Prepare for JDK 9

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Sessions

1. Prepare for JDK 9
2. Introduction to Modular Development
3. Advanced Modular Development
4. Modules and Services
5. Project Jigsaw: Under The Hood

Background: JDK 9 and Project Jigsaw goals

- Make Java SE more flexible and scalable
- Improve security and maintainability
- Make it easier to construct, maintain, deploy and upgrade large applications
- Enable improved performance

Background: Categories of APIs in the JDK

- Supported, intended for external use
  - JCP standard, java.*, javax.*
  - JDK-specific API, some com.sun.*, some jdk.*
- Unsupported, JDK-internal, not intended for external use
  - sun.* mostly

JDK Contents

Why Developers Should Not Write Programs That Call 'sun' Packages

The classes that JavaSoft includes with the JDK fall into at least two packages: java.* and sun.*. Only classes in java.* packages are a standard part of the Java Platform and will be supported into the future. In general, API outside of java.* can change at any time without notice, and so cannot be counted on either across OS platforms (Sun, Microsoft, Netscape, Apple, etc.) or across Java versions. Programs that contain direct calls to the sun.* API are not 100% Pure Java. In other words:

> **The java.* packages make up the official, supported, public Java interface.**
> If a Java program directly calls only API in java.* packages, it will operate on all Java-compatible platforms, regardless of the underlying OS platform.
>
> **The sun.* packages are *not* part of the supported, public Java interface.**
> A Java program that directly calls any API in sun.* packages is *not* guaranteed to work on all Java-compatible platforms. In fact, such a program is not guaranteed to work even in future versions on the same platform.

For these reasons, there is no documentation available for the sun.* classes. Platform-independence is one of the great advantages of developing in Java. Furthermore, JavaSoft, and our licensees of Java technology, are committed to maintaining the APIs in java.* for future versions of the Java platform. (Except for code that relies on bugs that we later fix, or APIs that we deprecate and eventually remove.) This means that once your program is written, the binary will work in future releases. That is, future implementations of the java platform will be backward compatible.

Each company that implements the Java platform will do so in their own private way. The classes in sun.* are present in the JDK to support the JavaSoft implementation of the Java platform: the sun.* classes are what make the classes in java.* work "under the covers" for the JavaSoft JDK. These classes will not in general be present on another vendor's Java platform. If your Java program asks for a class "sun.package.Foo" by name, it will likely fail with ClassNotFoundError, and you will have lost a major advantage of developing in Java.

Technically, nothing prevents your program from calling API in sun.* by name, but these classes are unsupported APIs, and we are not committed to maintaining backward compatibility for them. From one release to another, these classes may be removed,or they may be moved from one package to another, and it's fairly likely that the API (method names and signatures) will change. (From the JavaSoft point of view, since we are committed to maintaining the java.* APIs, we need to be able to change sun.* to enhance our products.) In this case, even if you are willing to run only on the JavaSoft implementation, you run the risk of a new version of the implementation breaking your program.

In general, writing java programs that rely on sun.* is risky: they are not portable, and the APIs are not supported.

General compatibility policies

- If an application uses only supported APIs and works on release N then it should work on N+1, even without recompilation
- Supported APIs can be removed but only with advance notice

