator has to do is to ask the response object to start the de-multiplexing process - by calling the complete method. This method calls `handleCompletion()` on the original request, passing in the response object. In turn, `handleCompletion()` calls the handle method on its completion handler, passing in both the request and the response. The right processing action has been dispatched to handle the response. Also, notice that the completion handler is linked to the request in the original invocation context, which makes it possible to provide the handler with all the needed information from the invocation context. Moreover, both the original request and the corresponding response are made available to the completion handler. This is enough to provide the completion handler with a suitable execution context - all the needed information from the original call stack is now available to the processing action.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.7 How to build an agent

An agent is created and managed by the container. Building an agent is done in two steps:

- write the agent code
- declare the agent in the `container.xml` file located in the `config` directory

The agent intercepts the events posted on the event bus.

Note: When a new version of the software is delivered, make sure you keep the `container.xml` shipped with the application and add the new agent entry to it.

15.7.1 Writing code

The following example creates a concrete agent `MyBrowserAgent`:

- Create a `myBrowser` package in the `agents` package.
- Create a class `MyBrowserAgent`, this class **MUST** implement the `Agent` interface to be initialized and the `AgentListener` to interact with other agents.

```
public class MyBrowserAgent
    implements Agent, AgentEventListener
{

    /** Reference to the registry. */
    private static Registry         registry;

    //no-arguments constructor required for initialization
    public MyBrowserAgent() {}

    //Follow methods required by the Agent Interface

    //No-op implementation in general
    public void activate()
    {
        //this method will be invoked during the activation by the container
    }

    //invoked before shutting down the application
```

```
    public boolean canTerminate() { return true; }

    //not yet implemented: invoked when shutting down the application
    public Map<String, Set> hasDataToSave() { return null; }

    //invoked while shutting down the application
    public void terminate() {}

    public void setContext(Registry ctx)
    {
        //Must be a reference to the Agent Registry to access services.
        registry = ctx;

        //register the events the agent listens to e.g. BrowseImage
        EventBus bus = registry.getEventBus();
        bus.register(this, BrowseImage.class);

    }



    //Follow methods required by the AgentEventListener Interface
    public void eventFired(AgentEvent e)
    {
        if (e instanceof BrowseImage) {
            //Do something
            browseImage((BrowseImage) e);
        }
    }

}
```

Where to create the `BrowseImage` event

- Create a `myBrowser` package in the `agents.events` package.
- Create a `BrowseImage` event in the `myBrowser` package.

```
public class BrowseImage
    extends RequestEvent
{

    /** The id of the image to browse. */
    private long imageID;

    /**
     * Creates a new instance.
     *
     * @param imageID The id of image to view.
     */
    public BrowseImage(long imageID)
    {
        if (imageID < 0)
            throw new IllegalArgumentException("ImageID not valid.");
        this.imageID = imageID;
    }


    /**
     * Returns the ID of the image to browse.
     *
     * @return See above.
```

```
     */
    public long getImageID() { return imageID; }

}
```

Listening to the `BrowseImage` event

To listen to events posted on the event bus, the agent **MUST** implement the `AgentListener` Interface and register the events to listen to.

- Register `BrowseImage` in the `setContext(Registry)` method of the `Agent` interface.
- Listen to `BrowseImage` in the `eventFired(AgentEvent)` method of the `AgentListener` interface.

For example, when clicking on an image in the Data Manager, the following event is posted:

```
EventBus bus = registry.getEventBus();
bus.post(new BrowseImage(imageID));
```

The `MyBrowserAgent` handles the event

```
public void eventFired(AgentEvent e)
{
    if (e instanceof BrowseImage) {
        //Do something
        browseImage((BrowseImage) e);
    }
}
```

Creating an agent's view

See *How to build an agent's view*

15.7.2 Declaring the agent

The `MyBrowserAgent` needs to be declared in the `container.xml`.

- Open the `container.xml` located in the `config` folder (see *Directory contents*).
- Add the following:

```
<agents>
    <structuredEntry name="/agents" type="agents">

      <!-- NOTE FOR DEVELOPERS
           Add an agent tag for each of your Agents.
           The name tag specifies the human-readable name of the Agent.
           The active tag specifies if the agent is turned on or off.
           Set to true to turn the agent on, false otherwise.
           The class tag specifies the FQN of the Agent class.
           The config tag specifies the name of the Agent's
           configuration file within the config directory.
      -->
      <agent>
         <name>My Browser</name>
         <active>true</active>
         <class>org.openmicroscopy.shoola.agents.mybrowser.MyBrowserAgent</class>
```

```
        <config>mybrowser.xml</config>
      </agent>
...
    </structuredEntry>
  </agents>
```

- Create a `mybrowser.xml` and add it to the `config` directory:

```
<?xml version="1.0" encoding="utf-8"?>
<agent name="My Browser">
   <resources>
     <iconFactories>
     <!-- This entry is turned into an instance of:
        org.openmicroscopy.shoola.env.config.IconFactory
        This object can then be used to retrieve any image file within
        the directory pointed by the location tag. -->
        <structuredEntry name="/resources/icons/Factory" type = "icons">
          <!-- The location tag specifies the FQN of the package that contains
          the icon files. -->
          <location>org.openmicroscopy.shoola.agents.myBrowser.graphx</location>
        </structuredEntry>

     </iconFactories>
     <fonts>
       <!-- This entry is turned into an instance of java.awt.Font. -->
       <structuredEntry name="/resources/fonts/Titles" type="font">
         <family>SansSerif</family>
         <size>12</size>
         <style>bold</style>
       </structuredEntry>
     </fonts>
</resources>
</agent>
```

The file `mybrowser.xml` allows the agent to define specific parameters.

See also:

Organization, *Retrieve data from server*

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.8 How to build an agent's view

This section explains how a view of the agent is created. All our agents follow the same approach. To see the code while reading the notes, go to components/insight/SRC/org/openmicroscopy/shoola/agents/treeviewer/view[14].

Using the previous example `MyBrowserAgent` (see *How to build an agent*):

1. Create a `view` package in the `mybrowser` package.
2. Create the following classes `MyBrowser` (interface), `MyBrowserComponent`, `MyBrowserModel`, `MyBrowserControl`, and `MyBrowserUI`. If you browse the source code, you will notice that we usually have a class used as a toolbar and a class used as a status bar. Both classes are initialized by the `BrowserUI`. For clarity, they have been omitted in the following diagram.
3. Create a `MyBrowserFactory`. This class keeps track of the `MyBrowser` instances created and not yet discarded. A component is only created if none of the tracked ones is displaying the data, otherwise the existing component is recycled.

[14] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/insight/SRC/org/openmicroscopy/shoola/agents/treeviewer/view

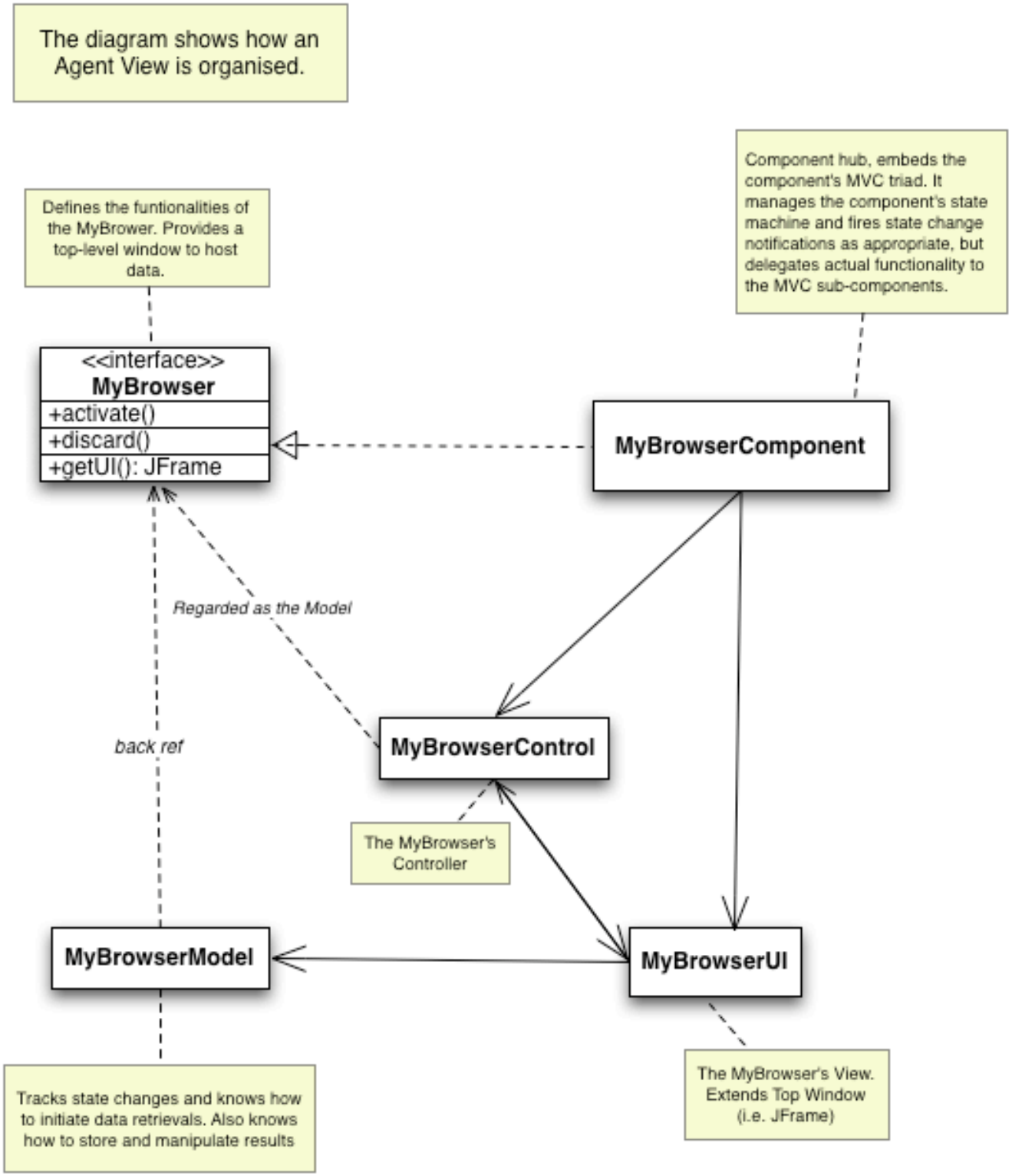

Figure 15.8: OMERO.insight agent view

15.8.1 Typical life-cycle of an agent view

The object is first created using the `MyBrowserFactory`

```
//Somewhere in the MyBrowserFactory code
```

```
/** The sole instance. */
private static final MyBrowserFactory  singleton = new MyBrowserFactory();

/**
 * Returns a viewer to display the specified images.
 *
 * @param images The <code>ImageData</code> objects.
 */
public static MyBrowser getViewer(Set<ImageData> images)
{
    MyBrowserModel model = new MyBrowserModel(images);
    return singleton.getViewer(model);
}


/**
 * Creates or recycles a viewer component for the specified
 * <code>model</code>.
 *
 * @param model The component's Model.
 * @return A {@link MyBrowser} for the specified <code>model</code>.
 */
private MyBrowser getViewer(MyBrowserModel model)
{
    Iterator v = viewers.iterator();
    MyBrowserComponent comp;
    while (v.hasNext()) {
        comp = (MyBrowserComponent) v.next();
        if (model.isSameDisplay(comp.getModel())) {
            comp.refresh(); //refresh the view.
            return comp;
        }
    }
    comp = new MyBrowserComponent(model);
    comp.initialize();
    comp.addChangeListener(this);
    viewers.add(comp);
    return comp;
}
```

After creation, the object is in the `MyBrowser#NEW` state and is waiting for the `MyBrowser#activate()` method to be called. Such a call usually triggers loading of the objects on the server. The object is now in the `MyBrowser#LOADING` state. After all the data have been retrieved, the object is in the `MyBrowser#READY` state and the data display is built and set on screen.

When the user quits the window, the `MyBrower#discard()` method is invoked and the object transitions to the `MyBrowser#DISCARDED` state. At which point, all clients should de-reference the component to allow for garbage collection.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.9 Retrieve data from server

To retrieve data stored in an OMERO server, Agents can either:

- directly access a Data service (container service) through their `Registry` (in which case, the call happens in the *Swing* dispatching thread, so it is not possible to give user feedback by showing a progress bar for example):

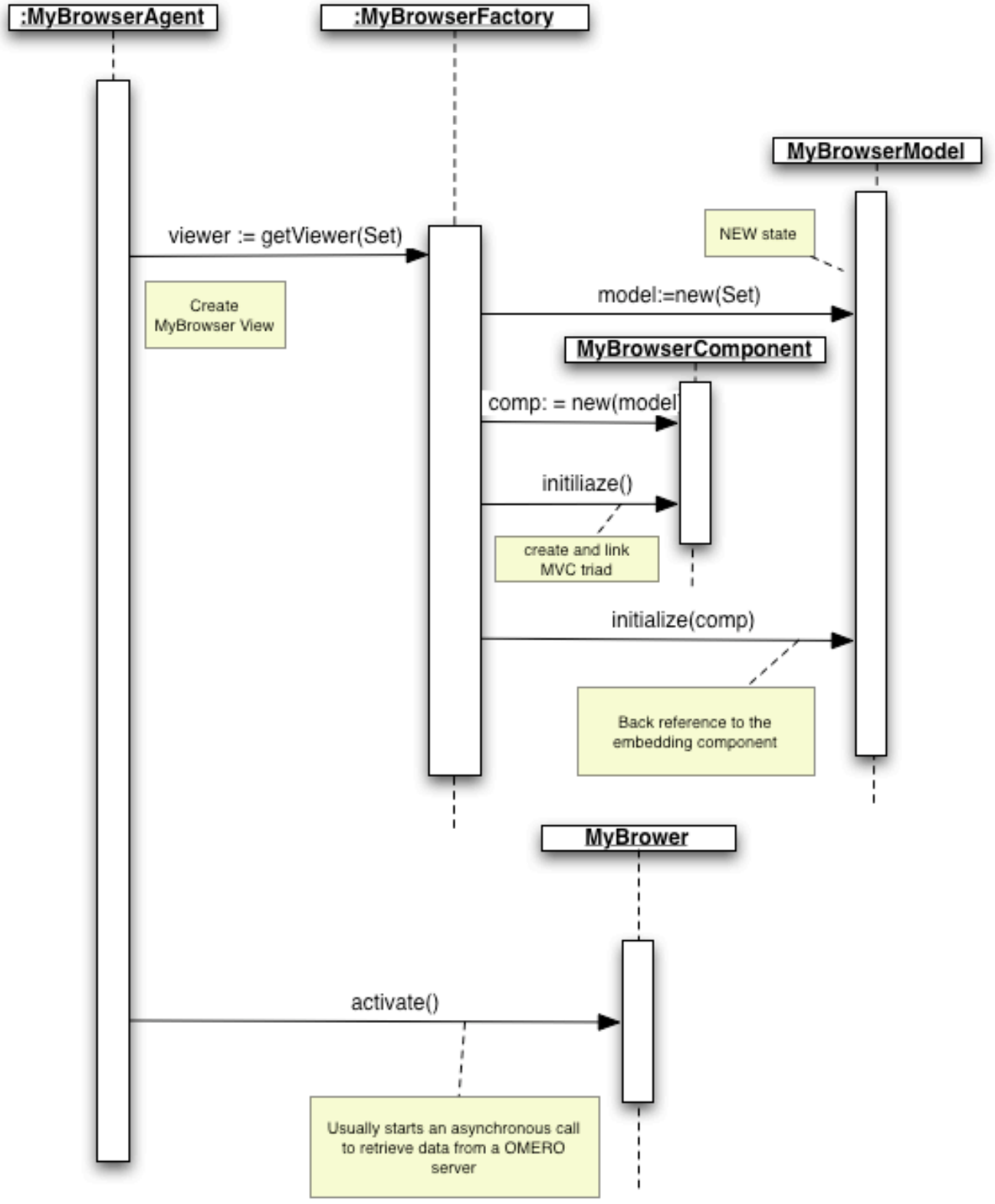

Figure 15.9: OMERO.insight agent view initialization

```
OmeroDataService service = registry.getDataService();
service.getServerName()
```

- or retrieve data asynchronously using a **Data Services View**

15.9.1 Data services view

Usage

A data services view is a logical grouping of data and operations that serve a specific purpose, for example to support dataset browsing by providing easy access to datasets, thumbnails, tags, etc. A data services view is defined by an interface that extends `DataServiceView` and consists of a collection of asynchronous calls that operate on (possibly) large portions of a data model in the background.

Agents obtain a reference to a given view through their registry by specifying the view's defining interface as follows (note the *required* cast on the returned reference):

```
XxxView view = (XxxView) registry.getDataServicesView(XxxView.class);
```

`XxxView` is obviously a made up name for one of the sub-interfaces of `DataServiceView` contained in this package. All calls are carried out asynchronously with respect to the caller's thread and return a `CallHandle` object which can be used to cancel execution. This object is then typically linked to a button so that the user can cancel the task, like in the following example:

```
final CallHandle handle = view.loadSomeDataInTheBg(observer);

   //The above call returns immediately, so we don't have to wait.
   //While the task is carried out, we allow the user to change
   //her mind and cancel the task:

   cancelButton.addActionListener(new ActionListener() {
       public void actionPerformed(ActionEvent e) {
           handle.cancel();
       }
   });
```

The `observer` argument to the above call is an instance of `AgentEventListener` (in `env.event`). Normally all calls within a view allow to specify this argument, which is used to provide the caller with feedback on the progress of the task and with its eventual outcome.

Specifically, as the computation proceeds in the background, `DSCallFeedbackEvents` (in `env.data.events`) are delivered to the `observer`. These event objects have a status field which contains a textual description of the activity currently being carried out within the computation and a progress indicator which is set to the percentage of the work done so far. So the indicator will be `0` for the first feedback event and, if the computation runs to completion, `100` for the last feedback event, which will always have its status field set to `null` – note that a `null` status is also possible for the previous events if no description was available at the time the event was fired. Moreover, any partial result that the computation makes available will be packed into the feedback event.

It is important to keep in mind that the computation may not run to completion – either because of an exception within the computation or because the agent cancels execution – `CallHandle.cancel()` (in `env.data.views`). In both cases, the feedback notification will not run to completion either. However, in any case a final `DSCallOutcomeEvent` (in `env.data.events`) is delivered to the `observer` to notify of the computation outcome – the event's methods can be used to find out the actual outcome and retrieve any result or exception. Every call documents what is the returned object and what are the possible exceptions so that the caller can later cast the returned value or exception as appropriate.

Here is the code for a prototypical `observer`:

```
public void eventFired(AgentEvent ae)
{
    if (AE instanceof DSCallFeedbackEvent) {  //Progress notification.
        update((DSCallFeedbackEvent) AE);  //Inform the user.
    } else {  //Outcome notification.
        DSCallOutcomeEvent oe = (DSCallOutcomeEvent) AE;
        switch (oe.getState()) {
        case DSCallOutcomeEvent.CANCELLED:  //The user cancelled.
            handleCancellation();
            break;
```

```
        case DSCallOutcomeEvent.ERROR:  //The call threw an exception.
            handleException(oe.getException());
            break;
        case DSCallOutcomeEvent.NO_RESULT:  //The call returned no value.
            handleNullResult();
            break;
        case DSCallOutcomeEvent.HAS_RESULT:  //The call returned a value.
            handleResult(oe.getResult());
        }
    }
}
```

Because the logic is likely to be common to most of the observers, the `DSCallAdapter` (in `env.data.events`) class factors it out to provide a more convenient way to write observers. Back to our previous example, the observer could look something like the following:

```
observer = new DSCallAdapter() {
     public void update(DSCallFeedbackEvent fe) {  //Received some feedback.
         String status = fe.getStatus();
         int percDone = fe.getPercentDone();
         if (status == null)
             status = (percDone == 100) ? "Done" :  //Else
                                          ""; //Description was not available.
         statusBar.setText(status);  //A JLabel object part of the UI.
         progressBar.setValue(percDone); //A JProgressBar object part of the UI.
     }
     public void onEnd() { //Called right before any of the handleXXX methods.
         progressBar.setVisible(false);  //Because the computation has finished.
     }
     Public void handleResult(Object result) {  //Computation returned a result.
         //We have a non-null return value.  Cast it to what
         //loadSomeDataInTheBg() declared to return.
         SomeData data = (SomeData) result;

         //Update model, UI, etc.
     }
     public void handleCancellation() {  //Computation was cancelled.
         UserNotifier un = registry.getUserNotifier();
         un.notifyInfo("Data Loading", "SomeData task cancelled.");
     }
     Public void handleException(Throwable exc) {  //An error occurred.
         UserNotifier UN = registry.getUserNotifier();
         un.notifyError("Data Loading Failure",
                        "Couldn't retrieve SomeData.", exc);
     }
   };
```

Note that the `observer`'s code in the example above works just like any other *Swing* listener. In fact, all events are delivered sequentially and within the *Swing* event dispatching thread. This means the `observer` can run synchronously with respect to the UI and will not need to worry about concurrency issues – as long as it runs within *Swing*. Finally, also note that subsequent feedback events imply computation progress and the `DSCallOutcomeEvent` is always the last event to be delivered in order of time.

The xxxLoader classes in agents.treeviewer are a good place to look at and see how to use data services view.

Execution

The next diagram analyzes a concrete call to a view to exemplify the pattern followed by all asynchronous calls in the various views. The call is mapped onto a command, the command is transferred to a processor for asynchronous execution, a handle to the call is returned to the invoker.

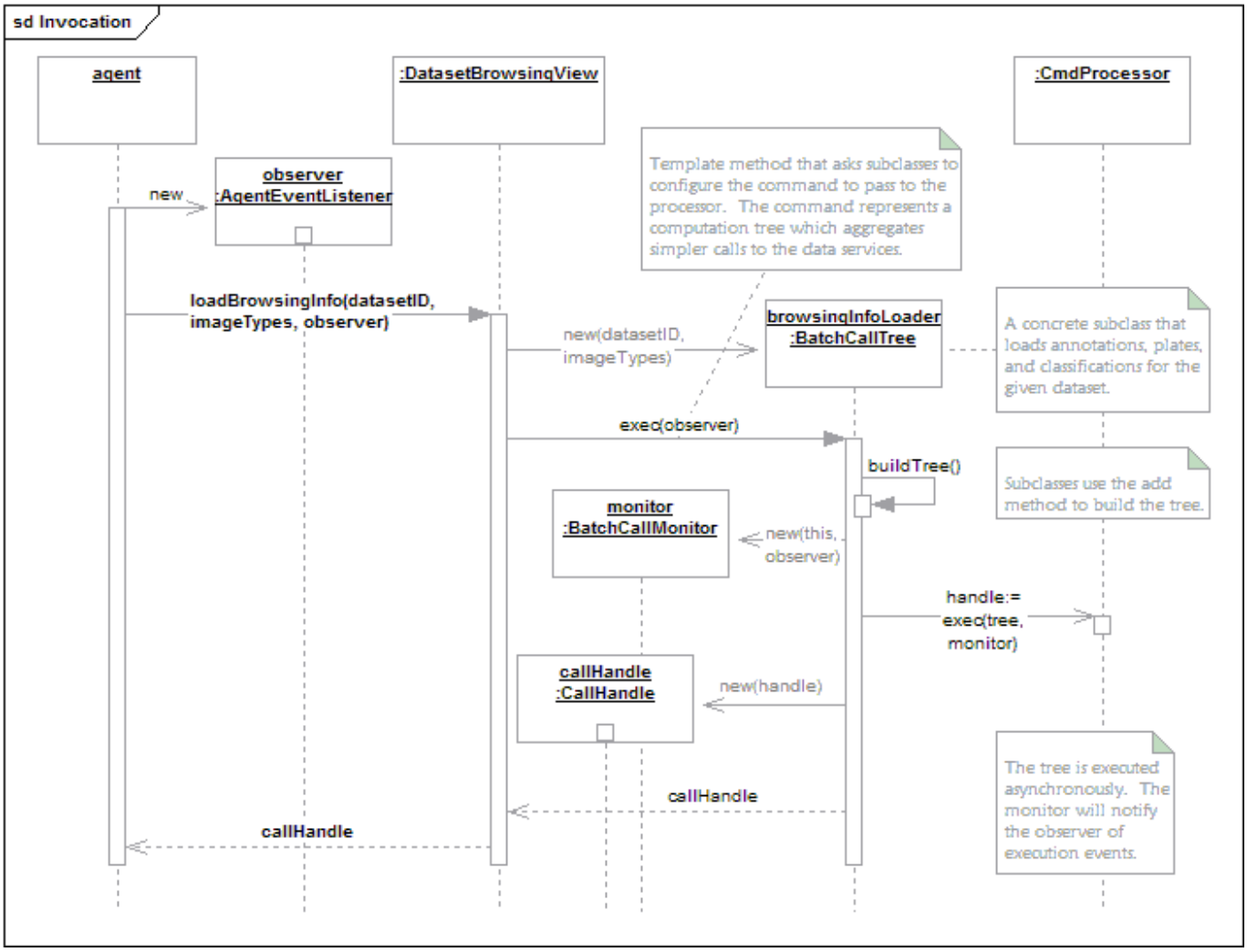

Figure 15.10: Retrieving data invocation

Initialization

The `DataViewsFactory` (in `env.data.views`) needs to be initialized before any concrete `BatchCallTree` (in `env.data.views`) is created. The reason for this is that `BatchCallTree`'s constructor needs to cache a reference to the registry so that concrete subclasses can access it later. The `DataViewsFactory` takes care of this initialization task during the container's start-up procedure by calling `DataViewsFactory.initialize(Container)`. Any data service view should be created in `env.data.views` and declared in `DataViewsFactory.makeNew(Class)`. The method returns an implementation of the corresponding view.

See also:

Directory contents

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

15.10 Organization

The source code is organized as follows. All classes share a common base namespace:

```
org.openmicroscopy.shoola
```

Two main packages sit under the shoola directory:

- `agents`: All the classes related to concrete agents.
- `env`: All the classes that make up the runtime environment, that is the container.

The `agents` package is further broken down into:

- `events`
- `dataBrowser`
- `imviewer`
- `measurement`
- `metadata`
- `treeviewer`
- `util`

These packages contain the code for the Data Browser, Data Manager, Viewer, and Measurement agents. The events package contains the events that are used by all these agents.

The `env` package is also broken down into further sub-packages:

- `config`: Registry-related classes.
- `data`: Defines the client's side interface and implementation of the Remote Facade that we use to access the OMERO server.
- `event`: The event bus classes.
- `init`: Classes to perform initialization tasks at start-up.
- `log`: Adapter classes to wrap log4j[15].
- `cache`: Adapter classes to wrap ehcache[16].
- `rnd`: The image data provider.
- `ui`: The top frame window and the user notification widgets.

Note: Two extra packages are part of the project for convenience reason only:

- `svc`: Provides general services e.g. transport service using *HTTP*.
- `util`: Collection of classes that be used outside the OMERO structure

---

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15.11 Taskbar

The container provides a top-level window, the taskbar, to let users control some of the container's tasks like the connection to the remote service or quitting the application. The taskbar contains a menu bar and several toolbars. Agents can add their own entries to the menu bar and to the toolbars in order to trigger agent-specific actions, or can ignore the taskbar altogether. For example, agents that are UIs typically add an entry to the Window menu and to the Quick-launch toolbar (this should be done during the agent's linking phase) for top-level windows that the user can bring up. Some utility classes provide agents with functionality to link their top-level windows to the taskbar and to manage the display of those windows on screen.

15.11.1 Structure and dynamics

The following diagram shows the classes that provide the taskbar service and their relationships:

[15] http://logging.apache.org/log4j/
[16] http://ehcache.org/

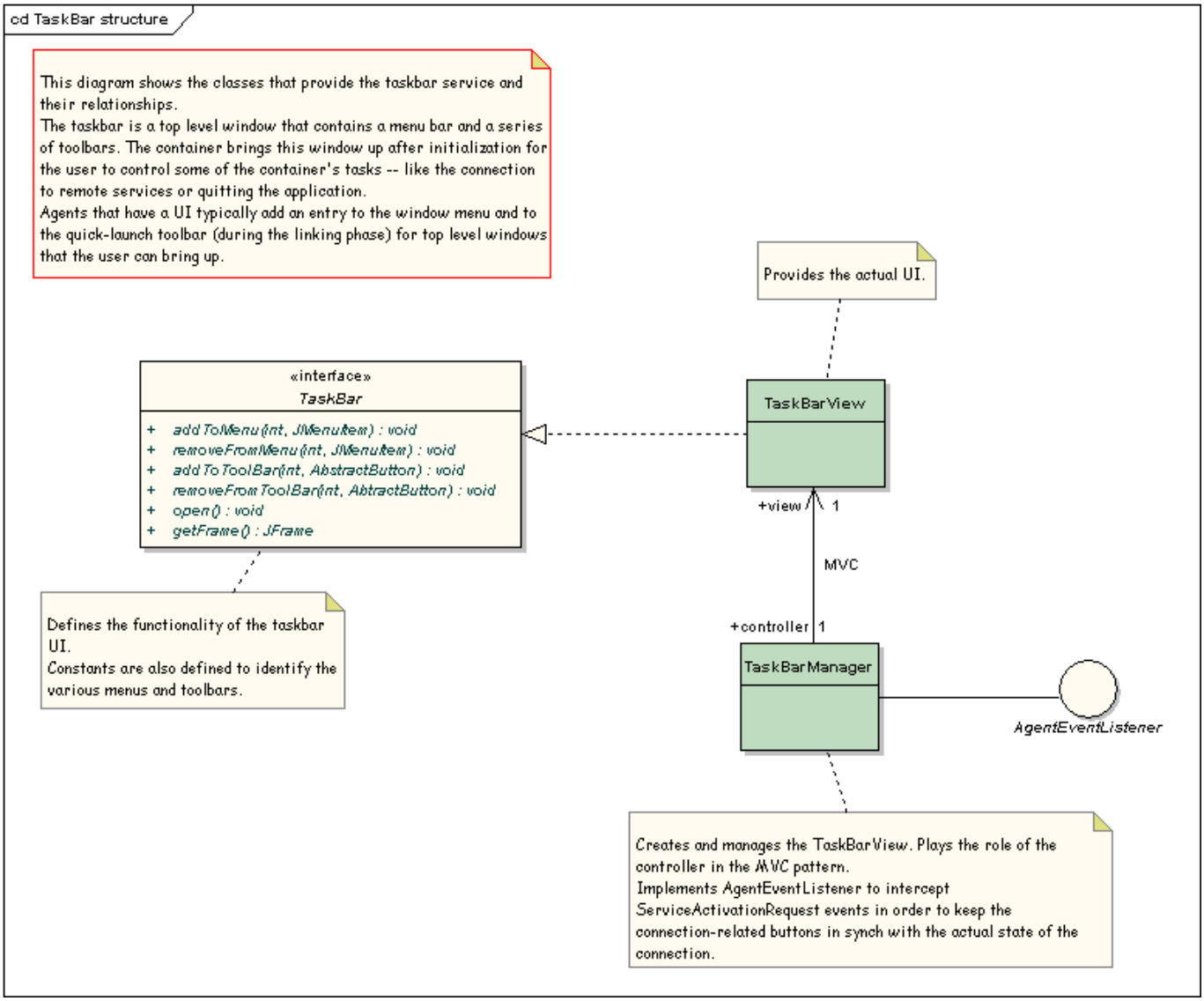


Figure 15.11: Taskbar structure

The following diagram shows how some utility classes that can be used to link windows to the `TaskBar` and to manage their display on screen:

The following diagram shows how the display state of a top window is managed by the `TopWindowManager`:

15.11.2 How to

Agents can use the taskbar directly to add entries to the various menus and toolbars. After retrieving the `TaskBar` from the `Registry`, the `addXXX` and `removeXXX` are available to do the job.

Agents can add entries to any of the menus within the menu bar – `File`, `Connect`, `Tasks`, `Window`, `Help`. Two toolbars, `Tasks` and `Quick-Launch`, are also provided for agents to plug in their buttons. Buttons in the Tasks toolbar are usually shortcuts to entries in the Tasks menu. Similarly, buttons in the Quick-Launch toolbar are usually shortcuts to entries in the Window menu.

However, some utility classes provide agents with built-in functionality to link their top-level windows to the taskbar and to manage the display of those windows on screen.

The `TopWindow` class extends `JFrame` to provide the base functionality for windows that are to be linked to the `TaskBar` by means of one quick-launch button and a menu entry in the `Window` menu. The constructor of this class automatically adds a button to the `Quick-Launch` toolbar and an entry in the `Window` menu – subclasses use the `configureXXX` methods to specify icons, names, and tool tips. These are display-trigger buttons that cause the window to be shown on screen. This class uses the `TopWindowManager` to control mouse clicks on these buttons as well as to manage the display state of the window

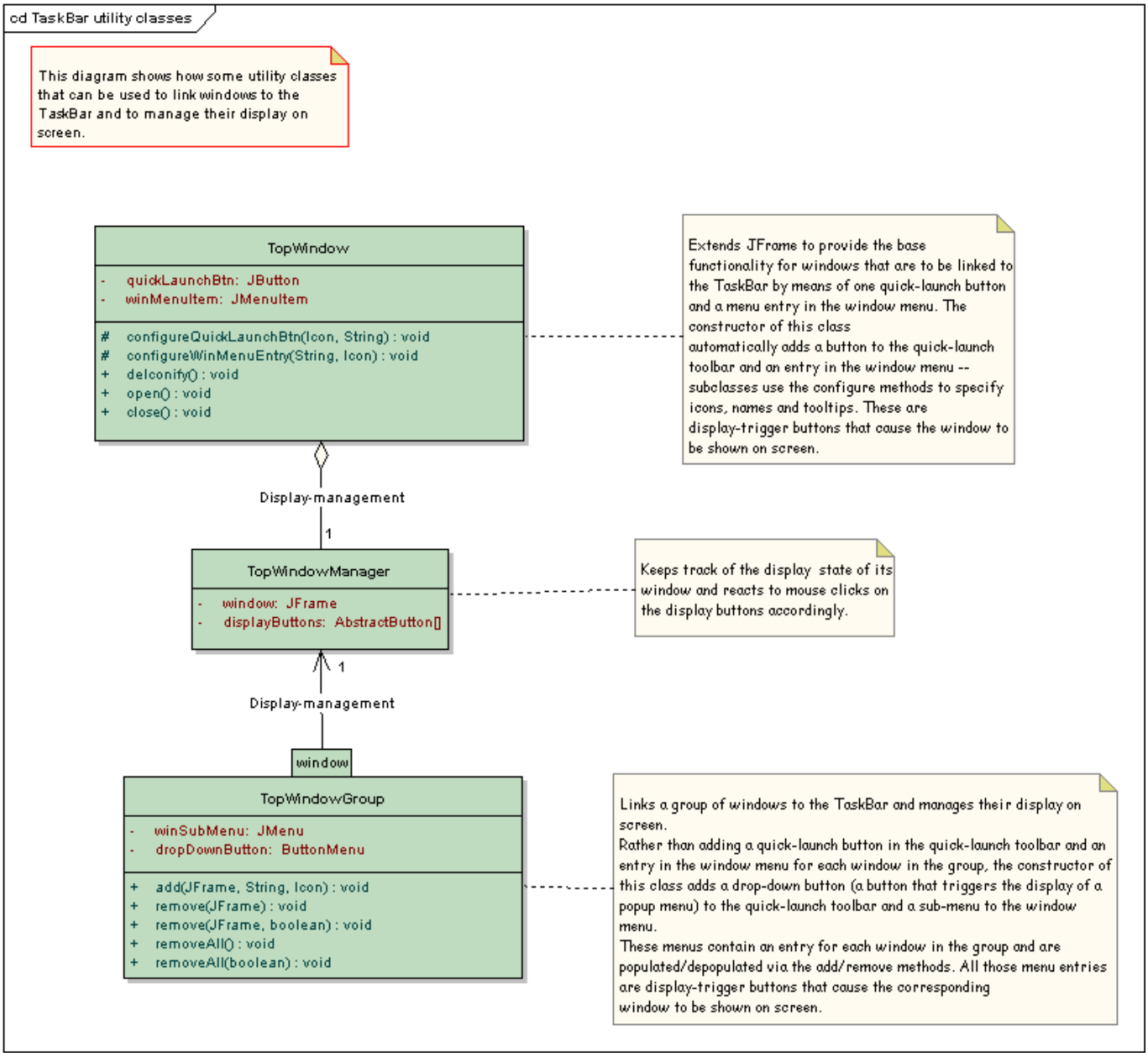


Figure 15.12: Taskbar utility classes

– how this display state is managed is specified by the `TopWindowManager` state machine, which is represented in one of the previous diagrams.

Here is an example of a window that inherits from `TopWindow`:

```
class MainWindow
    extends TopWindow
{
    //Member fields omitted.

    //Specifies names, icons, and tool tips for the quick-launch button and the
    //window menu entry in the taskbar.
    private void configureDisplayButtons()
    {
        configureQuickLaunchBtn(icons.getIcon("agent.png"),
                                "Display the main window.");
        configureWinMenuEntry("Example Agent", icons.getIcon("agent.png"));
    }
```

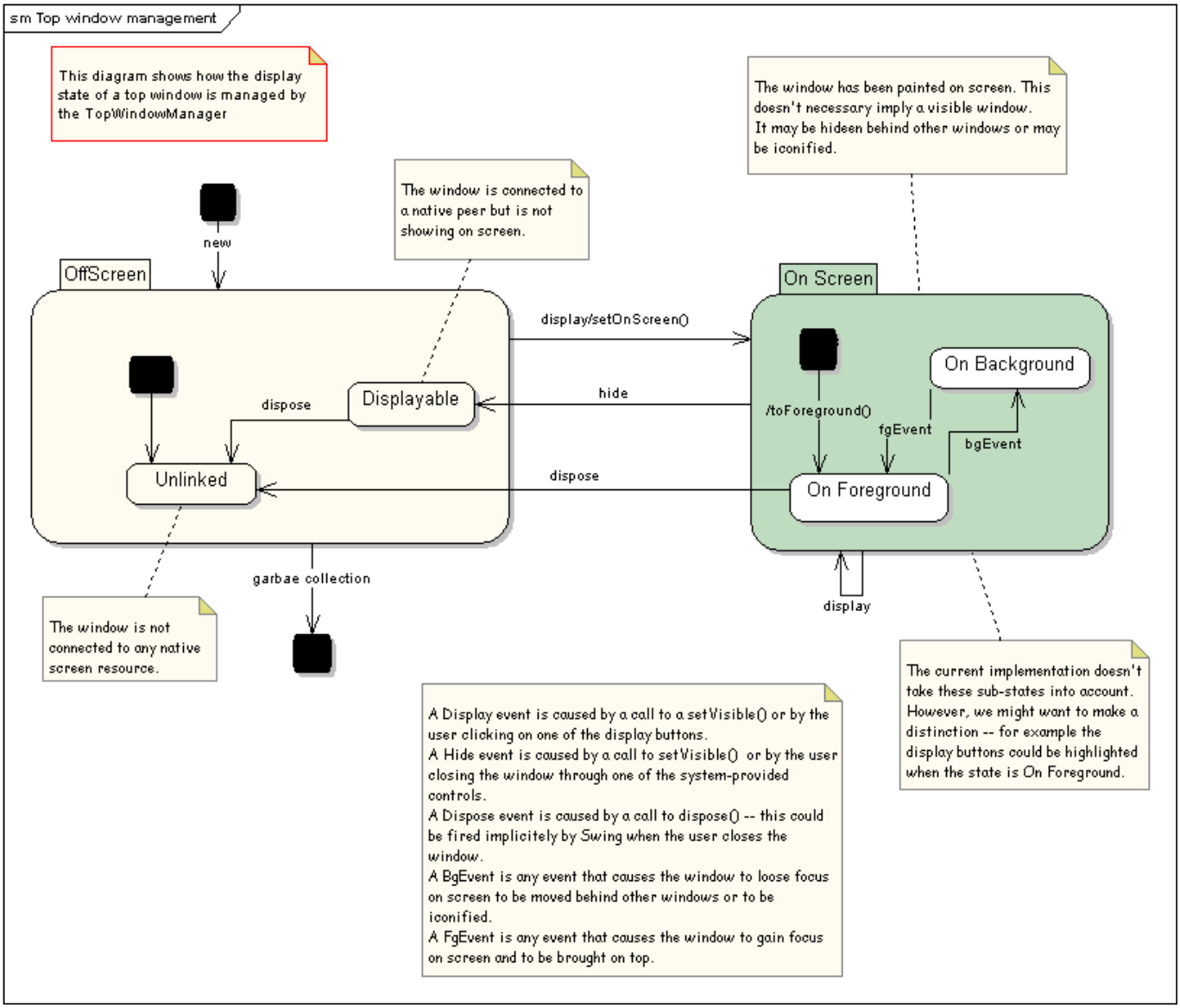


Figure 15.13: Taskbar window management

```
    //Builds and lays out this window.
    private void buildGUI() { /* Omitted. */ }



    //Creates a new instance.
    MainWindow(Registry config)
    {
        //We have to specify the title of the window to the superclass
        //constructor and pass a reference to the TaskBar, which we get
        //from the Registry.
        super("Example Agent", config.getTaskBar());

            configureDisplayButtons();
            buildGUI();
    }

}
```

The TopWindowGroup class links a group of windows to the TaskBar and manages their display on screen. Rather than adding a quick-launch button in the Quick-Launch toolbar and an entry in the window menu for each window in the group, the constructor of this class adds a drop-down button (a button that triggers the display of a popup menu) to the Quick-Launch toolbar and a sub-menu to the Window menu. These menus contain an entry for each window in the group and are populated/depopulated via the add/remove methods. All those menu entries are display-trigger buttons that cause the corresponding window to be shown on screen. This class uses the TopWindowManager to control mouse clicks on these buttons as well as to manage the display state of each window in the group.

The following UIManager class provides an example of how to use the TopWindowGroup class. This example class creates and controls an instance of MainWindow (which we have already seen in the previous example) as well as AuxiliaryWindow instances. This latter class is just a window which contains two buttons and its code is omitted. UIManager delegates to the TopWindowGroup class the linkage of AuxiliaryWindow's to the TaskBar as well as the management of their display state.

Follows the code:

```
class UIManager
{

    //Inherits from TopWindow, so it is automatically linked to the TaskBar.
    //Contains a button that we listen to.  When a mouse click occurs we call
    //createAuxWin().
    private MainWindow      mainWindow;

    //Manages all the AuxiliaryWindow's that we have created and not destroyed yet.
    private TopWindowGroup      auxWinGroup;

    //Counts how many {@link AuxiliaryWindow}'s that we have created so far.
    private int         auxWinCount;

    //Cached reference to access the icons.
    private IconFactory     icons;


    //Creates a new instance.
    UIManager(Registry config)
    {

        auxWinCount = 0;
        icons = (IconFactory) config.lookup("/resources/icons/MyFactory");
        mainWindow = new MainWindow(config);

        //The MainWindow contains a button (not shown in the previous example)
        //which we listen to in order to trigger the creation of new
        //AuxiliaryWindow's.
        mainWindow.openAuxiliary.addActionListener(new ActionListener() {
            public void actionPerformed(ActionEvent ae) { createAuxWin(); }
        });




        //We now create the window group.  The text we pass will be displayed by
        //the sub-menu within the Window menu along with the icon, which will also
        //be the icon displayed by the drop-down button in the Quick-Launch
        //toolbar.
        auxWinGroup = new TopWindowGroup("Aux Win",
                    icons.getIcon("edu_languages.png"),
                    config.getTaskBar());

    }

    //Creates an AuxiliaryWindow and adds it to the auxWinGroup.
    //Every AuxiliaryWindow contains two buttons, one labeled "Close" and the other
```

```
    //"Dispose".  We listen to mouse clicks on these buttons in order to hide the
    //window when the "Close" button is clicked and to remove the window (and dispose
    //of it) from the auxWinGroup when the "Dispose" button is clicked.
    private void createAuxWin()
    {
        String title = "Aux Window "+(++auxWinCount);
        final AuxiliaryWindow aw = new AuxiliaryWindow(title);

        //Attach listeners and specify actions.
        aw.close.addActionListener(new ActionListener() {
            public void actionPerformed(ActionEvent ae) {aw.setVisible(false);}
        });
        aw.dispose.addActionListener(new ActionListener() {
            public void actionPerformed(ActionEvent e) {
                //Remove from group and dispose.
                auxWinGroup.remove(aw, true);
            }
        });

        //Add to the group.  An entry will be added both to the Window sub-menu
        //and to the popup menu triggered by the drop-down button in the
        //Quick-Launch toolbar.  We set the display text of those entries to be
        //the same as the window's title, but we don't specify any icon.
        auxWinGroup.add(aw, title, null);

        //Bring the window up.
        aw.open();
    }

    //Releases all UI resources currently in use and returns them to the OS.
    void disposeUI()
    {
        mainWindow.dispose();
        auxWinGroup.removeAll(true);  //Empty group and dispose of all windows.
    }

}
```

CHAPTER

SIXTEEN

MORE ON API USAGE

OMERO can be extended by modifying these clients or by writing your own in any of the supported languages.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.1 Developing OMERO clients

Note:

- If you are only interested in **using** our OMERO clients, please see the *OMERO clients overview* section, which will point you to user guides, demo videos, and download sites.
- This page is intended for developers already familiar with client/server programming. If you are not, **your best starting point is to read the** Hello World[1] **chapter of the Ice manual (or more)**. A deeper understanding of Ice might not be necessary, but certainly understanding the Ice basics will make reading this guide **much** easier.

For developers, there are many examples listed below, all of which are stored under: examples[2] and buildable/runnable via scons[3]:

```
cd omero-src
./build.py build-all
cd omero-src/examples
python ../target/scons/scons.py
```

Other examples (in Python) can be found *here*.

16.1.1 Introduction

A Blitz client is any application which uses the *OMERO Application Programming Interface* to talk to the *OMERO.blitz* server in any of the supported languages, like *Python*, *C++*, *Java*, or *Matlab*. A general understanding of the *OMERO.server overview* may make what is happening behind the scenes more transparent, but is not necessary. The points below outline all that an application writer is expected to know with links to further information where necessary.

16.1.2 Distributed computing

The first hurdle when beginning to work with OMERO is to realize that building distributed-object systems is different from both building standalone clients and writing web applications in frameworks like mod_perl, django, or Ruby on Rails. The remoting framework used by OMERO is Ice[4] from ZeroC. Ice is comparable to CORBA in many ways, but is typically easier to use.

A good first step is to be aware of the difference between remote and local invocations. Any invocation on a proxy (`<class_name>Prx`, described below) will result in a call over the network with all the costs that entails. The often-cited

[1] https://doc.zeroc.com/display/Ice/Hello+World+Application
[2] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/examples
[3] http://www.scons.org
[4] https://zeroc.com

fallacies of distributed computing[5] all apply, and the developer must be aware of concurrency and latency issues, as well as complete loss of connectivity, all of which we will discuss below.

16.1.3 Objects

Before we can begin talking about what you can do with OMERO (the remote method calls available in the *OMERO Application Programming Interface*), it is helpful to first know what the objects are that we will be distributing. These are the only types that can pass through the API.

"Slice" mapping language

Ice provides an interface definition language (IDL)[6] for defining class hierarchies for passing data in a binary format. Similar to WSDL in web services or CORBA's IDL, slice provides a way to specify how types can pass between different programming languages. For just that reason, several constructs not available in all the supported languages are omitted:

- multiple inheritance (C++ and Python)
- nullable primitive wrappers (e.g. Java's java.lang.Integer)
- interfaces (Java)
- HashSet types
- iterator types

Primitives

Slice defines the usual primitives – `long`, `string`, `bool`, as well as `int`, `double`, and `float` – which map into each language as would be expected. Aliases like "Ice::Long" are available for C++ to handle both 32 and 64 bit architectures.

A simple struct can then be built out of any combination of these types. From components/blitz/resources/omero/System.ice[7]:

```
// The EventContext is all the information the server knows about a
// given method call, including user, read/write status, etc.
class EventContext
{
  …
  long   userId;
  string userName;
  …
  bool   isAdmin;
  …
```

Sequences, dictionaries, enums, and constants

Other than the "user-defined classes" which we will get to below, slice provides only four built-in building blocks for creating a type hierarchy.

- **Sequences.** & **Dictionaries** : Most of the sequences and dictionaries in use by the *OMERO Application Programming Interface* are defined in components/blitz/resources/omero/Collections.ice[8]. Each sequence or dictionary must be defined before it can be used in any class. By default a sequence will map to an array of the given type in Java or a vector in C++, but these mappings can be changed via metadata. (In most cases, a `List` is used in the Java mapping).
- **Constants.** : Most of the enumerations for *OMERO Application Programming Interface* are defined in components/blitz/resources/omero/Constants.ice[9]. These are values which can be defined once and then referenced in each of the supported programming languages. The only real surprise when working with enumerations is that in Java each constant is mapped to an interface with a single `public final static` field named "value".

[5] http://en.wikipedia.org/wiki/Fallacies_of_Distributed_Computing
[6] http://en.wikipedia.org/wiki/Interface_description_language
[7] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/System.ice
[8] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/Collections.ice
[9] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/Constants.ice

```
#include <iostream>
#include <omero/Constants.h>
using namespace omero::constants;
int main() {
    std::cout << "By default, no method call can pass more than ";
    std::cout << MESSAGESIZEMAX << "kb" << std::endl;
    std::cout << "By default, client.createSession() will wait ";
    std::cout << (CONNECTTIMEOUT / 1000) << " seconds for a connection" << std::endl;
}
```

Example: examples/OmeroClients/constants.cpp[10]

```
sz=omero.constants.MESSAGESIZEMAX.value;
to=omero.constants.CONNECTTIMEOUT.value/1000;
disp(sprintf('By default, no method call can pass more than %d kb',sz));
disp(sprintf('By default, client.createSession() will wait %d seconds for a connection', to));
```

Example: examples/OmeroClients/constants.m[11]

```
from omero.constants import *
print "By default, no method call can pass more than %s kb" % MESSAGESIZEMAX
print "By default, client.createSession() will wait %s seconds for a connection" % (CONNECTTIMEOUT/1000
```

Example: examples/OmeroClients/constants.py[12]

```
import static omero.rtypes.*;
public class constants {
    public static void main(String[] args) {
        System.out.println(String.format(
            "By default, no method call can pass more than %s kb",
            omero.constants.MESSAGESIZEMAX.value));
        System.out.println(String.format(
            "By default, client.createSession() will wait %s seconds for a connection",
            omero.constants.CONNECTTIMEOUT.value/1000));
    }
}
```

Example: examples/OmeroClients/constants.java[13]

- **Enums.** Finally, enumerations which are less used through *OMERO Application Programming Interface*, but which can be useful for simplyifying working with constants.

```
#include <iostream>
#include <omero/Constants.h>
using namespace omero::constants::projection;
int main() {
    std::cout << "IProjection takes arguments of the form: ";
    std::cout << MAXIMUMINTENSITY;
    std::cout << std::endl;
}
```

Example: examples/OmeroClients/enumerations.cpp[14]

[10] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constants.cpp
[11] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constants.m
[12] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constants.py
[13] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constants.java
[14] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/enumerations.cpp

```
v=omero.constants.projection.ProjectionType.MAXIMUMINTENSITY.value();
disp(sprintf('IProjection takes arguments of the form: %s', v));
```

Example: examples/OmeroClients/enumerations.m[15]

```
import omero
import omero_Constants_ice
print "IProjection takes arguments of the form: %s" % omero.constants.projection.ProjectionType.MAXIMUM
```

Example: examples/OmeroClients/enumerations.py[16]

```
public class enumerations {
    public static void main(String[] args) {
        System.out.println(String.format(
           "IProjection takes arguments of the form: %s",
             omero.constants.projection.ProjectionType.MAXIMUMINTENSITY));
    }
}
```

Example: examples/OmeroClients/enumerations.java[17]

RTypes

In Java, the Ice primitives map to non-nullable primitives. And in fact, for the still nullable types `java.lang.String` as well as all collections and arrays, Ice goes so far as to send an empty string ("") or collection([]) rather than null.

However, the database and OMERO support nullable values and so *OMERO.blitz* defines a hierarchy of types which wraps the primitives: RTypes[18] Since Ice allows references to be nulled, as opposed to primitives, it is possible to send null strings, integers, etc.

```
#include <omero/RTypesI.h>
using namespace omero::rtypes;
int main() {
    omero::RStringPtr s = rstring("value");
    omero::RBoolPtr b = rbool(true);
    omero::RLongPtr l = rlong(1);
    omero::RIntPtr i = rint(1);
}
```

Example: examples/OmeroClients/primitives.cpp[19]

```
import omero.rtypes;
a = rtypes.rstring('value');
b = rtypes.rbool(true);
l = rtypes.rlong(1);
i = rtypes.rint(1);
```

Example: examples/OmeroClients/primitives.m[20]

[15] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/enumerations.m
[16] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/enumerations.py
[17] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/enumerations.java
[18] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/RTypes.ice
[19] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/primitives.cpp
[20] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/primitives.m

```
from omero.rtypes import *
s = rstring("value")
b = rbool(True)
l = rlong(1)
i = rint(1)
```

Example: examples/OmeroClients/primitives.py[21]

```
import static omero.rtypes.*;
public class primitives {
    public static void main(String[] args) {
        omero.RString a = rstring("value");
        omero.RBool b = rbool(true);
        omero.RLong l = rlong(1l);
        omero.RInt i = rint(1);
    }
}
```

Example: examples/OmeroClients/primitives.java[22]

The same works for collections. The RCollection subclass of RType holds a sequence of any other RType.

```
#include <omero/RTypesI.h>
using namespace omero::rtypes;
int main() {
    // Sets and Lists may be interpreted differently on the server
    omero::RListPtr l = rlist(); // rstring("a"), rstring("b"));
    omero::RSetPtr s = rset();   // rint(1), rint(2));
                                 // No-varargs (#1242)
}
```

Example: examples/OmeroClients/rcollection.cpp[23]

```
% Sets and Lists may be interpreted differently on the server
ja = javaArray('omero.RString',2);
ja(1) = omero.rtypes.rstring('a');
ja(2) = omero.rtypes.rstring('b');
list = omero.rtypes.rlist(ja)
ja = javaArray('omero.RInt',2);
ja(1) = omero.rtypes.rint(1);
ja(2) = omero.rtypes.rint(2);
set = omero.rtypes.rset(ja)
```

Example: examples/OmeroClients/rcollection.m[24]

```
import omero
from omero.rtypes import *
# Sets and Lists may be interpreted differently on the server
list = rlist(rstring("a"), rstring("b"));
set = rset(rint(1), rint(2));
```

Example: examples/OmeroClients/rcollection.py[25]

[21] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/primitives.py
[22] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/primitives.java
[23] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/rcollection.cpp
[24] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/rcollection.m
[25] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/rcollection.py

```
import static omero.rtypes.*;
public class rcollection {
    public static void main(String[] args) {
        // Sets and Lists may be interpreted differently on the server
        omero.RList list = rlist(rstring("a"), rstring("b"));
        omero.RSet set = rset(rint(1), rint(2));
    }
}
```

Example: examples/OmeroClients/rcollection.java[26]

A further benefit of the RTypes is that they support **polymorphism**. The original *OMERO Application Programming Interface* was designed strictly for Java, in which the `java.lang.Object` type or collections of `java.lang.Object` could be passed. This is not possible with Ice, since there is no `Any` type as there is in CORBA.

Instead, `omero.RType` is the abstract superclass of our "**r**emote **type**" hierarchy, and any method which takes an "RType" can take any subclass of "RType".

To allow other types discussed later to also take part in the polymorphism, it is necessary to include RType wrappers for them. This is the category that `omero::RObject` and `omero::RMap` fall into.

`omero::RTime` and `omero::RClass` fall into a different category. They are identical to `omero::RLong` and `omero::RString`, respectively, but are provided as type safe variants.

OMERO model objects

With these components – rtypes, primitives, constants, etc. – it is possible to define the core nouns of OME, the *OME-Remote Objects*. The OMERO *OME-Remote Objects* is a translation of the OME XML specification[27] into objects for use by the server, built out of RTypes, sequences and dictionaries, and Details.

