Annotation-Driven Aspect-Oriented Programming

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What will you learn?

Why and how
Java 5 Annotations and AOP
can complement and
benefit from each other

Who are we?

Jonas Bonér

- Senior Software Engineer at Java Runtime Products Group, BEA Systems
- Founder of the AspectWerkz AOP framework
- Speaker at JavaPolis 2003, eWorld 2004, AOSD 2004, BEA User Group 2004, JavaOne 2004

Who are we?

Alexandre Vasseur

- Software Engineer at Java Runtime Products Group, BEA Systems
- Co-founder of the AspectWerkz AOP framework
- Speaker at eWorld 2004, AOSD 2004, BEA User Group 2004, JavaOne 2004

Agenda

AOP crash course

Annotation defined AOP

Matching on annotations

Demo

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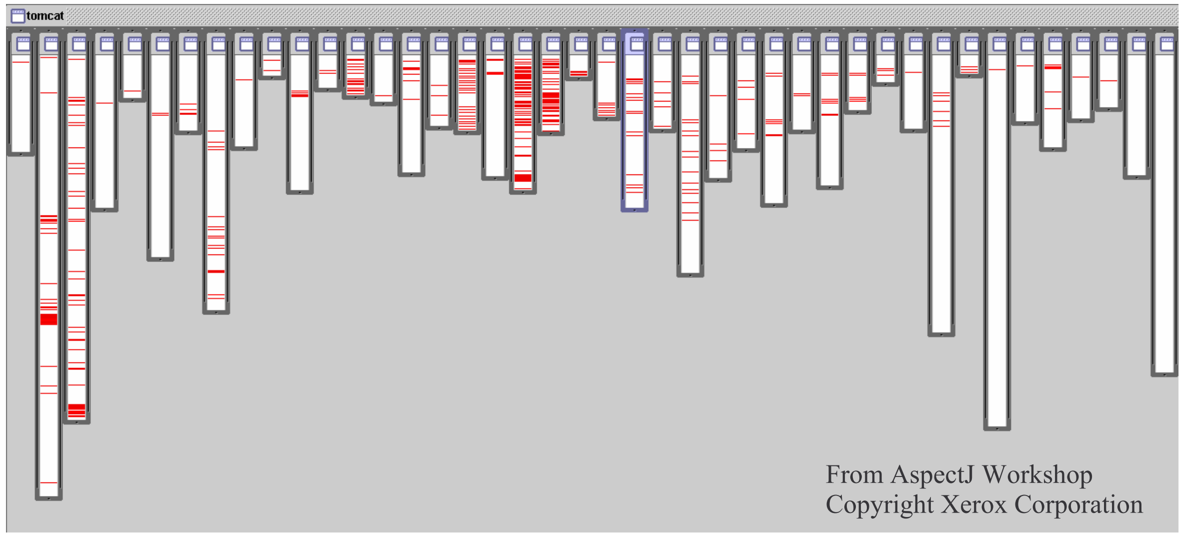
AOP Crash Course

- OOP fails to address "cross-cutting concerns"
  - Introduces "code tangling" and "code scattering"
  - Makes software harder to write, understand, reuse and maintain



Logging in **`org.apache.tomcat`** is not modularized

- AOP enables ”Separation of Concerns”
- The Aspect modularizes a crosscutting concern

Adds a new dimension to software dev.

