Having fun with Javassist

Me

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ZEROTURNAROUND

XRebel JRebel

We Javassist a lot!

You?

Are you interested in Javassist?

Want to become a better programmer?

Bytecode instrumentation, anyone?


Bytecode instrumentation
SPACE RANGER
LIGHTYEAR
Everywhere!

```java
@Entity
@Table(name = "owners")
public class Owner extends Person {
    @Column(name = "address")
    @NotEmpty
    private String address;

    @Column(name = "city")
    @NotEmpty
    private String city;

    @Column(name = "telephone")
    @NotEmpty
    @Digits(fraction = 0, integer = 10)
    private String telephone;

    @OneToMany(cascade = CascadeType.ALL,
               mappedBy = "owner")
    private Set<Pet> pets;
```

```
public class JavassistLazyInitializer
        extends BasicLazyInitializer
        implements MethodHandler {


final JavassistLazyInitializer instance
     = new JavassistLazyInitializer(…);

ProxyFactory factory = new ProxyFactory();
factory.setSuperclass(interfaces.length == 1?persistentClass:null);
factory.setInterfaces(interfaces);
factory.setFilter(FINALIZE_FILTER);

Class cl = factory.createClass();
final HibernateProxy proxy = (HibernateProxy) cl.newInstance();
((ProxyObject)proxy).setHandler(instance);
instance.constructed = true;
return proxy;
```

HIBERNATE

```
public class JavassistLazyInitializer
        extends BasicLazyInitializer
        implements MethodHandler {

final JavassistLazyInitializer instance
     = new JavassistLazyInitializer(…);

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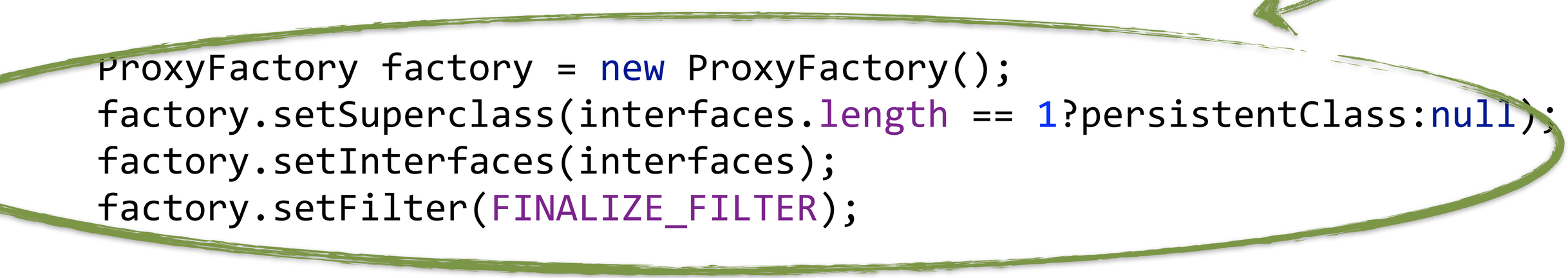
Class cl = factory.createClass();
final HibernateProxy proxy = (HibernateProxy) cl.newInstance();
((ProxyObject)proxy).setHandler(instance);
instance.constructed = true;
return proxy;
```

Generates proxy!



HIBERNATE

The main use case for bytecode generation in Java framewoks is to generate proxies


Hacks!
SPACE RANGER
LIGHTYEAR
Hacks everywhere!

Agenda

Javassist basics

-javaagent

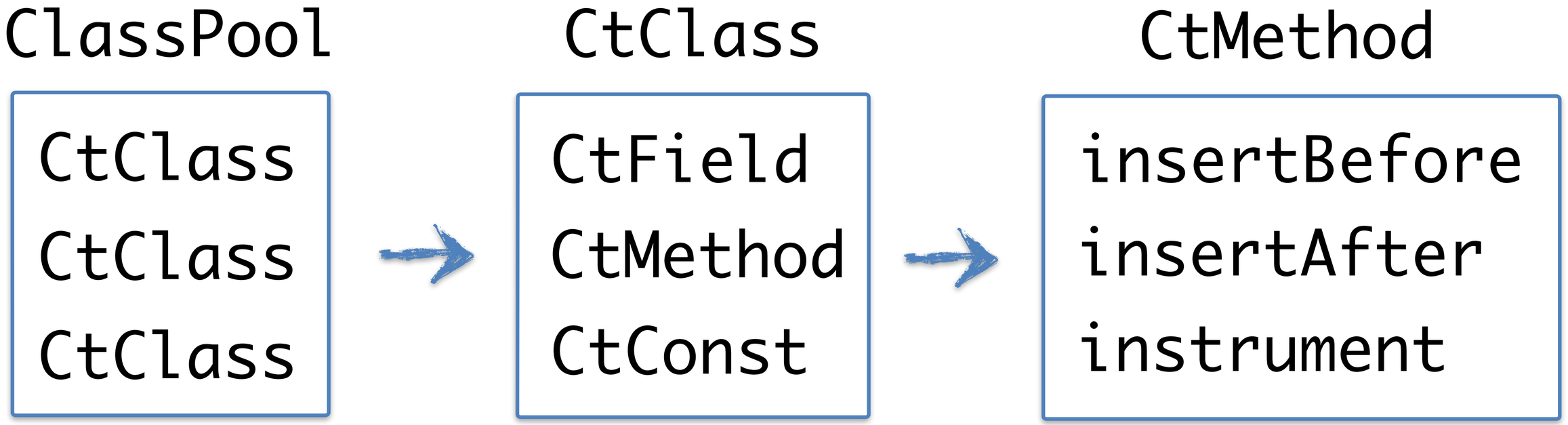
~~Hacks~~Applications

… and a little bit on the use of Javassist in JRebel

Javassist 101

www.javassist.org

It feels almost like Java Reflection API :)



```
public static void main(String[] args) throws Exception {




}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();

}
```

```
ClassPool cp = new ClassPool(null);
cp.appendSystemPath();
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();

    CtClass ct = cp.makeClass("com.zt.A",
        cp.get("com.zt.Clazz"));
```

```
public class A extends Clazz {
    public A() {
    }
}
```

```
}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();

    CtClass ct = cp.makeClass("com.zt.A",
        cp.get("com.zt.Clazz"));

    CtMethod[] methods = ct.getMethods();
    for (CtMethod method : methods) {
        //…
    }



}
```

```
public static void main(String[] args) throws Exception {

    mars:output anton$ javap -c com/zt/A.class Compiled from "A.java"
    public class com.zt.A extends com.zt.Clazz {
      public com.zt.A();
        Code:
          0: aload_0
          1: invokespecial #10
          4: return

    ct.writeFile("/output");

}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();

    CtClass ct = cp.makeClass("com.zt.A",
        cp.get("com.zt.Clazz"));

    CtMethod[] methods = ct.getMethods();
    for (CtMethod method : methods) {
        //…
    }

    ct.writeFile("/output");

}
```

Can generate classes from metadata at build time

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    cp.appendClassPath(new ClassPath(){ … });

    CtClass ct = cp.get("com.zt.A");

    CtMethod[] methods = ct.getMethods();
    for (CtMethod method : methods) {
        //…
    }

    ct.writeFile("/output");

}
```

… or you can post process the compiled classes

```
public static void main(String[] args) throws Exception {
```


```
}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    CtClass ctClass = cp.get("com.zt.A");









}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    CtClass ctClass = cp.get("com.zt.A");

    CtMethod foo = ctClass.getMethod("foo",
      "()V");
```

```
public void foo() {
}
```

```
}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    CtClass ctClass = cp.get("com.zt.A");

