The Future of Code Coverage for Eclipse

Marc R. Hoffmann

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Outline

- Code Coverage
- EclEmma
- EMMA
- JaCoCo

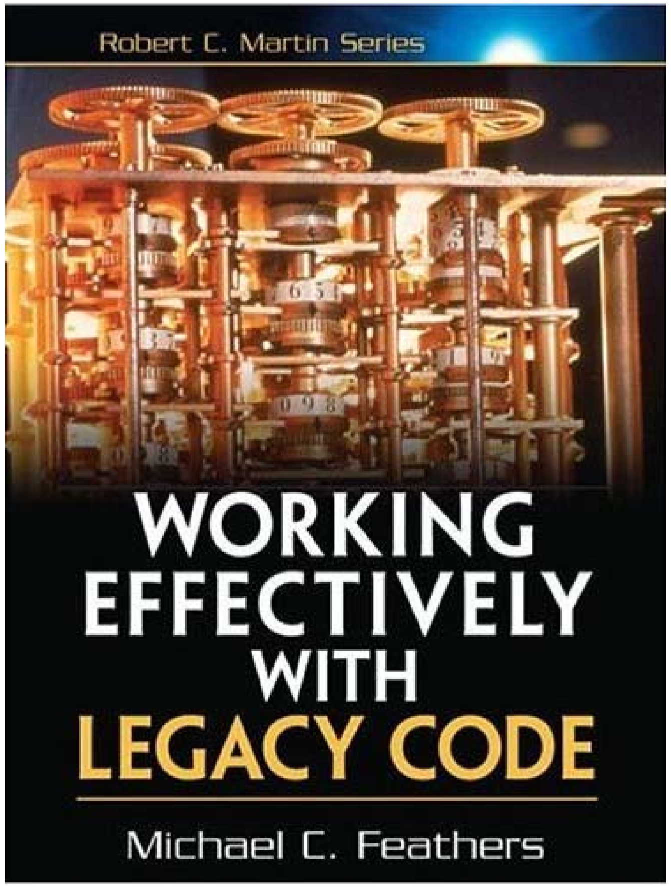
Sorry,
no robots ☹

Code Coverage

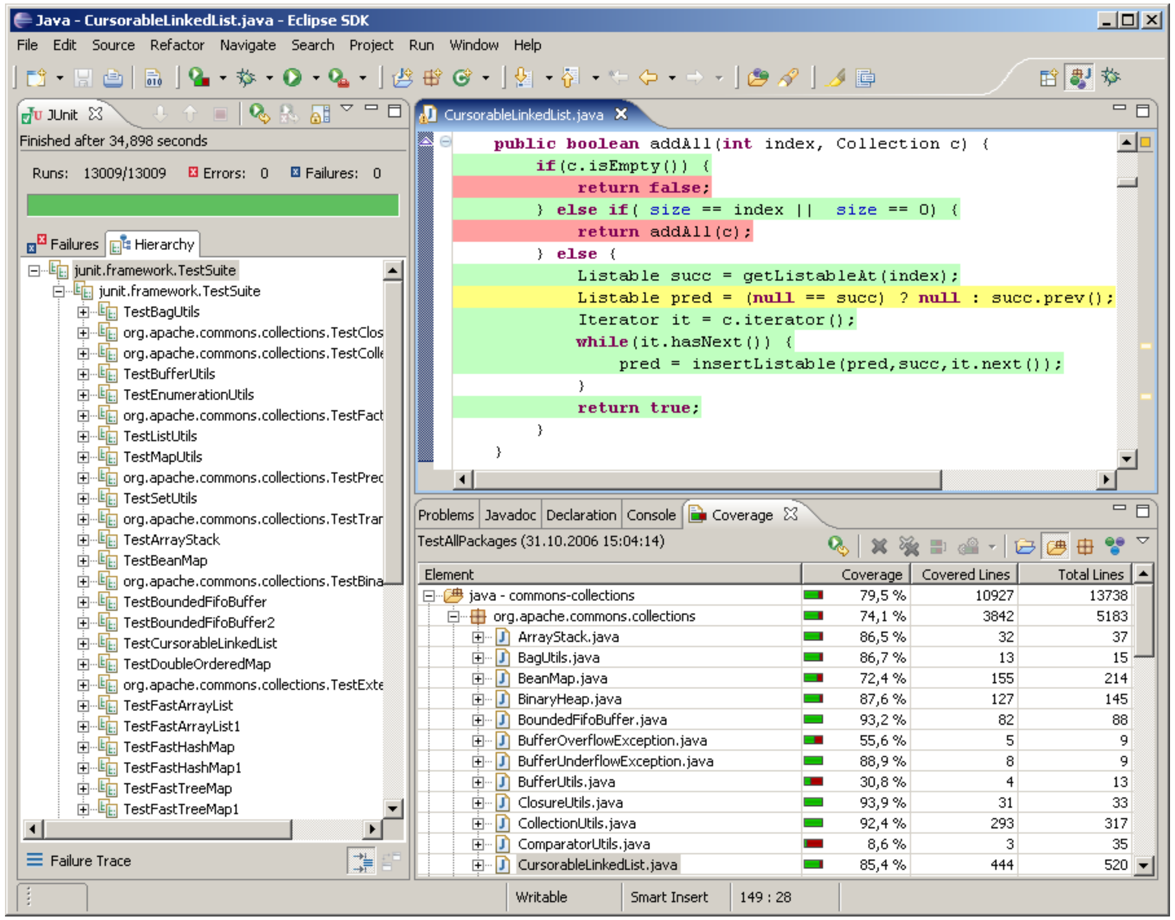
„Legacy Code is simply code without tests.“

Michael Feathers:

Working Effectively with Legacy Code



EclEmma – Code Coverage for Eclipse


Java - CursorableLinkedList.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
JUnit
Failures
Hierarchy
Failure Trace
CursorableLinkedList.java
Problems
Javadoc
Declaration
Console
Coverage
Writable
Smart Insert
149 : 28