From presentation by Frank Sauer
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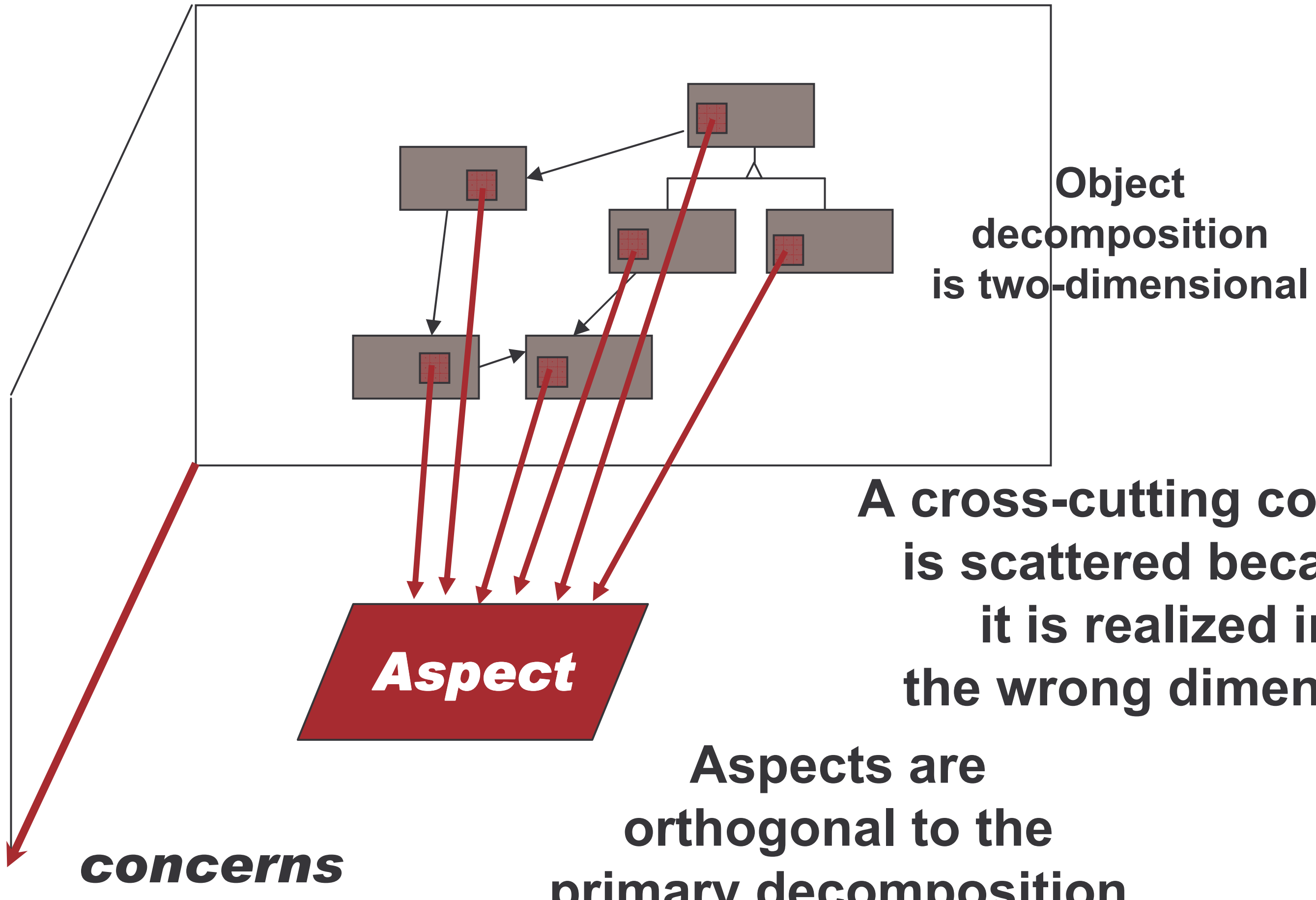
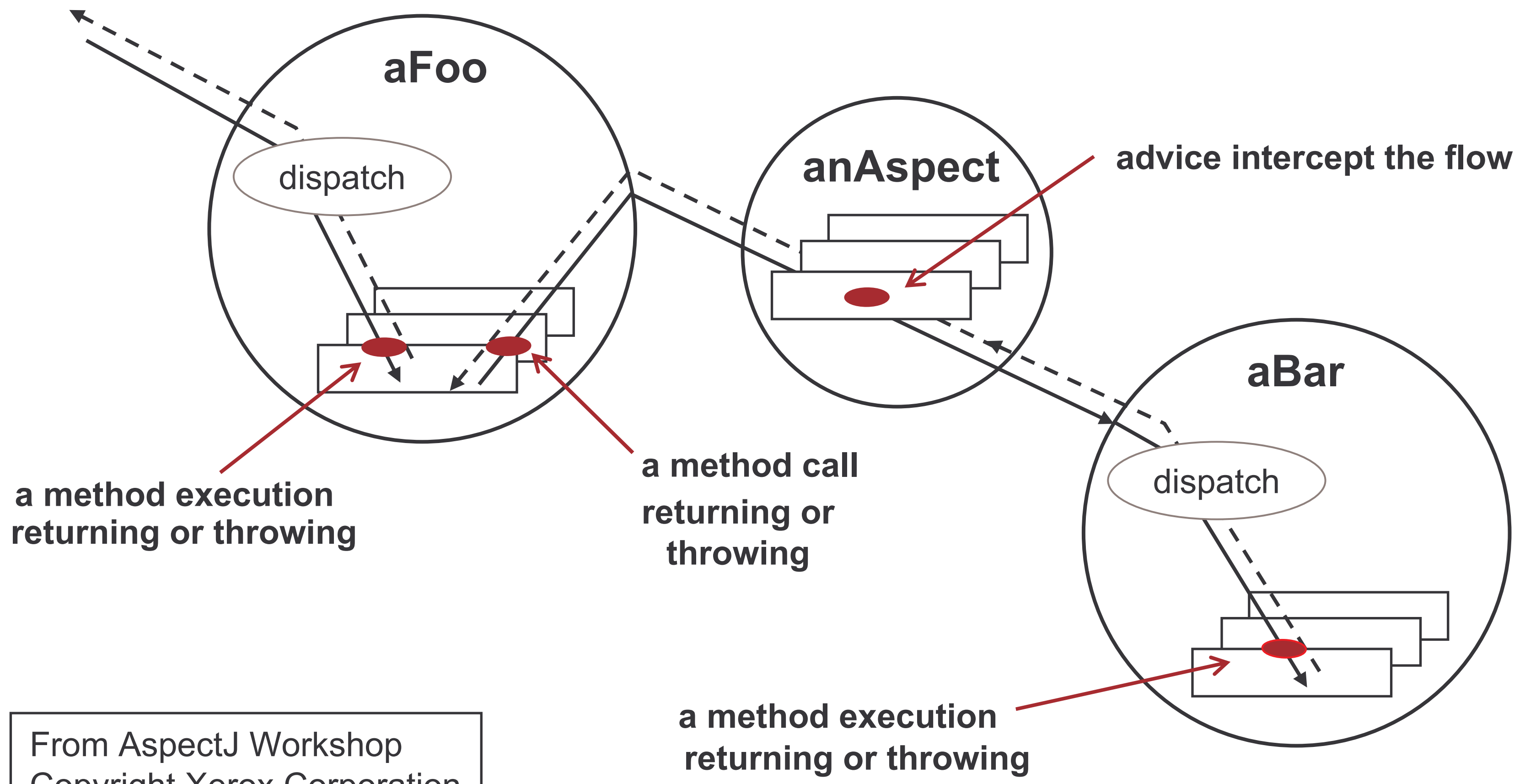