    CtMethod foo = ctClass.getMethod("foo",
      "(Ljava/lang/String;)V");
```

```
    public void foo(String s) {
    }
```

```
}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    CtClass ctClass = cp.get("com.zt.A");

    CtMethod foo = ctClass.getMethod("foo",
      "(Ljava/lang/String;Ljava/lang/String;Ljava/lang/String;Lja
```

Descriptors might get quite long ;)

```
}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    CtClass ctClass = cp.get("com.zt.A");

    CtMethod foo = ctClass.getMethod("foo",
      "(Ljava/lang/String;)V");

    foo.insertBefore("System.out.println($1)");

}
```

$1, $2, $3 – local variables
$0 – this for non-static methods

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
```

```
Exception in thread "main" javassist.CannotCompileException: [source error] ; is missing
    at javassist.CtBehavior.insertBefore(CtBehavior.java:774)
    at javassist.CtBehavior.insertBefore(CtBehavior.java:734)
    at com.zt.basics.Ex.main(Ex.java:35)
```

```
    foo.insertBefore("System.out.println($1)");

    Class c = ctClass.toClass();
    A a = (A) c.newInstance();
    a.foo("Hello");

}
```

```
public static void main(String[] args) throws Exception {

    ClassPool cp = ClassPool.getDefault();
    CtClass ctClass = cp.get("com.zt.A");

    CtMethod foo = ctClass.getMethod("foo",
      "(Ljava/lang/String;)V");

    foo.insertBefore("System.out.println($1);");

    Class c = ctClass.toClass();
    A a = (A) c.newInstance();
    a.foo("Hello");

}
```

```
CtMethod foo = …

foo.insertBefore(…);

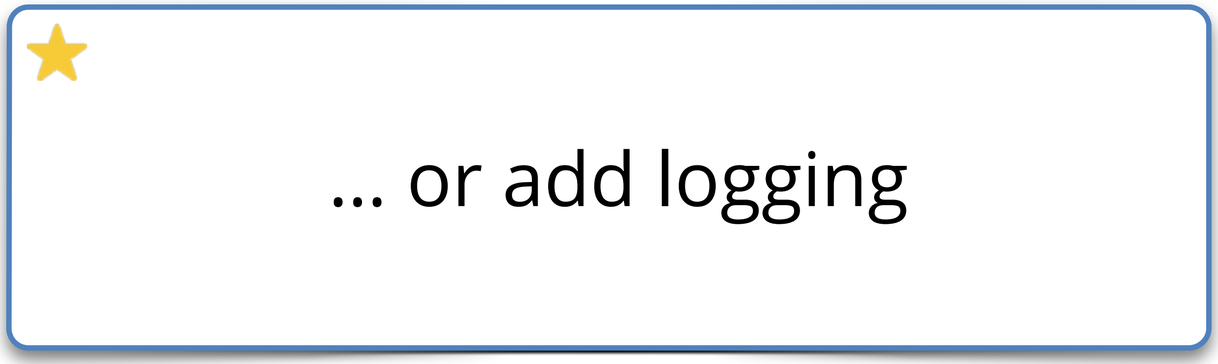
foo.insertAfter(…);
```

Can implement tracing

```
CtMethod foo = …

foo.insertBefore(…);

foo.insertAfter(…);
```



```
CtMethod foo = …

foo.insertBefore(…);

foo.insertAfter(…);
```

```
CtMethod foo = …

foo.instrument(new ExprEditor() {









});
```

```
CtMethod foo = …

foo.instrument(new ExprEditor() {
  @Override
  public void edit(NewExpr e)
      throws CannotCompileException {




  }
});
```

```
CtMethod foo = …

foo.instrument(new ExprEditor() {
  @Override
  public void edit(NewExpr e)
      throws CannotCompileException {
    e.replace("{" +
        "$_ = $proceed($$);" +
        "System.out.println($_);" +
        "}");
  }
});
```

Intercept new instances

```
CtMethod foo = …

foo.instrument(new ExprEditor() {
  @Override
  public void edit(NewExpr e)
      throws CannotCompileException {
    e.replace("{" +
        "$_ = $proceed($$);" +
        "System.out.println($_);" +
        "}");
  }
});
```

```
CtMethod foo = …

foo.instrument(new ExprEditor() {
  @Override
  public void edit(MethodCall m)
      throws CannotCompileException {
    if(m.getMethodName().contains("println")) {
      m.replace("{}");
    }
  }
});
```

Remove unwanted invocations

Replace direct field access with setter calls

```
CtMethod foo = …

foo.instrument(new ExprEditor() {
  @Override
  public void edit(FieldAccess m)
      throws CannotCompileException {
    if (f.isWriter()) {
      CtField field = f.getField();
      String setterName = findSetter(field);
      f.replace("{" + "$0." + setterName + "($$);" + "}");
    }
  }
});
```

This slide is intentionally left blank

Java Agent

Java Agent

```
import java.lang.instrument.ClassFileTransformer;
import java.lang.instrument.Instrumentation;

public class Agent {
  public static void premain(String args, Instrumentation inst)
  throws Exception {
    inst.addTransformer(new ClassFileTransformer {
        // here be code
    });
  }
}
```

```
META-INF/MANIFEST.MF
Premain-Class: Agent
```

```
$> java -javaagent:agent.jar application.Main
```

ClassFileTransformer

```
new ClassFileTransformer() {
  public byte[] transform(ClassLoader loader,
                          String className,
                          Class<?> classBeingRedefined,
                          ProtectionDomain protectionDomain,
                          byte[] classfileBuffer){

      ClassPool cp = ClassPool.getDefault();
      CtClass ct = cp.makeClass(new
                        ByteArrayInputStream(classfileBuffer));

      // here we can do all the things to ‘ct’

      return ct.toBytecode();
   }
}
```

