Reproducible Builds for the JVM

and beyond

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About Me

- Maven PMC Member, Attic PMC Chair
- ASF Member
- working on Software Supply Chain @ Sonatype
- SBOM: CycloneDX, SPDX
- signature: Sigstore

- Reproducible Builds for the JVM:
  - discovered in April 2016 (post-processing)
  - actively working since January 2019 (Maven built-in)

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Agenda

- Reproducible Builds
  - what? why? how?
- Reproducible Builds for the JVM
  - checking against Maven Central
  - configuring for Maven, Gradle, sbt
- Quiz: to be or not to be Reproducible
- What's next?

Reproducible Builds: what? why? how?

Reproducible Builds

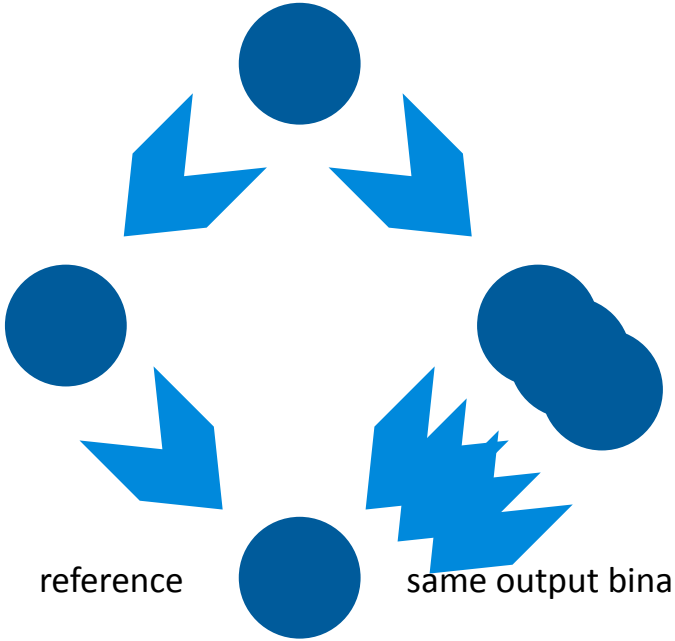
https://reproducible-builds.org/ (since 2013)

a set of software development practices that create an independently-verifiable path from source to binary code

input source code

builder

reference



rebuilder

output binaries

reference

same output binaries (bit for bit)

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Why does it matter?

- reproducible-builds.org:
  “allow verification that no vulnerabilities or backdoors have been introduced during the compilation process”
- my own return on experience
  - you have the source, but are you *really* able to rebuild?
    - is it the real Git commit? is “Build successful” message sufficient?
  - are you sure nothing from your build environment leaked into output binaries?
    - found username, hostname, path to current directory, private key passphrase, …
  - permits build efficiency from build cache
- **ASF policy: official source release vs convenience binaries**
  - how do you audit binaries staged by release manager? “Just trust”?

How?

- reproducible-build.org:

  3. users should be given a way to recreate a close enough build environment, perform the build process, and validate that the output matches the original build.

  2. the set of tools used to perform the build and more generally the build environment should either be recorded or pre-defined.

  1. the build system needs to be made entirely deterministic.
  For example, the current date and time must not be recorded and output always has to be written in the same order.

Reproducible Builds for the JVM:

2. check binaries: Maven Central
1. configure build: Maven, Gradle, sbt

Reproducible Central (started 03-2020)

https://github.com/jvm-repo-rebuild/reproducible-central

1. **Tools and methods allowing to verify that Java builds are reproducible**
2. **A list of reproducible releases published to Maven Central**

   rebuilding **2611 releases** of **550 projects**:

   - **2027** releases are confirmed **fully reproducible** (100% reproducible artifacts ✔️),
   - 584 releases are only partially reproducible (contain some unreproducible artifacts ⚠️)
   - on 550 projects, 439 have at least one fully reproducible release, 111 have none

Reproducible Central

https://github.com/jvm-repo-rebuild/reproducible-central

Rebuild Detailed Results

Central Repository groupId	artifactId(s)	versions	result: reproducible?
biz.aQute.bnd	bnd-plugin-parent	8	8 ✓
ch.qos.logback	logback-parent	16	10 ✓ / 6 ⚠
ch.qos.reload4j	reload4j	7	1 ✓ / 6 ⚠
ch.qos.logback.db	logback-parent-db	1	1 ⚠
com.flowlogix	flowlogix	10	6 ✓ / 4 ⚠

Project: org.apache.maven.plugins:maven-javadoc-plugin

Source code: https://github.com/apache/maven-javadoc-plugin.git

rebuilding **8 releases** of org.apache.maven.plugins:maven-javadoc-plugin:

