Software product lines

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Variability implementation mechanisms, part II

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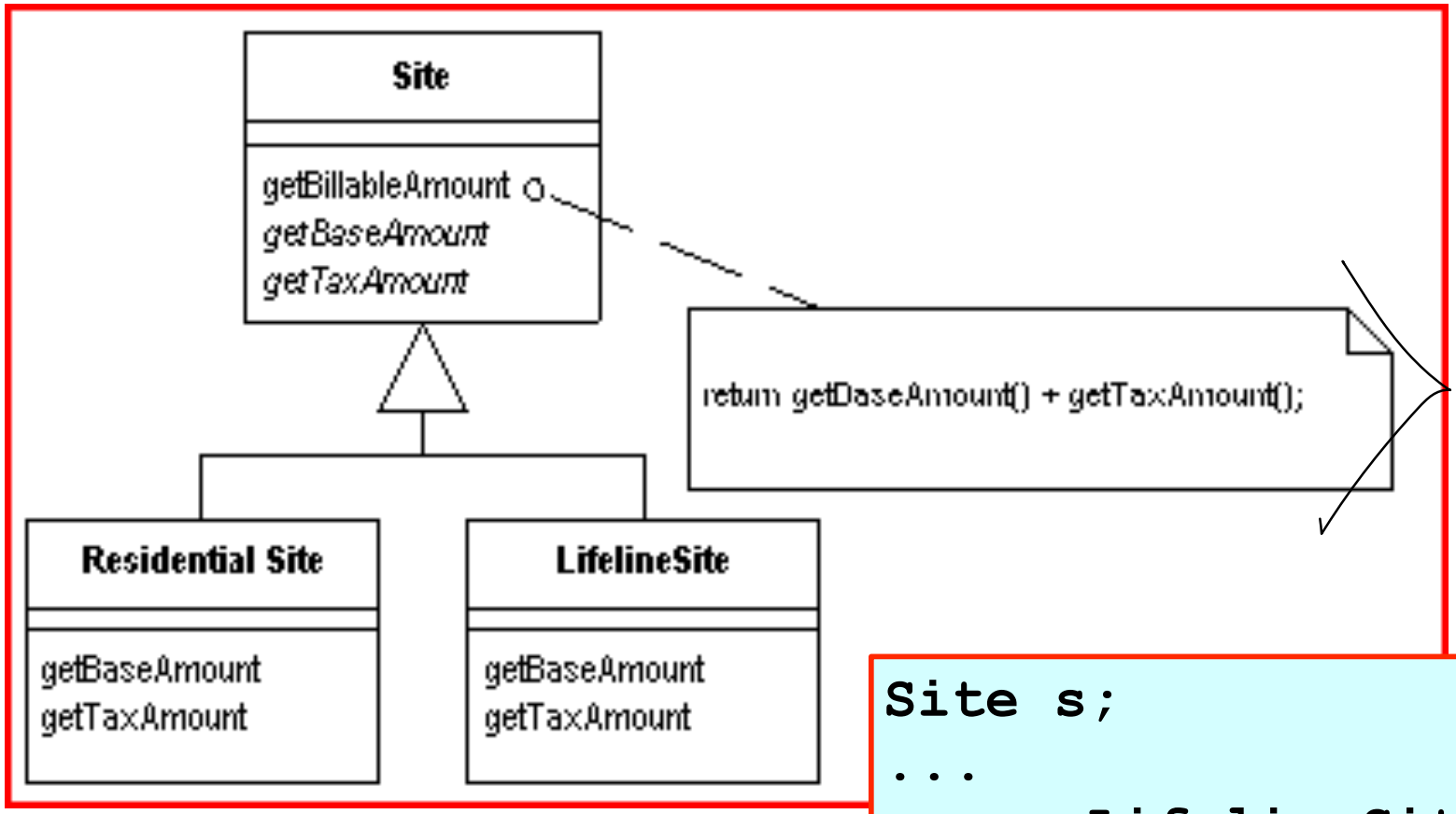
Subtype polymorphism…