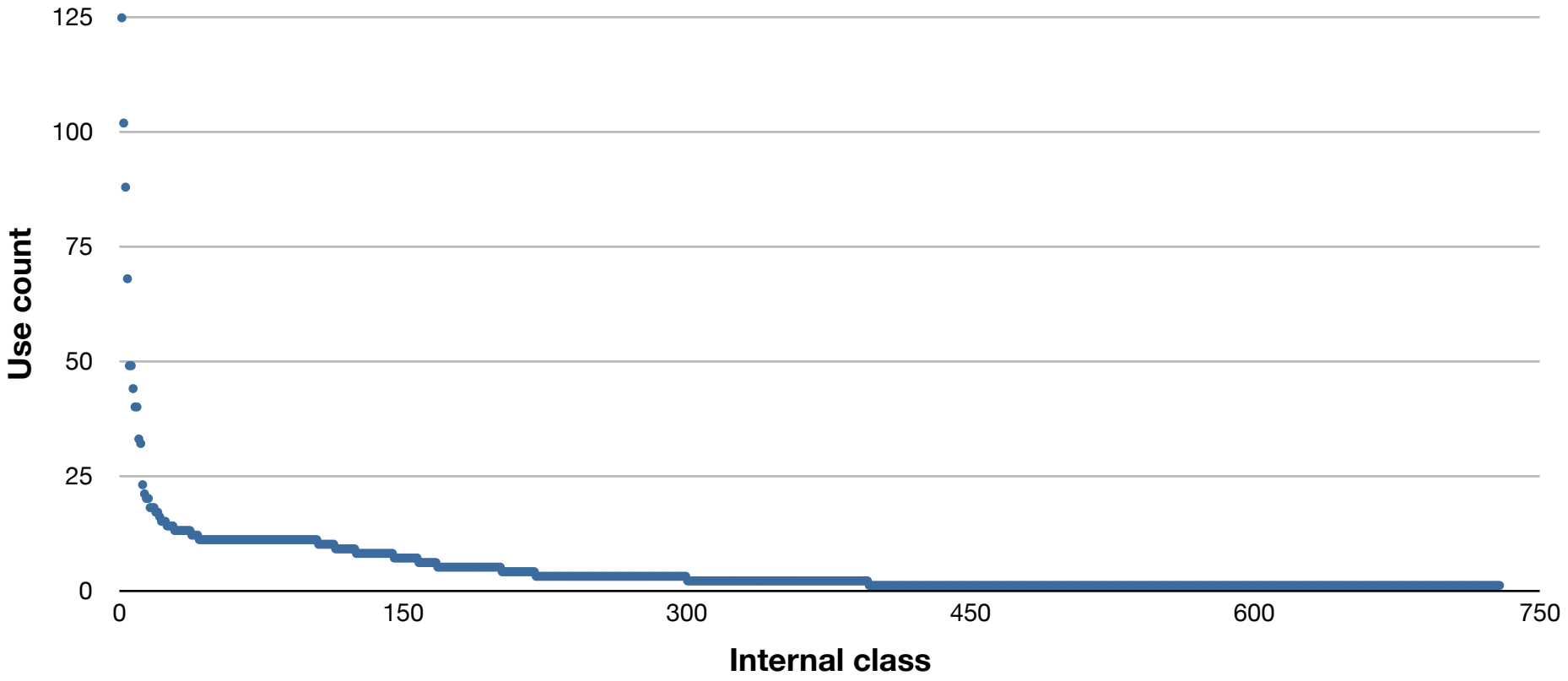
Managing incompatibilities

- Judge risk and impact based on actual data (where possible)
- Communicate early and vigorously
- Make it easy to understand how existing code will be affected
- When removing unsupported APIs, provide replacements where it makes sense
- Provide workarounds where possible