- **5** releases were found successfully **fully reproducible** (100% reproducible artifacts ✓),
- 3 had issues (some unreproducible artifacts ⚠️, see eventual 🔍 diffoscope and/or 📝 issue tracker links):

version	build spec	result: reproducible?	size
3.6.0	mvn jdk17	result: 5 ✓ 1 ⚠️ 🔍 📝	4.6M
3.5.0	mvn jdk8 w	result: 4 ✓	4.2M
3.4.1	mvn jdk8 w	result: 4 ✓	4.2M
3.4.0	mvn jdk8 w	result: 4 ✓	4.2M
3.3.2	mvn jdk8 w	result: 4 ✓	4.2M
3.3.1	mvn jdk8 w	result: 3 ✓ 1 ⚠️	4.2M
3.3.0	mvn jdk8 w	result: 4 ✓	4.1M
3.2.0	mvn jdk8	result: 3 ✓ 1 ⚠️	4.0M

`./rebuild.sh <path/to/...>/<project>-<version>.buildspec`

$ maven-javadoc-plugin-3.5.0.buildspec

content > org > apache > maven > plugins > maven-javadoc-plugin > $ maven-javadoc-plugin-3.5.0.buildspec

```
1   groupId=org.apache.maven.plugins
2   artifactId=maven-javadoc-plugin
3   display=${groupId}:${artifactId}
4   version=3.5.0
5
6   gitRepo=https://github.com/apache/${artifactId}.git
7   gitTag=${artifactId}-${version}
8
9   tool=mvn
10  jdk=8
11  newline=crlf
12
13  command="mvn -Papache-release clean package -Dmaven.javadoc.skip -Dgpg.skip -DskipTests"
14  buildinfo=target/${artifactId}-${version}.buildinfo
15
16  issue=
17
```

```
❯ ./rebuild.sh content/org/apache/maven/plugins/maven-javadoc-plugin/maven-javadoc-plugin-3.5.0.buildspec
[INFO] Rebuilding from spec content/org/apache/maven/plugins/maven-javadoc-plugin/maven-javadoc-plugin-3.5.0.buildspec
[INFO] - groupId: org.apache.maven.plugins
[INFO] - artifactId: maven-javadoc-plugin
[INFO] - version: 3.5.0
[INFO] - gitRepo: https://github.com/apache/maven-javadoc-plugin.git
[INFO] - gitTag: maven-javadoc-plugin-3.5.0
[INFO] - tool: mvn
[INFO] - jdk: 8
[WARN] - timezone: Using default value: "UTC"
[WARN] - locale: Using default value: "en_US"
[WARN] - umask: Using default value: "0002"
[INFO] - newline: crlf
[INFO] - command: mvn -Papache-release clean package -Dmaven.javadoc.skip -Dgpg.skip -DskipTests
[INFO] - buildinfo: target/maven-javadoc-plugin-3.5.0.buildinfo

[INFO] Fetching source code from Git https://github.com/apache/maven-javadoc-plugin.git on tag maven-javadoc-plugin-3.5.0
```

```
[INFO] Rebuilder Docker image is ready for use: rb-ubuntu-2204-jdk8-mvn3.6.3-toolchains-8-hboutemy-utc-en_us-0002
[INFO] Rebuilding org.apache.maven.plugins:maven-javadoc-plugin:3.5.0 release
[RUN ] docker run -it --rm --name rebuild-central -v /Users/hboutemy/dev/git/misc/reproducible-central/content/org/apache/maven/plugins/maven-javadoc-plugin/buildcache/maven-javadoc-plugin:/var/maven/app -v /Users/hboutemy/dev/git/misc/reproducible-central/m2:/var/maven/.m2 -v /Users/hboutemy/dev/git/misc/reproducible-central/.sbt:/var/maven/.sbt -v /Users/hboutemy/dev/git/misc/reproducible-central/.npm:/.npm -v /Users/hboutemy/dev/git/misc/reproducible-central/.bnd:/.bnd -u hboutemy:20 -e MAVEN_CONFIG=/var/maven/.m2 -e MVN_UMASK=0002 -w /var/maven/app rb-ubuntu-2204-jdk8-mvn3.6.3-toolchains-8-hboutemy-utc-en_us-0002 /var/maven/.m2/mvncrlf -Papache-release clean package -Dmaven.javadoc.skip -Dgpg.skip -DskipTests -V -e org.apache.maven.plugins:maven-artifact-plugin:3.5.0:compare -Dbuildinfo.reproducible -Dcompare.fail=false
Apache Maven 3.6.3 (cecedd343002696d0abb50b32b541b8a6ba2883f)
Maven home: /usr/local/apache-maven
Java version: 1.8.0_362, vendor: Private Build, runtime: /usr/lib/jvm/java-8-openjdk-amd64/jre
Default locale: en_US, platform encoding: UTF-8
OS name: "linux", version: "6.1.51-0-virt", arch: "amd64", family: "unix"
```

```
[INFO] rebuild from content/org/apache/maven/plugins/maven-javadoc-plugin/maven-javadoc-plugin-3.5.0.buildspec
[INFO]   results in content/org/apache/maven/plugins/maven-javadoc-plugin/maven-javadoc-plugin-3.5.0.buildinfo
[INFO] compared to Central Repository content/org/apache/maven/plugins/maven-javadoc-plugin/maven-javadoc-plugin-3.5.0.buildcompare:
    ok=4
    okFiles="maven-javadoc-plugin-3.5.0.pom maven-javadoc-plugin-3.5.0.jar maven-javadoc-plugin-3.5.0-source-release.zip maven-javadoc-plugin-3.5.0-sources.jar"
```

What If a Difference is Found?

