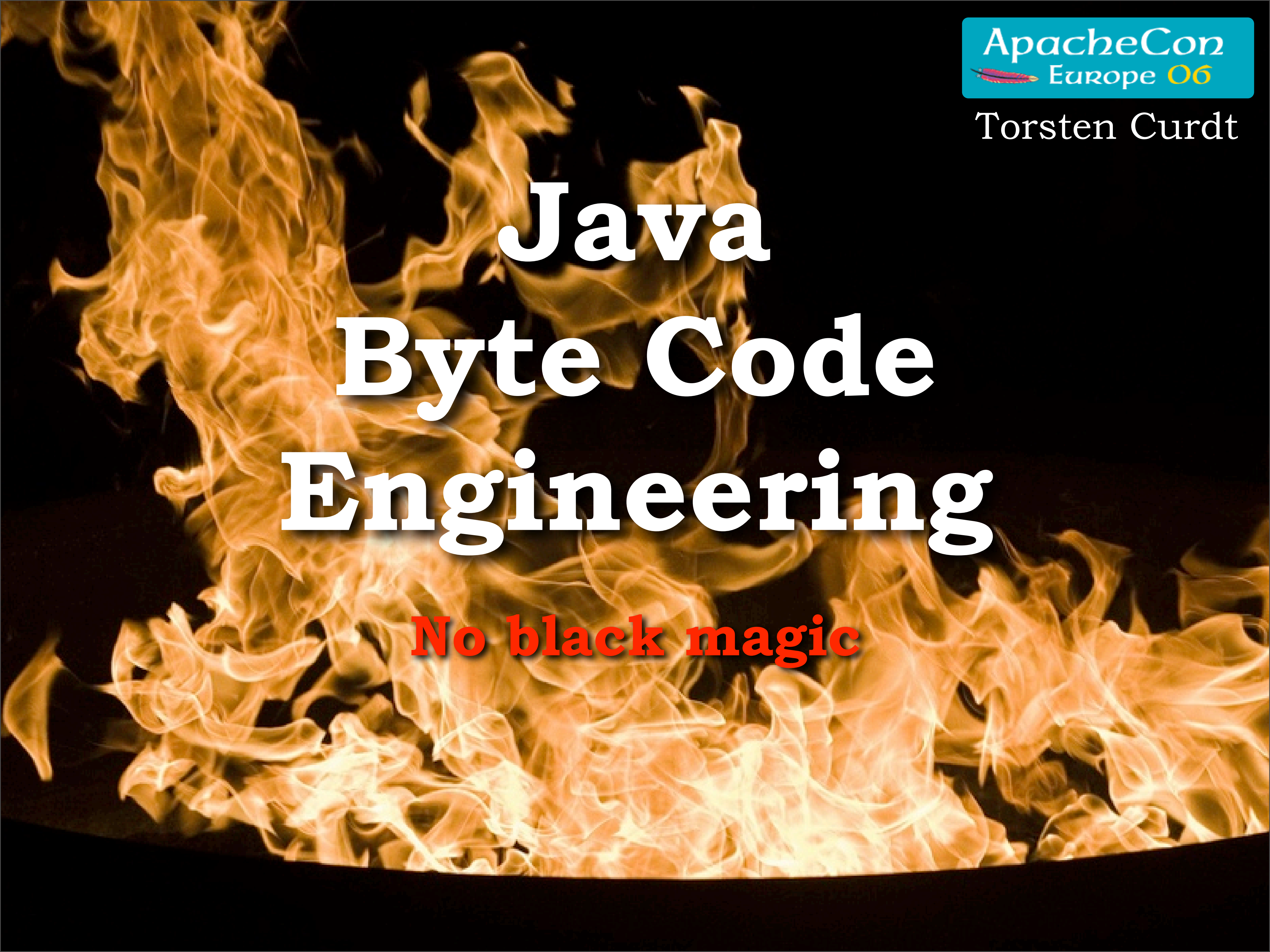


ApacheCon Europe 06

Torsten Curdt

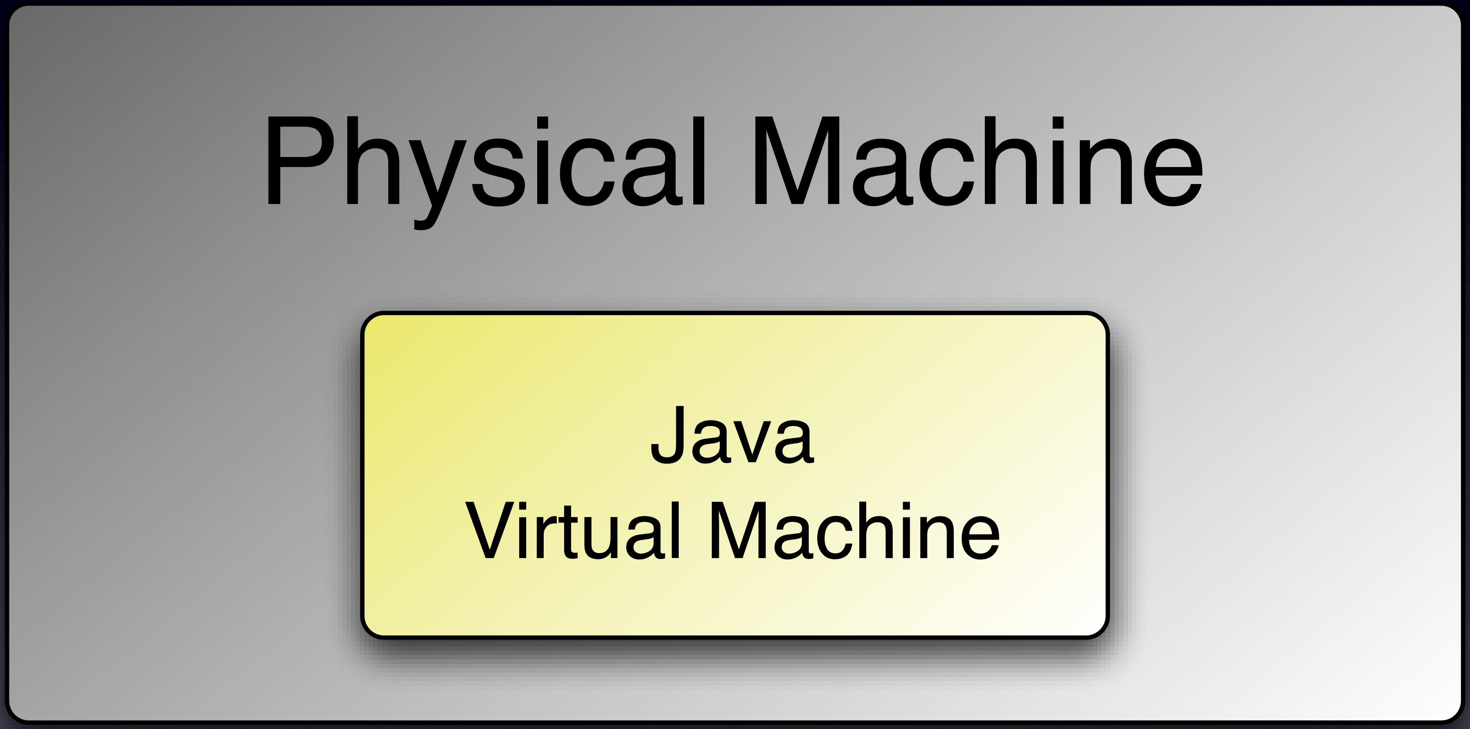
Java Byte Code Engineering

No black magic

Agenda

- Introduction and tools
- Libraries
- Use-cases

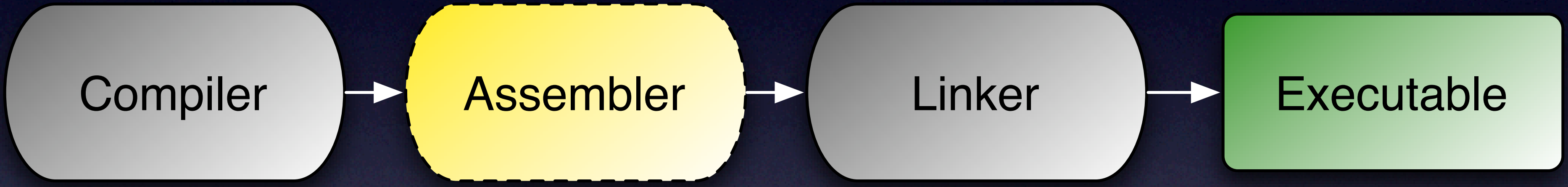
Virtual CPU



Physical Machine

Java
Virtual Machine

Intermediate Step



Native Assembler

```
#include <stdio.h>

int main(char** args) {
   printf("Hello, world");
   return 0;
}
```

```
gcc -S HelloWorld.c
```

```
        .cstring
        .align 2
LC0:
        .ascii "Hello, world
        .text
        .align 2
        .globl _main
_main:
        mflr r0
        stmw r30,-8(r1)
        stw r0,8(r1)
        stwu r1,-80(r1)
        mr r30,r1
        bcl 20,31,"L00000000
"L00000000001$pb":
        mflr r31
        stw r3,104(r30)
        addis r3,r31,ha16(LC
        la r3,lo16(LC0-"L000
        bl L_printf$LDBLStub
```

Native Assembler

```
#include <stdio.h>

int main(char** args
  printf("Hello, wor
  return 0;
}
```

```
mflr r0
stmw r30,-8(r1)
stw r0,8(r1)
stwu r1,-80(r1)
mr r30,r1
bcl 20,31,"L00000000001$pb"
...
```

```
gcc -S HelloWorld.c
```

Java Disassembler

```
public class HelloWorld {

  public static void main(String[] args) {
    System.out.println("Hello, world!");
  }

}
```

```
javap -c HelloWorld
```

```
Compiled from "Hello
public class HelloWo
public HelloWorld();
  Code:
   0:   aload_0
   1:   invokespecia