A cross-cutting concern
is scattered because
it is realized in
the wrong dimension

Aspects are
orthogonal to the
primary decomposition

Join points

- Well-defined points in the program flow



aFoo
dispatch
anAspect
advice intercept the flow
aBar
dispatch
a method execution returning or throwing
a method call returning or throwing
a method execution returning or throwing

From AspectJ Workshop
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AOP Crash Course

Core concepts

1. Define well-defined points in the program flow
   – Join points
2. Pick out these points
   – Pointcuts
3. Influence the behaviour at these points
   – Advice
4. Weave everything together in a functional system
   – Weaver

Example aspect

AspectJ sample

```
public aspect AsyncAspect {

    private Executor m_threadPool = ...

    pointcut async(): execution(void Math.async*(..));

    Object around(): async() {
        m_threadPool.execute(new Runnable() {
            public void run() {
                try {
                    // proceed the execution in a new thread
                    proceed();
                } catch (Throwable e) {
                    throw new WrappedRuntimeException(e);
                }
            });
        return null;
    }
}
```

aspect is a Java keyword

pointcut is a Java keyword

Advice binding

around defines and binds an around advice

proceed() invokes the next advice or the target join point (method, field …), – only for Around advice

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Annotation defined aspect

AspectWerkz sample

```
public class AsyncAspect {

    private Executor m_threadPool = ...

    @Expression("execution(void Math.async*(..))")
    Pointcut asyncMethods;

    @Around("asyncMethods")
    Object async(JoinPoint jp) {
        m_threadPool.execute(new Runnable() {
            public void run() {
                try {
                    // proceed the execution in a new thread
                    jp.proceed();
                } catch (Throwable e) {
                    throw new WrappedRuntimeException(e);
                }
            });
        return null;
    }
}
```

Aspect is a Java class

@Expression defines pointcuts

@Around annotated methods are around advices

Annotation defined AOP

- AOP constructs defined with Annotations

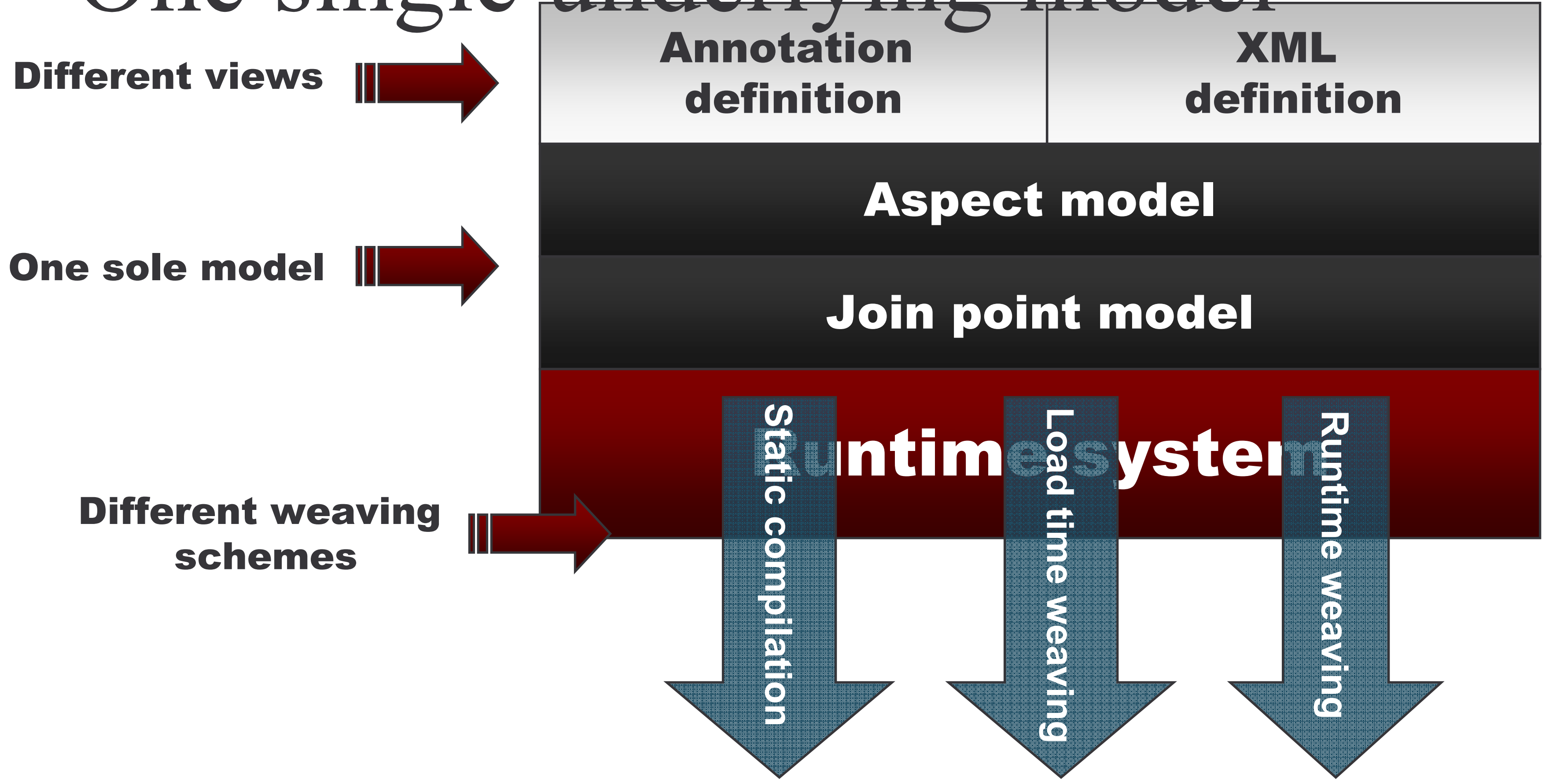
```
@Aspect
@Expression(...)
@Before(...), @Around(...), @After(...)
```