1. Where is the difference?

```
[ERROR] size mismatch maven-javadoc-plugin-3.6.0-source-release.zip: investigate with diffoscope target/referen                                    in-3.6.
0-source-release.zip target/maven-javadoc-plugin-3.6.0-source-release.zip
[ERROR] Reproducible Build output summary: 5 files ok, 1 different
```

2. What is the difference? https://diffoscope.org/


```
❯ diffoscope target/reference/org.apache.maven.plugins/maven-javadoc-plugin-3.6.0-source-release.zip target/ma
--- target/reference/org.apache.maven.plugins/maven-javadoc-plugin-3.6.0-source-release.zip
+++ target/maven-javadoc-plugin-3.6.0-source-release.zip
├── zipinfo {}
 @@ -1,8 +1,8 @@
 -Zip file size: 3609104 bytes, number of entries: 2481
 +Zip file size: 3607260 bytes, number of entries: 2479
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/it/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/it/mrm/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/it/mrm/3rdparty/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/it/mrm/3rdparty/doclet-1.0.jar/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/it/mrm/3rdparty/doclet-1.0.jar/org/
 @@ -1503,19 +1503,17 @@
  drwxr-xr-x  2.0 unx        0 b- stor 23-Sep-12 05:43 maven-javadoc-plugin-3.6.0/src/test/resources/unit/validate-options-test/src/main/
```

What If a Difference is Found?

1. Where is the difference?

```
[ERROR] size mismatch maven-javadoc-plugin-3.6.0-source-release.zip: investigate with diffoscope target/referen                                    in-3.6.
0-source-release.zip target/maven-javadoc-plugin-3.6.0-source-release.zip
[ERROR] Reproducible Build output summary: 5 files ok, 1 different
```

2. What is the difference? https://diffoscope.org/

3. Why? How to Fix?

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Reproducible Builds for the JVM:

2. check binaries: Maven Central
1. configure build: Maven, Gradle, sbt

Reproducible Builds for Maven (since 03-2020)

https://maven.apache.org/guides/mini/guide-reproducible-builds.html

1. Enable Reproducible Builds:

```
<properties>
  <project.build.outputTimestamp>2023-01-01T00:00:00Z</project.build.outputTimestamp>
</properties>
```

2. Check plugins known to require upgrade: `mvn artifact:check-buildplan`
   = https://maven.apache.org/plugins/maven-artifact-plugin/plugin-issues.html

Checking for Reproducible Builds

3. **after release pushed to Maven Central:**
   ```
   mvn -Papache-release -Dgpg.skip clean verify artifact:compare
   ```

2. **during VOTE:**
   ```
   mvn -Papache-release -Dgpg.skip clean verify artifact:compare
                  -Dreference.repo=https://repository.apache.org/content/repositories/staging/
   ```

1. **during SNAPSHOT development:**
   Check locally if you get the same result twice
   ```
   mvn clean install
   mvn clean verify artifact:compare
   ```
   ideally (harder): rebuilder on a different machine, or Docker, to detect more subtle environment impact

Reproducible Builds for Gradle

- since Gradle 3.4
  https://docs.gradle.org/current/userguide/working_with_files.html#sec:reproducible_archives

Kotlin Groovy

build.gradle

```
tasks.withType(AbstractArchiveTask).configureEach {
    preserveFileTimestamps = false
    reproducibleFileOrder = true
}
```

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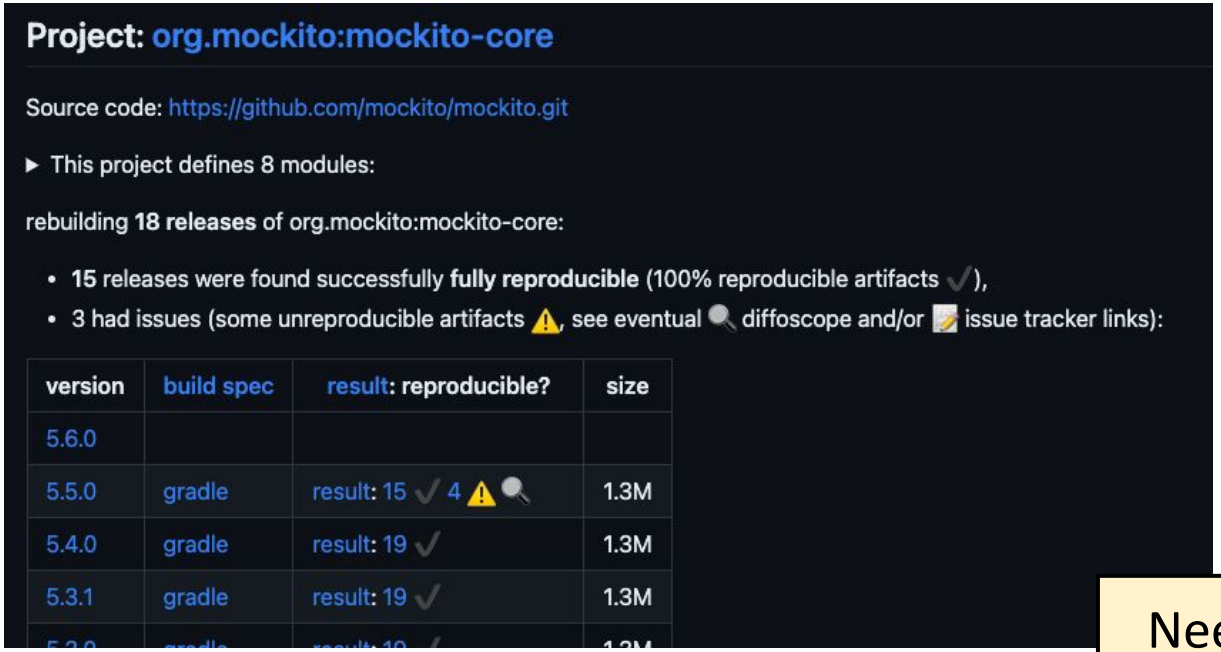
Gradle in Reproducible Central