Object."<init>":()V
   4:   return

public static void m
  Code:
   0:   getstatic
System.out:Ljava/io/
   3:   ldc      #3;
   5:   invokevirtua
            od jav
lang/String;)V
   8:   return
```

Java Disassembler

```
public class HelloW
    public static voi
        System.out.prin
    }
}
```

```
public static void main(java.lang.String[])
 Code:
  0: getstatic #2; //Field java/lang/
  3: ldc #3; //String Hello, world!
  5: invokevirtual #4; //Method java/io/
  8:
     return
}
```

```
javap -c HelloWorld
```

Jasmin Syntax

```
public class HelloW

  public static voi
    System.out.prin
  }

}
```

```
.method  public static main([Ljava/lang
  .limit stack 2
  .limit locals 1
  .line 4
  getstatic java/lang/System/out Ljava/
  ldc "Hello, world!"
  invokevirtual java/io/PrintStream/println
  .line 5
  return
.end method
```

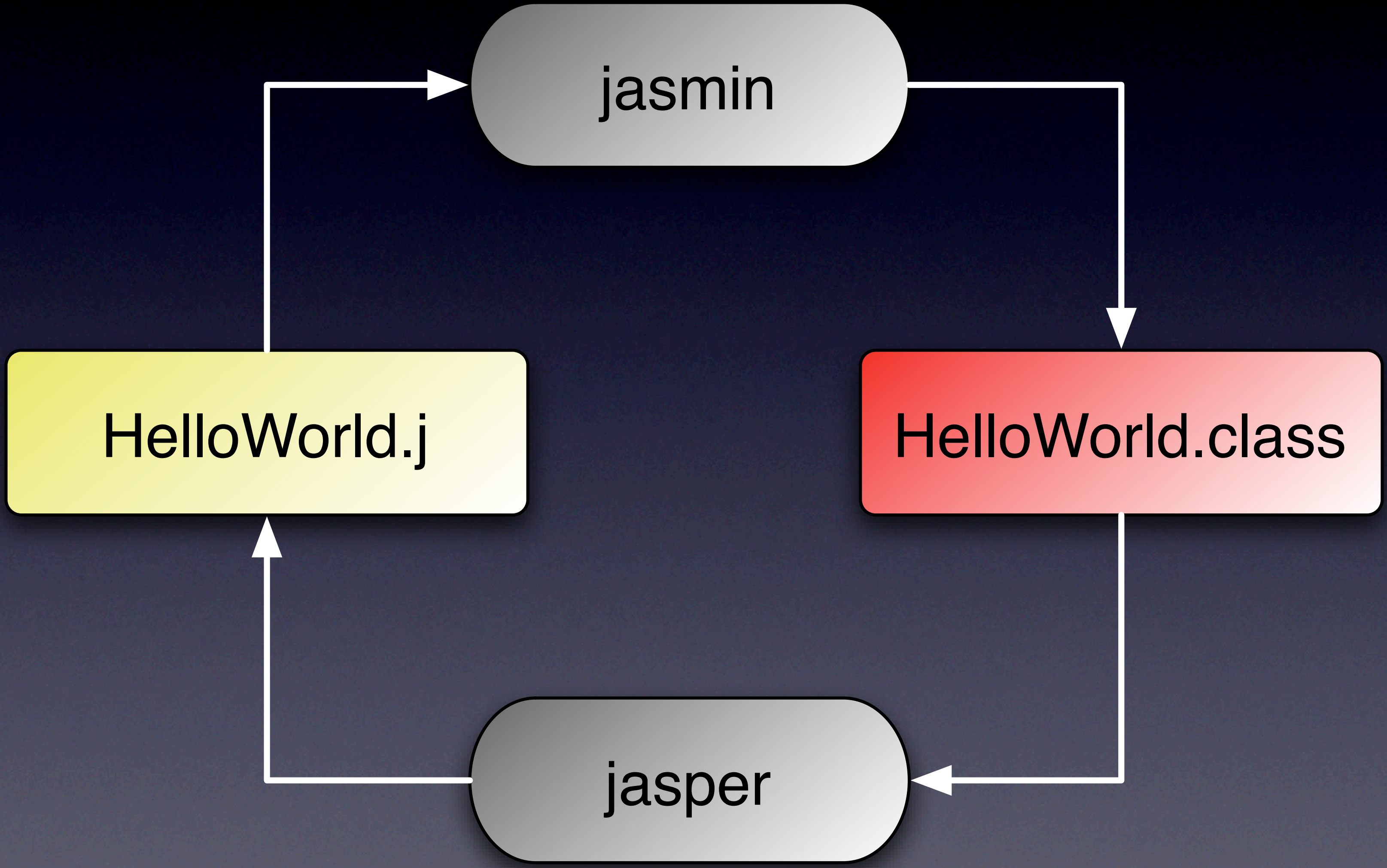
```
java -jar jasper.jar HelloWorld.class
```

Assembler

- Jasmin generates class files from assembler input
- http://jasmin.sourceforge.net

```
java -jar jasmin.jar HelloWorld.j
```

Roundtrip



Libraries

- ASM
- BCEL
- CGLIB
- Javassist

BCEL

- Object model based
- JDK 1.4 support
- Verifier
- “DOM”

ASM

- Event driven
- DOM available
- JDK 1.6 support
- “SAX”

BCEL vs ASM

- BCEL: xalan, findbugs, aspectj, javaflow, clirr, beanshell, just4log, ...
- ASM: jardiff, javaflow, groovy, cobertura, aspectwerkz, beanshell, retroweaver, ...