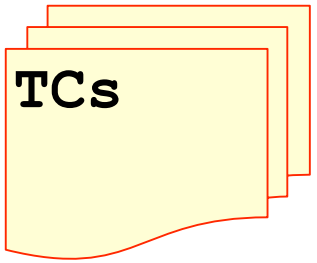

```
Site s;
...
s=new LifelineSite();
```

http://www.refactoring.com/catalog/formTemplateMethod.html

and OO patterns

```
abstract class TestCase {...
    void buildTest() {...
      buildPreconditions();...
      buildProcedures();...
    }
}
```

```
class TC5 extends TestCase {...
  void buildProcedures() {...
      launchApp(Phone.SOUNDS);
      createMelody(...);...
    }
}
```



Template method variation

```
abstract class TestCase {...
   void buildTest() {...
     buildPreconditions();...
     buildProcedures();...
   }
}
```

```
class TC5 extends TestCase {...
  void buildProcedures() {...
     launchApp(Phone.SOUNDS);
     createMelody(...);...
   }
}
```

```
class TC5Bluetooth extends TC5 {
   void buildProcedures() {
      super.buildProcedures();
      setBluetooth(ON);...
   }
}
```

```
class TC5Transflash extends TC5 {
   void buildProcedures() {
      super.buildProcedures();
      storeMultimedia(...);...
   }
}
```

SP core assets

Java files, abstract

```
abstract class TestCase {...
   void buildTest() {...
     buildPreconditions();...
     buildProcedures();...
   }
}
```

```
class TC5 extends TestCase {...
   void buildProcedures() {...
      launchApp(Phone.SOUNDS);
      createMelody(...);...
   }
}
```

Java files, concrete

```
class TC5Bluetooth extends TC5 {
  void buildProcedures() {
    super.buildProcedures();
    setBluetooth(ON);...
  }
}
```

```
class TC5Transflash extends TC5 {
  void buildProcedures() {
    super.buildProcedures();
    storeMultimedia(...);...
  }
}
```

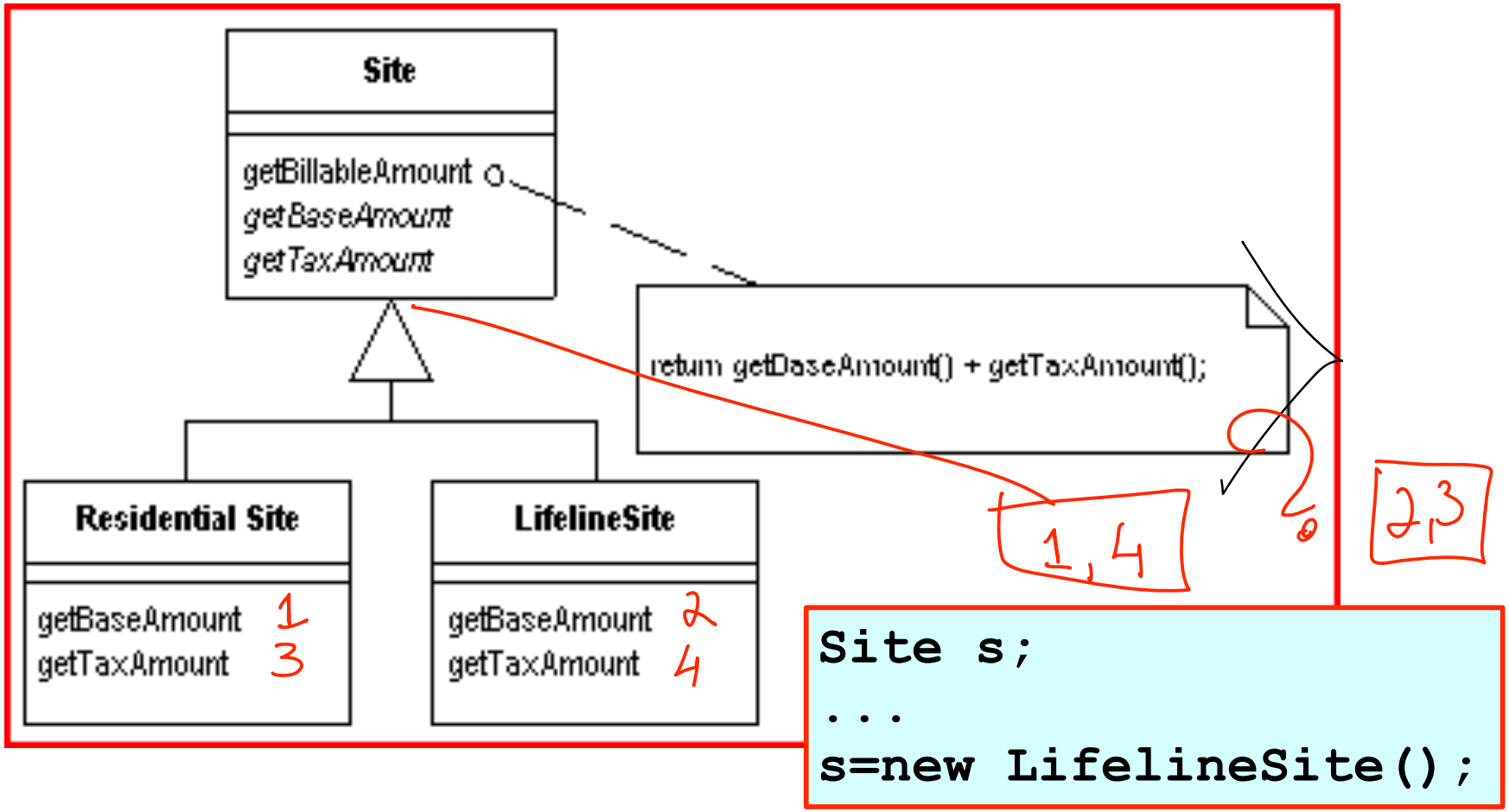
Java files, decision

```
...
new TC5Bluetooth
...
```

```
...
new TC5Transflash
...
```