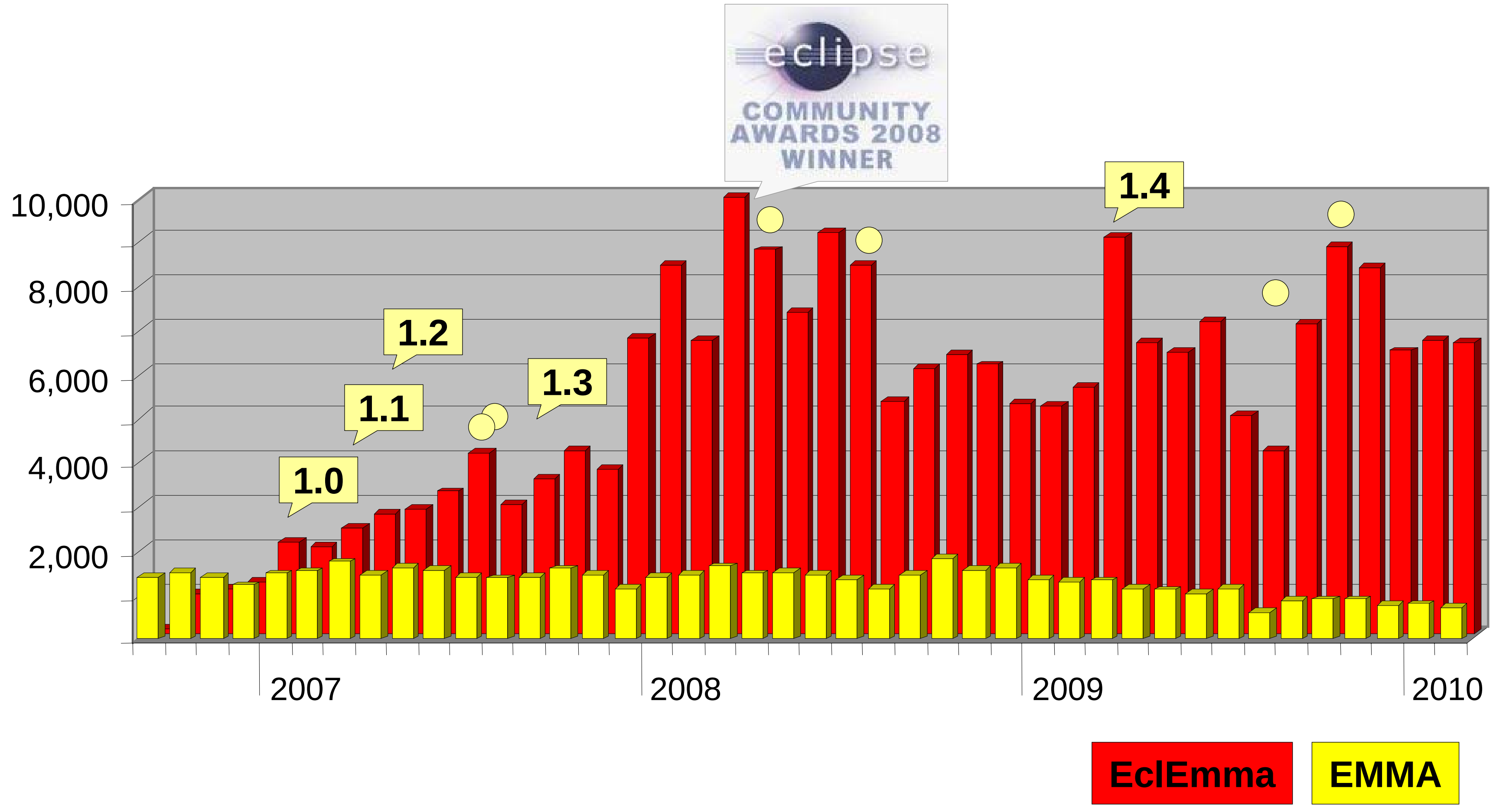
```
Finished after 34,898 seconds

Runs:  13009/13009    Errors:  0    Failures:  0

junit.framework.TestSuite
  junit.framework.TestSuite
    TestBagUtils
    org.apache.commons.collections.TestClos
    org.apache.commons.collections.TestColle
    TestBufferUtils
    TestEnumerationUtils
    org.apache.commons.collections.TestFact
    TestListUtils
    TestMapUtils
    org.apache.commons.collections.TestPred
    TestSetUtils
    org.apache.commons.collections.TestTrar
    TestArrayStack
    TestBeanMap
    org.apache.commons.collections.TestBina
    TestBoundedFifoBuffer
    TestBoundedFifoBuffer2
    TestCursorableLinkedList
    TestDoubleOrderedMap
    org.apache.commons.collections.TestExte
    TestFastArrayList
    TestFastArrayList1
    TestFastHashMap
    TestFastHashMap1
    TestFastTreeMap
    TestFastTreeMap1
```

```java
    public boolean addAll(int index, Collection c) {
        if(c.isEmpty()) {
            return false;
        } else if( size == index ||  size == 0) {
            return addAll(c);
        } else {
            Listable succ = getListableAt(index);
            Listable pred = (null == succ) ? null : succ.prev();
            Iterator it = c.iterator();
            while(it.hasNext()) {
                pred = insertListable(pred,succ,it.next());
            }
            return true;
        }
    }
```

TestAllPackages (31.10.2006 15:04:14)

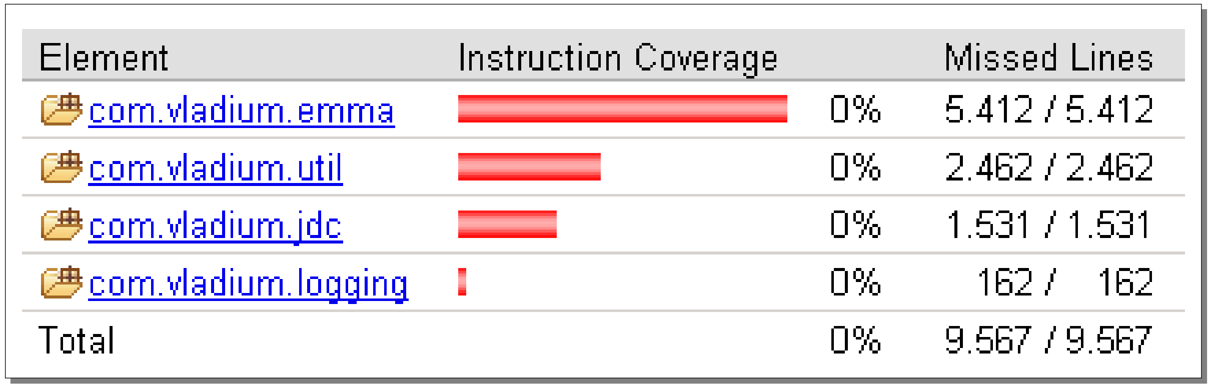
Element	Coverage	Covered Lines	Total Lines
java - commons-collections	79,5 %	10927	13738
org.apache.commons.collections	74,1 %	3842	5183
ArrayStack.java	86,5 %	32	37
BagUtils.java	86,7 %	13	15
BeanMap.java	72,4 %	155	214
BinaryHeap.java	87,6 %	127	145
BoundedFifoBuffer.java	93,2 %	82	88
BufferOverflowException.java	55,6 %	5	9
BufferUnderflowException.java	88,9 %	8	9
BufferUtils.java	30,8 %	4	13
ClosureUtils.java	93,9 %	31	33
CollectionUtils.java	92,4 %	293	317
ComparatorUtils.java	8,6 %	3	35
CursorableLinkedList.java	85,4 %	444	520