BCEL vs ASM

- Community
- JDK support
- “DOM” vs “SAX”
- API
- Tool support

Eclipse

Use-cases

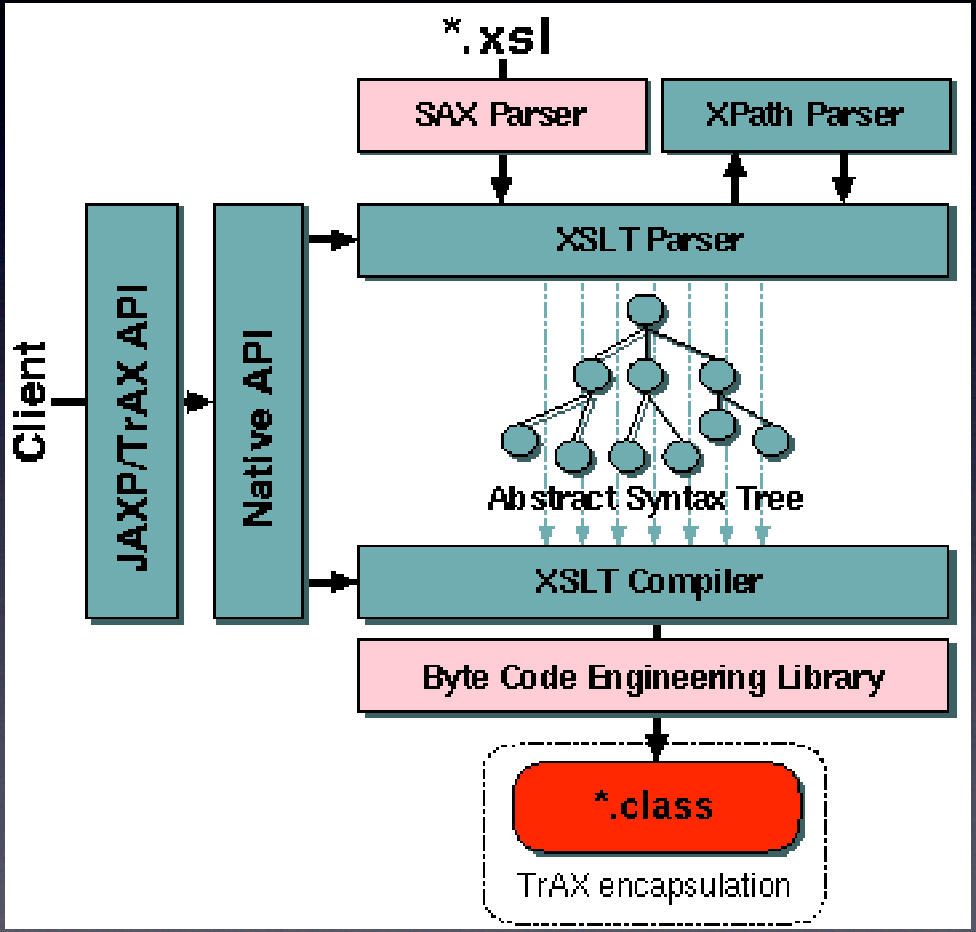
- Generation
- Analysis
- Modification

Generation

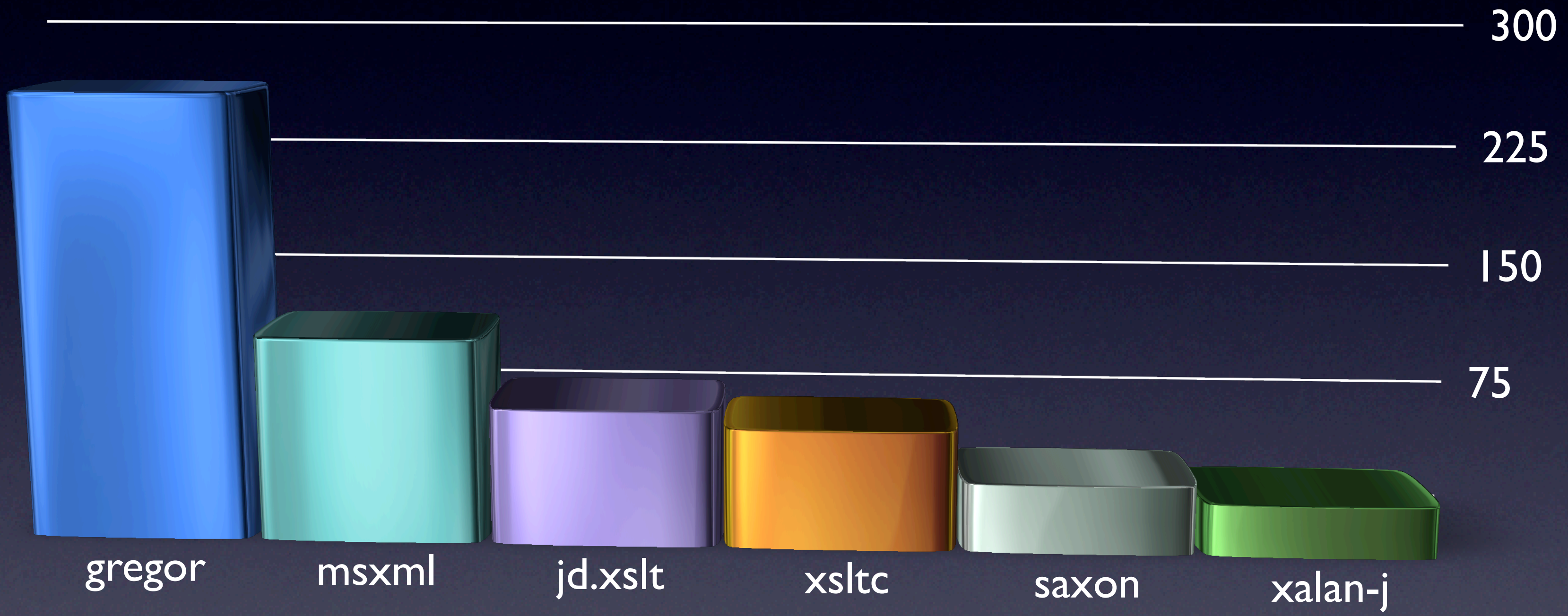
XSLTC

- XSLT to java compiler
- Creates a translet from xslt
- Translet as JAXP transformer

XSLTC


*.xsl
SAX Parser
XPath Parser
XSLT Parser
Client
JAXP/TrAX API
Native API
Abstract Syntax Tree
XSLT Compiler
Byte Code Engineering Library
*.class
TrAX encapsulation