Makefiles

Limitations of single inheritance



http://www.refactoring.com/catalog/formTemplateMethod.html

PDC, bridge variation...

```
class CadastroContas {
  private RepositorioContas contas;...

  public void cadastrar(Conta conta) {
    if (conta != null) {
        String numero = conta.getNumero();
        if (!contas.existe(numero)) {
            contas.inserir(conta);
        }
    }
}
```

Variation is whole data structure

```
interface RepositorioContas {
  void inserir(Conta conta);
  Conta procurar(String numero);
  boolean existe(String numero);
}
```

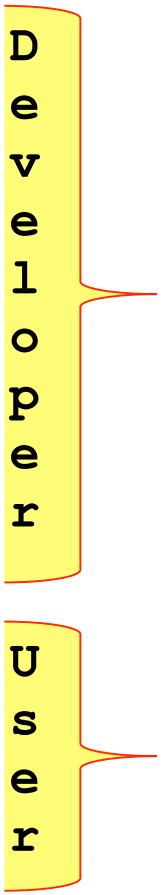
```
class ArrayContas implements
   RepositorioContas {...}

class VectorContas implements
   RepositorioContas {...}
```

Analyzing subtype polymorphism

- Variation point
  - supertypes (methods) in the program text
- Variation
  - subtypes (including methods and fields)
- Binding time
  - execution time, based on makefile choice (compilation/build time)
- Mechanism
  - subtype definition, variation modularization

Decision mechanisms for subtype polymorphism

- Makefiles (different mains or factories)
- Makefiles + property_files + conditionals
- Makefiles + property_files + reflection
- Input + conditionals
- Input + reflection



Environment decision, with dependency injection...

```
class CadastroContas {
  private RepositorioContas contas;
  void setRepositorio(RepositorioContas r) {
    contas = r;
  }
  ...
}
```

Not a developer decision,
nor a user decision!