ClassFileTransformer

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ClassFileTransformer

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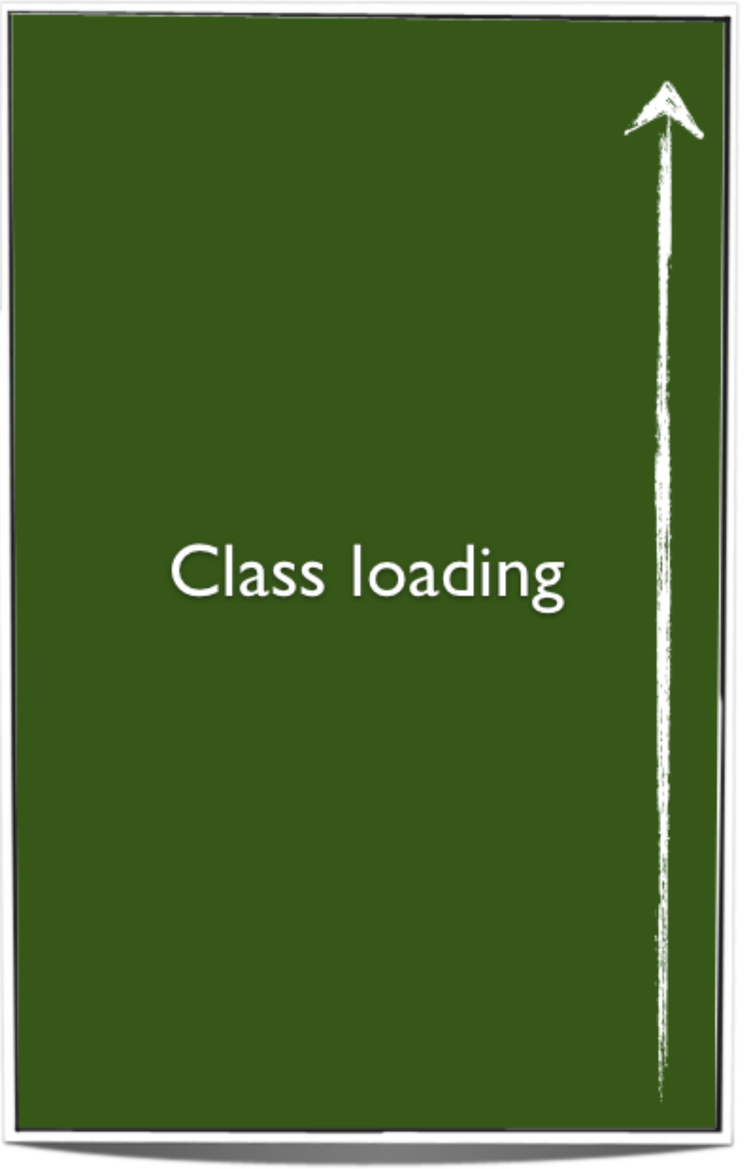
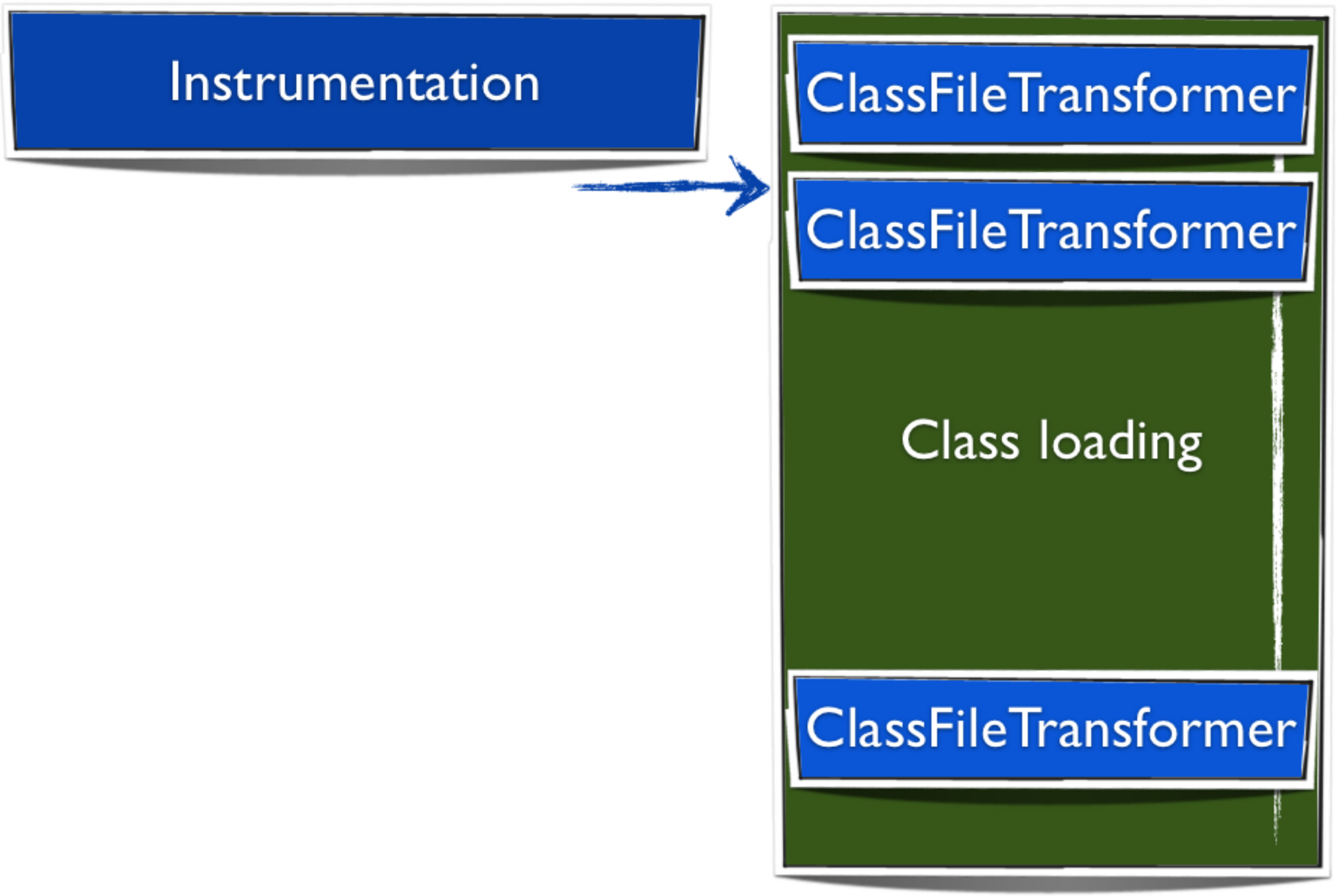
      CtClass ct = cp.makeClass(new
                        ByteArrayInputStream(classfileBuffer));

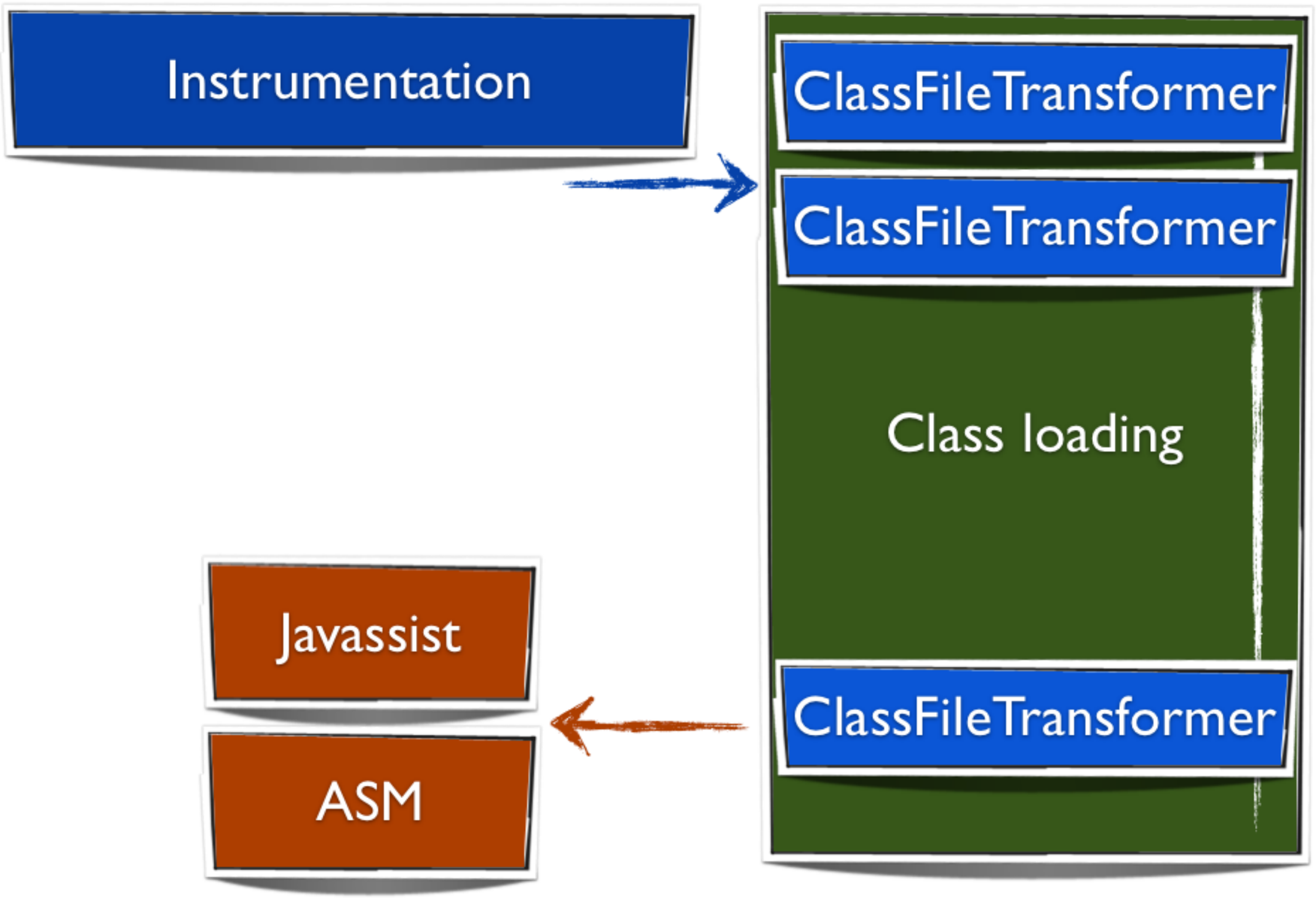
      // here we can do all the things to ‘ct’