Details

The `omero.model.Details` object contains security and other internal information which does not contain any domain value. Attempting to set any values which are not permitted, will result in a `SecurityViolation`, for example trying to change the `details.owner` to the current user.

```
#include <omero/model/ImageI.h>
#include <omero/model/PermissionsI.h>
using namespace omero::model;
int main() {
    ImagePtr image = new ImageI();
    DetailsPtr details = image->getDetails();
    PermissionsPtr p = new PermissionsI();
    p->setUserRead(true);
    assert(p->isUserRead());
    details->setPermissions(p);
    // Available when returned from server
    // Possibly modifiable
    details->getOwner();
    details->setGroup(new ExperimenterGroupI(1L, false));
    // Available when returned from server
    // Not modifiable
    details->getCreationEvent();
    details->getUpdateEvent();
}
```

Example: examples/OmeroClients/details.cpp[28]

[26] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/rcollection.java
[27] http://www.openmicroscopy.org/site/support/ome-model/ome-xml/
[28] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/details.cpp

```
image = omero.model.ImageI();
details_ = image.getDetails();
p = omero.model.PermissionsI();
p.setUserRead(true);
assert( p.isUserRead() );
details_.setPermissions( p );
% Available when returned from server
% Possibly modifiable
details_.getOwner();
details_.setGroup( omero.model.ExperimenterGroupI(1, false) );
% Available when returned from server
% Not modifiable
details_.getCreationEvent();
details_.getUpdateEvent();
```

Example: examples/OmeroClients/details.m[29]

```
import omero
import omero.clients
image = omero.model.ImageI()
details = image.getDetails()
p = omero.model.PermissionsI()
p.setUserRead(True)
assert p.isUserRead()
details.setPermissions(p)
# Available when returned from server
# Possibly modifiable
details.getOwner()
details.setGroup(omero.model.ExperimenterGroupI(1L, False))
# Available when returned from server
# Not modifiable
details.getCreationEvent()
details.getUpdateEvent()
```

Example: examples/OmeroClients/details.py[30]

```
import omero.model.Image;
import omero.model.ImageI;
import omero.model.Details;
import omero.model.Permissions;
import omero.model.PermissionsI;
import omero.model.ExperimenterGroupI;
public class details {
    public static void main(String args[]) {
        Image image = new ImageI();
        Details details = image.getDetails();
        Permissions p = new PermissionsI();
        p.setUserRead(true);
        assert p.isUserRead();
        details.setPermissions(p);
        // Available when returned from server
        // Possibly modifiable
        details.getOwner();
        details.setGroup(new ExperimenterGroupI(1L, false));
        // Available when returned from server
        // Not modifiable
        details.getCreationEvent();
        details.getUpdateEvent();
```

[29] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/details.m
[30] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/details.py

```
    }
}
```

Example: examples/OmeroClients/details.java[31]

ObjectFactory and casting

In the previous examples, you may have noticed how there are two classes for each type: `Image` and `ImageI`. Classes defined in slice are by default data objects, more like C++'s `structs` than anything else. As soon as a class defines a method, however, it becomes an abstract entity and requires application writers to provide a **concrete implementation** (hence the "I"). All OMERO classes define methods, but OMERO takes care of providing the implementations for you via code generation. For each slice-defined and Ice-generated class `omero.model.Something`, there is an OMERO-generated class `omero.model.SomethingI` which can be instantiated.

```
#include <omero/model/ImageI.h>
#include <omero/model/DatasetI.h>
using namespace omero::model;
int main() {
    ImagePtr image = new ImageI();
    DatasetPtr dataset = new DatasetI(1L, false);
    image->linkDataset(dataset);
}
```

Example: examples/OmeroClients/constructors.cpp[32]

```
import omero.model.*;
image = ImageI();
dataset = DatasetI(1, false);
image.linkDataset(dataset)
```

Example: examples/OmeroClients/constructors.m[33]

```
import omero
import omero.clients
image = omero.model.ImageI()
dataset = omero.model.DatasetI(long(1), False)
image.linkDataset(dataset)
```

Example: examples/OmeroClients/constructors.py[34]

```
import java.util.Iterator;
import omero.model.Image;
import omero.model.ImageI;
import omero.model.Dataset;
import omero.model.DatasetI;
import omero.model.DatasetImageLink;
import omero.model.DatasetImageLinkI;
public class constructors {
    public static void main(String args[]) {
        Image image = new ImageI();
        Dataset dataset = new DatasetI(1L, false);
        image.linkDataset(dataset);
```

[31] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/details.java
[32] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constructors.cpp
[33] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constructors.m
[34] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constructors.py

```
    }
}
```

Example: examples/OmeroClients/constructors.java[35]

When *OME-Remote Objects* instances are serialized over the wire and arrive in the client, the Ice runtime must determine which constructor to call. It consults with the ObjectFactory, also provided by OMERO, to create the new classes. If you would like to have your own classes or subclasses created on deserialization, see the `Advanced topics` section below.

Such concrete implementations provide features which are not available in the solely Ice-based versions. When you would like to use these features, it is necessary to down-cast to the OMERO-based type.

For example, objects in each language binding provide a "more natural" form of iteration for that language.

```
#include <omero/model/ImageI.h>
#include <omero/model/DatasetI.h>
#include <omero/model/DatasetImageLinkI.h>
using namespace omero::model;
int main() {
    ImageIPtr image = new ImageI();
    DatasetIPtr dataset = new DatasetI();
    DatasetImageLinkPtr link = dataset->linkImage(image);
    omero::model::ImageDatasetLinksSeq seq = image->copyDatasetLinks();
    ImageDatasetLinksSeq::iterator beg = seq.begin();
    while(beg != seq.end()) {
        beg++;
    }
}
```

Example: examples/OmeroClients/iterators.cpp[36]

```
import omero.model.*;
image = ImageI();
dataset = DatasetI();
link = dataset.linkImage(image);
it = image.iterateDatasetLinks();
while it.hasNext()
   it.next().getChild().getName()
end
```

Example: examples/OmeroClients/iterators.m[37]

```
import omero
from omero_model_ImageI import ImageI
from omero_model_DatasetI import DatasetI
from omero_model_DatasetImageLinkI import DatasetImageLinkI
image = ImageI()
dataset = DatasetI()
link = dataset.linkImage(image)
for link in image.iterateDatasetLinks():
    link.getChild().getName();
```

Example: examples/OmeroClients/iterators.py[38]

[35] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/constructors.java
[36] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/iterators.cpp
[37] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/iterators.m
[38] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/iterators.py

```
import omero.model.ImageI;
import omero.model.Dataset;
import omero.model.DatasetI;
import omero.model.DatasetImageLink;
import omero.model.DatasetImageLinkI;
import java.util.*;
public class iterators {
    public static void main(String args[]) {
        ImageI image = new ImageI();
        Dataset dataset = new DatasetI();
        DatasetImageLink link = dataset.linkImage(image);
        Iterator<DatasetImageLinkI> it = image.iterateDatasetLinks();
        while (it.hasNext()) {
            it.next().getChild().getName();
        }
    }
}
```

Example: examples/OmeroClients/iterators.java[39]

]

Also, each concrete implementation provides static constants of various forms.

```
#include <omero/model/ImageI.h>
#include <iostream>
int main() {
        std::cout << omero::model::ImageI::NAME << std::endl;
        std::cout << omero::model::ImageI::DATASETLINKS << std::endl;
}
```

Example: examples/OmeroClients/staticfields.cpp[40]

```
disp(omero.model.ImageI.NAME);
disp(omero.model.ImageI.DATASETLINKS);
```

Example: examples/OmeroClients/staticfields.m[41]

```
import omero
from omero_model_ImageI import ImageI as ImageI
print ImageI.NAME
print ImageI.DATASETLINKS
```

Example: examples/OmeroClients/staticfields.py[42]

```
import omero.model.ImageI;
public class staticfields {
    public static void main(String[] args) {
        System.out.println(ImageI.NAME);
        System.out.println(ImageI.DATASETLINKS);
    }
}
```

Example: examples/OmeroClients/staticfields.java[43]

[39] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/iterators.java
[40] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/staticfields.cpp
[41] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/staticfields.m
[42] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/staticfields.py
[43] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/staticfields.java

Visibility and loadedness

In the constructor example above, a constructor with two arguments was used to create the `Dataset` instance linked to the new `Image`. The `Dataset` instance so created is considered "unloaded".

Objects and collections can be created unloaded as a pointer to an actual instance or they may be returned unloaded from the server when they are not actively accessed in a query. Because of the interconnectedness of the *OME-Remote Objects*, loading one object could conceivably require downloading a large part of the database if there were not some way to "snip-off" sections.

```
#include <omero/model/ImageI.h>
#include <omero/model/DatasetI.h>
#include <omero/ClientErrors.h>
using namespace omero::model;
int main() {
    ImagePtr image = new ImageI();          // A loaded object by default
    assert(image->isLoaded());
    image->unload();                        // can then be unloaded
    assert(! image->isLoaded());
    image = new ImageI( 1L, false );        // Creates an unloaded "proxy"
    assert(! image->isLoaded());
    image->getId();                         // Ok
    try {
        image->getName();                   // No data access is allowed other than id.
    } catch (const omero::ClientError& ce) {
        // Ok.
    }
}
```

Example: examples/OmeroClients/unloaded.cpp[44]

```
image = omero.model.ImageI();                % A loaded object by default
assert(image.isLoaded());
image.unload();
assert( ~ image.isLoaded() );                % can then be unloaded
image = omero.model.ImageI( 1, false );
assert( ~ image.isLoaded() );                % Creates an unloaded "proxy"
image.getId();                               % Ok.
try
    image.getName();                         % No data access is allowed other than id
catch ME
    % OK
end
```

Example: examples/OmeroClients/unloaded.m[45]

```
import omero
import omero.clients
image = omero.model.ImageI()                # A loaded object by default
assert image.isLoaded()
image.unload()                              # can then be unloaded
assert (not image.isLoaded())
image = omero.model.ImageI( 1L, False )     # Creates an unloaded "proxy"
assert (not image.isLoaded())
image.getId()                               # Ok
try:
    image.getName()                         # No data access is allowed other than id.
except:
    pass
```

[44] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/unloaded.cpp
[45] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/unloaded.m

Example: examples/OmeroClients/unloaded.py[46]

```
import omero.model.ImageI;
public class unloaded {
    public static void main(String args[]) {
        ImageI image = new ImageI();           // A loaded object by default
        assert image.isLoaded();
        image.unload();                        // can then be unloaded
        assert ! image.isLoaded();
        image = new ImageI( 1L, false );       // Creates an unloaded "proxy"
        assert ! image.isLoaded();
        image.getId();                         // Ok.
        try {
            image.getName();                   // No data access is allowed other than id.
        } catch (Exception e) {
            // Ok.
        }
    }
}
```

Example: examples/OmeroClients/unloaded.java[47]

When saving objects that have unloaded instances in their graph, the server will automatically fill in the values. So, if your `Dataset` contains a collection of `Images`, all of which are unloaded, then they will be reloaded before saving, based on the id. If, however, you had tried to set a value on one of the `Images`, you will get an exception.

To prevent errors when working with unloaded objects, all the *OME-Remote Objects* classes are marked as protected in the slice definitions which causes the implementations in each language to try to hide the fields. In Java and C++ this results in fields with "protected" visibility. In Python, an underscore is prefixed to all the variables. (In the Python case, we have also tried to "strengthen" the hiding of the fields, by overriding `__setattr__`. This is not full proof, but only so much can be done to hide values in Python.)

Collections

Just as an entire object can be unloaded, any collection field can also be unloaded. However, as mentioned above, since it is not possible to send a null collection over the wire with Ice and working with RTypes can be inefficient, all the *OME-Remote Objects* collections are hidden behind several methods.

```
#include <omero/model/DatasetI.h>
#include <omero/model/DatasetImageLinkI.h>
#include <omero/model/EventI.h>
#include <omero/model/ImageI.h>
#include <omero/model/PixelsI.h>
using namespace omero::model;
int main(int argc, char* argv[]) {
    ImagePtr image = new ImageI(1, true);
    image->getDetails()->setUpdateEvent( new EventI(1L, false) );
    // On creation, all collections are
    // initialized to empty, and can be added
    // to.
    assert(image->sizeOfDatasetLinks() == 0);
    DatasetPtr dataset = new DatasetI(1L, false);
    DatasetImageLinkPtr link = image->linkDataset(dataset);
    assert(image->sizeOfDatasetLinks() == 1);
    // If you want to work with this collection,
    // you'll need to get a copy.
    ImageDatasetLinksSeq links = image->copyDatasetLinks();
    // When you are done working with it, you can
    // unload the datasets, assuming the changes
```

[46] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/unloaded.py
[47] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/unloaded.java

```
    // have been persisted to the server.
    image->unloadDatasetLinks();
    assert(image->sizeOfDatasetLinks() < 0);
    try {
        image->linkDataset( new DatasetI() );
    } catch (…) {
        // Can't access an unloaded collection
    }
    // The reload...() method allows one instance
    // to take over a collection from another, if it
    // has been properly initialized on the server.
    // sameImage will have its collection unloaded.
    ImagePtr sameImage = new ImageI(1L, true);
    sameImage->getDetails()->setUpdateEvent( new EventI(1L, false) );
    sameImage->linkDataset( new DatasetI(1L, false) );
    image->reloadDatasetLinks( sameImage );
    assert(image->sizeOfDatasetLinks() == 1);
    assert(sameImage->sizeOfDatasetLinks() < 0);
    // If you would like to remove all the member
    // elements from a collection, don't unload it
    // but "clear" it.
    image->clearDatasetLinks();
    // Saving this to the database will remove
    // all dataset links!
    // Finally, all collections can be unloaded
    // to use an instance as a single row in the database.
    image->unloadCollections();
    // Ordered collections have slightly different methods.
    image = new ImageI(1L, true);
    image->addPixels( new PixelsI() );
    image->getPixels(0);
    image->getPrimaryPixels(); // Same thing
    image->removePixels( image->getPixels(0) );
}
```

Example: examples/OmeroClients/collectionmethods.cpp[48]

```
import omero.model.*;
image = ImageI(1, true);
image.getDetails().setUpdateEvent( EventI(1, false) );
% On creation, all collections are
% initialized to empty, and can be added
% to.
assert(image.sizeOfDatasetLinks() == 0);
dataset = DatasetI(1, false);
link = image.linkDataset(dataset);
assert(image.sizeOfDatasetLinks() == 1);
% If you want to work with this collection,
% you'll need to get a copy.
links = image.copyDatasetLinks();
% When you are done working with it, you can
% unload the datasets, assuming the changes
% have been persisted to the server.
image.unloadDatasetLinks();
assert(image.sizeOfDatasetLinks() < 0);
try
    image.linkDataset( DatasetI() );
catch ME
    % Can't access an unloaded collection
end
% The reload...() method allows one instance
```

[48] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/collectionmethods.cpp

```
% to take over a collection from another, if it
% has been properly initialized on the server.
% sameImage will have its collection unloaded.
sameImage = ImageI(1, true);
sameImage.getDetails().setUpdateEvent( EventI(1, false) );
sameImage.linkDataset( DatasetI(1, false) );
image.reloadDatasetLinks( sameImage );
assert(image.sizeOfDatasetLinks() == 1);
assert(sameImage.sizeOfDatasetLinks() < 0);
% If you would like to remove all the member
% elements from a collection, don't unload it
% but "clear" it.
image.clearDatasetLinks();
% Saving this to the database will remove
% all dataset links!
% Finally, all collections can be unloaded
% to use an instance as a single row in the database.
image.unloadCollections();
% Ordered collections have slightly different methods.
image = ImageI(1, true);
image.addPixels( PixelsI() );
image.getPixels(0);
image.getPrimaryPixels(); % Same thing
image.removePixels( image.getPixels(0) );
```

Example: examples/OmeroClients/collectionmethods.m[49]

```
import omero
import omero.clients
ImageI = omero.model.ImageI
DatasetI = omero.model.DatasetI
EventI = omero.model.EventI
PixelsI = omero.model.PixelsI
image = ImageI(long(1), True)
image.getDetails().setUpdateEvent( EventI(1L, False) )
# On creation, all collections are
# initialized to empty, and can be added
# to.
assert image.sizeOfDatasetLinks() == 0
dataset = DatasetI(long(1), False)
link = image.linkDataset(dataset)
assert image.sizeOfDatasetLinks() == 1
# If you want to work with this collection,
# you'll need to get a copy.
links = image.copyDatasetLinks()
# When you are done working with it, you can
# unload the datasets, assuming the changes
# have been persisted to the server.
image.unloadDatasetLinks()
assert image.sizeOfDatasetLinks() < 0
try:
    image.linkDataset( DatasetI() )
except:
    # Can't access an unloaded collection
    pass
# The reload...() method allows one instance
# to take over a collection from another, if it
# has been properly initialized on the server.
# sameImage will have its collection unloaded.
sameImage = ImageI(1L, True)
sameImage.getDetails().setUpdateEvent( EventI(1L, False) )
```

[49] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/collectionmethods.m

```
sameImage.linkDataset( DatasetI(long(1), False) )
image.reloadDatasetLinks( sameImage )
assert image.sizeOfDatasetLinks() == 1
assert sameImage.sizeOfDatasetLinks() < 0
# If you would like to remove all the member
# elements from a collection, don't unload it
# but "clear" it.
image.clearDatasetLinks()
# Saving this to the database will remove
# all dataset links!
# Finally, all collections can be unloaded
# to use an instance as a single row in the database.
image.unloadCollections()
# Ordered collections have slightly different methods.
image = ImageI(long(1), True)
image.addPixels( PixelsI() )
image.getPixels(0)
image.getPrimaryPixels() # Same thing
image.removePixels( image.getPixels(0) )
```

Example: examples/OmeroClients/collectionmethods.py[50]

```
import omero.model.Dataset;
import omero.model.DatasetI;
import omero.model.DatasetImageLink;
import omero.model.DatasetImageLinkI;
import omero.model.EventI;
import omero.model.Image;
import omero.model.ImageI;
import omero.model.Pixels;
import omero.model.PixelsI;
import java.util.*;
public class collectionmethods {
    public static void main(String args[]) {
        Image image = new ImageI(1, true);
        image.getDetails().setUpdateEvent( new EventI(1L, false) );
        // On creation, all collections are
        // initialized to empty, and can be added
        // to.
        assert image.sizeOfDatasetLinks() == 0;
        Dataset dataset = new DatasetI(1L, false);
        DatasetImageLink link = image.linkDataset(dataset);
        assert image.sizeOfDatasetLinks() == 1;
        // If you want to work with this collection,
        // you'll need to get a copy.
        List<DatasetImageLink> links = image.copyDatasetLinks();
        // When you are done working with it, you can
        // unload the datasets, assuming the changes
        // have been persisted to the server.
        image.unloadDatasetLinks();
        assert image.sizeOfDatasetLinks() < 0;
        try {
            image.linkDataset( new DatasetI() );
        } catch (Exception e) {
            // Can't access an unloaded collection
        }
        // The reload...() method allows one instance
        // to take over a collection from another, if it
        // has been properly initialized on the server.
        // sameImage will have its collection unloaded.
        Image sameImage = new ImageI(1L, true);
```

[50] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/collectionmethods.py

```
        sameImage.getDetails().setUpdateEvent( new EventI(1L, false) );
        sameImage.linkDataset( new DatasetI(1L, false) );
        image.reloadDatasetLinks( sameImage );
        assert image.sizeOfDatasetLinks() == 1;
        assert sameImage.sizeOfDatasetLinks() < 0;
        // If you would like to remove all the member
        // elements from a collection, don't unload it
        // but "clear" it.
        image.clearDatasetLinks();
        // Saving this to the database will remove
        // all dataset links!
        // Finally, all collections can be unloaded
        // to use an instance as a single row in the database.
        image.unloadCollections();
        // Ordered collections have slightly different methods.
        image = new ImageI(1L, true);
        image.addPixels( new PixelsI() );
        image.getPixels(0);
        image.getPrimaryPixels(); // Same thing
        image.removePixels( image.getPixels(0) );
    }
}
```

Example: examples/OmeroClients/collectionmethods.java[51]

These methods prevent clients from accessing the collections directly, and any improper access will lead to an `omero.ClientError`.

Interfaces

As mentioned above, one of the Java features which is missing from the slice definition language is the ability to have concrete classes implement **multiple** interfaces. Much of the *OME-Remote Objects* in the RMI-based types (`ome.model`) was based on the use of interfaces.

- IObject[52] is the root interface for all object types. **Methods**: `getId()`, `getDetails()`, …
- IEnum[53] is an enumeration value. **Methods**: `getValue()`
- ILink[54] is a link between two other types. **Methods**: `getParent()`, `getChild()`
- IMutable[55] is an instance for changes will be persisted. **Methods**: `getVersion()`

Instead, the Ice-based types (`omero.model`) all subclass from the same concrete type – `omero.model.IObject` – and it has several methods defined for testing which of the `ome.model` interfaces are implemented by any type.

Use of such methods is naturally less object-oriented and requires if/then blocks, but within the confines of the mapping language is a next-best option.

```
# No cpp example
```

```
import omero.model.*;
o = EventI();
assert( ~ o.isMutable() );
o = ExperimenterI();
assert( o.isMutable() );
assert( o.isGlobal() );
```

[51] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/collectionmethods.java
[52] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/IObject.java
[53] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/IEnum.java
[54] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/ILink.java
[55] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/IMutable.java

```
assert( o.isAnnotated() );
o = GroupExperimenterMapI();
assert( o.isLink() );
someObject = ExperimenterI();
% Some method call and you no longer know what someObject is
if (~ someObject.isMutable() )
    % No need to update
elseif (someObject.isAnnotated())
    % deleteAnnotations(someObject);
end
```

Example: examples/OmeroClients/interfaces.m[56]

```
import omero
from omero_model_EventI import EventI
from omero_model_ExperimenterI import ExperimenterI
from omero_model_GroupExperimenterMapI import GroupExperimenterMapI
assert ( not EventI().isMutable() )
assert ExperimenterI().isMutable()
assert ExperimenterI().isGlobal()
assert ExperimenterI().isAnnotated()
assert GroupExperimenterMapI().isLink()
```

Example: examples/OmeroClients/interfaces.py[57]

```
import omero.model.IObject;
import omero.model.EventI;
import omero.model.ExperimenterI;
import omero.model.GroupExperimenterMapI;
public class interfaces {
    public static void main(String args[]) {
        assert ! new EventI().isMutable();
        assert new ExperimenterI().isMutable();
        assert new ExperimenterI().isGlobal();
        assert new ExperimenterI().isAnnotated();
        assert new GroupExperimenterMapI().isLink();
        IObject someObject = new ExperimenterI();
        // Some method call and you no longer know what someObject is
        if ( ! someObject.isMutable()) {
            // No need to update
        } else if (someObject.isAnnotated()) {
           // deleteAnnotations(someObject);
        }
    }
}
```

Example: examples/OmeroClients/interfaces.java[58]

Improvement of this situation by adding abstract classes is planned. However, the entire functionality will not be achievable because of single inheritance.

Language-specific behavior

Smart pointers (C++ only)

An important consideration when working with C++ is that the *OME-Remote Objects* classes themselves have no copy-constructors and no assignment operator (operator=), and so cannot be allocated on the stack. Combined with smart pointers this effectively

[56] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/interfaces.m
[57] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/interfaces.py
[58] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/interfaces.java

prevents memory leaks.

The code generated types must be allocated on the heap with `new` and used in combination with the smart pointer typedefs which handle calling the destructor when the reference count hits zero.

```
#include <omero/model/ImageI.h>
using namespace omero::model;
int main()
{
    // ImageI image();                  // ERROR
    // ImageI image = new ImageI();     // ERROR
    ImageIPtr image1 = new ImageI();     // OK
    ImageIPtr image2(new ImageI());      // OK
    // image1 pointer takes value of image2
    // image1's content is garbage collected
    image1 = image2;
    //
    // Careful with boolean contexts
    //
    if (image1 && image1 == 1) {
        // Means non-null
        // This object can be dereferenced
    }
    ImageIPtr nullImage; // No assignment
    if ( !nullImage && nullImage == 0) {
        // Dereferencing nullImage here would throw an exception:
        // nullImage->getId(); // IceUtil::NullHandleException !
    }
}
```

Example: examples/OmeroClients/smartpointers.cpp[59]

```
# No m example
```

```
# No py example
```

```
# No java example
```

Warning: As shown in the example, using a smart pointer instance in a boolean or integer/long context, returns 1 for true (i.e. non-null) or 0 for false (i.e. null). Be especially careful with the RTypes.

For more information, see 6.14.6 Smart Pointers for Classes[60] in the Ice manual, which also describes the `Ice.GC.Interval` parameter which determines how often garbage collection runs in C++ to reap objects. This is necessary with the *OME-Remote Objects* since there are inherently cycles in the object graph.

Another point type which may be of use is `omero::client_ptr`. It also performs reference counting and will call `client.closeSession()` once the reference count hits zero. Without `client_ptr`, your code will need to be surrounded by a try/catch block. Otherwise, 1) sessions will be left open on the server, and 2) your client may hang on exit.

```
#include <omero/client.h>
int main(int argc, char* argv[])
{
    // Duplicating the argument list. ticket:1246
    Ice::StringSeq args1 = Ice::argsToStringSeq(argc, argv);
    Ice::StringSeq args2(args1);
```

[59] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/smartpointers.cpp
[60] https://doc.zeroc.com/display/Ice/Smart+Pointers+for+Classes

```
    Ice::InitializationData id1, id2;
    id1.properties = Ice::createProperties(args1);
    id2.properties = Ice::createProperties(args2);
    // Either
    omero::client client(id1);
    try {
        // Do something like
        // client.createSession();
    } catch (…) {
        client.closeSession();
    }
    //
    // Or
    //
    {
        omero::client_ptr client = new omero::client(id2);
        // Do something like
        // client->createSession();
    }
    // Client was destroyed via RAII
}
```

Example: examples/OmeroClients/clientpointer.cpp[61]

```
# No m example
```

```
# No py example
```

```
# No java example
```

__getattr__ and __setattr__ (Python only)

Like smart pointers for *OMERO C++ language bindings*, the *OMERO Python language bindings* SDK defines `__getattr__` and `__setattr__` methods for all *OME-Remote Objects* classes. Rather than explicitly calling the `getFoo()` and `setFoo()` methods, field-like access can be used. (It should be noted, however, that the accessors will perform marginally faster.)

```
# No cpp example
```

```
# No m example
```

```
import omero
import omero.clients
from omero.rtypes import *
i = omero.model.ImageI()
#
# Without __getattr__ and __setattr__
#
i.setName( rstring("name") )
assert i.getName().getValue() == "name"
#
# With __getattr__ and __setattr__
```

[61] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/clientpointer.cpp

```
#
i = omero.model.ImageI()
i.name = rstring("name")
assert i.name.val == "name"
#
# Collections, however, cannot be accessed
# via the special methods due to the dangers
# outlined above
#
try:
    i.datasetLinks[0]
except AttributeError, ae:
    pass
```

Example: examples/OmeroClients/getsetattr.py[62]

```
# No java example
```

Method inspection and code completion (Matlab & Python)

Ice generates a number of internal (private) methods which are not intended for general consumption. Unfortunately, Matlab's code-completion as well as Python's `dir` method return these methods, which can lead to confusion. In general, the API user can ignore any method beginning with an underscore or with `ice_`. For example,

```
>>>for i in dir(omero.model.ImageI):
...     if i.startswith("_") or i.startswith("ice_"):
...             print i
...
(snip)
_op_addAllDatasetImageLinkSet
_op_addAllImageAnnotationLinkSet
_op_addAllPixelsSet
_op_addAllRoiSet
_op_addAllWellSampleSet
...
ice_id
ice_ids
ice_isA
ice_ping
ice_postUnmarshal
ice_preMarshal
ice_staticId
ice_type
>>>
```

16.1.4 Services overview

After discussing the many types and how to create them, the next obvious question is what one can actually do with them. For that, we have to look at what services are provided by *OMERO.blitz*, how they are obtained, used, and cleaned up.

OMERO client configuration

The first step in accessing the *OMERO Application Programming Interface* and therefore the first thing to plan when writing an OMERO client is the proper configuration of an `omero.client` instance. The omero.client (or in C++ omero::client) class tries to wrap together and simplify as much of working with Ice as possible. Where it can, it imports or <#includes> types for you,

[62] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/getsetattr.py

creates an Ice.Communicator and registers an ObjectFactory. Typically, the only work on the client developers part is to properly configure the omero.client object and then login.

In the simplest case, configuration requires only the server host, username, and password with which you want to login. But as you can see below, there are various ways to configure your client, and this is really only the beginning.

```
#include <omero/client.h>
#include <iostream>
int main(int argc, char* argv[]) {
    // All configuration in file pointed to by
    // --Ice.Config=file.config
    // No username, password entered
    try {
        omero::client client1(argc, argv);
        client1.createSession();
        client1.closeSession();
    } catch (const Glacier2::PermissionDeniedException& pd) {
        // Bad password?
    } catch (const Ice::ConnectionRefusedException& cre) {
        // Bad address or port?
    }
    // Most basic configuration.
    // Uses default port 4064
    // createSession needs username and password
    try {
        omero::client client2("localhost");
        client2.createSession("root", "ome");
        client2.closeSession();
    } catch (const Glacier2::PermissionDeniedException& pd) {
        // Bad password?
    } catch (const Ice::ConnectionRefusedException& cre) {
        // Bad address or port?
    }
    // Configuration with port information
    try {
        omero::client client3("localhost", 24063);
        client3.createSession("root", "ome");
        client3.closeSession();
    } catch (const Glacier2::PermissionDeniedException& pd) {
        // Bad password?
    } catch (const Ice::ConnectionRefusedException& cre) {
        // Bad address or port?
    }
    // Advanced configuration in C++ takes place
    // via an InitializationData instance.
    try {
        Ice::InitializationData data;
        data.properties = Ice::createProperties();
        data.properties->setProperty("omero.host", "localhost");
        omero::client client4(data);
        client4.createSession("root", "ome");
        client4.closeSession();
    } catch (const Glacier2::PermissionDeniedException& pd) {
        // Bad password?
    } catch (const Ice::ConnectionRefusedException& cre) {
        // Bad address or port?
    }
    // std::map to be added (ticket:1278)
    try {
        Ice::InitializationData data;
        data.properties = Ice::createProperties();
        data.properties->setProperty("omero.host", "localhost");
        data.properties->setProperty("omero.user", "root");
        data.properties->setProperty("omero.pass", "ome");
        omero::client client5(data);
```

```
        // Again, no username or password needed
        // since present in the data. But they *can*
        // be overridden.
        client5.createSession();
        client5.closeSession();
    } catch (const Glacier2::PermissionDeniedException& pd) {
        // Bad password?
    } catch (const Ice::ConnectionRefusedException& cre) {
        // Bad address or port?
    }
}
```

Example: examples/OmeroClients/configuration.cpp[63]

```
% All configuration in file pointed to by
% --Ice.Config=file.config
% No username, password entered
args = javaArray('java.lang.String',1);
args(1) = java.lang.String('--Ice.Config=ice.config');
client1 = omero.client(args);
client1.createSession();
client1.closeSession();
% Most basic configuration.
% Uses default port 4064
% createSession needs username and password
client2 = omero.client('localhost');
client2.createSession('root', 'ome');
client2.closeSession();
% Configuration with port information
client3 = omero.client('localhost', 10463);
client3.createSession('root', 'ome');
client3.closeSession();
% Advanced configuration can also be done
% via an InitializationData instance.
data = Ice.InitializationData();
data.properties = Ice.Util.createProperties();
data.properties.setProperty('omero.host', 'localhost');
client4 = omero.client(data);
client4.createSession('root', 'ome');
client4.closeSession();
% Or alternatively via a java.util.Map instance
map = java.util.HashMap();
map.put('omero.host', 'localhost');
map.put('omero.user', 'root');
map.put('omero.pass', 'ome');
client5 = omero.client(map);
% Again, no username or password needed
% since present in the map. But they *can*
% be overridden.
client5.createSession();
client5.closeSession();
```

Example: examples/OmeroClients/configuration.m[64]

```
import omero
import Ice
# All configuration in file pointed to by
# --Ice.Config=file.config or ICE_CONFIG
# environment variable;
```

[63] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/configuration.cpp
[64] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/configuration.m

```
# No username, password entered
try:
    client1 = omero.client()
    client1.createSession()
    client1.closeSession()
except Ice.ConnectionRefusedException:
    pass # Bad address or port?
# Most basic configuration.
# Uses default port 4064
# createSession needs username and password
try:
    client2 = omero.client("localhost")
    client2.createSession("root","ome")
    client2.closeSession()
except Ice.ConnectionRefusedException:
    pass # Bad address or port?
# Configuration with port information
try:
    client3 = omero.client("localhost", 24064)
    client3.createSession("root","ome")
    client3.closeSession()
except Ice.ConnectionRefusedException:
    pass # Bad address or port?
# Advanced configuration can also be done
# via an InitializationData instance.
data = Ice.InitializationData()
data.properties = Ice.createProperties()
data.properties.setProperty("omero.host", "localhost")
try:
    client4 = omero.client(data)
    client4.createSession("root","ome")
    client4.closeSession()
except Ice.ConnectionRefusedException:
    pass # Bad address or port?
# Or alternatively via a dict instance
m = {"omero.host":"localhost",
     "omero.user":"root",
     "omero.pass":"ome"}
client5 = omero.client(m)
# Again, no username or password needed
# since present in the map. But they *can*
# be overridden.
try:
    client5.createSession()
    client5.closeSession()
except Ice.ConnectionRefusedException:
    pass # Bad address or port?
```

Example: examples/OmeroClients/configuration.py[65]

```
public class configuration {
  public static void main(String[] args) throws Exception {
    // All configuration in file pointed to by
    // --Ice.Config=file.config
    // No username, password entered
    omero.client client1 = new omero.client(args);
    try {
        client1.createSession();
    } catch (Ice.ConnectionRefusedException cre) {
        // Bad address or port?
    } finally {
```

[65] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/configuration.py

```
        client1.closeSession();
    }
    // Most basic configuration.
    // Uses default port 4064
    // createSession needs username and password
    omero.client client2 = new omero.client("localhost");
    try {
        client2.createSession("root", "ome");
    } catch (Ice.ConnectionRefusedException cre) {
        // Bad address or port?
    } finally {
        client2.closeSession();
    }
    // Configuration with port information
    omero.client client3 = new omero.client("localhost", 24064);
    try {
        client3.createSession("root", "ome");
    } catch (Ice.ConnectionRefusedException cre) {
        // Bad address or port?
    } finally {
        client3.closeSession();
    }
    // Advanced configuration can also be done
    // via an InitializationData instance.
    Ice.InitializationData data = new Ice.InitializationData();
    data.properties = Ice.Util.createProperties();
    data.properties.setProperty("omero.host", "localhost");
    omero.client client4 = new omero.client(data);
    try {
        client4.createSession("root", "ome");
    } catch (Ice.ConnectionRefusedException cre) {
        // Bad address or port?
    } finally {
        client4.closeSession();
    }
    // Or alternatively via a java.util.Map instance
    java.util.Map<String, String> map = new java.util.HashMap<String, String>();
    map.put("omero.host", "localhost");
    map.put("omero.user", "root");
    map.put("omero.pass", "ome");
    omero.client client5 = new omero.client(map);
    // Again, no username or password needed
    // since present in the map. But they *can*
    // be overridden.
    try {
        client5.createSession();
    } catch (Ice.ConnectionRefusedException cre) {
        // Bad address or port?
    } finally {
        client5.closeSession();
    }
  }
}
```

Example: examples/OmeroClients/configuration.java[66]

To find out more about using the `Ice.Config` file for configuration, see etc/templates/ice.config[67].

[66] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/configuration.java
[67] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/ice.config

What is a ServiceFactory?

In each of the examples above, the result of configuration was the ability to call `createSession` which returns a `ServiceFactoryPrx`.

The ServiceFactory is the clients representation of the user's *server-side session*, which multiple clients can connect to it simultaneously. A ServiceFactoryPrx? object is acquired on login via the `createSession` method, and persists until either it is closed or a timeout is encountered **unless** additional clients attach to it. This is done via `client.joinSession(String uuid)`. In that case, the session is not finally closed until its reference count drops to zero.

It produces services!

Once a client has been configured properly, and has an active in ServiceFactory in hand, it is time to start accessing services.

The collection of all services provided by OMERO is known as the *OMERO Application Programming Interface*. Each service is defined in a slice file under components/blitz/resources/omero[68]. The central definitions are in components/blitz/resources/omero/API.ice[69], along with the definition of ServiceFactory itself:

```
interface ServiceFactory extends Glacier2::Session
{
    // Central OMERO.blitz stateless services.
    IAdmin*          getAdminService() throws ServerError;
    IConfig*         getConfigService() throws ServerError;
    …
    // Central OMERO.blitz stateful services.
    Gateway*         createGateway() throws ServerError;
    …
```

In the definition above, the return values look like C/C++ pointers, which in Ice's definition language represents return-by-proxy. When a client calls, serviceFactory.getAdminService() it will receive an IAdminPrx. **Any call on that object is a remote invocation.**

Stateless vs. stateful

Most methods on the ServiceFactory return either a stateless or a stateful service factory. Stateless services are those returned by calls to "getSomeNameService()". They implement `omero.api.ServiceInterface` but not its subinterface `omero.api.StatefulServiceInterface`. Stateless services are for all intents and purposes singletons, though the implementation may vary.

Stateful services are returned by calls to "createSomething()" and implement `omero.api.StatefulServiceInterface`. Each maintains a state machine with varying rules on initialization and usage. It is important to guarantee that calls are ordered as described in the documentation for each stateful service. **It is also important to always close stateful services to free up server resources.** If you fail to manually call `StatefulServiceInterfacePrx.close()`, it will be called for you on session close/timeout.

What are timeouts?

The following code has a resource leak:

```
import omero, sys
c = omero.client()
s = c.createSession()
sys.exit(0)
```

Although the client will not suffer any consequences, this snippet leaves a *session* open on the server. If the server failed to eventually reap such sessions, they would eventually consume all available memory. To get around this, the server implements

[68] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/blitz/resources/omero
[69] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/API.ice

timeouts on all sessions. **It is the clients responsibility to periodically contact the server to keep the session alive.** Since threading policies vary in applications, no strict guideline is available on how to do this. Almost any API method will suffice to tell the server that the client is still active. Important is that the call happens within every timeout window.

```
# No cpp example
```

```
# No m example
```

```
import time
import omero
import threading
IDLETIME = 5
c = omero.client()
s = c.createSession()
re = s.createRenderingEngine()
class KeepAlive(threading.Thread):
    def run(self):
        self.stop = False
        while not self.stop:
            time.sleep(IDLETIME)
            print "calling keep alive"
            # Currently, passing a null or empty array to keepAllAlive
            # would suffice. For future-proofing, however, it makes sense
            # to pass stateful services.
            try:
                s.keepAllAlive([re])
            except:
                c.closeSession()
                raise
keepAlive = KeepAlive()
keepAlive.start()
time.sleep(IDLETIME * 2)
keepAlive.stop = True
```

Example: examples/OmeroClients/timeout.py[70]

```
import omero.*;
import omero.api.*;
import omero.model.*;
import omero.sys.*;
public class timeout {
    static int IDLETIME = 5;
    static client c;
    static ServiceFactoryPrx s;
    public static void main(String[] args) throws Exception {
        final int idletime = args.length > 1 ? Integer.parseInt(args[0]) : IDLETIME;
        c = new client(args);
        s = c.createSession();
        System.out.println(s.getAdminService().getEventContext().sessionUuid);
        final RenderingEnginePrx re = s.createRenderingEngine(); // for keep alive
        class Run extends Thread {
            public boolean stop = false;
                public void run() {
                while ( ! stop ) {
                    try {
                        Thread.sleep(idletime*1000L);
                    } catch (Exception e) {
                        // ok
```

[70] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/timeout.py

```
                    }
                    System.out.println(System.currentTimeMillis() + " calling keep alive");
                    try {
                        // Currently, passing a null or empty array to keepAllAlive
                        // would suffice. For future-proofing, however, it makes sense
                        // to pass stateful services.
                        s.keepAllAlive(new ServiceInterfacePrx[]{re});
                    } catch (Exception e) {
                        c.closeSession();
                        throw new RuntimeException(e);
                    }
                }
            }
        }
        final Run run = new Run();
        class Stop extends Thread {
            public void run() {
                run.stop = true;
            }
        }
        Runtime.getRuntime().addShutdownHook(new Stop());
        run.start();
    }
}
```

Example: examples/OmeroClients/timeout.java[71]

Exceptions

Probably the most critical thing to realize is that any call on a proxy, which includes `ServiceFactoryPrx` or any of the *Prx service classes is a remote invocation on the server. Therefore proper exception handling is critical. The definition of the various exceptions is outlined on the *Exception handling* page and so will not be repeated here. However, how are these sensibly used?

One easy rule is that every `omero.client` object which you successfully call `createSession()` on must have `closeSession()` called on it before you exit.

```
omero.client client = new omero.client();
client.createSession();
try {
  // do whatever you want
} finally {
  client.closeSession();
}
```

Obviously, the work you do in your client will be much more complicated, and may be under layers of application code. But when designing where active `omero.client` objects are kept, be sure that your clean-up code takes care of them.

16.1.5 IQuery

Now that we have a good idea of the basics, it might be interesting to start asking the server what it has got. The most powerful way of doing this is by using IQuery and the Hibernate Query Language (HQL).

```
#include <omero/api/IQuery.h>
#include <omero/client.h>
#include <omero/RTypesI.h>
#include <omero/sys/ParametersI.h>
using namespace omero::rtypes;
```

[71] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/timeout.java

```
int main(int argc, char* argv[]) {
    omero::client_ptr client = new omero::client(argc, argv);
    omero::api::ServiceFactoryPrx sf = client->createSession();
    omero::api::IQueryPrx q = sf->getQueryService();
    std::string query_string = "select i from Image i where i.id = :id and name like :namedParameter";
    omero::sys::ParametersIPtr p = new omero::sys::ParametersI();
    p->add("id", rlong(1L));
    p->add("namedParameter", rstring("cell%mit%"));
    omero::api::IObjectList results = q->findAllByQuery(query_string, p);
}
```

Example: examples/OmeroClients/queries.cpp[72]

```
[client,sf] = loadOmero;
try
    q = sf.getQueryService();
    query_string = 'select i from Image i where i.id = :id and name like :namedParameter';
    p = omero.sys.ParametersI();
    p.add('id', omero.rtypes.rlong(1));
    p.add('namedParameter', omero.rtypes.rstring('cell%mit%'));
    results = q.findAllByQuery(query_string, p) % java.util.List
catch ME
    client.closeSession();
end
```

Example: examples/OmeroClients/queries.m[73]

```
import sys
import omero
from omero.rtypes import *
from omero_sys_ParametersI import ParametersI
client = omero.client(sys.argv)
try:
    sf = client.createSession()
    q = sf.getQueryService()
    query_string = "select i from Image i where i.id = :id and name like :namedParameter";
    p = ParametersI()
    p.addId(1L)
    p.add("namedParameter", rstring("cell%mit%"));
    results = q.findAllByQuery(query_string, p)
finally:
    client.closeSession()
```

Example: examples/OmeroClients/queries.py[74]

```
import java.util.List;
import static omero.rtypes.*;
import omero.api.ServiceFactoryPrx;
import omero.api.IQueryPrx;
import omero.model.IObject;
import omero.model.ImageI;
import omero.model.PixelsI;
import omero.sys.ParametersI;
public class queries {
    public static void main(String args[]) throws Exception {
        omero.client client = new omero.client(args);
        try {
```

[72] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/queries.cpp
[73] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/queries.m
[74] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/queries.py

```
            ServiceFactoryPrx sf = client.createSession();
            IQueryPrx q = sf.getQueryService();
            String query_string = "select i from Image i where i.id = :id and name like :namedParameter
            ParametersI p = new ParametersI();
            p.add("id", rlong(1L));
            p.add("namedParameter", rstring("cell%mit%"));
            List<IObject> results = q.findAllByQuery(query_string, p);
        } finally {
            client.closeSession();
        }
    }
}
```

Example: examples/OmeroClients/queries.java[75]

The `query_string` is an example of HQL. It looks a lot like SQL, but works with objects and fields rather than tables and columns (though in OMERO these are usually named the same). The `Parameters` object allow for setting named parameters (`:id`) in the query to allow for re-use, and is the only other argument need to `IQueryPrx.findAllByQuery()` to get a list of `IObject` instances back. They are guaranteed to be of type `omero::model::Image`, but you may have to cast them to make full use of that information.

16.1.6 IUpdate

After you have successfully read objects, an obvious thing to do is create your own. Below is a simple example of creating an image object:

```
#include <IceUtil/Time.h>
#include <omero/api/IUpdate.h>
#include <omero/client.h>
#include <omero/RTypesI.h>
#include <omero/model/ImageI.h>
using namespace omero::rtypes;
int main(int argc, char* argv[]) {
    omero::client_ptr client = new omero::client(argc, argv);
    omero::model::ImagePtr i = new omero::model::ImageI();
    i->setName( rstring("name") );
    i->setAcquisitionDate( rtime(IceUtil::Time::now().toMilliSeconds()) );
    omero::api::ServiceFactoryPrx sf = client->createSession();
    omero::api::IUpdatePrx u = sf->getUpdateService();
    i = omero::model::ImagePtr::dynamicCast( u->saveAndReturnObject( i ) );
}
```

Example: examples/OmeroClients/updates.cpp[76]

```
[client,sf] = loadOmero;
try
    i = omero.model.ImageI();
    i.setName(omero.rtypes.rstring('name'));
    i.setAcquisitionDate(omero.rtypes.rtime(java.lang.System.currentTimeMillis()));
    u = sf.getUpdateService();
    i = u.saveAndReturnObject( i );
    disp(i.getId().getValue());
catch ME
    disp(ME);
    client.closeSession();
end
```

[75] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/queries.java
[76] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/updates.cpp

Example: examples/OmeroClients/updates.m[77]

```
import sys
import time
import omero
import omero.clients
from omero.rtypes import *
client = omero.client(sys.argv)
try:
    i = omero.model.ImageI()
    i.name = rstring("name")
    i.acquisitionDate = rtime(time.time() * 1000)
    sf = client.createSession()
    u = sf.getUpdateService()
    i = u.saveAndReturnObject( i )
finally:
    client.closeSession()
```

Example: examples/OmeroClients/updates.py[78]

```
import java.util.List;
import static omero.rtypes.*;
import omero.api.ServiceFactoryPrx;
import omero.api.IUpdatePrx;
import omero.model.ImageI;
import omero.model.Image;
public class updates {
    public static void main(String args[]) throws Exception {
        omero.client client = new omero.client(args);
        try {
            Image i = new ImageI();
            i.setName( rstring("name") );
            i.setAcquisitionDate( rtime(System.currentTimeMillis()) );
            ServiceFactoryPrx sf = client.createSession();
            IUpdatePrx u = sf.getUpdateService();
            i = (Image) u.saveAndReturnObject( i );
        } finally {
            client.closeSession();
        }
    }
}
```

Example: examples/OmeroClients/updates.java[79]

16.1.7 Examples

To tie together some of the topics which we have outlined above, we would like to eventually have several more or less complete application examples which you can use to get started. For the moment, there is just one simpler example `TreeList`, but more will certainly be added. Let us know any ideas you may have.

TreeList

```
# No cpp example
```

[77] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/updates.m
[78] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/updates.py
[79] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/updates.java

```
function projects = AllProjects(query, username)
q = ['select p from Project p join fetch p.datasetLinks dil ',...
     'join fetch dil.child where p.details.owner.omeName = :name'];
p = omero.sys.ParametersI();
p.add('name', omero.rtypes.rstring(username));
projects = query.findAllByQuery(q, p);
```

Example: examples/TreeList/AllProjects.m[80]

```
import omero
from omero.rtypes import *
from omero_sys_ParametersI import ParametersI
def getProjects(query_prx, username):
    return query_prx.findAllByQuery(
            "select p from Project p join fetch p.datasetLinks dil join fetch dil.child where p.details
            ParametersI().add("name", rstring(username)))
```

Example: examples/TreeList/AllProjects.py[81]

```
import java.util.List;
import omero.model.Project;
import omero.api.IQueryPrx;
import omero.sys.ParametersI;
import static omero.rtypes.*;
public class AllProjects {
    public static List<Project> getProjects(IQueryPrx query, String username) throws Exception {
        List rv = query.findAllByQuery(
            "select p from Project p join fetch p.datasetLinks dil join fetch dil.child where p.details
            new ParametersI().add("name", rstring(username)));
        return (List<Project>) rv;
    }
}
```

Example: examples/TreeList/AllProjects.java[82]

```
# No cpp example
```

```
function PrintProjects(projects)
if (projects.size()==0)
    return;
end;
for i=0:projects.size()-1,
    project = projects.get(i);
    disp(project.getName().getValue());
    links = project.copyDatasetLinks();
    if (links.size()==0)
        return
    end
    for j=0:links.size()-1,
        pdl = links.get(j);
        dataset = pdl.getChild();
        disp(sprintf('  %s', char(dataset.getName().getValue())));
    end
end
```

[80] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/AllProjects.m
[81] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/AllProjects.py
[82] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/AllProjects.java

Example: examples/TreeList/PrintProjects.m[83]

```
def print_(projects):
    for project in projects:
        print project.getName().val
        for pdl in project.copyDatasetLinks():
            dataset = pdl.getChild()
            print "  " + dataset.getName().val
```

Example: examples/TreeList/PrintProjects.py[84]

```
import java.util.List;
import omero.model.Project;
import omero.model.ProjectDatasetLink;
import omero.model.Dataset;
public class PrintProjects {
    public static void print(List<Project> projects) {
        for (Project project : projects) {
            System.out.print(project.getName().getValue());
            for (ProjectDatasetLink pdl : project.copyDatasetLinks()) {
                Dataset dataset = pdl.getChild();
                System.out.println("  " + dataset.getName().getValue());
            }
        }
    }
}
```

Example: examples/TreeList/PrintProjects.java[85]

```
#include <omero/client.h>
#include <Usage.h>
#include <AllProjects.h>
#include <PrintProjects.h>
int main(int argc, char* argv[]) {
    std::string host, port, user, pass;
    try {
        host = argv[0];
        port = argv[1];
        user = argv[2];
        pass = argv[3];
    } catch (…) {
        Usage::usage();
    }
    omero::client client(argc, argv);
    int rc = 0;
    try {
        omero::api::ServiceFactoryPrx factory = client.createSession(user, pass);
        std::vector<omero::model::ProjectPtr> projects = AllProjects::getProjects(factory->getQueryServ
        PrintProjects::print(projects);
    } catch (…) {
        client.closeSession();
    }
    return rc;
}
```

Example: examples/TreeList/Main.cpp[86]

[83] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/PrintProjects.m
[84] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/PrintProjects.py
[85] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/PrintProjects.java
[86] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/Main.cpp

```
function Main(varargin)
try
    host = varargin{1};
    port = varargin{2};
    user = varargin{3};
    pass = varargin{4};
catch ME
    Usage
end
client = omero.client(host, port);
factory = client.createSession(user, pass);
projects = AllProjects(factory.getQueryService(), user);
PrintProjects(projects);
client.closeSession();
```

Example: examples/TreeList/Main.m[87]

```
import sys
import omero
import Usage, AllProjects, PrintProjects
if __name__ == "__main__":
    try:
        host = sys.argv[1]
        port = sys.argv[2]
        user = sys.argv[3]
        pasw = sys.argv[4]
    except:
        Usage.usage()
    client = omero.client(sys.argv)
    try:
        factory = client.createSession(user, pasw)
        projects = AllProjects.getProjects(factory.getQueryService(), user)
        PrintProjects.print_(projects)
    finally:
        client.closeSession()
```

Example: examples/TreeList/Main.py[88]

```
import omero.api.ServiceFactoryPrx;
import omero.model.Project;
import java.util.List;
public class Main {
    public static void main(String args[]) throws Exception{
        String host = null, port = null, user = null, pass = null;
        try {
            host = args[0];
            port = args[1];
            user = args[2];
            pass = args[3];
        } catch (Exception e) {
            Usage.usage();
        }
        omero.client client = new omero.client(args);
        try {
            ServiceFactoryPrx factory = client.createSession(user, pass);
            List<Project> projects = AllProjects.getProjects(factory.getQueryService(), user);
            PrintProjects.print(projects);
        } finally {
            client.closeSession();
```

[87] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/Main.m
[88] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/Main.py

```
        }
    }
}
```

Example: examples/TreeList/Main.java[89]

16.1.8 Advanced topics

Sudo

If you are familiar with the admin user concept in OMERO, you might wonder if it is possible for administrative users to perform tasks for regular users. Under Unix-based systems this is commonly known as "sudo" functionality. Although not (yet) as straightforward, it is possible to create sessions for other users and carry out actions on their behalf.

```
#include <iostream>
#include <omero/api/IAdmin.h>
#include <omero/api/ISession.h>
#include <omero/client.h>
#include <omero/model/Session.h>
int main(int argc, char* argv[]) {
    Ice::StringSeq args1 = Ice::argsToStringSeq(argc, argv);
    Ice::StringSeq args2(args1); // Copies
    // ticket:1246
    Ice::InitializationData id1;
    id1.properties = Ice::createProperties(args1);
    Ice::InitializationData id2;
    id2.properties = Ice::createProperties(args2);
    omero::client_ptr client = new omero::client(id1);
    omero::client_ptr sudoClient = new omero::client(id2);
    omero::api::ServiceFactoryPrx sf = client->createSession();
    omero::api::ISessionPrx sessionSvc = sf->getSessionService();
    omero::sys::PrincipalPtr p = new omero::sys::Principal();
    p->name = "root"; // Can change to any user
    p->group = "user";
    p->eventType = "User";
    omero::model::SessionPtr sudoSession = sessionSvc->createSessionWithTimeout( p, 3*60*1000L ); // 3
    omero::api::ServiceFactoryPrx sudoSf = sudoClient->joinSession( sudoSession->getUuid()->getValue()
    omero::api::IAdminPrx sudoAdminSvc = sudoSf->getAdminService();
    std::cout << sudoAdminSvc->getEventContext()->userName;
}
```

Example: examples/OmeroClients/sudo.cpp[90]

```
client = omero.client();
sudoClient = omero.client();
try
    sf = client.createSession('root','ome');
    sessionSvc = sf.getSessionService();
    p = omero.sys.Principal();
    p.name = 'root'; % Can change to any user
    p.group = 'user';
    p.eventType = 'User';
    sudoSession = sessionSvc.createSessionWithTimeout( p, 3*60*1000 ); % 3 minutes to live
    sudoSf = sudoClient.joinSession( sudoSession.getUuid().getValue() );
    sudoAdminSvc = sudoSf.getAdminService();
    disp(sudoAdmin.Svc.getEventContext().userName);
catch ME
```

[89] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/TreeList/Main.java
[90] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/sudo.cpp

```
    sudoClient.closeSession();
    client.closeSession();
end
```

Example: examples/OmeroClients/sudo.m[91]

```
import sys
import omero
args = list(sys.argv)
client = omero.client(args)
sudoClient = omero.client(args)
try:
    sf = client.createSession("root", "ome")
    sessionSvc = sf.getSessionService()
    p = omero.sys.Principal()
    p.name = "root" # Can change to any user
    p.group = "user"
    p.eventType = "User"
    sudoSession = sessionSvc.createSessionWithTimeout( p, 3*60*1000L ) # 3 minutes to live
    sudoSf = sudoClient.joinSession( sudoSession.getUuid().getValue() )
    sudoAdminSvc = sudoSf.getAdminService()
    print sudoAdminSvc.getEventContext().userName
finally:
    sudoClient.closeSession()
    client.closeSession()
```

Example: examples/OmeroClients/sudo.py[92]

```
import java.util.List;
import omero.api.IAdminPrx;
import omero.api.ISessionPrx;
import omero.api.ServiceFactoryPrx;
import omero.model.Session;
import omero.sys.Principal;
public class sudo {
    public static void main(String args[]) throws Exception {
        omero.client client = new omero.client(args);
        omero.client sudoClient = new omero.client(args);
        try {
            ServiceFactoryPrx sf = client.createSession("root", "ome");
            ISessionPrx sessionSvc = sf.getSessionService();
            Principal p = new Principal();
            p.name = "root"; // Can change to any user
            p.group = "user";
            p.eventType = "User";
            Session sudoSession = sessionSvc.createSessionWithTimeout( p, 3*60*1000L ); // 3 minutes to
            ServiceFactoryPrx sudoSf = sudoClient.joinSession( sudoSession.getUuid().getValue() );
            IAdminPrx sudoAdminSvc = sudoSf.getAdminService();
            System.out.println( sudoAdminSvc.getEventContext().userName );
        } finally {
            sudoClient.closeSession();
            client.closeSession();
        }
    }
}
```

Example: examples/OmeroClients/sudo.java[93]

[91] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/sudo.m
[92] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/sudo.py
[93] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/examples/OmeroClients/sudo.java

Proposed

Like the complete examples above, there are several topics which need to be covered in more detail:

- how to detect client/server version mismatches
- how to make asynchronous methods
- how to use client callbacks
- how to make use of your own `ObjectFactory`

16.1.9 Planned improvements and known issues

Topics to be added

Obviously, this introduction is still not exhaustive by any means. Some topics which we would like to see added here in the near future include:

- more examples of working with the *OME-Remote Objects*
- examples of all services
- security and ownership
- performance

Code generation

Although not directly relevant to writing a client, it is important to note that much of the code for *OMERO Python language bindings*, *OMERO C++ language bindings*, and *OMERO Java language bindings* is code generated by the BlitzBuild. Therefore, many of the imported and included files in the examples above cannot be found in github[94].

We plan to include packages of the generated source code in future releases. Until then, it is possible to find our latest builds on jenkins[95] or to build them locally, although some of the generated files are later overwritten by hand-written versions:

- model is located in `components/tools/OmeroCpp/src/omero/model/`
- OmeroPy is located in `components/tools/OmeroPy/src/`

Lazy loading and caching

Separate method calls will often return one and the same object, say `Dataset#123`. Your application, however, will not necessarily recognize them as the same entity unless you explicitly check the id value. A client-side caching mechanism would allow duplicate objects to be handled transparently, and would eventually facilitate lazy loading.

