



OMERO.server & Java support

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Outline



1. Java & OpenJDK
2. State of the OpenJDK LTS support
3. State of Java support in OME
4. Running OMERO.server on JDK 17
5. Next steps

Java programming language

- Object-oriented programming language
- Former developed by Sun Microsystems, now Oracle Corporation
- Releases
 - Java Platform, Standard Edition or Java Standard Edition or Java SE
 - Java Platform, Enterprise Edition or Jakarta EE
- Java language evolution
 - Governed via Java Community Process (JCP) <https://jcp.org/>
 - Java Enhancement Proposal (JEP)
 - Java Specification Requests (JSR), review and approval process
- Release frequency
 - Now time-driven every 6 months (March and September)
 - Some releases classified as long-term support (8, 11, 17, 21)
 - Specifications available from <https://docs.oracle.com/javase/specs/>

Java & OME project

- 30 repositories marked as Java
<https://github.com/ome?q=&type=all&language=java&sort=>
- Formats translation & conversion
 - Bio-Formats
 - Conversion tools
- Image data management
 - OMERO.server
 - OMERO.insight
 - Micro-services
- All latest releases require Java 8+, some require at least Java 11+

OpenJDK

- Java Virtual Machine (JVM)
- Java Runtime Environment (JRE)
- Java Development Kit (JDK)
- OpenJDK == Open Java Development Kit
 - Free and open-source implementation of the Java SE platform
 - Release in 2007 by Sun Microsystems
 - Licensed under GPL 2.0 with ClassPath Exception (<https://openjdk.org/legal/gplv2+ce.html>)
 - Reference implementation since Java SE 7

Towards multiple OpenJDK distributions

- 2009 Oracle Corporation acquires Sun Microsystems
- 2009-2018: Oracle releases Java under 2 builds
 - OpenJDK (GPLv2 + CE)
 - OracleJDK (Oracle Binary Code License)
- 2018: Oracle Technology Network License Agreement (OTNLA)
 - Introduces distinction between personal and commercial users
- 2019: Oracle announces end of support for OpenJDK 8
- Future OpenJDK builds only get support for 6 months
- Many vendors now build and ship their distribution of OpenJDK
 - Oracle JDK
 - Azul
 - Eclipse Temurin
 - Amazon Corretto
 - RedHat build of OpenJDK

OpenJDK support by distribution

		2024	2025	2026	2027	2028	2029
Java 8	Oracle JDK						
	Eclipse Temurin						
	Azul Zulu						
	Amazon Corretto						
	RedHat						
Java 11	Oracle JDK						
	Eclipse Temurin						
	Azul Zulu						
	Amazon Corretto						
	RedHat						
Java 17	Oracle JDK						
	Eclipse Temurin						
	Azul Zulu						
	Amazon Corretto						
	RedHat						
Java 21	Oracle JDK						
	Eclipse Temurin						
	Azul Zulu						
	Amazon Corretto						
	RedHat						

<https://endoflife.date/>

Bio-Formats & Java support



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Release of Bio-Formats 6.12.0

The OME team is pleased to announce the release of Bio-Formats 6.12.0

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Today we are releasing Bio-Formats 6.12.0 with a number of significant changes. Most notably for Java users, Bio-Formats has now been updated to fully support Java 17.

Additionally in this release there have been changes to the logging dependencies which will require users to update their dependencies. Bio-Formats previously included a logback dependency which is now marked as optional, this will require users to add a logging binding such as [logback](#). For further details on the changes to the logging dependencies and links to the relevant documentation, please see the [release notes](#).



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Release of Bio-Formats 7.3.0

The OME team is pleased to announce the release of Bio-Formats 7.3.0

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Today we are releasing Bio-Formats 7.3.0 which includes compatibility and support for Bio-Formats with Java-21 alongside a number of format improvements including updates for DICOM, CellSens VSI, and PerkinElmer Columbus.

The full list of changes included in this release are as follows:

File format fixes and improvements:

OMERO & Java support

OMERO
v5.6.10

Search docs

OMERO Overview and CLI User Documentation

System Administrator Documentation

- Getting started
 - Usage
 - Components
- Background reading
 - What's new for OMERO 5.6 for sysadmins
 - Version requirements: supported platforms and versions
 - System requirements: hardware specification and examples
 - Example production server set-ups
 - Known limitations
- Installation
- Upgrading
- Maintenance
- Optimizing Server Configuration

Read the Docs v: v5.6.10

If no version is provided, a suitable repository is indicated.