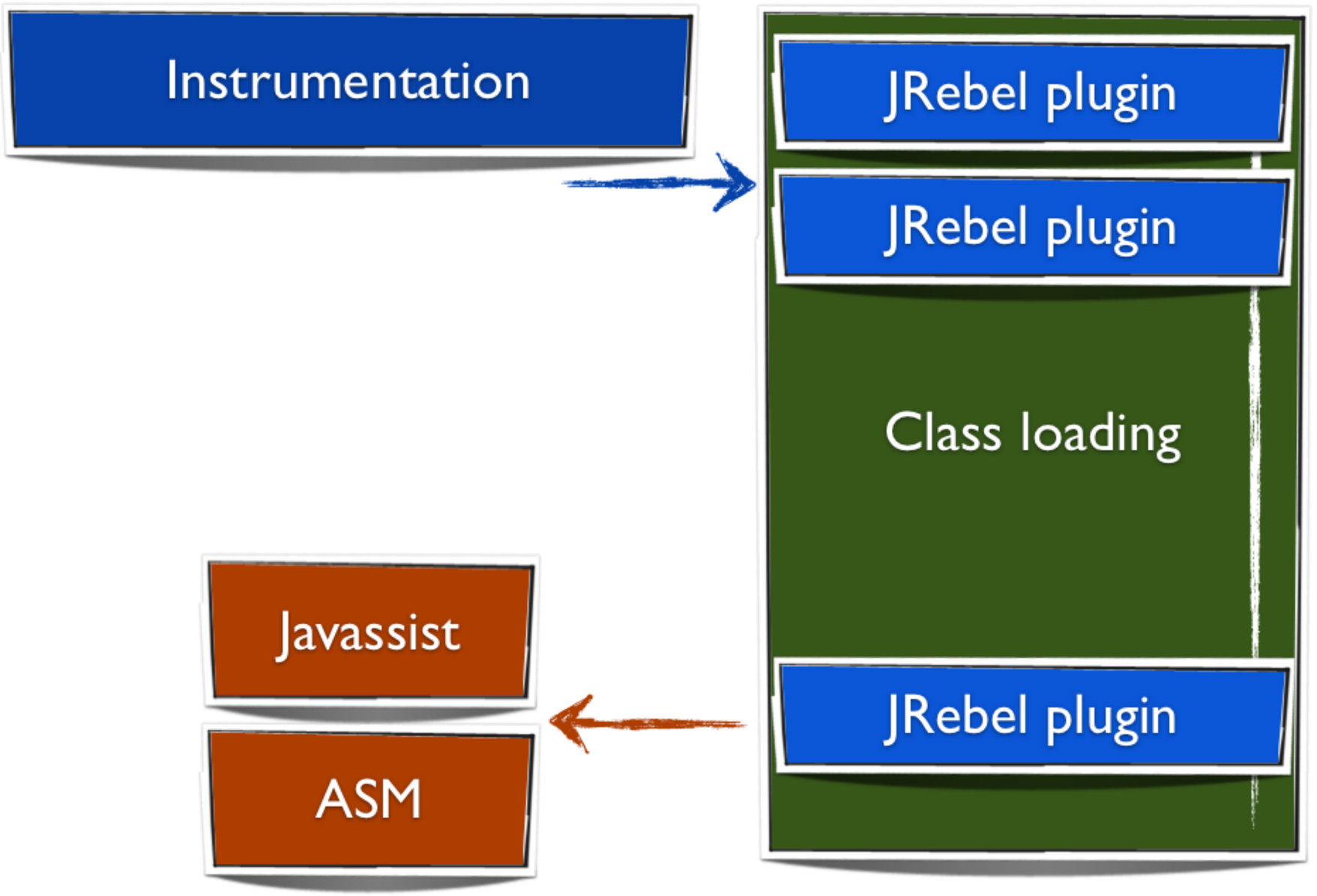
      return ct.toBytecode();
   }
}
```

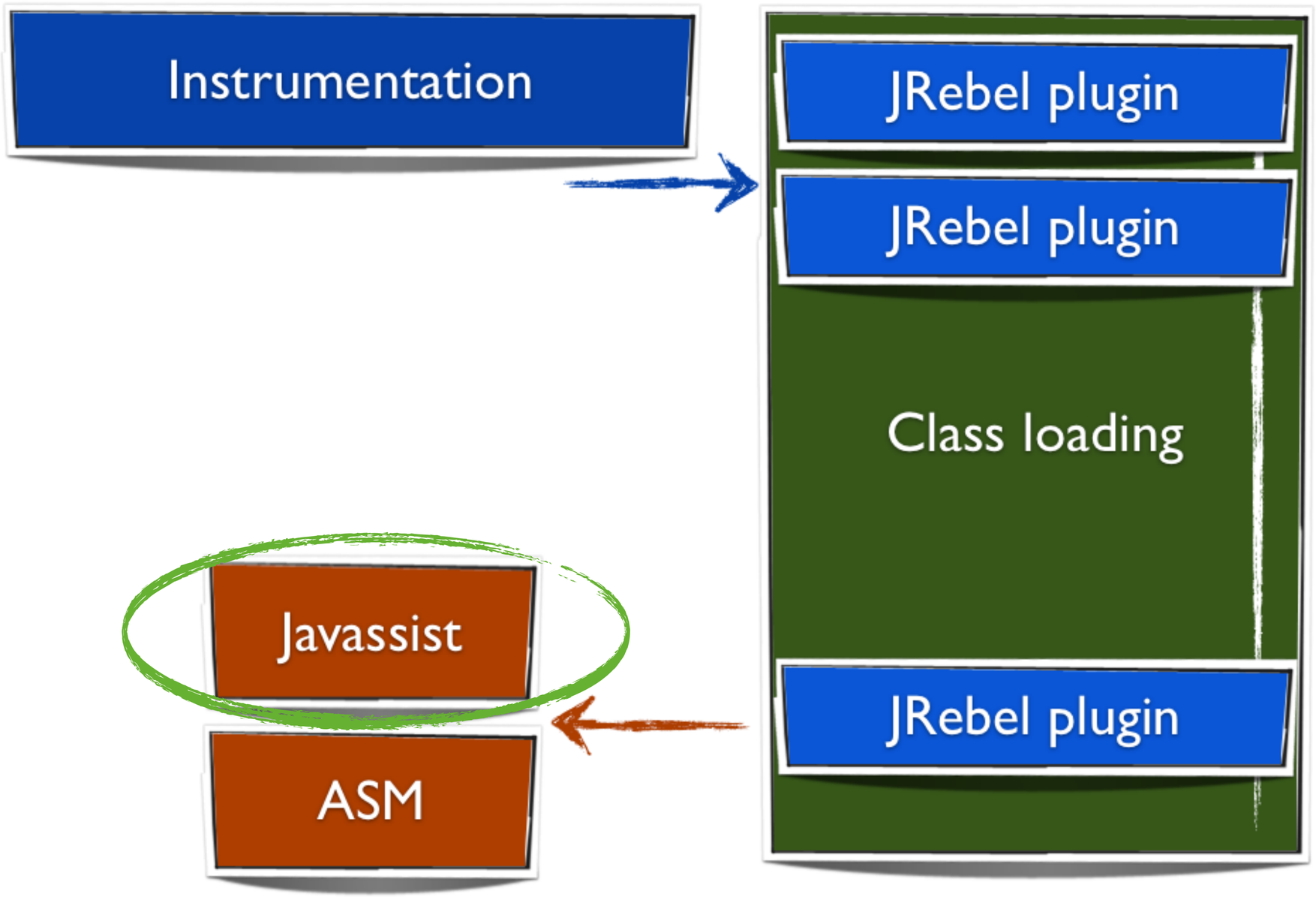
Instrumentation




Instrumentation
ClassFileTransformer
ClassFileTransformer
Class loading
ClassFileTransformer


Instrumentation
ClassFileTransformer
ClassFileTransformer
Class loading
ClassFileTransformer
Javassist
ASM

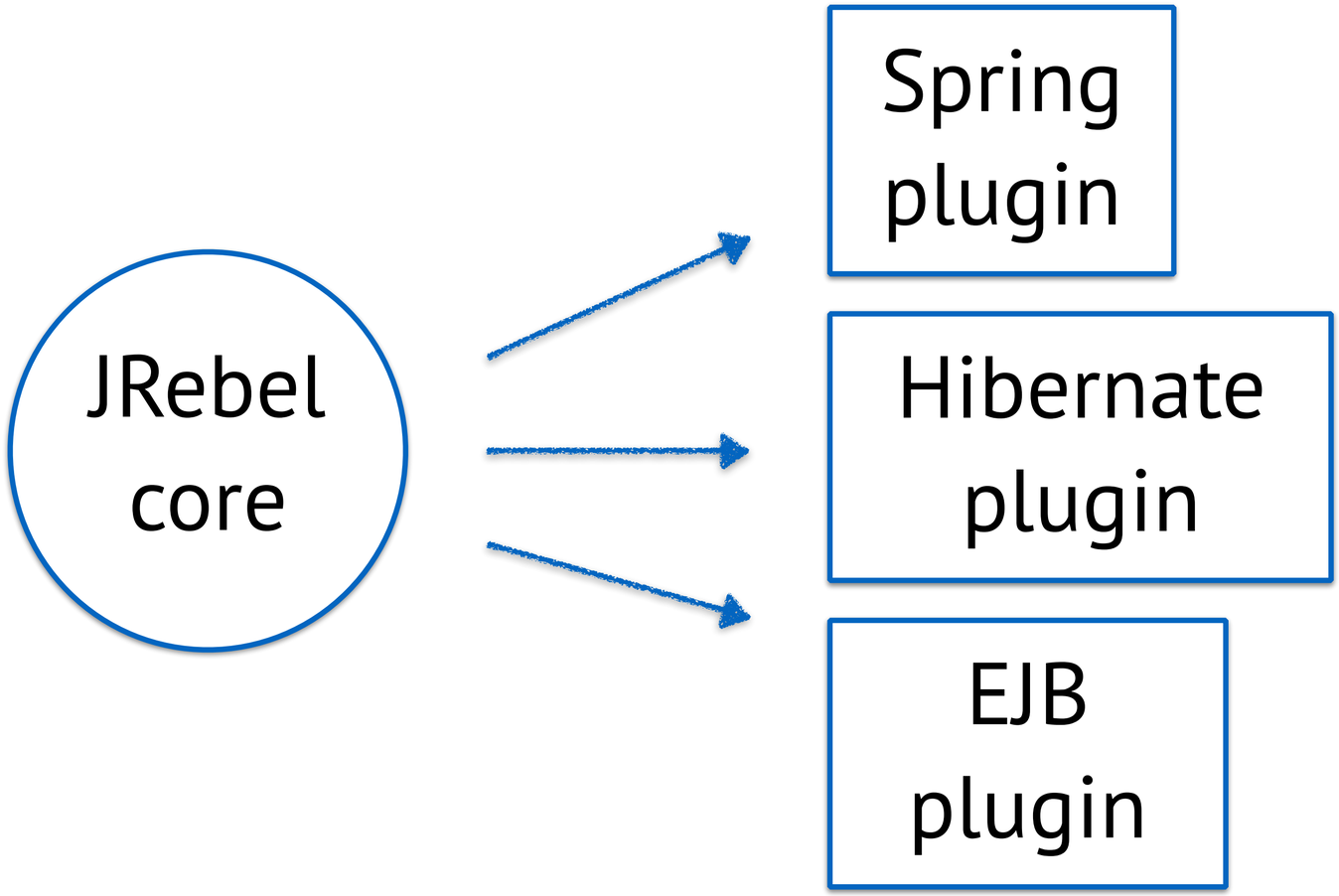

Instrumentation