Helper classes

Several types are harder to use than they need be. omero.sys.Parameters, for example, is a class for which native implementations are quite helpful. We have provided omero.sys.ParametersI in all supported languages, and will most likely support more over time:

Other

- Superclasses need to be introduced where possible to replace the `ome.model.*` interfaces
- Annotation-link-loading can behave strangely if `AnnotationLink.child` is not loaded.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

[94] https://github.com/openmicroscopy/openmicroscopy
[95] https://ci.openmicroscopy.org/

16.2 OMERO Application Programming Interface

All interaction with the OMERO server takes place via several API services available from a ServiceFactory. A service factory is obtained from the client connection e.g. Python:

```
client = omero.client("localhost")
session = client.createSession("username", "password")    # this is the service factory
adminService = session.getAdminService()                  # now we can get/create services
```

- The Service factory API[96] has methods for creating Stateless and Stateful services (see below).
  - Stateless services are obtained using "get…" methods e.g. `getQueryService()`
  - Stateful services are obtained using "create…" methods e.g. `createRenderingEngine()`
- Services will provide access to omero.model.objects. You will then need the API for these objects[97], e.g. Dataset, Image, Pixels etc.

16.2.1 Services list

The ome.api[98] package in the common component defines the central "verbs" of the OMERO system. All external interactions with the system should happen with these verbs, or services. Each OMERO service belongs to a particular service level with each level calling only on services from lower levels.

Service Level 1 (direct database and Hibernate connections)

- AdminService: src[99], API[100] for working with Experimenters, Groups and the current Context (switching groups etc).
- ConfigService: src[101], API[102] for getting and setting config parameters.
- ContainerService: API[103] for loading Project, Dataset and Image hierarchies.
- LdapService: src[104], API[105] for communicating with LDAP servers.
- MetadataService: API[106] for working with Annotations.
- PixelsService: API[107] for pixels stats and creating Images with existing or new Pixels.
- ProjectionService API[108]
- QueryService: src[109], API[110] for custom SQL-like queries.
- RenderingSettingsService API[111] for copying, pasting & resetting rendering settings.
- RepositoryInfo API[112] disk space stats.
- RoiService API[113] working with ROIs.
- ScriptService API[114] for uploading and launching Python scripts.

[96] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ServiceFactory.html
[97] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model.html
[98] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/common/src/ome/api
[99] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IAdmin.java
[100] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IAdmin.html
[101] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IConfig.java
[102] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IConfig.html
[103] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IContainer.html
[104] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/ILdap.java
[105] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ILdap.html
[106] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IMetadata.html
[107] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IPixels.html
[108] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IProjection.html
[109] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IQuery.java
[110] http://downloads.openmicroscopy.org/latest/omero/api/ome/api/IQuery.html
[111] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IRenderingSettings.html
[112] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IRepositoryInfo.html
[113] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IRoi.html
[114] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IScript.html

- SessionService API[115] for creating and working with OMERO sessions.
- ShareService API[116]
- TimelineService API[117] for queries based on time.
- TypesService API[118] for Enumerations.
- UpdateService: src[119], API[120] for saving and deleting omero.model objects.

Service Level 2

- IContainer[121]
- ITypes[122]

Stateful/Binary Services

- RawFileStore: src[123], API[124]
- RawPixelsStore: src[125], API[126]
- RenderingEngine: src[127], API[128] (see *OMERO rendering engine* for more)
- ThumbnailStore: src[129], API[130]
- IScale[131]

A complete list of service APIs can be found here[132] and some examples of API use in Python are provided. Java or C++ code can use the same API in a very similar manner.

16.2.2 Discussion

Reads and writes

IQuery and IUpdate are the basic building blocks for the rest of the (non-binary) API. IQuery is based on QuerySources and QueryParemeters which are explained under *Using server queries internally*. The goal of this design is to make wildly separate definitions of queries (templates, db-stored, Java code, C# code, …) runnable on the server.

IUpdate takes any graph composed of IObject[133] objects and checks them for dirtiness. All changes to the graph are stored in the database if the user calling IUpdate has the proper permissions, otherwise an exception is thrown.

Dirty checks follow the Three Commandments:

1. Any IObject-valued field with unloaded set to true is treated as a place holder (proxy) and is re-loaded from the database.
2. Any collection-valued field with a null value is re-loaded from the database.

[115] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ISession.html
[116] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/IShare.html
[117] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ITimeline.html
[118] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/ITypes.html
[119] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IUpdate.java
[120] http://downloads.openmicroscopy.org/latest/omero/api/ome/api/IUpdate.html
[121] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IContainer.java
[122] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/ITypes.java
[123] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/RawFileStore.java
[124] http://downloads.openmicroscopy.org/latest/omero/api/ome/api/RawFileStore.html
[125] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/RawPixelsStore.java
[126] http://downloads.openmicroscopy.org/latest/omero/api/ome/api/RawPixelsStore.html
[127] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/omeis/providers/re/RenderingEngine.java
[128] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api/RenderingEngine.html
[129] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/ThumbnailStore.java
[130] http://downloads.openmicroscopy.org/latest/omero/api/ome/api/ThumbnailStore.html
[131] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IScale.java
[132] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/api.html
[133] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/IObject.java

3. Any collection-valued field with the FILTERED flag is assumed to be dirty and is loaded from the database, with the future option of examining the filtered collection for any new and updated values and applying them to the real collection. (Deletions cannot happen this way since it would be unclear if the object was filtered or deleted.)

Administration

The IAdmin[134] interface defines all the actions necessary to administer the *Server security and firewalls* . It is explained further on the *OMERO admin interface* page.

Model Object Java

Certain operations, like those dealing with data management and viewing, happen more frequently than others (like defining microscopes). Those have been collected in the IContainer[135] interface. IContainer simplifies a few very common queries, and there is a related package ("omero.gateway.model.*") for working with the returned graphs. OMERO.insight works almost exclusively with the IContainer interface for its non-binary needs.

16.2.3 Examples

```
// Saving a simple change
Dataset d = iQuery.get( Dataset.class,1L );
d.setName( "test" );
iUpdate.saveObject( d );

// Creating a new object
Dataset d = new Dataset();
d.setName( "test" ); // not-null fields must be filled in
iUpdate.saveObject( d );

// Retrieving a graph
Set<Dataset> ds = iQuery.findAllByQuery( "from Dataset d left outer join d.images where d.name = 'test'"
```

16.2.4 Stateless versus stateful services

A stateless service has no client-noticeable lifecycle and all instances can be treated equally. A new stateful service, on the other hand, will be created for each client-side proxy (see the `ServiceFactory.create\*` methods). Once obtained, a stateful service proxy can only be used by a single user. After task completion, the service should be closed (`proxy.close()`) to free up server resources.

16.2.5 How to write a service

A tutorial is available at *How To create a service*. In general, if a properly annotated service is placed in any JAR of the OMERO EAR file (see *Build System* for more) then the service will be deployed to the server. In the case of *OMERO.blitz*, the service must be properly defined under components/blitz/resources[136].

16.2.6 OMERO annotations for validation

The server-side implementation of these interfaces makes use of ((JDK5)) *Structured annotations* and an *AOP* interceptor to validate all method parameters. Calls to `pojos.findContainerHierarches` are first caught by a method interceptor, which checks for annotations on the parameters and, if available, performs the necessary checks. The interceptor also makes proactive checks. For a range of parameter types (such as Java Collections) it requires that annotations exist and will refuse to proceed if not implemented.

[134] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IAdmin.java
[135] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IContainer.java
[136] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/blitz/resources

An API call of the form:

```
pojos.findContainerHierarches(Class,Set,Map)
```

is implemented as

```
pojos.findContainerHierarchies(@NotNull Class, @NotNull @Validate(Integer.class) Set, Map)
```

See also:

Using server queries internally, *OMERO rendering engine*, *Exception handling*

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.3 OMERO admin interface

The one central interface for administering the OMERO security system is IAdmin. Though several of the methods are restricted to system users (root and other administrators), many are also for general use. The `RolesAllowed` annotations on the LocalAdmin[137] class define who can use which methods.

16.3.1 Actions available through IAdmin and IUpdate

A couple of the methods in the IAdmin interface are also available implicitly through IUpdate, the main interface for updating the database. This duplication is mainly useful for large scale changes, such as changing the permissions to an entire object graph.

- changePermissions
- changeGroup

The following shows how these methods can be equivalently used:

```
 // setup
ServiceFactory sf = new ServiceFactory();
IAdmin iAdmin = sf.getAdminService();
IUpdate iUpdate = sf.getUpdateService();
Image myImg = … ; //

// using IAdmin -- let's change the group of myImg
// and then make it group private.
iAdmin.changeGroup(myImg, new ExperimenterGroup( 3L, false ));
iAdmin.changePermissions( myImg, new Permissions( Permissions.GROUP_PRIVATE ));

// and do the same using Details and IUpdate
myImg.getDetails().setPermissions( new Permissions( Permissions.GROUP_PRIVATE ));
myImg.getDetails().setGroup( new ExperimenterGroup( 3L, false ));
iUpdate.saveObject( myImg );
```

The benefit of the second method is the batching of changes into a single call. The benefit of the first is at most explicitness. Note, however, that changing any of the values of Details which are not also changeable through IAdmin will result in a `SecurityViolation`.

16.3.2 Actions only available through IAdmin

The rest of the write methods provided by IAdmin are disallowed for IUpdate and will throw `SecurityViolations`. This includes adding users, groups, user/group maps, events, enums, or similar. (Enums here are a special case, because they are created

[137] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/api/local/LocalAdmin.java

not through IAdmin but through ITypes). A system administrator may be able to use IUpdate to create these "System-Types" but using IAdmin is safer, cleaner, and guaranteed to work in the future.

The password methods and `synchronizeLoginCache` are also special cases in that they have no equivalent in any other API.

16.3.3 Similarities between IAdmin and IQuery

All of the read methods provided by IAdmin are also available from IQuery, that is, the IAdmin (currently) provide no special context or security privileges. However, having all of the methods in one interface reduces code duplication, which is especially useful when you want the entire user/group graph as provided by getExperimenter/getGroup/lookupExperimenter/lookupGroup.

See also:

OMERO Application Programming Interface

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.4 Deleting in OMERO

Deleting data in OMERO is complex due to the highly linked nature of data in the database. For example, an Image has links to Datasets, Comments, Tags, Instrument, Acquisition metadata etc. If the image is deleted, some of this other data should remain and some should be deleted with the image (since it has no other relevance).

In the 4.2.1 release of OMERO, an improved deleting service was introduced to fix several problems or requirements related to the delete functionality (see #2615[138] for tickets):

- Need a better way to define what gets deleted when certain data gets deleted (e.g. Image case above)
- Need to be able to configure this definition, since different users have different needs
- Deleting large amounts of data (e.g. Plate of HCS data) was too memory-intensive (data was loaded from the database during delete)
- Poor logging of deletes
- Large deletes (e.g. screen data) take time: Clients need to be able to keep working while deletes run 'in the background'
- Binary data (pixels, thumbnails, files etc) was not removed at delete time - required sysadmin to clean up later

Future releases will continue this work (see #2911[139]) and the 5.1.0 release of OMERO offers a new implementation of deletion.

16.4.1 Finality of deletion

Import in OMERO 5.x uploads the image and companion files intact and stores them within subdirectories of the directory configured by the value of `omero.managed.dir`, typically `ManagedRepository`. The files relating to a specific fileset are stored together on the server's filesystem and they are read by Bio-Formats when images are viewed in OMERO clients. If any of a fileset's files, or the corresponding entries for them in the database, are deleted, then the fileset may no longer be readable. If all the fileset's files are deleted, the fileset will certainly be unreadable, and there is no 'undo' that will bring it back.

16.4.2 Delete behavior (technical)

Configuring what gets deleted is done using XML files. Since OMERO 5.1, the delete behavior defaults to a *Model graph operations* implementation that is configured by components/blitz/resources/ome/services/blitz-graph-rules.xml[140].

[138] https://trac.openmicroscopy.org/ome/ticket/2615
[139] https://trac.openmicroscopy.org/ome/ticket/2911
[140] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/ome/services/blitz-graph-rules.xml

Delete Image

The general delete behavior for deleting an Image is to remove every piece of data from the database that was added when the image was imported, removing pixel data and thumbnails from disk. In addition, the following data is deleted:

- Comments on the image
- Rating of the image
- ROIs for this image (see below)
- Image Rendering settings for yourself and other users

Optional - In OMERO.web and OMERO.insight, you will be asked whether you also want to delete:

- Files attached to the image (if not linked elsewhere). In that case, the binary data will be removed from disk too.
- Your own tags on the image (if not used elsewhere)

The same option is available when deleting dataset, project, plate, screen.

Delete Dataset or Project

When deleting a Project or Dataset, you have the option to also delete tags and annotations (as for Image above). You also can choose whether to 'delete contents'. This will delete any Datasets (or Images) that are contained in the Project (or Dataset). However, Datasets and Images will not get deleted if they are also contained in other Projects or Datasets respectively.

If a user decides to delete/keep the annotations (see **Optional** above) when deleting a Project (or Dataset) and its contents, the rule associated to the annotation will be apply to all objects.

Delete Screen, Plate or Plate Acquisition

When deleting a Screen, you have the option to also delete tags and annotations. You also can choose whether to 'delete contents'. This will delete any Plates that are contained in the Screen. However, Plates will not get deleted if they are also contained in other Screen.

When deleting a Plate, you have the option to also delete tags and annotations but **NOT** the option to 'delete contents'.

If the Plate has Plate Acquisitions, you can delete one or more Plate Acquisition at once.

Delete Tag/Attachment

You can delete a Tag/Attachment, and it will be removed from all images. However you cannot delete a Tag/Attachment if it has been used by another user in the same collaborative group. This is to prevent potential loss of significant amount of annotation effort by other users. You will need to get the other users to first remove your Tag/Attachment where they have used it, before you can delete it.

Known Issue: if the owner of the Tag/Attachment is also an owner of the group (e.g. PI), they will be able to delete their Tag/Attachment, even if others have used it.

Delete multi-file Images and Image sets

An Image, or a set of Images, may come from a single file or a set of dependent files. For instance, a single Leica LIF file may contain many Images, as may a Zeiss mdb file with lsm files. On the other hand, some file formats, like Deltavision with log file, or the original ICS file format, use multiple files to represent a single Image. At import time, these groups of related files and Images are organized into Filesets: a Fileset is a set of files that encode a set of Images. The simplest case where there is one file per Image still has a corresponding Fileset.

Even if many Images come from the same file, they may be separately selected and viewed in client software. However, at least at present, a Fileset may not be partially deleted: either all the files and Images from it are deleted, or none are. So, for instance, the Images from the same Leica LIF file may be deleted only all at once, and the Deltavision log file is not deleted separately from the main file. The same applies to high-content screening data: a Plate with its Wells and Images are all stored in one Fileset and may be deleted only together.

Each Fileset has a corresponding directory on the server in which, perhaps in subdirectories, all its files are stored. All the file paths for an Image's Fileset can be accessed from the tool-bar at the top of the right-hand panel.

Delete in collaborative group

Some more discussion of delete issues in a collaborative group, where your data are linked to data of other users, can be found on the *Groups and permissions system* page.

- A user cannot remove Images from another user's Dataset, or remove Datasets (or Plates) from Projects (or Screens).
- A user cannot delete anything that belongs to another user.

Group owner rights

An owner of the group, usually a PI, can delete anything that belongs to other members of the group.

Edge cases

These are 'known issues' that may cause problems for some users (not for most). These will be resolved in future depending on priority.

- Other users' ROIs (and associated measurements) are deleted from images.
- Multiply-linked objects are unlinked and not deleted e.g. Project p1 contains two Datasets d1 and d2, Project p2 contains Dataset d1. If the Project p1 is deleted, the Dataset d1 is only unlinked from p1 and not completely deleted.

Binary data

When Images, Plates or File Annotations have been successfully deleted from the database the corresponding binary data is deleted from the binary repository (see *Unix* and *Windows* versions). It is possible that some files may not be successfully deleted if they are locked for any reason. This is a known problem on Windows servers. In this case, the undeleted files can be removed manually via `omero admin cleanse`. This also deletes any empty directories left behind after the binary data that they contained has been deleted.

Warning: Do not run cleanse as an operating system user while logged into OMERO as a non-administrative user as this will lead to data loss. Instead, you should always run as an administrative user such as "root". See this announcement[a] for further details.

[a] http://www.openmicroscopy.org/community/viewtopic.php?f=11&t=8060

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.5 OMERO Import Library

The Import Library is a re-usable framework for building import clients. Several are provided by the OMERO team directly:

- the integrated *importer*
- *Command Line Importer* tool

16.5.1 Components

The primary classes which make up the Import Library are:

- ImportLibrary.java[141] itself, which is the main driver

[141] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/importer/ImportLibrary.java

- ImportCandidates.java[142] which takes file paths and determines the proper files to import
- ImportConfig.java[143], an extensible mechanism for storing the properties used during import
- ImportEvent.java[144], the various events raised during import to `IObserver`and `IObservable` implementations
- OMEROMetadataStoreClient.java[145], the low-level connection to the server
- OMEROWrapper.java[146], the OMERO adapter for the Bio-Formats `ImageReaders` class
- In OMERO.insight, the main entry point is the importImage method of OMEROGateway.java[147]
- In the CLI, the main entry point is the CommandLineImporter[148] class

16.5.2 Earlier Import Workflow

Prior to OMERO 5.0, the import workflow was very much client-side. Using the ImportLibrary a client would determine the import candidates and then import the image. The import phase would comprise copying the pixel data to the OMERO data directory, writing the metadata into the database, and optionally copying the original file to the OMERO data directory for archiving.

16.5.3 FS Managed Repository Import Workflow

From 5.0 the workflow has changed. The client still determines the import candidates but the client-side import process simply uploads the original files to the OMERO data directory and then uses the ManagedRepository service to initiate a server-side import. On the server the import is then completed by writing the metadata into the database. After import, pixel data is accessed directly from the original files using Bio-Formats. This means that data files are no longer duplicated and any nested directory structure is preserved. It also allows OMERO to take advantage of pre-generated pyramids available in some formats e.g. SVS.

For full details of the import workflow see *Import under OMERO.fs*.

16.5.4 Example

The `CommandLineImporter.java` class shows a straightforward import. An `ErrorHandler` instance is passed both to the `ImportCandidates` constructor (since errors can occur while parsing a directory) and to the `ImportLibrary`. This and other handlers receive `ImportEvents` which notify listeners of the state of the current import.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.6 TempFileManager

Class to be used by *Working with OMERO* and server components to allow a uniform creation of temporary files and folders with a best-effort guarantee of deleting the resources on exit. The manager searches three locations in order, taking the first which allows lockable write-access (See #1653[149]):

- The environment property setting `OMERO_TMPDIR`
- The user's home directory, for example specified in Java via `System.getProperty("user.home")`
- The system temp directory, in Java `System.getProperty("java.io.tmpdir")` and in Python `tempfile.gettempdir()`

[142] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/importer/ImportCandidates.java
[143] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/importer/ImportConfig.java
[144] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/importer/ImportEvent.java
[145] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/OMEROMetadataStoreClient.java
[146] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/importer/OMEROWrapper.java
[147] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/insight/SRC/org/openmicroscopy/shoola/env/data/OMEROGateway.java
[148] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/formats/importer/cli/CommandLineImporter.java
[149] https://trac.openmicroscopy.org/ome/ticket/1653

16.6.1 Creating temporary files

For the user "ralph",

```
from omero.util.temp_files import create_path
path = create_path("omero",".tmp")
```

or

```
import omero.util.TempFileManager
File file = TempFileManager.create_path("omero",".tmp")
```

both produce a file under the directory:

```
/tmp/omero_ralph/$PID/omero$RANDOM.tmp
```

where $PID is the current process id and $RANDOM is some random sequence of alphanumeric characters.

16.6.2 Removing files

If `remove_path` is called on the return value of `create_path`, then the temporary resources will be cleaned up immediately. Otherwise, when the Java or Python process exits, they will be deleted. This is achieved in Java through `Runtime#addShutdownHook(Thread)` and in Python via `atexit.register()`.

16.6.3 Creating directories

If an entire directory with a unique directory is needed, pass "true" as the "folder" argument of the `create_path` method:

```
create_path("omero", ".tmp", folder = True)
```

and

```
TempFileManager.create_path("omero", ".tmp", true);
```

Note: All contents of the generated directory will be deleted.

See also:

#1534[150]

Note: **This documentation is for OMERO 5.2.** This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.7 Exception handling

16.7.1 Client exceptions

The exceptions which can be received by a client due to a remote call on the OMERO server are all defined in components/blitz/resources/omero/ServerErrors.ice[151] (included below). This file contains two separate hierarchies rooted at `Ice::Exception` and `omero::ServerError`.

[150] https://trac.openmicroscopy.org/ome/ticket/1534
[151] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/ServerErrors.ice

For a better understanding of how to handle exceptions, please read both of the `*.ice` files carefully, and see *Working with OMERO* for examples of exception handling.

```
/*
 *   $Id$
 *
 *   Copyright 2007 Glencoe Software, Inc. All rights reserved.
 *   Use is subject to license terms supplied in LICENSE.txt
 *
 */
#ifndef OMERO_SERVERERRORS_ICE
#define OMERO_SERVERERRORS_ICE
#include <Glacier2/Session.ice>
/**
 * Exceptions thrown by OMERO server components. Exceptions thrown client side
 * are available defined in each language binding separately, but will usually
 * subclass from "ClientError"
 *
 * including examples of what a appropriate try/catch block would look like.
 *
 * <p>
 * All exceptions that are thrown by a remote call (any call on a *Prx instance)
 * will be either a subclass of [Ice::UserException] or [Ice::LocalException].
 * <a href="http://doc.zeroc.com/display/Ice/Run-Time+Exceptions#Run-TimeExceptions-InheritanceHierarch
 * from the Ice manual shows the entire exception hierarchy. The exceptions described in
 * this file will subclass from [Ice::UserException]. Other Ice-runtime exceptions subclass
 * from [Ice::LocalException].
 * </p>
 *
 * <pre>
 *
 * OMERO Specific:
 * ===============
 *  ServerError (root server exception)
 *    |
 *    |_ InternalException (server bug)
 *    |
 *    |_ ResourceError (non-recoverable)
 *    |  \_ NoProcessorAvailable
 *    |
 *    |_ ConcurrencyException (recoverable)
 *    |  |_ ConcurrentModification (data was changed)
 *    |  |_ OptimisticLockException (changed data conflicts)
 *    |  |_ LockTimeout (took too long to acquire lock)
 *    |  |_ TryAgain (some processing required before server is ready)
 *    |  \_ TooManyUsersException
 *    |     \_ DatabaseBusyException
 *    |
 *    |_ ApiUsageException (misuse of services)
 *    |   |_ OverUsageException (too much)
 *    |   |_ QueryException (bad query string)
 *    |   \_ ValidationException (bad data)
 *    |
 *    |_ SecurityViolation (some no-no)
 *    |   \_ GroupSecurityViolation
 *    |      |_ PermissionMismatchGroupSecurityViolation
 *    |      \_ ReadOnlyGroupSecurityViolation
 *    |
 *    \_SessionException
 *       |_ RemovedSessionException (accessing a non-extant session)
 *       |_ SessionTimeoutException (session timed out; not yet removed)
 *       \_ ShutdownInProgress      (session on this server will most likely be destroyed)
 * </pre>
 *
```

```
 *
 * <p>
 * However, in addition to [Ice::LocalException] subclasses, the Ice runtime also
 * defines subclasses of [Ice::UserException]. In some cases, OMERO subclasses
 * from these exceptions. The subclasses shown below are not exhaustive, but show those
 * which an application's exception handler may want to deal with.
 * </p>
 *
 *
 * <pre>
 *  Ice::Exception (root of all Ice exceptions)
 *   |
 *   |_ Ice::UserException (super class of all application exceptions)
 *   |  |
 *   |  |_ Glacier2::CannotCreateSessionException (1 of 2 exceptions throwable by createSession)
 *   |  |   |_ omero::AuthenticationException (bad login)
 *   |  |   |_ omero::ExpiredCredentialException (old password)
 *   |  |   |_ omero::WrappedCreateSessionException (any other server error during createSession)
 *   |  |   \_ omero::licenses::NoAvailableLicensesException (see tools/licenses/resources/omero/Licens
 *   |  |
 *   |  \_ Glacier2::PermissionDeniedException (other of 2 exceptions throwable by createSession)
 *   |
 *   \_ Ice::LocalException (should generally be considered fatal. See exceptions below)
 *       |
 *       |_ Ice::ProtocolException (something went wrong on the wire. Wrong version?)
 *       |
 *       |_ Ice::RequestFailedException
 *       |   |_ ObjectNotExistException (Service timeout or similar?)
 *       |   \_ OperationNotExistException (Improper use of uncheckedCast?)
 *       |
 *       |_ Ice::UknownException (server threw an unexpected exception. Bug!)
 *       |
 *       \_ Ice::TimeoutException
 *           \_ Ice::ConnectTimeoutException (Couldn't establish a connection. Retry?)
 *
 * </pre>
 *
 **/
module omero
{
  /*
   * Base exception. Equivalent to the ome.conditions.RootException.
   * RootException must be split into a ServerError and a ClientError
   * base-class since the two systems are more strictly split by the
   * Ice-runtime than is done in RMI/Java.
   */
  exception ServerError
    {
      string serverStackTrace;
      string serverExceptionClass;
      string message;
    };
  // SESSION EXCEPTIONS --------------------------------
  /**
   * Base session exception, though in the OMERO.blitz
   * implementation, all exceptions thrown by the Glacier2
   * must subclass CannotCreateSessionException. See below.
   */
  exception SessionException extends ServerError
    {
    };
  /**
   * Session has been removed. Either it was closed, or it
   * timed out and one "SessionTimeoutException" has already
```

```
 * been thrown.
 */
exception RemovedSessionException extends SessionException
  {
  };
/**
 * Session has timed out and will be removed.
 */
exception SessionTimeoutException extends SessionException
  {
  };
/**
 * Server is in the progress of shutting down which will
 * typically lead to the current session being closed.
 */
exception ShutdownInProgress extends SessionException
  {
  };
// SESSION EXCEPTIONS (Glacier2) ---------------------
/**
 * createSession() is a two-phase process. First, a PermissionsVerifier is
 * called which must return true; then a SessionManager is called to create
 * the session (ServiceFactory). If the PermissionsVerifier returns false,
 * then PermissionDeniedException will be thrown. This, however, cannot be
 * subclassed and so string parsing must be used.
 */
/**
 * Thrown when the information provided omero.createSession() or more
 * specifically Glacier2.RouterPrx.createSession() is incorrect. This
 * does -not- subclass from the omero.ServerError class because the
 * Ice Glacier2::SessionManager interface can only throw CCSEs.
 */
exception AuthenticationException extends Glacier2::CannotCreateSessionException
  {
  };
/**
 * Thrown when the password for a user has expried. Use: ISession.changeExpiredCredentials()
 * and login as guest. This does -not- subclass from the omero.ServerError class because the
 * Ice Glacier2::SessionManager interface can only throw CCSEs.
 */
exception ExpiredCredentialException extends Glacier2::CannotCreateSessionException
  {
  };
/**
 * Thrown when any other server exception causes the session creation to fail.
 * Since working with the static information of Ice exceptions is not as easy
 * as with classes, here we use booleans to represent what has gone wrong.
 */
exception WrappedCreateSessionException extends Glacier2::CannotCreateSessionException
  {
    bool    concurrency;
    long    backOff;    /* Only used if ConcurrencyException */
    string  type;       /* Ice static type information */
  };
// OTHER SERVER EXCEPTIONS ----------------------------
/**
 * Programmer error. Ideally should not be thrown.
 */
exception InternalException extends ServerError
  {
  };
// RESOURCE
/**
 * Unrecoverable error. The resource being accessed is not available.
```

```
 */
exception ResourceError extends ServerError
  {
  };
/**
 * A script cannot be executed because no matching processor
 * was found.
 */
exception NoProcessorAvailable extends ResourceError
  {
      /**
       * Number of processors that responded to the inquiry.
       * If 1 or more, then the given script was not acceptable
       * (e.g. non-official) and a specialized processor may need
       * to be started.
       **/
      int processorCount;
  };
// CONCURRENCY
/**
 * Recoverable error caused by simultaneous access of some form.
 */
exception ConcurrencyException extends ServerError
  {
     long backOff; /* Backoff in milliseconds */
  };
/**
 * Currently unused.
 */
exception ConcurrentModification extends ConcurrencyException
  {
  };
/**
 * Too many simultaneous database users. This implies that a
 * connection to the database could not be acquired, no data
 * was saved or modifed. Clients may want to wait the given
 * backOff period, and retry.
 */
exception DatabaseBusyException extends ConcurrencyException
  {
  };
/**
 * Conflicting changes to the same piece of data.
 */
exception OptimisticLockException extends ConcurrencyException
  {
  };
/**
 * Lock cannot be acquired and has timed out.
 */
exception LockTimeout extends ConcurrencyException
  {
      int seconds; /* Informational field on how long timeout was */
  };
/**
 * Background processing needed before server is ready
 */
exception TryAgain extends ConcurrencyException
  {
  };
exception MissingPyramidException extends ConcurrencyException
 {
      long pixelsID;
 };
```

```
  // API USAGE
  exception ApiUsageException extends ServerError
    {
    };
  exception OverUsageException extends ApiUsageException
    {
    };
  /**
   *
   */
  exception QueryException extends ApiUsageException
    {
    };
  exception ValidationException extends ApiUsageException
    {
    };
  // SECURITY
  exception SecurityViolation extends ServerError
    {
    };
  exception GroupSecurityViolation extends SecurityViolation
    {
    };
  exception PermissionMismatchGroupSecurityViolation extends SecurityViolation
    {
    };
  exception ReadOnlyGroupSecurityViolation extends SecurityViolation
    {
    };
  // OMEROFS
    /**
     * OmeroFSError
     *
     * Just one catch-all UserException for the present. It could be
     * subclassed to provide a finer grained level if necessary.
     *
     * It should be fitted into or subsumed within the above hierarchy
     **/
    exception OmeroFSError extends ServerError
      {
        string reason;
      };
};
#endif // OMERO_SERVERERRORS_ICE
```

16.7.2 Server exceptions

Due to the strict API boundary enforced by Ice, the client and server exception hierarchies, though related, are distinct. The discussion below is possibly of interest for server developers only. Client developers should refer to the information and examples under *Working with OMERO*.

Interceptor

Exception handling in the OMERO is centralized in an *Aspect-oriented programming* interceptor (source code[152]). All exceptions thrown by code are caught in a `try {} catch (Throwable t) {}` block. Exceptions which do not subclass ome.conditions.RootException[153] are wrapped in an ome.conditions.InternalException[154].

[152] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4//components/server/src/ome/services/util/ServiceHandler.java
[153] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/conditions/RootException.java
[154] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/conditions/InternalException.java

The only exceptions to this are any interceptors which may be run before the exception handler is run. The order of interceptors is defined in services.xml[155].

Hierarchy

The current exception hierarchy (package ome.conditions[156]) used is as follows:

- RootException
  - InternalException - should not reach the client; Bug! Contact administrator e.g. NullPointerException, assertion failed, etc.
  - ResourceError - fatal error in server, e.g. OutOfMemory, disk space full, the database is in illegal state, etc.
  - DataAccessException
    * SecurityViolation - do not do that! E.g. edit locked project, create new user.
    * OptimisticLockException - re-load and compare e.g. "someone else has already updated this project"
    * ApiUsageException - something wrong with how you did things e.g. IllegalStateException, object uninitialized, etc.
    * ValidationException - something wrong with what you sent; sends list of fields, etc.; edit and retry, e.g. no "?" in image names.

where the colors indicate:

Abstract

FixAndRetryConditions

RetryConditions

NoRecourseConditions

Any other exception which reaches the client should be considered an `OutOfServiceException`, meaning that something is (hopefully only) temporarily wrong with the server, e.g. no connection, server down, server restarting. But since this cannot be caught since the server cannot be reached, there is no way to guarantee that a real `OutOfServiceException` is thrown.

16.7.3 Moving forward

`FixAndRetryConditions` need to have information about what should be fixed, like a Validation object which lists fields with error messages. A `RetryCondition` could have a back-off value to prevent too frequent retries.

Questions

- What data should be available in the exceptions?
- What other logic do we want on our exceptions, keeping in mind they will have to be re-implemented in all target languages?

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.8 Omero logging

All OMERO components written in Java use the SLF4J[157] logging facade, typically backed by Logback[158]; all components written in python use the built-in `logging` module.

[155] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/services.xml
[156] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/model/src/ome/conditions
[157] http://www.slf4j.org/
[158] http://logback.qos.ch/

Warning: Refrain from calling `logging.basicConfig()` anywhere in your module except in `if __name__ == "__main__"` blocks.

16.8.1 Java clients

Java clients log to `$HOME/omero/log`. The number of files and their size are limited.

logback-cli.xml[159] controls the output for the command line importer: all logging goes to standard err, while useful output (pixel ids, or used files) goes to standard out. It is contained within the blitz.jar itself. Therefore, to modify the settings use *-Dlogback.configurationFile=/path/to/logback.xml* or similar.

OMERO.insight logging is configured via *logback.xml* which is available in the config/ directory of any OMERO.insight install.

16.8.2 Java servers

Java server components are configured by passing `-Dlogback.configurationFile=etc/logback.xml` to each Java process. Entry.java[160] guarantees that the logback.xml[161] file is read periodically so that changes to your logging configuration do not require a restart.

By default, the output from logback is sent to: `var/log/<servername>.log`. Once files reach a size of 500MB, they are rolled over to `<servername>.log.1`, `<servername>.log.2`, etc. Once the files have rolled over, you can safely delete or compress (bzip2, gzip, zip) them. Alternatively, once you are comfortable with the stability of your server, you can either reduce logging or the number and size of the files kept. **Note:** if something goes wrong with your server installation, the log files can be very useful in tracking down issues.

In addition, each import process logs to a file under the managed repository which matches the timestamped fileset directory's name. For example, if an imported fileset is uploaded to `/OMERO/ManagedRepository/userA_1/2013-06/17/12-00-00.000`, then the log file can be found under `/OMERO/ManagedRepository/userA_1/2013-06/17/12-00-00.000.log`.

16.8.3 Python servers

Python servers are configured by a call to `omero.util.configure_server_logging(props)`. The property values are taken from the configuration file passed to the server via icegridnode. For example, the config file for Processor-0 can be found in `var/master/servers/Processor-0/config/config`. These values come from `etc/grid/templates.xml`.

All the "omero.logging.*" properties can be overwritten in your `etc/grid/default.xml` file (or on Windows, `etc/grid/windefault.xml`). See the "Profile" properties block for how to configure for your site.

Similar to logback, logging is configured to be written to `var/log/<servername>.log` and to maintain 9 backups of at most 500MB.

16.8.4 stdout and stderr

Though all components try to avoid it, some output will still go to stdout/stderr. On non-Windows systems, all of this output will be sent to the `var/log/master.out` and `var/log/master.err` files.

16.8.5 Windows stdout and stderr

On Windows, the state of stdout and stderr is somewhat different. No information will be written to master.out, master.err, or similar files. Instead, what logging is produced will go to the Windows Event Viewer, but finding error situations can be considerably more challenging (See #1449[162] for more information).

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event

[159] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/logback-cli.xml
[160] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/ome/services/blitz/Entry.java
[161] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/logback.xml
[162] https://trac.openmicroscopy.org/ome/ticket/1449

of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

16.9 Using the new 5.1 graph requests

16.9.1 Migration is required

OMERO 5.1.0 introduced a new implementation of *Model graph operations* offered through the API via Chgrp2[163], Chown2[164], Delete2[165], and their superclass GraphModify2[166]. OMERO 5.1.2 added Chmod2[167]. The legacy request operations Chgrp[168], Chmod[169], Chown[170], Delete[171], and their superclass GraphModify[172], are now deprecated and will be *removed* in OMERO 5.3. *Now* is the time to adjust client code accordingly so that the OME team can fix any regressions before the release of OMERO 5.3.

16.9.2 Target objects

For specifying which model objects to operate on, instead of using one request for each object through GraphModify[173]'s `type` and `id` data members, use GraphModify2[174]'s `targetObjects` which allows specification of multiple model object classes, each with an unordered list of IDs, all in a single request. To specify a type, no longer use `/`-delimited paths, but instead just the class name, e.g. `Image` instead of `/Image`. To achieve a root-anchored subgraph operation use SkipHead[175] to wrap your request: for instance, for `/Image/Pixels/RenderingDef`, set the `SkipHead` request's `targetObjects` to the image(s), and set `startFrom` to `RenderingDef`.

16.9.3 Translating options

GraphModify[176]'s `options` data member has its related analog in GraphModify2[177]'s `childOptions`, an ordered list of ChildOption[178] instances, each of which allows its applicability to annotations to be limited by namespace. Some examples:

- To move a dataset with all its images, removing those images from other datasets where necessary, use `Chgrp2` with a `ChildOption`'s `includeType` set to `Image`.
- To delete a dataset without deleting any images at all from it, use `Delete2` with a `ChildOption`'s `excludeType` set to `Image`.
- To delete annotations except for the tags that are in a specific namespace, use `Delete2` with a `ChildOption`'s `excludeType` set to `TagAnnotation` and `includeNs` set to that namespace.

GraphUtil.java[179] includes the `translateOptions` method that may give additional insight on how to translate the previous style of option. This method too will be removed in OMERO 5.3.

[163] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp2.html
[164] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chown2.html
[165] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Delete2.html
[166] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify2.html
[167] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chmod2.html
[168] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp.html
[169] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chmod.html
[170] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chown.html
[171] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Delete.html
[172] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify.html
[173] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify.html
[174] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify2.html
[175] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/SkipHead.html
[176] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify.html
[177] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify2.html
[178] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/graphs/ChildOption.html
[179] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/omero/cmd/graphs/GraphUtil.java

16.9.4 Examples in Python

Move images

```
chgrps = DoAll()
chgrps.requests = [Chgrp(type="/Image", id=n, grp=5) for n in [1,2,3]]
sf.submit(chgrps)
```

becomes,

```
chgrp = Chgrp2(targetObjects={'Image': [1,2,3]}, groupId=5)
sf.submit(chgrp)
```

Delete plate, but not annotations

```
keepAnn = {"/Annotation": "KEEP"}
delete = Delete(type="/Plate", id=8, options=keepAnn)
sf.submit(delete)
```

becomes,

```
keepAnn = [ChildOption(excludeType=['Annotation'])]
delete = Delete2(targetObjects={'Plate': [8]}, childOptions=keepAnn)
sf.submit(delete)
```

Delete an image's rendering settings

```
delete = Delete(type="/Image/Pixels/RenderingDef", id=6)
sf.submit(delete)
```

becomes,

```
anchor = {'Image': [6]}
targets = ['RenderingDef']
delete = SkipHead(targetObjects=anchor, startFrom=targets,
                  request=Delete2())
sf.submit(delete)
```

16.9.5 Java request factory

A utility class Requests.java[180] provides convenient instantiation of graph requests. This class allows the requests from the above Python examples to be created by,

```
// move images
Chgrp2 example1 = Requests.chgrp("Image", Arrays.asList(1L,2L,3L), 5L);

// delete plate, but not annotations
ChildOption childOption = Requests.option(null, "Annotation");
```

[180] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/omero/gateway/util/Requests.java

```
Delete2 example2 = Requests.delete("Plate", 8L, childOption);

// delete an image's rendering settings
SkipHead example3 =
    Requests.skipHead("Image", 6L, "RenderingDef", new Delete2());
```

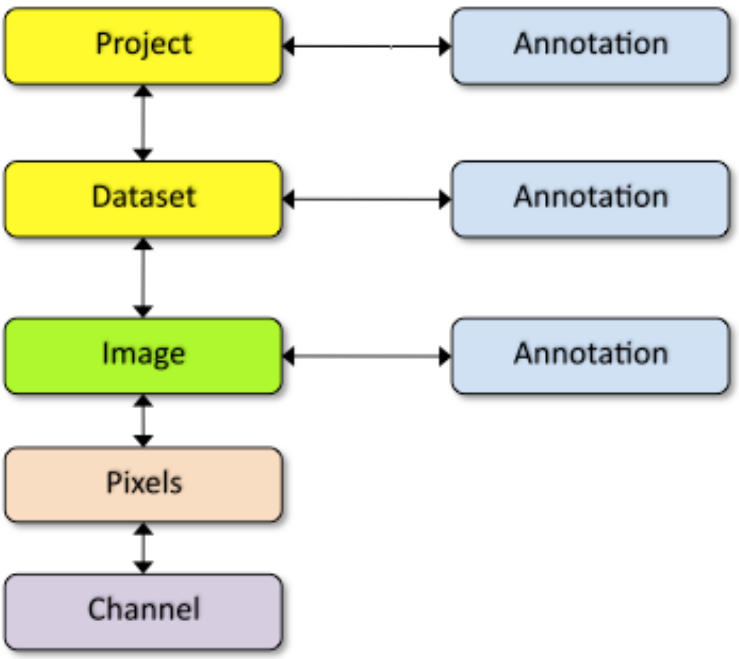
CHAPTER

SEVENTEEN

THE OME DATA MODEL

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

17.1 OME-Remote Objects



OMERO is based on the OME data model which can appear overly complex for new users. However, the core entities you need for getting started are much simpler.

Images in OMERO are organized into a many-to-many container hierarchy: "Project" -> "Dataset" -> "Image". These containers (and various other objects) can be annotated to link various types of data. Annotation types include Comment (string), Tag (short string), Boolean, Long, Xml, File attachment etc.

Images are represented as Pixels with 5 dimensions: X, Y, Z, Channel, Time.

At the core of the work on the Open Microscopy Environment[1] is the definition of a vocabulary for working with microscopic data. This vocabulary has a representation in the XML specification[2], in the database (the data model), and in code. This last representation is the object model with which we will concern ourselves here.

[1] http://www.openmicroscopy.org/site
[2] http://www.openmicroscopy.org/site/support/ome-model/ome-xml/

Because of its complexity, the object model is generated from a central definition[3] using our own code-generator[4]. It relies on no libraries and can be used in both the server and the RMI clients. The relationships among the objects are enumerated in a cross-referenced *reference document*. *OMERO.blitz* uses a second mapping[5] to generate *OMERO Java language bindings*, *OMERO Python language bindings*, and *OMERO C++ language bindings* classes, which can be mapped[6] back and forth to the server object model. *This document discusses only the server object-model and how it is used internally.*

Instances of the object model have no direct interaction with the database, rather the mapping is handled externally by the O/R framework, Hibernate[7]. That means, by and large, generated classes are data objects, composed only of getter and setter fields for fields representing columns in the database, and contain no business logic. However, to make working with the model easier, and perhaps more powerful, there are several features which we have built in.

Note: The discussion here of object types is still relevant but uses the ome.model.* objects for examples. These are server internal types which may lead to some confusion. Clients work with omero.model.* objects. This documentation will eventually be updated to reflect both hierarchies.

17.1.1 OMERO type language

The Model has two general parts: first, the long-studied and well-established core model and second, the user-specified portion. It is vital that there is a central definition of both parts of the object model. To allow users to easily define new types, we need a simple domain specific language (or little language) which can be mapped to Hibernate mapping files. See an example at:

- components/model/resources/mappings/acquisition.ome.xml[8]

From this DSL, various artifacts can be generated: XML Schema, Java classes, SQL for generating tables, etc. The ultimate goal is to have no exceptions in the model.

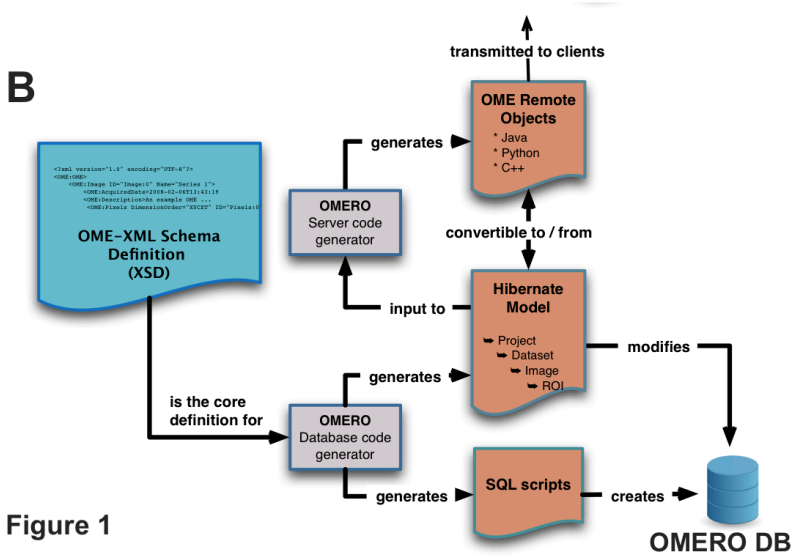


Figure 1

Conceptually, the XSD files under the `components/specification` source directory are the starting point for all code generation. Currently however, the files under components/model/resources/mappings[9] are hand-written based on the XSD files.

The ant task created from the components/dsl/src[10] Java files is then used to turn the mapping files into generated Java code under the `model/target/generated/src` directory. These classes are all within the ome.model package. A few hand-written Java classes can also be found in components/model/src/ome/model/internal[11].

[3] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/model
[4] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/dsl
[5] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/blitz/resources/templates
[6] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/omero/util/IceMapper.java
[7] http://www.hibernate.org
[8] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/resources/mappings/acquisition.ome.xml
[9] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/model/resources/mappings
[10] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/dsl/src
[11] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/model/src/ome/model/internal

The build-schema ant target takes the generated ome.model classes as input and generates the sql/psql[12] scripts which get used by `omero db script` to generate a working OMERO database. Files named like `OMEROVERSION__PATCH.sql` are hand-written update scripts.

The primary consumer of the ome.model classes at runtime is the components/server[13] component.

The above classes are considered the internal server code, and are the only objects which can take part in Hibernate transactions.

External to the server code is the "blitz" layer. These classes are in the omero.model package. They are generated by another call to the DSL ant task in order to generate the Java, Python, C++, and Ice files under `components/blitz/generated`.

The generated Ice files along with the hand-written Ice files from components/blitz/resources/omero[14] are then run through the `slice2cpp`, `slice2java`, and `slice2py` command-line utilities in order to generate source code in each of these languages. Clients pass in instances of these omero.model (or in the case of C++, omero::model) objects. These are transformed to ome.model objects, and then persisted to the database.

If we take a concrete example, a C++ client might create an Image via new `omero::model::ImageI()`. The "I" suffix represents an "implementation" in the Ice naming scheme and this subclasses from omero::model::Image. This can be remotely passed to the server which will be deserialized as an omero.model.ImageI object. This will then get converted to an ome.model.core.Image, which can finally be persisted to the database.

Keywords

Some words are not allowed as properties/fields of OMERO types. These include:

- id
- version
- details
- … any SQL keyword

17.1.2 Improving generated data objects

Constructors

Two special constructors are generated for each model object. One is for creating proxy instances, and the other is for filling all NOT-NULL fields:

```
Pixels p_proxy  = new Pixels(Long, boolean);
Pixels p_filled = new Pixels(ome.model.core.Image, ome.model.enums.PixelsType,
       java.lang.Integer, java.lang.Integer, java.lang.Integer, java.lang.Integer, java.lang.Integer,
       java.lang.String, ome.model.enums.DimensionOrder, ome.model.core.PixelsDimensions);
```

The first should almost always be used as: `new Pixels(5L, false)`. Passing in an argument of `true` would imply that this object is actually loaded, and therefore the server would attempt to null all the fields on your object. See below for a discussion on loadedness.

In the special case of Enumerations, a constructor is generated which takes the `value` field for the enumeration:

```
Format file_format = new Format("text/plain");
```

Further, this is the only example of a managed object which will be loaded by the server **without** its id. This allows applications to record only the string `"text/plain"` and not need to know the actual id value for `"text/plain"`.

[12] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/sql/psql
[13] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server
[14] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/blitz/resources/omero

Details

Each table in the database has several columns handling low-level matters such as security, ownership, and provenance. To hide some of these details in the object model, each IObject instance contains an ome.model.internal.Details instance.

Details works something like unix's `stat`:

```
/Types/Images>ls -ltrAG
total 0
-rw-------  1 josh 0 2006-01-25 20:40 Image1
-rw-------  1 josh 0 2006-01-25 20:40 Image2
-rw-------  1 josh 0 2006-01-25 20:40 Image3
-rw-r--r--  1 josh 0 2006-01-25 20:40 Image100
/Types/Images>stat Image1
  File: 'Image1'
  Size: 0               Blocks: 0          IO Block: 4096   regular empty file
Device: 1602h/5634d     Inode: 376221      Links: 1
Access: (0600/-rw-------)  Uid: ( 1003/    josh)   Gid: ( 1001/ ome)
Access: 2006-01-25 20:40:30.000000000 +0100
Modify: 2006-01-25 20:40:30.000000000 +0100
Change: 2006-01-25 20:40:30.000000000 +0100
```

though it can also store arbitrary other attributes (meta-metadata, so to speak) about our model instances. See *Dynamic methods* below for more information.

The main methods on Details are:

```
Permissions Details.getPermissions();
List Details.getUpdates();
Event Details.getCreationEvent();
EventDetails.getUpdatEvent();
Experimenter Details.getOwner();
ExperimenterGroup Details.getGroup();
ExternalInfo getExternalInfo();
```

though some of the methods will return `null`, if that column is not available for the given object. See *Interfaces* below for more information.

Consumers of the API are encouraged to pass around Details instances rather than specifying particulars, like:

```
if (securitySystem.allowLoad(Project.class, project.getDetails())) {}
// and not
if (project.getDetails().getPermissions().isGranted(USER,READ) && project.getDetails().getOwner().getId
```

This should hopefully save a good deal of re-coding if we move to true ACL rather than the current filesystem-like access control.

Because it is a field on every type, Details is also on the list of keywords in the type language (above).

Interfaces

To help work with the generated objects, several interfaces are added to their "implements" clause:

Property	Applies_to	Interface	Notes
Base			
owner	! global		need sudo
group	! global		need sudo
version	! immutable		
creationEvent	! global		
updateEvent	! global && ! immutable		
permissions			
externalInfo			
Other			
name		Named	
description		Described	
linkedAnnotationList		IAnnotated	

For example, `ome.model.meta.Experimenter` is a "global" type, therefore it has no `Details.owner` field. In order to create this type of object, you will either need to have admin privileges, or in some cases, use the `ome.api.IAdmin` interface directly (in the case of enums, you will need to use the `ome.api.ITypes` interface).

Inheritance

Inheritance is supported in the object model. The superclass relationships can be defined simply in the mapping files. One example is the annotation hierarchy in components/model/resources/mappings/annotations.ome.xml[15]. Hibernate supports this polymorphism, and will search all subclasses when a superclass is returned. *However*, due to Hibernate's use of bytecode-generated proxies, testing for class equality is not always straightforward.

Hibernate uses CGLIB and Javassist and similar bytecode generation to perform much of its magic. For these bytecode generated objects, the getClass() method returns something of the form "ome.model.core.Image_$$_javassist" which cannot be passed back into Hibernate. Instead, we must first parse that class String with Utils#trueClass()[16].

Model report objects

To support the Collection Counts requirement in which users would like to know how many objects are in a collection by owner, it was necessary to add read-only `Map<String, Long>` fields to all objects with links. See the *Collection counts* page for more information.

Dynamic methods

Finally, because not all programming fits into the static programming frame, the object model provides several methods for working dynamically with all IObject subclasses.

fieldSet / putAt / retrieve

Each model class contains a public final static String for each field in that class (superclass fields are omitted). A copy of all these fields is available through `fieldSet()`. This field identifier can be used in combination with the putAt and retrieve methods to store arbitrary data in a class instance. Calls to `putAt/retrieve` with a string found in fieldSet delegate to the traditional getters/setters. Otherwise, the value is stored in lazily-initialized Map (if no data is stored, the map is `null`).

acceptFilter

An automation of calls to `putAt / retrieve` can be achieved by implementing an ome.util.Filter. A Filter is a VisitorPattern-like interface which not only visits every field of an object, but also has the chance to replace the field value with an arbitrary other value. Much of the internal functionality in OMERO is achieved through filters.

[15] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/resources/mappings/annotations.ome.xml
[16] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/util/Utils.java

Limitations

- The filter methods override all standard checks such as IObject#isLoaded and so null-pointer exceptions etc. may be thrown.
- The types stored in the dynamic map currently do not propagate to the *OMERO.blitz* model objects, since not all java.lang.Objects can be converted.

17.1.3 Entity lifecycle

These additions make certain operations on the model objects easier and cleaner, but they do not save the developer from understanding how each object interacts with Hibernate. Each object has a defined lifecycle and it is important to know both the origin (client, server, or backend) as well as its current state to understand what will and can happen with it.

States

Each instance can be found in one of several states. Quickly, they are:

transient The entity has been created (`"new Image()"`) and not yet shown to the backend.

persistent The entity has been stored in the database and has a non-`null` id (`IObject.getId()`). Here Hibernate differentiates between detached, managed, and deleted entities. Detached entities do not take part in lazy-loading or dirty detection like managed entities do. They can, however, be re-attached (made "managed"). Deleted entities cannot take part in most of the ORM activities, and exceptions will be thrown if they are encountered.

unloaded (a reference, or proxy) To solve the common problem of lazy loading exceptions found in many Hibernate applications, we have introduced the concept of unloaded proxy objects which are objects with all fields nulled other than the id. Attempts to get or set any other property will result in an exception. The backend detects these proxies and restores their value before operating on the graph. There are two related states for collections – `null` which is completely unloaded, and filtered in which certain items have been removed (more on this below).

Identity, references, and versions

Critical for understanding these states is understanding the concepts of identity and versioning as it relates to ORM. Every object has an id field that if created by the backend will not be `null`. However, every table does not have a primary key field – subclasses contain a foreign key link to their superclass. Therefore all objects without an id are assumed to be non-persistent (i.e. transient).

Though the id cannot be the sole decider of equality since there are issues with the Java definition of equals() and hashCode(), we often perform lookups based on the class and id of an instance. Here again caution must be taken not to unintentionally use a possibly bytecode-generated subclass. See the discussion under *Inheritance* above.

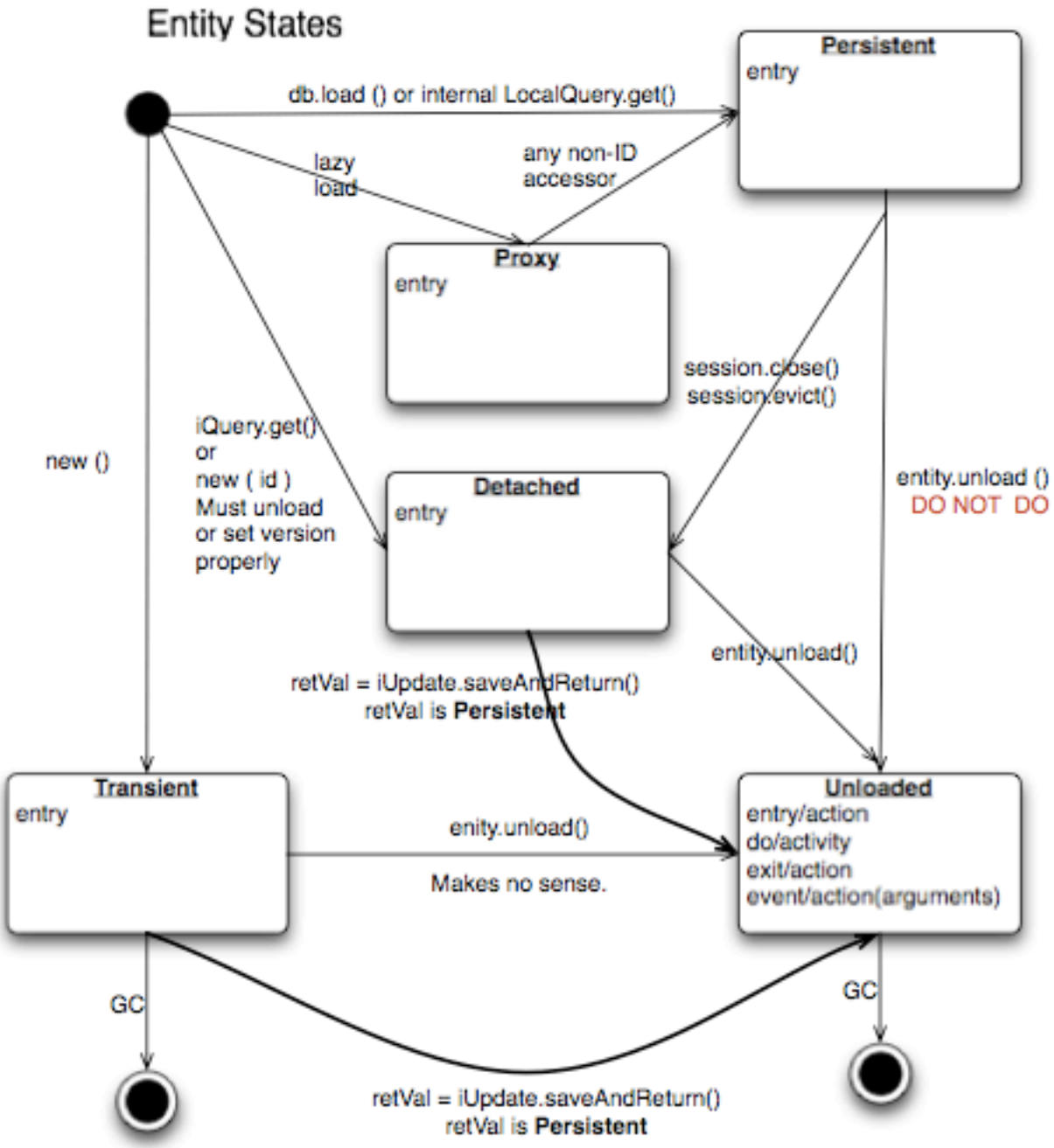
Class/id-based lookup is in fact so useful that it is possible to take an model object and call `obj.unload()` to have a "reference" – essentially a placeholder for a model object that contains only an id. Calls to any accessors other than get/setId will throw an exception. An object can be tested for loadedness with `obj.isLoaded()`.