Monthly EclEmma Downloads



Current Status of EMMA

- Great Tool! ☺
- Last Release ☹
  - ➔ 2.0.5312, 2005-06-13
- Project Activity ☹
  - ➔ Latest Commit 2006-02-23



Element	Instruction Coverage		Missed Lines
com.vladium.emma	🟥	0%	5.412 / 5.412
com.vladium.util	🟥	0%	2.462 / 2.462
com.vladium.jdc	🟥	0%	1.531 / 1.531
com.vladium.logging	🟥	0%	162 / 162
Total		0%	9.567 / 9.567

Action Required!

- Making EMMA alive?
- Using a different Library?
- Starting a new Project?

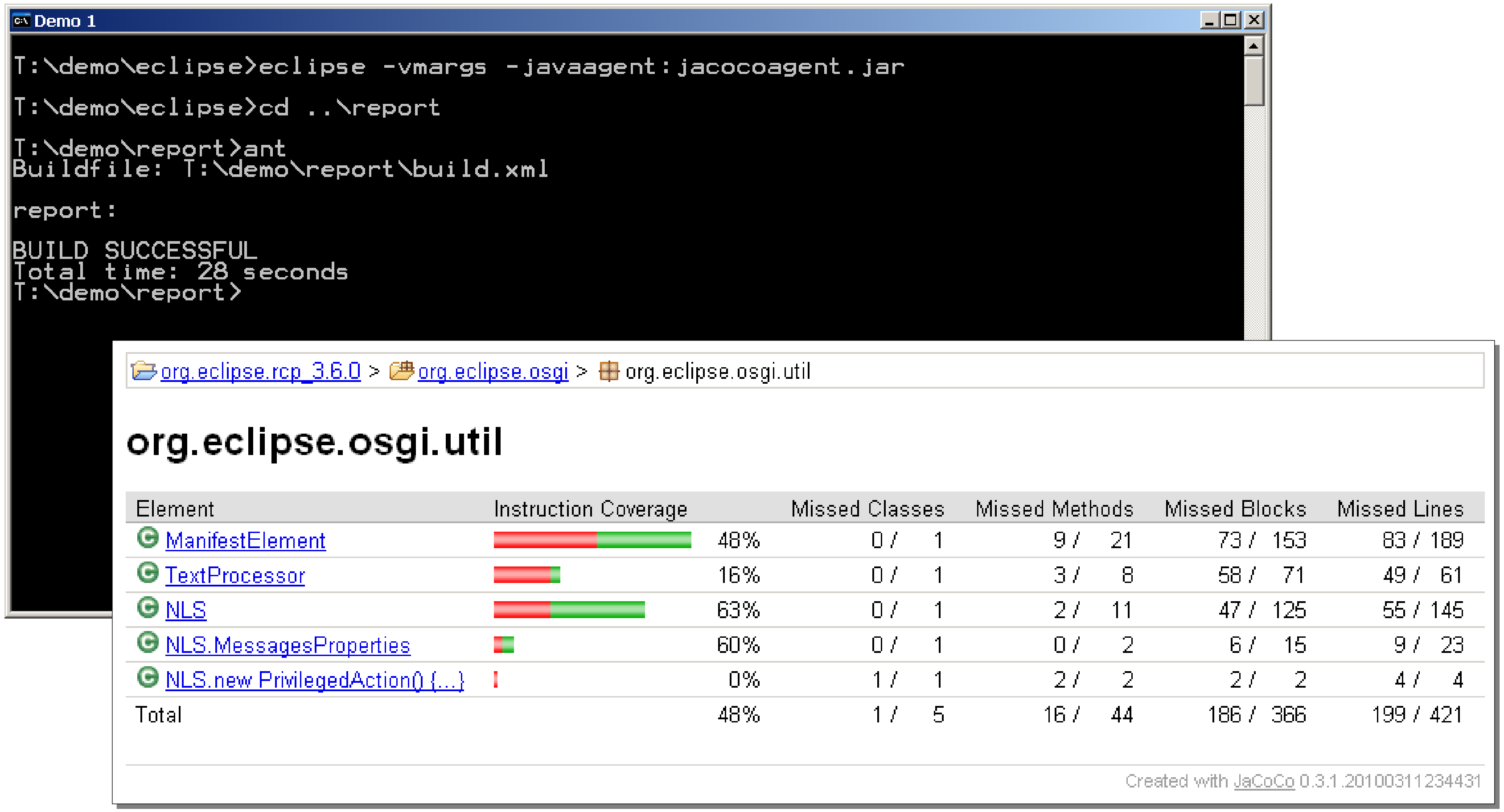
Requirements for a Code Coverage Library

- Be a Library!
  - ➔ Open for Different Usage Scenarios
  - ➔ Designed for Integration
- Regression Tests
- Framework Independent
- Scalable for Large Projects
- Fast Enough for Agile Teams

The „JaCoCo“ Project

- **Ja**va **Co**de **Co**verage
- Started Mid of 2009
- Beta Releases Sinces End of 2009
- EPL
- Hosted within EclEmma (SourceForge)
  - ➔ www.eclemma.org/jacoco
- Team
  - ➔ Marc R. Hoffmann (GER)
  - ➔ Brock Janiczak (AUS)
  - ➔ Christoph Beck (GER)
  - ➔ Radek Liba (GER)

JaCoCo Demo



```
T:\demo\eclipse>eclipse -vmargs -javaagent:jacocoagent.jar

T:\demo\eclipse>cd ..\report

T:\demo\report>ant
Buildfile: T:\demo\report\build.xml

report:

BUILD SUCCESSFUL
Total time: 28 seconds
T:\demo\report>
```