JRebel plugin
JRebel plugin
Class loading
JRebel plugin
Javassist
ASM

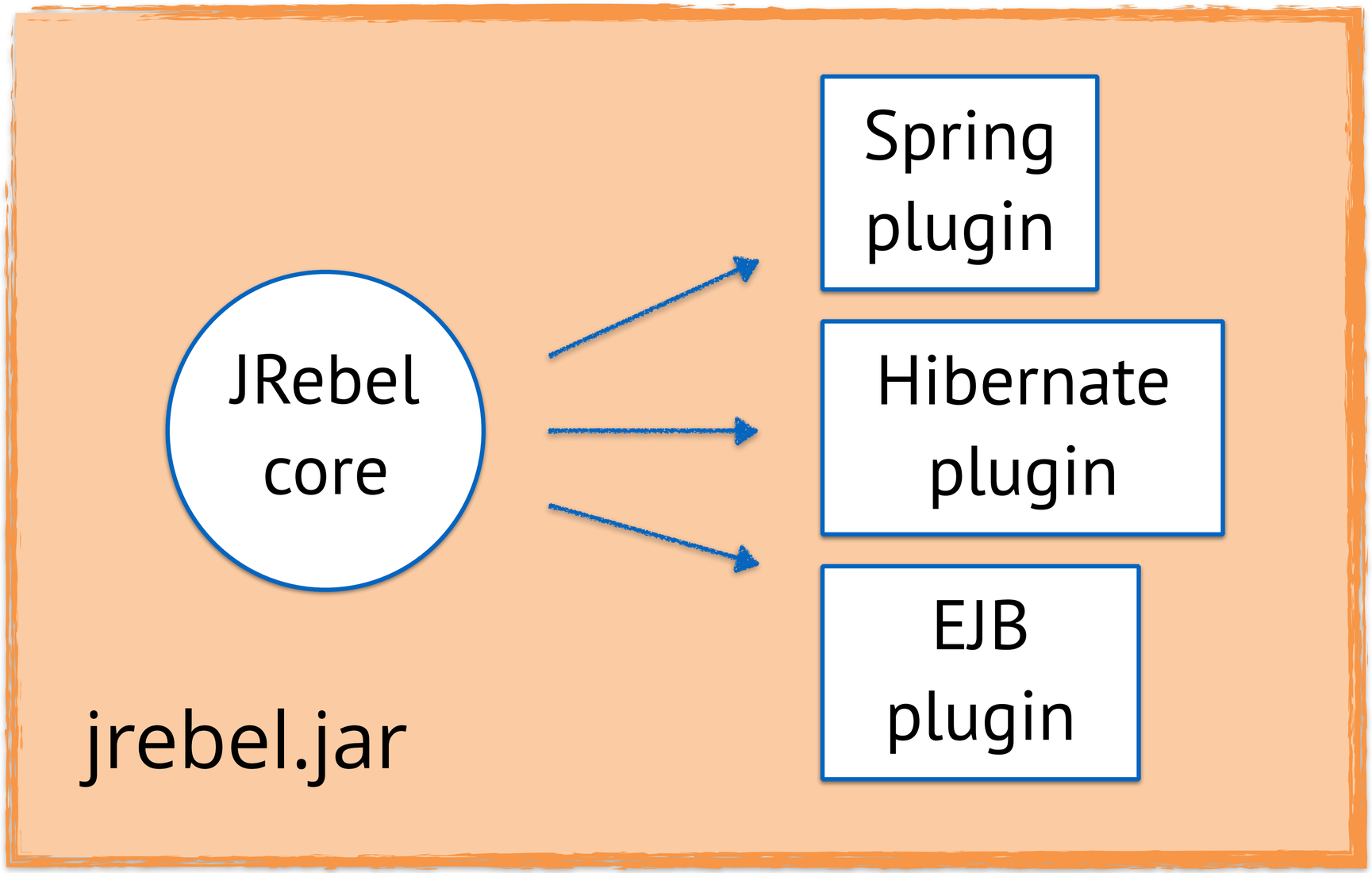

Instrumentation
JRebel plugin
JRebel plugin
Class loading
JRebel plugin
Javassist
ASM

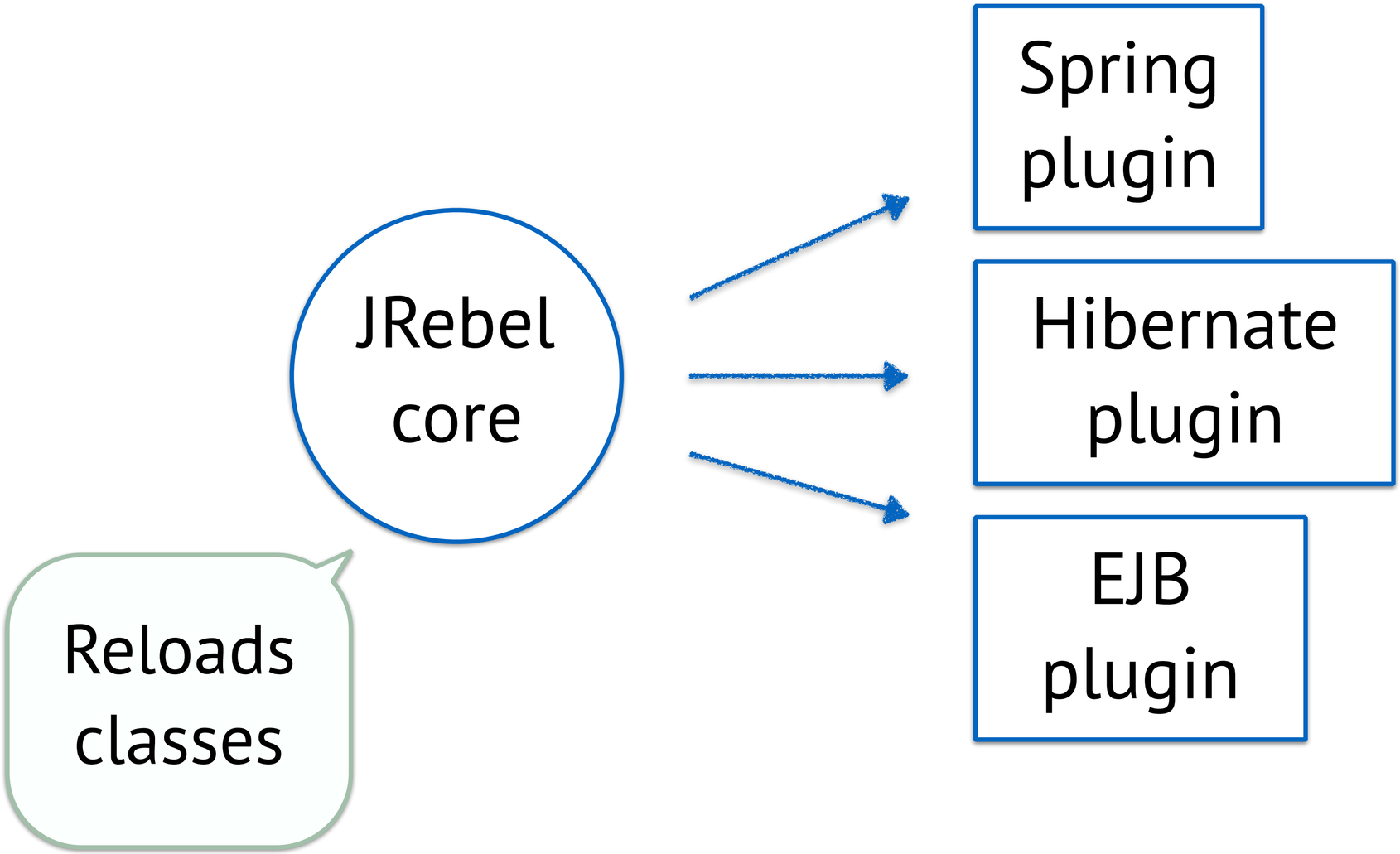
https://github.com/zeroturnaround/callspy

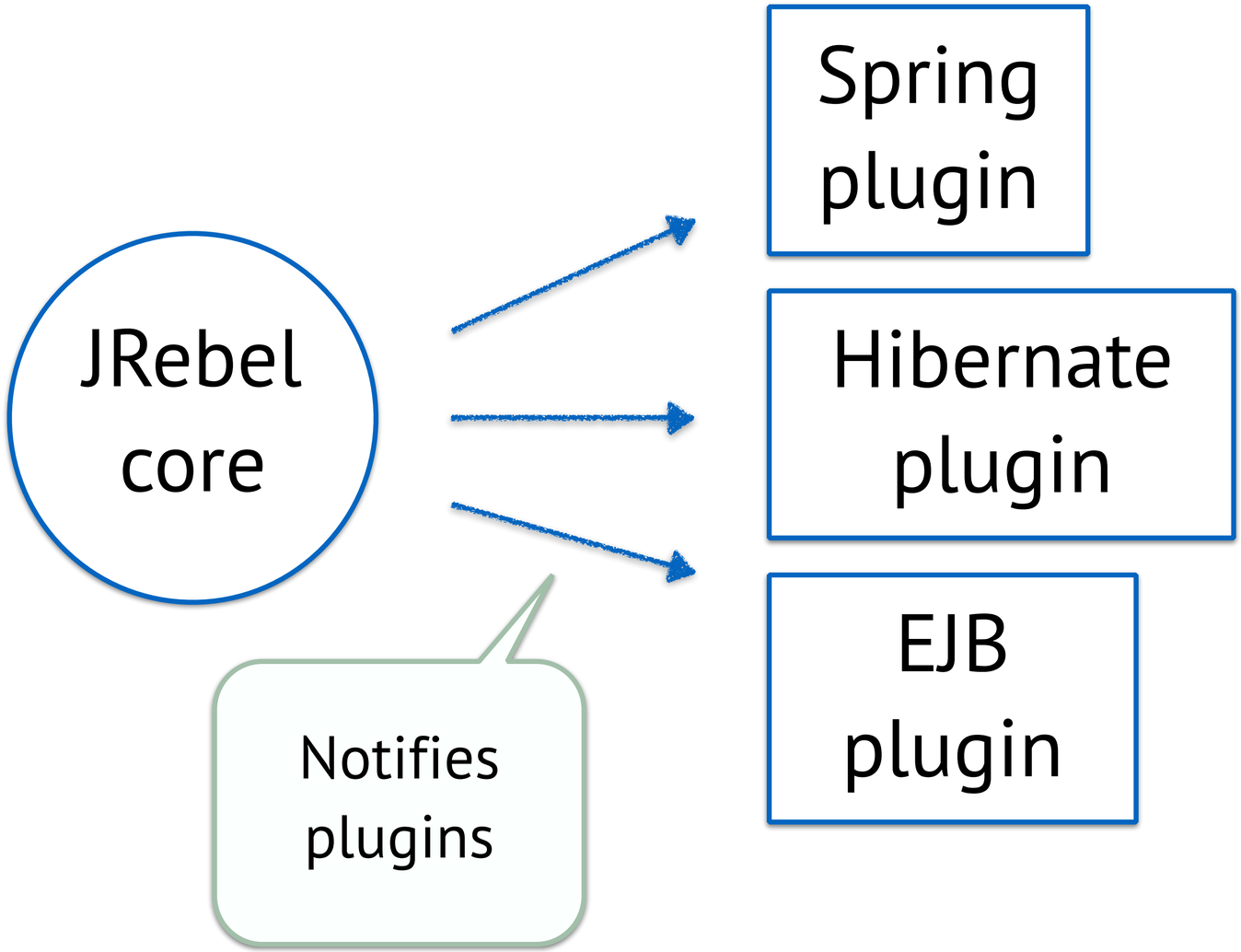
Javassist in JRebel

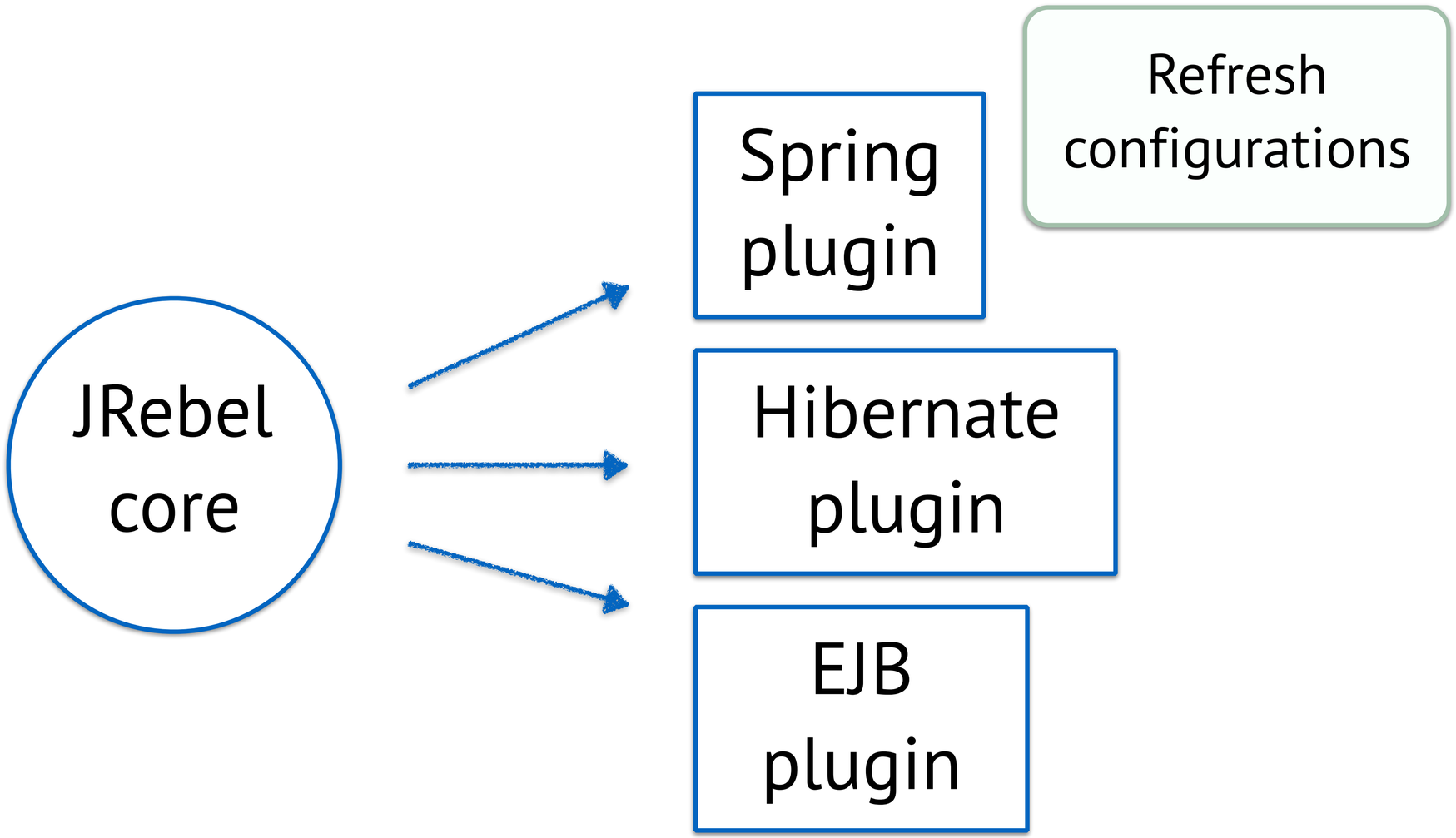