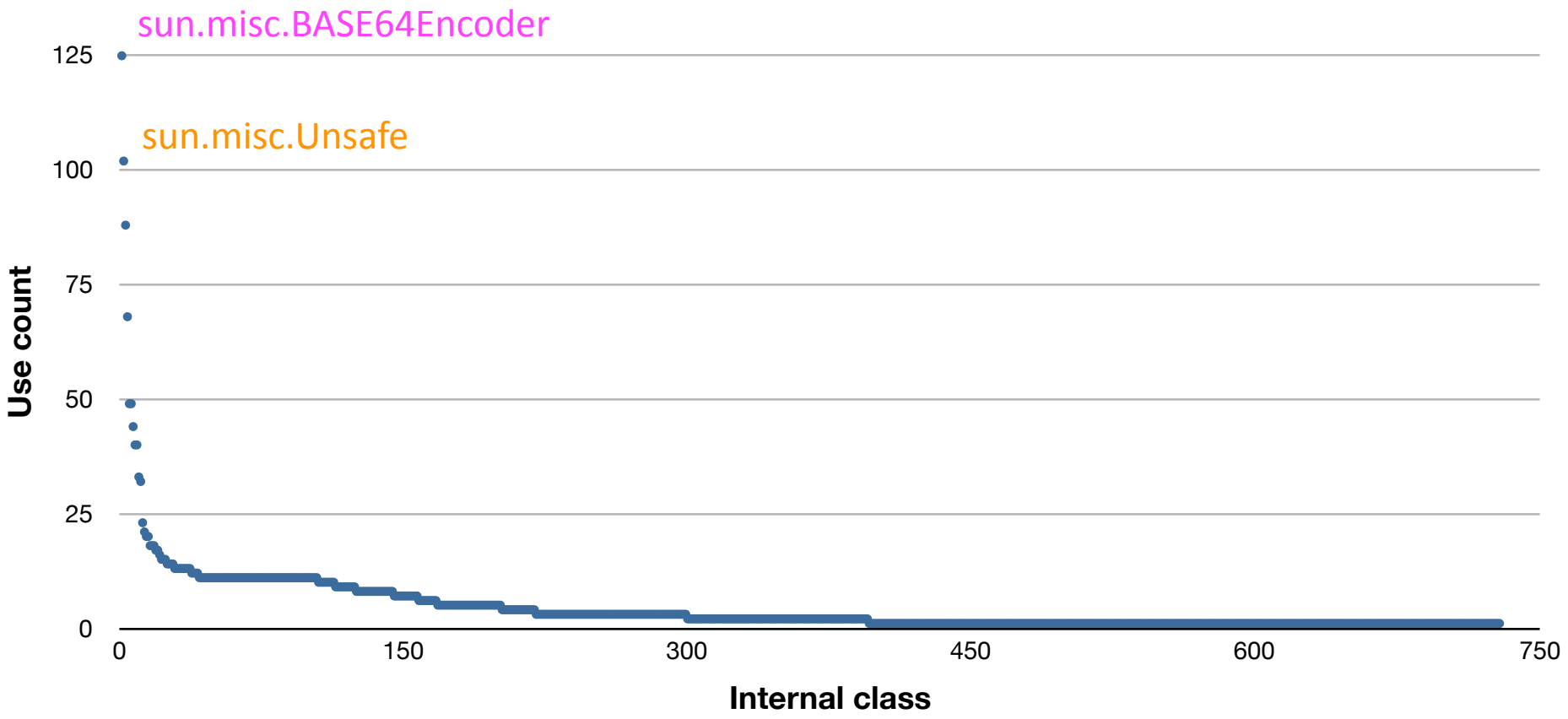
Incompatible changes in JDK 9

- Encapsulate most JDK-internal APIs
- Change the binary structure of the JRE and JDK
- Remove a small number of supported, JCP-standard APIs
- Remove the endorsed-standards override and extension mechanisms
- Java EE modules not resolved by default
- New version-string format

Uses of JDK-internal APIs



Uses of JDK-internal APIs



Categories of JDK-internal APIs

- Non-critical
  - No evidence of use outside of JDK
  - or used only for convenience
- Critical
  - Functionality that would be difficult, if not impossible, to implement outside of the JDK

JEP 260

- Encapsulate all non-critical internal APIs by default
- Encapsulate all critical internal APIs for which supported replacements exist in JDK 8
- Do not encapsulate critical internal APIs
  - Deprecate them in JDK 9
  - Plan to remove in JDK 10
  - Provide a workaround via command-line flag

JEP 260

- Propose as critical internal APIs
  - sun.misc.Unsafe
  - sun.misc.{Signal,SignalHandler}
  - sun.reflect.Reflection::getCallerClass
  - sun.reflect.ReflectionFactory

Uses of JDK-internal APIs

State	Count	Type
R8	125	sun.misc.BASE64Encoder
C	102	sun.misc.Unsafe
R8	88	sun.misc.BASE64Decoder
R2	68	java.awt.peer.ComponentPeer
R4	49	com.sun.image.codec.jpeg.JPEGImageEncoder
R4	49	com.sun.image.codec.jpeg.JPEGCodec
R3	44	com.sun.net.ssl.internal.ssl.Provider
R1	40	sun.security.action.GetPropertyAction
R4	40	com.sun.image.codec.jpeg.JPEGEncodeParam
C	33	sun.reflect.ReflectionFactory
X	32	sun.security.util.DerValue
X	23	com.sun.org.apache.xml.internal.serialize.XMLSerializer
R4	21	com.sun.image.codec.jpeg.JPEGImageDecoder
C	20	sun.reflect.ReflectionFactory$GetReflectionFactoryAction
X	20	com.sun.org.apache.xml.internal.serialize.OutputFormat
X	18	sun.net.www.ParseUtil
R4	18	sun.security.x509.X500Name
X	18	sun.security.util.ObjectIdentifier
R9	17	sun.security.krb5.EncryptionKey
R9	17	com.sun.org.apache.xml.internal.resolver.tools.CatalogResolver
R0	16	java.awt.peer.LightweightPeer
X	15	sun.net.www.protocol.http.HttpURLConnection
R6	15	sun.misc.Service
R9	15	sun.awt.CausedFocusEvent$Cause
X	14	sun.nio.cs.Surrogate$Parser

State	Count	Type
X	14	sun.nio.cs.Surrogate
R7	14	com.sun.rowset.CachedRowSetImpl
X	14	sun.security.x509.X509CertImpl
X	13	sun.java2d.pipe.Region
S9	13	org.w3c.dom.xpath.XPathResult
S9	13	org.w3c.dom.xpath.XPathNSResolver
S9	13	org.w3c.dom.xpath.XPathEvaluator
X	13	com.sun.org.apache.xpath.internal.objects.XObject
X	13	com.sun.org.apache.xpath.internal.objects.XNodeSet
R9	13	com.sun.org.apache.xml.internal.resolver.CatalogManager
R9	13	com.sun.org.apache.xml.internal.resolver.Catalog
X	13	com.sun.org.apache.xerces.internal.jaxp.DocumentBuilder…
C	12	sun.reflect.Reflection
X	12	sun.misc.CharacterEncoder
X	12	sun.security.util.DerInputStream