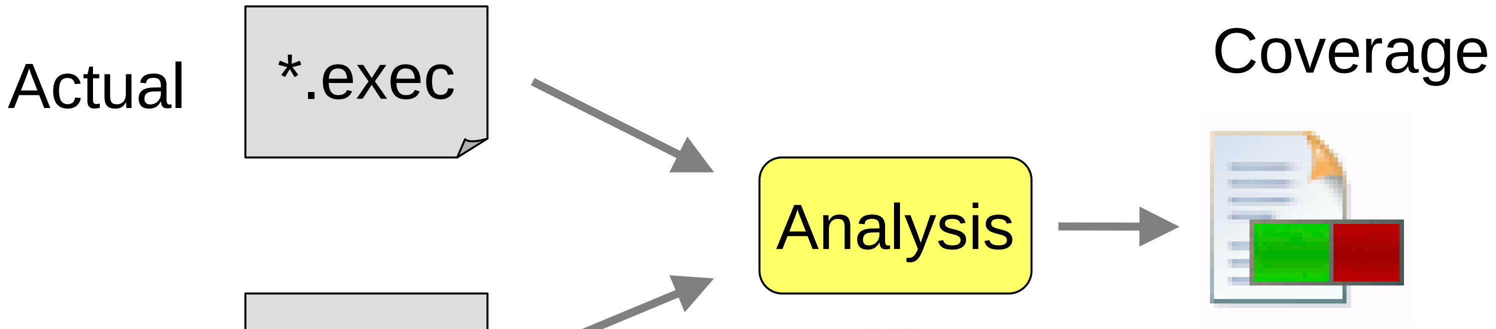
org.eclipse.rcp_3.6.0 > org.eclipse.osgi > org.eclipse.osgi.util

org.eclipse.osgi.util

Element	Instruction Coverage		Missed Classes	Missed Methods	Missed Blocks	Missed Lines
ManifestElement		48%	0 / 1	9 / 21	73 / 153	83 / 189
TextProcessor		16%	0 / 1	3 / 8	58 / 71	49 / 61
NLS		63%	0 / 1	2 / 11	47 / 125	55 / 145
NLS.MessagesProperties		60%	0 / 1	0 / 2	6 / 15	9 / 23
NLS.new PrivilegedAction() {...}		0%	1 / 1	2 / 2	2 / 2	4 / 4
Total		48%	1 / 5	16 / 44	186 / 366	199 / 421

Created with JaCoCo 0.3.1.20100311234431

Coverage Analysis



JaCoCo Ant Tasks: Coverage

```xml
<jacoco:coverage>
    <java classname="org.jacoco.examples.HelloJaCoCo" fork="true">
        <classpath>
            <pathelement location="./bin"/>
        </classpath>
    </java>
</jacoco:coverage>


<jacoco:coverage>
    <junit fork="true" forkmode="once">
        <test name="org.jacoco.examples.HelloJaCoCoTest"/>
        <classpath>
            <pathelement location="./bin"/>
        </classpath>
    </junit>
</jacoco:coverage>
```

JaCoCo Ant Tasks: Report

```
<jacoco:report>

    <executiondata>
        <file file="jacoco.exec"/>
    </executiondata>

    <structure name="Example Project">
        <classfiles>
            <fileset dir="bin"/>
        </classfiles>
        <sourcefiles encoding="UTF-8">
            <fileset dir="src"/>
        </sourcefiles>
    </structure>

    <html destdir="report"/>

</jacoco:report>
```

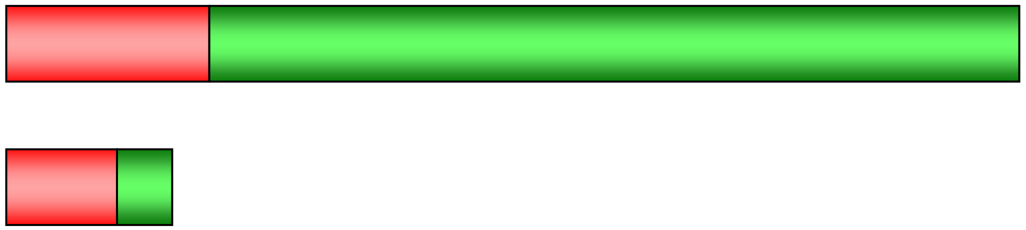
JaCoCo Ant Tasks: Report

```
<structure name="JaCoCo">
    <group name="org.jacoco.core">
        <classfiles>
            <path refid="bundle-org.jacoco.core"/>
        </classfiles>
        <sourcefiles>
            <fileset dir="${workspace.dir}/org.jacoco.core/src"/>
        </sourcefiles>
    </group>
    <group name="org.jacoco.report">
        <classfiles>
            <path refid="bundle-org.jacoco.report"/>
        </classfiles>
        <sourcefiles>
            <fileset dir="${workspace.dir}/org.jacoco.report/src"/>
        </sourcefiles>
    </group>

    ...

</structure>
```