A client can use unloaded instances to inform the backend that a certain information is not available and should be filled in server-side. For example, a user can do the following:

```
Project p = new Project();
Dataset d = new Dataset( new Long(1), false); // this means create an already unloaded instance
p.linkDataset(d);
iUpdate.saveObject(p);
```

The server, in turn, also uses references to replace backend proxies that would otherwise throw `LazyInitializationExceptions` on serialization. Clients, therefore, must code with the expectation that the leaves in an object graph may be unloaded. Extending a query with "outer join fetch" will cause these objects to be loaded as well. For example:

```
select p from Project p
    left outer join fetch p.datasetLinks as links
    left outer join fetch links.child as dataset
```



but eventually in the complex OME metadata graph, it is certain that something will remain unloaded.

Versions are the last piece to understanding object identity. Two entities with the same id should not be considered equal if they have differing versions. On each write operation, the version of an entity is incremented. This allows us to perform optimistic locking so that two users do not simultaneously edit the same object. That works so:

1. User A and User B retrieve Object X id=1, version=0.
2. User A edits Object X and saves it. Version is incremented to 1.
3. User B edits Object X and tries to save it. The SQL generated is: UPDATE table SET value = newvalue WHERE id = 1 and version = 0; which upates no rows.
4. The fact that no rows were altered is seen by the backend and an `OptimisticLockException` is thrown.

Identity and versioning make working with the object model difficult sometimes, but guarantee that our data is never corrupted.

Note: There is one exception to this discussed below under *Links*.

17.1.4 Working with the object model

With these states in mind, it is possible to start looking at how to actually use model objects. From the point of view of the server, everything is either an assertion of an object graph (a "write") or a request for an object graph (a "read"), whether they are coming from an RMI client, an *OMERO.blitz* client, or even being generated internally.

Writing

Creating new objects is as simple as instantiating objects and linking them together. If all NOT-NULL fields are not filled, then a `ValidationException` will be thrown by the server:

```
IUpdate update = new ServiceFactory().getUpdateService();
Image i = new Image();
try {
     update.saveObject(i);
catch (ValidationException ve) {
     // not ok.
}
i.setName("image");
return update.saveAndReturnObject(i); // ok.
```

Otherwise, the returned value will be the Image with its id field filled. This works on arbitrarily complex graphs of objects:

```
Image i = new Image("image-name"); // This constructor exists because "name" is the only required field.
Dataset d = new Dataset("dataset-name");
TagAnnotation tag = new TagAnnotation();
tag.setTextValue("some-tag");
i.linkDataset(d);
i.linkAnnotation(tag);
update.saveAndReturnObject(i);
```

Reading

Reading is a similarly straightforward operation. From a simple id-based lookup, `iQuery.get(Experimenter.class, 1L)` to a search for an arbitrarily complex graph:

```
Image i = iQuery.findByQuery("select i from Image i "+
     "join fetch i.datasetLinks as dlinks "+
     "join fetch i.annotationLinks as alinks "+
     "join fetch i.details.owner as owner "+
     "join fetch owner.details.creationEvent "+
     "where i.id = :id", new Parameters().addId(1L));
```

In the return graph, you are guaranteed that any two instances of the same class with the same id are the same object. For example:

```
Image i = …; // From query
Dataset d = i.linkedDatasetList().get(0);
Image i2 = d.linkedImageList().get(0);
if (i.getId().equals(i2.getId()) {
  assert i == i2 : "Instances must be referentially equal";
}
```

Reading and writing

Complications arise when you try to mix objects from different read operations because of the difference in equality. In all but the most straightforward applications, references to `IObject` instances from different return graphs will start to intermingle. For

example, when a user logins in, you might query for all Projects belonging to the user:

```
List<Project> projects = iQuery.findAllByQuery("select p from Project p where p.details.owner.omeName =
Project p = projects.get(0);
Long id = p.getId();
```

Later you might query for Datasets, and be returned some of the same Projects again within the same graph. You have now possibly got two versions of the Project with a given id within your application. And if one of those Projects has a new Dataset reference, then Hibernate would not know whether the object should be removed or not.

```
Project oldProject = …; // Acquired from first query
// Do some other work
Dataset dataset = iQuery.findByQuery("select d from Dataset d "+
        "join fetch d.projectsLinks links "+
        "join fetch links.parent "+
        "where d.id = :id", new Parameters().addId(5L));
Project newProject = dataset.linkedProjectList().get(0);
assert newProject.getId().equals(oldProject.getId()) : "same object";
assert newProject.sizeOfDatasetLinks() == oldProject.sizeOfDatasetLinks() :
        "if this is false, then saving oldProject is a problem";
```

Without optimistic locks, trying to save oldProject would cause whatever Datasets were missing from it to be removed from newProject as well. Instead, an `OptimisticLockException` is thrown if a user tries to change an older reference to an entity. Similar problems also arise in multi-user settings, when two users try to access the same object, but it is not purely due to multiple users or even multiple threads, but simply due to stale state.

Note: There is an issue with multiple users in which a `SecurityViolation` is thrown instead of an `OptimisticLock-Exception`.

Various techniques to help to manage these duplications are:

- Copy all data to your own model.
- Return unloaded objects wherever possible.
- Be very careful about the operations you commit and about the order they take place in.
- Use a `ClientSession`.

Lazy loading

An issue related to identity is lazy loading. When an object graph is requested, Hibernate loads only the objects which are directly requested. All others are replaced with proxy objects. Within the Hibernate session, these objects are "active" and if accessed, they will be automatically loaded. This is taken care of by the first-level cache, and is also the reason that referential equality is guaranteed within the Hibernate session. Outside of the session however, the proxies can no longer be loaded and so they cannot be serialized to the client.

Instead, as the return value passes through OMERO's AOP layer, they get disconnected. Single-valued fields are replaced by an unloaded version:

```
OriginalFile ofile = …; // Object to test
if ( ! Hibernate.isInitialized( ofile.getFormat() ) {
  ofile.setFormat( new Format( ofile.getFormat().getId(), false) );
}
```

Multi-valued fields, or collections, are simply nulled. In this case, the `sizeOfXXX` method will return a value less than zero:

```
Dataset d = …; // Dataset obtained from a query. Didn't request Projects
assert d.sizeOfProjects() < 0 : "Projects should not be loaded";
```

This is why it is necessary to specify all "join fetch" clauses for instances which are required on the client-side. See ProxyCleanupFilter[17] for the implementation.

Collections

More than just the nulling during serialization, collections pose several interesting problems.

For example, a collection may be filtered on retrieval:

```
Dataset d = iQuery.findByQuery("select d from Dataset d "+
        "join fetch d.projectLinks links "+
        "where links.parent.id > 2000", null);
```

Some `ProjectDatasetLink` instances have been filtered from the projectLinks collection. If the client decides to save this collection back, there is no way to know that it is incomplete, and Hibernate will remove the missing Projects from the Dataset. It is the developer's responsibility to know what state a collection is in. In the case of links, discussed below, one solution is to use the link objects directly, even if they are largely hidden with the API, but the problem remains for 1-N collections.

Links

A special form of links collection model the many-to-many relationship between two other objects. A Project can contain any number of Datasets, and a Dataset can be in any number of Projects. This is achieved by `ProjectDatasetLinks`, which have a Project "parent" and a Dataset "child" (the parent/child terms are somewhat arbitrary but are intended to fit roughly with the users' expectations for those types).

It is possible to both add and remove a link directly:

```
ProjectDatasetLink link = new ProjectDatasetLink();
link.setParent( someProject );
link.setChild(  someDataset );
link = update.saveAndReturnObject( link );

// someDataset is now included in someProject

update.deleteObject(link);
// or update.deleteObject(new ProjectDatasetLink(link.getId(), false)); // a proxy

// Now the Dataset is not included,
// __unless__ there was already another link.
```

However, it is also possible to have the links managed for you:

```
someProject.linkDataset( someDataset ); // This creates the link
update.saveObject( someProject ); // Notices added link, and saves it

someProject.unlinkDataset( someDataset );
update.saveObject( someProject ); // Notices removal, and deletes it
```

The difficulty with this approach is that `unlinkDataset()` will fail if the someDataset which you are trying to remove is not referentially equal. That is:

```
someProject.linkDataset( someDataset );
updatedProject = update.saveAndReturnObject( someProject );

updatedProject.unlinkDataset( someDataset );
update.saveObject( updateProject ); // will do __nothing__ !
```

[17] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/tools/hibernate/ProxyCleanupFilter.java

does not work since someDataset is not included in updatedProject, but rather updatedDataset with the same id is. Therefore, it would be necessary to do something along the following lines of:

```
updatedProject = …; // As before
for (Dataset updatedDataset : updatedProject.linkedDatasetList() ) {
    if (updatedDataset.getId().equals( someDataset.getId() )) {
        updatedProject.unlinkDataset( updatedDataset );
    }
}
```

The unlink method in this case, removes the link from both the Project.datasetLinks collection as well as from the Dataset.projectLinks collection. Hibernate notices that both collections are in agreement, and deletes the ProjectDatasetLink (this is achieved via the "delete-orphan" annotation in Hibernate). If only one side of the collection has had its link removed, an exception will be thrown.

Synchronization

Another important point is that the model objects are in no way synchronized. All synchronization must occur within application code.

17.1.5 Limitations

We try to minimize differences between the Model as described by the XML specification and its implementation in the OMERO database but some Objects may behave in a more restricted fashion within OMERO. Examples include:

- ROIs and rendering settings can only belong to one Image

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

17.2 Structured annotations

Structured annotations permit the attachment of data and metadata outside the OMERO data model to certain types within the model. The annotations are designed for individualized use by both sites and tools. Annotations can be attached to multiple instances simultaneously to quickly annotated all entities in a view. Each annotation has a "name" which can be interpreted as a "namespace" by tools, which can filter out all unknown namespaces. Further, to prevent users from overwriting or editing important information, annotations are immutable, but editing can be simulated via copy and delete.

17.2.1 Annotated and annotating types

Each type which can be annotated implements `ome.model.IAnnotated`. Currently, these are:

- `Project`
- `Dataset`
- `Image`
- `Pixels`
- `OriginalFile`
- `PlaneInfo`
- `Roi`
- `Channel`
- `Annotation` and all annotation subtypes in order to form hierarchies
- ScreenPlateWell: `Screen`, `ScreenAcquisition`, `Plate`, `Well`, `Reagent`

- …

Annotation hierarchy

Though they largely are all String or numeric values, a hierarchy of annotations makes differentiating between just what interpretation should be given to the annotation. This may eventually include validation of the input string and/or file.

```
Annotation (A*) ..................... A name field and a description
  ListAnnotation ..................... Uses AnnotationAnnotation links to form a list of annotations
  BasicAnnotation (A*) ................ Literal or "primitive" values
    BooleanAnnotation ................. A simple true/false flag
    TimeStampAnnotation ............... A date/time
    TermAnnotation .................... A term used in an ontology
  NumericAnnotation (A*) .............. Floating point and integer values
    DoubleAnnotation
    LongAnnotation
  TextAnnotation (A*) ................. A single text field
    CommentAnnotation ................. A user comment
    TagAnnotation ..................... Interpreted as a Web 2.0 "tag" on an object, tags on tags form
    XmlAnnotation ..................... An xml snippet attached to some object
    MapAnnotation ..................... A set of key-value pairs
  TypeAnnotation (A*) ................. Links some entity to another (possibly to be replaced by <any/>
    FileAnnotation .................... Uses the Format field on OriginalFile to specify type

A* = abstract
```

See also:

Schema documentation for Structured Annotations[18] Section of the auto-generated schema documentation describing the structured annotations

17.2.2 Names and namespaces

Since arbitrary blobs or clobs can be attached to an entity, it is necessary for clients to have some way to differentiate what it can parse. In many cases, the name might be a simple reminder for a user to find the file s/he has annotated. Applications, however, will most likely want to define a namespace, like `http://name-of-application-provider.com/name-of-application/file-type/version`. Queries can then be produced which search for the proper namespace or match on a part of the name space:

```
iQuery.findAllByQuery("select annotation from FileAnnotation where "+
 "name like 'http://name-of-application-provider.com/name-of-application/%'");
```

Tags will most likely begin without a namespace. As a tag gets escalated to a common vocabulary, it might make sense to add a possibly site-specific namespace with more well-defined semantics.

17.2.3 Descriptions

Unlike the previous, `ImageAnnotation` and `DatasetAnnotation` types, the new structured annotations do not have a description field. The single description field was limited for multi-user scenarios, and can be fully replaced by `TextAnnotations` attached to another annotation.

```
FileAnnotation fileAnnotation = …;
TextAnnotation description = …;
fileAnnotation.linkAnnotation(description);
```

17.2.4 Immutability

The actual content value of an annotation – the text, long, double, file value, etc – is immutable. Links to and from the annotation, however, can be modified.

Currently the namespace field of annotations is mutable. See #878[19] for discussion.

17.2.5 Examples

Basics

```
import ome.model.IAnnotated;
import ome.model.annotations.FileAnnotation;
import ome.model.annotations.TagAnnotation;
import ome.model.core.OriginalFile;
import ome.model.display.Roi;

List<Annotation> list = iAnnotated.linkedAnnotationList();
// do something with list
```

Attaching a tag

```
TagAnnotation tag = new TagAnnotation();
tag.setTextValue("interesting");

Roi roi = …; // Some region of interest
ILink link = roi.linkAnnotation(tag);

iUpdate.saveObject(link);
```

Attaching a file

```
// or attach something new
OriginalFile myOriginalFile = new OriginalFile();
myOriginalFile.setName("output.pdf");
// upload PDF

FileAnnotation annotation = new FileAnnotation();
annotation.setName("http://example.com/myClient/analysisOutput");
annotation.setFile(myOriginalFile);

ILink link = iAnnotated.linkAnnotation(annotation)
link = iUpdate.saveAndReturnObject(link);
```

All write changes are intended to occur through the IUpdate interface, whereas searching should be significantly easier through ome.api.Search than IQuery.

See also:

Extending OMERO.server

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

[19] https://trac.openmicroscopy.org/ome/ticket/878

17.3 Glossary of all OMERO Model Objects

17.3.1 Overview

In navigating the model objects used by the *OMERO API* and in `omero hql` it is often useful to look up the names of the object properties and the types of their values. This reference document lists every OMERO model object and their more useful properties, with an emphasis on enumerating every direct relationship among the objects.

17.3.2 Reference

AcquisitionMode

Used by: *LogicalChannel.mode*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[20]

Annotation

Subclasses: *BasicAnnotation*, *ListAnnotation*, *MapAnnotation*, *TextAnnotation*, *TypeAnnotation*

Used by: *AnnotationAnnotationLink.child*, *AnnotationAnnotationLink.parent*, *ChannelAnnotationLink.child*, *DatasetAnnotationLink.child*, *DetectorAnnotationLink.child*, *DichroicAnnotationLink.child*, *ExperimenterAnnotationLink.child*, *ExperimenterGroupAnnotationLink.child*, *FilesetAnnotationLink.child*, *FilterAnnotationLink.child*, *ImageAnnotationLink.child*, *InstrumentAnnotationLink.child*, *LightPathAnnotationLink.child*, *LightSourceAnnotationLink.child*, *NamespaceAnnotationLink.child*, *NodeAnnotationLink.child*, *ObjectiveAnnotationLink.child*, *OriginalFileAnnotationLink.child*, *PlaneInfoAnnotationLink.child*, *PlateAcquisitionAnnotationLink.child*, *PlateAnnotationLink.child*, *ProjectAnnotationLink.child*, *ReagentAnnotationLink.child*, *RoiAnnotationLink.child*, *ScreenAnnotationLink.child*, *SessionAnnotationLink.child*, *ShapeAnnotationLink.child*, *WellAnnotationLink.child*

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
name: `string` (optional)
ns: `string` (optional)
version: `integer` (optional), see IMutable[21]

AnnotationAnnotationLink

Used by: *Annotation.annotationLinks*

Properties:

child: *Annotation*, see ILink[22]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*

[20] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[21] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[22] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

details.updateEvent: *Event*
parent: *Annotation*, see ILink[23]
version: `integer` (optional), see IMutable[24]

Arc

Properties:

annotationLinks: *LightSourceAnnotationLink* (multiple) from *LightSource*
details.creationEvent: *Event* from *LightSource*
details.externalInfo: *ExternalInfo* (optional) from *LightSource*
details.group: *ExperimenterGroup* from *LightSource*
details.owner: *Experimenter* from *LightSource*
details.updateEvent: *Event* from *LightSource*
instrument: *Instrument* from *LightSource*
lotNumber: `string` (optional) from *LightSource*
manufacturer: `string` (optional) from *LightSource*
model: `string` (optional) from *LightSource*
power.unit: enumeration of Power[25] (optional) from *LightSource*
power.value: `double` (optional) from *LightSource*
serialNumber: `string` (optional) from *LightSource*
type: *ArcType*
version: `integer` (optional) from *LightSource*

ArcType

Used by: *Arc.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[26]

BasicAnnotation

Subclasses: *BooleanAnnotation*, *NumericAnnotation*, *TermAnnotation*, *TimestampAnnotation*

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

[23] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[24] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[25] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Power.html
[26] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

Binning

Used by: *DetectorSettings.binning*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[27]

BooleanAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
boolValue: `boolean` (optional)
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

Channel

Used by: *ChannelAnnotationLink.parent*, *LogicalChannel.channels*, *Pixels.channels*

Properties:

alpha: `integer` (optional)
annotationLinks: *ChannelAnnotationLink* (multiple)
blue: `integer` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
green: `integer` (optional)
logicalChannel: *LogicalChannel*
lookupTable: `string` (optional)
pixels: *Pixels*
red: `integer` (optional)
statsInfo: *StatsInfo* (optional)
version: `integer` (optional), see IMutable[28]

ChannelAnnotationLink

Used by: *Channel.annotationLinks*

Properties:

child: *Annotation*, see ILink[29]
details.creationEvent: *Event*

[27] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[28] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[29] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Channel*, see ILink[30]
version: `integer` (optional), see IMutable[31]

ChannelBinding

Used by: *RenderingDef.waveRendering*

Properties:

active: `boolean`
alpha: `integer`
blue: `integer`
coefficient: `double`
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
family: *Family*
green: `integer`
inputEnd: `double`
inputStart: `double`
lookupTable: `string` (optional)
noiseReduction: `boolean`
red: `integer`
renderingDef: *RenderingDef*
version: `integer` (optional), see IMutable[32]

ChecksumAlgorithm

Used by: *OriginalFile.hasher*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[33]

CodomainMapContext

Subclasses: *ContrastStretchingContext*, *PlaneSlicingContext*, *ReverseIntensityContext*

Used by: *RenderingDef.spatialDomainEnhancement*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*

[30] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[31] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[32] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[33] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

renderingDef: *RenderingDef*
version: `integer` (optional), see IMutable[34]

CommentAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
textValue: `text` (optional) from *TextAnnotation*
version: `integer` (optional) from *Annotation*

ContrastMethod

Used by: *LogicalChannel.contrastMethod*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[35]

ContrastStretchingContext

Properties:

details.creationEvent: *Event* from *CodomainMapContext*
details.externalInfo: *ExternalInfo* (optional) from *CodomainMapContext*
details.group: *ExperimenterGroup* from *CodomainMapContext*
details.owner: *Experimenter* from *CodomainMapContext*
details.updateEvent: *Event* from *CodomainMapContext*
renderingDef: *RenderingDef* from *CodomainMapContext*
version: `integer` (optional) from *CodomainMapContext*
xend: `integer`
xstart: `integer`
yend: `integer`
ystart: `integer`

Correction

Used by: *Objective.correction*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[36]

[34] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[35] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[36] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

DBPatch

Properties:

currentPatch: `integer`
currentVersion: `string`
details.externalInfo: *ExternalInfo* (optional)
finished: `timestamp` (optional)
message: `string` (optional)
previousPatch: `integer`
previousVersion: `string`

Dataset

Used by: *DatasetAnnotationLink.parent*, *DatasetImageLink.parent*, *ProjectDatasetLink.child*

Properties:

annotationLinks: *DatasetAnnotationLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
imageLinks: *DatasetImageLink* (multiple)
name: `string`
projectLinks: *ProjectDatasetLink* (multiple)
version: `integer` (optional), see IMutable[37]

DatasetAnnotationLink

Used by: *Dataset.annotationLinks*

Properties:

child: *Annotation*, see ILink[38]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Dataset*, see ILink[39]
version: `integer` (optional), see IMutable[40]

DatasetImageLink

Used by: *Dataset.imageLinks*, *Image.datasetLinks*

Properties:

child: *Image*, see ILink[41]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)

[37] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[38] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[39] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[40] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[41] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Dataset*, see ILink[42]
version: `integer` (optional), see IMutable[43]

Detector

Used by: *DetectorAnnotationLink.parent*, *DetectorSettings.detector*, *Instrument.detector*

Properties:

amplificationGain: `double` (optional)
annotationLinks: *DetectorAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
gain: `double` (optional)
instrument: *Instrument*
lotNumber: `string` (optional)
manufacturer: `string` (optional)
model: `string` (optional)
offsetValue: `double` (optional)
serialNumber: `string` (optional)
type: *DetectorType*
version: `integer` (optional), see IMutable[44]
voltage.unit: enumeration of ElectricPotential[45] (optional)
voltage.value: `double` (optional)
zoom: `double` (optional)

DetectorAnnotationLink

Used by: *Detector.annotationLinks*

Properties:

child: *Annotation*, see ILink[46]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Detector*, see ILink[47]
version: `integer` (optional), see IMutable[48]

DetectorSettings

Used by: *LogicalChannel.detectorSettings*

[42] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[43] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[44] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[45] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/ElectricPotential.html
[46] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[47] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[48] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

Properties:

binning: *Binning* (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
detector: *Detector*
gain: `double` (optional)
integration: `integer` (optional)
offsetValue: `double` (optional)
readOutRate.unit: enumeration of Frequency[49] (optional)
readOutRate.value: `double` (optional)
version: `integer` (optional), see IMutable[50]
voltage.unit: enumeration of ElectricPotential[51] (optional)
voltage.value: `double` (optional)
zoom: `double` (optional)

DetectorType

Used by: *Detector.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[52]

Dichroic

Used by: *DichroicAnnotationLink.parent*, *FilterSet.dichroic*, *Instrument.dichroic*, *LightPath.dichroic*

Properties:

annotationLinks: *DichroicAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
instrument: *Instrument*
lotNumber: `string` (optional)
manufacturer: `string` (optional)
model: `string` (optional)
serialNumber: `string` (optional)
version: `integer` (optional), see IMutable[53]

DichroicAnnotationLink

Used by: *Dichroic.annotationLinks*

Properties:

[49] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Frequency.html
[50] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[51] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/ElectricPotential.html
[52] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[53] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

child: *Annotation*, see ILink[54]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Dichroic*, see ILink[55]
version: `integer` (optional), see IMutable[56]

DimensionOrder

Used by: *Pixels.dimensionOrder*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[57]

DoubleAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
doubleValue: `double` (optional)
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

Ellipse

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
cx: `double` (optional)
cy: `double` (optional)
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[58] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*

[54] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[55] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[56] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[57] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[58] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
locked: `boolean` (optional) from *Shape*
roi: *Roi* from *Shape*
rx: `double` (optional)
ry: `double` (optional)
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[59] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*

Event

Used by: *Annotation.details.creationEvent*, *Annotation.details.updateEvent*, *AnnotationAnnotationLink.details.creationEvent*, *AnnotationAnnotationLink.details.updateEvent*, *Channel.details.creationEvent*, *Channel.details.updateEvent*, *ChannelAnnotationLink.details.creationEvent*, *ChannelAnnotationLink.details.updateEvent*, *ChannelBinding.details.creationEvent*, *ChannelBinding.details.updateEvent*, *CodomainMapContext.details.creationEvent*, *CodomainMapContext.details.updateEvent*, *Dataset.details.creationEvent*, *Dataset.details.updateEvent*, *DatasetAnnotationLink.details.creationEvent*, *DatasetAnnotationLink.details.updateEvent*, *DatasetImageLink.details.creationEvent*, *DatasetImageLink.details.updateEvent*, *Detector.details.creationEvent*, *Detector.details.updateEvent*, *DetectorAnnotationLink.details.creationEvent*, *DetectorAnnotationLink.details.updateEvent*, *DetectorSettings.details.creationEvent*, *DetectorSettings.details.updateEvent*, *Dichroic.details.creationEvent*, *Dichroic.details.updateEvent*, *DichroicAnnotationLink.details.creationEvent*, *DichroicAnnotationLink.details.updateEvent*, *Event.containingEvent*, *EventLog.event*, *Experiment.details.creationEvent*, *Experiment.details.updateEvent*, *ExperimenterAnnotationLink.details.creationEvent*, *ExperimenterAnnotationLink.details.updateEvent*, *ExperimenterGroupAnnotationLink.details.creationEvent*, *ExperimenterGroupAnnotationLink.details.updateEvent*, *ExternalInfo.details.creationEvent*, *Fileset.details.creationEvent*, *Fileset.details.updateEvent*, *FilesetAnnotationLink.details.creationEvent*, *FilesetAnnotationLink.details.updateEvent*, *FilesetEntry.details.creationEvent*, *FilesetEntry.details.updateEvent*, *FilesetJobLink.details.creationEvent*, *FilesetJobLink.details.updateEvent*, *Filter.details.creationEvent*, *Filter.details.updateEvent*, *FilterAnnotationLink.details.creationEvent*, *FilterAnnotationLink.details.updateEvent*, *FilterSet.details.creationEvent*, *FilterSet.details.updateEvent*, *FilterSetEmissionFilterLink.details.creationEvent*, *FilterSetEmissionFilterLink.details.updateEvent*, *FilterSetExcitationFilterLink.details.creationEvent*, *FilterSetExcitationFilterLink.details.updateEvent*, *Image.details.creationEvent*, *Image.details.updateEvent*, *ImageAnnotationLink.details.creationEvent*, *ImageAnnotationLink.details.updateEvent*, *ImagingEnvironment.details.creationEvent*, *ImagingEnvironment.details.updateEvent*, *Instrument.details.creationEvent*, *Instrument.details.updateEvent*, *InstrumentAnnotationLink.details.creationEvent*, *InstrumentAnnotationLink.details.updateEvent*, *Job.details.creationEvent*, *Job.details.updateEvent*, *JobOriginalFileLink.details.creationEvent*, *JobOriginalFileLink.details.updateEvent*, *LightPath.details.creationEvent*, *LightPath.details.updateEvent*, *LightPathAnnotationLink.details.creationEvent*, *LightPathAnnotationLink.details.updateEvent*, *LightPathEmissionFilterLink.details.creationEvent*, *LightPathEmissionFilterLink.details.updateEvent*, *LightPathExcitationFilterLink.details.creationEvent*, *LightPathExcitationFilterLink.details.updateEvent*, *LightSettings.details.creationEvent*, *LightSettings.details.updateEvent*, *LightSource.details.creationEvent*, *LightSource.details.updateEvent*, *LightSourceAn-*

[59] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

notationLink.details.creationEvent, *LightSourceAnnotationLink.details.updateEvent*, *Link.details.creationEvent*, *Link.details.updateEvent*, *LogicalChannel.details.creationEvent*, *LogicalChannel.details.updateEvent*, *MicrobeamManipulation.details.creationEvent*, *MicrobeamManipulation.details.updateEvent*, *Microscope.details.creationEvent*, *Microscope.details.updateEvent*, *NamespaceAnnotationLink.details.creationEvent*, *NamespaceAnnotationLink.details.updateEvent*, *NodeAnnotationLink.details.creationEvent*, *NodeAnnotationLink.details.updateEvent*, *OTF.details.creationEvent*, *OTF.details.updateEvent*, *Objective.details.creationEvent*, *Objective.details.updateEvent*, *ObjectiveAnnotationLink.details.creationEvent*, *ObjectiveAnnotationLink.details.updateEvent*, *ObjectiveSettings.details.creationEvent*, *ObjectiveSettings.details.updateEvent*, *OriginalFile.details.creationEvent*, *OriginalFile.details.updateEvent*, *OriginalFileAnnotationLink.details.creationEvent*, *OriginalFileAnnotationLink.details.updateEvent*, *Pixels.details.creationEvent*, *Pixels.details.updateEvent*, *PixelsOriginalFileMap.details.creationEvent*, *PixelsOriginalFileMap.details.updateEvent*, *PlaneInfo.details.creationEvent*, *PlaneInfo.details.updateEvent*, *PlaneInfoAnnotationLink.details.creationEvent*, *PlaneInfoAnnotationLink.details.updateEvent*, *Plate.details.creationEvent*, *Plate.details.updateEvent*, *PlateAcquisition.details.creationEvent*, *PlateAcquisition.details.updateEvent*, *PlateAcquisitionAnnotationLink.details.creationEvent*, *PlateAcquisitionAnnotationLink.details.updateEvent*, *PlateAnnotationLink.details.creationEvent*, *PlateAnnotationLink.details.updateEvent*, *Project.details.creationEvent*, *Project.details.updateEvent*, *ProjectAnnotationLink.details.creationEvent*, *ProjectAnnotationLink.details.updateEvent*, *ProjectDatasetLink.details.creationEvent*, *ProjectDatasetLink.details.updateEvent*, *QuantumDef.details.creationEvent*, *QuantumDef.details.updateEvent*, *Reagent.details.creationEvent*, *Reagent.details.updateEvent*, *ReagentAnnotationLink.details.creationEvent*, *ReagentAnnotationLink.details.updateEvent*, *RenderingDef.details.creationEvent*, *RenderingDef.details.updateEvent*, *Roi.details.creationEvent*, *Roi.details.updateEvent*, *RoiAnnotationLink.details.creationEvent*, *RoiAnnotationLink.details.updateEvent*, *Screen.details.creationEvent*, *Screen.details.updateEvent*, *ScreenAnnotationLink.details.creationEvent*, *ScreenAnnotationLink.details.updateEvent*, *ScreenPlateLink.details.creationEvent*, *ScreenPlateLink.details.updateEvent*, *Session.events*, *SessionAnnotationLink.details.creationEvent*, *SessionAnnotationLink.details.updateEvent*, *Shape.details.creationEvent*, *Shape.details.updateEvent*, *ShapeAnnotationLink.details.creationEvent*, *ShapeAnnotationLink.details.updateEvent*, *StageLabel.details.creationEvent*, *StageLabel.details.updateEvent*, *StatsInfo.details.creationEvent*, *StatsInfo.details.updateEvent*, *Thumbnail.details.creationEvent*, *Thumbnail.details.updateEvent*, *TransmittanceRange.details.creationEvent*, *TransmittanceRange.details.updateEvent*, *Well.details.creationEvent*, *Well.details.updateEvent*, *WellAnnotationLink.details.creationEvent*, *WellAnnotationLink.details.updateEvent*, *WellReagentLink.details.creationEvent*, *WellReagentLink.details.updateEvent*, *WellSample.details.creationEvent*, *WellSample.details.updateEvent*

Properties:

containingEvent: *Event* (optional)
details.externalInfo: *ExternalInfo* (optional)
experimenter: *Experimenter*
experimenterGroup: *ExperimenterGroup*
logs: *EventLog* (multiple)
session: *Session*
status: `string` (optional)
time: `timestamp`
type: *EventType*

EventLog

Used by: *Event.logs*

Properties:

action: `string`
details.externalInfo: *ExternalInfo* (optional)
entityId: `long`
entityType: `string`
event: *Event*

EventType

Used by: *Event.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[60]

Experiment

Used by: *Image.experiment*, *MicrobeamManipulation.experiment*

Properties:

description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
microbeamManipulation: *MicrobeamManipulation* (multiple)
type: *ExperimentType*
version: `integer` (optional), see IMutable[61]

ExperimentType

Used by: *Experiment.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[62]

Experimenter

Used by: *Annotation.details.owner*, *AnnotationAnnotationLink.details.owner*, *Channel.details.owner*, *ChannelAnnotationLink.details.owner*, *ChannelBinding.details.owner*, *CodomainMapContext.details.owner*, *Dataset.details.owner*, *DatasetAnnotationLink.details.owner*, *DatasetImageLink.details.owner*, *Detector.details.owner*, *DetectorAnnotationLink.details.owner*, *DetectorSettings.details.owner*, *Dichroic.details.owner*, *DichroicAnnotationLink.details.owner*, *Event.experimenter*, *Experiment.details.owner*, *ExperimenterAnnotationLink.details.owner*, *ExperimenterAnnotationLink.parent*, *ExperimenterGroupAnnotationLink.details.owner*, *ExternalInfo.details.owner*, *Fileset.details.owner*, *FilesetAnnotationLink.details.owner*, *FilesetEntry.details.owner*, *FilesetJobLink.details.owner*, *Filter.details.owner*, *FilterAnnotationLink.details.owner*, *FilterSet.details.owner*, *FilterSetEmissionFilterLink.details.owner*, *FilterSetExcitationFilterLink.details.owner*, *GroupExperimenterMap.child*, *Image.details.owner*, *ImageAnnotationLink.details.owner*, *ImagingEnvironment.details.owner*, *Instrument.details.owner*, *InstrumentAnnotationLink.details.owner*, *Job.details.owner*, *JobOriginalFileLink.details.owner*, *LightPath.details.owner*, *LightPathAnnotationLink.details.owner*, *LightPathEmissionFilterLink.details.owner*, *LightPathExcitationFilterLink.details.owner*, *LightSettings.details.owner*, *LightSource.details.owner*, *LightSourceAnnotationLink.details.owner*, *Link.details.owner*, *LogicalChannel.details.owner*, *MicrobeamManipulation.details.owner*, *Microscope.details.owner*, *NamespaceAnnotationLink.details.owner*, *NodeAnnotationLink.details.owner*, *OTF.details.owner*, *Objective.details.owner*, *ObjectiveAnnotationLink.details.owner*, *ObjectiveSettings.details.owner*, *OriginalFile.details.owner*, *OriginalFileAnnotationLink.details.owner*, *Pixels.details.owner*, *PixelsOriginalFileMap.details.owner*, *PlaneInfo.details.owner*, *PlaneInfoAnnotationLink.details.owner*, *Plate.details.owner*, *PlateAcquisition.details.owner*, *PlateAcquisitionAnnotationLink.details.owner*, *PlateAnnotationLink.details.owner*, *Project.details.owner*, *ProjectAnnotationLink.details.owner*, *ProjectDatasetLink.details.owner*, *QuantumDef.details.owner*, *Reagent.details.owner*, *ReagentAnnotationLink.details.owner*, *RenderingDef.details.owner*, *Roi.details.owner*, *RoiAnnotationLink.details.owner*, *Screen.details.owner*, *ScreenAnnotationLink.details.owner*, *ScreenPlateLink.details.owner*, *Session.owner*, *SessionAnnotationLink.details.owner*, *Shape.details.owner*, *ShapeAnnotationLink.details.owner*, *ShareMember.child*, *StageLabel.details.owner*, *StatsInfo.details.owner*, *Thumbnail.details.owner*, *TransmittanceRange.details.owner*, *Well.details.owner*, *WellAnnotationLink.details.owner*, *WellReagentLink.details.owner*, *WellSample.details.owner*

Properties:

[60] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[61] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[62] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

annotationLinks: *ExperimenterAnnotationLink* (multiple)
details.externalInfo: *ExternalInfo* (optional)
email: `string` (optional)
firstName: `string`
groupExperimenterMap: *GroupExperimenterMap* (multiple)
institution: `string` (optional)
lastName: `string`
ldap: `boolean`
middleName: `string` (optional)
omeName: `string`
version: `integer` (optional), see IMutable[63]

ExperimenterAnnotationLink

Used by: *Experimenter.annotationLinks*

Properties:

child: *Annotation*, see ILink[64]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Experimenter*, see ILink[65]
version: `integer` (optional), see IMutable[66]

ExperimenterGroup

Used by: *Annotation.details.group*, *AnnotationAnnotationLink.details.group*, *Channel.details.group*, *ChannelAnnotationLink.details.group*, *ChannelBinding.details.group*, *CodomainMapContext.details.group*, *Dataset.details.group*, *DatasetAnnotationLink.details.group*, *DatasetImageLink.details.group*, *Detector.details.group*, *DetectorAnnotationLink.details.group*, *DetectorSettings.details.group*, *Dichroic.details.group*, *DichroicAnnotationLink.details.group*, *Event.experimenterGroup*, *Experiment.details.group*, *ExperimenterAnnotationLink.details.group*, *ExperimenterGroupAnnotationLink.details.group*, *ExperimenterGroupAnnotationLink.parent*, *ExternalInfo.details.group*, *Fileset.details.group*, *FilesetAnnotationLink.details.group*, *FilesetEntry.details.group*, *FilesetJobLink.details.group*, *Filter.details.group*, *FilterAnnotationLink.details.group*, *FilterSet.details.group*, *FilterSetEmissionFilterLink.details.group*, *FilterSetExcitationFilterLink.details.group*, *GroupExperimenterMap.parent*, *Image.details.group*, *ImageAnnotationLink.details.group*, *ImagingEnvironment.details.group*, *Instrument.details.group*, *InstrumentAnnotationLink.details.group*, *Job.details.group*, *JobOriginalFileLink.details.group*, *LightPath.details.group*, *LightPathAnnotationLink.details.group*, *LightPathEmissionFilterLink.details.group*, *LightPathExcitationFilterLink.details.group*, *LightSettings.details.group*, *LightSource.details.group*, *LightSourceAnnotationLink.details.group*, *Link.details.group*, *LogicalChannel.details.group*, *MicrobeamManipulation.details.group*, *Microscope.details.group*, *NamespaceAnnotationLink.details.group*, *NodeAnnotationLink.details.group*, *OTF.details.group*, *Objective.details.group*, *ObjectiveAnnotationLink.details.group*, *ObjectiveSettings.details.group*, *OriginalFile.details.group*, *OriginalFileAnnotationLink.details.group*, *Pixels.details.group*, *PixelsOriginalFileMap.details.group*, *PlaneInfo.details.group*, *PlaneInfoAnnotationLink.details.group*, *Plate.details.group*, *PlateAcquisition.details.group*, *PlateAcquisitionAnnotationLink.details.group*, *PlateAnnotationLink.details.group*, *Project.details.group*, *ProjectAnnotationLink.details.group*, *ProjectDatasetLink.details.group*, *QuantumDef.details.group*, *Reagent.details.group*, *ReagentAnnotationLink.details.group*, *RenderingDef.details.group*, *Roi.details.group*, *RoiAnnotationLink.details.group*, *Screen.details.group*, *ScreenAnnotationLink.details.group*, *ScreenPlateLink.details.group*, *SessionAnnotationLink.details.group*, *Shape.details.group*, *ShapeAnnotationLink.details.group*, *Share.group*, *StageLabel.details.group*, *StatsInfo.details.group*, *Thumbnail.details.group*, *TransmittanceRange.details.group*, *Well.details.group*, *WellAnnotationLink.details.group*, *WellReagentLink.details.group*, *WellSample.details.group*

Properties:

[63] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[64] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[65] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[66] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

annotationLinks: *ExperimenterGroupAnnotationLink* (multiple)
config: list (multiple)
description: `text` (optional)
details.externalInfo: *ExternalInfo* (optional)
groupExperimenterMap: *GroupExperimenterMap* (multiple)
ldap: `boolean`
name: `string`
version: `integer` (optional), see IMutable[67]

ExperimenterGroupAnnotationLink

Used by: *ExperimenterGroup.annotationLinks*

Properties:

child: *Annotation*, see ILink[68]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *ExperimenterGroup*, see ILink[69]
version: `integer` (optional), see IMutable[70]

ExternalInfo

Used by: *AcquisitionMode.details.externalInfo*, *Annotation.details.externalInfo*, *AnnotationAnnotationLink.details.externalInfo*, *ArcType.details.externalInfo*, *Binning.details.externalInfo*, *Channel.details.externalInfo*, *ChannelAnnotationLink.details.externalInfo*, *ChannelBinding.details.externalInfo*, *ChecksumAlgorithm.details.externalInfo*, *CodomainMapContext.details.externalInfo*, *ContrastMethod.details.externalInfo*, *Correction.details.externalInfo*, *DBPatch.details.externalInfo*, *Dataset.details.externalInfo*, *DatasetAnnotationLink.details.externalInfo*, *DatasetImageLink.details.externalInfo*, *Detector.details.externalInfo*, *DetectorAnnotationLink.details.externalInfo*, *DetectorSettings.details.externalInfo*, *DetectorType.details.externalInfo*, *Dichroic.details.externalInfo*, *DichroicAnnotationLink.details.externalInfo*, *DimensionOrder.details.externalInfo*, *Event.details.externalInfo*, *EventLog.details.externalInfo*, *EventType.details.externalInfo*, *Experiment.details.externalInfo*, *ExperimentType.details.externalInfo*, *Experimenter.details.externalInfo*, *ExperimenterAnnotationLink.details.externalInfo*, *ExperimenterGroup.details.externalInfo*, *ExperimenterGroupAnnotationLink.details.externalInfo*, *ExternalInfo.details.externalInfo*, *Family.details.externalInfo*, *FilamentType.details.externalInfo*, *Fileset.details.externalInfo*, *FilesetAnnotationLink.details.externalInfo*, *FilesetEntry.details.externalInfo*, *FilesetJobLink.details.externalInfo*, *Filter.details.externalInfo*, *FilterAnnotationLink.details.externalInfo*, *FilterSet.details.externalInfo*, *FilterSetEmissionFilterLink.details.externalInfo*, *FilterSetExcitationFilterLink.details.externalInfo*, *FilterType.details.externalInfo*, *Format.details.externalInfo*, *GroupExperimenterMap.details.externalInfo*, *Illumination.details.externalInfo*, *Image.details.externalInfo*, *ImageAnnotationLink.details.externalInfo*, *ImagingEnvironment.details.externalInfo*, *Immersion.details.externalInfo*, *Instrument.details.externalInfo*, *InstrumentAnnotationLink.details.externalInfo*, *Job.details.externalInfo*, *JobOriginalFileLink.details.externalInfo*, *JobStatus.details.externalInfo*, *LaserMedium.details.externalInfo*, *LaserType.details.externalInfo*, *LightPath.details.externalInfo*, *LightPathAnnotationLink.details.externalInfo*, *LightPathEmissionFilterLink.details.externalInfo*, *LightPathExcitationFilterLink.details.externalInfo*, *LightSettings.details.externalInfo*, *LightSource.details.externalInfo*, *LightSourceAnnotationLink.details.externalInfo*, *Link.details.externalInfo*, *LogicalChannel.details.externalInfo*, *Medium.details.externalInfo*, *MicrobeamManipulation.details.externalInfo*, *MicrobeamManipulationType.details.externalInfo*, *Microscope.details.externalInfo*, *MicroscopeType.details.externalInfo*, *Namespace.details.externalInfo*, *NamespaceAnnotationLink.details.externalInfo*, *Node.details.externalInfo*, *NodeAnnotationLink.details.externalInfo*, *OTF.details.externalInfo*, *Objective.details.externalInfo*, *ObjectiveAnnotationLink.details.externalInfo*, *ObjectiveSettings.details.externalInfo*, *OriginalFile.details.externalInfo*, *OriginalFileAnnotationLink.details.externalInfo*, *PhotometricInterpretation.details.externalInfo*, *Pixels.details.externalInfo*,

[67] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[68] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[69] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[70] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

PixelsOriginalFileMap.details.externalInfo, *PixelsType.details.externalInfo*, *PlaneInfo.details.externalInfo*, *PlaneInfoAnnotationLink.details.externalInfo*, *Plate.details.externalInfo*, *PlateAcquisition.details.externalInfo*, *PlateAcquisitionAnnotationLink.details.externalInfo*, *PlateAnnotationLink.details.externalInfo*, *Project.details.externalInfo*, *ProjectAnnotationLink.details.externalInfo*, *ProjectDatasetLink.details.externalInfo*, *Pulse.details.externalInfo*, *QuantumDef.details.externalInfo*, *Reagent.details.externalInfo*, *ReagentAnnotationLink.details.externalInfo*, *RenderingDef.details.externalInfo*, *RenderingModel.details.externalInfo*, *Roi.details.externalInfo*, *RoiAnnotationLink.details.externalInfo*, *Screen.details.externalInfo*, *ScreenAnnotationLink.details.externalInfo*, *ScreenPlateLink.details.externalInfo*, *Session.details.externalInfo*, *SessionAnnotationLink.details.externalInfo*, *Shape.details.externalInfo*, *ShapeAnnotationLink.details.externalInfo*, *ShareMember.details.externalInfo*, *StageLabel.details.externalInfo*, *StatsInfo.details.externalInfo*, *Thumbnail.details.externalInfo*, *TransmittanceRange.details.externalInfo*, *Well.details.externalInfo*, *WellAnnotationLink.details.externalInfo*, *WellReagentLink.details.externalInfo*, *WellSample.details.externalInfo*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
entityId: `long`
entityType: `string`
lsid: `string` (optional)
uuid: `string` (optional)

Family

Used by: *ChannelBinding.family*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[71]

Filament

Properties:

annotationLinks: *LightSourceAnnotationLink* (multiple) from *LightSource*
details.creationEvent: *Event* from *LightSource*
details.externalInfo: *ExternalInfo* (optional) from *LightSource*
details.group: *ExperimenterGroup* from *LightSource*
details.owner: *Experimenter* from *LightSource*
details.updateEvent: *Event* from *LightSource*
instrument: *Instrument* from *LightSource*
lotNumber: `string` (optional) from *LightSource*
manufacturer: `string` (optional) from *LightSource*
model: `string` (optional) from *LightSource*
power.unit: enumeration of Power[72] (optional) from *LightSource*
power.value: `double` (optional) from *LightSource*
serialNumber: `string` (optional) from *LightSource*
type: *FilamentType*
version: `integer` (optional) from *LightSource*

FilamentType

Used by: *Filament.type*

[71] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[72] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Power.html

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[73]

FileAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
file: *OriginalFile* (optional)
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

Fileset

Used by: *FilesetAnnotationLink.parent*, *FilesetEntry.fileset*, *FilesetJobLink.parent*, *Image.fileset*

Properties:

annotationLinks: *FilesetAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
images: *Image* (multiple)
jobLinks: *FilesetJobLink* (multiple)
templatePrefix: `text`
usedFiles: *FilesetEntry* (multiple)
version: `integer` (optional), see IMutable[74]

FilesetAnnotationLink

Used by: *Fileset.annotationLinks*

Properties:

child: *Annotation*, see ILink[75]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Fileset*, see ILink[76]
version: `integer` (optional), see IMutable[77]

[73] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[74] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[75] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[76] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[77] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

FilesetEntry

Used by: *Fileset.usedFiles*, *OriginalFile.filesetEntries*

Properties:

clientPath: `text`
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
fileset: *Fileset*
originalFile: *OriginalFile*
version: `integer` (optional), see IMutable[78]

FilesetJobLink

Used by: *Fileset.jobLinks*

Properties:

child: *Job*, see ILink[79]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Fileset*, see ILink[80]
version: `integer` (optional), see IMutable[81]

Filter

Used by: *FilterAnnotationLink.parent*, *FilterSetEmissionFilterLink.child*, *FilterSetExcitationFilterLink.child*, *Instrument.filter*, *LightPathEmissionFilterLink.child*, *LightPathExcitationFilterLink.child*

Properties:

annotationLinks: *FilterAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
emissionFilterLink: *FilterSetEmissionFilterLink* (multiple)
excitationFilterLink: *FilterSetExcitationFilterLink* (multiple)
filterWheel: `string` (optional)
instrument: *Instrument*
lotNumber: `string` (optional)
manufacturer: `string` (optional)
model: `string` (optional)
serialNumber: `string` (optional)
transmittanceRange: *TransmittanceRange* (optional)
type: *FilterType* (optional)

[78] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[79] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[80] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[81] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

version: `integer` (optional), see IMutable[82]

FilterAnnotationLink

Used by: *Filter.annotationLinks*

Properties:

child: *Annotation*, see ILink[83]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Filter*, see ILink[84]
version: `integer` (optional), see IMutable[85]

FilterSet

Used by: *FilterSetEmissionFilterLink.parent*, *FilterSetExcitationFilterLink.parent*, *Instrument.filterSet*, *LogicalChannel.filterSet*, *OTF.filterSet*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
dichroic: *Dichroic* (optional)
emissionFilterLink: *FilterSetEmissionFilterLink* (multiple)
excitationFilterLink: *FilterSetExcitationFilterLink* (multiple)
instrument: *Instrument*
lotNumber: `string` (optional)
manufacturer: `string` (optional)
model: `string` (optional)
serialNumber: `string` (optional)
version: `integer` (optional), see IMutable[86]

FilterSetEmissionFilterLink

Used by: *Filter.emissionFilterLink*, *FilterSet.emissionFilterLink*

Properties:

child: *Filter*, see ILink[87]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *FilterSet*, see ILink[88]

[82] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[83] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[84] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[85] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[86] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[87] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[88] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

version: `integer` (optional), see IMutable[89]

FilterSetExcitationFilterLink

Used by: *Filter.excitationFilterLink*, *FilterSet.excitationFilterLink*

Properties:

child: *Filter*, see ILink[90]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *FilterSet*, see ILink[91]
version: `integer` (optional), see IMutable[92]

FilterType

Used by: *Filter.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[93]

Format

Used by: *Image.format*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[94]

GenericExcitationSource

Properties:

annotationLinks: *LightSourceAnnotationLink* (multiple) from *LightSource*
details.creationEvent: *Event* from *LightSource*
details.externalInfo: *ExternalInfo* (optional) from *LightSource*
details.group: *ExperimenterGroup* from *LightSource*
details.owner: *Experimenter* from *LightSource*
details.updateEvent: *Event* from *LightSource*
instrument: *Instrument* from *LightSource*
lotNumber: `string` (optional) from *LightSource*
manufacturer: `string` (optional) from *LightSource*
map: list (multiple)
model: `string` (optional) from *LightSource*
power.unit: enumeration of Power[95] (optional) from *LightSource*
power.value: `double` (optional) from *LightSource*

[89] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[90] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[91] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[92] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[93] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[94] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[95] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Power.html

serialNumber: `string` (optional) from *LightSource*
version: `integer` (optional) from *LightSource*

GroupExperimenterMap

Used by: *Experimenter.groupExperimenterMap*, *ExperimenterGroup.groupExperimenterMap*

Properties:

child: *Experimenter*, see ILink[96]
details.externalInfo: *ExternalInfo* (optional)
owner: `boolean`
parent: *ExperimenterGroup*, see ILink[97]
version: `integer` (optional), see IMutable[98]

Illumination

Used by: *LogicalChannel.illumination*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[99]

Image

Used by: *DatasetImageLink.child*, *Fileset.images*, *ImageAnnotationLink.parent*, *Pixels.image*, *Roi.image*, *WellSample.image*

Properties:

acquisitionDate: `timestamp` (optional)
annotationLinks: *ImageAnnotationLink* (multiple)
archived: `boolean` (optional)
datasetLinks: *DatasetImageLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
experiment: *Experiment* (optional)
fileset: *Fileset* (optional)
format: *Format* (optional)
imagingEnvironment: *ImagingEnvironment* (optional)
instrument: *Instrument* (optional)
name: `string`
objectiveSettings: *ObjectiveSettings* (optional)
partial: `boolean` (optional)
pixels: *Pixels* (multiple)
rois: *Roi* (multiple)
series: `integer` (optional)
stageLabel: *StageLabel* (optional)
version: `integer` (optional), see IMutable[100]

[96] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[97] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[98] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[99] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[100] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

wellSamples: *WellSample* (multiple)

ImageAnnotationLink

Used by: *Image.annotationLinks*

Properties:

child: *Annotation*, see ILink[101]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Image*, see ILink[102]
version: `integer` (optional), see IMutable[103]

ImagingEnvironment

Used by: *Image.imagingEnvironment*

Properties:

airPressure.unit: enumeration of Pressure[104] (optional)
airPressure.value: `double` (optional)
co2percent: `double` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
humidity: `double` (optional)
map: list (multiple)
temperature.unit: enumeration of Temperature[105] (optional)
temperature.value: `double` (optional)
version: `integer` (optional), see IMutable[106]

Immersion

Used by: *Objective.immersion*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[107]

ImportJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*

[101] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[102] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[103] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[104] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Pressure.html
[105] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Temperature.html
[106] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[107] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
imageDescription: `string`
imageName: `string`
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

IndexingJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

Instrument

Used by: *Detector.instrument*, *Dichroic.instrument*, *Filter.instrument*, *FilterSet.instrument*, *Image.instrument*, *InstrumentAnnotationLink.parent*, *LightSource.instrument*, *OTF.instrument*, *Objective.instrument*

Properties:

annotationLinks: *InstrumentAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
detector: *Detector* (multiple)
dichroic: *Dichroic* (multiple)
filter: *Filter* (multiple)
filterSet: *FilterSet* (multiple)

lightSource: *LightSource* (multiple)
microscope: *Microscope* (optional)
objective: *Objective* (multiple)
otf: *OTF* (multiple)
version: `integer` (optional), see IMutable[108]

InstrumentAnnotationLink

Used by: *Instrument.annotationLinks*

Properties:

child: *Annotation*, see ILink[109]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Instrument*, see ILink[110]
version: `integer` (optional), see IMutable[111]

IntegrityCheckJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

Job

Subclasses: *ImportJob*, *IndexingJob*, *IntegrityCheckJob*, *MetadataImportJob*, *ParseJob*, *PixelDataJob*, *ScriptJob*, *ThumbnailGenerationJob*, *UploadJob*

Used by: *FilesetJobLink.child*, *JobOriginalFileLink.parent*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)

[108] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[109] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[110] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[111] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
finished: `timestamp` (optional)
groupname: `string`
message: `string`
originalFileLinks: *JobOriginalFileLink* (multiple)
scheduledFor: `timestamp`
started: `timestamp` (optional)
status: *JobStatus*
submitted: `timestamp`
type: `string`
username: `string`
version: `integer` (optional), see IMutable[112]

JobOriginalFileLink

Used by: *Job.originalFileLinks*

Properties:

child: *OriginalFile*, see ILink[113]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Job*, see ILink[114]
version: `integer` (optional), see IMutable[115]

JobStatus

Used by: *Job.status*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[116]

Label

Properties:

anchor: `string` (optional)
annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
baselineShift: `string` (optional)
decoration: `string` (optional)
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*

[112] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[113] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[114] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[115] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[116] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

direction: `string` (optional)
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[117] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
glyphOrientationVertical: `integer` (optional)
locked: `boolean` (optional) from *Shape*
roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[118] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*
writingMode: `string` (optional)
x: `double` (optional)
y: `double` (optional)

Laser

Properties:

annotationLinks: *LightSourceAnnotationLink* (multiple) from *LightSource*
details.creationEvent: *Event* from *LightSource*
details.externalInfo: *ExternalInfo* (optional) from *LightSource*
details.group: *ExperimenterGroup* from *LightSource*
details.owner: *Experimenter* from *LightSource*
details.updateEvent: *Event* from *LightSource*
frequencyMultiplication: `integer` (optional)
instrument: *Instrument* from *LightSource*
laserMedium: *LaserMedium*
lotNumber: `string` (optional) from *LightSource*
manufacturer: `string` (optional) from *LightSource*
model: `string` (optional) from *LightSource*
pockelCell: `boolean` (optional)

[117] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[118] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

power.unit: enumeration of Power[119] (optional) from *LightSource*
power.value: `double` (optional) from *LightSource*
pulse: *Pulse* (optional)
pump: *LightSource* (optional)
repetitionRate.unit: enumeration of Frequency[120] (optional)
repetitionRate.value: `double` (optional)
serialNumber: `string` (optional) from *LightSource*
tuneable: `boolean` (optional)
type: *LaserType*
version: `integer` (optional) from *LightSource*
wavelength.unit: enumeration of Length[121] (optional)
wavelength.value: `double` (optional)

LaserMedium

Used by: *Laser.laserMedium*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[122]

LaserType

Used by: *Laser.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[123]