XSLTC Speed

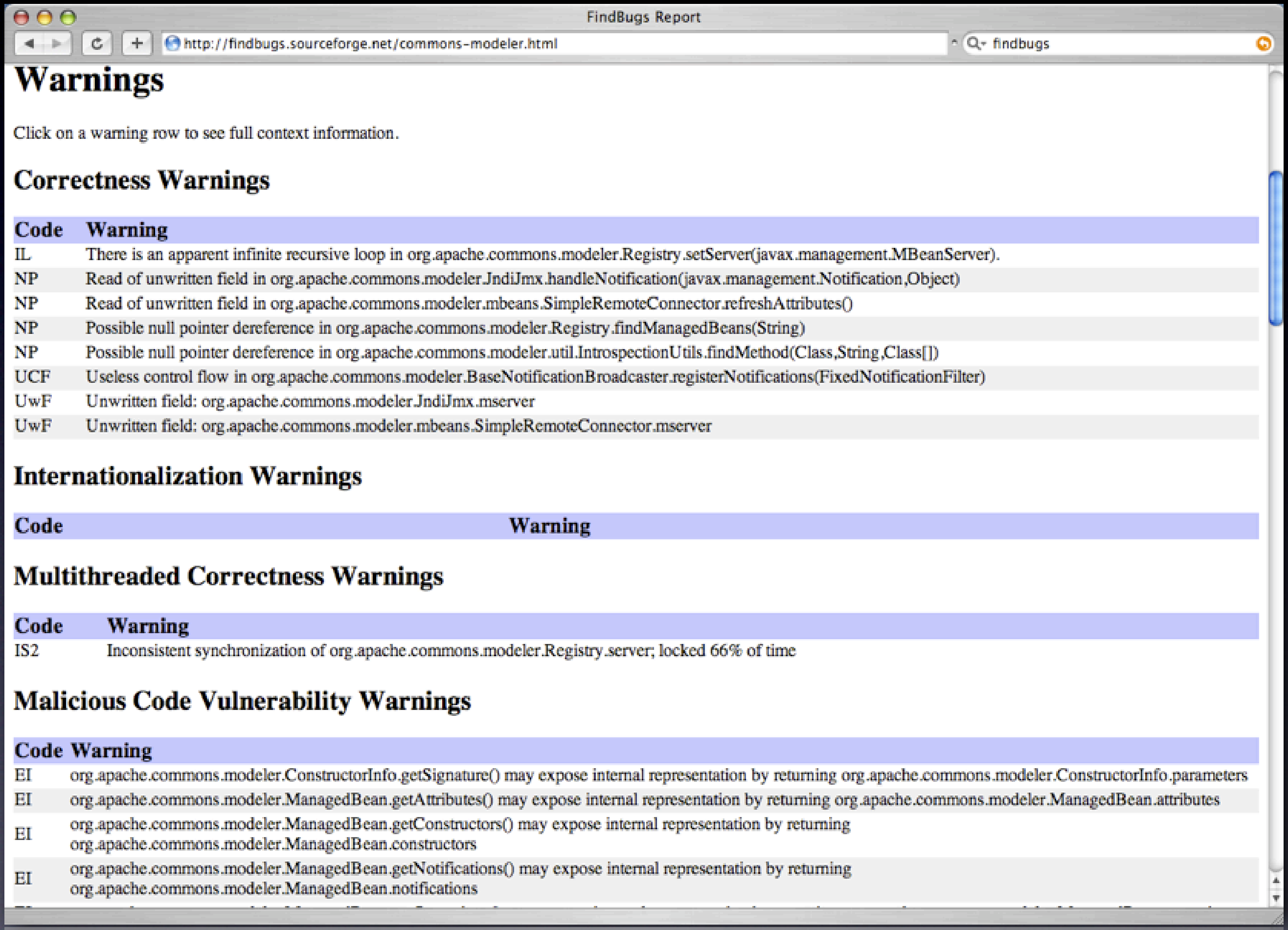


Analysis

Findbugs

- Static analysis for bug patterns
- False positives

Findbugs



Warnings

Click on a warning row to see full context information.

Correctness Warnings

Code	Warning
IL	There is an apparent infinite recursive loop in org.apache.commons.modeler.Registry.setServer(javax.management.MBeanServer).
NP	Read of unwritten field in org.apache.commons.modeler.JndiJmx.handleNotification(javax.management.Notification,Object)
NP	Read of unwritten field in org.apache.commons.modeler.mbeans.SimpleRemoteConnector.refreshAttributes()
NP	Possible null pointer dereference in org.apache.commons.modeler.Registry.findManagedBeans(String)
NP	Possible null pointer dereference in org.apache.commons.modeler.util.IntrospectionUtils.findMethod(Class,String,Class[])
UCF	Useless control flow in org.apache.commons.modeler.BaseNotificationBroadcaster.registerNotifications(FixedNotificationFilter)
UwF	Unwritten field: org.apache.commons.modeler.JndiJmx.mserver
UwF	Unwritten field: org.apache.commons.modeler.mbeans.SimpleRemoteConnector.mserver