Mixins

```
abstract class TestCase {...
   void buildTest() {...
     buildPreconditions();...
     buildProcedures();...
   }
}
```

```
class TC5 extends TestCase {...
   void buildProcedures() {...
      launchApp(Phone.SOUNDS);
      createMelody(...);...
    }
}
```

```
cclass TC5Bluetooth extends TC5 {
   void buildProcedures() {
      super.buildProcedures();
      setBluetooth(ON);...
   }
}
```

```
cclass TC5Transflash extends TC5{
   void buildProcedures() {
      super.buildProcedures();
      storeMultimedia(...);...
   }
}
```

```
cclass TC5TransBlue extends
   TC5Transflash & TC5Bluetooth {}
```

Components

- Improvement over subtype polymorphism and Java packages
  - not by defining subtypes of abstract classes, but of interfaces
  - clientship + subtype polymorphism
  - deployment independence
  - service location and management
  - module visibility and versions

OSGi startup and shutdown notification

```
package com.javaworld.sample.helloworld;
import org.osgi.framework.BundleActivator;
import org.osgi.framework.BundleContext;
public class Activator implements BundleActivator {
    public void start(BundleContext context) throws Exception {
        System.out.println("Hello world");
    }
    public void stop(BundleContext context) throws Exception {
        System.out.println("Goodbye World");
    }
}
```

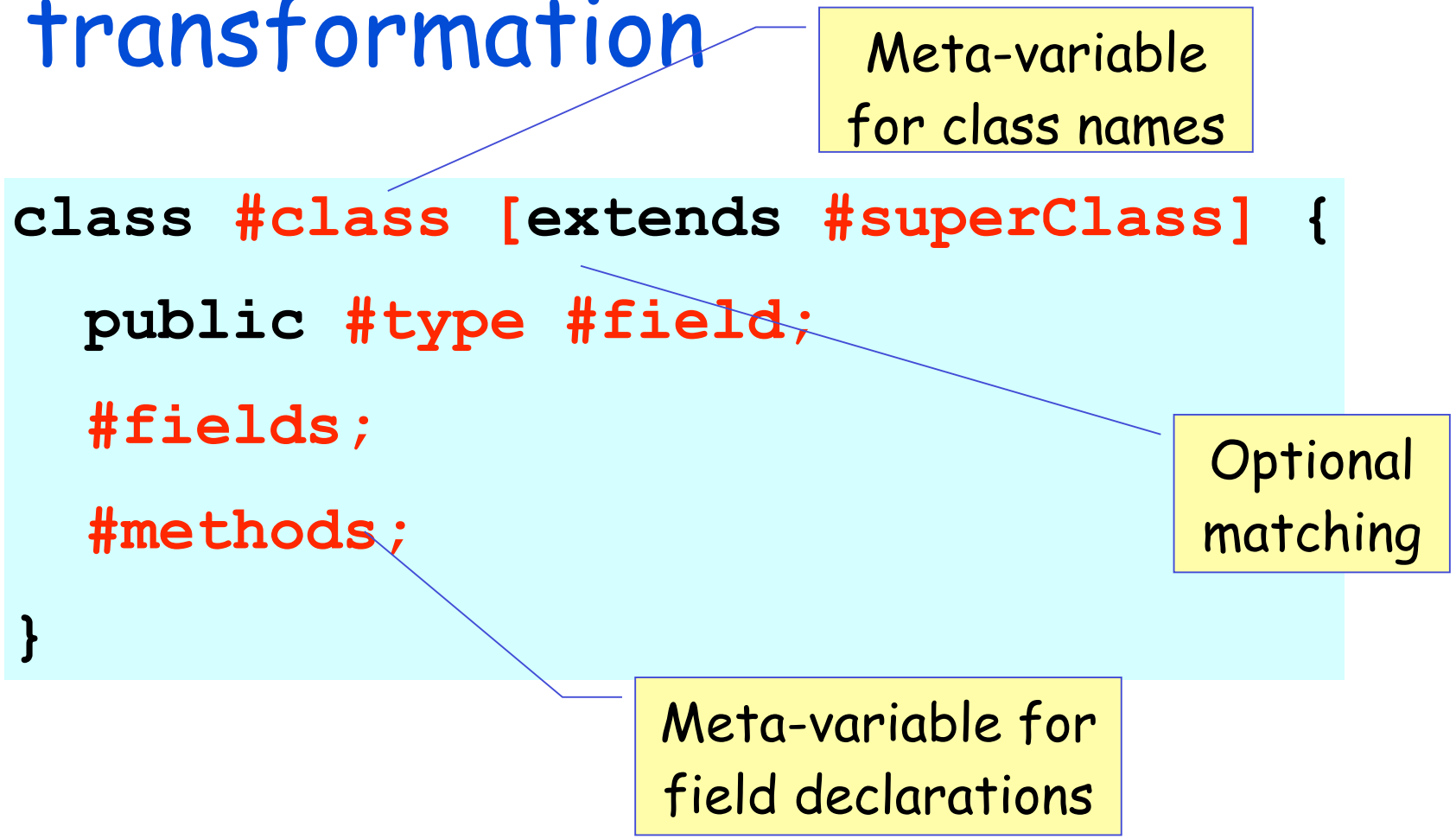
http://www.javaworld.com/javaworld/jw-03-2008/jw-03-osgi1.html?page=2