http://0t.ee/javaone-jr

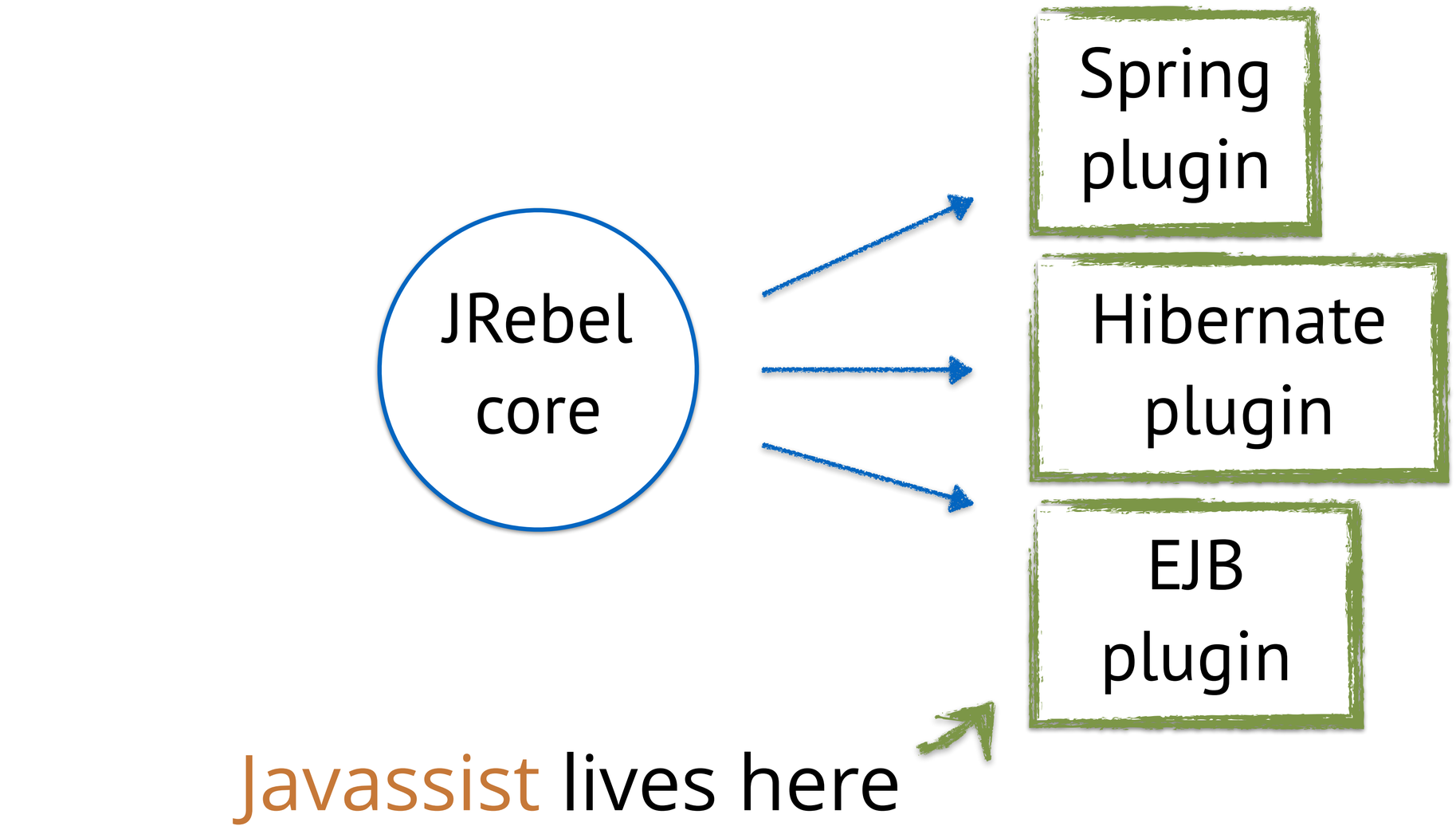

JRebel
core
Spring
plugin
Hibernate
plugin
EJB
plugin

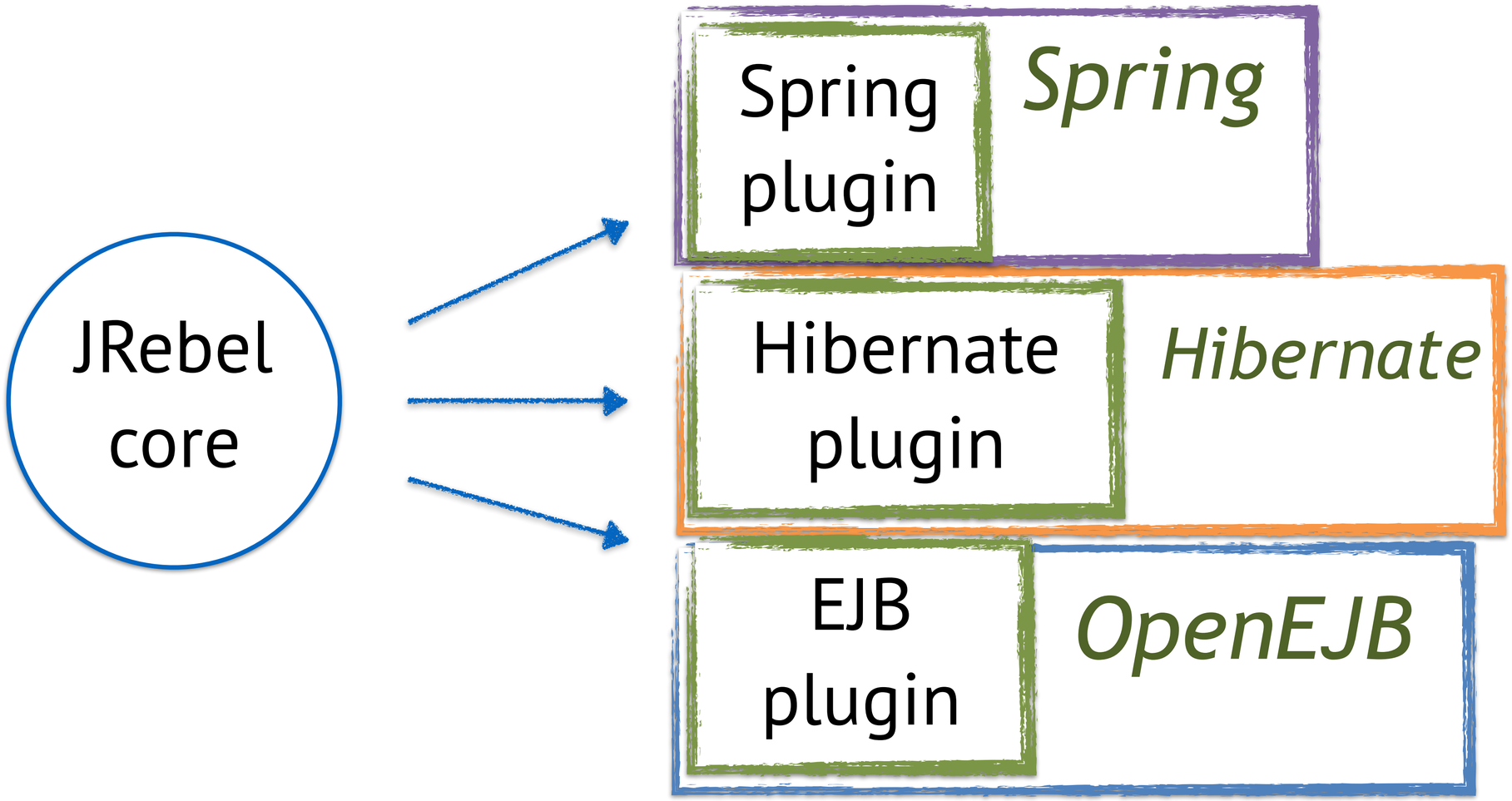

JRebel
core
Spring
plugin
Hibernate
plugin
EJB
plugin
jrebel.jar


JRebel
core
Spring
plugin
Hibernate
plugin
EJB
plugin
Reloads
classes


JRebel
core
Spring
plugin
Hibernate
plugin
EJB
plugin
Notifies
plugins


JRebel
core
Spring
plugin
Hibernate
plugin
EJB
plugin
Refresh
configurations


JRebel
core
Spring
plugin
Hibernate
plugin
EJB
plugin
Javassist lives here


JRebel
core
Spring
plugin
Spring
Hibernate
plugin
Hibernate
EJB
plugin
OpenEJB

```
class Framework {
  public void configure(){
  }
}

class Framework
 implements Listener {
  public void configure(){
  }
}
```

```
CtClass framework
  = cp.get("com.zt.Framework");


framework.addInterface(
 cp.get("com.zt.jrebel.Listener"));

framework.addMethod(
  CtNewMethod.make(
    "public void onEvent(){" +
    "  configure();" +
    "}",
    framework
));
```

https://github.com/antonarhipov/jpoint

HowItWorks


WAT.

Javassist

Your task

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https://speakerdeck.com/antonarhipov

http://www.slideshare.net/arhan

http://0t.ee/javaone-jr