Internationalization Warnings

Code	Warning

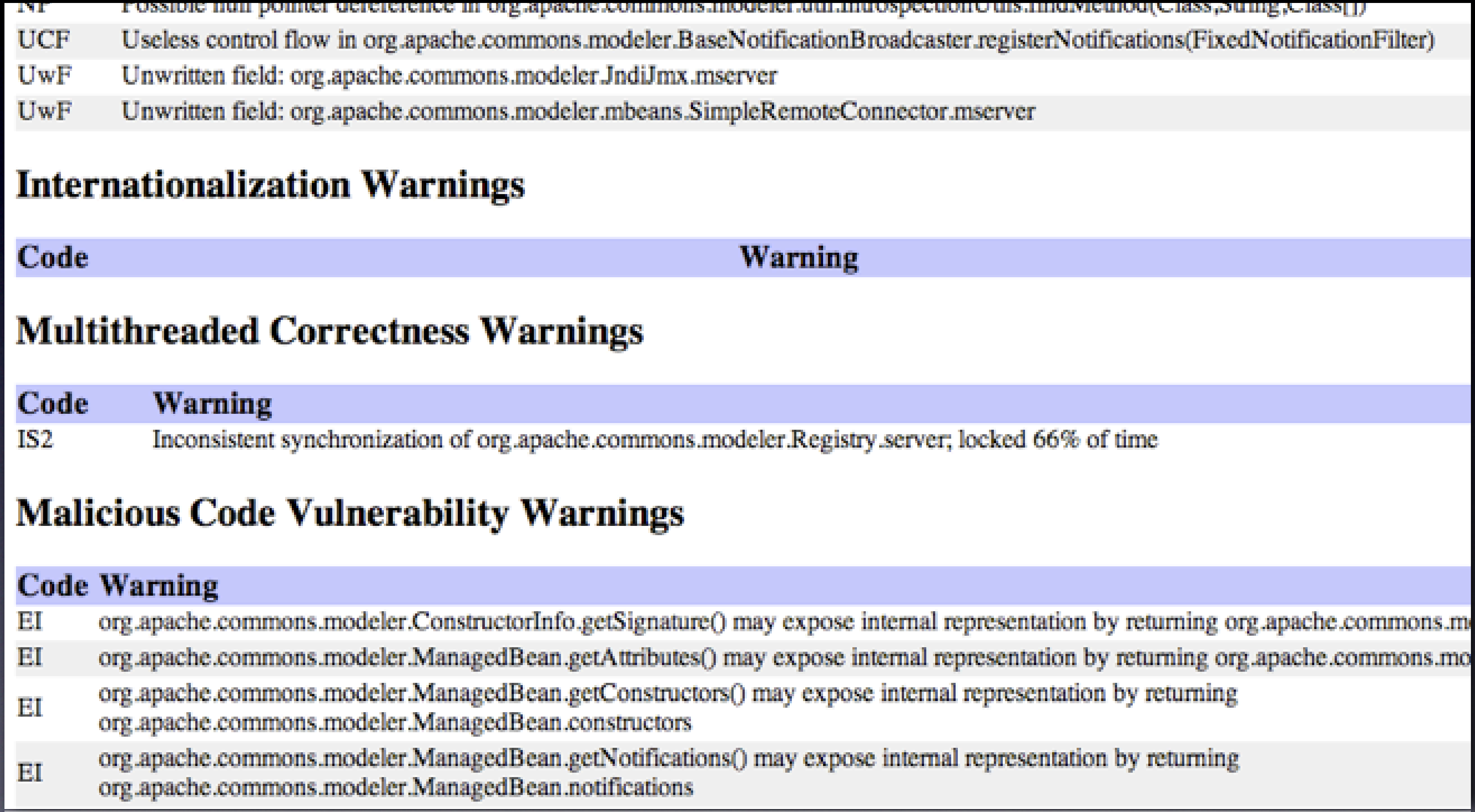
Multithreaded Correctness Warnings

Code	Warning
IS2	Inconsistent synchronization of org.apache.commons.modeler.Registry.server; locked 66% of time

Malicious Code Vulnerability Warnings

Code	Warning
EI	org.apache.commons.modeler.ConstructorInfo.getSignature() may expose internal representation by returning org.apache.commons.modeler.ConstructorInfo.parameters
EI	org.apache.commons.modeler.ManagedBean.getAttributes() may expose internal representation by returning org.apache.commons.modeler.ManagedBean.attributes
EI	org.apache.commons.modeler.ManagedBean.getConstructors() may expose internal representation by returning org.apache.commons.modeler.ManagedBean.constructors
EI	org.apache.commons.modeler.ManagedBean.getNotifications() may expose internal representation by returning org.apache.commons.modeler.ManagedBean.notifications

Findbugs



NP	Possible null pointer dereference in org.apache.commons.modeler.util.IntrospectionUtils.findMethod(Class,String,Class[])
UCF	Useless control flow in org.apache.commons.modeler.BaseNotificationBroadcaster.registerNotifications(FixedNotificationFilter)
UwF	Unwritten field: org.apache.commons.modeler.JndiJmx.mserver
UwF	Unwritten field: org.apache.commons.modeler.mbeans.SimpleRemoteConnector.mserver

Internationalization Warnings

Code	Warning

Multithreaded Correctness Warnings

Code	Warning
IS2	Inconsistent synchronization of org.apache.commons.modeler.Registry.server; locked 66% of time

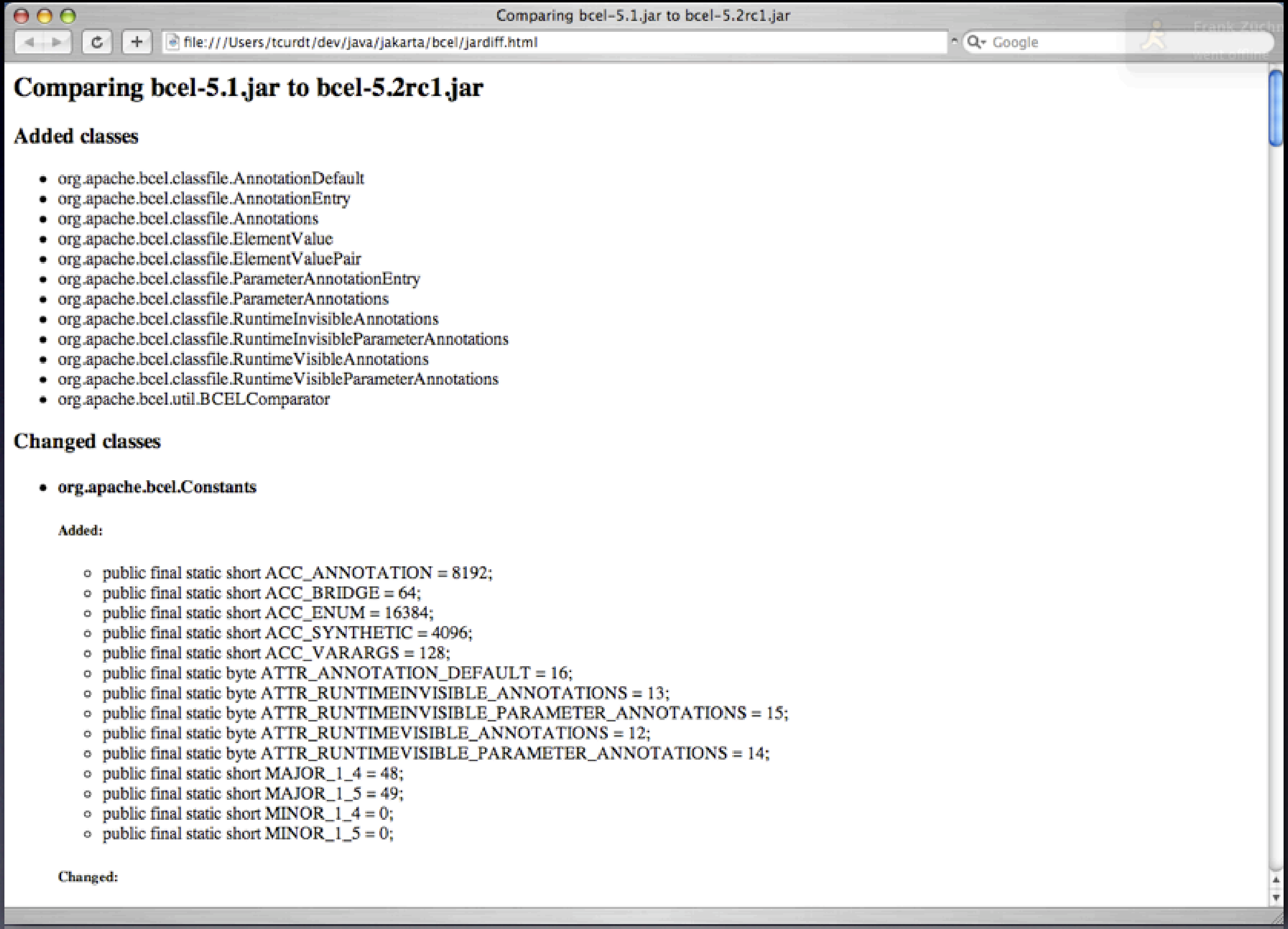
Malicious Code Vulnerability Warnings

Code	Warning
EI	org.apache.commons.modeler.ConstructorInfo.getSignature() may expose internal representation by returning org.apache.commons.m
EI	org.apache.commons.modeler.ManagedBean.getAttributes() may expose internal representation by returning org.apache.commons.mo
EI	org.apache.commons.modeler.ManagedBean.getConstructors() may expose internal representation by returning org.apache.commons.modeler.ManagedBean.constructors
EI	org.apache.commons.modeler.ManagedBean.getNotifications() may expose internal representation by returning org.apache.commons.modeler.ManagedBean.notifications