Project: org.mockito:mockito-core

Source code: https://github.com/mockito/mockito.git

▶ This project defines 8 modules:

rebuilding **18 releases** of org.mockito:mockito-core:

- **15** releases were found successfully **fully reproducible** (100% reproducible artifacts ✔️),
- 3 had issues (some unreproducible artifacts ⚠️, see eventual 🔍 diffoscope and/or 📝 issue tracker links):

version	build spec	result: reproducible?	size
5.6.0			
5.5.0	gradle	result: 15 ✔️ 4 ⚠️🔍	1.3M
5.4.0	gradle	result: 19 ✔️	1.3M
5.3.1	gradle	result: 19 ✔️	1.3M

Need Help!

Reproducible Builds for sbt

Project: com.scalapenos:stamina_2.11

Source code: https://github.com/scalapenos/stamina.git

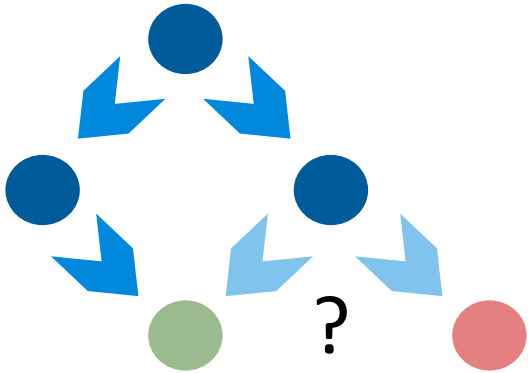
rebuilding **2 releases** of com.scalapenos:stamina_2.11:

- **2** releases were found successfully **fully reproducible** (100% reproducible artifacts ✔️),
- 0 had issues (some unreproducible artifacts ⚠️, see eventual 🔍 diffoscope and/or 📝 issue tracker links):

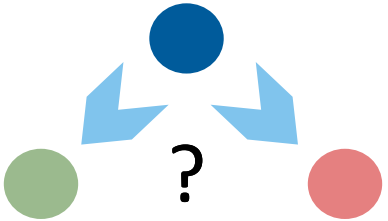
version	build spec	result: reproducible?	size
0.1.6	sbt jdk8	24 ✔️	146K
0.1.5	sbt jdk8	24 ✔️	146K

Need Help!

Quiz:
to be or not to be Reproducible



#1 Reproducible or not?




```
[INFO] --- artifact:3.5.0:compare (default-cli) @ maven-javadoc-plugin ---
[INFO] Saved info on build to /Users/hboutemy/dev/git/misc/reproducible-central/content/org/apa
n/target/maven-javadoc-plugin-3.5.0.buildinfo
[INFO] Checking against reference build from central...
Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-j
[INFO] Reference buildinfo file not found: it will be generated from downloaded reference artif
[INFO] Reference build java.version: 1.8 (from MANIFEST.MF Build-Jdk-Spec)
[INFO] Reference build os.name: Windows (from pom.properties newline)
[INFO] Minimal buildinfo generated from downloaded artifacts: /Users/hboutemy/dev/git/misc/repr
n/buildcache/maven-javadoc-plugin/target/reference/maven-javadoc-plugin-3.5.0.buildinfo
[INFO] Reproducible Build output summary: 4 files ok
```

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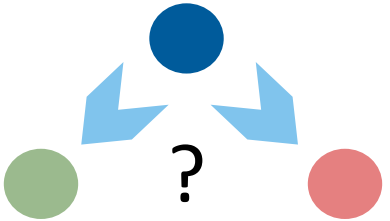
#2 Reproducible or not?




```
[INFO] Reference build java.version: 1.8 (from MANIFEST.MF Build-Jdk-Spec)
[ERROR] Current build java.version: 11 (from MANIFEST.MF Build-Jdk-Spec)
[INFO] Reference build os.name: Windows (from pom.properties newline)
[INFO] Minimal buildinfo generated from downloaded artifacts: /Users/hboutemy/dev/git/misc/
n/buildcache/maven-javadoc-plugin/target/reference/maven-javadoc-plugin-3.5.0.buildinfo
[ERROR] size mismatch maven-javadoc-plugin-3.5.0.jar: investigate with diffoscope target/re
ven-javadoc-plugin-3.5.0.jar
[ERROR] Reproducible Build output summary: 3 files ok, 1 different
```