LightEmittingDiode

Properties:

annotationLinks: *LightSourceAnnotationLink* (multiple) from *LightSource*
details.creationEvent: *Event* from *LightSource*
details.externalInfo: *ExternalInfo* (optional) from *LightSource*
details.group: *ExperimenterGroup* from *LightSource*
details.owner: *Experimenter* from *LightSource*
details.updateEvent: *Event* from *LightSource*
instrument: *Instrument* from *LightSource*
lotNumber: `string` (optional) from *LightSource*
manufacturer: `string` (optional) from *LightSource*
model: `string` (optional) from *LightSource*
power.unit: enumeration of Power[124] (optional) from *LightSource*
power.value: `double` (optional) from *LightSource*
serialNumber: `string` (optional) from *LightSource*
version: `integer` (optional) from *LightSource*

[119] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Power.html
[120] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Frequency.html
[121] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[122] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[123] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[124] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Power.html

LightPath

Used by: *LightPathAnnotationLink.parent*, *LightPathEmissionFilterLink.parent*, *LightPathExcitationFilterLink.parent*, *LogicalChannel.lightPath*

Properties:

annotationLinks: *LightPathAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
dichroic: *Dichroic* (optional)
emissionFilterLink: *LightPathEmissionFilterLink* (multiple)
excitationFilterLink: *LightPathExcitationFilterLink* (multiple)
version: `integer` (optional), see IMutable[125]

LightPathAnnotationLink

Used by: *LightPath.annotationLinks*

Properties:

child: *Annotation*, see ILink[126]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *LightPath*, see ILink[127]
version: `integer` (optional), see IMutable[128]

LightPathEmissionFilterLink

Used by: *LightPath.emissionFilterLink*

Properties:

child: *Filter*, see ILink[129]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *LightPath*, see ILink[130]
version: `integer` (optional), see IMutable[131]

LightPathExcitationFilterLink

Used by: *LightPath.excitationFilterLink*

[125] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[126] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[127] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[128] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[129] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[130] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[131] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

Properties:

child: *Filter*, see ILink[132]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *LightPath*, see ILink[133]
version: `integer` (optional), see IMutable[134]

LightSettings

Used by: *LogicalChannel.lightSourceSettings*, *MicrobeamManipulation.lightSourceSettings*

Properties:

attenuation: `double` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
lightSource: *LightSource*
microbeamManipulation: *MicrobeamManipulation* (optional)
version: `integer` (optional), see IMutable[135]
wavelength.unit: enumeration of Length[136] (optional)
wavelength.value: `double` (optional)

LightSource

Subclasses: *Arc*, *Filament*, *GenericExcitationSource*, *Laser*, *LightEmittingDiode*

Used by: *Instrument.lightSource*, *Laser.pump*, *LightSettings.lightSource*, *LightSourceAnnotationLink.parent*

Properties:

annotationLinks: *LightSourceAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
instrument: *Instrument*
lotNumber: `string` (optional)
manufacturer: `string` (optional)
model: `string` (optional)
power.unit: enumeration of Power[137] (optional)
power.value: `double` (optional)
serialNumber: `string` (optional)
version: `integer` (optional), see IMutable[138]

[132] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[133] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[134] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[135] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[136] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[137] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Power.html
[138] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

LightSourceAnnotationLink

Used by: *LightSource.annotationLinks*

Properties:

child: *Annotation*, see ILink[139]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *LightSource*, see ILink[140]
version: `integer` (optional), see IMutable[141]

Line

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[142] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
locked: `boolean` (optional) from *Shape*
roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[143] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*

[139] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[140] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[141] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[142] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[143] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*
x1: `double` (optional)
x2: `double` (optional)
y1: `double` (optional)
y2: `double` (optional)

Link

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
version: `integer` (optional), see IMutable[144]

ListAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

LogicalChannel

Used by: *Channel.logicalChannel*

Properties:

channels: *Channel* (multiple)
contrastMethod: *ContrastMethod* (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
detectorSettings: *DetectorSettings* (optional)
emissionWave.unit: enumeration of Length[145] (optional)
emissionWave.value: `double` (optional)
excitationWave.unit: enumeration of Length[146] (optional)
excitationWave.value: `double` (optional)
filterSet: *FilterSet* (optional)
fluor: `string` (optional)

[144] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[145] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[146] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

illumination: *Illumination* (optional)
lightPath: *LightPath* (optional)
lightSourceSettings: *LightSettings* (optional)
mode: *AcquisitionMode* (optional)
name: `string` (optional)
ndFilter: `double` (optional)
otf: *OTF* (optional)
photometricInterpretation: *PhotometricInterpretation* (optional)
pinHoleSize.unit: enumeration of Length[147] (optional)
pinHoleSize.value: `double` (optional)
pockelCellSetting: `integer` (optional)
samplesPerPixel: `integer` (optional)
version: `integer` (optional), see IMutable[148]

LongAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
longValue: `long` (optional)
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

MapAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
mapValue: list (multiple)
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

Mask

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
bytes: `binary` (optional)
details.creationEvent: *Event* from *Shape*

[147] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[148] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[149] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
height: `double` (optional)
locked: `boolean` (optional) from *Shape*
pixels: *Pixels* (optional)
roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[150] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*
width: `double` (optional)
x: `double` (optional)
y: `double` (optional)

Medium

Used by: *ObjectiveSettings.medium*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[151]

MetadataImportJob

Properties:

details.creationEvent: *Event* from *Job*

[149] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[150] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[151] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*
versionInfo: list (multiple)

MicrobeamManipulation

Used by: *Experiment.microbeamManipulation*, *LightSettings.microbeamManipulation*

Properties:

description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
experiment: *Experiment*
lightSourceSettings: *LightSettings* (multiple)
type: *MicrobeamManipulationType*
version: `integer` (optional), see IMutable[152]

MicrobeamManipulationType

Used by: *MicrobeamManipulation.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[153]

Microscope

Used by: *Instrument.microscope*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
lotNumber: `string` (optional)

[152] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[153] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

manufacturer: `string` (optional)
model: `string` (optional)
serialNumber: `string` (optional)
type: *MicroscopeType*
version: `integer` (optional), see IMutable[154]

MicroscopeType

Used by: *Microscope.type*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[155]

Namespace

Used by: *NamespaceAnnotationLink.parent*

Properties:

annotationLinks: *NamespaceAnnotationLink* (multiple)
description: `text` (optional)
details.externalInfo: *ExternalInfo* (optional)
display: `boolean` (optional)
displayName: `string` (optional)
keywords: list (optional)
multivalued: `boolean` (optional)
name: `string`
version: `integer` (optional), see IMutable[156]

NamespaceAnnotationLink

Used by: *Namespace.annotationLinks*

Properties:

child: *Annotation*, see ILink[157]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Namespace*, see ILink[158]
version: `integer` (optional), see IMutable[159]

Node

Used by: *NodeAnnotationLink.parent*, *Session.node*

Properties:

annotationLinks: *NodeAnnotationLink* (multiple)

[154] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[155] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[156] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[157] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[158] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[159] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

conn: `text`
details.externalInfo: *ExternalInfo* (optional)
down: `timestamp` (optional)
scale: `integer` (optional)
sessions: *Session* (multiple)
up: `timestamp`
uuid: `string`
version: `integer` (optional), see IMutable[160]

NodeAnnotationLink

Used by: *Node.annotationLinks*

Properties:

child: *Annotation*, see ILink[161]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Node*, see ILink[162]
version: `integer` (optional), see IMutable[163]

NumericAnnotation

Subclasses: *DoubleAnnotation*, *LongAnnotation*

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

OTF

Used by: *Instrument.otf*, *LogicalChannel.otf*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
filterSet: *FilterSet* (optional)

[160] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[161] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[162] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[163] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

instrument: *Instrument*
objective: *Objective*
opticalAxisAveraged: `boolean`
path: `string`
pixelsType: *PixelsType*
sizeX: `integer`
sizeY: `integer`
version: `integer` (optional), see IMutable[164]

Objective

Used by: *Instrument.objective*, *OTF.objective*, *ObjectiveAnnotationLink.parent*, *ObjectiveSettings.objective*

Properties:

annotationLinks: *ObjectiveAnnotationLink* (multiple)
calibratedMagnification: `double` (optional)
correction: *Correction*
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
immersion: *Immersion*
instrument: *Instrument*
iris: `boolean` (optional)
lensNA: `double` (optional)
lotNumber: `string` (optional)
manufacturer: `string` (optional)
model: `string` (optional)
nominalMagnification: `double` (optional)
serialNumber: `string` (optional)
version: `integer` (optional), see IMutable[165]
workingDistance.unit: enumeration of Length[166] (optional)
workingDistance.value: `double` (optional)

ObjectiveAnnotationLink

Used by: *Objective.annotationLinks*

Properties:

child: *Annotation*, see ILink[167]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Objective*, see ILink[168]
version: `integer` (optional), see IMutable[169]

[164] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[165] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[166] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[167] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[168] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[169] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

ObjectiveSettings

Used by: *Image.objectiveSettings*

Properties:

correctionCollar: `double` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
medium: *Medium* (optional)
objective: *Objective*
refractiveIndex: `double` (optional)
version: `integer` (optional), see IMutable[170]

OriginalFile

Used by: *FileAnnotation.file*, *FilesetEntry.originalFile*, *JobOriginalFileLink.child*, *OriginalFileAnnotationLink.parent*, *PixelsOriginalFileMap.parent*, *Roi.source*

Properties:

annotationLinks: *OriginalFileAnnotationLink* (multiple)
atime: `timestamp` (optional)
ctime: `timestamp` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
filesetEntries: *FilesetEntry* (multiple)
hash: `string` (optional)
hasher: *ChecksumAlgorithm* (optional)
mimetype: `string` (optional)
mtime: `timestamp` (optional)
name: `string`
path: `text`
pixelsFileMaps: *PixelsOriginalFileMap* (multiple)
size: `long` (optional)
version: `integer` (optional), see IMutable[171]

OriginalFileAnnotationLink

Used by: *OriginalFile.annotationLinks*

Properties:

child: *Annotation*, see ILink[172]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*

[170] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[171] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[172] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

details.updateEvent: *Event*
parent: *OriginalFile*, see ILink[173]
version: `integer` (optional), see IMutable[174]

ParseJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
params: `binary` (optional)
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

Path

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
d: `text` (optional)
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[175] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
locked: `boolean` (optional) from *Shape*
roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*

[173] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[174] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[175] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[176] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*

PhotometricInterpretation

Used by: *LogicalChannel.photometricInterpretation*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[177]

PixelDataJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

Pixels

Used by: *Channel.pixels*, *Image.pixels*, *Mask.pixels*, *Pixels.relatedTo*, *PixelsOriginalFileMap.child*, *PlaneInfo.pixels*, *RenderingDef.pixels*, *Thumbnail.pixels*

Properties:

channels: *Channel* (multiple)
details.creationEvent: *Event*

[176] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[177] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
dimensionOrder: *DimensionOrder*
image: *Image*
methodology: `string` (optional)
physicalSizeX.unit: enumeration of Length[178] (optional)
physicalSizeX.value: `double` (optional)
physicalSizeY.unit: enumeration of Length[179] (optional)
physicalSizeY.value: `double` (optional)
physicalSizeZ.unit: enumeration of Length[180] (optional)
physicalSizeZ.value: `double` (optional)
pixelsFileMaps: *PixelsOriginalFileMap* (multiple)
pixelsType: *PixelsType*
planeInfo: *PlaneInfo* (multiple)
relatedTo: *Pixels* (optional)
settings: *RenderingDef* (multiple)
sha1: `string`
significantBits: `integer` (optional)
sizeC: `integer`
sizeT: `integer`
sizeX: `integer`
sizeY: `integer`
sizeZ: `integer`
thumbnails: *Thumbnail* (multiple)
timeIncrement.unit: enumeration of Time[181] (optional)
timeIncrement.value: `double` (optional)
version: `integer` (optional), see IMutable[182]
waveIncrement: `integer` (optional)
waveStart: `integer` (optional)

PixelsOriginalFileMap

Used by: *OriginalFile.pixelsFileMaps*, *Pixels.pixelsFileMaps*

Properties:

child: *Pixels*, see ILink[183]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *OriginalFile*, see ILink[184]
version: `integer` (optional), see IMutable[185]

[178] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[179] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[180] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[181] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Time.html
[182] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[183] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[184] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[185] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

PixelsType

Used by: *OTF.pixelsType*, *Pixels.pixelsType*

Properties:

bitSize: `integer` (optional)
details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[186]

PlaneInfo

Used by: *Pixels.planeInfo*, *PlaneInfoAnnotationLink.parent*

Properties:

annotationLinks: *PlaneInfoAnnotationLink* (multiple)
deltaT.unit: enumeration of Time[187] (optional)
deltaT.value: `double` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
exposureTime.unit: enumeration of Time[188] (optional)
exposureTime.value: `double` (optional)
pixels: *Pixels*
positionX.unit: enumeration of Length[189] (optional)
positionX.value: `double` (optional)
positionY.unit: enumeration of Length[190] (optional)
positionY.value: `double` (optional)
positionZ.unit: enumeration of Length[191] (optional)
positionZ.value: `double` (optional)
theC: `integer`
theT: `integer`
theZ: `integer`
version: `integer` (optional), see IMutable[192]

PlaneInfoAnnotationLink

Used by: *PlaneInfo.annotationLinks*

Properties:

child: *Annotation*, see ILink[193]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*

[186] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[187] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Time.html
[188] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Time.html
[189] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[190] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[191] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[192] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[193] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

parent: *PlaneInfo*, see ILink[194]
version: `integer` (optional), see IMutable[195]

PlaneSlicingContext

Properties:

constant: `boolean`
details.creationEvent: *Event* from *CodomainMapContext*
details.externalInfo: *ExternalInfo* (optional) from *CodomainMapContext*
details.group: *ExperimenterGroup* from *CodomainMapContext*
details.owner: *Experimenter* from *CodomainMapContext*
details.updateEvent: *Event* from *CodomainMapContext*
lowerLimit: `integer`
planePrevious: `integer`
planeSelected: `integer`
renderingDef: *RenderingDef* from *CodomainMapContext*
upperLimit: `integer`
version: `integer` (optional) from *CodomainMapContext*

Plate

Used by: *PlateAcquisition.plate*, *PlateAnnotationLink.parent*, *ScreenPlateLink.child*, *Well.plate*

Properties:

annotationLinks: *PlateAnnotationLink* (multiple)
columnNamingConvention: `string` (optional)
columns: `integer` (optional)
defaultSample: `integer` (optional)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
externalIdentifier: `string` (optional)
name: `string`
plateAcquisitions: *PlateAcquisition* (multiple)
rowNamingConvention: `string` (optional)
rows: `integer` (optional)
screenLinks: *ScreenPlateLink* (multiple)
status: `string` (optional)
version: `integer` (optional), see IMutable[196]
wellOriginX.unit: enumeration of Length[197] (optional)
wellOriginX.value: `double` (optional)
wellOriginY.unit: enumeration of Length[198] (optional)
wellOriginY.value: `double` (optional)
wells: *Well* (multiple)

[194] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[195] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[196] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[197] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[198] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

PlateAcquisition

Used by: *Plate.plateAcquisitions*, *PlateAcquisitionAnnotationLink.parent*, *WellSample.plateAcquisition*

Properties:

annotationLinks: *PlateAcquisitionAnnotationLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
endTime: `timestamp` (optional)
maximumFieldCount: `integer` (optional)
name: `string` (optional)
plate: *Plate*
startTime: `timestamp` (optional)
version: `integer` (optional), see IMutable[199]
wellSample: *WellSample* (multiple)

PlateAcquisitionAnnotationLink

Used by: *PlateAcquisition.annotationLinks*

Properties:

child: *Annotation*, see ILink[200]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *PlateAcquisition*, see ILink[201]
version: `integer` (optional), see IMutable[202]

PlateAnnotationLink

Used by: *Plate.annotationLinks*

Properties:

child: *Annotation*, see ILink[203]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Plate*, see ILink[204]
version: `integer` (optional), see IMutable[205]

[199] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[200] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[201] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[202] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[203] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[204] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[205] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

Point

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
cx: `double` (optional)
cy: `double` (optional)
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[206] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
locked: `boolean` (optional) from *Shape*
roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[207] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*

Polygon

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*

[206] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[207] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[208] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
locked: `boolean` (optional) from *Shape*
points: `text` (optional)
roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[209] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*

Polyline

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[210] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
locked: `boolean` (optional) from *Shape*
points: `text` (optional)

[208] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[209] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[210] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

roi: *Roi* from *Shape*
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*
strokeWidth.unit: enumeration of Length[211] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*

Project

Used by: *ProjectAnnotationLink.parent*, *ProjectDatasetLink.parent*

Properties:

annotationLinks: *ProjectAnnotationLink* (multiple)
datasetLinks: *ProjectDatasetLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
name: `string`
version: `integer` (optional), see IMutable[212]

ProjectAnnotationLink

Used by: *Project.annotationLinks*

Properties:

child: *Annotation*, see ILink[213]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Project*, see ILink[214]
version: `integer` (optional), see IMutable[215]

[211] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[212] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[213] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[214] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[215] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

ProjectDatasetLink

Used by: *Dataset.projectLinks*, *Project.datasetLinks*

Properties:

child: *Dataset*, see ILink[216]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Project*, see ILink[217]
version: `integer` (optional), see IMutable[218]

Pulse

Used by: *Laser.pulse*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[219]

QuantumDef

Used by: *RenderingDef.quantization*

Properties:

bitResolution: `integer`
cdEnd: `integer`
cdStart: `integer`
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
version: `integer` (optional), see IMutable[220]

Reagent

Used by: *ReagentAnnotationLink.parent*, *Screen.reagents*, *WellReagentLink.child*

Properties:

annotationLinks: *ReagentAnnotationLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
name: `string` (optional)

[216] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[217] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[218] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[219] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html
[220] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

reagentIdentifier: `string` (optional)
screen: *Screen*
version: `integer` (optional), see IMutable[221]
wellLinks: *WellReagentLink* (multiple)

ReagentAnnotationLink

Used by: *Reagent.annotationLinks*

Properties:

child: *Annotation*, see ILink[222]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Reagent*, see ILink[223]
version: `integer` (optional), see IMutable[224]

Rectangle

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple) from *Shape*
details.creationEvent: *Event* from *Shape*
details.externalInfo: *ExternalInfo* (optional) from *Shape*
details.group: *ExperimenterGroup* from *Shape*
details.owner: *Experimenter* from *Shape*
details.updateEvent: *Event* from *Shape*
fillColor: `integer` (optional) from *Shape*
fillRule: `string` (optional) from *Shape*
fontFamily: `string` (optional) from *Shape*
fontSize.unit: enumeration of Length[225] (optional) from *Shape*
fontSize.value: `double` (optional) from *Shape*
fontStretch: `string` (optional) from *Shape*
fontStyle: `string` (optional) from *Shape*
fontVariant: `string` (optional) from *Shape*
fontWeight: `string` (optional) from *Shape*
g: `string` (optional) from *Shape*
height: `double` (optional)
locked: `boolean` (optional) from *Shape*
roi: *Roi* from *Shape*
rx: `double` (optional)
strokeColor: `integer` (optional) from *Shape*
strokeDashArray: `string` (optional) from *Shape*
strokeDashOffset: `integer` (optional) from *Shape*
strokeLineCap: `string` (optional) from *Shape*
strokeLineJoin: `string` (optional) from *Shape*
strokeMiterLimit: `integer` (optional) from *Shape*

[221] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[222] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[223] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[224] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[225] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

strokeWidth.unit: enumeration of Length[226] (optional) from *Shape*
strokeWidth.value: `double` (optional) from *Shape*
textValue: `text` (optional)
theC: `integer` (optional) from *Shape*
theT: `integer` (optional) from *Shape*
theZ: `integer` (optional) from *Shape*
transform: `string` (optional) from *Shape*
vectorEffect: `string` (optional) from *Shape*
version: `integer` (optional) from *Shape*
visibility: `boolean` (optional) from *Shape*
width: `double` (optional)
x: `double` (optional)
y: `double` (optional)

RenderingDef

Used by: *ChannelBinding.renderingDef*, *CodomainMapContext.renderingDef*, *Pixels.settings*

Properties:

compression: `double` (optional)
defaultT: `integer`
defaultZ: `integer`
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
model: *RenderingModel*
name: `string` (optional)
pixels: *Pixels*
quantization: *QuantumDef*
spatialDomainEnhancement: *CodomainMapContext* (multiple)
version: `integer` (optional), see IMutable[227]
waveRendering: *ChannelBinding* (multiple)

RenderingModel

Used by: *RenderingDef.model*

Properties:

details.externalInfo: *ExternalInfo* (optional)
value: `string`, see IEnum[228]

ReverseIntensityContext

Properties:

details.creationEvent: *Event* from *CodomainMapContext*
details.externalInfo: *ExternalInfo* (optional) from *CodomainMapContext*
details.group: *ExperimenterGroup* from *CodomainMapContext*
details.owner: *Experimenter* from *CodomainMapContext*

[226] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[227] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[228] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IEnum.html

details.updateEvent: *Event* from *CodomainMapContext*
renderingDef: *RenderingDef* from *CodomainMapContext*
reverse: `boolean`
version: `integer` (optional) from *CodomainMapContext*

Roi

Used by: *Image.rois*, *RoiAnnotationLink.parent*, *Shape.roi*

Properties:

annotationLinks: *RoiAnnotationLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
image: *Image* (optional)
keywords: list (optional)
name: `string` (optional)
namespaces: list (optional)
shapes: *Shape* (multiple)
source: *OriginalFile* (optional)
version: `integer` (optional), see IMutable[229]

RoiAnnotationLink

Used by: *Roi.annotationLinks*

Properties:

child: *Annotation*, see ILink[230]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Roi*, see ILink[231]
version: `integer` (optional), see IMutable[232]

Screen

Used by: *Reagent.screen*, *ScreenAnnotationLink.parent*, *ScreenPlateLink.parent*

Properties:

annotationLinks: *ScreenAnnotationLink* (multiple)
description: `text` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*

[229] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[230] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[231] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[232] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

details.updateEvent: *Event*
name: `string`
plateLinks: *ScreenPlateLink* (multiple)
protocolDescription: `string` (optional)
protocolIdentifier: `string` (optional)
reagentSetDescription: `string` (optional)
reagentSetIdentifier: `string` (optional)
reagents: *Reagent* (multiple)
type: `string` (optional)
version: `integer` (optional), see IMutable[233]

ScreenAnnotationLink

Used by: *Screen.annotationLinks*

Properties:

child: *Annotation*, see ILink[234]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Screen*, see ILink[235]
version: `integer` (optional), see IMutable[236]

ScreenPlateLink

Used by: *Plate.screenLinks*, *Screen.plateLinks*

Properties:

child: *Plate*, see ILink[237]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Screen*, see ILink[238]
version: `integer` (optional), see IMutable[239]

ScriptJob

Properties:

description: `string` (optional)
details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*

[233] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[234] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[235] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[236] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[237] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[238] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[239] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

Session

Subclasses: *Share*

Used by: *Event.session*, *Node.sessions*, *SessionAnnotationLink.parent*

Properties:

annotationLinks: *SessionAnnotationLink* (multiple)
closed: `timestamp` (optional)
defaultEventType: `string`
details.externalInfo: *ExternalInfo* (optional)
events: *Event* (multiple)
message: `text` (optional)
node: *Node*
owner: *Experimenter*
started: `timestamp`
timeToIdle: `long`
timeToLive: `long`
userAgent: `string` (optional)
userIP: `string` (optional)
uuid: `string`
version: `integer` (optional), see IMutable[240]

SessionAnnotationLink

Used by: *Session.annotationLinks*

Properties:

child: *Annotation*, see ILink[241]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Session*, see ILink[242]
version: `integer` (optional), see IMutable[243]

[240] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[241] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[242] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[243] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

Shape

Subclasses: *Ellipse*, *Label*, *Line*, *Mask*, *Path*, *Point*, *Polygon*, *Polyline*, *Rectangle*

Used by: *Roi.shapes*, *ShapeAnnotationLink.parent*

Properties:

annotationLinks: *ShapeAnnotationLink* (multiple)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
fillColor: `integer` (optional)
fillRule: `string` (optional)
fontFamily: `string` (optional)
fontSize.unit: enumeration of Length[244] (optional)
fontSize.value: `double` (optional)
fontStretch: `string` (optional)
fontStyle: `string` (optional)
fontVariant: `string` (optional)
fontWeight: `string` (optional)
g: `string` (optional)
locked: `boolean` (optional)
roi: *Roi*
strokeColor: `integer` (optional)
strokeDashArray: `string` (optional)
strokeDashOffset: `integer` (optional)
strokeLineCap: `string` (optional)
strokeLineJoin: `string` (optional)
strokeMiterLimit: `integer` (optional)
strokeWidth.unit: enumeration of Length[245] (optional)
strokeWidth.value: `double` (optional)
theC: `integer` (optional)
theT: `integer` (optional)
theZ: `integer` (optional)
transform: `string` (optional)
vectorEffect: `string` (optional)
version: `integer` (optional), see IMutable[246]
visibility: `boolean` (optional)

ShapeAnnotationLink

Used by: *Shape.annotationLinks*

Properties:

child: *Annotation*, see ILink[247]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*

[244] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[245] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[246] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[247] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html

details.updateEvent: *Event*
parent: *Shape*, see ILink[248]
version: `integer` (optional), see IMutable[249]

Share

Used by: *ShareMember.parent*

Properties:

active: `boolean`
annotationLinks: *SessionAnnotationLink* (multiple) from *Session*
closed: `timestamp` (optional) from *Session*
data: `binary`
defaultEventType: `string` from *Session*
details.externalInfo: *ExternalInfo* (optional) from *Session*
events: *Event* (multiple) from *Session*
group: *ExperimenterGroup*
itemCount: `long`
message: `text` (optional) from *Session*
node: *Node* from *Session*
owner: *Experimenter* from *Session*
started: `timestamp` from *Session*
timeToIdle: `long` from *Session*
timeToLive: `long` from *Session*
userAgent: `string` (optional) from *Session*
userIP: `string` (optional) from *Session*
uuid: `string` from *Session*
version: `integer` (optional) from *Session*

ShareMember

Properties:

child: *Experimenter*, see ILink[250]
details.externalInfo: *ExternalInfo* (optional)
parent: *Share*, see ILink[251]
version: `integer` (optional), see IMutable[252]

StageLabel

Used by: *Image.stageLabel*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
name: `string`

[248] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[249] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[250] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[251] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[252] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

positionX.unit: enumeration of Length[253] (optional)
positionX.value: `double` (optional)
positionY.unit: enumeration of Length[254] (optional)
positionY.value: `double` (optional)
positionZ.unit: enumeration of Length[255] (optional)
positionZ.value: `double` (optional)
version: `integer` (optional), see IMutable[256]

StatsInfo

Used by: *Channel.statsInfo*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
globalMax: `double`
globalMin: `double`
version: `integer` (optional), see IMutable[257]

TagAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
textValue: `text` (optional) from *TextAnnotation*
version: `integer` (optional) from *Annotation*

TermAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*

[253] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[254] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[255] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[256] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[257] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

ns: `string` (optional) from *Annotation*
termValue: `text` (optional)
version: `integer` (optional) from *Annotation*

TextAnnotation

Subclasses: *CommentAnnotation*, *TagAnnotation*, *XmlAnnotation*

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
textValue: `text` (optional)
version: `integer` (optional) from *Annotation*

Thumbnail

Used by: *Pixels.thumbnails*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
mimeType: `string`
pixels: *Pixels*
ref: `string` (optional)
sizeX: `integer`
sizeY: `integer`
version: `integer` (optional), see IMutable[258]

ThumbnailGenerationJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*

[258] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*

TimestampAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
timeValue: `timestamp` (optional)
version: `integer` (optional) from *Annotation*

TransmittanceRange

Used by: *Filter.transmittanceRange*

Properties:

cutIn.unit: enumeration of Length[259] (optional)
cutIn.value: `double` (optional)
cutInTolerance.unit: enumeration of Length[260] (optional)
cutInTolerance.value: `double` (optional)
cutOut.unit: enumeration of Length[261] (optional)
cutOut.value: `double` (optional)
cutOutTolerance.unit: enumeration of Length[262] (optional)
cutOutTolerance.value: `double` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
transmittance: `double` (optional)
version: `integer` (optional), see IMutable[263]

TypeAnnotation

Subclasses: *FileAnnotation*

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*

[259] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[260] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[261] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[262] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[263] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html

details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
version: `integer` (optional) from *Annotation*

UploadJob

Properties:

details.creationEvent: *Event* from *Job*
details.externalInfo: *ExternalInfo* (optional) from *Job*
details.group: *ExperimenterGroup* from *Job*
details.owner: *Experimenter* from *Job*
details.updateEvent: *Event* from *Job*
finished: `timestamp` (optional) from *Job*
groupname: `string` from *Job*
message: `string` from *Job*
originalFileLinks: *JobOriginalFileLink* (multiple) from *Job*
scheduledFor: `timestamp` from *Job*
started: `timestamp` (optional) from *Job*
status: *JobStatus* from *Job*
submitted: `timestamp` from *Job*
type: `string` from *Job*
username: `string` from *Job*
version: `integer` (optional) from *Job*
versionInfo: list (multiple)

Well

Used by: *Plate.wells*, *WellAnnotationLink.parent*, *WellReagentLink.parent*, *WellSample.well*

Properties:

alpha: `integer` (optional)
annotationLinks: *WellAnnotationLink* (multiple)
blue: `integer` (optional)
column: `integer` (optional)
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
externalDescription: `string` (optional)
externalIdentifier: `string` (optional)
green: `integer` (optional)
plate: *Plate*
reagentLinks: *WellReagentLink* (multiple)
red: `integer` (optional)
row: `integer` (optional)
status: `string` (optional)
type: `string` (optional)

version: `integer` (optional), see IMutable[264]
wellSamples: *WellSample* (multiple)

WellAnnotationLink

Used by: *Well.annotationLinks*

Properties:

child: *Annotation*, see ILink[265]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Well*, see ILink[266]
version: `integer` (optional), see IMutable[267]

WellReagentLink

Used by: *Reagent.wellLinks*, *Well.reagentLinks*

Properties:

child: *Reagent*, see ILink[268]
details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
parent: *Well*, see ILink[269]
version: `integer` (optional), see IMutable[270]

WellSample

Used by: *Image.wellSamples*, *PlateAcquisition.wellSample*, *Well.wellSamples*

Properties:

details.creationEvent: *Event*
details.externalInfo: *ExternalInfo* (optional)
details.group: *ExperimenterGroup*
details.owner: *Experimenter*
details.updateEvent: *Event*
image: *Image*
plateAcquisition: *PlateAcquisition* (optional)
posX.unit: enumeration of Length[271] (optional)
posX.value: `double` (optional)
posY.unit: enumeration of Length[272] (optional)
posY.value: `double` (optional)

[264] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[265] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[266] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[267] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[268] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[269] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/ILink.html
[270] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[271] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html
[272] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/units/Length.html

timepoint: `timestamp` (optional)
version: `integer` (optional), see IMutable[273]
well: *Well*

XmlAnnotation

Properties:

annotationLinks: *AnnotationAnnotationLink* (multiple) from *Annotation*
description: `text` (optional) from *Annotation*
details.creationEvent: *Event* from *Annotation*
details.externalInfo: *ExternalInfo* (optional) from *Annotation*
details.group: *ExperimenterGroup* from *Annotation*
details.owner: *Experimenter* from *Annotation*
details.updateEvent: *Event* from *Annotation*
name: `string` (optional) from *Annotation*
ns: `string` (optional) from *Annotation*
textValue: `text` (optional) from *TextAnnotation*
version: `integer` (optional) from *Annotation*

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

17.4 Units

A number of properties in the OME model are physical measurements which inherently have a unit associated with them. Earlier versions of OME defined a default unit for the measurement. Now users, clients, and acquisition systems can specify the unit themselves rather than converting their internal unit to the OME default.

See also:

Data Model documentation for units[274]

17.4.1 Supported units

- Electric potential[275]
- Frequency[276]
- Length[277]
- Power[278]
- Pressure[279]
- Temperature[280]
- Time[281]

Each of the supported units contain a number of values from the International System of Units (SI) in the most common prefixes from yotta (10^24) to yocto (10^-24). The Length unit also contains values from the Imperial system as well as internal values which are internal to OME: reference frame and pixel.

[273] http://downloads.openmicroscopy.org/latest/omero/api/ome/model/IMutable.html
[274] http://www.openmicroscopy.org/site/support/ome-model/developers/ome-units.html
[275] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/ElectricPotentialI.html
[276] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/FrequencyI.html
[277] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/LengthI.html
[278] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/PowerI.html
[279] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/PressureI.html
[280] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/TemperatureI.html
[281] http://downloads.openmicroscopy.org/latest/omero/api/omero/model/TimeI.html

17.4.2 Unit fields

The following fields in the OMERO model have a unit type:

Class	Field	Type	Default value
Channel	EmissionWavelength	Length	nm
Channel	ExcitationWavelength	Length	nm
Channel	PinholeSize	Length	µm
Detector	Voltage	ElectricPotential	V
DetectorSettings	ReadOutRate	Frequency	MHz
DetectorSettings	Voltage	ElectricPotential	V
ImagingEnvironment	AirPressure	Pressure	mbar
ImagingEnvironment	Temperature	Temperature	°C
Laser	RepetitionRate	Frequency	Hz
Laser	Wavelength	Length	nm
LightSource	Power	Power	mW
LightSourceSettings	Wavelength	Length	nm
Objective	WorkingDistance	Length	µm
Pixels	PhysicalSizeX	Length	µm
Pixels	PhysicalSizeY	Length	µm
Pixels	PhysicalSizeZ	Length	µm
Pixels	TimeIncrement	Time	s
Plane	DeltaT	Time	s
Plane	ExposureTime	Time	s
Plane	PositionX	Length	reference frame
Plane	PositionY	Length	reference frame
Plane	PositionZ	Length	reference frame
Plate	WellOriginX	Length	reference frame
Plate	WellOriginY	Length	reference frame
Shape	FontSize	Length	pt
Shape	StrokeWidth	Length	pixel
StageLabel	X	Length	reference frame
StageLabel	Y	Length	reference frame
StageLabel	Z	Length	reference frame
TransmittanceRange	CutIn	Length	nm
TransmittanceRange	CutInTolerance	Length	nm
TransmittanceRange	CutOut	Length	nm
TransmittanceRange	CutOutTolerance	Length	nm
WellSample	PositionX	Length	reference frame
WellSample	PositionY	Length	reference frame

Units of type *reference frame* cannot be assumed comparable to units from other properties including those with type *reference frame*.

17.4.3 Unit objects

Each unit quantity consists of a double-precision scalar and an enumeration which chooses one of the pre-defined values from the model. In code, uppercase spellings of the enumerations are used, while in the schema, in OME-XML files, and in the database, the Unicode symbol for the unit is used.

Language	Representation
Ice	*enum UnitsLength { MICROM, ... };*
Java and Python	*omero.model.enums.UnitsLength.MICROM*
C++	*omero::model::enums::MICROM*
PostgreSQL	*'µm'::unitslength*

Defining a unit

```
Pixels p = ...; // Defined elsewhere
Length l = new LengthI(2.1, UnitsLength.MICROM); // µm
p.setPhysicalSizeX(l);
p.setPhysicalSizeY(l);
iUpdatePrx.saveObject(p);
```

The above stores a Pixels object in the database with X and Y physical lengths of "µm".

Converting a unit

Often a measurement will not be in the most convenient unit for display, e.g. 0.00001 mm. could better be expressed in microns. In order to convert between units, pass the measurement that you have available to a constructor of the same type, passing in the target unit that you would like to see:

```
Pixels p = ...; // As saved above
Length l1 = p.getPhysicalSizeX(); // 2.1 microns
Length l2 = new LengthI(x1, UnitsLength.NM); // As nanometers
```

Getting a symbol

The enumerations used in the "units" field of each measurement is of type *omero.model.enums.UnitsNAME* where NAME is *Length*, *Temperature*, etc. These members of that enumeration are all uppercased, code-safe versions of the unit name. To get the symbol as defined in the SI specification, for example, use the *getSymbol* method:

```
Length l1 = ...; // As above
l1.getSymbol(); // Returns "µm"
```

17.4.4 Querying units

In HQL queries, the scalar and the enumeration value can be separately retrieved.

```
select planeInfo.exposureTime.value from PlaneInfo planeInfo ...
```

will retrieve just the double scalar value while

```
select planeInfo.exposureTime.unit from PlaneInfo planeInfo ...
```

will retrieve a string representation of the enum which can be used in each language to create an enum object, e.g.:

```
UnitsTime.valueOf(unit); // Java
getattr(UnitsTime, unit) # Python
```

To load the symbolic representation of the enum which is used internally in the database and is more concise, use an HQL cast:

```
select cast(planeInfo.exposureTime.unit as text) from PlaneInfo planeInfo ...
```

Returning the entire unit quantity will result in a hash map with the various representations:

```
select planeInfo.exposureTime from PlaneInfo planeInfo ...
{'symbol': 's', 'unit': 'SECOND', 'value': 1.2000000476837158}
```

See also:

- http://en.wikipedia.org/wiki/Units_of_measurement
- http://en.wikipedia.org/wiki/System_of_measurement
- http://en.wikipedia.org/wiki/International_System_of_Units

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17.5 Key-value pairs

Ongoing advancements in microscopic techniques, analysis systems, and other areas for which OME attempts to provide metadata exchange require a certain flexibility in the OME model. There is a need to store instrument configuration, script parameters, and similar for later use.

Basic text representations are too difficult to parse to be of significant use. An XML format can be more easily parsed, but a single format would have to be agreed upon by all users. Therefore, it is useful to add particular extension points to the model for which no consensus on a data format has been reached, but where more structure than just text is needed.

A *hash map* was the most likely candidate for this data; however, rather than limit this to traditional associative arrays, OME maps are defined as a **"ordered list of key-value pairs"**. The benefit of this representation is that configuration files which are standard for Java `java.util.Properties` objects can be represented fully in a single map. Duplicates are maintained since there is no unique constraint on the list of pairs.

In most cases, the interpretation of the ordered list will be such that the final value for a particular key "wins" as if each value were placed into a hash map in order, with duplicate values replacing previous ones.

17.5.1 OME-XML

In the OME-XML model, these maps are represented in a compact format. Any map field is defined by the MapPairs complex type which consists of M elements of the form:

```
<M K="key">value</M>
```

17.5.2 OMERO languages

In OMERO, a slightly more verbose representation of these objects is used. Each map type consists of a list or vector in the respective language, composed of NamedValue objects and possibly nulls.

```
// OMERO.java
ImagingEnvironment environment = new ImagingEnvironmentI();
environment.setMap(new List<NamedValue>());
environment.getMap().add(new NamedValue("altitude", "1000m"));
image.setImagingEnvironment(environment);
```

Fields

The concrete fields which are present in the model are currently:

- ExperimenterGroup.config

- GenericExcitationSource.map
- ImagingEnvironment.map
- ImportJob.versionInfo

More will be added as demand increases.

17.5.3 MapAnnotations

In addition to the fields above, there is also a *structured annotation* which contains a key-valued pair, the `MapAnnotation`.

```
// OMERO.cpp
MapAnnotation ann = new MapAnnotationI();
ann->getMapValue().push_back(new NamedValueI("run", "5.0"));
ann->getMapValue().push_back(new NamedValueI("run", "4.9"));
ann->getMapValue().push_back(new NamedValueI("run", "5.1"));
```

This permits the flexible attachment of key-value pairs to any of the OME types which are annotatable. Such annotations attached to key UI elements like images and datasets will be presented by the clients, and can be edited with the appropriate permissions. See Managing Data[282] on OMERO User Help[283] for more information.

17.5.4 Storage and queries

Each map-based field in the OMERO model is represented by an extra table of the form *$className_$fieldName*. For example, MapAnnotation.mapValue becomes *annotation.mapValue*, where the loss of "map" from the class name is due to the subclassing of *Annotation* by *MapAnnotation*.

In general, use of the specific tables is not necessary and it suffices to write HQL queries based on the classes and field names themselves.

Find the value for a key

```
select nv.value from MapAnnotation ann
  join ann.mapValue as nv
 where nv.name = 'altitude'
```

Finding objects with a key

```
select ann from MapAnnotation ann
  join ann.mapValue as nv
 where nv.name = 'altitude'
```

Finding objects without a key

```
select ann from MapAnnotation ann
 where not exists(
    from MapAnnotation m2
    join m2.mapValue as nv2
   where nv2.name like 'size%')
```

[282] http://help.openmicroscopy.org/managing-data.html#keyvalue
[283] http://help.openmicroscopy.org/

Finding objects with multiple values

```
select ann from MapAnnotation ann
  join ann.mapValue as nv1
  join ann.mapValue as nv2
 where nv1.name = 'date'
   and nv2.name = 'owner'
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

17.6 Available transformations

Available transforms	Direction	Status
2003-FC-to-2007-06.xsl	upgrade	excellent
2003-FC-to-2008-09.xsl	upgrade	excellent
2007-06-to-2008-02.xsl	upgrade	excellent
2007-06-to-2008-09.xsl	upgrade	excellent
2008-02-to-2008-09.xsl	upgrade	excellent
2008-09-to-2009-09.xsl	upgrade	excellent
2009-09-to-2010-04.xsl	upgrade	excellent
2010-04-to-2010-06.xsl	upgrade	excellent
2010-06-to-2011-06.xsl	upgrade	excellent
2011-06-to-2012-06.xsl	upgrade	excellent
2012-06-to-2013-06.xsl	upgrade	excellent
2013-06-to-2015-01.xsl	upgrade	excellent
2010-06-to-2003-FC.xsl	downgrade	poor (very lossy)
2010-06-to-2008-02.xsl	downgrade	fair (lossy)
2011-06-to-2010-06.xsl	downgrade	good
2012-06-to-2011-06.xsl	downgrade	good
2013-06-to-2012-06.xsl	downgrade	good
2015-01-to-2013-06.xsl	downgrade	good

17.6.1 Quality of transformations

Source \ Targets	/2003-FC/	/2007-06/	/2008-02/	/2008-09/	/2009-09/	/2010-04/	/2010-06/	/2011-06/	/2012-06/	/2013-06/	/2015-01/
/2003-FC/	—	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent
/2007-06/	poor	—	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent
/2008-02/	poor	poor	—	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent
/2008-09/	poor	poor	poor	—	excellent	excellent	excellent	excellent	excellent	excellent	excellent
/2009-09/	poor	poor	poor	poor	—	excellent	excellent	excellent	excellent	excellent	excellent
/2010-04/	poor	poor	poor	fair	fair	—	excellent	excellent	excellent	excellent	excellent
/2010-06/	poor	poor	fair	fair	fair	fair	—	excellent	excellent	excellent	excellent
/2011-06/	poor	poor	fair	fair	fair	fair	good	—	excellent	excellent	excellent
/2012-06/	poor	poor	fair	fair	fair	fair	good	good	—	excellent	excellent
/2013-06/	poor	poor	fair	fair	fair	fair	good	good	good	—	excellent
/2015-01/	poor	poor	fair	fair	fair	fair	good	good	good	good	—

Upgrades

Downgrades

17.6.2 Key to quality

- **poor** (very lossy) - the bare minimum of metadata is preserved to allow image display, all other metadata is lost
- **fair** (lossy) - a portion of the metadata is preserved, at least enough to display the image and some other data, it will be far from complete however
- **good** - most information is preserved, it may be possible to do a better job but could be difficult for technical reasons or require custom code not just a transform

- **excellent** - as much information as possible is preserved, some values can still be lost if there are completely incompatible with the new schema

17.6.3 Matrix of transformation paths

This shows the sequence of transformations used to convert one version of the schema to another version.

	Targets													
Source	**/2003-FC/**	**/2003-FC/-TIFF**	**/2007-06/**	**/2007-06/ V2**	**/2008-02/**	**/2008-02/ V2**	**/2008-09/**	**/2009-09/**	**/2010-04/**	**/2010-06/**	**/2011-06/**	**/2012-06/**	**/2013-06/**	**/2015-01/**
/2003-FC/	—	code	xslt: very lossy	xslt: very lossy	via: /2007-06/ very lossy	via: /2007-06/ very lossy	xslt: good	via: /2008-09/ good	via: /2008-09/ & /2009-09/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ & / 2012-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ & / 2012-06/& / 2013-06/ good
/2003-FC/-TIFF	code	—	xslt: very lossy	xslt: very lossy	via: /2007-06/ very lossy	via: /2007-06/ very lossy	xslt: good	via: /2008-09/ good	via: /2008-09/ & /2009-09/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2007-06/	via: 2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: 2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ very lossy	—	—	xslt: very lossy	xslt: very lossy	xslt: good	via: /2008-09/ good	via: /2008-09/ & /2009-09/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ & / 2012-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2007-06/ V2	via: 2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: 2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	—	—	xslt: very lossy	xslt: very lossy	xslt: good	via: /2008-09/ good	via: /2008-09/ & /2009-09/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2008-02/	via: 2008-09/ & /2009-09/ & / 2010-06/very lossy	via: 2008-09/ & /2009-09/ & / 2010-06/very lossy	via: /2003-FC/ & /2008-09/ & / 2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: /2003-FC/ & /2008-09/ & / 2009-09/ & / 2010-04/ & / 2010-06/very lossy	—	—	xslt: good	via: /2008-09/ good	via: /2008-09/ & /2009-09/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2008-02/ V2	via: 2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: 2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: /2003-FC/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: /2003-FC/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	—	—	xslt: good	via: /2008-09/ good	via: /2008-09/ & /2009-09/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/ good	via: /2008-09/ & /2009-09/ & / 2010-04/ & / 2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2008-09/	via: /2009-09/ & /2010-04/ & / 2010-06/very lossy	via: /2009-09/ & /2010-04/ & / 2010-06/very lossy	via: /2003-FC/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: /2003-FC/ & /2009-09/ & / 2010-04/ & / 2010-06/very lossy	via: /2009-09/ & /2010-04/ & / 2010-06/ lossy	via: /2009-09/ & /2010-04/ & / 2010-06/ lossy	—	xslt: good	via: /2009-09/ good	via: /2009-09/ & /2010-04 good	via: /2009-09/ & /2010-04 & / 2010-06/good	via: /2009-09/ & /2010-04 & / 2010-06/ & / 2011-06/ good	via: /2009-09/ & /2010-04 & / 2010-06/ & / 2011-06/& / 2012-06/ good	via: /2009-09/ & /2010-04 & / 2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2009-09/	via: /2010-04/ & /2010-06/ very lossy	via: /2010-04/ & /2010-06/ very lossy	via: /2003-FC/ & /2010-04/ & / 2010-06/very lossy	via: /2003-FC/ & /2010-04/ & / 2010-06/very lossy	via: /2010-04/ & /2010-06/ lossy	via: /2010-04/ & /2010-06/ lossy	via: /2010-04/ & /2010/06/ & / 2008-02/ lossy	—	xslt: good	via: /2010-04/ good	via: /2010-04/ & /2010-06/ good	via: /2010-04/ & /2010-06/ & / 2011-06/ good	via: /2010-04/ & /2010-06/ & / 2011-06/& / 2012-06/ good	via: /2010-04/ & /2010-06/ & / 2011-06/& / 2012-06/& / 2013-06/ good
/2010-04/	via: /2010-06/ very lossy	via: /2010-06/ very lossy	via: /2003-FC/ & /2010-06/ very lossy	via: /2003-FC/ & /2010-06/ very lossy	via: /2010-06/ lossy	via: /2010-06/ lossy	via: /2010/06/ & /2008-02/ lossy	via: /2010/06/ & /2008-02/ & / 2008-09/ lossy	—	xslt: good	via: /2010-06/ good	via: /2010-06/ & /2011-06/ good	via: /2010-06/ & /2011-06/& / 2012-06/ good	via: /2010-06/ & /2011-06/& / 2012-06/& / 2013-06/ good
/2010-06/	xslt: very lossy	xslt: very lossy	via: /2003-FC/ very lossy	via: /2003-FC/ very lossy	xslt: lossy	xslt: lossy	via: /2008-02/ lossy	via: /2008-02/ & /2008-09/ lossy	via: /2008-02/ & /2008-09/ & / 2009-09/ lossy	—	xslt: good	via: /2011-06 good	via: /2011-06/ & /2012-06/ good	via: /2011-06/ & /2012-06/& / 2013-06/ good
/2011-06/	via: /2010-06/ very lossy	via: /2010-06/ very lossy	via: /2010-06/ & /2003-FC/ very lossy	via: /2010-06/ & /2003-FC/ very lossy	via: /2010-06/ lossy	via: /2010-06/ lossy	via: /2010-06/ & /2008-02/ lossy	via: /2010-06/ & /2008-02/ & / 2008-09/ lossy	via: /2010-06/ & /2008-02/ & / 2008-09/ & / 2009-09/ lossy	xslt: good	—	xslt: good	via: /2012-06/ good	via: /2012-06/ & /2013-06/ good
/2012-06/	via: /2011-06/ & /2010-06/ very lossy	via: /2011-06/ & /2010-06/ very lossy	via: /2011-06/ & /2010-06/ & / 2003-FC/ very lossy	via: /2011-06/ & /2010-06/ & / 2003-FC/ very lossy	via: /2011-06/ & /2010-06/ lossy	via: /2011-06/ & /2010-06/ lossy	via: /2011-06/ & /2010-06/ & / 2008-02/ lossy	via: /2011-06/ & /2010-06/ & / 2008-02/ & / 2008-09/ lossy	via: /2011-06/ & /2010-06/ & / 2008-02/ & / 2008-09/ & / 2009-09/ lossy	via: /2011-06 good	xslt: good	—	xslt: good	via: /2013-06/ good
/2013-06/	via: /2012-06/ & /2011-06/ & / 2010-06/ very lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ very lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ & / 2003-FC/ very lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ & / 2003-FC/ very lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ & / 2008-02/ lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ & / 2008-02/ & / 2008-09/ lossy	via: /2012-06/ & /2011-06/ & / 2010-06/ & / 2008-02/ & / 2008-09/ & / 2009-09/ lossy	via: /2012-06/ & /2011-06 good	via: /2012-06/ good	xslt: good	—	xslt: good
/2015-01/	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ very lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ very lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ & / 2003-FC/ very lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ & / 2003-FC/ very lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ & / 2008-02/ lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ & / 2008-02/ & / 2008-09/ lossy	via: /2013-06/ & /2012-06/ & / 2011-06/ & / 2010-06/ & / 2008-02/ & / 2008-09/ & / 2009-09/ lossy	via: /2013-06/ & /2012-06/ & / 2011-06 good – units lost	via: /2013-06/ & /2012-06/ good – units lost	via: /2013-06/ good – units lost	xslt: good – units lost	—

CHAPTER

EIGHTEEN

SEARCHING

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

18.1 OMERO search

Beginning with 3.0-Beta3, the OMERO server will use Lucene[1] to index all string and timestamp information in the database, as well as all `OriginalFiles` which can be parsed to simple text (see *File parsers* for more information). The index is stored under `/OMERO/FullText` (or the `FullText` subdirectory of your `omero.data.dir`, and can be searched with Google-like queries.

Once an entity is indexed, it is possible to start writing querying against the server via `IQuery.findAllByFullText()`. Use `new Parameters(new Filter().owner())` and `.group()` to restrict your search. Or alternatively use the `oma.api.Search` interface (below).

See also:

Search and indexing configuration Section of the sysadmin documentation describing the configuration of the search and indexing for the server.

18.1.1 Field names

Each row in the database becomes a single Lucene `Document` parsed into the several `Fields`. A field is referenced by prefixing a search term with the field name followed by a colon. For example, *name:myImage* searches for myImage anywhere in the name field.

[1] http://lucene.apache.org

Field	Comments
	Any unprefixed field searches the combination of all fields together i.e. a search for *cell AND name:myImage* gets translated to *combined_fields:cell AND name:myImage*.
<field name>	Each string, timestamp, or `Details` field of the entity also gets its own Field entry, like the `name` field above
details.owner.omeName	Login name of the owner of the object
details.owner.firstName	First name of the owner of the object
details.owner.lastName	Last name of the owner of the object
details.group.name	Group name of the owning group of the object
details.creationEvent.id	Id of the Event of this objects creation
details.creationEvent.time	When that Event took place
details.updateEvent.id	Id of the Event of this objects last modification
details.updateEvent.time	When that Event took place
details.permissions	Permissions in the form *rwrwrw* or *rw-*
tag	Contents from a `TagAnnotation`.
annotation	Contents from any annotations, including `TagAnnotation` and any `TextAnnotation` on another `TextAnnotation` (a.k.a. a *description*). Non-string annotations like file annotations are not covered by this definition and are handled separately. See below.
annotation.ns	Namespace (if present) for any annotations on an object
annotation.type	Short type name, e.g. `TextAnnotation` or `FileAnnotation` for any annotations on an object
file.name	For `FileAnnotations` and objects they are attached to, the name of the `OriginalFile`
file.format	For `FileAnnotations` and objects they are attached to, the format of the `OriginalFile`
file.path	For `FileAnnotations` and objects they are attached to, the path of the `OriginalFile`
file.sha1	For `FileAnnotations` and objects they are attached to, the sha1 of the `OriginalFile`
file.contents	For `FileAnnotations` and objects they are attached to as well as the `OriginalFile` itself, the file contents themselves if their Format is configured with the File parsers.
${NAME}	For `MapAnnotations` and objects they are attached to, dynamic fields are generated for each of the NamedValue entries in the annotation. For example, if `NamedValue('temperature', '37')` is one such value, a field named `temperature` will exist.
has_key	As `${NAME}`, but a single field of name `has_key` is generated for each `NamedValue` entry with a value of the key such that a search for `has_key:temperature` in the example above is possible.
Internal	
combined_fields	The default field prefix.
_hibernate_class	Used by Hibernate Search to record the entity type. The class value, e.g. ome.model.core.Image is also entered in combined_fields. Unimportant for the casual users.
id	The primary key of the entity. Unimportant for the casual user

18.1.2 Queries

Search queries are very similar to Google searches. When search terms are entered without a prefix ("name:"), then the default field will be used which combines all available fields. Otherwise, a prefix can be added to restrict the search.

18.1.3 Indexing

Successful searching depends on understanding how the text is indexed. The default analyzer used is the FullTextAnalyzer[2].

[2] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/fulltext/FullTextAnalyzer.java

```
1. Desktop/image_GFP-H2B_1.dv  --->  "desktop", "image", "gfp", "h2b", "1", "dv"
2. Desktop/image_GFP-H2B_2.dv  --->  "desktop", "image", "gfp", "h2b", "2", "dv
3. Desktop/image_GFP_01-H2B.dv --->  "desktop", "image", "gfp", "01", "h2b", "dv"
4. Desktop/image_GFP-CSFV_a.dv --->  "desktop", "image", "gfp", "csfv", "a", "dv"
```

Assuming these entries above for Image.name:

- searching for **GFP-H2B** returns 1 and 2.
- searching for **"GFP H2B"** also returns 1 and 2.
- searching for **GFP H2B** returns 1, 2, and 3, since the two terms are joined by an **OR**.

18.1.4 Information for developers

ome.api.IQuery

The current IQuery implementation restricts searches to a single class at a time.

- `findAllByFullText(Image.class, "metaphase")` – Images which contain or are annotated with "metaphase"
- `findAllByFullText(Image.class, "annotation:metaphase")` – Images which are annotated with "metaphase"
- `findAllByFullText(Image.class, "tag:metaphase")` – Images which are tagged with "metaphase" (specialization of the previous)
- `findAllByFullText(Image.class, "file.contents:metaphase")` – Images which have files attached containing "metaphase"
- `findAllByFullText(OriginalFile.class, "file.contents:metaphase")` – File containing "metaphase"

ome.api.Search

The Search API offers a number of different queries along with various filters and settings which are all maintained on the server.

The matrix below show which combinations of parameters and queries are supported (S), will throw an exception (X), and which will simply silently be ignored (I).

Query Method –>	byGroupForTags/byTagsForGroup	byFullText/SomeMustNone	byAnnotatedWith
Parameters			
annotated between	S	S	S
annotated by	S	S	S
annotated by	S	I	I
created between	S	I	I
modified between	S	I (Immutable)	S
owned by	S	S	S
all types	X	I	X
1 type	S	I	S
N types	X	I	X
only ids	S	I	S
Ordering / Fetches			
orderBy	S	I	S
fetchAnnotations	[3]	I	[4]
Other			
setProjections [5]	X	X	X
current*Metdata [6]	X	X	X

[3] Any fetchAnnotation() argument to byFullText() or related queries, returns **all** annotations.
[4] byAnnotatedWith() does not accept a fetchAnnotation() argument of `Annotation.class`.

Leading wildcard searches

Leading wildcard searches are disallowed by default. "?omething" or "*hatever", for example, would both throw exceptions. They can be run by using:

```
Search search = serviceFactory.createSearchService();
search.setAllowLeadingWildcards(true);
```

There is a performance penalty, however. In addition, wildcard searches get expanded on the server to boolean queries. For example, assuming "ACELL", "BCELL", and "CCELL" are all terms in your index, then the query:

```
*CELL
```

gets expanded to:

```
ACELL OR BCELL OR CCELL
```

If there are more than `omero.search.maxclause` terms in the expansion (default is 4096), then an exception will be thrown. This requires the user to enter a more refined search, but not because there are too many results, only because there is not enough room in memory to search on all terms at once.

Extension points

Two extension points are currently available for searching. The first are the *File parsers* mentioned above. By configuring the map of Formats (roughly mime-types) of files to parser instances, extracting information from attached binary files can be made quick and straightforward.

Similarly, *Search bridges* provide a mechanism for parsing all metadata entering the system. One built in bridge (the FullTextBridge[7]) parses out the fields mentioned above, but by creating your own bridge it is possible to extract more information specific to your site.

See also:

Structured annotations, *Search bridges*, *File parsers*, Query Parser Syntax[8],

Luke[9] a Java application which you can download and point at your `/OMERO/FullText` directory to get a better feeling for Lucene queries.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

18.2 File parsers

File parsers extract text from various file types and provide it as a `Reader` to the `FullTextBridge` for use during search indexing. Plain text formats can use the default `fileParser` bean, but any specialized format, such as PDF or RTF requires special libraries and special registration.

18.2.1 Configuration

Currently, configuration takes places solely in service-ome.api.Search.xml[10]. Eventually, it should be able to replace file parsers at configuration or even runtime.

[5] setProjects may need to be removed if Lucene cannot handle OMERO's security requirements.
[6] Not yet implemented.
[7] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/fulltext/FullTextBridge.java
[8] http://lucene.apache.org/core/3_6_0/queryparsersyntax.html
[10] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/service-ome.api.Search.xml

18.2.2 Available parsers

File type	Parser
application/pdf	http://pdfbox.apache.org
text/xml	(internal)
text/plain	(internal)
text/csv	(internal)

The base class for File parsers are FileParser.java[11]

See also:

OMERO search

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

18.3 Search bridges

A "bridge" is the mapping between your metadata and how it is stored in the Lucene[12] index. *OMERO search* uses one internal bridge to parse all of your metadata for later searching. If, however, there is more metadata that you would like to add to the index, you can implement the `org.hibernate.search.bridge.FieldBridge` interface yourself, or subclass the helper class components/server/src/ome/services/fulltext/BridgeHelper.java[13]

18.3.1 Example

Assume you wanted to be able to search for a project based on the name of all images contained in that project. In the set method,

```
public void set(final String name, final Object value,
        final Document document, final Field.Store store,
        final Field.Index index, final Float boost) {
```

you would need to add a field to the `Document` for each `Image`.