OSGi Metadata

```
Manifest-Version: 1.0
Bundle-ManifestVersion: 2
Bundle-Name: HelloWorld Plug-in
Bundle-SymbolicName: com.javaworld.sample.HelloWorld
Bundle-Version: 1.0.0
Bundle-Activator: com.javaworld.sample.helloworld.Activator
Bundle-Vendor: JAVAWORLD
Bundle-Localization: plugin
Import-Package: org.osgi.framework;version="1.3.0"
```

http://www.javaworld.com/javaworld/jw-03-2008/jw-03-osgi1.html?page=2

Code generation and transformation



Semantics-aware matching

```
class #class [extends #superClass] {
  public #type #field;
  #fields;
  #methods;
}
```

```
class Account {
  private String number;
  public double balance;
  ...
}
```

Transformations

```
class #class [extends #superClass] {
  public #type #field;
  #fields; #methods;
}
```

LHS

```
class #class [extends #superClass] {
  private #type #field;
  #fields; #methods;
}
```

RHS

Pre-conditions…

Transformations

```
class #class [extends #superClass] {
  public String endereco;
  #fields; #methods;
}
```

LHS

```
class #class [extends #superClass]
implements X {
    int #y;
  #fields; #methods;
}
```

RHS

Pre-conditions...

Iterative expressions

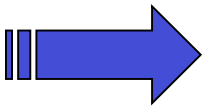
```
class #class [extends #superClass] {
  #fields; #methods;
  for all #f in #fields {
    let #n = <#f.getName()>;
        #t = <#f.getType()>;
    in
        #t <#n.addPrefix("get")>(){
          return this.#n;
        }
  }
}
```

Transformations

#classes

```
public class Person implements java.io.Serializable {
   private String nome; ...
   public Person(String nome, …) {
      this.nome = nome; …
   }
   public String getNome() {
      return nome;
   } …
}
```

```
public class Person implements java.io.Serializable {
   private String nome; ...
   public Person(String nome, …) {
      this.nome = nome; …
   }
   public String getNome() {
      return nome;
   } …
}
```



```
public interface IFacade extends java.rmi.Remote {
   ublic void updateComplaint complaint)
        throws TransactionException, RepositoryException,
        ObjectNotFoundException, ObjectNotValidException,
        RemoteException;
 …
}
```

```
public class Person implements java.io.Serializable {
   private String nome; ...
   public Person(String nome, …) {
      this.nome = nome; …
   }
   public String getNome() {
      return nome;
   } …
}
```

```
public class Person implements java.io.Serializable {
   private String nome; ...
   public Person(String nome, …) {
      this.nome = nome; …
     private X x = new X();
}
```

```
Class X {}
   public String getNome() {
      return nome;
   } …
}
```