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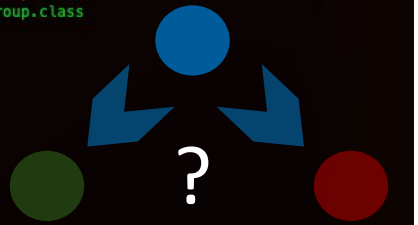
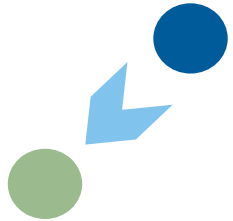
```
❯ diffoscope target/reference/org.apache.maven.plugins/maven-javadoc-plugin-3.5.0.jar target/maven-javadoc-plugin-3.5.0.jar
--- target/reference/org.apache.maven.plugins/maven-javadoc-plugin-3.5.0.jar
+++ target/maven-javadoc-plugin-3.5.0.jar
├── zipinfo {}
 @@ -1,10 +1,10 @@
 -Zip file size: 506940 bytes, number of entries: 102
 +Zip file size: 505348 bytes, number of entries: 102
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 META-INF/
 --rw-r--r--  2.0 unx      351 b- defN 23-Feb-12 17:47 META-INF/MANIFEST.MF
 +-rw-r--r--  2.0 unx      350 b- defN 23-Feb-12 17:47 META-INF/MANIFEST.MF
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 META-INF/maven/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 META-INF/maven/org.apache.maven.plugins/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 META-INF/maven/org.apache.maven.plugins/maven-javadoc-plugin/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 META-INF/sisu/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 org/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 org/apache/
  drwxr-xr-x  2.0 unx        0 b- stor 23-Feb-12 17:47 org/apache/maven/
 @@ -25,44 +25,44 @@
  -rw-r--r--  2.0 unx      887 b- defN 23-Feb-12 17:47 javadoc-report_de.properties
  -rw-r--r--  2.0 unx     1237 b- defN 23-Feb-12 17:47 javadoc-report_en.properties
  -rw-r--r--  2.0 unx      895 b- defN 23-Feb-12 17:47 javadoc-report_es.properties
  -rw-r--r--  2.0 unx      887 b- defN 23-Feb-12 17:47 javadoc-report_fr.properties
  -rw-r--r--  2.0 unx      886 b- defN 23-Feb-12 17:47 javadoc-report_nl.properties
  -rw-r--r--  2.0 unx      887 b- defN 23-Feb-12 17:47 javadoc-report_sv.properties
  -rw-r--r--  2.0 unx     1065 b- defN 23-Feb-12 17:47 log4j.properties
 --rw-r--r--  2.0 unx     4788 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AbstractFixJavadocMojo$JavaEntityTags.class
 --rw-r--r--  2.0 unx    56443 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AbstractFixJavadocMojo.class
 --rw-r--r--  2.0 unx   125012 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AbstractJavadocMojo.class
 +-rw-r--r--  2.0 unx     4782 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AbstractFixJavadocMojo$JavaEntityTags.class
 +-rw-r--r--  2.0 unx    55968 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AbstractFixJavadocMojo.class
 +-rw-r--r--  2.0 unx   124307 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AbstractJavadocMojo.class
  -rw-r--r--  2.0 unx      368 b- defN 23-Feb-12 17:47 org/apache/maven/plugins/javadoc/AdditionalDependency.class
```

```
org/apache/maven/plugins/javadoc/options/Group.class
javap -verbose -constants -s -l -private {}
@@ -1,35 +1,35 @@
-Classfile /var/folders/b2/nyfdb2213ll8lnmjt_ghtpr40000gn/T/diffoscope_i31qk9_k_target/tmpeve87e38_ZipContainer/Group.class
+Classfile /var/folders/b2/nyfdb2213ll8lnmjt_ghtpr40000gn/T/diffoscope_i31qk9_k_target/tmpf8fqas5h_ZipContainer/Group.class
   Compiled from "Group.java"
 public class org.apache.maven.plugins.javadoc.options.Group implements java.io.Serializable
   minor version: 0
   major version: 52
   flags: (0x0021) ACC_PUBLIC, ACC_SUPER
   this_class: #2                          // org/apache/maven/plugins/javadoc/options/Group
   super_class: #17                        // java/lang/Object
   interfaces: 1, fields: 2, methods: 8, attributes: 1
 Constant pool:
-   #1 = Methodref          #17.#52        // java/lang/Object."<init>":()V
-   #2 = Class              #53            // org/apache/maven/plugins/javadoc/options/Group
-   #3 = Methodref          #2.#54         // org/apache/maven/plugins/javadoc/options/Group.getTitle:()Ljava/lang/String;
-   #4 = Methodref          #55.#56        // java/lang/String.equals:(Ljava/lang/Object;)Z
-   #5 = Methodref          #2.#57         // org/apache/maven/plugins/javadoc/options/Group.getPackages:()Ljava/lang/String;
-   #6 = Fieldref           #2.#58         // org/apache/maven/plugins/javadoc/options/Group.packages:Ljava/lang/String;
-   #7 = Fieldref           #2.#59         // org/apache/maven/plugins/javadoc/options/Group.title:Ljava/lang/String;
-   #8 = Methodref          #55.#60        // java/lang/String.hashCode:()I
-   #9 = Class              #61            // java/lang/StringBuilder
-  #10 = Methodref          #9.#62         // java/lang/StringBuilder."<init>":(I)V
-  #11 = String             #63            // title = \'
-  #12 = Methodref          #9.#64         // java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
-  #13 = String             #65            // \'
-  #14 = String             #66            // \n
-  #15 = String             #67            // packages = \'
-  #16 = Methodref          #9.#68         // java/lang/StringBuilder.toString:()Ljava/lang/String;
-  #17 = Class              #69            // java/lang/Object
-  #18 = Class              #70            // java/io/Serializable
+   #1 = Methodref          #17.#51        // java/lang/Object."<init>":()V
+   #2 = Class              #52            // org/apache/maven/plugins/javadoc/options/Group
+   #3 = Methodref          #2.#53         // org/apache/maven/plugins/javadoc/options/Group.getTitle:()Ljava/lang/String;
+   #4 = Methodref          #54.#55        // java/lang/String.equals:(Ljava/lang/Object;)Z
+   #5 = Methodref          #2.#56         // org/apache/maven/plugins/javadoc/options/Group.getPackages:()Ljava/lang/String;
+   #6 = Fieldref           #2.#57         // org/apache/maven/plugins/javadoc/options/Group.packages:Ljava/lang/String;
+   #7 = Fieldref           #2.#58         // org/apache/maven/plugins/javadoc/options/Group.title:Ljava/lang/String;
+   #8 = Methodref          #54.#59        // java/lang/String.hashCode:()I
+   #9 = Class              #60            // java/lang/StringBuilder
+  #10 = Methodref          #9.#61         // java/lang/StringBuilder."<init>":(I)V
+  #11 = String             #62            // title = \'
+  #12 = Methodref          #9.#63         // java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
+  #13 = String             #64            // \'
+  #14 = String             #65            // \n
+  #15 = String             #66            // packages = \'
+  #16 = Methodref          #9.#67         // java/lang/StringBuilder.toString:()Ljava/lang/String;
+  #17 = Class              #68            // java/lang/Object
+  #18 = Class              #69            // java/io/Serializable
   #19 = Utf8               title
   #20 = Utf8               Ljava/lang/String;
   #21 = Utf8               packages
```