```
Project p = (Project) value;
List<Image> images = getImages(p);
for (Image image : images) {
        add(document, "image_name", image.getName(), store, index, boost);

 }
```

18.3.2 Configuration

Custom bridges are configured in *Search* but can be overridden via the *standard configuration mechanisms*. The `omero.search.bridges` property defines a comma-separated list of bridge classes which will be passed to components/server/src/ome/services/fulltext/FullTextBridge.java[14].

See *Java deployment* for how to have your bridge classes included on the server's classpath if it doesn't get built by the *Build System*.

[11] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/fulltext/FileParser.java
[12] http://lucene.apache.org
[13] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/fulltext/BridgeHelper.java
[14] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/fulltext/FullTextBridge.java

18.3.3 Available bridges

See components/server/src/ome/services/fulltext/bridges[15] for a list of provided (example) bridges.

18.3.4 Re-indexing

`BridgeHelper` provides two methods – `reindex(IObject)` and `reindexAll(List<IObject>)` – for keeping the indexes for objects in sync.

For example, if the `image.name` above were to be changed, the index for the `Project` would be stale until the `Project` itself were re-indexed. Custom bridges can call `reindex(Project)` while indexing the image to have the Project re-indexed from the **backlog**. Before any new changes are processed, the backlog is always first cleared. One caveat: while processing the backlog, no new objects can be added to it.

For bridge writers, this means concretely that implementations should check for all related types and index them in groups, rather than relying on transitivity. For example,

```
if (value instanceof Project) {
     final Project p = (Project) value;
     handleProject(p, document, store, index, boost);

     for (final ProjectDatasetLink pdl : p.unmodifiableDatasetLinks()) {
         final Dataset d = pdl.child();
         reindex.add(d);
         handleDataset(d, document, store, index, boost);

         for (final DatasetImageLink dil : d.unmodifiableImageLinks()) {
             final Image i = dil.child();
             reindex.add(i);
             handleImage(document, store, index, two_step_boost, i);
         }
     }
 } else if (value instanceof Dataset) {
     final Dataset d = (Dataset) value;
     handleDataset(d, document, store, index, boost);

     for (final ProjectDatasetLink pdl : d.unmodifiableProjectLinks()) {
         final Project p = pdl.parent();
         reindex.add(p);
         handleProject(p, document, store, index, two_step_boost);
     }

     for (final DatasetImageLink dil : d.unmodifiableImageLinks()) {
         final Image i = dil.child();
         reindex.add(i);
         handleImage(document, store, index, two_step_boost, i);
     }

 } else if (value instanceof Image) {

     final Image i = (Image) value;
     handleImage(document, store, index, two_step_boost, i);


     for (final DatasetImageLink dil : i.unmodifiableDatasetLinks()) {
         final Dataset d = dil.parent();
         reindex.add(d);
         handleDataset(d, document, store, index, boost);
         for (final ProjectDatasetLink pdl : d
                 .unmodifiableProjectLinks()) {
             final Project p = pdl.parent();
             reindex.add(p);
```

[15] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server/src/ome/services/fulltext/bridges

```
                    handleProject(p, document, store, index, boost);
                }
            }
        }

        //
        // Handle re-indexing
        //
        if (reindex.size() > 0) {
            reindexAll(reindex);
        }

}
```

In which case, regardless of whether an Image, Dataset, or Project is indexed, all related objects are simultaneously added to the backlog, which will be processed in the next cycle, but **their** indexing will not add any new values to the backlog.

See #955[16] and #1102[17]

See also:

OMERO search

[16] https://trac.openmicroscopy.org/ome/ticket/955
[17] https://trac.openmicroscopy.org/ome/ticket/1102

CHAPTER

NINETEEN

AUTHENTICATION AND SECURITY

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

19.1 Password Provider

A *Password Provider* is an implementation of the Java interface ome.security.auth.PasswordProvider[1]. Several implementations exist currently:

- ome.security.auth.JdbcPasswordProvider[2] is the most common provider, and uses the "password" table for storing passwords hashed using MD5 and salt per user.
- ome.security.auth.FilePasswordProvider[3] is rarely used, but in some scenarios may be useful since it permits setting usernames and passwords in a plain text file.
- ome.security.auth.LdapPasswordProvider[4] is a highly configurable provider which provides READ-ONLY access to an LDAP server and can create users and groups on the fly. See *LDAP plugin design* for more information.

The "chainedPasswordProvider" (ome.security.auth.PasswordProviders[5]) is configured for use by default in *Security* under `omero.security.password_provider`. It first checks with the `LdapPasswordProvider` and then falls back to the `JdbcPasswordProvider`.

To write your own provider, you can either subclass from ome.security.auth.ConfigurablePasswordProvider[6] as the providers above do, or write your own implementation from scratch. You will need to define your object in a Spring XML file matching the pattern `ome/services/db-*.xml`. See *Extending OMERO.server* more for information.

19.1.1 Things to keep in mind

- All the existing implementations take care to publish a LoginAttemptMessage[7] so that any *LoginAttemptListener* implementation can properly react to failed logins. Your implementation should probably do the same.
- When dealing with chains of password providers, an implementation can safely return null from `checkPassword` to say "I don't know anything about this". This is only important if you configure your own chained password provider with your new implementation as one of the elements.

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[1] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/PasswordProvider.java
[2] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/JdbcPasswordProvider.java
[3] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/FilePasswordProvider.java
[4] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/LdapPasswordProvider.java
[5] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/PasswordProviders.java
[6] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/ConfigurablePasswordProvider.java
[7] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/messages/LoginAttemptMessage.java

19.2 LoginAttemptListener

All the *Password Provider* implementations provided by default publish a "LoginAttemptMessage[8]" every time they check a password value. This permits any `org.springframework.context.ApplicationListener<LoginAttemptMessage>` to react to the login. Only one implementation is active by default (as of 4.2.1): ome.security.auth.LoginAttemptListener[9] which throttles logins after a given number of failed attempts. Configuration for this listener is available in *Security*:

```
omero.security.login_failure_throttle_count=1 # Number of failed attempts before throttling begins
omero.security.login_failure_throttle_time=3000 # Time in milliseconds
```

A more sophisticated listener would lock the user's account until an administrator intervenes. This is the goal of #3139[10].

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19.3 LDAP plugin design

Once configured, *LDAP authentication* allows sysadmins to control OMERO's user and group creation via an external, locally-maintained LDAP server. Due to the flexibility of LDAP, each instance may have a number of requirements that cannot be supported out of the box. Below, we discuss the design of the LDAP plugin as well as how it can be extended for local use.

19.3.1 Simple walkthrough

The LDAP plugin follows these steps:

1. Sysadmin configures properties mapping users and groups from LDAP to OMERO.
2. Once LDAP is enabled, any OMERO user who has a value of `true` in the `ldap` column of the `experimenter` table will have their password checked against LDAP and **not** against OMERO (changing the password via OMERO is *not* supported). This functionality is provided by the *Password Provider*. The DN (Distinguished Name) is not stored in the OMERO DB and is retrieved from the LDAP server on each user login.
3. If there is no OMERO user for a given name, the LDAP plugin will use `omero.ldap.user_filter` and `omero.ldap.user_mapping` to look for a valid user:
   (a) The `user_mapping` property is of the form: `omeName=<ldap attribute>;firstName=<ldapAttribute>;...`
   (b) For looking up new users, the plugin will only use the `omeName` attribute. For example, if a user tries to login with "emma" and the `user_mapping` starts with `omeName=cn;` then the LDAP search will be for `(cn=emma)`.
   (c) The `(cn=emma)` LDAP filter is then added to the value of `omero.ldap.user_filter`. For example, if the user filter is `(objectClass=inetOrgPerson)`, the full query for the new user will be: `(&(objectClass=inetOrgPerson)(cn=emma))`
4. **If** the search returns a **single** LDAP user, then an OMERO user will be created with all properties mapped according to `omero.ldap.user_mapping` and the `ldap` property set to `true`.
5. Then the user will be placed in groups according to the value of `omero.ldap.new_user_group`, which are created if necessary. Details of the various options can be found under *LDAP authentication*. Each option is handled by a different `NewUserGroupBean` implementation.

[8] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/messages/LoginAttemptMessage.java
[9] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/LoginAttemptListener.java
[10] https://trac.openmicroscopy.org/ome/ticket/3139

19.3.2 NewUserGroupBean.java

The interface described for the ":bean:" `new_user_group` prefix, is ome.security.auth.NewUserGroupBean[11]. It defines a single method: `groups(…, AttributeSet set)` which returns a list of `ExperimenterGroup` ids (`List<Long>`) which the user should be added to.

Other prefix handlers also implement the interface as examples. In the same package are:

- **`:attribute:`** - AttributeNewUserGroupBean.java[12]
- **`:ou:`** - OrgUnitNewUserGroupBean[13]
- **`:query:`** - QueryNewUserGroupBean[14]

See also:

OMERO.server installation Instructions for installing OMERO.server on UNIX and UNIX-like platforms

OMERO.server installation Instructions for installing OMERO.server on Windows platforms

Server security and firewalls General instructions on server security

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19.4 OMERO roles

There are two areas where roles are used. The first is in service-level security (**deciding who can make what calls**) and the second is in object-level security (**who can read and edit individual objects**). Both of these sets of roles are composed of "ExperimenterGroups".

19.4.1 Setting roles

An Experimenter is given a role by being a member of an ExperimenterGroup (specifically, this means that there exists a GroupExperimenterMap where child == the experimenter id and parent == the experimenter group id). Creating a GroupExperimenterMap is generally done transparently by `IAdmin` service. Instead, administrators call:

- `IAdmin.createUser(user)`
- `IAdmin.createGroup(group)`
- `IAdmin.addGroups(user, group, group, …)`
- `IAdmin.removeGroups(user, group, group, …)`
- `IAdmin.createSystemUser(user)`

19.4.2 Service-level

The two main roles that are distinguished at the service-level are "system" and "user" groups. These groups are created during installation and must not be configured by administrators. All users added through `IAdmin.createUser(user)` are automatically added to the "user" group, and all users added through `IAdmin.createSystemUser(user)` are added to both "system" and "user" groups.

During login, a user is checked against all groups for membership in "user" or "system", and no special action needs to be taken by the user or client developer.

Note: Although currently all methods in the session beans are labelled as `@RolesAllowed("user")` or `@RolesAllowed("system")`, there is nothing stopping a developer from writing a service method which accepts another role, as long as that role has been created in the ExperimenterGroup table.

[11] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/NewUserGroupBean.java
[12] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/AttributeNewUserGroupBean.java
[13] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/OrgUnitNewUserGroupBean.java
[14] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/auth/QueryNewUserGroupBean.java

19.4.3 Object-level

Object-level security is more complicated. When execution reaches the `EventHandler`, a second login takes place to authorize the user with the OMERO security system. This second authorization process takes into account the group that (can be) passed into the client `ServiceFactory\ (Login)` via `Login(String,String,String,String)`. If a user has not set the group name or the default "user" group has been set, then the default group for that user will be used (a user is not allowed to use the "user" group for object updates). If the group is set to "system", then the "system" group **will** be used, and a user is granted admin privileges for object updates. This means that a user could be authorized to call a method by being in the "system" group, but if the "system" group is not specified, `SecurityViolations` will most likely be thrown.

19.4.4 Special privileges for PIs

There is one other special, implicit role which is group leader. The user listed as "owner" for a group is considered the group leader, also known as the PI (principal investigator) of that group. For all objects that are assigned to that group, the PI has near-admin access. Objects which are set to unreadable ("-wu-wu-wu") will still be visible to the PI. The same objects can also be updated regardless of the permissions set.

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19.5 OMERO security system

The OMERO security system is intended to be as transparent as possible while permitting users to configure the visibility of their data. For the user, this means that with no special actions, data and metadata created will be readable by both members of the same group and by other users, but will be writable by no one, comparable to a umask of 755 on Unix. For the developer, transparency means that there is little or no code that must be written to prevent security violations, and simple mechanisms for allowing restricted operations when the time comes.

Other links which may be of use:

- *OMERO admin interface*
- *OMERO roles*
- *Groups and permissions system*
- *OMERO permissions history, querying and usage*

19.5.1 Concepts

Several concepts and/or components from our and other code bases play a role in OMERO security:

Hibernate Listeners and Events[15] listeners and events are the two extension points provided by Hibernate for responding to and influencing internal actions. Essentially any method on the `org.hibernate.Session` interface has a corresponding event, and almost the same is true for the interceptor. Additionally interceptors can change the state of the objects before INSERT and UPDATE, and after SELECT.

Hibernate Filters[16] filters are a mechanism for injecting SQL clauses into the SELECT statements generated by Hibernate. Similar to listeners and events for write actions, filters allow us to extend Hibernate functionality with our own logic.

Handler/interceptor as outlined in *Aspect-oriented programming*, OMERO makes extensive use of method interceptors to relieve the developer of some coding burden. Transactions, session management, and, naturally, security are handled largely by our interceptors (or "handlers").

Events Every write action produces an Event in the database. This database contains several `EventLogs` which specify exactly what was created or altered during that specific event.

19.5.2 Participants

Now, with the concepts cleared up, we can take a look at all of the concrete source artifacts ("participants") which are important for security.

Top-level and build

omero.properties[17] contains login and connection information for the database and OMERO.

build.properties.example[18] contains the default root password. This can be overridden with your own `etc/local.properties` file.

hibernate.properties[19] contains default connection information for the database, this includes the user name and if necessary the user password. These values can be overridden in local.properties.

omero.properties[20] contains a default user group, event type, and connection information for logging in from the client side, if no Login or Server is specified to ServiceFactory. These values can be overridden in local.properties.

mapping.vm[21] specifies the default permissions that all objects will have after construction, as well as attaches the security filter to all classes and collections.

data.vm[22] used by DSLTask to generate psql-footer.sql which is used to bootstrap the database security system (root et al).

common/build.xml[23] contains an ant target (adduser) which will create a user and empty password from the command line. This target can also be called from the top-level (java omero adduser).

Client and common

the server uses the information in /etc/local.properties to create a Login object. If no Login, Server, or Properties is provided to the ServiceFactory constructor, the empty properties defined in ome/config.xml[24] is used.

IAdmin.java[25] main interface for administering accounts and privileges. See *OMERO admin interface* for more.

ITypes.java[26] only related to security by necessity. The security system disallows the creation of certain "System-Types". Enumerations are one of these. ITypes, however, provides a createEnumeration method with general access.

GraphHolder.java[27] all model objects (implementations of IObject have a never-null GraphHolder instance available. This graph holder is responsible for various OMERO and Hibernate internal processes. One of these is the exchange of Tokens. For the server, the existence of a special token within the GraphHolder grants certain privileges to that IObject. This logic is encapsulated within the SecuritySystem.

Details.java[28] contains all the fields necessary to perform access control, such as owner, group, and permissions.

Permissions.java[29] representation of rights and roles. For more information, see *Groups and permissions system*.

Token.java[30] an extremely simple class ("public class Token {}") which is only significant when it is equivalent ("==") to a privileged Token stored within the SecuritySystem.

IEnum.java[31] the only non-access control related types which are considered "System-Types" are enumerations. IEnum is a marker interface for all enumerations and creation of IEnum implementations can only be performed through ITypes.

SecurityViolation.java[32] the exception thrown by the *OMERO security system* at the first hint of misdoings.

Principal.java[33] an Omero-speciific implementation of the java.security.Principal interface. Carries in addition to the typical name field, information about the user group, the event type, and the session umasks.

meta.ome.xml[34]

JBoss-only

ServiceFactory.java[35] Login.java[36] Server.java[37]

[24] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/resources/ome/config.xml
[34] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/resources/mappings/meta.ome.xml
[35] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/ServiceFactory.java
[36] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/Login.java
[37] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/Server.java

Server side

AdminImpl.java[38] CurrentDetails.java[39] SecureAction.java[40] SecuritySystem.java[41] BasicSecuritySystem.java[42] ACLEventListener.java[43] EventHandler.java[44] MergeEventListener.java[45] OmeroInterceptor.java[46] SessionHandler.java[47] SecurityFilter.java[48] EventLogListener.java[49] EventListenersFactoryBean.java[50] LocalAdmin.java[51] hibernate.xml[52] sec-system.xml[53] services.xml[54]

19.5.3 End-to-end

Build system

Security starts with the build system and installation. During the generation of the model (by the DSLTask), a sql script is created called "data.sql". After ddl.sql creates the database, data.sql bootstraps the security system by creating the initial (root) experimenter, and event, and then creates the "system" group and the "user" group. It then creates a password table and sets the root password to "ome". (It also creates all of the enumeration values, but that is unimportant for security).

Note: The password table is not mapped into Hibernate, and is only accessible via the *OMERO admin interface*.

Client-side

To begin the runtime security process, a user logs in by providing a Login and/or a Server instance to ServiceFactory. These types are immutable and their values remain constant for the lifetime of the ServiceFactory. The user can also set the umask property on ServiceFactory_. This value is mutable and can be set at anytime.

The values are converted to java.util.Properties which are merged with the properties from the *.properties files from /etc to create the client *OmeroContext* (also known as the "application context"). The context contains a Principal and user credentials (password etc.) which are associated with the thread before each method execution in a specialized TargetSource. Finally, these objects are serialized to the application server along with the method arguments.

Application server

The application server first performs one query (most likely SQL) to check that the credentials match those for the given user name. A second query is executed to retrieve all roles/groups for the given user. If the roles returned are allowed to invoke the desired method, invocation continues with the queried user and roles stored in the InvocationContext.

Server code

Execution then passes to OMERO code, specifically to the interceptors and lifecycle methods defined on our session beans. This intercepting code checks the passed Principal for OMERO-specific information. If this information is available, it is passed into the SecuritySystem through the login method. Finally, execution is returned to the actual bean which can either delegate to OMERO services or perform logic themselves.

[38] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/logic/AdminImpl.java
[39] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/CurrentDetails.java
[40] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/SecureAction.java
[41] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/SecuritySystem.java
[42] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/BasicSecuritySystem.java
[43] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/ACLEventListener.java
[44] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/EventHandler.java
[45] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/MergeEventListener.java
[46] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/OmeroInterceptor.java
[47] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/tools/hibernate/SessionHandler.java
[48] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/SecurityFilter.java
[49] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/EventLogListener.java
[50] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/EventListenersFactoryBean.java
[51] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/api/local/LocalAdmin.java
[52] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/hibernate.xml
[53] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/sec-system.xml
[54] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/services.xml

Interceptors

All calls to the delegates (and in the future all calls on the session beans) are also caught intercepted by Spring-configured interceptors. These guarantee that the system is always in a valid and secure state. In stack order they are:

- the service handler, which handles logging and checks all arguments against ServiceInterface annotations;
- the proxy handler, which after execution, removes all uninitialized Hibernate objects to prevent exceptions (special logic allows this to happen See unloaded objects);
- the transaction handler, which binds a transaction to the thread,
- the session handler, which uses the now prepared transaction to initialize either a new or a cached (in the case of stateful session beans) session and also bind it to the thread;
- and finally, the event handler, which performs what one might actually consider login. It instatiates Experimenter, ExperimenterGroup, and Event objects from Hibernate and gives them a special Token so that they can authenticate themselves later to the SecuritySystem and turns session read security on for the entirety of execution below its frame.

Services

Finally execution has reached the OMERO services and can begin to perform logic. Because of these layers, almost no special logic (other than eviction and not calling write methods from within read methods. see #223[55]) needs to be considered. There are, however, a few special cases.

IQuery (within the application server), for example will always return a graph of active Hibernate objects. Changes to them will be persisted to the database on flush.

IUpdate, on the other hand, does contain some logic for easing persistence, though this will eventually be ported to the Hibernate event system. This includes pre-saving the newly created event and the work of UpdateFilter like reloading objects unloaded by the proxy handler (above).

Finally, **IAdmin** is special in that it and it alone access the non-Hibernate password data store and even access application server APIs (like JMX) in order to make authentication and authorization function properly.

Hibernate

Once execution has left this service layer, it enters the world of Hibernate ORM. Here we cannot actively change functionality but only provide callbacks like the OmeroInterceptor and EventListeners. The OmeroInterceptor instance registered with the Hibernate SessionFactory (via Spring) is allowed for calling back to the often mentioned SecuritySystem to determine what objects can be saved and which deleted. It also properly sets the, for a user mostly unimportant, Details object. The EventListeners are more comprehensive than the OmeroInterceptor and can influence almost every phase of the Hibernate lifecycle, specifically every method on the Session interface.

The event listeners which implement AbstractSaveEventListener (i.e. MergeEventListener, SaveOrUpdateEventListener, etc.) are responsible for reloading unloaded objects (and will hopefully take this functionality fully from IUpdate) and provide special handling for enums and other system types. There are also event listeners which are the equivalent of database triggers (pre-update, post-delete, etc.) and these are used for generating our audit log.

So much for write activities. Select queries are, as mentioned above, secured through the use of Hibernate filters which add join and where clauses dynamically to queries. For example an HQL query of the form:

```
select i from Image i
```

would be filtered so that the current user does not receive references to any objects with reduced visibility:

```
select i from Image i where ( current_user = :root OR i.permissions = :readable )
```

The actual clauses added are much more complex and are added for each joined entity type (i.e. table) which apears in a query.

[55] https://trac.openmicroscopy.org/ome/ticket/223

```
select i from Image i join i.defaultPixels p
```

would contain the "(current_user = :root …)" clause twice.

Currently, subqueries are an issue in that the clauses do not get added to them. This may cause consternation for some particular queries.

Security system

All of this is supported by an implementation of the SecuritySystem interface which encapsulates all logic regarding security. It also hides as much as it can, and if not specifically needed should be ignored. However, before you attempt to manually check security, by all means use the security system, and for that, it may need to be acquired from the server-side *OmeroContext*. Currently, there is no client-side security system. See #234[56].

The *OMERO security system* and its current only implementation BasicSecuritySystem? are somewhat inert and expect well-defined and trusted (see #235[57]) methods to invoke callbacks during the proper Hibernate phase.

19.5.4 Logging in (client-side)

When using the client library and the ServiceFactory, logging in is trivial. One need only set several System properties or place them in an omero.properties file somewhere on the classpath. Internally, Spring takes the System properties and creates an ome.system.Principal[58] instance. This is then passed to the server on each invocation of a proxy obtained from JNDI.

19.5.5 Logging in (server-side)

Much of this infrastructure is not available to server-side code (no ome/client/spring.xml, no ServiceFactory, etc.). As such, the Principal needs to be manually created and provided to the server-side SecuritySystem.java[59].

Basically it amounts to this:

```
Principal p = new Principal( omeroUserName, omeroGroupName, omeroEventTypeValue );
securitySystem.login( p );
```

This must be run otherwise the EventHandler[60] will throw a security exception.

Note: The code above is being run in a secure context (i.e. you are root). Please be careful.

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19.6 OMERO permissions history, querying and usage

19.6.1 Introduction

The OMERO permissions model has had a significant overhaul from version 4.1.x to 4.4.x. Users and groups have existed in OMERO since well before the initial 4.1.x releases and numerous permissions levels were possible in the 4.1.x series but it was largely assumed that an Experimenter belonged to a single Group and that the permissions of that Group were private.

The OMERO permissions system received its first significant update in 4.2.0 with the introduction of multiple group support throughout the platform and group permissions levels.

[56] https://trac.openmicroscopy.org/ome/ticket/234
[57] https://trac.openmicroscopy.org/ome/ticket/235
[58] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/Principal.java
[59] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/SecuritySystem.java
[60] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/EventHandler.java

In a 4.1.x object graph `Group` containment was not enforced i.e. two linked objects (such as a `Project` and `Dataset`) could in theory be members of two distinct `Groups`. All objects continued to carry their permissions and those permissions were persisted in the database.

Things to note about 4.2.x permissions

- Objects could not be moved between groups easily.
- It was not possible to reduce the permissions level of a group.
- The delete service (introduced in OMERO 4.2.1) was made aware of the permissions system.
- 'Default Group' switching was required to make queries in different permissions contexts.

Note: Queries span only one group at a time. Inserts and updates as other users must be done by creating a session as that user.

See also:

OMERO 4.2.0 Server Permissions[61] Database upgrade from 4.1 to 4.2[62] *Deleting in OMERO*

Changes for OMERO 4.4.x

The second major OMERO permissions system innovations were performed in 4.4.0:

- Cross group querying was reintroduced.
- Change group was enabled, allowing the movement of graphs of objects between groups.
- Permissions level reduction was made possible for read-annotate to read-only transitions.
- **A thorough user interface review resulted in the following features being made available in the UI:**
  - single group browsing and user-switching (available since 4.4.0)
  - browsing data across multiple groups (available since 4.4.6 and refined in 4.4.7)
- The concept of a 'Default or Primary Group' was deprecated.

Note: Queries, inserts and updates span `any` or `all` groups and `any` user via options flags.

19.6.2 Working with the OMERO 5.2.4 permissions system

Example environment

- OMERO 5.2.4 server
- IPython shell initiated by running `omero shell --login`

Group membership

User	private-1	read-only-1	read-write-1	read-annotate-1
user-2	Yes	Yes	No	No
user-3	No	Yes	No	Yes

[61] http://www.openmicroscopy.org/site/support/previous/omero420/server/permissions
[62] http://www.openmicroscopy.org/site/support/previous/omero420/server/db-upgrade-41-to-42

Simple inserts and queries

While the 'Default Group' is essentially a deprecated concept, a user must be logged into one to provide a default context. It is still possible to change this default group but it is no longer required to make queries in other permissions contexts.

All remote calls to an OMERO server, since well before version 4.1.x, have the option of taking an Ice context object. Through this object, and manipulations thereof, we can affect our query context. What follows is a series of examples exploring inserts and queries using contexts that span a single group at a time.

Retrieving a user's event context and group membership

```
#!python
# Session that has already been created for user-2
session = client.getSession()

# Retrieve the services we are going to use
admin_service = session.getAdminService()

ec = admin_service.getEventContext()
print ec
groups = [admin_service.getGroup(v) for v in ec.memberOfGroups]
for group in groups:
    print 'Group name: %s' % group.name.val
```

Example output:

```
object #0 (::omero::sys::EventContext)
{
    shareId = -1
    sessionId = 1783
    sessionUuid = 213adc46-2c5f-449b-81fc-fe24dec38b58
    userId = 10
    userName = user-2
    groupId = 9
    groupName = private-1
    isAdmin = False
    eventId = -1
    eventType = User
    memberOfGroups =
    {
        [0] = 9
        [1] = 8
        [2] = 1
    }
    leaderOfGroups =
    {
    }
    groupPermissions = object #1 (::omero::model::Permissions)
    {
        _restrictions =
        {
        }
        _perm1 = -120
    }
}

Group name: private-1
Group name: read-only-1
Group name: user
```

Here you can see and validate that, when logged in as `user-2`, we are a member of both the `private-1` and `read-only-1` groups. Membership of the `user` group is required in order to login. This group essentially acts as a role, letting the OMERO security system know whether or not the user is active.

Inserting and querying data from specific groups

For the purposes of this example, we will prepare a single `Project` in both the `private-1` and `read-only-1` groups and then perform various queries on those `Projects`.

```
#!python
from omero.model import *
from omero.rtypes import *
from omero.sys import ParametersI
from omero.cmd import Delete
from omero.callbacks import CmdCallbackI

# Session that has already been created for user-2
session = client.getSession()

# Project object instantiation
private_project = ProjectI()
private_project.name = rstring('private-1 project')
read_only_project = ProjectI()
read_only_project.name = rstring('read-only-1 project')

# Retrieve the services we are going to use
update_service = session.getUpdateService()
admin_service = session.getAdminService()
query_service = session.getQueryService()

# Groups we are going to write data into
private_group = admin_service.lookupGroup('private-1')
read_only_group = admin_service.lookupGroup('read-only-1')

# Save and return our two projects, setting the context correctly for each
ctx = {'omero.group': str(private_group.id.val)}
private_project = update_service.saveAndReturnObject(private_project, ctx)
ctx = {'omero.group': str(read_only_group.id.val)}
read_only_project = update_service.saveAndReturnObject(read_only_project, ctx)

private_project_id = private_project.id.val
read_only_project_id = read_only_project.id.val
print 'Created Project:%d in group private-1' % (private_project_id)
print 'Created Project:%d in group read-only-1' % (read_only_project_id)

# Query for the private project we created using private-1
#
# You will notice that this returns the Project as we have specified
# the group that the Project is in within the context passed to the
# query service.
ctx = {'omero.group': str(private_group.id.val)}
params = ParametersI()
params.addId(private_project_id)
projects = query_service.findAllByQuery(
        'select p from Project as p ' \
        'where p.id = :id', params, ctx)

print 'Found %d Project(s) with ID %d in group private-1' % \
        (len(projects), private_project_id)

# Query for the private project we created using read-only-1
#
# You will notice that this does not return the Project as we have **NOT**
```

```
# specified the group that the Project is in within the context
# passed to the query service.
ctx = {'omero.group': str(read_only_group.id.val)}
params = ParametersI()
params.addId(private_project_id)
projects = query_service.findAllByQuery(
        'select p from Project as p ' \
        'where p.id = :id', params, ctx)

print 'Found %d Project(s) with ID %d in group read-only-1' % \
        (len(projects), private_project_id)

# Use the OMERO 4.3.x introduced delete service to clean up the Projects
# we have just created.
handle = session.submit(Delete('/Project', private_project_id, None))
try:
    callback = CmdCallbackI(client, handle)
    callback.loop(10, 1000)  # Loop a maximum of ten times each 1000ms
finally:
     # Safely ensure that the Handle to the delete request is cleaned up,
     # otherwise there is the possibility of resource leaks server side that
     # will only be cleaned up periodically.
     handle.close()
handle = session.submit(Delete('/Project', read_only_project_id, None))
try:
    callback = CmdCallbackI(client, handle)
    callback.loop(10, 1000)  # Loop a maximum of ten times each 1000ms
finally:
    handle.close()
```

Example output:

```
Created Project:113 in group private-1
Created Project:114 in group read-only-1
Found 1 Project(s) with ID 113 in group private-1
Found 0 Project(s) with ID 113 in group read-only-1
```

Advanced queries

In OMERO 4.4.0, cross group querying was reintroduced. Again, we make use of the Ice context object. Through this object, and manipulations thereof, we can expand our query context to span all groups via the use of `-1`. What follows is a series of example queries using contexts that span all groups.

Querying data across groups

```
#!python
from omero.model import *
from omero.rtypes import *
from omero.sys import ParametersI
from omero.cmd import Delete, DoAll
from omero.callbacks import CmdCallbackI

# Session that has already been created for user-2
session = client.getSession()

# Project object instantiation
private_project = ProjectI()
private_project.name = rstring('private-1 project')
```

```
read_only_project = ProjectI()
read_only_project.name = rstring('read-only-1 project')

# Retrieve the services we are going to use
update_service = session.getUpdateService()
admin_service = session.getAdminService()
query_service = session.getQueryService()

# Groups we are going to write data into
private_group = admin_service.lookupGroup('private-1')
read_only_group = admin_service.lookupGroup('read-only-1')

# Save and return our two projects, setting the context correctly for each.
# ALL interactions with the update service where NEW objects are concerned
# must be passed an explicit context and NOT '-1'.  Otherwise the server
# has no idea which set of owners to assign to the object when persisted.
ctx = {'omero.group': str(private_group.id.val)}
private_project = update_service.saveAndReturnObject(private_project, ctx)
ctx = {'omero.group': str(read_only_group.id.val)}
read_only_project = update_service.saveAndReturnObject(read_only_project, ctx)

private_project_id = private_project.id.val
read_only_project_id = read_only_project.id.val
print 'Created Project:%d in group private-1' % (private_project_id)
print 'Created Project:%d in group read-only-1' % (read_only_project_id)

# Query for the private project we created using private-1
#
# You will notice that this returns both Projects as we have specified
# '-1' in the context passed to the query service.
ctx = {'omero.group': '-1'}
params = ParametersI()
params.addIds([private_project_id, read_only_project_id])
projects = query_service.findAllByQuery(
        'select p from Project as p ' \
        'where p.id in (:ids)', params, ctx)

print 'Found %d Project(s)' % (len(projects))

# Use the OMERO 4.3.x introduced delete service to clean up the Projects
# we have just created. The delete service uses '-1' by default for all its
# internal queries.  We are also introducing the 'DoAll' command, which
# allows for the aggregation of 'Delete' commands.
delete_requests = [
    Delete('/Project', private_project_id, None),
    Delete('/Project', read_only_project_id, None)
]
handle = session.submit(DoAll(delete_requests))
try:
    callback = CmdCallbackI(client, handle)
    callback.loop(10, 1000)  # Loop a maximum of ten times each 1000ms
finally:
    # Safely ensure that the Handle to the delete request is cleaned up,
    # otherwise there is the possibility of resource leaks server side that
    # will only be cleaned up periodically.
    handle.close()
```

Example output:

```
Created Project:117 in group private-1
Created Project:118 in group read-only-1
Found 2 Project(s)
```

Querying data across users in the same group

Through the use of an `omero.sys.ParametersI` filter, restricting a query to a given user is possible. For the purposes of these examples, we will assume that both `user-2` and `user-3` have a single project each in the `read-only-1` group.

```
#!python
from omero.model import *
from omero.rtypes import *
from omero.sys import ParametersI

# Session that has already been created for user-2
session = client.getSession()

# Retrieve the services we are going to use
admin_service = session.getAdminService()
query_service = session.getQueryService()

# Groups we are going to query
read_only_group = admin_service.lookupGroup('read-only-1')

# Users we are going to query
user_2 = admin_service.lookupExperimenter('user-2')
user_3 = admin_service.lookupExperimenter('user-3')

# Print the members of 'read-only-1'
print 'Members of "read-only-1" (experimenter_id, username): %r' % \
    [(v.id.val, v.omeName.val) for v in read_only_group.linkedExperimenterList()]

# Query for all projects
ctx = {'omero.group': str(read_only_group.id.val)}
projects = query_service.findAllByQuery(
        'select p from Project as p', None, ctx)
print 'All projects in "read-only-1" (project_id, owner_id): %r' % \
    [(v.id.val, v.details.owner.id.val) for v in projects]

# Query for projects owned by 'user-2'
ctx = {'omero.group': str(read_only_group.id.val)}
params = ParametersI()
params.addId(user_2.id.val)
projects = query_service.findAllByQuery(
        'select p from Project as p ' \
        'where p.details.owner.id = :id', params, ctx)
print 'Projects owned by "user-2" in "read-only-1" (project_id, owner_id): %r' % \
    [(v.id.val, v.details.owner.id.val) for v in projects]

# Query for projects owned by 'user-3'
ctx = {'omero.group': str(read_only_group.id.val)}
params = ParametersI()
params.addId(user_3.id.val)
projects = query_service.findAllByQuery(
        'select p from Project as p ' \
        'where p.details.owner.id = :id', params, ctx)
print 'Projects owned by "user-3" in "read-only-1" (project_id, owner_id): %r' % \
    [(v.id.val, v.details.owner.id.val) for v in projects]
```

Example output:

```
Members of "read-only-1" (experimenter_id, username): [(10L, 'user-2'), (9L, 'user-3')]
All projects in "read-only-1" (project_id, owner_id): [(4L, 10L), (7L, 9L)]
Projects owned by "user-2" in "read-only-1" (project_id, owner_id): [(4L, 10L)]
Projects owned by "user-3" in "read-only-1" (project_id, owner_id): [(7L, 9L)]
```

Utilizing the Permissions object

Every object that is retrieved from the server via the query service, regardless of the context used, has a fully functional `omero.model.PermissionsI` object. This object contains various methods to allow the caller to interrogate the operations that are possible by the current user on the object:

- canAnnotate()[63]
- canDelete()[64]
- canEdit()[65]
- canLink()[66]

19.6.3 Troubleshooting permissions issues

Data disappears after a change of the primary group of a user

As outlined above, changes were made so that by default queries do not span multiple groups and the 'Primary or Default Group' is essentially a deprecated concept. If you have multiple groups and you are attempting to make queries by switching the 'Active Group' via the `setSecurityContext()` method of an active session (`omero.cmd.SessionPrx`), those queries will be scoped only to that group. If you want your queries to act more like they did in 4.1.x, setting `omero.group=-1` will achieve that.

However, the reasons we made these changes have more to them than just API usage and the OMERO client history of only showing the data from one group at a time. Changing the 'Active Group' is both expensive because of the atomicity requirements the server enforces and can create dangerous concurrency situations. This is further complicated by the addition of the change group and delete background processes since 4.1.x. Manipulating a session's 'Primary or Default Group' during these tasks can have drastic effects. Changing the 'Active Group' is forbidden if there are any stateful services (`omero.api.RenderingPrx` for example) currently open.

In short, in OMERO 5.2.4 you absolutely **should not** be switching the 'Primary or Default Group' of the user, or the 'Active Group' of a session, as a means to achieve cross group querying.

Listing other users' data in read-only groups

In order to list other users' data associated with read-only groups of which you are a member, you can also use the context object and set the omero.group to -1. In addition, you can add a filter to the query to only select the other users' data. You can do this either by using the `omero.sys.ParametersI` object's `exp()` method when using the `IContainer` service, or by an explicit query when using `IQuery` service.

Is the default group the primary group when not specifying the context?

The value of the `groupId` property of the `omero.sys.EventContext` is the "Active Group" for the created session. It can be modified as described above with the restrictions outlined. Unless the session has been created by means other than `createSession()` on an `omero.client` object, this will be the user's "Primary or Default Group." A user's 'Primary or Default Group' is the first group in the collection that describes the relation `Experimenter <--> ExperimenterGroup`. It can be set by the `setDefaultGroup()` method on the `IAdmin` service.

What about when importing data without specifying the context object?

Exactly as outlined above. Import does nothing different or special. If you want the operating context of an import to be different from the default you must specify it as such.

[63] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Permissions.html#canAnnotate
[64] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Permissions.html#canDelete
[65] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Permissions.html#canEdit
[66] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/model/Permissions.html#canLink

Specifying the group context as -1 when deleting data

There is no need to do this. Complete graphs cannot span multiple groups and queries are only (unless otherwise filtered) restricted at the group level and not at the level of the user. Furthermore, the delete service always internally performs all its queries in the `omero.group=-1` context unless another more explicit one is specified.

CHAPTER

TWENTY

OMERO.SERVER IN DEPTH

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.1 OMERO.server overview

20.1.1 OMERO sequence narrative

Trying to understand all of what goes on with the server can be a bit complicated. This short narrative tries to touch on the most critical aspects.

- A request reaches the server over one of the two remoting protocols: RMI or ICE. First, the Principal[1] is examined for a valid *session* which was created via ISession.createSession(String username, String password)[2].
- These values are checked against the `experimenter`, `experimentergroup` and `password` tables. A valid login consists of a user name which is to be found in the `omename` column of `experimenter`. This row from `experimenter` must also be contained in the "user" experimenter group which is done via the mapping table `groupexperimentermap` (see this SQL template[3] for how `root` and the intial groups are setup).
- If the server is configured for *LDAP Authentication*, an `Experimenter` may be created when ISessions attempts to check the password via `IAdmin.checkPassword()`.
- If authentication occurs, the request is passed to an EJB3[4] interceptor which checks whether or not the authenticated user is authorized for that service method. Methods are labelled either `@RolesAllowed("user")`, `@RolesAllowed("system")`, or `@PermitAll`. All users are a member of "user", but only administrators will be able to run "system" methods.
- If authorization occurs, the request finally reaches a container-managed stateful or stateless *service* The service will *prepare* the OMERO runtime for the particular user – checking method parameters, creating a new *event*, initializing the *security system*, etc. – and pass execution onto the method implementation. This is done using references acquired (or injected) from the Spring *application context*.
- The actual service implementation (from ome.logic[5] or ome.services[6]) will be either read-only (IQuery[7]-based) or a read-write (IUpdate[8]-based).
- In the case of a read-only action, the implementation asks the database layer for the needed object graph, transforms them where necessary, and returns the values to the remoting subsystem. On the client-side, the returned graph can be mapped to an internal model via the ((OMERO Model Mapping|model wrapper)).
- In the case of a read-write action, the change to the database is first passed to a validation layer for extensive checking. Then the graph is passed to the database layer which prepares the SQL, including an audit trail of the changes made to the database.

[1] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/Principal.java
[2] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/ISession.java
[3] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/dsl/resources/ome/dsl/psql-footer.vm
[4] http://www.oracle.com/technetwork/java/javaee/ejb/index.html
[5] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server/src/ome/logic
[6] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server/src/ome/services
[7] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IQuery.java
[8] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IUpdate.java

- After execution, the OMERO runtime is reset, the method call is logged, and either the successful results are returned or an *exception* is thrown.

20.1.2 Technologies

It is fairly easy to work with the server without understanding all of its layers. The API is clearly outlined in the ome.api package and the client proxies work almost as if the calls were being made from within the same virtual machine. The only current caveat is that objects returned between two different calls will not be referentially (i.e. obj1 == obj2) equivalent. We are working on removing this restriction.

To understand the full technology stack, however, there are several concepts which are of importance:

- A layered architecture ensures that components only "talk to" the minimum necessary number of other components. This reduces the complexity of the entire system. Ensuring a loose-coupling of various components is facilitated by dependency injection. Dependency injection is the process of allowing a managing component to place a needed resource in a component's hand. Code for lookup or creation of resources, in turn, is unneeded, and explicit implementation details do not need to be hard-coded.
- Object-relational mapping (ORM) is the process of mapping relational tables to object-oriented classes. Currently OMERO uses Hibernate[9] to provide this functionality. ORM allows the developer to work in a known environment, here the type-safe world of Java, rather than writing difficult to debug sql.
- Aspect-oriented programming, a somewhat new and misunderstood technology, is perhaps the last technology which should be mentioned. Various pieces of code ("aspects") are *inserted* at various moments ("joinpoints") of execution. Collecting logic into aspects, whether logging, transactions, security etc., also reduces the overall complexity of the code.

20.1.3 Server design

The server logic resides in the components/server[10] component.

Topics

- *Exception handling*
- *OME-Remote Objects*
- *Server security and firewalls*

See also:

OMERO.grid

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.2 Extending OMERO.server

Overview

Despite all the effort put into building OMERO, it will never satisfy the requirements of every group. Where we have seen it useful to do so, we have created extension points which can be used by third-party developers to extend, improve, and adapt OMERO. We outline most of these options below as well as some of their trade-offs. We are also always interested to hear other possible extension points. Please contact the ome-devel mailing list[a] with any such suggestions.

[a] http://lists.openmicroscopy.org.uk/mailman/listinfo/ome-devel/

[9] http://www.hibernate.org
[10] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server

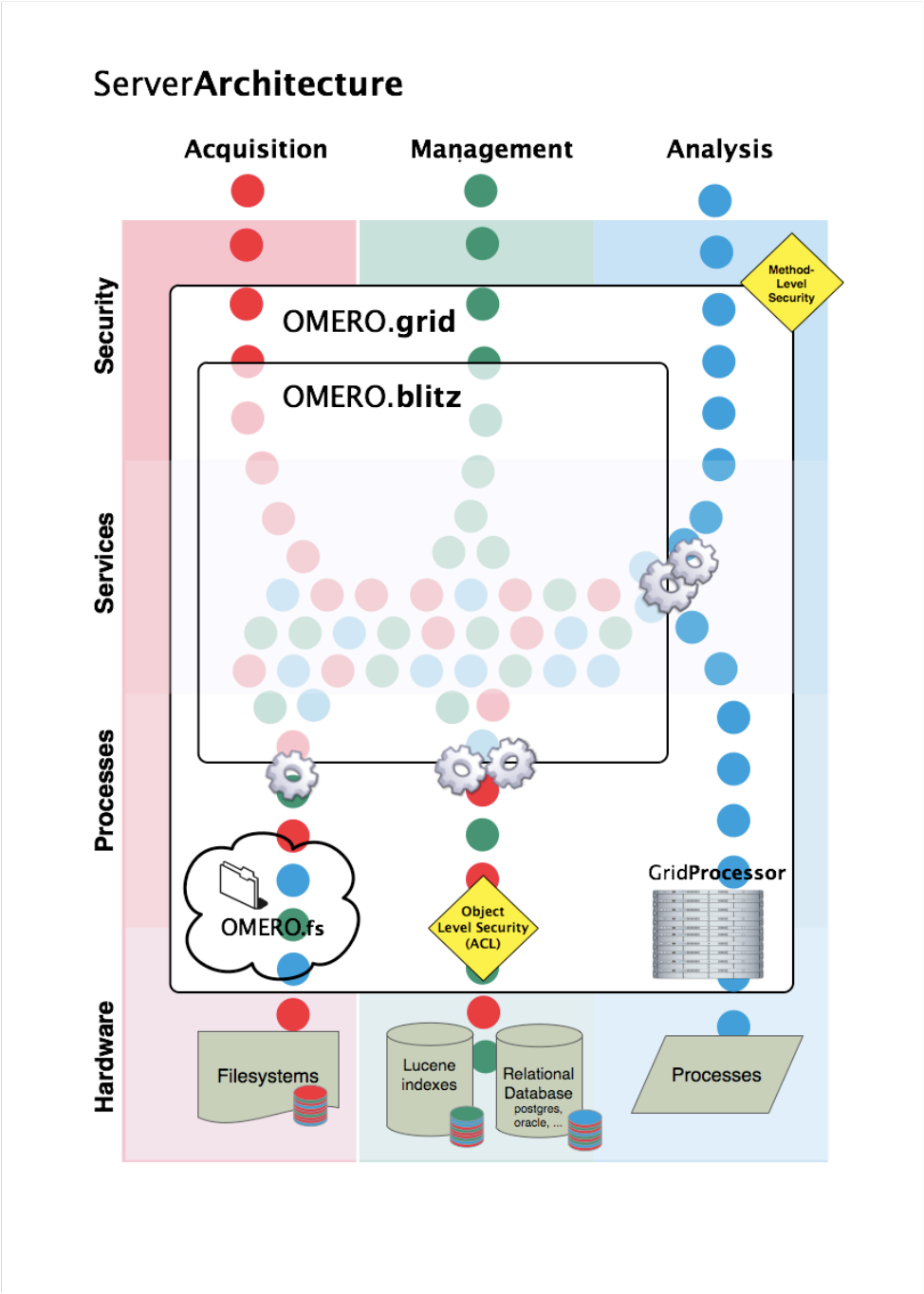


Figure 20.1: Server Architecture

20.2.1 Existing extension points

To get a feeling for what type of extension points are available, you might want to take a look at the following pages. Many of them will point you back to this page for packaging and deploying your new code.

- *File parsers* - write Java file parsers to further extend search
- *LoginAttemptListener* - write a Java handler for failed login attempts
- *Command Line Interface as an OMERO development tool* - write drop in Python extensions for the command-line
- *Introduction to OMERO.scripts* - write python scripts to process data server-side
- *LDAP plugin design* - write a Java authentication plugin
- *Password Provider* - write a Java password backend
- *Search bridges* - write Java Lucene parsers to extend search

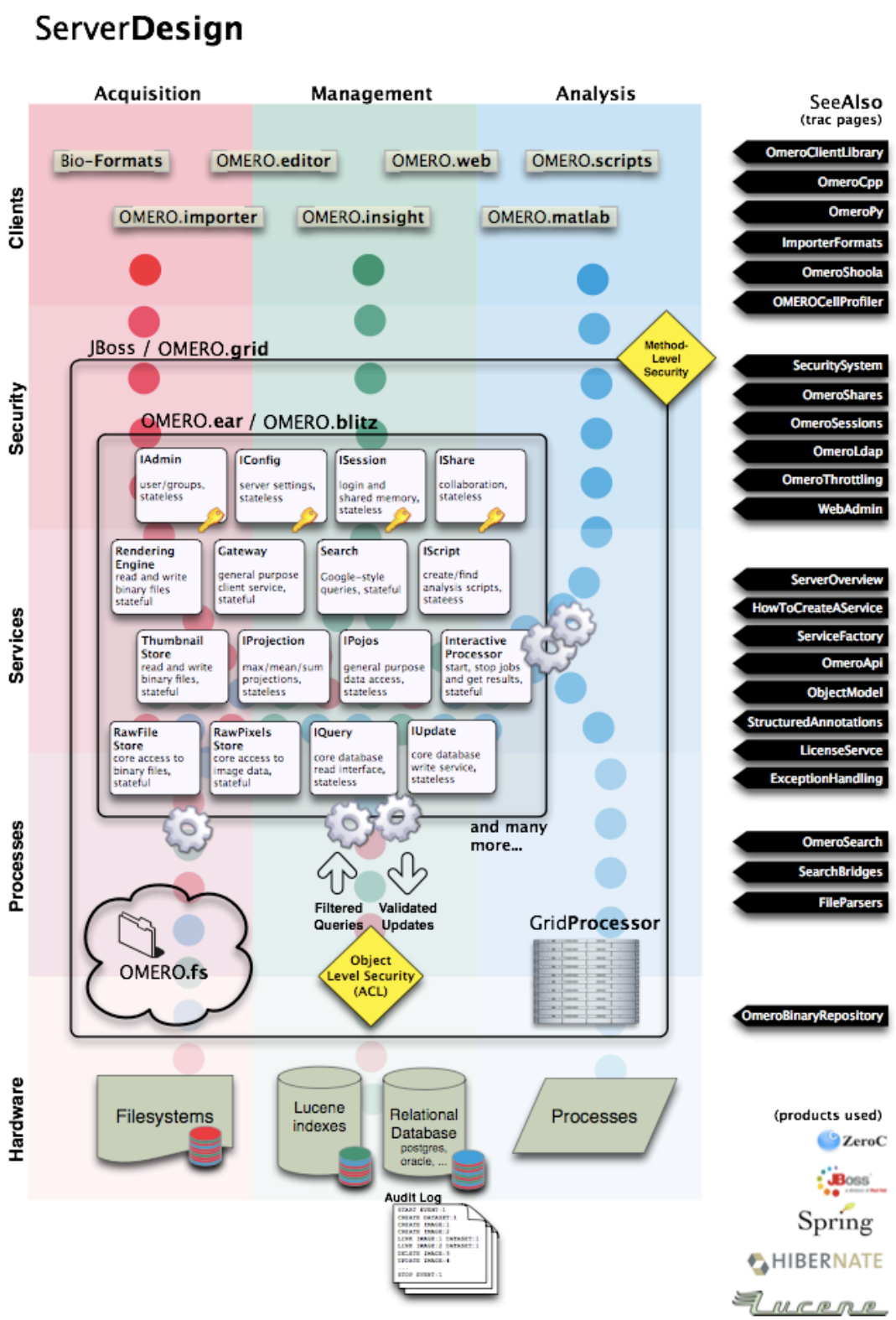


Figure 20.2: Server Design

- *OMERO.mail* - server email sender (added in OMERO 5.1, no developer documentation as yet)
- `omero.policy.bean` - policy configuration point e.g. for setting download restriction policy on users (added in OMERO 5.1, no developer documentation as yet)

20.2.2 Extending the Model

The OME Data Model and its OMERO representation, the *OME-Remote Objects*, intentionally draw lines between what metadata can be supported and what cannot. Though we are always examining new fields for inclusion, it is not possible to represent everyone's model within OME.

Structured annotations

The primary extension point for including external data are the *Structured annotations* (SAs). SAs are designed as email-like attachments which can be associated with various core metadata types. In general, they should link to information outside of the OME model, i.e. information which OMERO clients and servers do not understand. URLs can point to external data sources, or XML in a non-OME namespace can be attached.

The primary drawbacks are that the attachments are opaque and cannot be used in a fine-grain manner.

Code generation

Since it is prohibitive to model full objects with the SAs, one alternative is to add types directly to the *generated code*. By adding a file named `*.ome.xml` to components/model/resources/mappings[11] and running a full-build, it is possible to have new objects generated in all *OMERO.blitz* languages. Supported fields include:

- boolean
- string
- long
- double
- timestamp
- links to any other `ome.model.*` object, including enumerations

For example:

```
<types>
  <!-- "named" and "described" are short-cuts to generate the fields "name" and "description" -->
  <type id="ome.model.myextensions.Example" named="true" described="true">
    <required name="valueA" type="boolean"/>  <!-- This is NONNULL -->
    <optional name="valueB" type="long"/>     <!-- This is nullable -->
    <onemany  name="images" type="ome.model.core.Image"/> <!-- A set of images -->
  </type>
</types>
```

Collections of primitive values like `<onemany name="values" type="long"/>` are not supported. Please see the existing mapping files for more examples of what can be done.

The primary drawback of code-generating your own types is isolation and maintenance. Firstly, your installation becomes isolated from the rest of the OME ecosystem. New types are not understood by other servers and clients, and cannot be exported or shared. Secondly, you will need to maintain your own server **and** client builds of the system, since the provided binary builds would not have your new types.

Measurement results

For storing large quantities of only partially structured data, such as tabular/CSV data with no pre-defined columns, neither the SAs nor the code-generation extensions are ideal. SAs cannot easily be aggregated, and code-generation would generate too many types. This is particularly clear in the storage and management of HCS analysis results.

To solve this problem, we provide the *OMERO.tables* API for storing tabular data indexed via Roi, Well, or Image id.

[11] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/model/resources/mappings

20.2.3 Services

Traditionally, services were added via Java interfaces in the components/common/src/ome/api[12] package. The creation of such "core" services is described under *How To create a service*. However, with the introduction of *OMERO.blitz*, it is also possible to write blitz-only services which are defined by a slice definition under components/blitz/resources/omero[13].

A core service is required when server internal code should also make use of the interface. Since this is very rarely the case for third-party developers wanting to extend OMERO, only the creation of blitz services will be discussed here.

Add a slice definition

The easiest possible service definition in slice is:

```
module example {
  interface NewService {
    void doSomething();
  };
};
```

This should be added to any existing or a new `*.ice` file under the `blitz/resources/omero` directory. After the next ant build, stubs will be created for all the *OMERO.blitz* languages, i.e. *OMERO Java language bindings*, *OMERO Python language bindings*, and *OMERO C++ language bindings*.

Note: Once you have gotten your code working, it is most re-usable if you can put it all in a single directory under tools/. These components also have their `resources/*.ice` files turned into code, and they can produce their own artifacts which you can distribute without modifying the main code base.

Warning: exceptions

You will need to think carefully about what exceptions to handle. Ice (especially *OMERO C++ language bindings*) does not handle exceptions well that are not strictly defined. In general, if you would like to add your own exception type, feel free to do so, but either 1) subclass `omero::ServerError` or 2) add to the appropriate `throws` clauses. And regardless, if you are accessing any internal OMERO API, add `omero::ServerError` to your `throws` clause.

See *Exception handling* for more information.

Java implementation using _Disp

To implement your service, create a class subclassing "example._NewServiceDisp" class which was code-generated. In this example, the class would be named "NewServiceI" by convention. If this service needs to make use of any of the internal API, it should do so via dependency injection. For example, to use IQuery add either:

```
void setLocalQuery(LocalQuery query) {
    this.query = query;
}
```

or

```
NewServiceI(LocalQuery query) {
    this.query = query;
}
```

The next step "Java Configuration" will take care of how those objects get injected.

[12] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/common/src/ome/api
[13] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/blitz/resources/omero

Java implementation using _Tie

Rather than subclassing the `_Disp` object, it is also possible to implement the `_Tie` interface for your new service. This allows wrapping and testing your implementation more easily at the cost of a little indirection. You can see how such an object is configured in blitz-servantDefinitions[14].

Java configuration

Configuration in the Java servers takes place via Spring[15]. One or more files matching a pattern like `ome/services/blitz-*.xml` should be added to your application.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE beans PUBLIC "-//SPRING//DTD BEAN//EN" "http://www.springframework.org/dtd/spring-beans.dtd">
<beans>

  <bean class="NewServiceI">
    <description>
    This is a simple bean definition in Spring. The description is not necessary.
    </description>
    <constructor-arg ref="internal-ome.api.IQuery"/>
  </bean>

</beans>
```

The three patterns which are available are:

- `ome/services/blitz-*.xml` - highest-level objects which have access to all the other defined objects.
- `ome/services/services-*.xml` - internal server objects which do not have access to `blitz-*.xml` objects.
- `ome/services/db-*.xml` - base connection and security objects. These will be included in background java process like the index and pixeldata handlers.