- Pointcuts can expose contextual information

```
@Args, @This, @Target

@Before("call(double Math.divide(int, int))")
void advice(JoinPoint jp,
            @Args int value,
            @Args int divideBy
            @This Object callee) {
   if (divideBy == 0) {
       throw new IllegalArgumentException(
           "division with 0 by " +
           callee.toString());
   }
}
```

Annotations and XML – One single underlying model



Annotation defined AOP

Annotations improve Java support for AOP

- AOP constructs are regular Java elements
- Does not break Java parser, IDEs
- Integrates well into existing tools (refactoring, testing, etc.)

But might not always be the best option

- XML deployment descriptor allows for late definition and binding
- JavaDoc annotations are needed for Java 1.3/1.4

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Annotation driven AOP

Matching on annotations

```
@Service
public class Math {

    @Async(timeout=10)
    public void asyncAdd(int a, int b) {
        ...
    }
}

public class AsyncAspect {
    @Around
    @Execution(Async.class)
    @Within(Service.class)
    @Around("execution(void Math.asyncAdd(..))")
    @Around("@execution(@Async) && @within(@Service)")
    Object async(JoinPoint jp) {
        ...
    }
}
```

Strongly typed

Annotation driven AOP

Matching on annotations

```
@Service
public class Math {

    @Async(timeout=10)
    public void asyncAdd(int a, int b) {
        ...
    }
}

public class AsyncAspect {
    @Around
    @Execution(Async.class)
    @Within(Service.class)
    Object async(JoinPoint jp) {
        ...
    }
}
```

Strongly typed

Matching on annotations

Advantages

- Strongly typed matching
- More predictable matching
- Supports refactoring
- Higher abstraction level
  - The "contract“ is based on meta-data instead of implementation details (names and types)
- Possibility of using standardized annotations (JSR-250, EJB3, JSR-181 etc.)

Demo

Annotation driven AOP

- Annotation defined AOP
- Matching on annotations

Matching on annotations

Drawbacks

- Annotations introduce "*code scattering*“
- Requires developer awareness
- Obliviousness of AOP is reduced

- Might introduce stronger coupling between aspects and target application
- Defines an explicit contract that both needs to be aware of

Wrap up

- Annotation defined AOP
  - Framework-defined annotations
  - AOP constructs are regular Java elements
  - Does not break existing Java parsers, IDEs, tools etc.

- Matching on annotations
  - User-defined annotations can be used to define system behaviour
  - AOP is a way to implement this behaviour
  - Standardization of annotations is starting
  - More predictable strongly typed matching

If you only remember one thing…

AOP adds behaviour to
annotations static metadata

For More Information

- http://aspectwerkz.codehaus.org
- http://www.bea.com/products/weblogic/jrockit/

- http://blogs.codehaus.org/people/jboner
- http://blogs.codehaus.org/people/avasseur

Q&A

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