Version	CentOS/RHEL	Ubuntu
3.6	9 (zeroc-ice-rhel9-x86_64)	22.04 (zeroc-ice-ubuntu2204-x86_64)

Java

[General overview](#)

OMERO support policies

Version	Release date	Supported until	OMERO 5.6	Details
7	Jul 2011	Apr 2015	✗	Reference
8	Mar 2014	Nov 2026	✓	Reference
11	Sep 2018	Oct 2024	✓	Reference
17	Sep 2018	Oct 2027	⬆	Reference

Version provided by distribution

Version	CentOS/RHEL	Ubuntu
11	9	22.04
Details		Reference

OMERO.server & Java 17: reflection issue

- Ubuntu 22.04
- OMERO.server 5.6.10
- Default configuration

- OpenJDK 11 pass
- OpenJDK 17 fail
- OpenJDK 21 fail

```
omero-server-jep403 — omero@4698ba119c93: ~ — docker-compose · docker compose exec jdk17 bash — 108x35
docker compose exec jdk11
certificates created: /OMERO/certs/server.key /OMERO/certs/server.pem /OMERO/certs/server.p12
(OMERO.venv) omero@4698ba119c93:~$ omero admin start
WARNING: Your server has not been configured for production use.
See https://docs.openmicroscopy.org/omero/latest/sysadmins/server-performance.html?highlight=poolsize
for more information.
Creating /opt/omero/OMERO.current/var/master
Initializing /opt/omero/OMERO.current/var/log
Creating /opt/omero/OMERO.current/var/registry
No descriptor given. Using etc/grid/default.xml
Waiting on startup. Use CTRL-C to exit
.....
Failed to startup some components after 300 seconds
Calling "stop" on remaining components
Waiting on shutdown. Use CTRL-C to exit
.....(OMERO.venv) omero@4698ba119c93:~$ tail -n 15 OMERO.current/var/log/Blitz-0.log
... 101 common frames omitted
Caused by: java.lang.reflect.InaccessibleObjectException: Unable to make protected final java.lang.Class java
a.lang.ClassLoader.defineClass(java.lang.String,byte[],int,int,java.security.ProtectionDomain) throws java.l
ang.ClassFormatError accessible: module java.base does not "opens java.lang" to unnamed module @fdc8126
    at java.base/java.lang.reflect.AccessibleObject.checkCanSetAccessible(AccessibleObject.java:354)
    at java.base/java.lang.reflect.AccessibleObject.checkCanSetAccessible(AccessibleObject.java:297)
    at java.base/java.lang.reflect.Method.checkCanSetAccessible(Method.java:199)
    at java.base/java.lang.reflect.Method.setAccessible(Method.java:193)
    at javassist.util.proxy.SecurityActions.setAccessible(SecurityActions.java:159)
    at javassist.util.proxy.DefineClassHelper$JavaOther.defineClass(DefineClassHelper.java:213)
    at javassist.util.proxy.DefineClassHelper$Java11.defineClass(DefineClassHelper.java:52)
    at javassist.util.proxy.DefineClassHelper.toClass(DefineClassHelper.java:260)
    at javassist.ClassPool.toClass(ClassPool.java:1232)
    at javassist.CtClass.toClass(CtClass.java:1384)
    at bitronix.tm.resource.jdbc.proxy.JdbcJavassistProxyFactory.generateProxyClass(JdbcJavassistProxyFa
ctory.java:265)
    at bitronix.tm.resource.jdbc.proxy.JdbcJavassistProxyFactory.createProxyConnectionClass(JdbcJavassis
tProxyFactory.java:156)
    ... 110 common frames omitted
(OMERO.venv) omero@4698ba119c93:~$
```

<https://github.com/sbesson/omero-server-jep403>

Strong encapsulation in the JDK

- JEP 403: Strongly Encapsulate JDK Internals (<https://openjdk.org/jeps/403>)
 - Disallows usage of reflection to access parts of the JDK that are meant for internal use only
- JDK 9 through JDK 16
 - Allowed the reflection to continue
 - Emitted warnings about illegal reflective access
 - Can be controlled via `--illegal-access`
- JDK 17 and later
 - Strongly encapsulated
 - Reflection no longer permitted by default
 - `--illegal-access` flag obsolete

<https://docs.oracle.com/en/java/javase/17/migrate/migrating-jdk-8-later-jdk-releases.html#GUID-7BB28E4D-99B3-4078-BDC4-FC24180CE82B>

Strong encapsulation: --add-opens

- `java.lang.reflect.InaccessibleObjectException`
- Usage of reflection API to access protected/private methods of Java API
- Workaround: use `--add-opens`
 - `--add-opens <module>/<package>=<target-module> (<target-module>)*`
 - `--add-opens java.management/sun.management=ALL-UNNAMED`
- OMERO configuration: `omero.jvmcfg.append`

```
$ omero config set omero.jvmcfg.append '--add-opens  
java.base/java.lang=ALL-UNNAMED'
```

<https://docs.oracle.com/en/java/javase/17/migrate/migrating-jdk-8-later-jdk-releases.html#GUID-7BB28E4D-99B3-4078-BDC4-FC24180CE82B>