  Note: *Password Provider* and similar should be included at this level.

See components/blitz/resources/ome/services[16] and components/server/resources/ome/services[17] for all the available objects.

Java deployment

Finally, these resources should all be added to `OMERO_DIST/lib/server/extensions.jar`:

- the code generated classes
- your `NewServiceI.class` file and any related classes
- your `ome/service/blitz-*.xml` file (or other XML)

Non-service beans

In addition to writing your own services, the instructions above can be used to package any Spring-bean into the OMERO server. For example:

```
//
// MyLoginAttemptListener.java
//
import ome.services.messages.LoginAttemptMessage;
```

[14] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/ome/services/blitz-servantDefinitions.xml#L36
[15] http://spring.io
[16] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/blitz/resources/ome/services
[17] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server/resources/ome/services

```
import org.springframework.context.ApplicationListener;

/**
 * Trivial listener for login attempts.
 */

public class MyLoginAttemptListener implements
        ApplicationListener<LoginAttemptMessage> {

    public void onApplicationEvent(LoginAttemptMessage lam) {
        if (lam.success != null && !lam.success) {
            // Do something
        }
    }

}
```

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE beans PUBLIC "-//SPRING//DTD BEAN//EN" "http://www.springframework.org/dtd/spring-beans.dtd">
<!--
//
// ome/services/blitz-myLoginListener.xml
//
-->
<beans>
  <bean class="myLoginAttemptListener" class="MyLoginAttemptListener">
    <description>
    This listener will be added to the Spring runtime and listen for all LoginAttemptMessages.
    </description>
  </bean>

</beans>
```

Putting `MyLoginAttemptListener.class` and `ome/services/blitz-myLoginListener.xml` into `lib/server/extensions.jar` is enough to activate your code:

```
~/example $ ls -1
MyLoginListener.class
MyLoginListener.java
lib
...
~/example $ jar cvf lib/server/extensions.jar MyLoginListener.class ome/services/blitz-myLoginListener.
added manifest
adding: MyLoginListener.class(in = 0) (out= 0)(stored 0%)
adding: ome/services/blitz-myLoginListener.xml(in = 0) (out= 0)(stored 0%)
```

20.2.4 Servers

With the *OMERO.grid* infrastructure, it is possible to have your own processes managed by the OMERO infrastructure. For example, at some sites, Nginx[18] is started to host *OMERO.web framework*. Better integration is possible however, if your server also uses the Ice[19] remoting framework.

One way or the other, to have your server started, monitored, and eventually shutdown by *OMERO.grid*, you will need to add it to the "application descriptor" for your site. When using:

[18] http://wiki.nginx.org/Main
[19] https://zeroc.com

```
bin/omero admin start
```

the application descriptor used is `etc/grid/default.xml`. The `<application>` element contains various `<node>`s. Each node is a single daemon process that can start and stop other processes. Inside the nodes, you can either directly add a `<server>` element, or in order to reuse your description, you can use a `<server-instance>` which must refer to a `<server-template>`.

To clarify with an example, if you have a simple application which should watch for newly created Images and send you an email: `mail_on_import.py`, you could add this in either of the following ways:

Server element

```
<node name="my-emailer-node">  <!-- this could also be an existing node, but it must be unique -->
  <server id="my-emailer-server" exe="/home/josh/mail_on_import.py" activation="always">
    <env>${PYTHONPATH}</env>
    <!-- The adapter name must also be unique -->
    <adapter name="MyAdapter" register-process="true" endpoints="tcp"/>
  </server>
</node>
```

Server-template and server-instance elements

```
<server-template id="emailer-template">  <!-- must also be unique -->
  <property name="user"/>
  <server id="emailer-server-${user}" exe="/home/${user}/mail_on_import.py" activation="always">
    <env>${PYTHONPATH}</env>
    <adapter name="MyAdapter" register-process="true" endpoints="tcp"/>
  </server>
</server-template>

<node name="our-emailer-node">
  <server-instance id="emailer-template" user="ann">
  <server-instance id="emailer-template" user="ann">
</node>
```

See also:

[ome-devel] model description driven code generation[20]

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.3 OMERO.blitz

The OMERO.blitz server is responsible for providing secure access to data and metadata via user sessions (*OMERO sessions*), and cleaning up all resources when they are no longer being used. Various server capabilities are accessed via a multitude of services collectively known as the *OMERO Application Programming Interface*.

20.3.1 Metadata

Metadata stored in an object-relational database is mapped into the OMERO *OME-Remote Objects* via Hibernate[21]. Hibernate Query Language (HQL) calls can be made against the server and have all ownership information automatically taken into account.

[20] http://lists.openmicroscopy.org.uk/pipermail/ome-devel/2009-July/001332.html
[21] http://www.hibernate.org

20.3.2 Image data

The binary image data can either be accessed in its raw form via the RawPixelsStore service, or can be rendered by the *OMERO.server image rendering* service.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.4 OMERO.fs

OMERO.fs is a series of on-going changes designed to improve the way an OMERO.server interacts with existing directories of acquired image data. It currently consists of two components:

OMERO.dropbox is designed for watching a directory and kicking off an automatic import. The configuration of the DropBox system is covered on the *OMERO.dropbox* system administrator's page.

OMERO.fs Managed Repository is designed to store original data in an unaltered form without requiring the data duplication that was carried out by a pre-5.0 import. The changes to the import system mean that an OMERO.fs server stores the original files in the `ManagedRepository`, preserving file names and any nested directory structure. The repository may even contain direct *in-place links* to original data without an file upload step. These changes improve the way OMERO deals with High Content Screening (HCS) and other complex heterogeneous data types, reducing storage requirements and using Bio-Formats to recognize *Filesets* (groups of files which correspond to multi-dimensional images and accompanying information) so they can be treated as single entities within the OMERO clients. OMERO.fs has some *configuration properties* that allow sysadmins to customize it for their site; developers should be aware of the *how the new import process works* and how this is affected by the configuration.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.5 Import under OMERO.fs

The OMERO 5 release introduces OMERO.fs, a new way of storing files in the OMERO binary repository and thus a new method of importing images to the server.

In previous versions of OMERO the import process was very much client-centered. When importing an image the client pushed pixel data, metadata and, optionally, original image files to the OMERO server. With the advent of OMERO 5, OMERO.fs allows the pixels to be accessed directly from the original image files. This means that much of the import process can now take place on the server once the original image files have been uploaded.

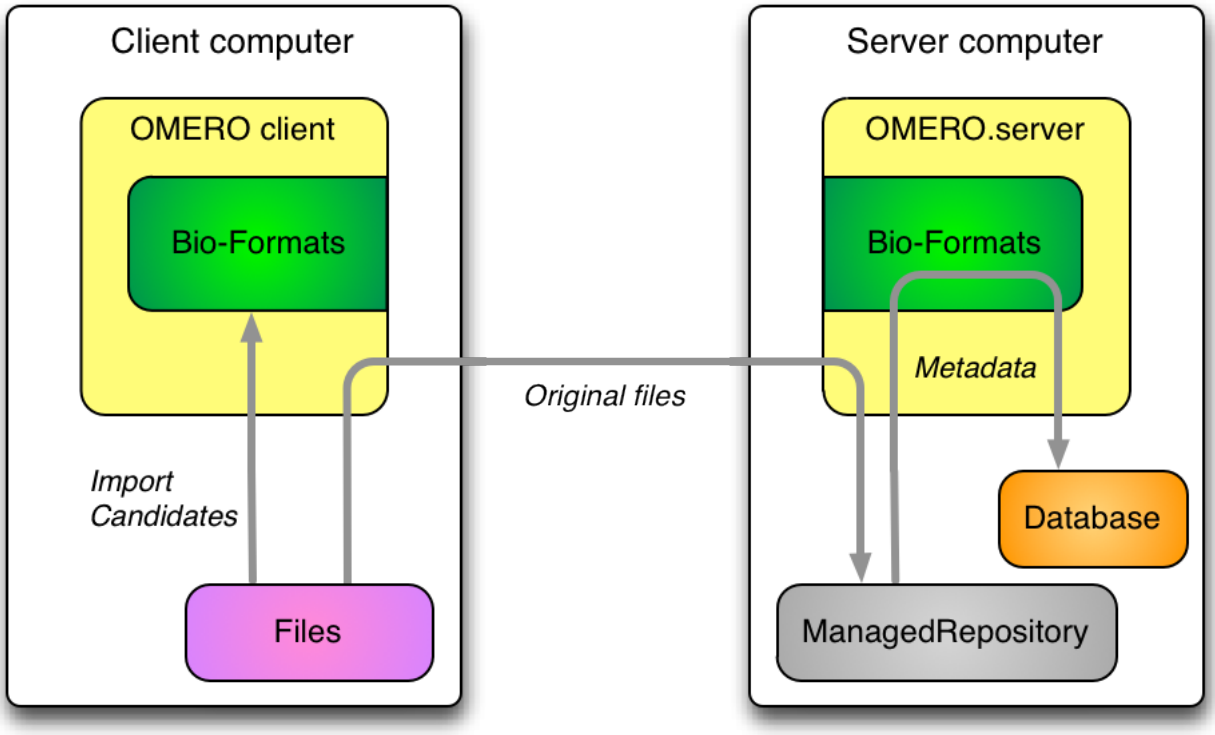
This page looks at the implications for the developer writing import clients. A broad description of the import workflow is followed by some of the model changes needed to facilitate this workflow. The current API sequence is then introduced before looking at server-side classes and sequence. Finally, the configuration required for OMERO.fs is specified.

20.5.1 Import overview

The broad import workflow comprises selecting a file or set of files to be imported client-side. Using Bio-Formats on the client this selection is resolved into a number of import candidates. Here an import candidate is a file or set of files that represents a single image, a multi-image set or a plate. Each import candidate, which may be one file or several files, is then treated as `Fileset` for import. The import of each `Fileset` is then undertaken by the client in two stages: upload and server-side import.

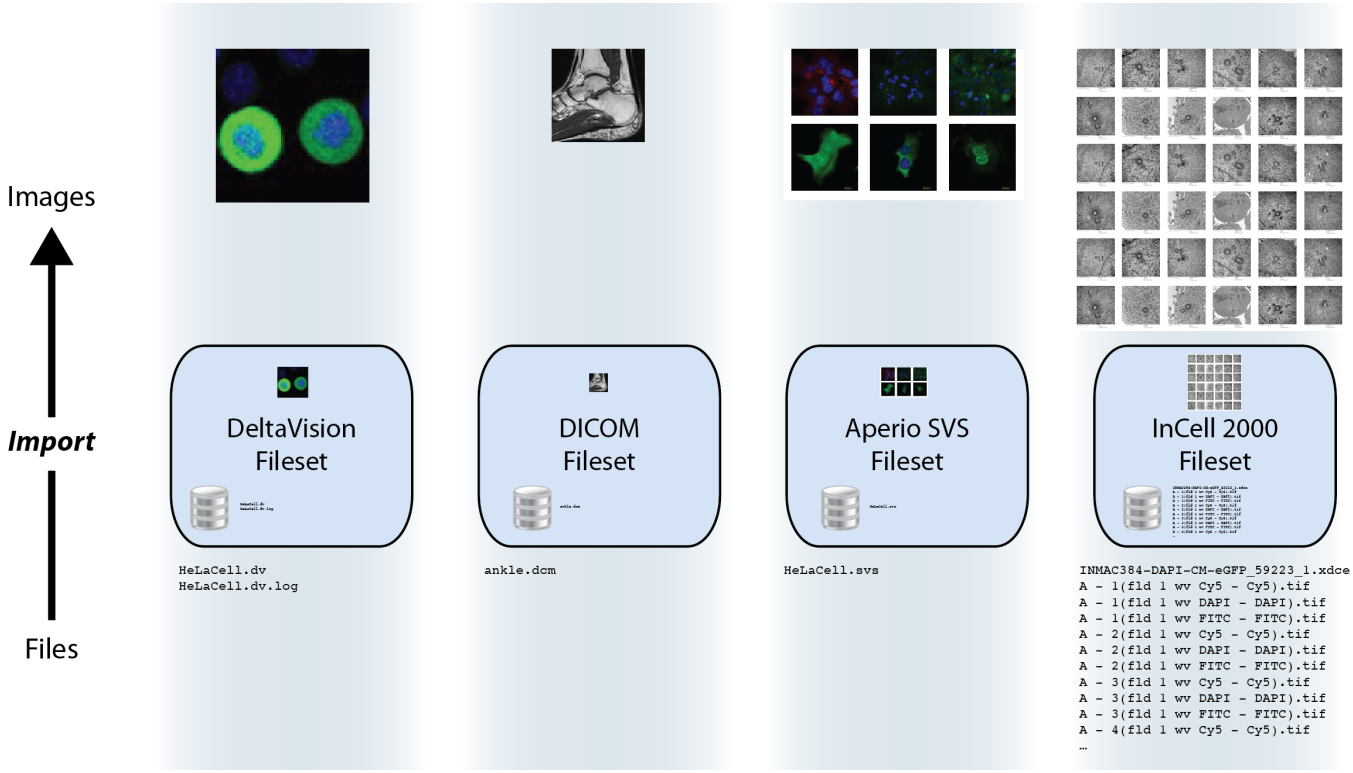
A `Fileset` is uploaded to the server into a location determined by the server, multiple `Filesets` may be uploaded in parallel by a client. A checksum is calculated before upload by the client and after upload by the server. If these checksums match then the client triggers a server-side import. The client can then move on to doing other work and leave the import to complete on the server.

Once the `Fileset` is on the server and an import has been initiated by the client all processing then takes place on the server. The server then uses Bio-Formats to extract and store the metadata, calculate the minimum and maximum pixel values and do other import processing.



20.5.2 Filesets

A `fileset` is a concept new to OMERO.fs which captures how Bio-Formats[22] relates files to the images that they encode. If importing a single file leads to a single corresponding image being viewable then a one-to-one mapping exists from file to image. However, an image's information may be split among multiple files, or a single file may encode multiple images. In other cases, especially in high-content screening, many images of wells may be encoded in a complex manner by many files. In all these cases, a fileset is used to hold the set of files and the set of images to which those files correspond.



[22] http://www.openmicroscopy.org/site/support/bio-formats/

Filesets are essentially indivisible: the files or images that a fileset represents are deleted, or moved between groups, only as one unit together, and on the server each fileset has a directory in which only its files are stored. Each fileset firmly binds sets of files and images because the dependencies among them mean that **splitting components away leaves a partial fileset making the remaining data unreadable**. Similarly, **you should not rename any components of a fileset** as this will also break the dependencies holding them together.

20.5.3 Model description

See acquisition.ome.xml[23].

- `ome.model.fs.Fileset`
  - Represents a group of files which are considered to belong together.
  - In the future the client may upload a single "import set" that is subsequently resolved by Bio-Formats into multiple filesets on the server.
  - Also links to multiple ome.model.jobs.Job instances.
  - Links to the image objects that are created during import.
- `ome.model.jobs.Job` subclasses
  - Each one represents some action which takes place server-side on the Fileset.
  - For the standard sequence described above, the first will always be an `UploadJob` which contains version info from the client. If the files were not uploaded however, this may not be the case. Then a `MetadataImportJob` follows, which is the basic import.
  - Other jobs may be necessary for regular usage (`PixelDataJob`, `IndexingJob`, etc.). *Later jobs may also be added like a re-parse job, a re-check of the hashes to detect corruption, or an archive job*.
  - For job definitions, see jobs.ome.xml[24].
  - Some subclasses have a `versionInfo` property for storing a snapshot of process information along with software versions. Most important for knowing how files were parsed, therefore when using `importPaths`, a "synthetic" version info might be created to say that these were just uploaded blindly.
- `ome.model.fs.FilesetEntry`
  - Link from a `Fileset` to exactly one `ome.model.core.OriginalFile`
  - Critically, it also contains the original absolute client path of that file.

20.5.4 API sequence

- Choose which files to import by either:
  - `ImportLibrary` and friends (Java only)
  - listing all files (not directories) manually.
- Choose a `ManagedRepositoryPrx` from `SharedResourcesPrx.repositories()`.
- Call either:
  - `ImportLibrary.importImage()` which calls `ManagedRepositoryPrx.importFilesets(Fileset, ImportSettings)`, or
  - directly use `ManagedRepositoryPrx.importPaths(StringSet)`.
- Receive an `ImportProcessPrx`.
- For each `FileEntry` in the `FileSet` or each path in the `StringSet` (in order), call `ImportProcessPrx.getUploader()` and receive a `RawFileStorePrx`.
- Upload the file via `RawFileStorePrx.write()` while reading the files locally to write, be sure to calculate the checksum.

[23] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/resources/mappings/acquisition.ome.xml
[24] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/resources/mappings/jobs.ome.xml

- Pass a list of checksums (in order) to `ImportProcessPrx.verifyUpload(StringSet)`. If the hashes match, receive a `HandlePrx`. Otherwise an exception is thrown.

At this point, the client should be able to disconnect and the rest of the import should happen independently.

- Create an `CmdCallbackI` that wraps the `HandlePrx` and wait for successful completion.

At this point, the main metadata import is finished, but background processing may still be occurring. Handles for the background processing will also be returned.

20.5.5 Server-side classes/concepts

`AbstractRepositoryI` and all of its subclasses are implementations of the InternalRepository API. These objects are for internal use only and should never be accessible by the clients. Each instance is initialized with a directory which the servant attempts to "acquire" (i.e. grab a lock file). Once it does so, it is the serving repository.

Each internal repository provides a public view which in turn provides the `Repository` API. All method calls assume Unix-style strings, which are guaranteed by `CheckedPath`, a loose wrapper around `java.io.File`. CheckedPath objects along with the active `Ice.Current` instance are passed to the `RepositoryDao` interface, which provides database access for all repositories. Access to raw IO is provided by the `RepoRawFileStoreI` servant, which wraps a `RawFileBean`.

The `ManagedRepository` implementation is responsible for import and enforces further constraints (beyond those of CheckedPath) on where and what files are created. Most importantly, the `omero.fs.repo.path` template value is expanded and pre-pended to all uploads. A further responsibility of the `ManagedRepository` is to maintain a list of all currently running `ManagedImportProcessI`, each of which is held in the `ProcessContainer`. These `ManagedImportProcessI` instances further wrap `RepoRawFileStoreI` instances with a subclass, `ManagedRawFileStoreI`. For file import through *ManagedRepository.importFileset*, although *hasher* is nullable ordinarily, it will be set through the mandatory *ImportSettings.checksumAlgorithm* property. *ManagedRepository.listChecksumAlgorithms* lists the hashers supported by the server. *ManagedRepository.suggestChecksumAlgorithm* helps the client and server to negotiate a mutually acceptable algorithm, as in *ImportLibrary.createImport*; the result is affected by the server's configuration setting for `omero.checksum.supported`. ImportLibrary calculates each file's hash using hashers obtained through *ChecksumProviderFactory.getProvider*. In fetching *OriginalFile* objects by HQL through the Query Service one needs *JOIN FETCH* on the hasher property to read the hasher's name.

20.5.6 Server-side sequence

NB: Server-side `ImportLibrary` is no longer being used. That logic is currently moved to `ManagedImportRequestI`. This may not be the best location. Further, several other layers might also be collapsible, like `OMEROMetadataStore` which is currently accessible as a "hidden" service `MetadataStorePrx`. Here, "hidden" means that it is not directly retrievable from `ServiceFactoryPrx`.

- `ManagedRepositoryI.importPaths()`
  - reuses `ImportContainer.fillData()` to create an `ImportSettings` and a `Fileset` and then calls `importFileset(Fileset, ImportSettings)`
- `ManagedRepositoryI.importFileset()`
  - determines an `ImportLocation` calling `PublicRepositoryI.makeDir()` where necessary.
  - `createImportProcess` creates a `ManagedImportProcessI`, registers it, and returns it.
  - After this, the repository is only responsible for periodically having the ping and eventually the shutdown method called, via `ProcessContainer`.
- `ManagedImportProcessI.getUploader()`
  - creates a new `RepositoryRawFileStoreI` for each file in the paths/fileset.
  - Once `close()` is called on this instance, `closeCalled(int i)` will be called on the import process and the instance will be removed.
  - If `getUploader()` is called again, then a new file store will be created.
- `ManagedImportProcessI.verifyUpload()`

  - If all hashes match, then a `ManagedImportRequestI` instance is created and submitted to `omero.cmd.SessionI.submit_async()` for background processing. The client can wait for the returned `omero.cmd.HandlePrx` to finish by using a `CmdCallbackI`.
  - At this point, the `ImportProcessPrx` can be closed as well as the entire client and the import would still continue. Only if `HandlePrx.cancel()` is called, will the import be aborted.
  - QUESTION: How to handle rollback at this point?
- `ManagedImportRequestI.init` (within transaction)
  - `Registry.getInternalServiceFactory()` grabs a `ServiceFactoryPrx` without the need for an `omero.client` instance.
  - `OMEROWrapper` and a `OMEROMetadataStoreClient` are created with this connection.
  - Some other basic configuration takes place.
- `ManagedImportRequest.step()` (N times, each within same transaction as `init()`)
  - NB: it may later make more sense for this bit to happen in a separate process.
  - At the moment, 5 steps are hard-coded. Each performing roughly the same amount of work. Some of these may later be done in the background.
    * `importMetadata()` calls `store.saveToDB()`, which calls `MetadataStorePrx.saveToDb()`, a remote call. This could possibly be inlined.
    * `generateThumbnails()` calls `store.resetDefaultsAndGenerateThumbnails()`, another remote call, which could also be inlined.
    * `pixelData()` calls `store.setPixelsParams()`, `updatePixels()`, and `populateMinMax()`. Min/Max especially should be backgrounded.
    * Finally, `store.launchProcessing()` is called, which should remain, but could also be inlined. The returned script processes could be returned in the `ImportResponse`.
    * Return appropriate values.
  - `notifyObservers()` currently does nothing, since this was client-side functionality in `ImportLibrary`. This needs to be replaced!
- `ManagedImportRequest.buildResponse()` (N times, outside the transaction)
  - Only step 4 does anything, storing the pixels in a `ImportResponse`
- `ManagedImportRequest.getResponse()` (1 time, regardless of exception or not)
  - Performs cleanup, then returns the `ImportResponse` assuming that no call to `helper.cancel()` has been made. At this point, `ImportLibrary.importImage()` returns successfully.

See also:

FS configuration options

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.6 OMERO.processor

The Processor is a python process-launcher which can be run on any Unix system to execute scripts for a user. This makes use of the *scripting service* functionality. As many processor nodes can be started as physical computers are available.

- Source code: components/tools/OmeroPy/src/omero/processor.py[25]
- Documentation: *OMERO.grid*

[25] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/tools/OmeroPy/src/omero/processor.py

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.7 OMERO.server image rendering

A major requirement for any image data application is the ability to display images. In most applications, this is achieved by reading pixel data from a filesystem and then mapping the pixel data to the 256 grey level available on most computer display monitors. It is common in some experiments to record and display multiple channels at once. Typically three, four, or even five separate images must be mapped, and then presented as a color image for painting on a monitor. Because these operations can require many thousands of operations and must be displayed rapidly to support the display of time-lapse movies, most image display software applications use a high-speed graphics CPU and dedicated hardware for image rendering and display. This requirement limits the deployment of these applications to high-powered workstations.

OMERO.server includes an image server, a software application that delivers rendered images to a client. This ensures that client applications can display image data. The OMERO Rendering Engine (OMERO-RE) has been designed to minimize the amount of data transferred to the client and thus removes the requirement for a specific graphics CPU, allowing high-performance image viewing on standard laptop computers. The OMERO-RE achieves this by limiting data transfer times by being close to the data, using highly efficient network transfer protocols, utilizing modern multi-processor and multi-core machines to provide the data to clients in a format that is as efficient to display as possible. OMERO-RE is multi-threaded and can use multi-core servers to simultaneously render individual channels before assembly into a final color image ready for transfer to the client. The use of the RE is not mandatory. If a client needs to have the full pixel data, it can. This OriginalPixels facility is used for client-side analysis, like that performed in the OMERO.insight measurement tool.

Transfer of image data even after rendering can limit performance, especially when accessing data remotely on connections with limited bandwidth (e.g. domestic ADSL). Therefore the OMERO-RE contains a compression service with an API that allows a client adjustable compression providing minimal image artefacts and a 20-fold range of data size to the client.

The OMERO Rendering Engine is accessed by OMERO client applications written in Java, C++, or Python via a binary protocol (ICE) provided by ZeroC[26].

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.8 Clustering

Clustering an OMERO instance consists of starting multiple *OMERO.blitz* servers with each allocating user sessions based on some criteria. There are at least two reasons you may want to cluster the OMERO server: availability and throughput.

20.8.1 Availability

Having the ability to have two servers up at the same time implies that even if you have to restart one of the servers, there should be no down-time. Currently, *OMERO sessions* are sticky to a cluster node and so it is not possible shutdown a node at any time. All new sessions can be redirected to the server which is to be left turned on however, then when all active sessions have completed, the chosen server can be shutdown.

20.8.2 Throughput

The other main reason to have other servers running is to service more user sessions simultaneously. Out of the box, each *OMERO.blitz* process is configured for 400MB of memory. When dealing with memory intensive operations like rendering, each added server can make a positive difference. This is only a part of the story, since much of the bottleneck is not the server itself but other shared resources, like the database or the filesystem, and so to further extend throughput, you will need to parallelize these.

[26] https://zeroc.com

20.8.3 Installation

If you are using the default *OMERO.grid* application descriptor[27] quickly enabling clustering is as simple as executing:

```
bin/omero config set omero.cluster.redirector configRedirector
bin/omero node backup start
```

This starts a second node, named "backup", which contains a second *OMERO.blitz* server, "Blitz-1". By default, this newly created server will not be used until sessions are manually redirected to it.

See also:

Scaling Omero

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.9 Collection counts

The IContainer[28] interface has always provided a method for returning the count of some collection types via `getDetails().getCounts()`. The server has database views for all link collections. These are accessed through HQL directly, such as:

```
Long self = iAdmin.getEventContext().getCurrentUserId();
Image i = iQuery.findByQuery(
   "select i from Image i left outer join fetch i.annotationLinksCountPerOwner", null);
Map<Long, Long> countsPerOwner = i.getAnnotationLinksCountPerOwner();

// Map may be null if not fetched.
if (countsPerOwner != null) {

    // countOfAnnotationsForImageByUser
    Long count = countsPerOwner.get(self);
    if (count != null) {
        // do something
    }
}
```

Values written to the map will not be persisted to the database, since they are continually re-generated.

20.9.1 Pojo options

The PojoOptions configuration of what elements are counted has been removed from the API. Instead, the returned map contains all values for all users, and can be summed to acquire the total count.

20.9.2 Restrictions

Currently a Hibernate bug (waiting to be filed) prevents retrieving the counts on any other than the top-level object ("select this").

20.9.3 Instructions

The views.sql script is automatically executed when initializing your database.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event

[27] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/templates/grid/default.xml
[28] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IContainer.java

of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.10 How To create a service

Overview

These instructions are for core developers only and may be slightly out of date. They will eventually be revised, but if you are looking for general instructions on extending OMERO with a service, see *Extending OMERO.server*. If you would indeed like to create a core service, please contact the ome-devel mailing[a] list

[a] http://www.openmicroscopy.org/site/community/mailing-lists

To fulfill #306[29], r905 provides all the classes and modifications needed to create a new stateless service (where this varies from stateful services is also detailed). In brief, a service provider must create an interface[30], an implementation[31] of that interface, a Spring configuration file[32], as well as modify the server configuration[33] and the central service factory[34] (These last two points stand to change with #314[35]).

Note: With the creation of *OMERO.blitz*, there are several other locations which need to be modified. These are also listed below.

20.10.1 Files to create

components/common/src/ome/api/IConfig.java[36] the interface which will be made available to client and server alike (which is why all interfaces must be located in the **/common** component). Only serializable and client-available types should enter or exit the API. Must subclass **''ome.api.ServiceInterface''**.

components/server/src/ome/logic/ConfigImpl.java[37] the implementation which will usually subclass `AbstractLevel{1,2}Service` or `AbstractBean` (See more below on **super-classes**) This is class obviously requires the most work, both to fulfill the interface's contract and to provide all the metadata (annotations) necessary to properly deploy the service.

components/server/resources/ome/services/service-ome.api.IConfig.xml[38] a Spring[39] configuration file, which can "inject" any value available in the server (Omero)context into the implementation. Two short definitions are the minimum. (Currently not definable with annotations.) As explained in the file, the name of the file is not required and in fact the two definitions can be added to any of the files which fall within the lookup definition in the server's beanRefContext.xml[40] file (see below).

components/blitz/src/ome/services/blitz/impl/ConfigI.java[41] a Ice[42] "servant" implementation which can use on of several methods for delegating to the `ome.api.IConfig` interface, but all of which support *throttling*.

20.10.2 Files to edit (not strictly necessary, see #314)

components/common/src/ome/system/ServiceFactory.java[43] our central API factory, needs an additional method for looking up the new interface (**get<interface name>Service()**)

components/server/resources/ome/services/[44] **server Spring**[45] configurations, which makes the use of JNDI and JAAS significantly simpler.

[29] https://trac.openmicroscopy.org/ome/ticket/306
[30] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/api/IConfig.java
[31] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/logic/ConfigImpl.java
[32] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/service-ome.api.IConfig.xml
[33] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/
[34] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/ServiceFactory.java
[35] https://trac.openmicroscopy.org/ome/ticket/314
[39] http://spring.io
[40] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/beanRefContext.xml
[42] https://zeroc.com

components/blitz/resources/omero/API.ice[46] **(blitz)** a ZeroC[47] slice definition file, which provides cross-language mappings. Add the same service method to `ServiceFactoryI` as to `ServiceFactory.java`.

components/blitz/resources/ome/services/blitz-servantDefinitions.xml[48] **(blitz)** a Spring[49] configuration, which defines a mapping between Ice servants and Java services.

components/blitz/resources/omero/Constants.ice[50] **(blitz)** a ZeroC[51] slice definition file, which provides constants needed for looking up services, etc.

components/blitz/src/ome/services/blitz/impl/ServiceFactoryI.java[52] **(blitz)** the central session in a blitz. Should always be edited parallel to `ServiceFactory.java`. Also optional in that `MyServicePrxHelper.uncheckedCast( serviceFactoryI.getByName(String) )` can be used instead.

20.10.3 Files involved

components/server/resources/beanRefContext.xml[53]

components/blitz/resources/beanRefContext.xml[54] Singleton definitions[55] which allow for the static location of the active context. These do not need to be edited, but in the case of the server beanRefContext.xml[56], it does define which files will be used to create the new context (of importance is the line **classpath*:ome/services/service-*.xml**). blitz's `beanRefContext.xml` defines the pattern **classpath*:ome/services/blitz-*.xml** to allow for blitz-specific configuration.

20.10.4 And do not forget the tests

components/server/test/ome/server/itests/ConfigTest.java[57] tests only the implementation without a container.

blitz: Currently, testing blitz is outside the scope of this document.

20.10.5 Things to be aware of

Local APIs

Several services implement a server-side subclass of the **ome.api** interface rather than the interface itself. These interfaces are typically in ome.api.local[58]. Such local interfaces can provide methods that should not be made available to clients, but which are needed within the server. Though not currently used, the **@Local()** annotation on the implementation can list the local interface for future use. See UpdateImpl[59] for an example.

Stateful services

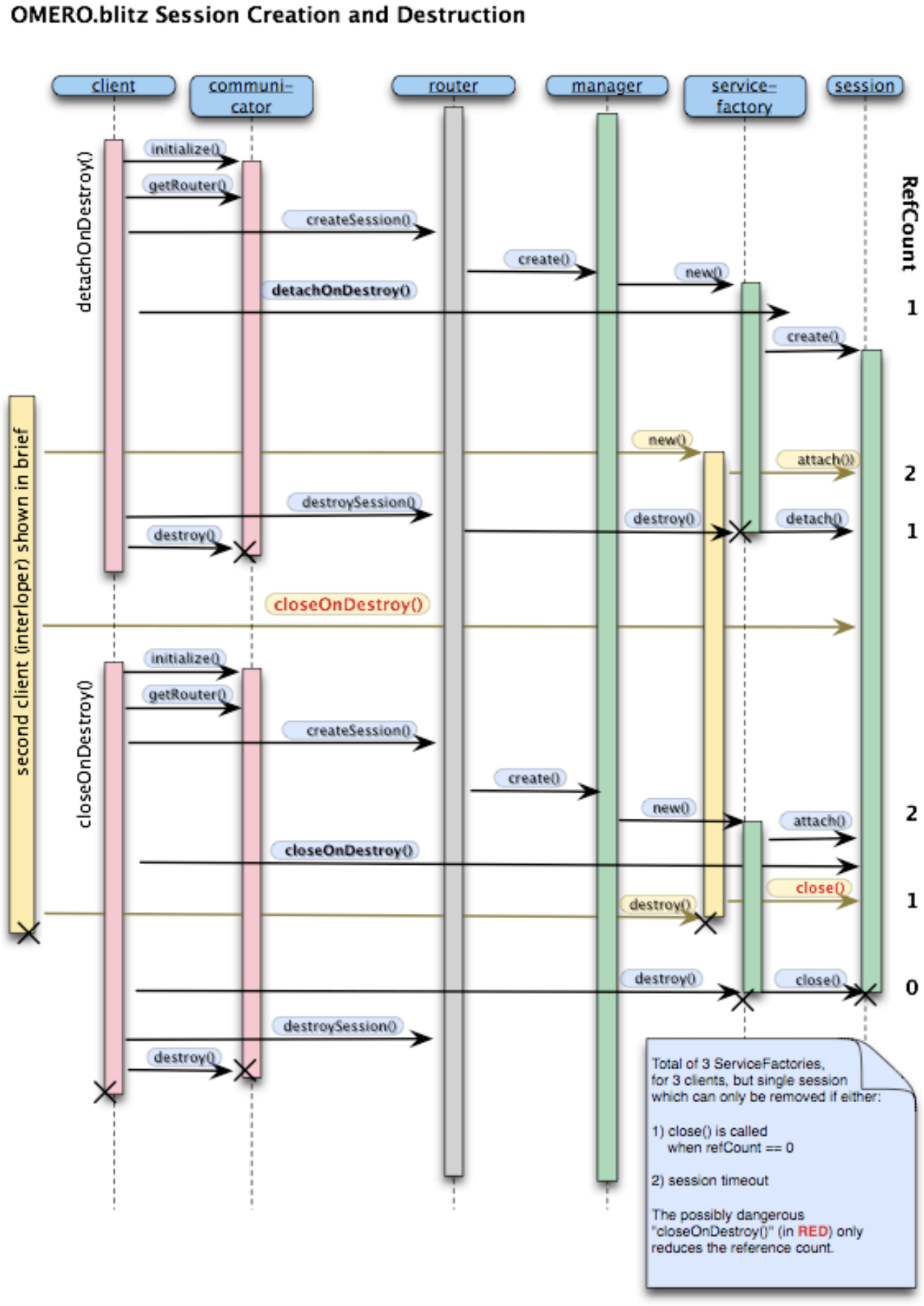
Currently all stateful services are in their own component (components/rendering[60] and components/romio[61]) but their interface will still need to be under components/common[62] for them to be accessible to clients. To be done.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.11 OMERO sessions

OMERO sessions simplifies the handling of login sessions for *OMERO.blitz*.

[47] https://zeroc.com
[49] http://spring.io
[51] https://zeroc.com
[53] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/beanRefContext.xml
[55] http://docs.spring.io/spring/docs/2.0.x/reference/beans.html#beans-factory-scopes-singleton
[56] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/beanRefContext.xml
[58] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server/src/ome/api/local
[59] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/logic/UpdateImpl.java
[60] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/rendering
[61] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/romio
[62] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/common


OMERO.blitz Session Creation and Destruction
client
communi-cator
router
manager
service-factory
session
RefCount
detachOnDestroy()
initialize()
getRouter()
createSession()
create()
new()
detachOnDestroy()
1
create()
second client (interloper) shown in brief
new()
attach()
2
destroySession()
destroy()
destroy()
detach()
1
closeOnDestroy()
closeOnDestroy()
initialize()
getRouter()
createSession()
create()
new()
attach()
2
closeOnDestroy()
close()
destroy()
1
destroy()
close()
0
destroySession()
destroy()
Total of 3 ServiceFactories, for 3 clients, but single session which can only be removed if either:
1) close() is called when refCount == 0
2) session timeout
The possibly dangerous "closeOnDestroy()" (in RED) only reduces the reference count.

In short:

- Sessions are a replacement for the standard JavaEE security infrastructure.
- Sessions unify the Blitz and RMI session handling, making working with Java RMI more like Blitz (since the JavaEE interaction is essentially "conversationless").
- Sessions provide the ability (especially in Blitz) to quit a session and rejoin it later as long as it has not timed out, possibly useful for moving from one machine to another.
- Sessions provide the ability to share the same space. Two users/clients attached to the same session would experience the same life-cycle.
- Sessions provide a scratch space to which any data can be written for and by job/script executions.
- Sessions act as a global cache (in memory or on disk) to speed up various server tasks, including login. With further extensions like http://terracotta.org/, sessions could serve as a "distributed" cache.
- Sessions prevent sending passwords in plain text or any other form. After that, all session interactions take place via a shared secret key.

20.11.1 Design

All services other than `ISession`, assume that a user is logging in with a username equal to session uuid. Whereas previously one logged in with:

```
ome.system.Principal p = new ome.system.Principal("josh","user","User");
```

behind the scenes, now the "josh" value is replaced by the UUID of a `ome.model.meta.Session` instance.

The session is acquired by a call to:

```
ome.api.ISession.createSession(Principal princpal, String credentials);
```

and carries information related to the current user's session.

```
Session session;
session.getUuid();       // Unique identifier; functions as a temporary password. DO NOT SHARE IT.
session.getTimeToIdle(); // Number of milliseconds which the user can idle without session timeout
session.getTimeToLive(); // Total number of milliseconds for which the session can live
session.getStarted();    // Start of session
session.getClosed();     // if != null, then session is closed
```

These properties cannot be modified.

Other properties are for use by clients:

```
session.getMessage();            // General purpose message statement
session.getAgent();              // Can be used to specify which program the user is using
session.getDefaultEventType();   // Default event type (the third argument "User" to Principal above)
session.getDefaultPermissions(); // String representation of umask (e.g. "rw----")
```

After changing a property on the session returned by `createSession()` it is possible to save them to the server via:

```
ome.api.ISession.updateSession(Session);
```

Finally, when finished, to conserve resources it is possible to destroy the session via:

```
ome.api.ISession.closeSession(Session);
```

20.11.2 Existing sessions

In *OMERO.blitz*, it is possible to reacquire the session if it is still active, by passing the previous session UUID as your password (User principal is ignored).

```
client = omero.client()
servicefactory = client.createSession()
iadmin = servicefactory.getAdminService()
olduuid = iadmin.getEventContext().sessionUuid

// lose connection

client = omero.client()
servicefactory = client.createSession(omero.sys.Principal(), olduuid)
// now reattached
```

See also:

Server security and firewalls

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.12 Aspect-oriented programming

Aspect-oriented programming is, among other things, the attempt to define and centralize cross-cutting concerns. In other words, it is not much more than the tried-and-true principle of modularization. Having possibly unseen aspects operating on a given class however, can complicate an initial examination of the code. Therefore, it is important to be aware of what portions of the OMERO code base are "advised" and where to find the advisors (in the case of OMERO solely interceptors).

In Spring[63], advisors are declared in the bean definition files (under components/server/resources/ome/services[64], services.xml[65], hibernate.xml[66], and others.

In these configuration files, various Spring beans (shared objects) are defined with names like "proxyHandler", "eventHandler", "serviceHandler", and "transactionHandler". Each of these is a method interceptor which is passed execution before the actual logic is reached. The interceptor can inspect or replace the return value, but can also stop the method execution from ever taking place.

Unlike with AspectJ[67], the AOP implementation used by OMERO only allows for the advising of interfaces. Simply creating a new service implementation via "new QueryImpl()" will not produce an advised object, which in turn will not function properly, if at all. Instead, advised objects can only be acquired from the Spring *context*.

By and large, only the *API service methods* are advised in OMERO.

20.12.1 Why?

Often, when implementing or adding code, it becomes clear just how many requirements are placed by libraries, the application server, and existing code on any new code. This can include transaction handling, session handling, security checks, object validation, logging etc. As a code-base grows, these dependencies slow development and make code unmanageable. AOP tries to reduce these dependencies by defining each of these concerns in a single place.

[63] http://spring.io
[64] https://github.com/openmicroscopy/openmicroscopy/tree/v5.2.4/components/server/resources/ome/services
[65] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/services.xml
[66] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/hibernate.xml
[67] http://eclipse.org/aspectj/

As a quick example, in OMERO transactions and exceptions are handled through method interceptors. Rather than writing:

```
void method1(){
    try {

        Transaction tx = new Transaction();
        tx.begin();
        // your code goes here
        tx.commit();
    } catch (TxException e) {
         tx.rollback();
    } catch (OtherException e) {

    }

}
```

you just write:

```
void method1(){
    // your code goes here
}
```

See also:

Aspect Oriented Programming[68] Chapter of the Spring documentation

AOP Alliance [69] Joint project defining interfaces for various AOP implementations

AspectJ[70] The arguable leader in Java/AOP development. Not used in Omero, but a good starting point.

Aspect-oriented programming[71] Wikipedia page on AOP

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.13 OmeroContext

The entire OMERO application (on a single JVM) resides in a single ome.system.OmeroContext. Each call belongs additionally to a single org.hibernate.Session (which can span over multiple calls) and to a single ome.model.meta.Event (which is restricted to a single task).

The container for all OMERO applications is the *OmeroContext* (components/common/src/ome/system/OmeroContext.java[72]). Based on the Spring[73] configuration backing the context, it can be one of `client`, `internal`, or `managed`. The use of a ServiceFactory simplifies this usage for the client.

20.13.1 Hibernate sessions

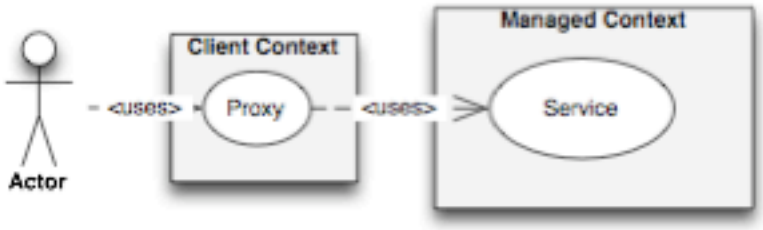
A `Hibernate Session` comprises a Unit-of-Work[74] which translates for OMERO's *OME-Remote Objects* model to a relational database. It keeps references to all Database-backed objects so that within a single session, object-identity stays constant and object changes can be persisted.

A session can span multiple calls by being disconnected from the underlying database transaction, and then reconnected to a new transaction on the next call (see components/server/src/ome/tools/hibernate/SessionHandler.java[75] for the implementation).

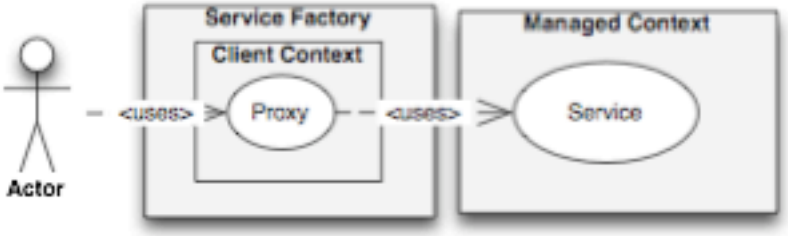
For information about Events see *OMERO events and provenance*.

[72] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/src/ome/system/OmeroContext.java
[73] http://spring.io
[74] http://www.martinfowler.com/eaaCatalog/unitOfWork.html
[75] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/tools/hibernate/SessionHandler.java

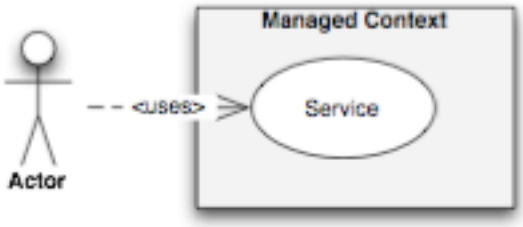
Omero Context Usage



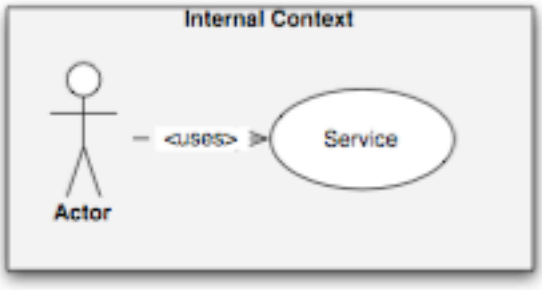
Client context: user accesses a proxy acquired from a context instantiated with `OmeroContext.getClientContext()` All objects are serialized and a transaction starts at the barrier to the Managed Context (see below).



Client context (with ServiceFactory): more commonly, user instantiates a `new ServiceFactory()` and uses the public getters to acquire proxies.



Managed context: user accesses a wrapped service from a context instantiated with `OmeroContext.getManagedContext()` Each call takes part in a single transaction.



Internal context: user accesses a raw service acquired from a context instantiated with `OmeroContext.getClientContext()` No interception takes place. User must be careful to start transactions, open & flush sessions, and commit the transaction.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.14 OMERO events and provenance

20.14.1 What is an event?

As described under *OmeroContext*, each method call takes place within a single application context (always the same), session, and event. Of these, only event is guaranteed to be unique for every task*. The components/server/src/ome/security/basic/EventHandler.java[76] is responsible for creating new events.

20.14.2 Events as audit log

On each Database-update (INSERT/UPDATE/DELETE), an `EventLog` is created by a `HibernateInterceptor` which is then saved to the database at the end of the method call (in `UpdateImpl`).

20.14.3 Relationship to ModuleExecutions

The OMERO Event plays a similar role to the `ModuleExecution` in the OME 2 system. They both contain time of create/update/deletion, status, and type information. Event, however, has lost its ACL/permissions role. These values have been moved to embedded values represented by the Details object. Event also is not linked to all the created `SemanticTypes` as was `ModuleExecution`, and so cannot fully represent the provenance data needed by the `AnalysisEngine`. At such time as the `AnalysisEngine` is ported to Java, the `ModuleExecution` object will have to be added.

* Here we say "task" and not method call, because all method calls to a single stateful service instance belong to the same event. This is the nature of a stateful service. Logically, however, it is a single action.

See also:

Hibernate events[77]

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.15 Properties

Under the `etc/` directory in both the source and the binary distributions, several files are provided which help to configure OMERO.server:

etc/omero.properties[78] Our central configuration file with all defaults

etc/hibernate.properties[79] Required by Hibernate since some properties are only configurable via a classpath:hibernate.properties file

etc/logback.xml[80] Logging configuration

etc/build.properties[81] The properties that you will most likely want to change

`etc/local.properties` Local file overriding `etc/build.properties` (used by build only)

The most useful of the properties are listed in a *glossary*.

During the build, these files get stored in the `blitz.jar` and are read-only. On creation of an *OmeroContext*, the lookup for properties is (first wins):

- Properties passed into the constructor (if none, then the default properties in config.xml[82])
- System.properties set via "java -Dproperty=value"
- Configuration files in order listed.

[76] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/security/basic/EventHandler.java
[77] http://docs.jboss.org/hibernate/core/3.6/reference/en-US/html/events.html
[82] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/common/resources/ome/config.xml

This ordering is defined for the various components via "placeholder configurers" in:

- components/server/resources/ome/services/services.xml[83]

Once configured at start, all values declared in one of the mentioned ways can be used in Spring configurations via the syntax:

```
<bean id=…>
  <property name="mySetter" value="${property.name}"/>
</bean>
```

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.16 Using server queries internally

Overview

This page is aimed at internal server developers and does not contain information for how to perform API queries. If that is the kind of information you are looking for, you may find *OMERO Application Programming Interface* more useful as a starting point.

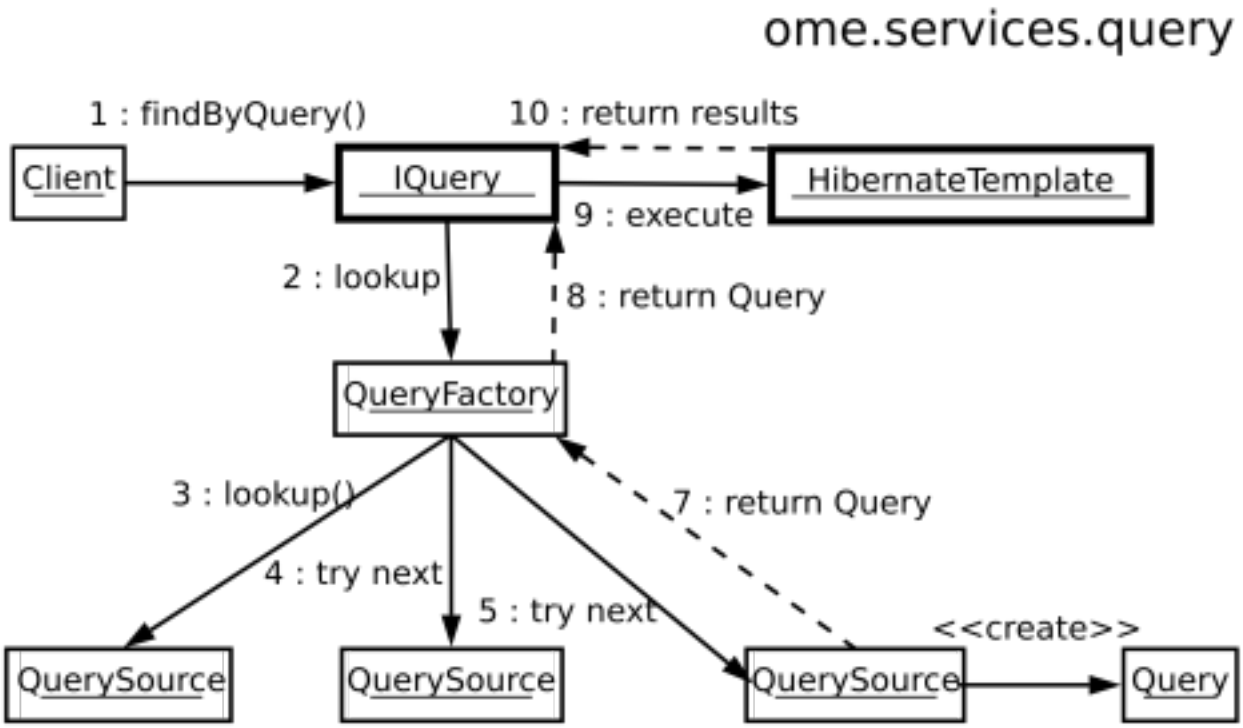


Figure 20.3: omero.services.query

20.16.1 Introduction

The ome.services.queries package is intended to allow for the easy definition of queries by both developers and clients. Due to the fragility of HQL defined queries, a framework allowing for easy definition, multiple formats (Velocity templates, Database values, class files), and transparent lookup is critical.

[83] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/resources/ome/services/services.xml

Lookup happens among all `QuerySources` that are registered with the `QueryFactory` instance present in OMERO services. The first non-null Query instance returned by a `QuerySource` for a given String id is used.

Queries implement the `HibernateCallback` interface and are passed directly into an `HibernateTemplate` instance. Therefore, care should be taken as to which `QuerySources` are registered with the `QueryFactory`.

20.16.2 Parameters

Critical for using queries is the specification of named parameters, number of results to return, offset of the first result to return etc. These features are offered by the ome.parameters package. The ome.parameters.Parameters class is the starting point for building new parameters (although the ome.parameters.Filter object is used by some methods).

To specify parameters, instantiate a Parameters object either with or without a Filter object argument. The version with Filter object is useful for specifying the number of results to be returned and whether or not a java.util.Collection or a ome.model.IObject instance will be returned. For example,

```
Parameters p = new Parameters( new Filter().unique() );
```

will specify that the given query should return a single instance. An exception will be thrown if more than one result is found.