Report Sorting

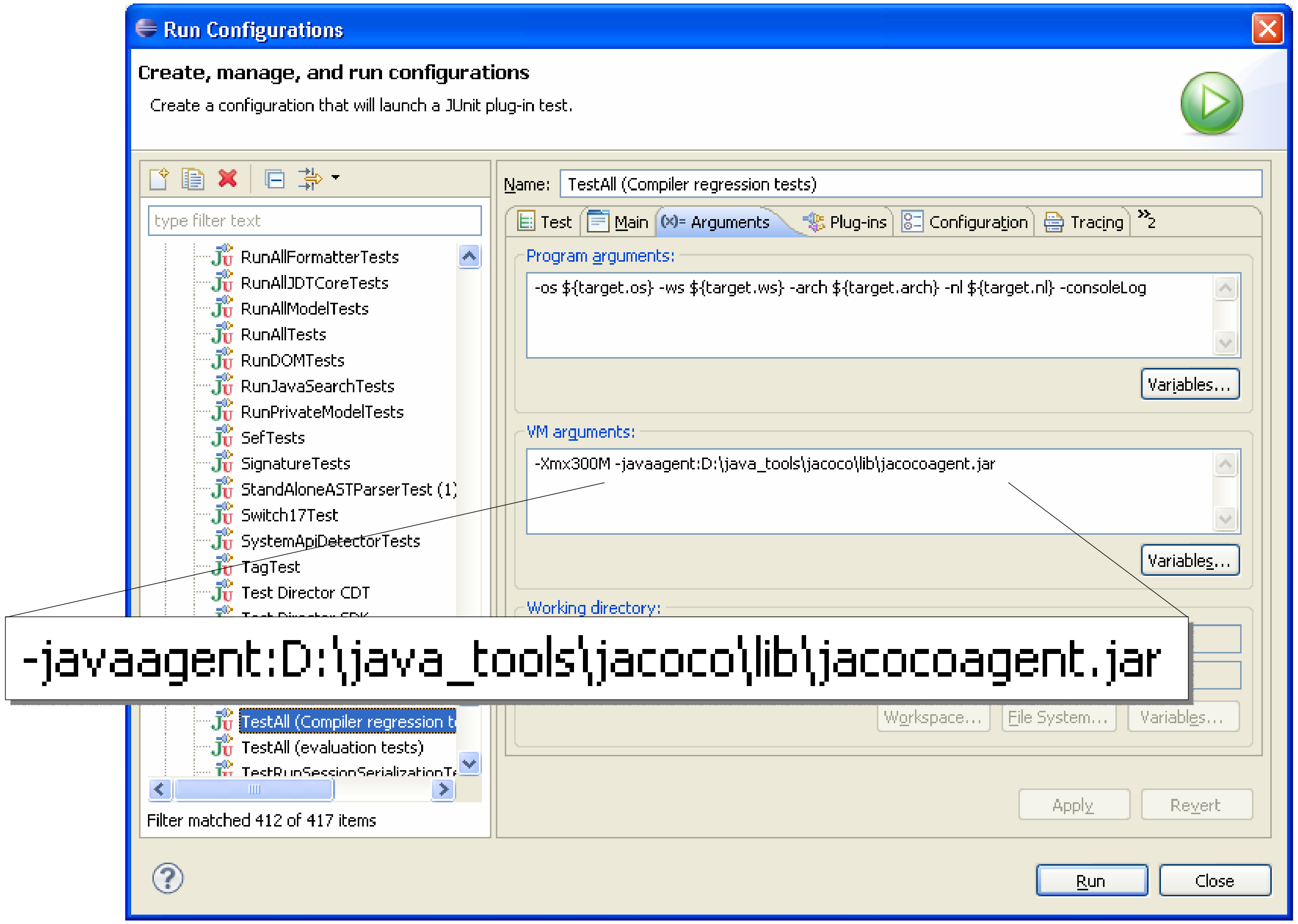
Project A 80%

Project B 35%



Sort Items by absolut amount of missed code.

JaCoCo in Eclipse



Name: TestAll (Compiler regression tests)

Program arguments:

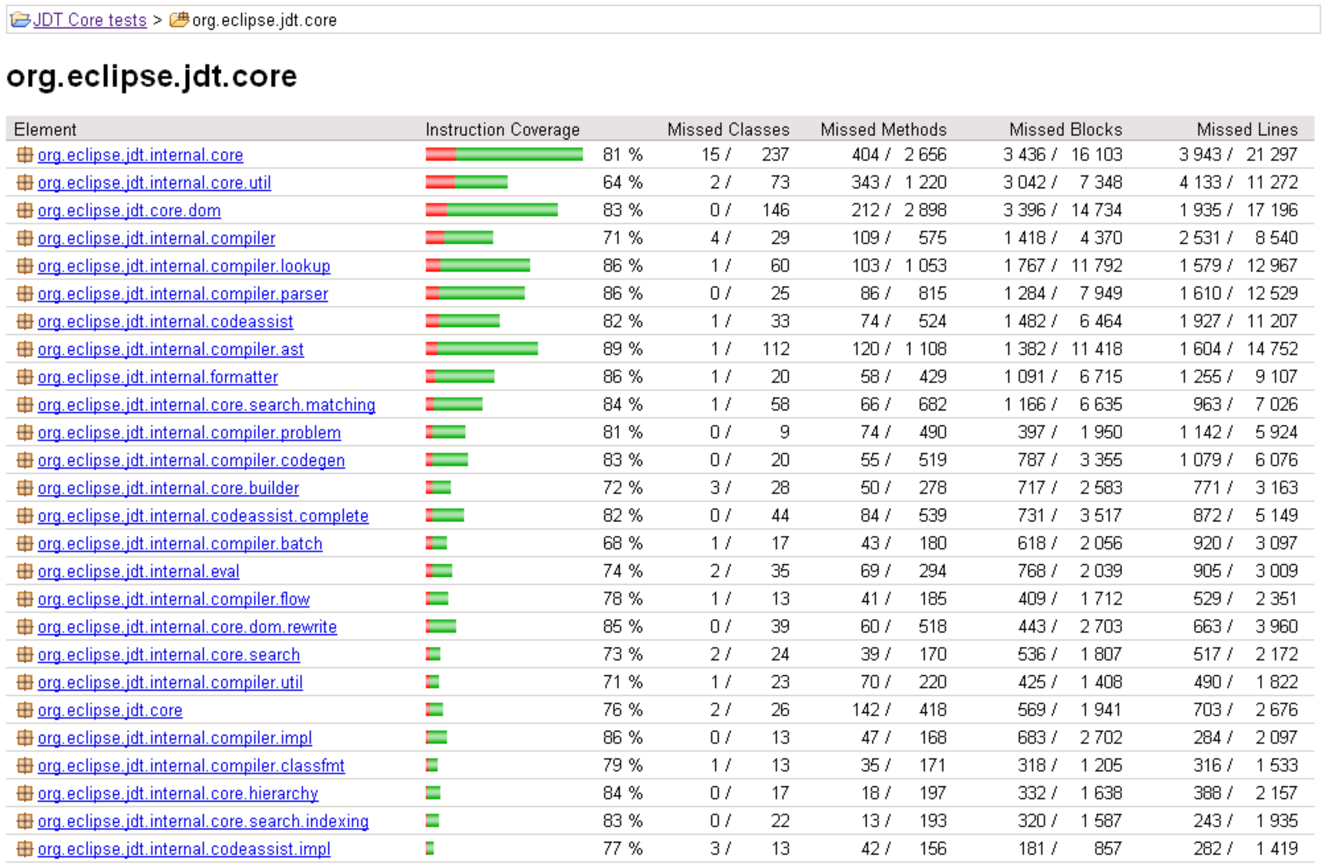
```
-os ${target.os} -ws ${target.ws} -arch ${target.arch} -nl ${target.nl} -consoleLog
```