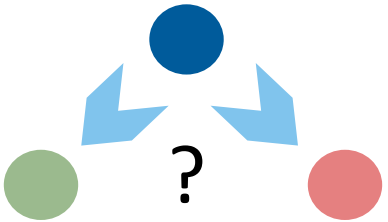
#2 Reproducible or not?



```
── META-INF/MANIFEST.MF
@@ -1,10 +1,10 @@
 Manifest-Version: 1.0
-Implementation-Title: Apache Maven Javadoc Plugin
-Implementation-Version: 3.5.0
-Specification-Vendor: The Apache Software Foundation
-Specification-Title: Apache Maven Javadoc Plugin
-Build-Jdk-Spec: 1.8
 Created-By: Maven JAR Plugin 3.3.0
+Build-Jdk-Spec: 11
+Specification-Title: Apache Maven Javadoc Plugin
```

```
[INFO] Reference build java.version: 1.8 (from MANIFEST.MF Build-Jdk-Spec)
[ERROR] Current build java.version: 11 (from MANIFEST.MF Build-Jdk-Spec)
[INFO] Reference build os.name: Windows (from pom.properties newline)
[INFO] Minimal buildinfo generated from downloaded artifacts: /Users/hboutemy/dev/git/misc/
n/buildcache/maven-javadoc-plugin/target/reference/maven-javadoc-plugin-3.5.0.buildinfo
[ERROR] size mismatch maven-javadoc-plugin-3.5.0.jar: investigate with diffoscope target/re
ven-javadoc-plugin-3.5.0.jar
[ERROR] Reproducible Build output summary: 3 files ok, 1 different
```

