# *Eliminating Cross-Cutting Concerns with Aspect-Oriented Programming*

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**Michael P. Redlich**
**(908) 730-3416**
**michael.p.redlich@exxonmobil.com**

# *My Background (1)*


- Degree
  - B.S. in Computer Science
  - Rutgers University (go Scarlet Knights!)
- ExxonMobil Research & Engineering
  - Senior Research Technician (1988-1998, 2004-present)
  - Systems Analyst (1998-2002)
- Ai-Logix, Inc.
  - Technical Support Engineer (2003-2004)
- Amateur Computer Group of New Jersey (ACGNJ)
  - Java Users Group Leader (2001-present)
  - President (2007-present)
  - Secretary (2006)

# *My Background (2)*


- Publications (co-authored with Barry Burd)
  - James: The Java Apache Mail Enterprise Server
  - Avoid Excessive Subclassing with the Decorator Design Pattern
  - Keeping Your Java Objects Informed with the Observer Design Pattern
  - Manufacturing Java Objects with the Factory Method Design Pattern
  - Resistance is Futile – How to Make Your Java Objects Conform with the Adapter Pattern
  - Get to Know Your Java Object's State of Mind with the State Pattern
  - Encapsulating Algorithms with the Template Method Design Pattern

# *Objectives*


- Cross-Cutting Concerns
- Introduce Aspect-Oriented Programming (AOP)
- Example Application

# *Software Concerns*


- **Primary concerns**
  - **Core application functionality**
- **Secondary concerns**
  - **System-wide objects that can be used in any primary concern**

# *What are Cross-Cutting Concerns?*


- Secondary, system-wide concerns that can be found in multiple primary concerns
  - Logging
  - Authentication
  - Authorization
  - Persistence
- Requires certain behavior to occur at one or more points in the control flow of a program for its implementation to be correct

```
// cross-cutting concerns?
```

Is this method a cross-cutting concern?

```
public void addClaim(Claim claim) {
    if(claim == null)
        throw new IllegalArgumentException("null claim");
    this.claims.add(claim);
    }
```

Is this method a cross-cutting concern?

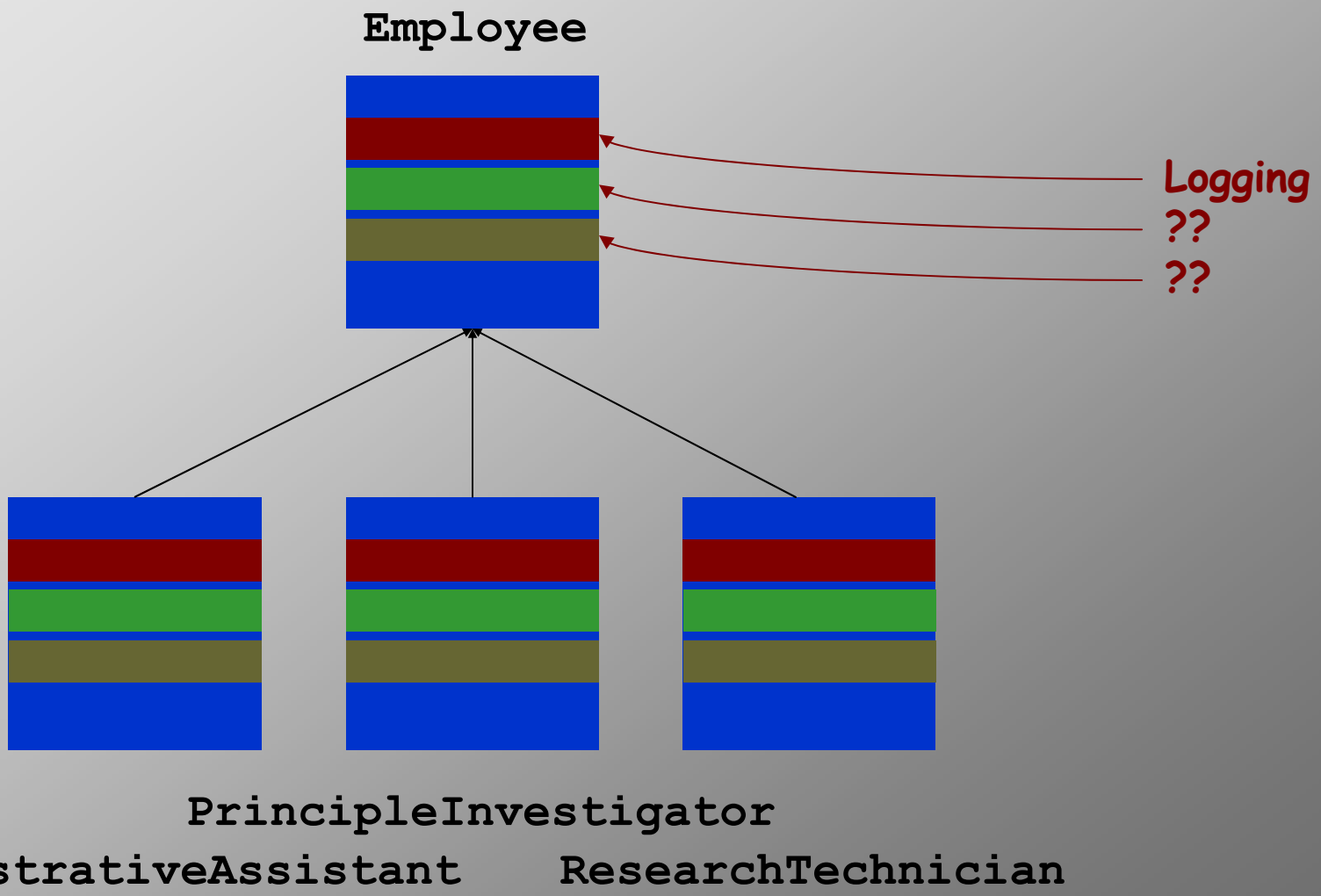
```
protected void notifyListeners() {
    for(Iterator iterator = listeners.iterator();
      iterator.hasNext();) {
        PolicyListener listener = iterator.next();
        listener.policyUpdated(this);
        }
    }
```