VM arguments:

```
-Xmx300M -javaagent:D:\java_tools\jacoco\lib\jacocoagent.jar
```

```
-javaagent:D:\java_tools\jacoco\lib\jacocoagent.jar
```

JaCoCo on JDT Test Suite



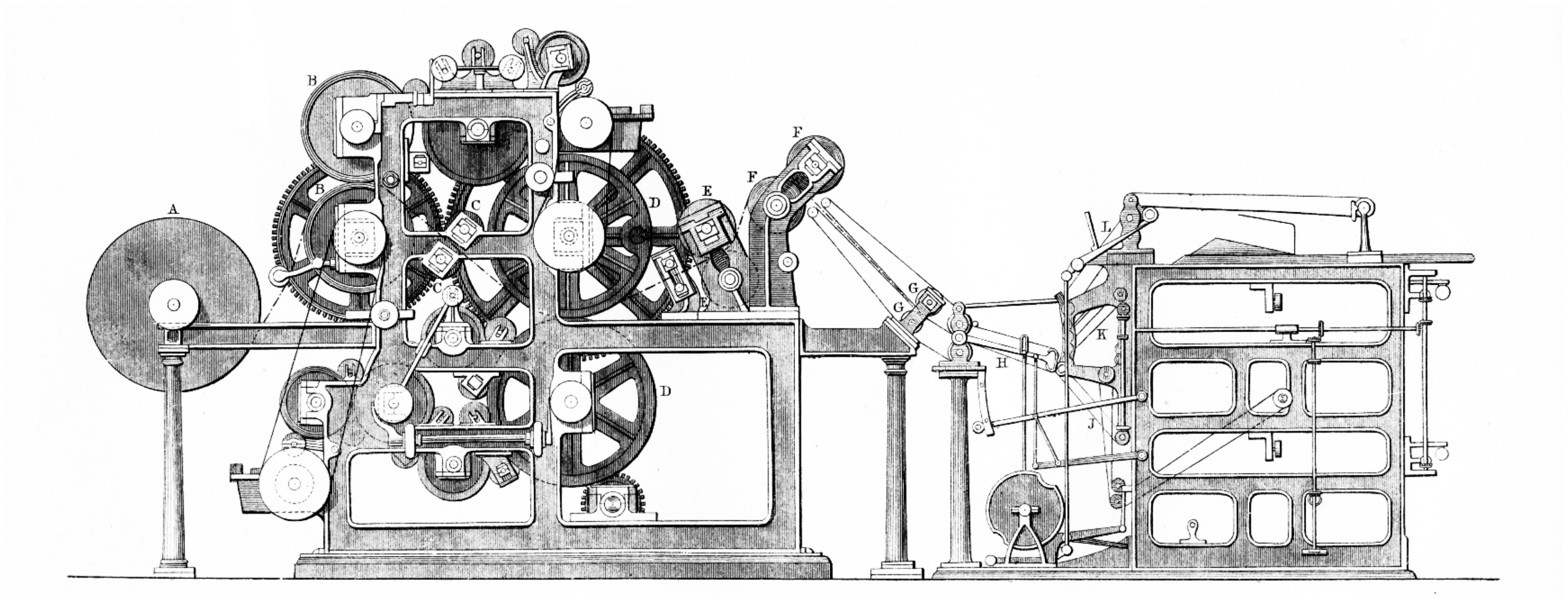
JDT Core tests > org.eclipse.jdt.core

org.eclipse.jdt.core

Element	Instruction Coverage	Missed Classes	Missed Methods	Missed Blocks	Missed Lines
org.eclipse.jdt.internal.core	81 %	15 / 237	404 / 2 656	3 436 / 16 103	3 943 / 21 297
org.eclipse.jdt.internal.core.util	64 %	2 / 73	343 / 1 220	3 042 / 7 348	4 133 / 11 272
org.eclipse.jdt.core.dom	83 %	0 / 146	212 / 2 898	3 396 / 14 734	1 935 / 17 196
org.eclipse.jdt.internal.compiler	71 %	4 / 29	109 / 575	1 418 / 4 370	2 531 / 8 540
org.eclipse.jdt.internal.compiler.lookup	86 %	1 / 60	103 / 1 053	1 767 / 11 792	1 579 / 12 967
org.eclipse.jdt.internal.compiler.parser	86 %	0 / 25	86 / 815	1 284 / 7 949	1 610 / 12 529
org.eclipse.jdt.internal.codeassist	82 %	1 / 33	74 / 524	1 482 / 6 464	1 927 / 11 207
org.eclipse.jdt.internal.compiler.ast	89 %	1 / 112	120 / 1 108	1 382 / 11 418	1 604 / 14 752
org.eclipse.jdt.internal.formatter	86 %	1 / 20	58 / 429	1 091 / 6 715	1 255 / 9 107
org.eclipse.jdt.internal.core.search.matching	84 %	1 / 58	66 / 682	1 166 / 6 635	963 / 7 026
org.eclipse.jdt.internal.compiler.problem	81 %	0 / 9	74 / 490	397 / 1 950	1 142 / 5 924
org.eclipse.jdt.internal.compiler.codegen	83 %	0 / 20	55 / 519	787 / 3 355	1 079 / 6 076
org.eclipse.jdt.internal.core.builder	72 %	3 / 28	50 / 278	717 / 2 583	771 / 3 163
org.eclipse.jdt.internal.codeassist.complete	82 %	0 / 44	84 / 539	731 / 3 517	872 / 5 149
org.eclipse.jdt.internal.compiler.batch	68 %	1 / 17	43 / 180	618 / 2 056	920 / 3 097
org.eclipse.jdt.internal.eval	74 %	2 / 35	69 / 294	768 / 2 039	905 / 3 009
org.eclipse.jdt.internal.compiler.flow	78 %	1 / 13	41 / 185	409 / 1 712	529 / 2 351
org.eclipse.jdt.internal.core.dom.rewrite	85 %	0 / 39	60 / 518	443 / 2 703	663 / 3 960
org.eclipse.jdt.internal.core.search	73 %	2 / 24	39 / 170	536 / 1 807	517 / 2 172
org.eclipse.jdt.internal.compiler.util	71 %	1 / 23	70 / 220	425 / 1 408	490 / 1 822
org.eclipse.jdt.core	76 %	2 / 26	142 / 418	569 / 1 941	703 / 2 676
org.eclipse.jdt.internal.compiler.impl	86 %	0 / 13	47 / 168	683 / 2 702	284 / 2 097
org.eclipse.jdt.internal.compiler.classfmt	79 %	1 / 13	35 / 171	318 / 1 205	316 / 1 533
org.eclipse.jdt.internal.core.hierarchy	84 %	0 / 17	18 / 197	332 / 1 638	388 / 2 157
org.eclipse.jdt.internal.core.search.indexing	83 %	0 / 22	13 / 193	320 / 1 587	243 / 1 935
org.eclipse.jdt.internal.codeassist.impl	77 %	3 / 13	42 / 156	181 / 857	282 / 1 419