C = Critical, no supported replacement in 8, will remain in 9, gone in 10
S9 = Non-critical, but now supported in 9
RN = Non-critical, supported replacement added in JDK N (N < 9), encapsulated in 9
X = Non-critical, no replacement planned, encapsulated in 9

Finding uses of JDK-internal APIs

- jdeps tool in JDK 8, improved in JDK 9
- Maven JDeps Plugin

```
$ jdeps -jdkinternals glassfish/modules/security.jar
security.jar -> java.base
   com.sun.enterprise.common.iiop.security.GSSUPName (security.jar)
      -> sun.security.util.ObjectIdentifier                JDK internal API (java.base)
   com.sun.enterprise.common.iiop.security.GSSUtilsContract (security.jar)
      -> sun.security.util.ObjectIdentifier                JDK internal API (java.base)
   com.sun.enterprise.security.auth.login.LoginContextDriver (security.jar)
      -> sun.security.x509.X500Name                        JDK internal API (java.base)
   com.sun.enterprise.security.auth.login.LoginContextDriver$4 (security.jar)
      -> sun.security.x509.X500Name                        JDK internal API (java.base)
   com.sun.enterprise.security.auth.realm.certificate.CertificateRealm (security.jar)
      -> sun.security.x509.X500Name                        JDK internal API (java.base)
   com.sun.enterprise.security.auth.realm.ldap.LDAPRealm (security.jar)
      -> sun.security.x509.X500Name                        JDK internal API (java.base)
   com.sun.enterprise.security.ssl.JarSigner (security.jar)
      -> sun.security.pkcs.ContentInfo                     JDK internal API (java.base)
      -> sun.security.pkcs.PKCS7                           JDK internal API (java.base)
      -> sun.security.pkcs.SignerInfo                      JDK internal API (java.base)
      -> sun.security.x509.AlgorithmId                     JDK internal API (java.base)
      -> sun.security.x509.X500Name                        JDK internal API (java.base)

Warning: JDK internal APIs are unsupported and private to JDK implementation that are
subject to be removed or changed incompatibly and could break your application.
Please modify your code to eliminate dependency on any JDK internal APIs.
For the most recent update on JDK internal API replacements, please check:
https://wiki.openjdk.java.net/display/JDK8/Java+Dependency+Analysis+Tool

JDK Internal API                        Suggested Replacement
----------------                        ---------------------
sun.security.x509.X500Name              Use javax.security.auth.x500.X500Principal @since 1.4
```

Example: Glassfish 4.1

java.lang.IllegalAccessError: class com.sun.enterprise.security.provider.PolicyWrapper (in unnamed module @0x7cdbc5d3) cannot access class sun.security.provider.PolicyFile (in module java.base), because module java.base does not export sun.security.provider to unnamed module @0x7cdbc5d3

```
com.sun.enterprise.security.provider.PolicyWrapper.getNewPolicy(PolicyWrapper.java:75)
```
at com.sun.enterprise.security.provider.BasePolicyWrapper.<init>(BasePolicyWrapper.java:148)
at com.sun.enterprise.security.provider.PolicyWrapper.<init>(PolicyWrapper.java:67)
at sun.reflect.NativeConstructorAccessorImpl.newInstance0(java.base@9.0/Native Method)
at sun.reflect.NativeConstructorAccessorImpl.newInstance(java.base@9.0/NativeConstructorAccessorImpl.java:62)
at sun.reflect.DelegatingConstructorAccessorImpl.newInstance(java.base@9.0/DelegatingConstructorAccessorImpl.java:45)
at java.lang.reflect.Constructor.newInstance(java.base@9.0/Constructor.java:443)
at java.lang.Class.newInstance(java.base@9.0/Class.java:525)
at com.sun.enterprise.security.PolicyLoader.loadPolicy(PolicyLoader.java:155)
at com.sun.enterprise.security.SecurityLifecycle.onInitialization(SecurityLifecycle.java:163)
at com.sun.enterprise.security.SecurityLifecycle.postConstruct(SecurityLifecycle.java:208)
:

Example: Gradle 2.7

```
:compileJava FAILED

FAILURE: Build failed with an exception.

* What went wrong:
Execution failed for task ':compileJava'.
> Could not create an instance of type com.sun.tools.javac.api.JavacTool.

* Try:
Run with --stacktrace option to get the stack trace. Run with --info or --debug option to get
more log output.

BUILD FAILED
```