#classes

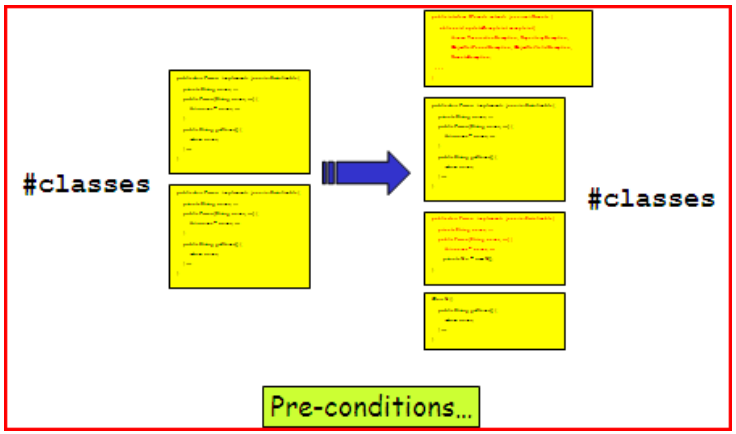
Pre-conditions…

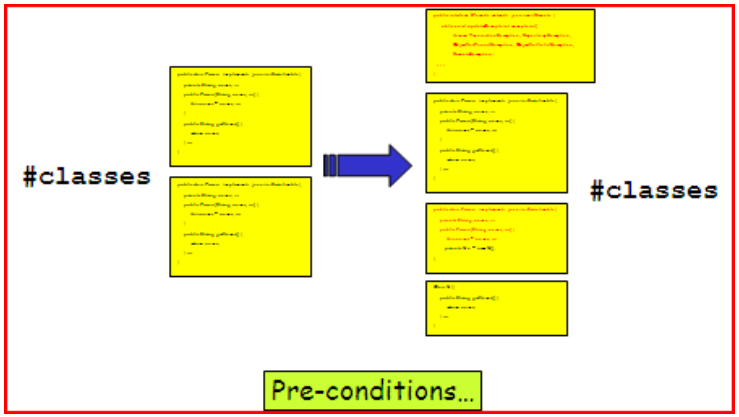
CGT core assets

Java files (commom)

```
class Account {
  private String number;
  public double balance;
  ...
}
```

Transformation files





Makefiles

Analyzing CGT

- Variation point
  - any element (not point) in the program text
- Variation
  - elements (including methods and fields)
- Binding time
  - precompilation time, based on makefile choice
- Mechanism
  - instantiation, transformation, generation

Aspects core assets

Java files

```
class Account {
  private String number;
  public double balance;
  ...
}
```

Makefiles

Aspects

```
aspect HelloAOPWorld {
  pointcut printCall():
    call(public void *.print(String));
  after():
    printCall() && within(HelloWorld) {
    System.out.println(" AOP World!");
  }
}
```

```
aspect HelloAOPWorld {
  pointcut printCall():
    call(public void *.print(String));
  after():
    printCall() && within(HelloWorld) {
    System.out.println(" AOP World!");
  }
}
```

```
aspect HelloAOPWorld {
  pointcut printCall():
    call(public void *.print(String));
  after():
    printCall() && within(HelloWorld) {
    System.out.println(" AOP World!");
  }
}
```

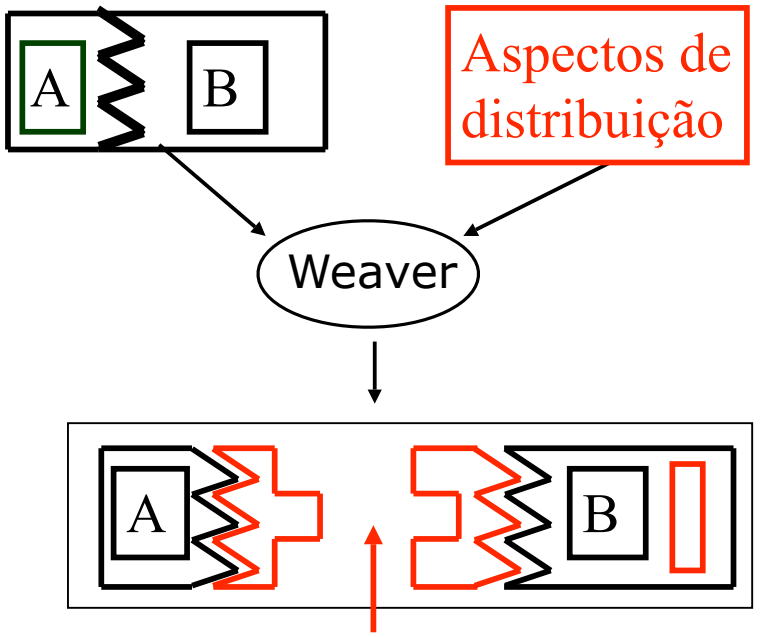
Weaving é usado para...