#3 Reproducible or not?




```
❯ diffoscope target/reference/org.apache.maven.plugins/maven-shade-plugin-3.5.1-sources.jar target/maven-shade-plugin-3.5.1-sources.jar
--- target/reference/org.apache.maven.plugins/maven-shade-plugin-3.5.1-sources.jar
+++ target/maven-shade-plugin-3.5.1-sources.jar
├── zipinfo {}
│ @@ -59,10 +59,10 @@
│   -rw-r--r--  2.0 unx     1171 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/shade/resource/properties/MicroprofileConfigTransformer.java
│   -rw-r--r--  2.0 unx     1221 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/shade/resource/properties/OpenWebBeansPropertiesTransformer.java
│   -rw-r--r--  2.0 unx     6608 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/shade/resource/properties/PropertiesTransformer.java
│   -rw-r--r--  2.0 unx     2653 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/shade/resource/properties/SortedProperties.java
│   -rw-r--r--  2.0 unx     1808 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/shade/resource/properties/io/NoCloseOutputStream.java
│   -rw-r--r--  2.0 unx     2481 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/shade/resource/properties/io/SkipPropertiesDateLineWriter.java
│   -rw-r--r--  2.0 unx    15200 b- defN 23-Sep-21 19:38 org/apache/maven/plugins/maven_shade_plugin/HelpMojo.java
│   --rw-r--r--  2.0 unx    13506 b- defN 23-Sep-21 19:38 META-INF/maven/org.apache.maven.plugins/maven-shade-plugin/pom.xml
│   --rw-r--r--  2.0 unx       77 b- defN 23-Sep-21 19:38 META-INF/maven/org.apache.maven.plugins/maven-shade-plugin/pom.properties
│   +-rw-rw-r--  2.0 unx    13506 b- defN 23-Sep-21 19:38 META-INF/maven/org.apache.maven.plugins/maven-shade-plugin/pom.xml
│   +-rw-rw-r--  2.0 unx       77 b- defN 23-Sep-21 19:38 META-INF/maven/org.apache.maven.plugins/maven-shade-plugin/pom.properties
│    66 files, 341671 bytes uncompressed, 84146 bytes compressed:  75.4%
```

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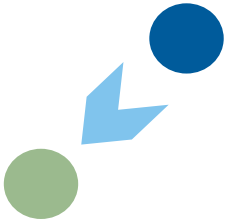
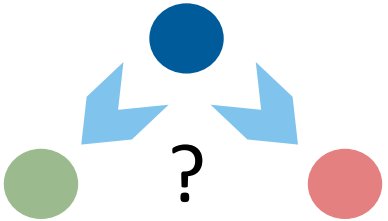
#3 Reproducible or not?



content > org > apache > maven > plugins > maven-shade-plugin > $ maven-shade-plugin-3.5.1.buildspec

```
groupId=org.apache.maven.plugins
artifactId=maven-shade-plugin
display=${groupId}:${artifactId}
version=3.5.1

gitRepo=https://github.com/apache/${artifactId}.git
gitTag=${artifactId}-${version}

tool=mvn
jdk=17
newline=lf
umask=022

command="mvn -Papache-release clean package -DskipTests -Dmaven.javadoc.skip -Dgpg.skip"
buildinfo=target/${artifactId}-${version}.buildinfo

issue=
```

#4 Reproducible or not?




```
❯ ./rebuild.sh content/com/flowlogix/flowlogix-7.0.2.buildspec
```

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```
[INFO] Reference build java.version: 20 (from MANIFEST.MF Build-Jdk-Spec)
[INFO] Reference build os.name: Unix (from pom.properties newline)
[INFO] Minimal buildinfo generated from downloaded artifacts: /Users/hboutemy/dev/git/
ference/jee-examples-7.0.2.buildinfo
[ERROR] sha512 mismatch jee-examples-7.0.2.war: investigate with diffoscope target/re
-examples-7.0.2.war
[ERROR] Reproducible Build output summary: 11 files ok, 1 different
```

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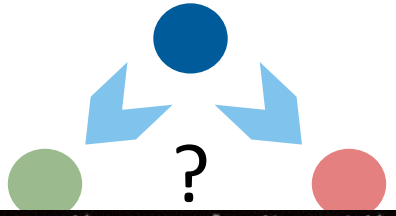
CODE

#4 Reproducible or not?