Example: Gradle 2.7

$ gradle --stacktrace myjar

:

Caused by: **java.lang.IllegalAccessException: class org.gradle.internal.reflect.DirectInstantiator cannot access class com.sun.tools.javac.api.JavacTool (in module jdk.compiler) because module jdk.compiler does not export package com.sun.tools.javac.api to unnamed module @2f490758**

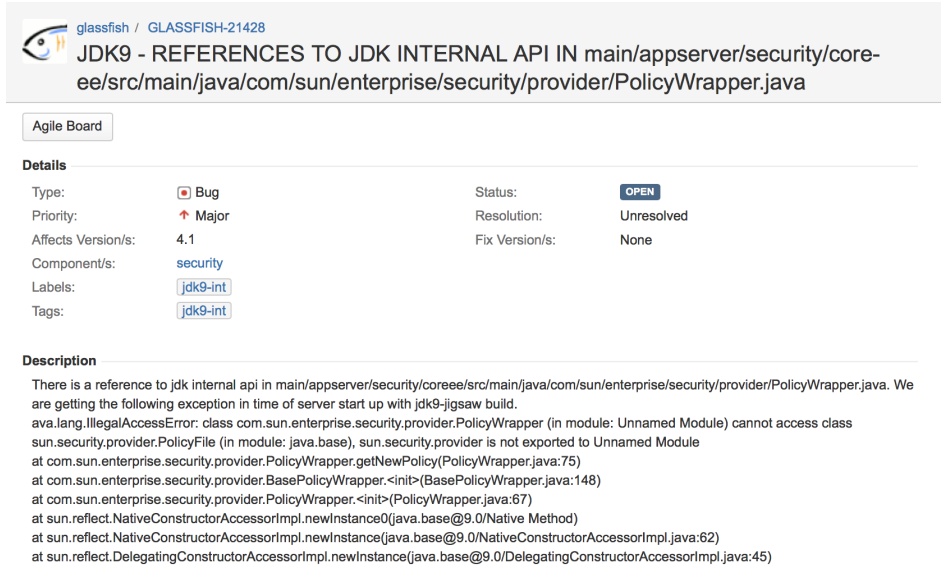
at org.gradle.internal.reflect.DirectInstantiator.newInstance(DirectInstantiator.java:49)
... 82 more

Don’t panic

```
--add-exports java.base/sun.security.provider=ALL-UNNAMED
--add-exports java.base/sun.security.pkcs=ALL-UNNAMED
--add-exports java.base/sun.security.util=ALL-UNNAMED
--add-exports java.base/sun.security.x509=ALL-UNNAMED
:
```

Don’t panic

```
--add-exports java.base/sun.security.provider=ALL-UNNAMED
--add-exports java.base/sun.security.pkcs=ALL-UNNAMED
--add-exports java.base/sun.security.util=ALL-UNNAMED
--add-exports java.base/sun.security.x509=ALL-UNNAMED
:
```



glassfish / GLASSFISH-21428

JDK9 - REFERENCES TO JDK INTERNAL API IN main/appserver/security/core-ee/src/main/java/com/sun/enterprise/security/provider/PolicyWrapper.java

Agile Board

Details

Type:	Bug	Status:	OPEN
Priority:	Major	Resolution:	Unresolved
Affects Version/s:	4.1	Fix Version/s:	None
Component/s:	security		
Labels:	jdk9-int		
Tags:	jdk9-int		

Description

There is a reference to jdk internal api in main/appserver/security/coreee/src/main/java/com/sun/enterprise/security/provider/PolicyWrapper.java. We are getting the following exception in time of server start up with jdk9-jigsaw build.

```
ava.lang.IllegalAccessError: class com.sun.enterprise.security.provider.PolicyWrapper (in module: Unnamed Module) cannot access class sun.security.provider.PolicyFile (in module: java.base), sun.security.provider is not exported to Unnamed Module
at com.sun.enterprise.security.provider.PolicyWrapper.getNewPolicy(PolicyWrapper.java:75)
at com.sun.enterprise.security.provider.BasePolicyWrapper.<init>(BasePolicyWrapper.java:148)
at com.sun.enterprise.security.provider.PolicyWrapper.<init>(PolicyWrapper.java:67)
at sun.reflect.NativeConstructorAccessorImpl.newInstance0(java.base@9.0/Native Method)
at sun.reflect.NativeConstructorAccessorImpl.newInstance(java.base@9.0/NativeConstructorAccessorImpl.java:62)
at sun.reflect.DelegatingConstructorAccessorImpl.newInstance(java.base@9.0/DelegatingConstructorAccessorImpl.java:45)
```