Clirr / Jardiff

- Diff for jars or class files
- Detecting API changes

Jardiff



Comparing bcel-5.1.jar to bcel-5.2rc1.jar
file:///Users/tcurdt/dev/java/jakarta/bcel/jardiff.html
Google

Comparing bcel-5.1.jar to bcel-5.2rc1.jar

Added classes

- org.apache.bcel.classfile.AnnotationDefault
- org.apache.bcel.classfile.AnnotationEntry
- org.apache.bcel.classfile.Annotations
- org.apache.bcel.classfile.ElementValue
- org.apache.bcel.classfile.ElementValuePair
- org.apache.bcel.classfile.ParameterAnnotationEntry
- org.apache.bcel.classfile.ParameterAnnotations
- org.apache.bcel.classfile.RuntimeInvisibleAnnotations
- org.apache.bcel.classfile.RuntimeInvisibleParameterAnnotations
- org.apache.bcel.classfile.RuntimeVisibleAnnotations
- org.apache.bcel.classfile.RuntimeVisibleParameterAnnotations
- org.apache.bcel.util.BCELComparator

Changed classes

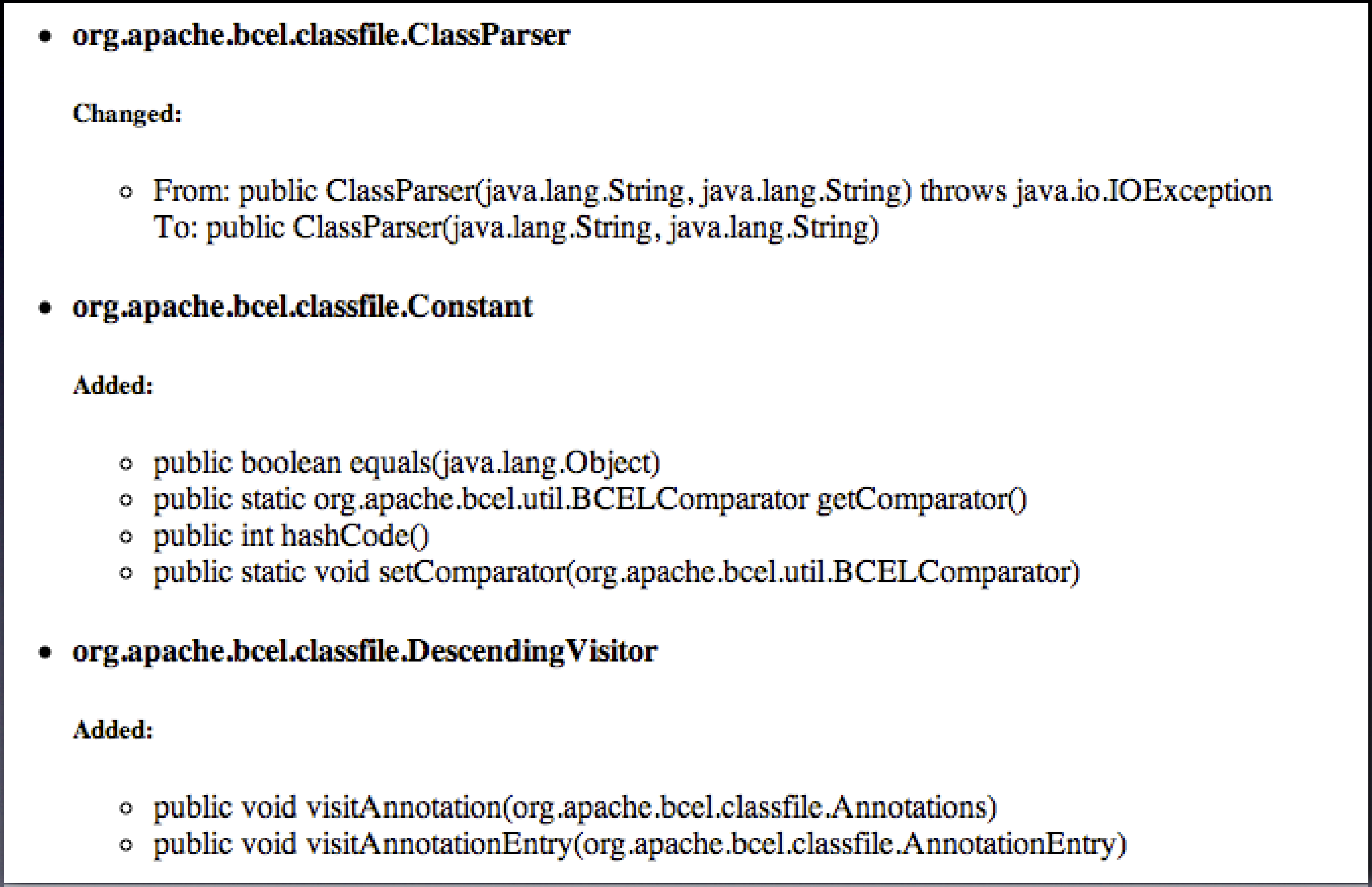
- **org.apache.bcel.Constants**

  Added:

  - public final static short ACC_ANNOTATION = 8192;
  - public final static short ACC_BRIDGE = 64;
  - public final static short ACC_ENUM = 16384;
  - public final static short ACC_SYNTHETIC = 4096;
  - public final static short ACC_VARARGS = 128;
  - public final static byte ATTR_ANNOTATION_DEFAULT = 16;
  - public final static byte ATTR_RUNTIMEINVISIBLE_ANNOTATIONS = 13;
  - public final static byte ATTR_RUNTIMEINVISIBLE_PARAMETER_ANNOTATIONS = 15;
  - public final static byte ATTR_RUNTIMEVISIBLE_ANNOTATIONS = 12;
  - public final static byte ATTR_RUNTIMEVISIBLE_PARAMETER_ANNOTATIONS = 14;
  - public final static short MAJOR_1_4 = 48;
  - public final static short MAJOR_1_5 = 49;
  - public final static short MINOR_1_4 = 0;
  - public final static short MINOR_1_5 = 0;

  Changed:

Jardiff



- **org.apache.bcel.classfile.ClassParser**

  Changed:

  - From: public ClassParser(java.lang.String, java.lang.String) throws java.io.IOException
    To: public ClassParser(java.lang.String, java.lang.String)

- **org.apache.bcel.classfile.Constant**

  Added:

  - public boolean equals(java.lang.Object)
  - public static org.apache.bcel.util.BCELComparator getComparator()
  - public int hashCode()
  - public static void setComparator(org.apache.bcel.util.BCELComparator)

- **org.apache.bcel.classfile.DescendingVisitor**

  Added:

  - public void visitAnnotation(org.apache.bcel.classfile.Annotations)
  - public void visitAnnotationEntry(org.apache.bcel.classfile.AnnotationEntry)

Dependency

- Analyses class dependencies
- Finding unused classes
- Renaming classes

Dependency

```
Set dependencies = DependencyUtils
   .getDependenciesOfClass(
      Class1.class
    );
```