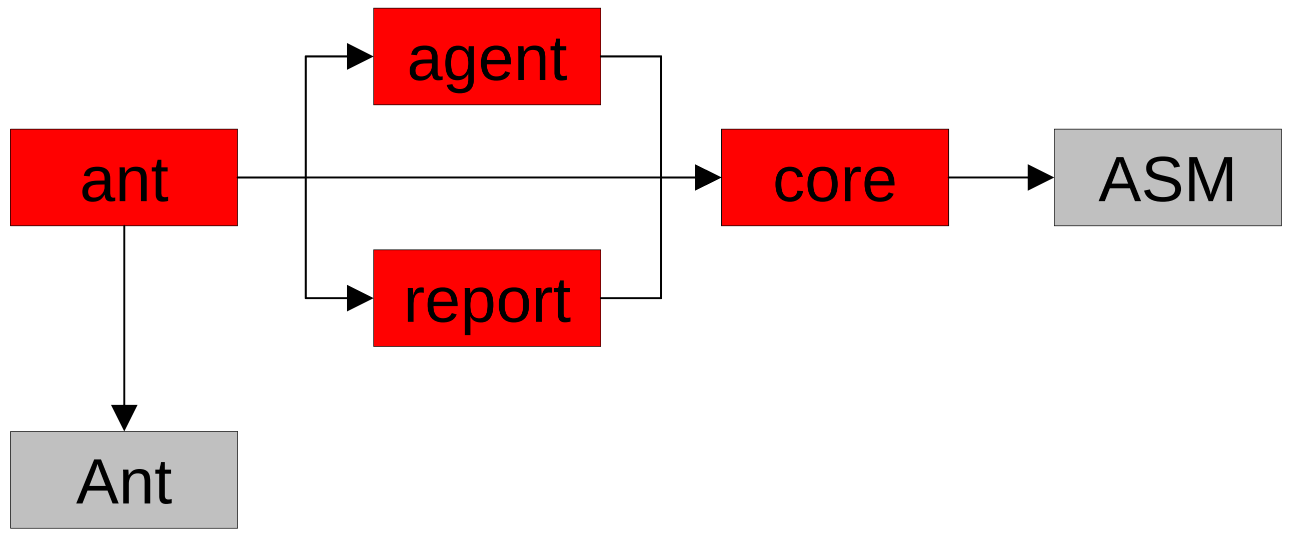
Credits: Olivier Thomann

Implementation Details



Architecture Overview

- Set of OSGi Bundles



Java Agent

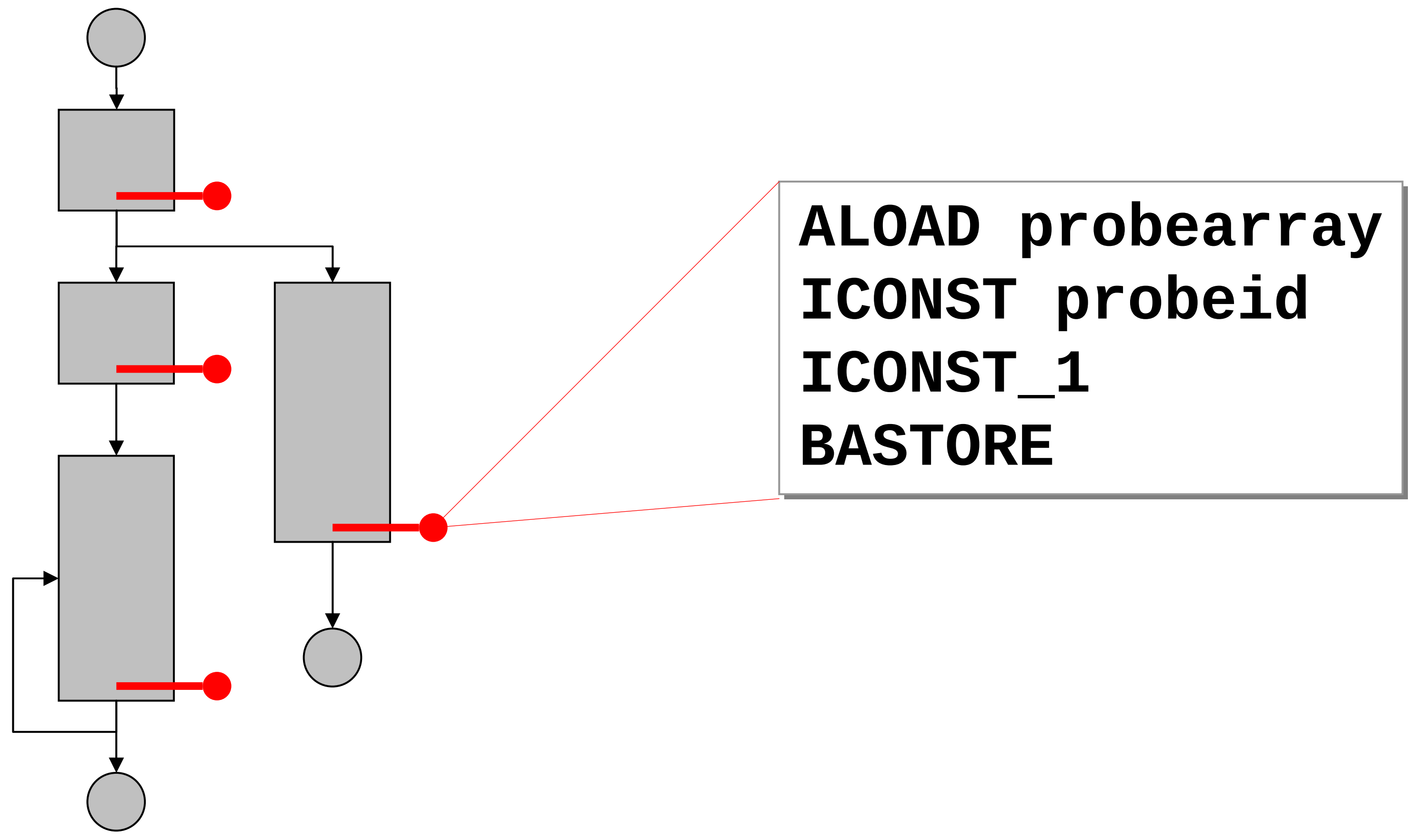
- **`java.lang.instrument`**
  - ➔ In-Memory
  - ➔ No class file preprocessing

```
byte[] transform(ClassLoader loader,
                 String className,
                 Class<?> classBeingRedefined,
                 ProtectionDomain protectionDomain,
                 byte[] classfileBuffer)
                 throws IllegalClassFormatException
```