Breaking encapsulation using the command line

```
--add-exports java.base/sun.security.provider=ALL-UNNAMED
```

Breaking encapsulation with the JAR file manifest

```
Add-Exports: java.base/sun.security.provider
```

Incompatible changes in JDK 9

- Encapsulate most JDK-internal APIs
- Change the binary structure of the JRE and JDK
- Remove a small number of supported, JCP-standard APIs
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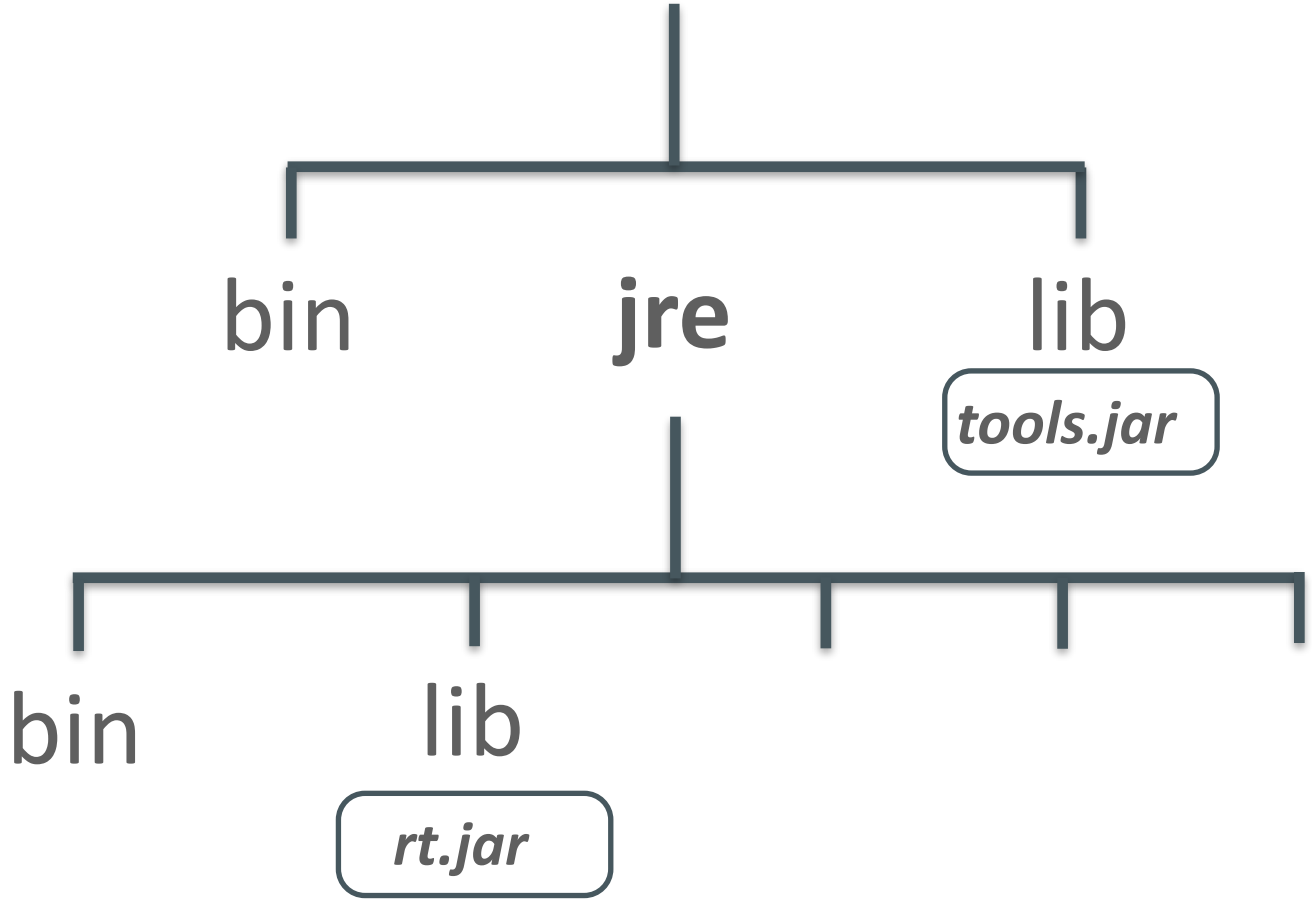
- Java EE modules not resolved by default
- New version-string format