Dependency

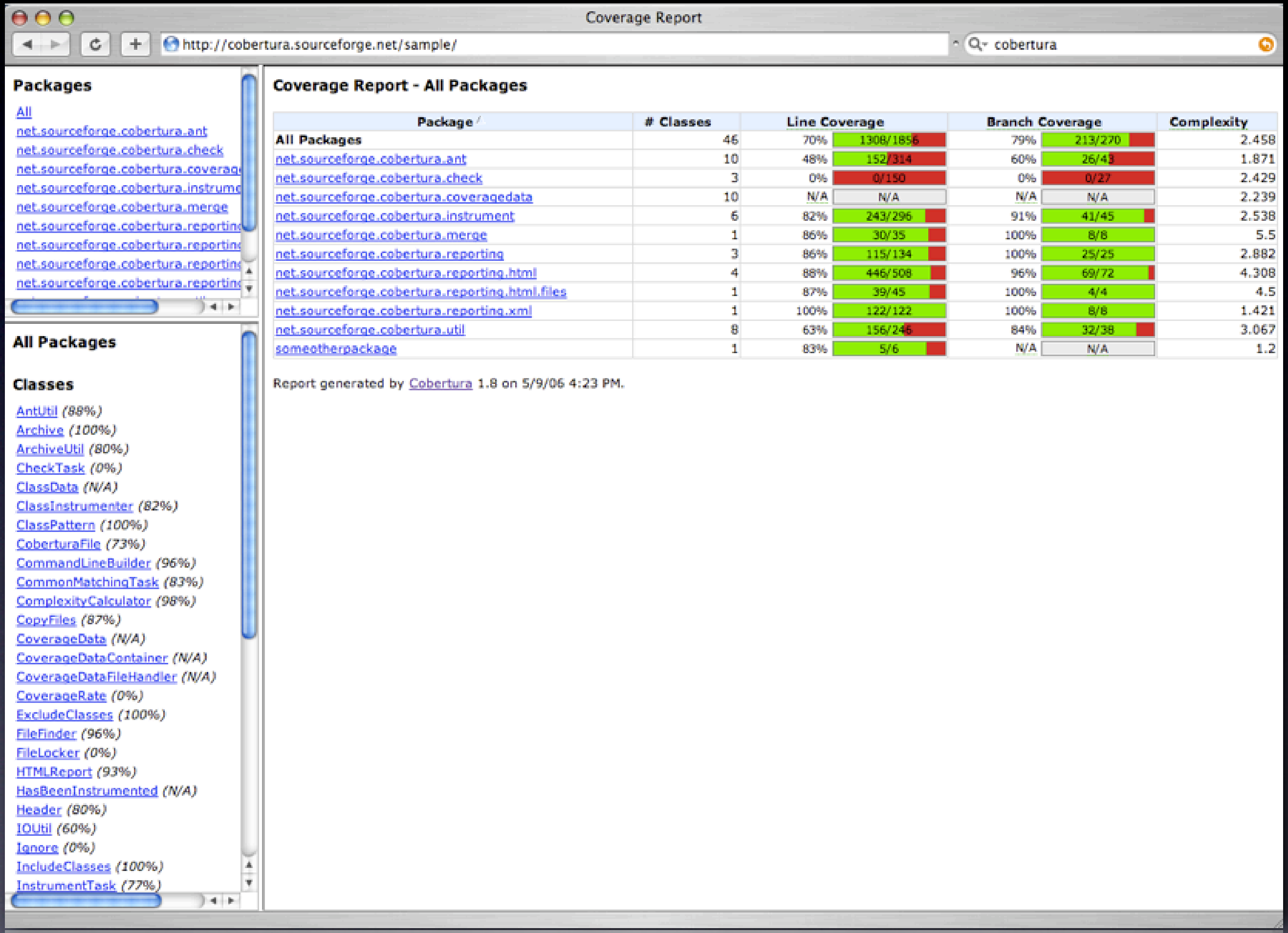
```
new ResourceRenamer() {
 String getNewNameFor(String oldName) {
  if (oldName.startsWith(
      "java.util.HashMap")) {
          return "my." + oldName;
  }
  return oldName;
}
```

Modification

Cobertura / Clover

- Testcase coverage
- Recording the execution path
- Maven plugin

Cobertura



Packages

All
net.sourceforge.cobertura.ant
net.sourceforge.cobertura.check
net.sourceforge.cobertura.coverag
net.sourceforge.cobertura.instrum
net.sourceforge.cobertura.merge
net.sourceforge.cobertura.reportin
net.sourceforge.cobertura.reportin
net.sourceforge.cobertura.reportin
net.sourceforge.cobertura.reportin

All Packages

Classes

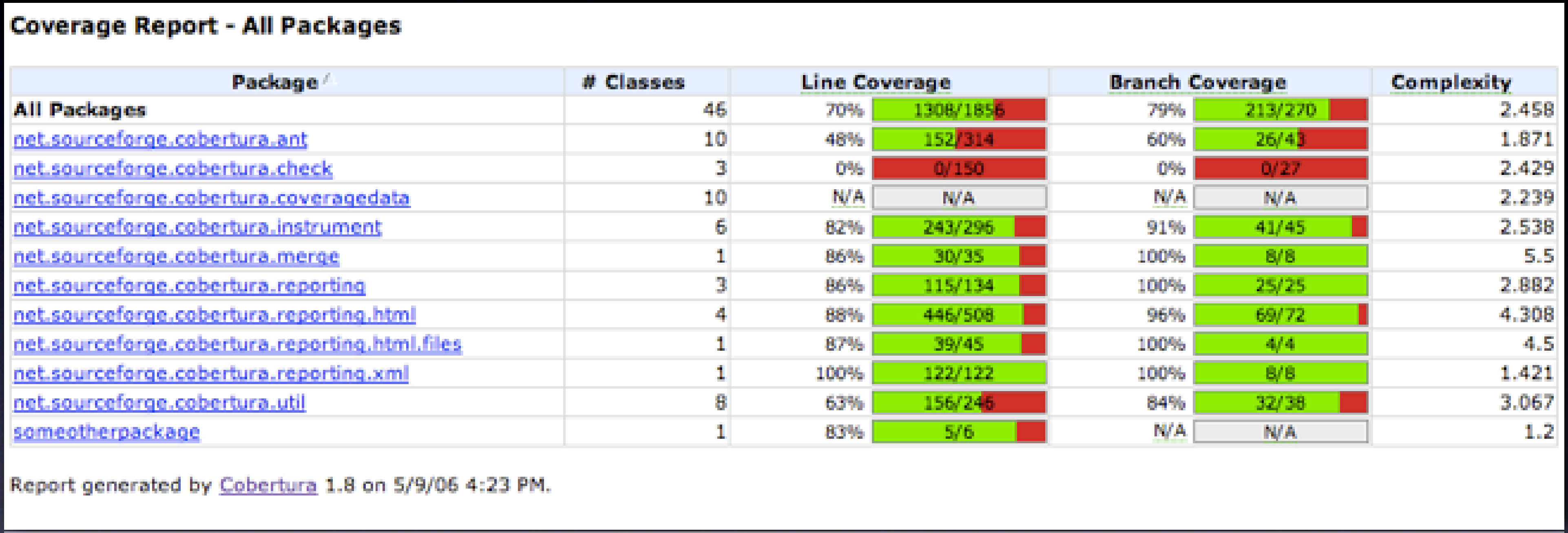
AntUtil *(88%)*
Archive *(100%)*
ArchiveUtil *(80%)*
CheckTask *(0%)*
ClassData *(N/A)*
ClassInstrumenter *(82%)*
ClassPattern *(100%)*
CoberturaFile *(73%)*
CommandLineBuilder *(96%)*
CommonMatchingTask *(83%)*
ComplexityCalculator *(98%)*
CopyFiles *(87%)*
CoverageData *(N/A)*
CoverageDataContainer *(N/A)*
CoverageDataFileHandler *(N/A)*
CoverageRate *(0%)*
ExcludeClasses *(100%)*
FileFinder *(96%)*
FileLocker *(0%)*
HTMLReport *(93%)*
HasBeenInstrumented *(N/A)*
Header *(80%)*
IOUtil *(60%)*
Ignore *(0%)*
IncludeClasses *(100%)*
InstrumentTask *(77%)*