Keep the Good Ideas of EMMA

- Byte Code Instrumentation
  - ➔ JRE and Platform Independent
- Basic Block Coverage
  - ➔ Good Tradeoff between Datails and Overhead
- Using **`boolean[]`** Arrays for Probe Storage
  - ➔ Concurrency Possible
  - ➔ Sharing the Instance

Basic Block Coverage



```
ALOAD probearray
ICONST probeid
ICONST_1
BASTORE
```

Class Identity

- Issues
  - ➔ Multiple Versions of the Same Class in one VM
  - ➔ Modified Classes over Time
- Use CRC64 Hash
  - ➔ Fits into Java **`long`**

Avoid Coverage Runtime Dependency

- Avoid Class Loading Issues
- Use JRE APIs only!

```
Object access = ... // Retrieve instance

Object[] args = new Object[3];
args[0] = Long.valueOf(0x89f47a04b2881d38); // class id
args[1] = "com/example/MyClass"; // class name
args[2] = Integer.valueOf(24); // probe count

access.equals(args);

boolean[] probes = (boolean[]) args[0];
```

How to Share an Object Instance?

- The Challenge:

  Share a given object instance
  by using JDK APIs only.

- **Current Solutions:**
  - ➔ **Object as System Property**
  - ➔ **Install Custom Handler with Java Logging**
  - ➔ **Instrumented JRE Class**

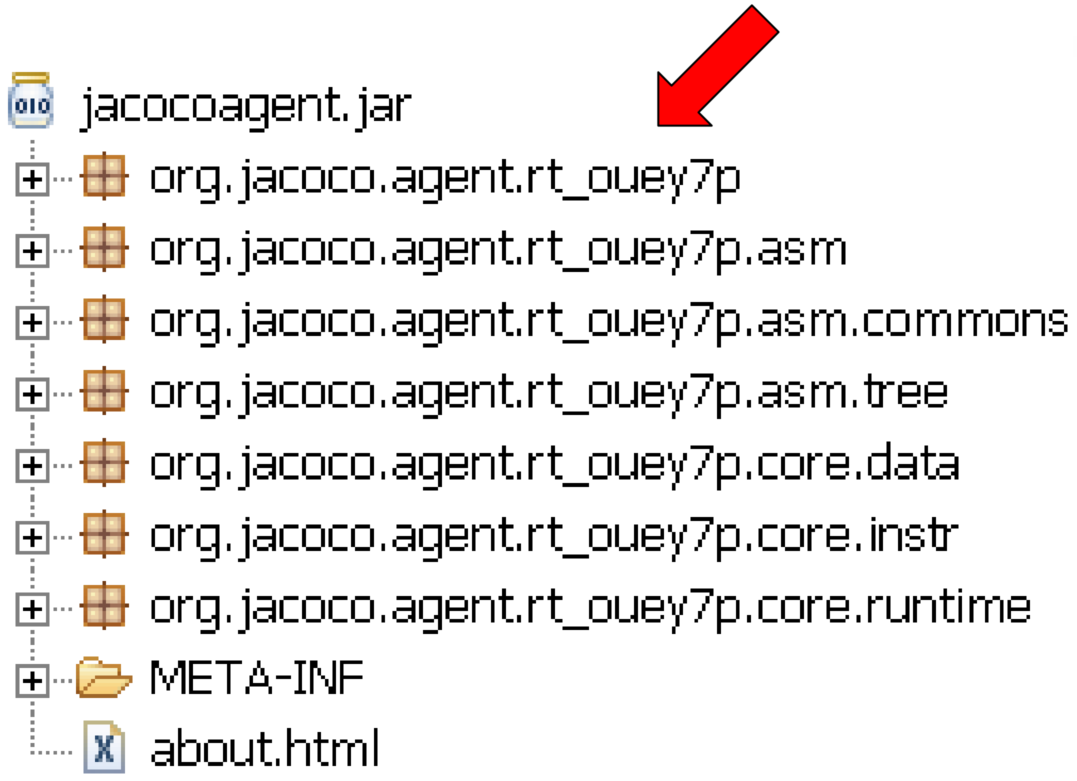
Runtime Isolation

Eating one‘s own dog food:

Run JaCoCo on JaCoCo?

- Java Agent becomes part of the application classpath ☹
- Rename classes in jacocoagent.jar during build ☺

Runtime Isolation


jacocoagent.jar
- org.jacoco.agent.rt_ouey7p
- org.jacoco.agent.rt_ouey7p.asm
- org.jacoco.agent.rt_ouey7p.asm.commons
- org.jacoco.agent.rt_ouey7p.asm.tree
- org.jacoco.agent.rt_ouey7p.core.data
- org.jacoco.agent.rt_ouey7p.core.instr
- org.jacoco.agent.rt_ouey7p.core.runtime
- META-INF
- about.html

JaCoCo Implementation Maxims

- Test First
- Keep it simple and **fast**
- Release Often and Consistent
  - ➔ Every Work Item released as Trunk Build

JaCoCo Status

- Statement Coverage
- HTML, XML, CSV Reports
- Ant Tasks
- Documentation
- APIs not frozen yet!

Future Plans

- Branch Coverage
- Filters
- Eclipse Plugin
- Maven Integration

Get Involved

- Download the Latest Build at http://www.eclemma.org/jacoco
- Integrate it With Your
  - Build
  - Whatever Tool
- Get in Touch for
  - Feature Requests
  - Bug Reports
  - Contributions

Short-Term Plans

- San Francisco Area until Saturday
- Get in Touch
  - ➔ hoffmann@mountainminds.com

Questions?
Thank You!