OMERO.server & Java 17: export issue

```
omero-server-jep403 — omero@4698ba119c93: ~ — docker-compose - docker compose exec jdk17 bash — 125x35
export
... 110 common frames omitted
(OMERO.venv) omero@4698ba119c93:~$ omero config set omero.jvmcfg.append '--add-opens java.base/java.lang=ALL-UNNAMED'
(OMERO.venv) omero@4698ba119c93:~$ omero admin start
WARNING: Your server has not been configured for production use.
See https://docs.openmicroscopy.org/omero/latest/sysadmins/server-performance.html?highlight=poolsize
for more information.
No descriptor given. Using etc/grid/default.xml
Waiting on startup. Use CTRL-C to exit
.....
Failed to startup some components after 300 seconds
Calling "stop" on remaining components
Waiting on shutdown. Use CTRL-C to exit
(OMERO.venv) omero@4698ba119c93:~$ tail -n 15 OMERO.current/var/log/Blitz-0.log
    at org.springframework.beans.factory.support.AbstractBeanFactory.doGetBean(AbstractBeanFactory.java:308)
    at org.springframework.beans.factory.support.AbstractBeanFactory.getBean(AbstractBeanFactory.java:197)
    at org.springframework.beans.factory.support.BeanDefinitionValueResolver.resolveReference(BeanDefinitionValueResolver
.java:351)
... 162 common frames omitted
Caused by: java.lang.IllegalAccessException: class org.springframework.ldap.core.support.AbstractContextSource (in unnamed module
@0x161b062a) cannot access class com.sun.jndi.ldap.LdapCtxFactory (in module java.naming) because module java.naming does no
t export com.sun.jndi.ldap to unnamed module @0x161b062a
    at org.springframework.ldap.core.support.AbstractContextSource.<clinit>(AbstractContextSource.java:77)
    at java.base/jdk.internal.reflect.NativeConstructorAccessorImpl.newInstance0(Native Method)
    at java.base/jdk.internal.reflect.NativeConstructorAccessorImpl.newInstance(NativeConstructorAccessorImpl.java:77)
    at java.base/jdk.internal.reflect.DelegatingConstructorAccessorImpl.newInstance(DelegatingConstructorAccessorImpl.jav
a:45)
    at java.base/java.lang.reflect.Constructor.newInstanceWithCaller(Constructor.java:499)
    at java.base/java.lang.reflect.Constructor.newInstance(Constructor.java:480)
    at org.springframework.beans.BeanUtils.instantiateClass(BeanUtils.java:142)
    at org.springframework.beans.factory.support.SimpleInstantiationStrategy.instantiate(SimpleInstantiationStrategy.java
:122)
    at org.springframework.beans.factory.support.ConstructorResolver.autowireConstructor(ConstructorResolver.java:271)
... 171 common frames omitted
(OMERO.venv) omero@4698ba119c93:~$
```

Strong encapsulation: --add-exports

- `java.lang.IllegalAccessError`
- Direct import of internal API that has been strongly encapsulated
- Workaround: use `--add-exports`
 - `--add-exports <source-module>/<package>=<target-module>(,<target-module>)*`
 - `--add-exports java.management/sun.management=ALL-UNNAMED`
- OMERO configuration: `omero.jvmcfg.append`

```
$ omero config set omero.jvmcfg.append '--add-opens  
java.base/java.lang=ALL-UNNAMED --add-exports  
java.naming/com.sun.jndi.ldap=ALL-UNNAMED'
```

<https://docs.oracle.com/en/java/javase/17/migrate/migrating-jdk-8-later-jdk-releases.html#GUID-7BB28E4D-99B3-4078-BDC4-FC24180CE82B>

OMERO & Java 17

```
omero-server-jep403 — omero@4698ba119c93: ~ — docker-compose · docker compose exec jdk17 bash — 125x35
Q export
(OMERO.venv) omero@4698ba119c93:~$ omero config set omero.jvmcfg.append '--add-opens java.base/java.lang=ALL-UNNAMED --add-ex
ports java.naming/com.sun.jndi.ldap=ALL-UNNAMED'
(OMERO.venv) omero@4698ba119c93:~$ omero admin start
WARNING: Your server has not been configured for production use.
See https://docs.openmicroscopy.org/omero/latest/sysadmins/server-performance.html?highlight=poolsize
for more information.
No descriptor given. Using etc/grid/default.xml
Waiting on startup. Use CTRL-C to exit
(OMERO.venv) omero@4698ba119c93:~$ omero login root@localhost
Password:
Created session for root@localhost:4064. Idle timeout: 10 min. Current group: system
(OMERO.venv) omero@4698ba119c93:~$
```

OMERO & Java 17+: next steps

- Limitations
 - Test coverage
 - --add-opens/--add-exports only valid for Java 9+
See <https://github.com/glencoesoftware/bioformats2raw/issues/239> for an example of impact on Java 8
 - Possible candidate for troubleshooting section
- Server dependencies upgrade
 - com.github.marcus-nl.btm:btm / org.javassist:javassist
 - org.springframework.security:spring-security-ldap/spring-ldap-core
- Opportunity to audit server dependencies

Summary

- Evolution of the Java ecosystem
- Current support
 - Bio-Formats: all Java LTS releases (8, 11, 17, 21) tested and supported
 - OMERO: Java 8 supported, Java 11 recommended
 - Running OMERO.server on Java 17/21 possible with configuration changes
 - See <https://github.com/ome/openmicroscopy/issues/6383> for more details
- Next steps
 - Define roadmap for Java 17 & 21 OMERO support
 - Review and upgrade server dependencies
 - Integrate Java 17, 21 in the daily testing
 - Building OMERO components on JDK 17, 21

Questions?



Glencoe
SOFTWARE