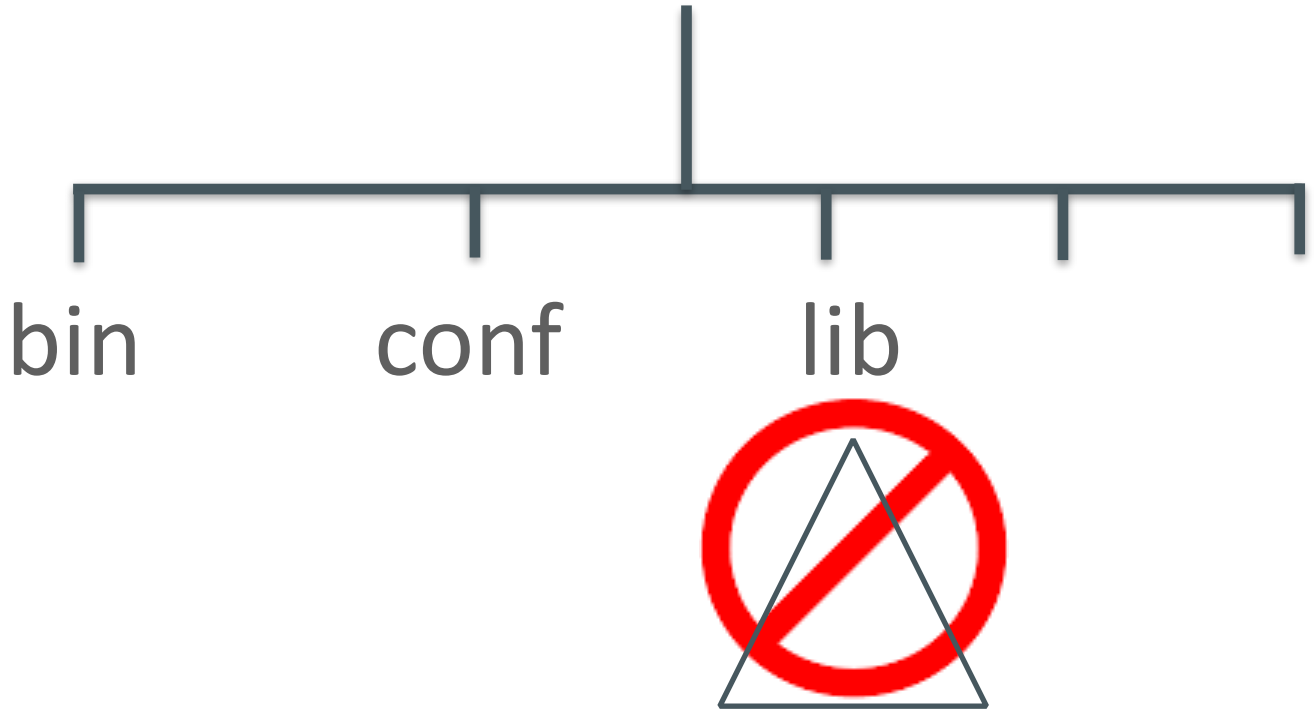
Change the binary structure of the JRE and JDK

- Motivation
- Not an API but still a disruptive change
- Details in JEP 220
- In JDK 9 since late 2014 to give lots of time for the tools to catch up

JDK 8 runtime image



Modular run-time image



~~jre directory~~

~~rt.jar~~

~~tools.jar~~

Removed 6 deprecated methods

- Removed
  - java.util.logging.LogManager::addPropertyChangeListener
  - java.util.logging.LogManager::removePropertyChangeListener
  - java.util.jar.Pack200.Packer::addPropertyChangeListener
  - java.util.jar.Pack200.Packer::removePropertyChangeListener
  - java.util.jar.Pack200.Unpacker::addPropertyChangeListener
  - java.util.jar.Pack200.Unpacker::removePropertyChangeListener
- Flagged for removal in JSR 337, and JEP 162

Removed

- Endorsed standards override mechanism
- Extension mechanism

```
java -cp jsr305.jar …
```

```
javax.annotation.Notnull
javax.annotation.Nullable
:
```

Modules shared with Java EE not resolved by default

- java.corba —> CORBA
- java.transaction —> Java SE subset of the Java Transactton API
- java.annotations.common —> Java SE subset of the Common Annotations
- java.activation —> JavaBeans Activition Framework
- java.xml.ws —> JAX-WS
- java.xml.bind —> JAXB

Modules shared with Java EE not resolved by default

- Use a command line option to ensure the module is resolved
  - `--add-modules java.corba`
- Deploy on the upgrade module path
  - `--upgrade-module-path corba.jar –add-modules java.corba`
- Deploy on the class path
  - `--class-path java.corba.jar`

Other changes

- Application and extension class loaders are no longer instances of java.net.URLClassLoader
- Removed: -Xbootclasspath and -Xbootclasspath/p are removed
- Removed: system property sun.boot.class.path
- JEP 261 has the full list of the issues that we know about