Coverage Report - All Packages

Package	# Classes	Line Coverage		Branch Coverage		Complexity
All Packages	46	70%	1308/1856	79%	213/270	2.458
net.sourceforge.cobertura.ant	10	48%	152/314	60%	26/43	1.871
net.sourceforge.cobertura.check	3	0%	0/150	0%	0/27	2.429
net.sourceforge.cobertura.coveragedata	10	N/A	N/A	N/A	N/A	2.239
net.sourceforge.cobertura.instrument	6	82%	243/296	91%	41/45	2.538
net.sourceforge.cobertura.merge	1	86%	30/35	100%	8/8	5.5
net.sourceforge.cobertura.reporting	3	86%	115/134	100%	25/25	2.882
net.sourceforge.cobertura.reporting.html	4	88%	446/508	96%	69/72	4.308
net.sourceforge.cobertura.reporting.html.files	1	87%	39/45	100%	4/4	4.5
net.sourceforge.cobertura.reporting.xml	1	100%	122/122	100%	8/8	1.421
net.sourceforge.cobertura.util	8	63%	156/246	84%	32/38	3.067
someotherpackage	1	83%	5/6	N/A	N/A	1.2

Report generated by Cobertura 1.8 on 5/9/06 4:23 PM.

Cobertura



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Report generated by Cobertura 1.8 on 5/9/06 4:23 PM.

Throttling

- Wrap SocketInputStream to deliver according to settings
- Cannot rewrite java.* classes

Retroweaver

- Compile with jdk 1.5 features, run on 1.4
- Static conversion
- Runtime conversion

Just4log

```
for(int i=0; i<500000; i++) {
  if(log.isDebugEnabled()) {
    log.debug("message"
      + someLongTaskToExecute());
  }
  normalCodeToExecute();
}
```

AspectJ

```
public aspect LogAspect
{
  declare precedence : LogAspect, *;

  pointcut voidCalls() :
    !within(LogAspect)
    && execution(void *.*(..))
  );
```

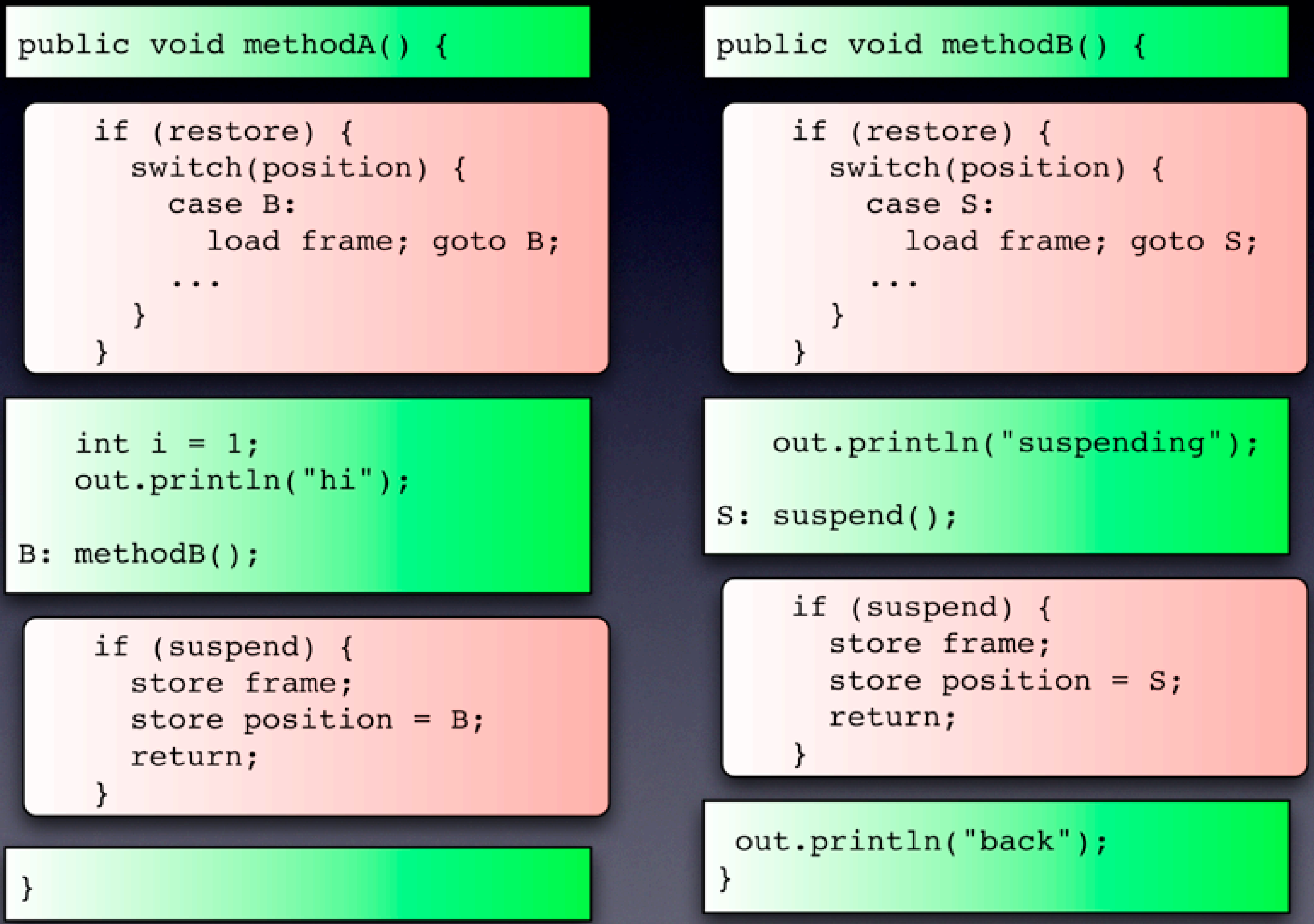
AspectJ

```
Object around() : voidCalls() {

 Signature sig = thisJoinPoint
   .getSignature();

 log.debug('<' + getFullSig(thisJoinPoint));
 Object result = proceed();
 log.debug('>' + sig.getName());
```

Javaflow

```
class MyRunnable implements Runnable {
  public void run() {
    for(int i=0; i<10; i++ )
      Continuation.suspend();
  }}
Continuation c = Continuation.startWith(
                      new MyRunnable());
Continuation d = Continuation.continueWith(c);
...
```

Javaflow



```
public void methodA() {

    if (restore) {
      switch(position) {
        case B:
          load frame; goto B;
        ...
      }
    }

   int i = 1;
   out.println("hi");

B: methodB();

    if (suspend) {
      store frame;
      store position = B;
      return;
    }

}
```

```
public void methodB() {

    if (restore) {
      switch(position) {
        case S:
          load frame; goto S;
        ...
      }
    }

   out.println("suspending");

S: suspend();

    if (suspend) {
      store frame;
      store position = S;
      return;
    }

 out.println("back");
}
```

Thanks!