```
❯ diffoscope target/reference/com.flowlogix/jee-examples-7.0.2.war jakarta-ee/jee-examples/target/jee-exam
--- target/reference/com.flowlogix/jee-examples-7.0.2.war
+++ jakarta-ee/jee-examples/target/jee-examples-7.0.2.war
├── zipinfo {}
 @@ -36,21 +36,21 @@
  -rw-r--r--  2.0 unx      432 b- defN 23-Jun-27 19:19 WEB-INF/classes/com/flowlogix/examples/ui/servlets
  -rw-r--r--  2.0 unx     1241 b- defN 23-Jun-27 19:19 WEB-INF/classes/com/flowlogix/logcapture/LogCaptur
  -rw-r--r--  2.0 unx     3166 b- defN 23-Jun-27 19:19 WEB-INF/classes/com/flowlogix/logcapture/LogCaptur
  -rw-r--r--  2.0 unx      830 b- defN 23-Jun-27 19:19 WEB-INF/classes/com/flowlogix/logcapture/LogCaptur
  -rw-r--r--  2.0 unx      190 b- defN 23-Jun-27 19:19 WEB-INF/classes/git.properties
  -rw-r--r--  2.0 unx     1264 b- defN 23-Jun-27 19:19 WEB-INF/errorpages/invalidErrorPage.xhtml
  -rw-r--r--  2.0 unx     2376 b- defN 23-Jun-27 19:19 WEB-INF/faces-config.xml
  --rw-------  2.0 unx   587402 b- defN 23-Jun-27 19:19 WEB-INF/lib/commons-lang3-3.12.0.jar
  +-rw-r--r--  2.0 unx   587402 b- defN 23-Jun-27 19:19 WEB-INF/lib/commons-lang3-3.12.0.jar
  -rw-r--r--  2.0 unx    23391 b- defN 23-Jun-27 19:19 WEB-INF/lib/flowlogix-datamodel-7.0.2-tests.jar
  -rw-r--r--  2.0 unx    30477 b- defN 23-Jun-27 19:19 WEB-INF/lib/flowlogix-datamodel-7.0.2.jar
  -rw-r--r--  2.0 unx    37027 b- defN 23-Jun-27 19:19 WEB-INF/lib/flowlogix-jee-7.0.2-tests.jar
  -rw-r--r--  2.0 unx    42647 b- defN 23-Jun-27 19:19 WEB-INF/lib/flowlogix-jee-7.0.2.jar
  -rw-r--r--  2.0 unx   827896 b- defN 23-Jun-27 19:19 WEB-INF/lib/omnifaces-4.1.jar
  --rw-------  2.0 unx  4802204 b- defN 23-Jun-27 19:19 WEB-INF/lib/primefaces-12.0.0-jakarta.jar
  +-rw-r--r--  2.0 unx  4802204 b- defN 23-Jun-27 19:19 WEB-INF/lib/primefaces-12.0.0-jakarta.jar
  -rw-r--r--  2.0 unx    63635 b- defN 23-Jun-27 19:19 WEB-INF/lib/slf4j-api-2.0.7.jar
  -rw-r--r--  2.0 unx    10346 b- defN 23-Jun-27 19:19 WEB-INF/lib/slf4j-jdk14-2.0.7.jar
```

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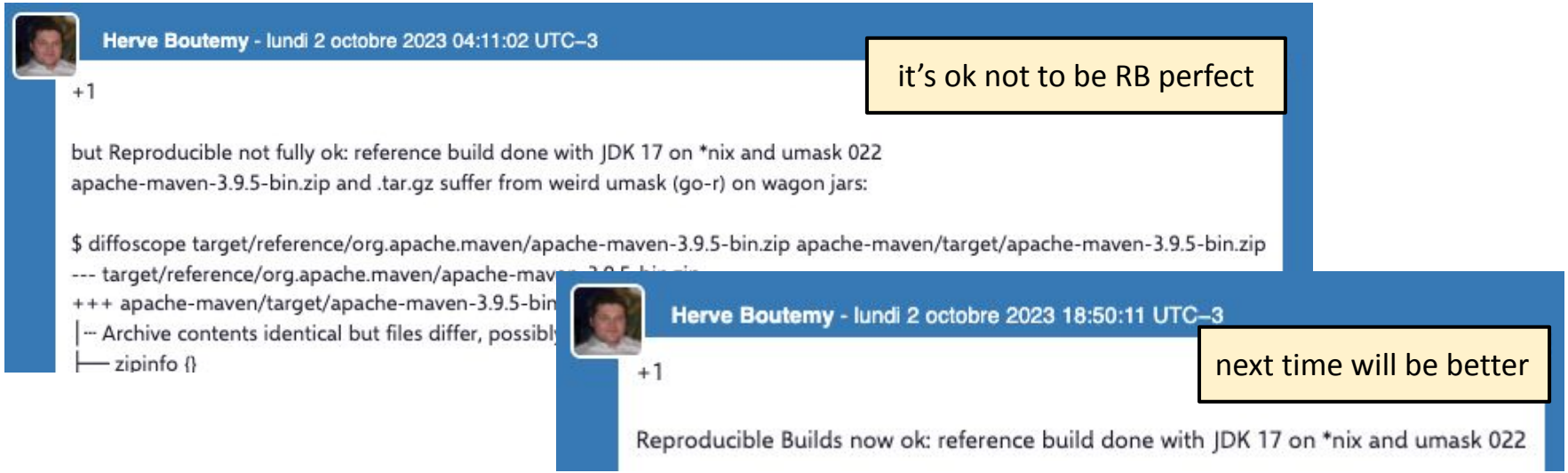
What’s next?

for the JVM…
and Beyond…

- Maven:
  - make more Maven plugins produce Reproducible output
  - help more projects enable Reproducible Builds
- Gradle:
  - help more projects enable Reproducible Builds
  - improve Reproducible Central rebuilds for these
- sbt
- npm & npmjs
- pip & PyPI
- .NET & NuGet Gallery
- …

for the ASF:
please audit your binaries during VOTEs




```
mvn -Papache-release -Dgpg.skip clean verify artifact:compare
        -Dreference.repo=https://repository.apache.org/content/repositories/staging/
```

COMMUNITY

Merci

Diversity in Community is Great,
not in Binary Code