```
Parameters p = new Parameters( new Filter().unique().page(0,1) );
```

However, this will guarantee that only one result will be returned, since more than 1 result ("maxResults") will be ignored. Here, an ordering of the results might make sense.

Once a Parameters instance is available, named parameters can be added using any of the `add...()` methods. These parameters will be dynamically bound during query preparation. For example, a query of the form:

```
select e from Experimenter e where omeName = :name
```

has one named parameter "name", which can be specified by the call:

```
parameters.addString("name","<myNamHere>");
```

Positional parameters of the form

```
select e from Experimenter where omeName = ?
```

are not supported.

20.16.3 Adding queries

Subclassing query

Other than by defining String queries via `new QueryDef()` TBD, the easiest way to create queries is to subclass ome.services.query.Query. The only non-optional requirements on the Query implementor are then to define the (possibly optional) named parameters to the Query, and to override the "buildQuery" (which must call one and only one of "setQuery()" or "setCriteria()")

Other than that, the Query implementor can enable filters on the Hibernate session (an attempt is made to clean up after the Query runs), and in general use any of the Hibernate session methods.

20.16.4 Defining a QuerySource

A more involved but perhaps more rewarding method would be to implement `QuerySource` and configure `QueryFactory` to lookup query ids also in your `QuerySource`. This would allow you to write Velocity (or Freemarker/Ruby/Python/Groovy…) `QuerySources` which use some form of templating or scripting to generate HQL queries.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.17 OMERO throttling

Throttling consists of reducing the total number of resources that one user or group can consume at a given time. The throttling service is a new component of *OMERO.blitz* which should ensure a more fair usage.

For example, each blitz server has a pre-defined maximum number of server threads. Any calls beyond this number must wait on a currently executing call to finish. Before throttling, a single user could consume all the available threads and all other users would have to wait.

With throttling, all invocations are placed on configurable on a **queue** which is worked on my any number of configurable **slots**. Each site can configure the number and type of slots based on which **throttling strategy** has been chosen.

20.17.1 Planning

Planned for milestone:3.0-Beta4, the infrastructure for throttling was committed to milestone 3.0-Beta3.1[84] with the in-thread strategy, which uses the calling thread for execution. This provides the same semantics as the current blitz server.

Other strategies include:

- a per-session strategy
- a per-user strategy
- a per-group strategy

each of which allows the session, user, or group a fair slice of execution, but no more. Within each strategy, the order of operation is guaranteed not to change once the execution reaches the server. However, there is nothing the server can do to prevent re-ordering if two calls are made by the client simultaneously.

More advanced strategies are possible based on total consumed resources over some window, or even a service-level agreement (SLA) or Quality of Service (QoS)-style planning. All strategies must guarantee a proper method ordering.

It is also intended that the throttling service provide limits to memory usage, database hits within a single transaction, and total execution time.

20.17.2 Terminology

- **Slots** - are the number of available executions that a single session, user, or group can perform simultaneously on a **single** machine. (If the server is clustered, there will be the given number of slots per hosts)
- **Hard** and **soft** limits - hard limits throw an `OverUsageException` and require some form of compensation on the clients. Soft limits, on the other hand, simply slow down, or throttle, execution to give other operations a chance to succeed.
- **Strictness** - when a strategy is configured as strict, then once a session, user, or group has reached its limits, the hard or soft limit will be enforced even if no one else is using the server. A non-strict policy will "borrow" someone else's slot for the duration of one execution.

See also:

Scaling Omero

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

[84] https://trac.openmicroscopy.org/ome/milestone/3.0-Beta3.1

20.18 OMERO rendering engine

20.18.1 Description

The rendering component provides for the efficient rendering of raw pixels based on per-user display settings. A user can change settings and see them take effect in real time. Changes can also be persisted to the database and then viewed from another machine or even client.

20.18.2 Server-port

The rendering engine has been ported to also now sit on the server-side, though equally usable from any Java setting.

20.18.3 Optimizations

Here we have a listing of the various rendering engine optimizations that have taken place over time:

- Packed Integers (#449[85])
- Region Based Rendering (#450[86])
- Removal of RGB Rendering Model (#452[87])

20.18.4 Compression

With r1744 and r1748, the rendering engine now supports compression. (#6[88])

20.18.5 Design

The following diagrams describe the original design of the Rendering Engine. Designed initially for the client-side, much of this information needs to be updated. Textual explanations are included as notes in each diagram.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.19 Scaling Omero

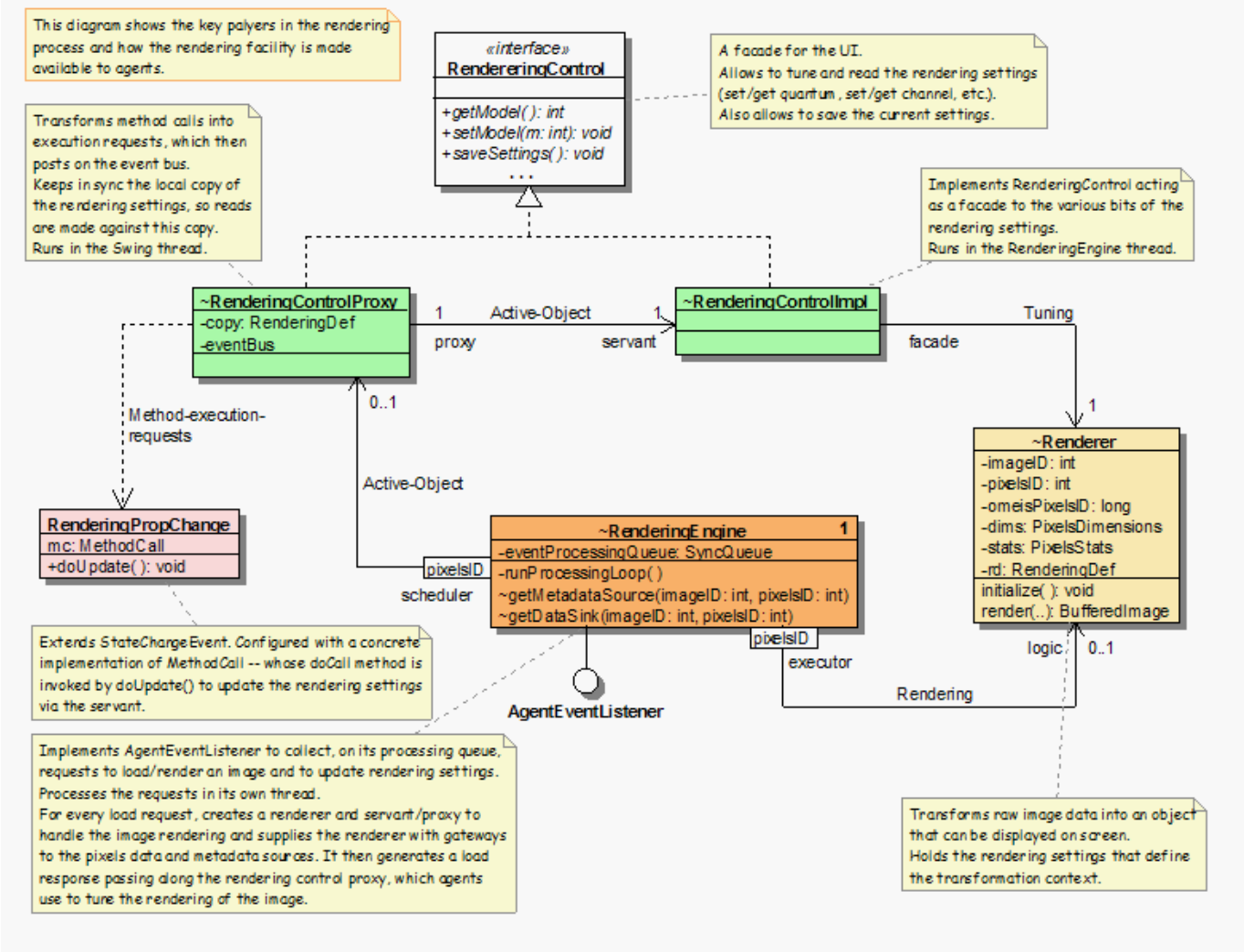
There are several ways that OMERO, or any server system, can scale. Optimizing your system for more than one of these factors is non-trivial, but we try to lay out some guidelines below for what has worked, what almost certainly will not work, and what – under the right circumstances – might be optimal.

20.19.1 Concurrent invocations

The bottlenecks for concurrent invocations are:

- database connections
- server threads
- the router

[85] https://trac.openmicroscopy.org/ome/ticket/449
[86] https://trac.openmicroscopy.org/ome/ticket/450
[87] https://trac.openmicroscopy.org/ome/ticket/452
[88] https://trac.openmicroscopy.org/ome/ticket/6



Database connections

Database servers, in general, have a maximum number of allowed connections. In postgres, the default `max_connections` is 100, though in many cases this will be significantly lower due to the available shared memory (SHMMAX). If OMERO were to use direct connections to the database, after `max_connections` invocations, all further attempts to connect to the server would fail with "too many connection" exceptions. Instead, OMERO uses a **connection pool** in front of Postgres, which manages many more simultaneous attempts to connect to the database.

With the default `max_connection` set to 64, it is possible to execute 500 queries simultaneously without database exceptions. Instead, one receives server exceptions.

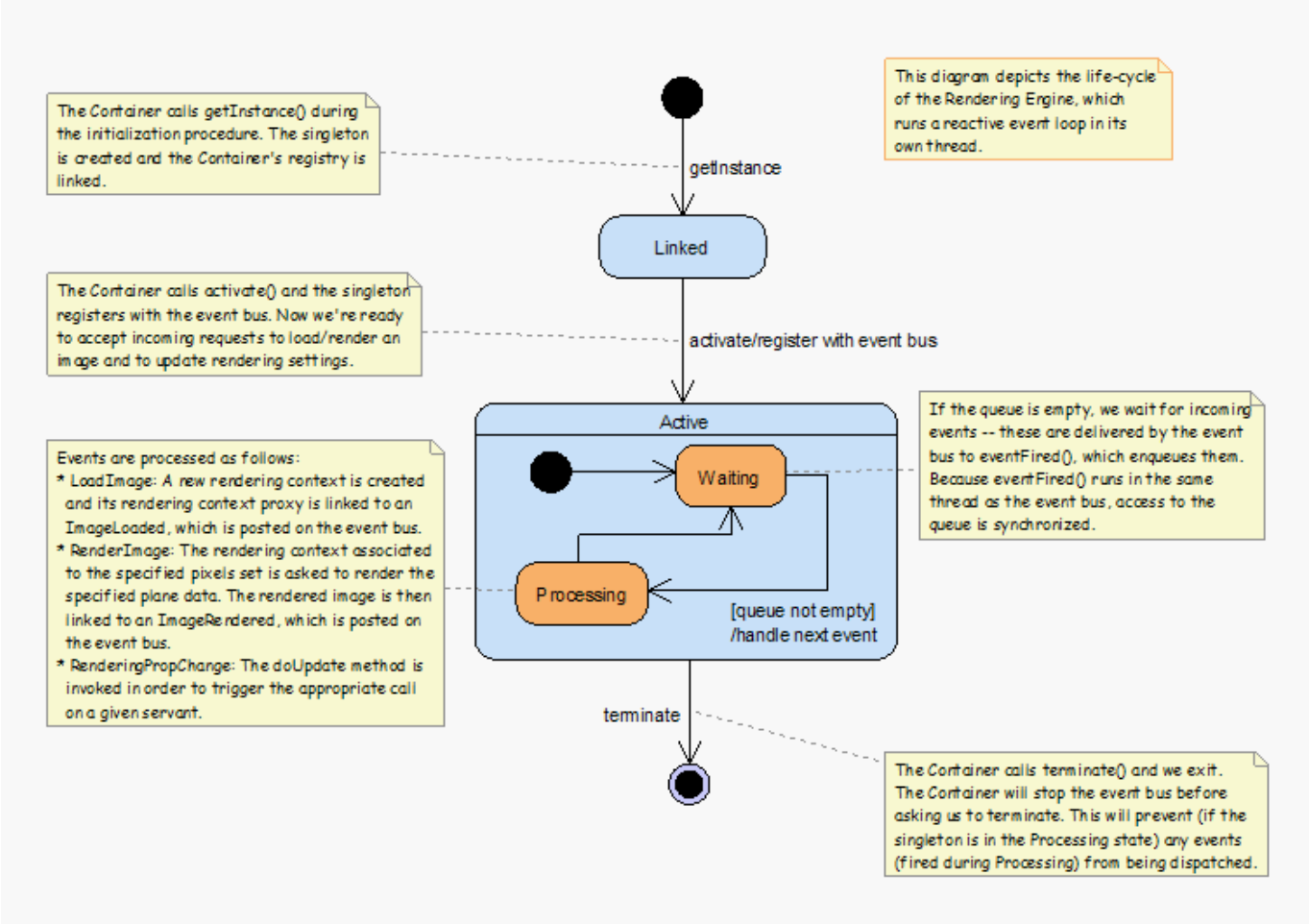
Server threads

In *OMERO.blitz*, too many (500+ on the default configuration) simultaneous invocations will result in `ConnectionLost` exceptions. We are currently working on ways to extend the number of single invocations on one server, but a simpler solution is to start another *OMERO.blitz* server.

20.19.2 Total throughput

The bottlenecks for throughput are:

- maximum message size
- server memory
- IO



- network

See also:

OMERO.server and PostgreSQL Instructions about OMERO.server and PostgreSQL under UNIX & UNIX-like platforms.

OMERO.server and PostgreSQL Instructions about OMERO.server and PostgreSQL under Windows platforms.

OMERO.grid

#906[89]

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

20.20 SqlAction

Internal server interface used to wrap all calls which speak JDBC directly. This allows special logic to be introduced where necessary for each RDBM.

Calls which use Hibernate for the cross-database conversion can use the `org.hibernate.Session` interface.

Note: This documentation is for OMERO 5.2. This version is now in maintenance mode and will only be updated in the event of critical bugs or security concerns. OMERO 5.3 is expected before the end of 2016.

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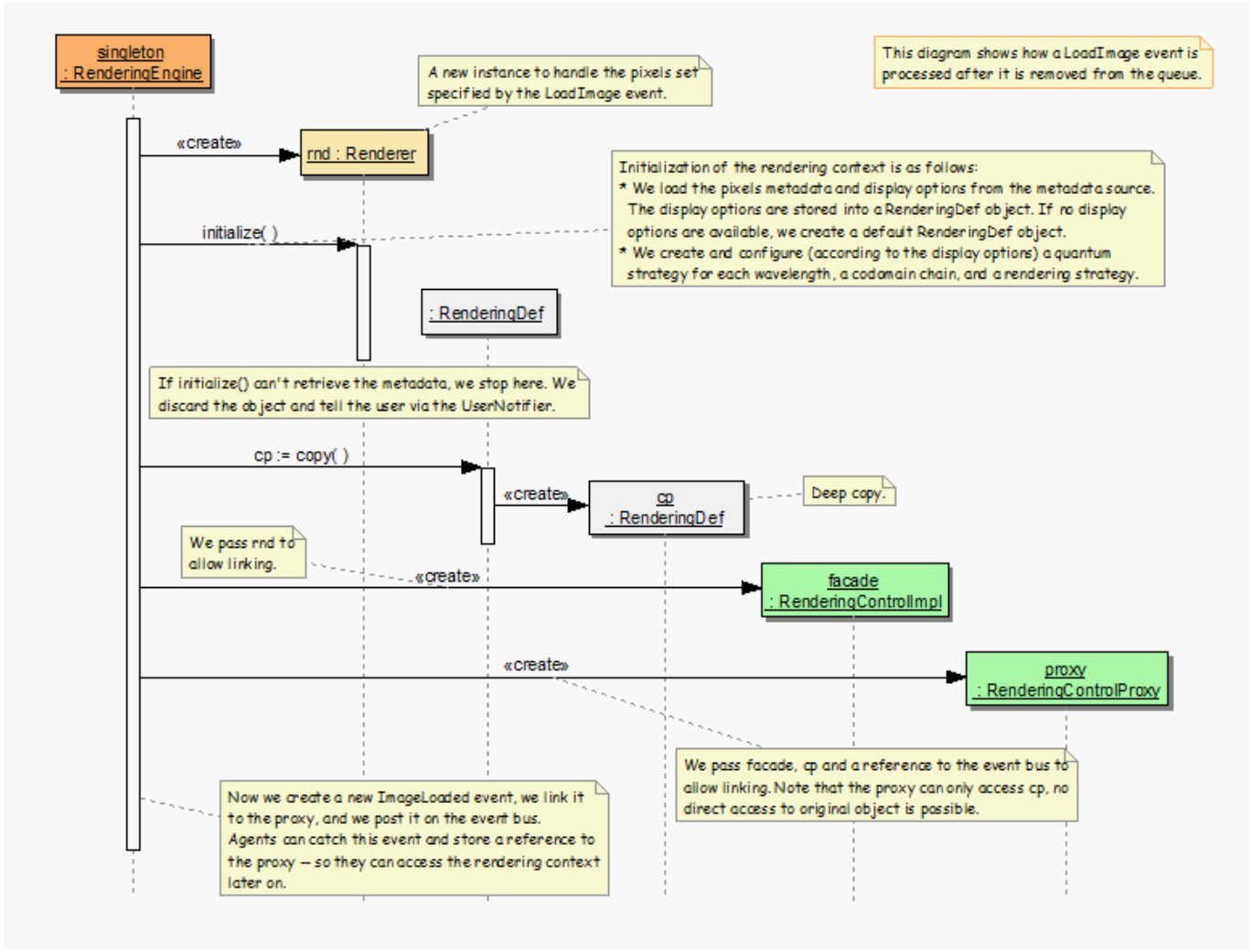
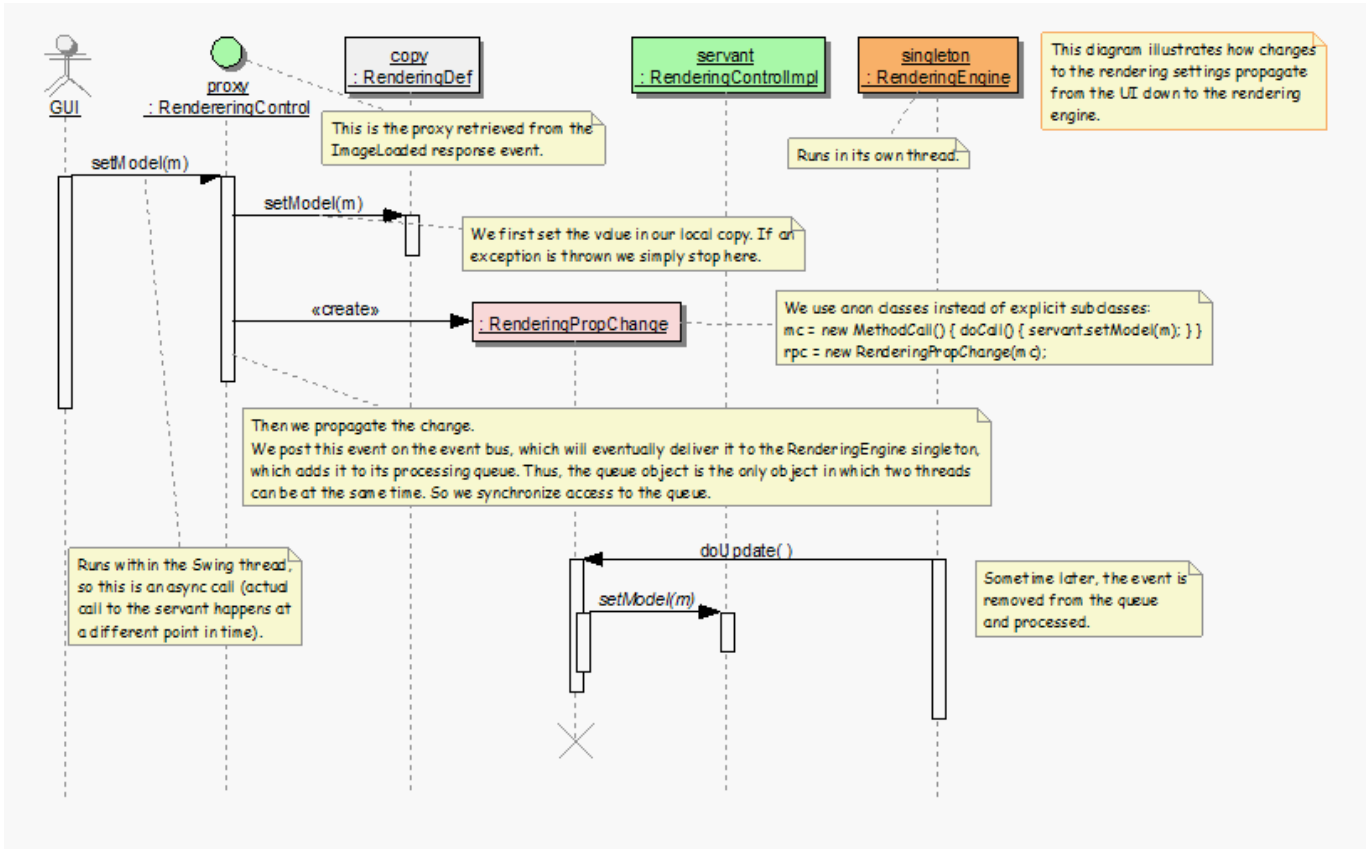
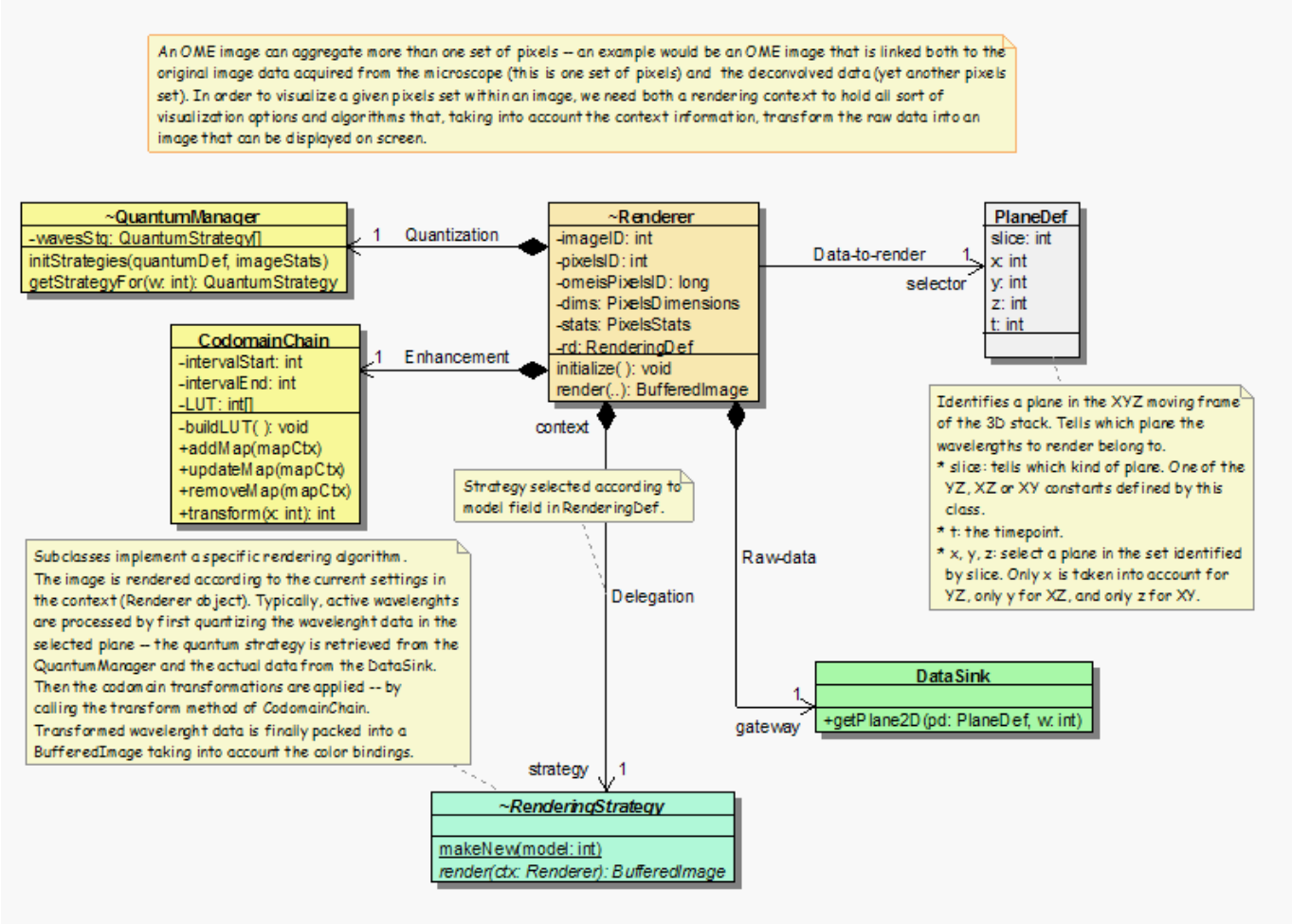
[89] https://trac.openmicroscopy.org/ome/ticket/906


singleton
: RenderingEngine
A new instance to handle the pixels set specified by the LoadImage event.
This diagram shows how a LoadImage event is processed after it is removed from the queue.
«create»
rnd : Renderer
Initialization of the rendering context is as follows:
* We load the pixels metadata and display options from the metadata source. The display options are stored into a RenderingDef object. If no display options are available, we create a default RenderingDef object.
* We create and configure (according to the display options) a quantum strategy for each wavelength, a codomain chain, and a rendering strategy.
initialize( )
: RenderingDef
If initialize() can't retrieve the metadata, we stop here. We discard the object and tell the user via the UserNotifier.
cp := copy( )
«create»
cp
: RenderingDef
Deep copy.
We pass rnd to allow linking.
«create»
facade
: RenderingControlImpl
«create»
proxy
: RenderingControlProxy
We pass facade, cp and a reference to the event bus to allow linking. Note that the proxy can only access cp, no direct access to original object is possible.
Now we create a new ImageLoaded event, we link it to the proxy, and we post it on the event bus. Agents can catch this event and store a reference to the proxy -- so they can access the rendering context later on.


GUI
proxy
: RendereringControl
copy
: RenderingDef
servant
: RenderingControlImpl
singleton
: RenderingEngine
This diagram illustrates how changes to the rendering settings propagate from the UI down to the rendering engine.
This is the proxy retrieved from the ImageLoaded response event.
Runs in its own thread.
setModel(m)
setModel(m)
We first set the value in our local copy. If an exception is thrown we simply stop here.
«create»
: RenderingPropChange
We use anon classes instead of explicit subclasses:
mc = new MethodCall() { doCall() { servant.setModel(m); } }
rpc = new RenderingPropChange(mc);
Then we propagate the change.
We post this event on the event bus, which will eventually deliver it to the RenderingEngine singleton, which adds it to its processing queue. Thus, the queue object is the only object in which two threads can be at the same time. So we synchronize access to the queue.
Runs within the Swing thread, so this is an async call (actual call to the servant happens at a different point in time).
doUpdate( )
setModel(m)
Sometime later, the event is removed from the queue and processed.



20.21 Model graph operations

Overview

When the OMERO server acts on its model objects it must determine the impact on related objects. For instance, deleting an image may entail deleting users' rendering settings for that image, also the links to any datasets that the image is in. Version 5.1.0 of the OMERO server included a new algorithm for determining which model objects to act on. Clients should be *using the new 5.1 graph requests* because the previous ones will be *removed* in OMERO 5.3. Understanding the details of the new implementation substantially assists in debugging or creating server operations that act on the directed graph of model objects.

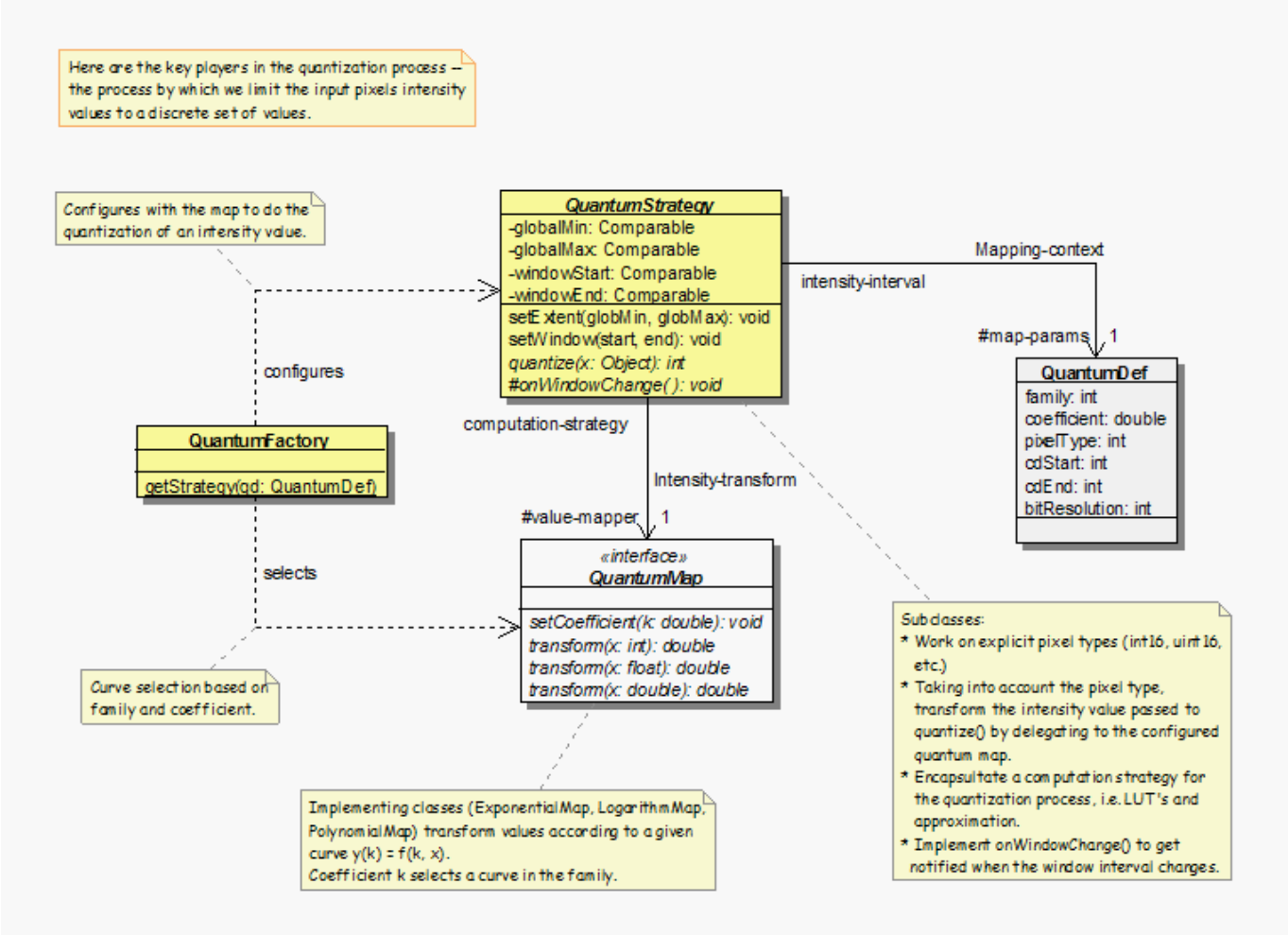
20.21.1 Motivation

The OMERO model objects are interlinked. Plates may have wells whose samples come from multiple runs. Both datasets and well samples may have images, but in different ways. Datasets, wells, images, among others, may all be annotated. Images themselves are not simple: for example, they may be in a fileset, they may have ROIs drawn on them, they may share an instrument with the projection of that image. All these entities are separate objects that can be thought of as forming the nodes (vertices) of a directed graph of relationships.

Various operations supported by the OMERO server, most commonly moving objects to a different group, or deleting them, may implicitly include many related objects. For example, if one deletes a fileset, one also deletes the images from that fileset, and even the comments on those images. This section describes how the graph of model objects is traversed and how the target set of related objects is determined, under the new implementation of graph traversal first offered in version 5.1.0 of OMERO.

This technical detail is important to understand if one wishes to,

- adjust the set of related model objects that are included in operations



- change the types of *OME-Remote Objects* model objects or the permissible links among them
- fix bugs in the related request objects defined in Graphs.ice[90] that may be submitted to *OMERO sessions* for execution.

20.21.2 Approach

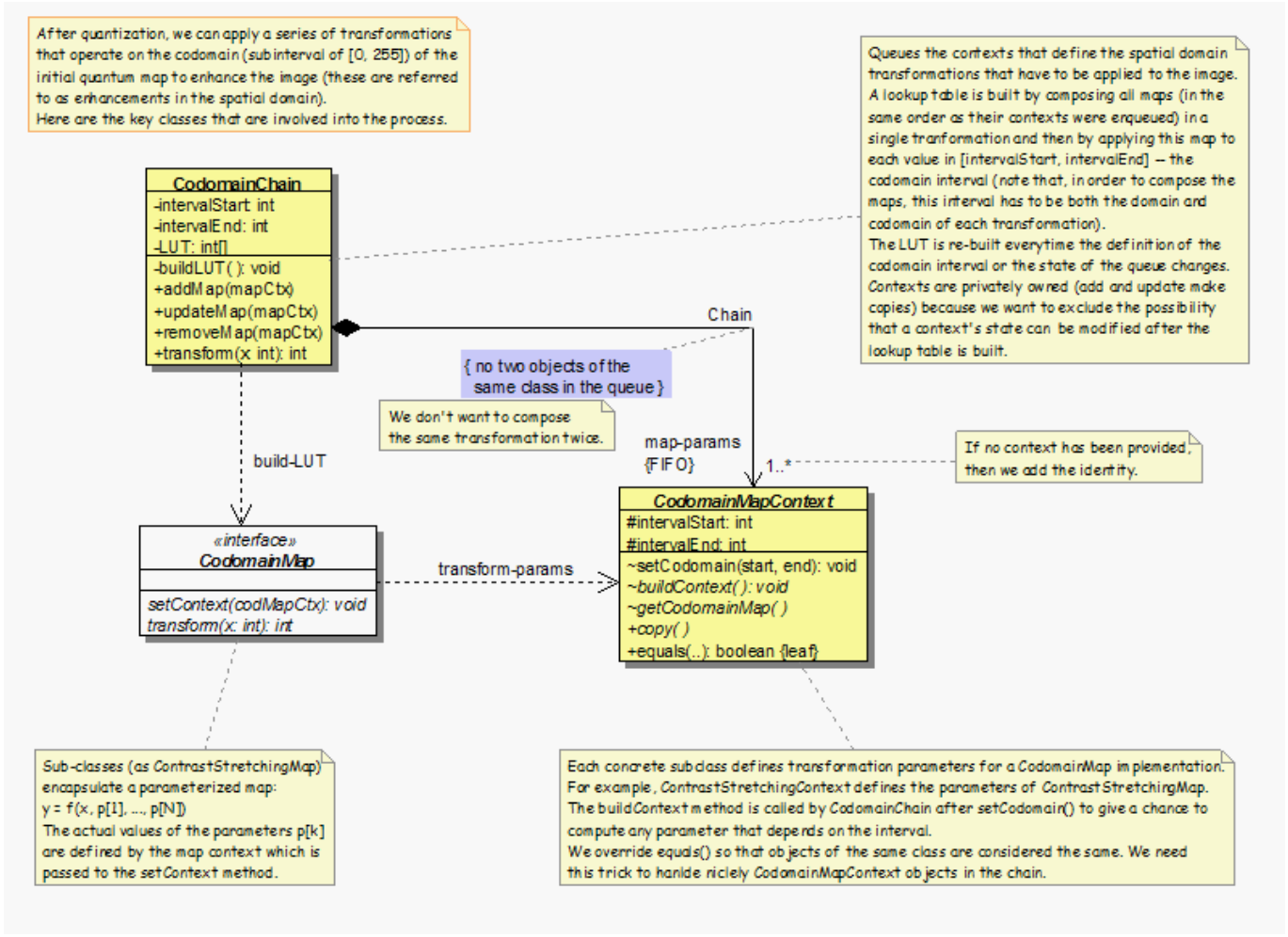
Graph node states and transitions

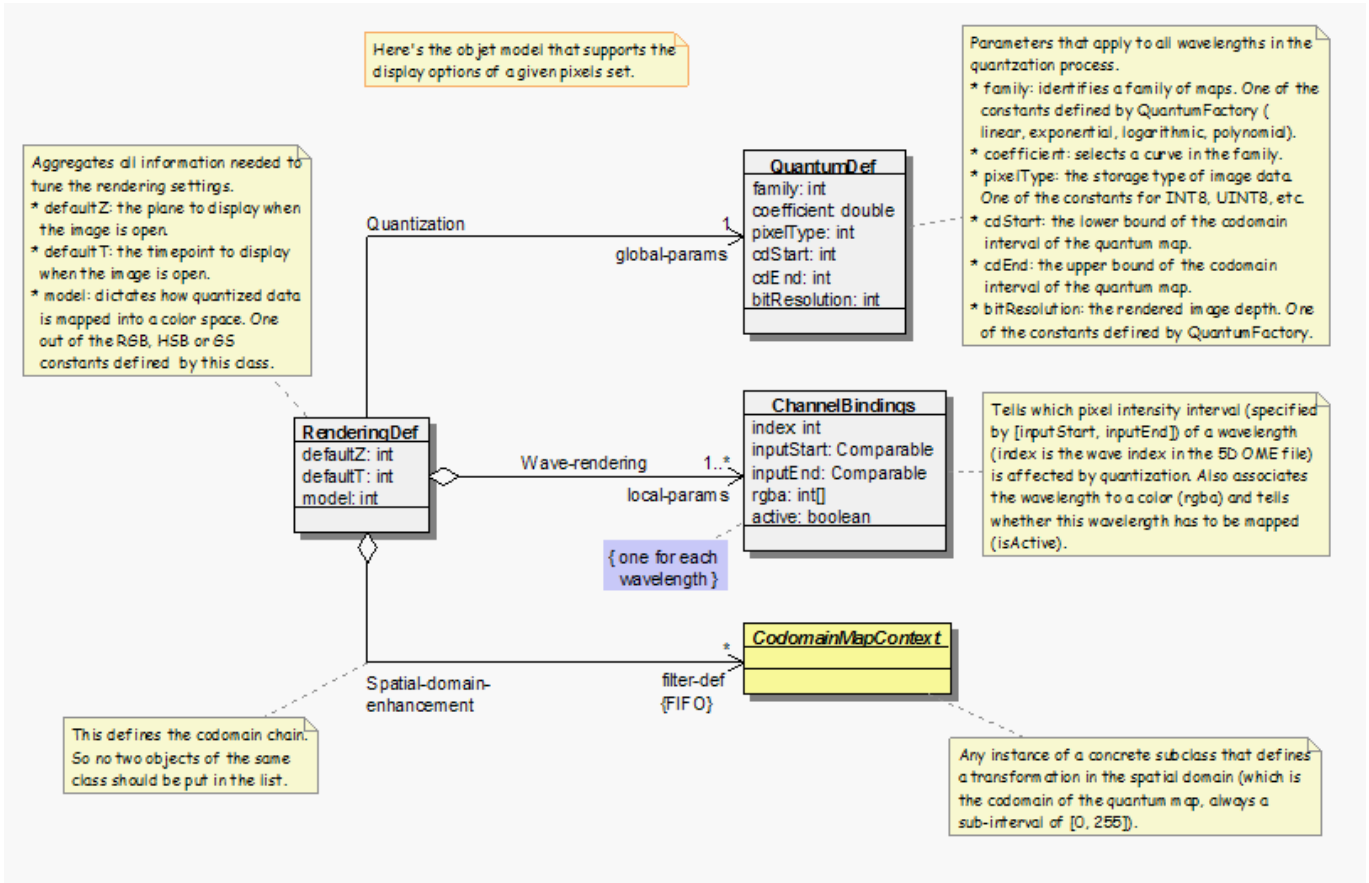
In determining which model objects to process, and how, each corresponding graph node is in one of these states:

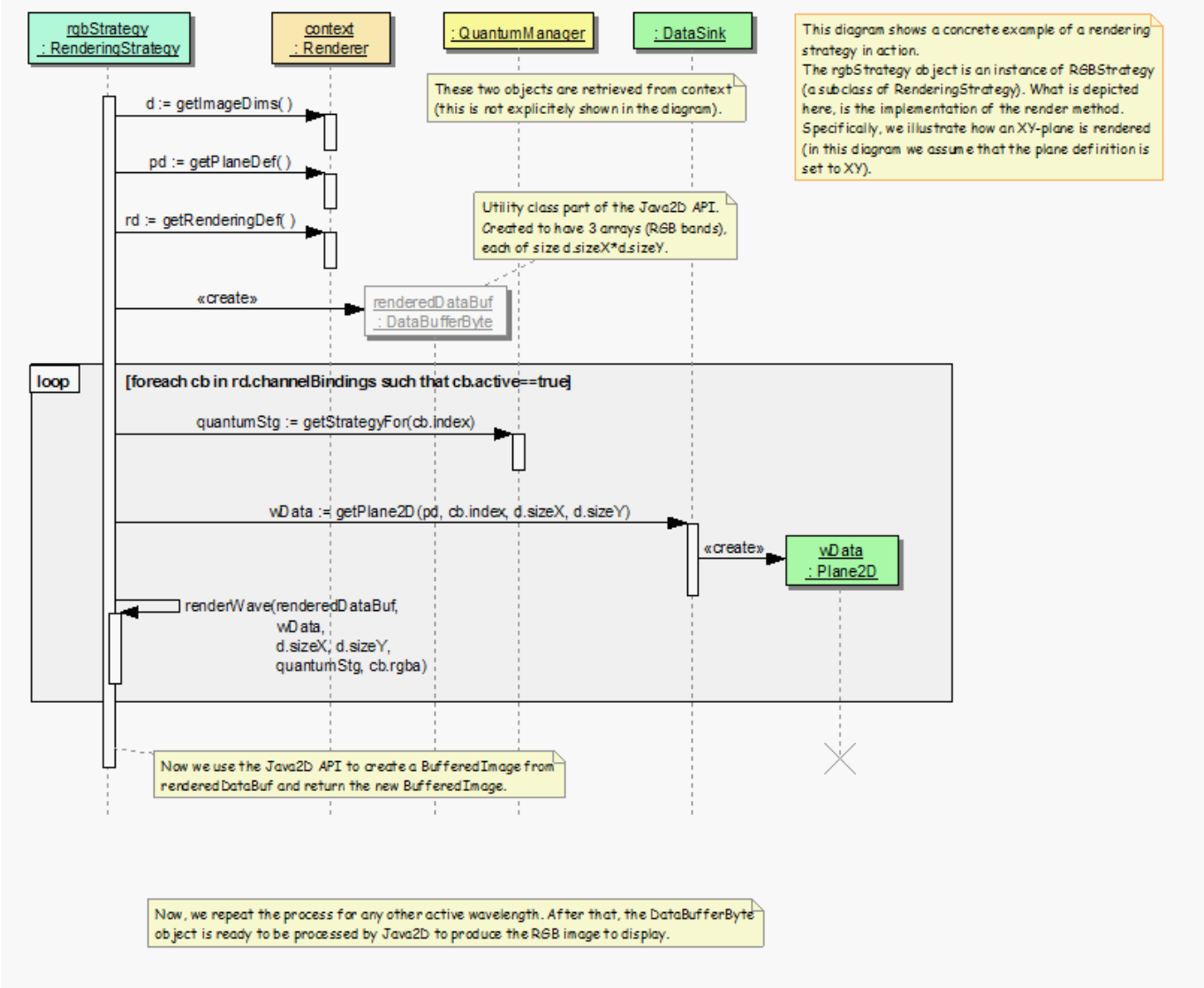
adjective	rule format	Action enum	Orphan enum
irrelevant	`[E]{i}`	`EXCLUDE`	`IRRELEVANT`
relevant	`[E]{r}`	`EXCLUDE`	`RELEVANT`
orphaned	`[E]{o}`	`EXCLUDE`	`IS_LAST`
attached	`[E]{a}`	`EXCLUDE`	`IS_NOT_LAST`
to delete	`[D]`	`DELETE`	n/a
to include	`[I]`	`INCLUDE`	n/a
outside	`[O]`	`OUTSIDE`	n/a

"enum" refers to the enumerations defined in GraphPolicy.java[91]. Note also that, as for the introduction to *Deleting in OMERO*, "links" are simply edges in the graph, distinct from the classes implementing ILink.java[92] which themselves have several links, not least to their parent and child objects.

[90] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/omero/cmd/Graphs.ice
[91] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/graphs/GraphPolicy.java
[92] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/ILink.java


After quantization, we can apply a series of transformations that operate on the codomain (subinterval of [0, 255]) of the initial quantum map to enhance the image (these are referred to as enhancements in the spatial domain).
Here are the key classes that are involved into the process.
CodomainChain
-intervalStart: int
-intervalEnd: int
-LUT: int[]
-buildLUT( ): void
+addMap(mapCtx)
+updateMap(mapCtx)
+removeMap(mapCtx)
+transform(x: int): int
Queues the contexts that define the spatial domain transformations that have to be applied to the image. A lookup table is built by composing all maps (in the same order as their contexts were enqueued) in a single tranformation and then by applying this map to each value in [intervalStart, intervalEnd] – the codomain interval (note that, in order to compose the maps, this interval has to be both the domain and codomain of each transformation).
The LUT is re-built everytime the definition of the codomain interval or the state of the queue changes. Contexts are privately owned (add and update make copies) because we want to exclude the possibility that a context's state can be modified after the lookup table is built.
Chain
{ no two objects of the same class in the queue }
We don't want to compose the same transformation twice.
map-params
{FIFO}
1..*
If no context has been provided, then we add the identity.
build-LUT
«interface»
CodomainMap
setContext(codMapCtx): void
transform(x: int): int
transform-params
CodomainMapContext
#intervalStart: int
#intervalEnd: int
~setCodomain(start, end): void
~buildContext( ): void
~getCodomainMap( )
+copy( )
+equals(..): boolean {leaf}
Sub-classes (as ContrastStretchingMap) encapsulate a parameterized map:
y = f(x, p[1], ..., p[N])
The actual values of the parameters p[k] are defined by the map context which is passed to the setContext method.
Each concrete subclass defines transformation parameters for a CodomainMap implementation. For example, ContrastStretchingContext defines the parameters of ContrastStretchingMap. The buildContext method is called by CodomainChain after setCodomain() to give a chance to compute any parameter that depends on the interval.
We override equals() so that objects of the same class are considered the same. We need this trick to handle nicely CodomainMapContext objects in the chain.


Here's the objet model that supports the display options of a given pixels set.
Aggregates all information needed to tune the rendering settings.
* defaultZ: the plane to display when the image is open.
* defaultT: the timepoint to display when the image is open.
* model: dictates how quantized data is mapped into a color space. One out of the RGB, HSB or GS constants defined by this class.
Quantization
1
global-params
QuantumDef
family: int
coefficient: double
pixelType: int
cdStart: int
cdEnd: int
bitResolution: int
Parameters that apply to all wavelengths in the quantization process.
* family: identifies a family of maps. One of the constants defined by QuantumFactory (linear, exponential, logarithmic, polynomial).
* coefficient: selects a curve in the family.
* pixelType: the storage type of image data. One of the constants for INT8, UINT8, etc.
* cdStart: the lower bound of the codomain interval of the quantum map.
* cdEnd: the upper bound of the codomain interval of the quantum map.
* bitResolution: the rendered image depth. One of the constants defined by QuantumFactory.
RenderingDef
defaultZ: int
defaultT: int
model: int
Wave-rendering
1..*
local-params
ChannelBindings
index int
inputStart: Comparable
inputEnd: Comparable
rgba: int[]
active: boolean
Tells which pixel intensity interval (specified by [inputStart, inputEnd]) of a wavelength (index is the wave index in the 5D OME file) is affected by quantization. Also associates the wavelength to a color (rgba) and tells whether this wavelength has to be mapped (isActive).
{ one for each wavelength }
Spatial-domain-enhancement
*
filter-def
{FIFO}
CodomainMapContext
This defines the codomain chain. So no two objects of the same class should be put in the list.
Any instance of a concrete subclass that defines a transformation in the spatial domain (which is the codomain of the quantum map, always a sub-interval of [0, 255]).



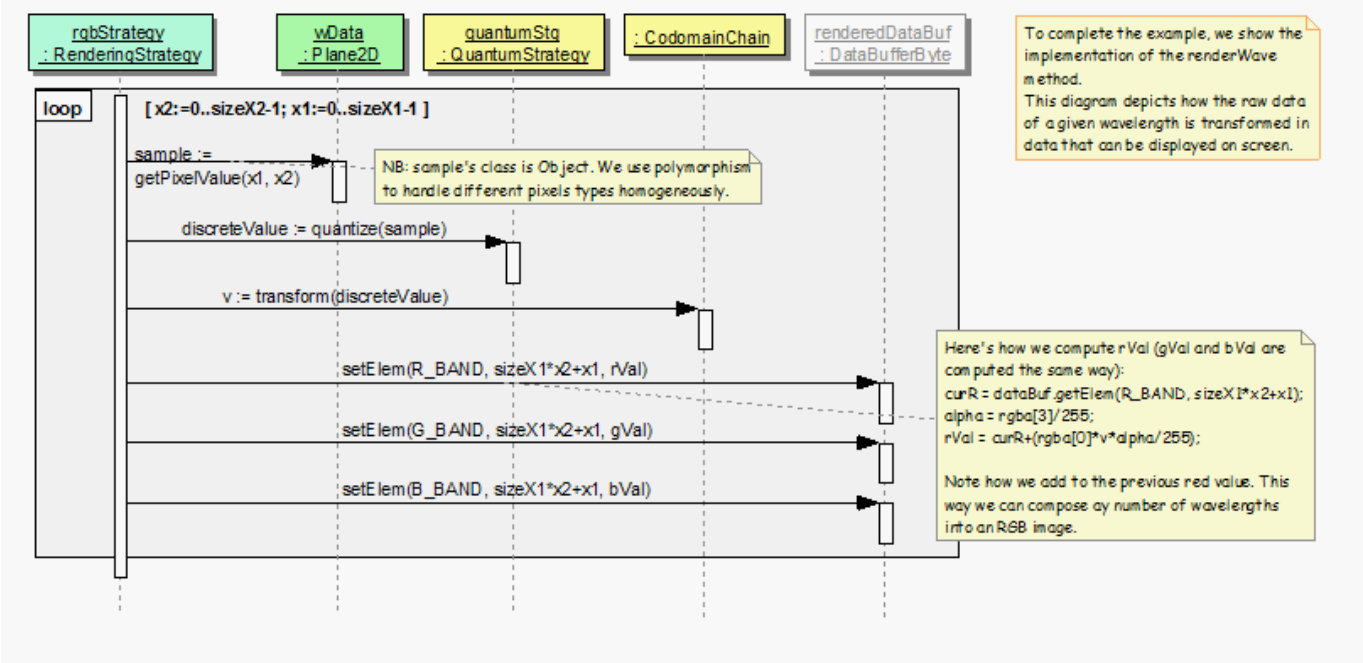
When traversal begins, the target objects are to be *included* (e.g., for Chgrp2[93]) or *deleted* (e.g., for Delete2[94]) and other objects are *irrelevant*.

A list of transition rules is associated with the requested operation. Each of the target objects is examined in turn and the rules matched against the state of that object and of those directly linked to it in either direction. If a rule matches, it may either abort the operation with an error condition or, more usually, change the state of any of the objects it matches. Changed objects are themselves queued for examination and rule matching. The traversal is complete when all queued objects have been examined with no further transition rule matches. Rules that can abort the operation are checked only after the other rules have completed processing. GraphTraversal.java[95]'s `planOperation` method is at the heart of this matching process.

Further graph node states

Usual behavior is for *orphaned* objects related to the target objects to be included in the operation, but not the otherwise-*attached* objects, the non-orphans who have *excluded* parents that are to be neither deleted nor included. The related children that may be orphans are exactly those identified as being *relevant*. Transition rules match these against excluded parents to discover if the relevant objects do have any qualifying parents, changing them to be attached objects. If no further rules match and some objects remain as relevant, then they are automatically changed to orphans and examined for further rule matches. After that processing completes, attached objects are changed back to being relevant to confirm that excluded qualifying parents still exist to change them to being attached: this is necessary in case, after an object was considered attached, other rules changed all those qualifying parents from being excluded so that the object is now an orphan.

[93] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp2.html
[94] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Delete2.html
[95] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/graphs/GraphTraversal.java



Objects that are changed to be *outside* are effectively rendered invisible, outside consideration in the execution phase. In the execution of an operation the graph traversal code removes links between included and excluded objects, but it allows links to remain between outside objects and other objects. Outside objects typically implement IGlobal.java[96] and have no owner or group.

An additional aspect of objects' state is if permissions are to be checked for them. For instance, typically I may move only my own objects to a different group, but if another user tags my image with my tag, then I may still move my image and tag to a different group, also moving that link even though it is not my own object: in that case, permissions checking is disabled for that `ImageAnnotationLink`. All objects initially have permissions checking enabled, but the consequence of a rule may be to disable permissions checking, and if an object with permissions checking disabled matches a further rule, the objects changed by that rule also have permissions checking disabled.

20.21.3 Configuration

Defining the model graph transition rules

To reduce its complexity, GraphTraversal.java[97] does not include specific detail of how to traverse the graph of *OME-Remote Objects* model objects. Instead, subclasses of GraphPolicy.java[98] guide the traversal of the model object graph, configured by blitz-graph-rules.xml[99] which names and defines the lists of transition rules. The named lists of rules are associated with request object classes by the definition of the `graphRequestFactory` bean in blitz-servantDefinitions.xml[100], which also specifies which model object properties may never be set to `null` in executing any requested operation.

blitz-graph-rules.xml[101] begins with a comment that provides a key to the notation used for transition rules. The rules name and match model objects based on the state of the graph nodes, the types of the corresponding objects, the permissions the user has on those objects, and the names of the properties linking the objects. To illustrate this, the following sections briefly describe some different kinds of rule from the `deleteRules` list.

Propagating deletion

```
p:matches="L:ILink.parent = [D], L.child = C:[E]{o}/d"
p:changes="C:[D]"
```

[96] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/model/src/ome/model/IGlobal.java
[97] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/graphs/GraphTraversal.java
[98] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/graphs/GraphPolicy.java
[99] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/ome/services/blitz-graph-rules.xml
[100] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/ome/services/blitz-servantDefinitions.xml
[101] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/ome/services/blitz-graph-rules.xml

If an `ILink`'s parent (e.g., a dataset) is to be deleted, and its child (e.g., an image) is orphaned and deletable by the user, then delete the child also.

```
p:matches="PlateAcquisition[D].wellSample = WS:WellSample[E]"
p:changes="WS:[D]"
```

If a plate acquisition (run) is to be deleted, also delete its well samples (fields).

```
p:matches="Fileset[D] = I:Image[E].fileset"
p:changes="I:[D]"
```

If a fileset is to be deleted, then also delete its images.

```
p:matches="T:Thumbnail[E].pixels =/!o [D]"
p:changes="T:[D]/n"
```

If the pixels of a thumbnail are to be deleted, and are owned by a different user, then delete the thumbnail regardless of permissions on it.

Curtailing deletion

```
p:matches="Well[D].plate = C:[E]{!a}"
p:changes="C:{a}"
```

If a well is to be deleted but its plate is excluded and not attached, regard the plate as attached.

```
p:matches="C:Channel[E]{r}.pixels = Pixels[E]{i}"
p:changes="C:{a}"
```

If an irrelevant pixels object has a relevant channel, then regard the channel as attached.

```
p:matches="Pixels[D].relatedTo = P:[E]{!a}"
p:changes="P:{a}"
```

If a pixels object is to be deleted, regard any related, excluded pixels objects as attached. Because the pixels of an image are related to the pixels of a projection of that image, this rule prevents the deletion of an image from causing inadvertent deletion of the image's projections.

```
p:matches="L:ILink[!D].parent = [E]/d, L.child = C:[E]{r}"
p:changes="C:{a}"
```

If an `ILink` that is not to be deleted itself has a deletable, excluded parent and a relevant child, regard that child as attached.

Other kinds of transition rule

```
p:matches="E:IEnum[E]"
p:changes="E:[O]"
```

Regard excluded `IEnum` objects as being outside the operation. (Rules do not need to match on links among multiple objects.)

```
p:matches="F:Fileset[!D].images = [D], F.images = [!D]"
p:error="may not split {F}"
```

Throw an error if a fileset that is not to be deleted includes an image that is to be deleted and an image that is not to be deleted.

In reviewing the `chgrpRules` list, one sees conditions that require matching `$to_private` or `!$to_private`. A request, in this case Chgrp2I.java[102], may set arbitrary conditions upon which rules may be predicated. The `to_private` condition, or its absence, is used to cause different behavior when the objects are being moved into a private group.

20.21.4 Logging

Changing the log level

It is informative to observe the sequence of rule applications as the graph is traversed and decisions about model objects are made. To do so requires configuring *Omero logging* for the server, specifically etc/logback.xml[103]. To activate graph traversal debug logging, adjust the ends of the lines,

```
<logger name="omero.cmd.graphs" level="INFO"/>
<logger name="ome.services.graphs" level="INFO"/>
```

such that they instead read,

```
<logger name="omero.cmd.graphs" level="DEBUG"/>
<logger name="ome.services.graphs" level="DEBUG"/>
```

The resulting extra information in `var/log/Blitz-0.log` is of particular assistance in debugging: it pinpoints the rule applications that caused incorrect determinations of what action to take with model objects. Note that a `*` suffix on a model object referenced in the logs indicates that permissions are not to be checked for it.

Expanding the reports of transition rule matches

In the previous section, it can be seen that model objects that match rule conditions may be named. For example, in,

```
p:matches="Fileset[D] = I:Image[E].fileset"
p:changes="I:[D]"
```

the image is named `I`. When a rule matches, the debug logging reports which model object matched each name. If it remains unclear why a rule matched, further objects may be named. For example, changing the first line to name the fileset,

```
p:matches="F:Fileset[D] = I:Image[E].fileset"
```

would also report in the log which fileset matched the rule.

20.21.5 Encouragement

On first reading, the above may feel daunting. If model object graph traversal is not working as desired, thus requires adjustment, review of debug logs from `var/log/Blitz-0.log` typically pinpoints the cause and a minor adjustment to blitz-graph-rules.xml[104] often suffices as the fix, with integration tests providing reassurance that the adjustment was acceptable. Sometimes it can take time and thought to devise that fix, but one can expect small changes to suffice to fix most bugs. In getting this new graph

[102] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/omero/cmd/graphs/Chgrp2I.java
[103] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/etc/logback.xml
[104] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/resources/ome/services/blitz-graph-rules.xml

traversal implementation to initially pass integration testing, no test failures required a substantial rethink of the basic approach and GraphTraversal.java[105] itself did not require a significant rewrite.

The actual lists of transition rules arose in part as a way to achieve the desired behavior and are not yet as simple and comprehensive as they could be. While they necessarily reflect the inherent complexity of the object model of *OME-Remote Objects*, there is potential for reviewing the rule lists and, perhaps with some additional marker interfaces, making them more succinct and regular. Incremental movements toward this goal are worth pursuing.

20.21.6 Options

Every one of the request object classes introduced in the new implementation of graph traversal is a derived class of GraphModify2[106] and inherits data members that configure its operation. Each request may define additional data members for options specific to it, for instance Chgrp2[107] requires the ID of the target group to be specified. The data members offered by all of the new requests are,

`targetObjects` specifies which model objects the operation is to target

`childOptions` specifies types of model objects (and, for annotations, namespaces) that should always or never be included in the operation (i.e. always considered to be orphans, or attached, regardless of excluded parents)

`dryRun` specifies if the request is to determine which model objects would be included in and deleted by the operation, without actually executing the operation.

20.21.7 SkipHead

The request object classes derived from GraphModify[108] allow specification of the target objects with reference to a common parent. For example, setting the request's `type` to `/Plate/Well/WellSample/Image` targets the images of a specific plate.

The SkipHead[109] request offers a similar feature. It wraps an inner `request` data member that starts acting only after graph traversal reaches types listed in `startFrom`. For that inner request to behave as if given the previous `/Plate/Well/WellSample/Image` type, a plate may be given in `targetObjects` and `Image` named in `startFrom`.

This feature is achieved by running the initial request with `dryRun` set to `true` and the graph traversal policy modified so as to not examine included nodes of types listed in `startFrom`. A subsequent request then runs, targeting the `startFrom` model objects that were included in the first request.

20.21.8 Compatibility

The previous implementation of model graph traversal has request object classes derived from GraphModify[110] instead of the newer GraphModify2[111]. For API compatibility a set of "facade" requests are defined by the new implementation that offer an approximation of the older API but run the newer code under the hood. For instance, Chgrp[112] is implemented by ChgrpFacadeI.java[113] by means of Chgrp2I.java[114].

[105] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/server/src/ome/services/graphs/GraphTraversal.java
[106] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify2.html
[107] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp2.html
[108] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify.html
[109] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/SkipHead.html
[110] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify.html
[111] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/GraphModify2.html
[112] http://downloads.openmicroscopy.org/latest/omero/api/slice2html/omero/cmd/Chgrp.html
[113] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/omero/cmd/graphs/ChgrpFacadeI.java
[114] https://github.com/openmicroscopy/openmicroscopy/blob/v5.2.4/components/blitz/src/omero/cmd/graphs/Chgrp2I.java

Symbols

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