New version-string scheme, JEP 223

- Old versioning format is difficult to understand
- New format addresses these problems
- Impacts java -version and related properties

New version-string format

	Old		New	
Release Type	long	short	long	short
Early Access	1.9.0-ea-b19	9-ea	9-ea+19	9-ea
Major	1.9.0-b100	9	9+100	9
Security #1	1.9.0_5-b20	9u5	9.0.1+20	9.0.1
Security #2	1.9.0_11-b12	9u11	9.0.2+12	9.0.2
Minor #1	1.9.0_20-b62	9u20	9.1.2+62	9.1.2
Security #3	1.9.0_25-b15	9u25	9.1.3+15	9.1.3
Security #4	1.9.0_31-b08	9u31	9.1.4+8	9.1.4
Minor #2	1.9.0_40-b45	9u40	9.2.4+45	9.2.4

System properties

System Property	Existing	Proposed
Major (GA)		
java.version	1.9.0	9
java.runtime.version	1.9.0-b100	9+100
java.vm.version	1.9.0-b100	9+100
java.specification.version	1.9	9
java.vm.specification.version	1.9	9
Minor #1 (GA)		
java.version	1.9.0_20	9.1.2
java.runtime.version	1.9.0_20-b62	9.1.2+62
java.vm.version	1.9.0_20-b62	9.1.2+62
java.specification.version	1.9	9
java.vm.specification.version	1.9	9

- JEP 238: Multi-Release JAR Files
- JEP 247: Compile for Older Platforms Versions

Consider this

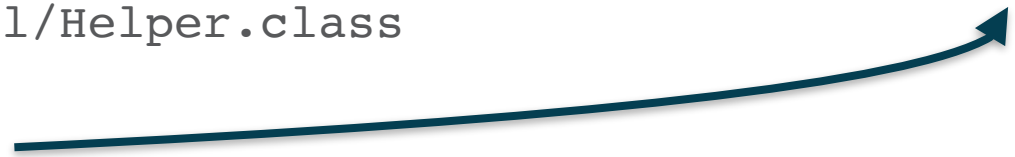
- My application uses JDK internal APIs
  - Not going to work on JDK 9 without a command-line option
- I can replace these usages by using new APIs in Java SE 9
  - e.g. VarHandles or the new XML Catalog API
- But my application needs to continue to build + run on JDK 8

Multi-Release JAR files

- JAR format has been extended to allow multiple, Java-release specifc versions class files to coexist in a single archive
- Contents for an example MR JAR file:

```
com/acme/stats/cli/Main.class
com/acme/stats/internal/Helper.class
META-INF/
META-INF/MANIFEST.MF
META-INF/versions/9/com/acme/stats/internal/Helper.class
```

```
Multi-Release: true
```



Multi-Release JAR files

```
$ java -jar stats-cli.jar
```

- JDK 8
  - `com.acme.stats.internal.Helper` loaded from base section
- JDK 9
  - `com.acme.stats.internal.Helper` loaded from `META-INF/versions/9`

Do I need two JDK versions in my build environment?

- Historically needed to do this:
  - `javac -source 7 -target 8 -bootclasspath:$JDK7 ..`
- With JDK 9:
  - `javac --release 7 ..`
- This means one JDK version in the build environment
- With Maven and other tooling/IDE support then it shouldn't be hard

What can you do to prepare for JDK 9?

- Check code for usages of JDK-internal APIs with jdeps
- Check code that might be sensitive to the version change
- If you develop tools then check code for a dependency on rt.jar or tools.jar or the runtime-image layout
- Test the JDK 9 EA builds and Project Jigsaw EA builds
- Get familar with new features like MR JARs and the ability to compile to older releases

More Information

OpenJDK Project Jigsaw page, this has links to all the JEPs
http://openjdk.java.net/projects/jigsaw/
mailto:jigsaw-dev@openjdk.java.net

Early Access Builds
https://jdk9.java.net/download

Java Dependency Analysis Tool
https://wiki.openjdk.java.net/display/JDK8/Java+Dependency+Analysis+Tool

JEP 223: New Version-String Scheme
http://openjdk.java.net/jeps/223

JEP 238: Multi-Release JAR files
http://openjdk.java.net/jeps/238

Other sessions, mostly this room

- Introduction to Modular Development: Mon @ 2.30pm, Wed @ 3pm
- Advanced Modular Development: Mon @ 5.30pm, Wed @ 4.30pm
- Modules and Services, Tues @ 11.00am, Thur @ 2.30pm
- Project Jigsaw: Under The Hood: Tues @ 4pm.
- Project Jigsaw Hack Session: Wed @ 8.30am

Safe Harbor Statement

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