This method needs to be invoked at the appropriate points in the control flow of the application

# *So, Are You Ready...*


- **...to review an initial Laboratory application?**

# Cross-Cutting Concerns



# What is Aspect-Oriented Programming?


- A programming paradigm
- Separates cross-cutting concerns from the core functionality of the application
- Implementations:
  - Spring AOP
  - AspectJ
  - JBoss AOP
  - AspectWerkz

# *What About Object-Oriented Programming?*


- Object-Oriented Programming is excellent...
  - ...for modeling real-world objects
  - ...for separation of implementation from interface
  - ...for creating interfaces that allow for loose object coupling
- However, secondary concerns must still be referenced in each of the primary concerns
  - creating cross-cutting concerns
- Even Design Patterns can suffer from cross-cutting concerns!

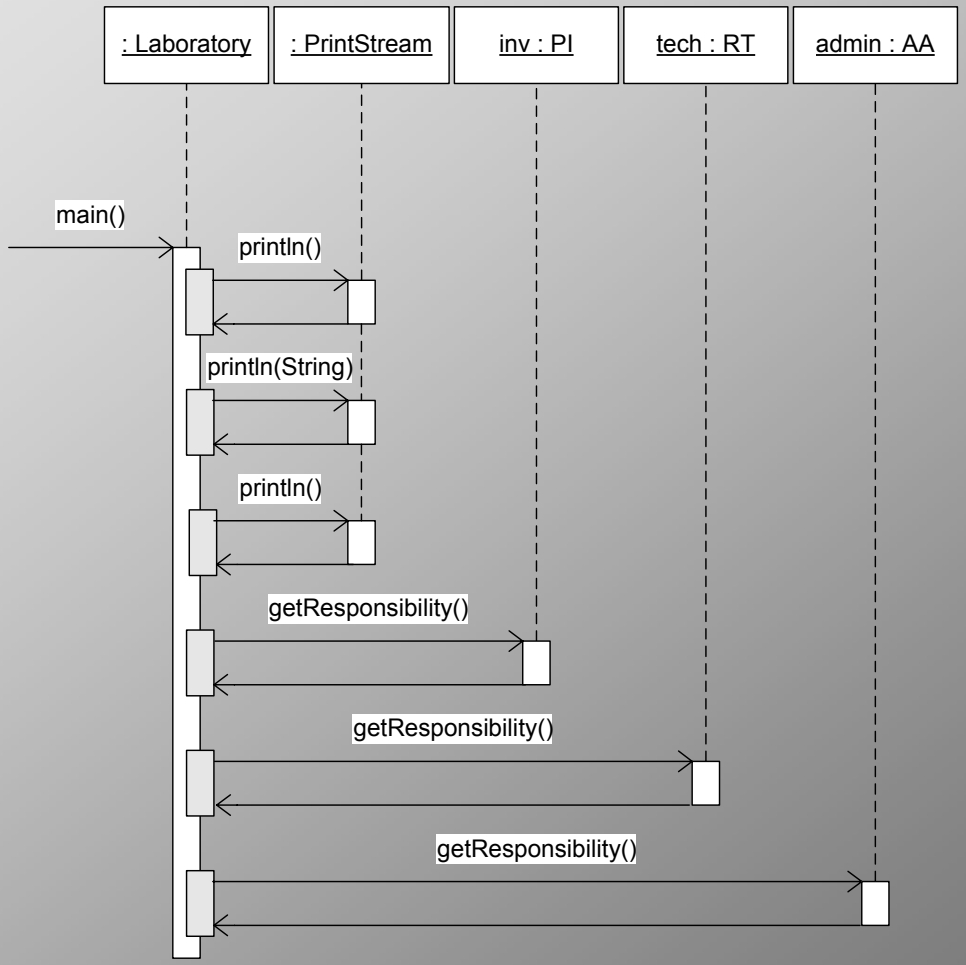
# *Core Concepts*


- Join Points
- Pointcuts
- Advice
- Aspect

# Join Points (1)


- Identifiable points within the execution of a program
  - Calling methods
  - Initializing objects (constructor calls)
  - Accessing/updating data members
- Place into which aspects are woven
- Join Point Model
  - Defines a set of events visible to an aspect during program execution
  - Join Points
  - Pointcuts

# Join Points (2)



# Pointcuts


- Filters to match join points that meet a specification
- Three (3) types:
  - Kind
  - Scope
  - Context
- Prototype:

```
[visibility-modifier] pointcut name(ParameterList) :
PointcutExpression ;
```

# *Pointcuts (2)*


- **Pointcut Expression**
  - **Combination of pointcut designators and operators (`&&`), (`||`), and (`!`) as necessary**

# Pointcut Designators


- Kind designators
  - Match certain “kinds” of join point events
  - `call(methodSignature)`
  - `execution(methodSignature)`
- Context designators
  - Match join points based on join point context
  - `target(Type)`
  - `args(Type)`
- Scope designators
  - Match join points within a certain scope

# Advice


- Specifies what to do at the join points of interest
- Code that is woven into a pointcut
- Three (3) types:
  - Before
  - After
  - Around

# *Before Advice*


- Executes before a matched join point
- Prototype:

```
before(ParameterList) : pointcutName(ParameterList) {
    // body of advice...
    }
```

# *After Advice (1)*


- Executes after a matched join point
- Three (3) basic forms:
  - Successful return from a matched join point
  - Returning from a matched join point upon some exception condition
  - Returning from a matched join point either normally or upon an exception condition

# *After Advice (2)*

- Prototypes:

```
after(ParameterList) returning(returnValue) :
pointcutName(ParameterList) {
    // body of advice...
    }
after(ParameterList) throwing(ExceptionType):
pointcutName(ParameterList) {
    // body of advice...
    }
after(parameterList) : pointcutName(ParameterList) {
    // body of advice...
    }
```

# Around Advice


- Executes before and after a matched join point
- Can determine:
  - Continuation of program execution into matched join point
  - Return type
- Prototype:

```
ReturnType around(ParameterList) :
pointcutName(ParameterList) {
    // body of advice
    if(// some desired condition)
        proceed(ParameterList)
    }
```

# Aspect


- A unit of modularity, encapsulation, and abstraction
  - Sound familiar??
- Aspect = Pointcut + Advice
- Prototype:

```
[visibility-modifier] aspect {
    // pointcut definition(s)...
    // advice definitions(s)...
    // other methods...
    }
```

# *So, Are You Ready...*


- ...to review the refactored Laboratory application?

# Resources (1)


- Spring Framework
  - http://www.springframework.org/
- AspectJ
  - http://www.eclipse.org/aspectj/
- JBoss AOP
  - http://labs.jboss.com/jbossaop/
- AspectWerkz
  - http://aspectwerkz.codehaus.org/

# Resources (2)


- Philly Spring Users Group
  - http://phillyspring.org/
- Chariot Solutions
  - http://www.chariotsolutions.com/
- redlich.net
  - http://www.redlich.net/

# *Further Reading (1)*


- Professional Java Development with the Spring Framework
  - Rod Johnson, et. al
  - ISBN 0-76457-483-3
- Pro Spring
  - Rob Harrop and Jan Machacek
  - ISBN 1-59059-461-4
- Spring in Action
  - Craig Walls and Ryan Breidenbach
  - ISBN 1-93239-435-4

# *Further Reading (2)*


- Eclipse AspectJ
  - Adrian Colyer, et. al
  - ISBN 0-321-24587-3
- AspectJ in Action
  - Ramnivas Laddad
  - ISBN 1-930-110-93-6