- Compor a base do sistema com os aspectos

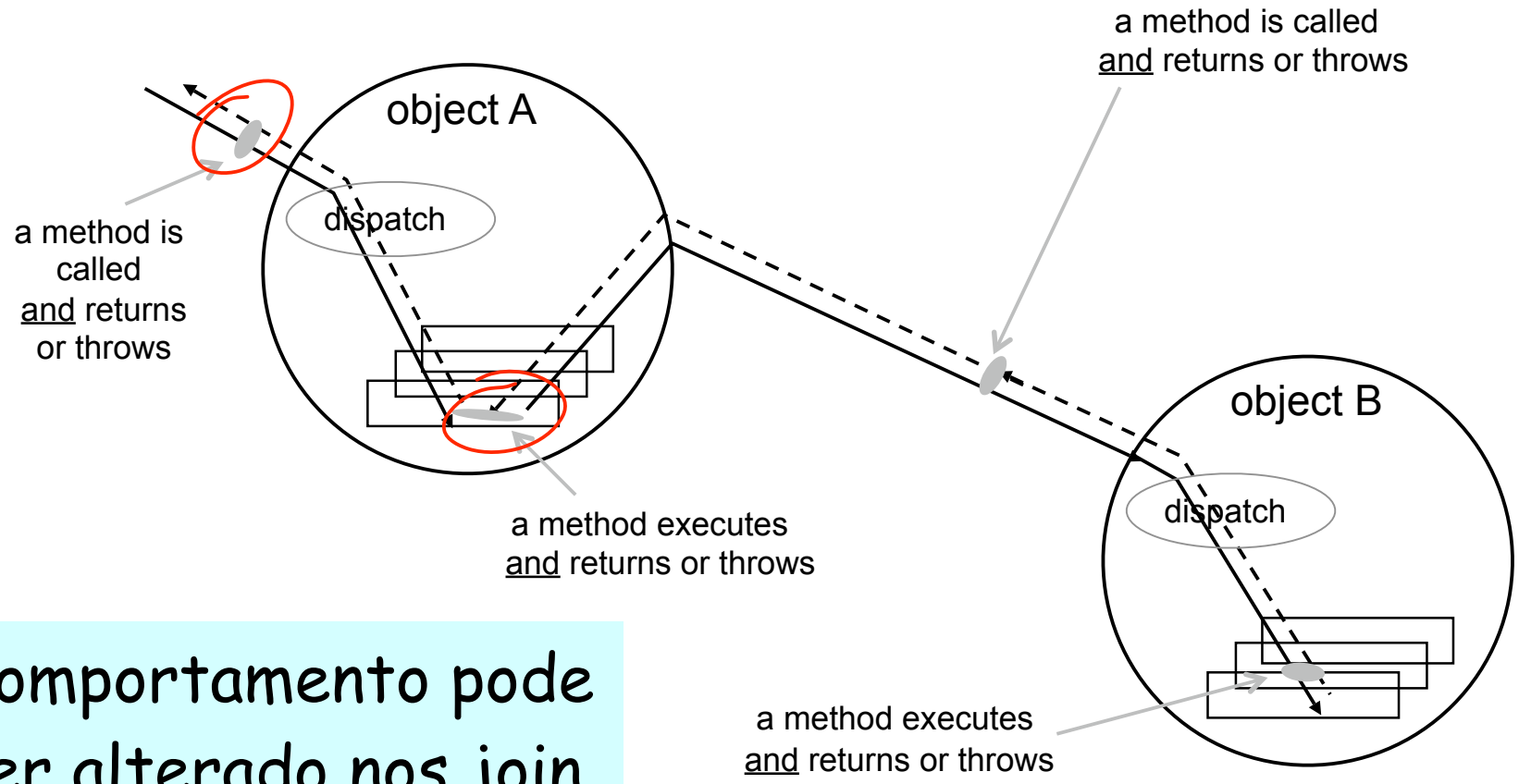
Sistema original
chamadas locais entre A e B

Processo de composição

Sistema distribuído
chamadas remotas entre A e B



Composição nos join points



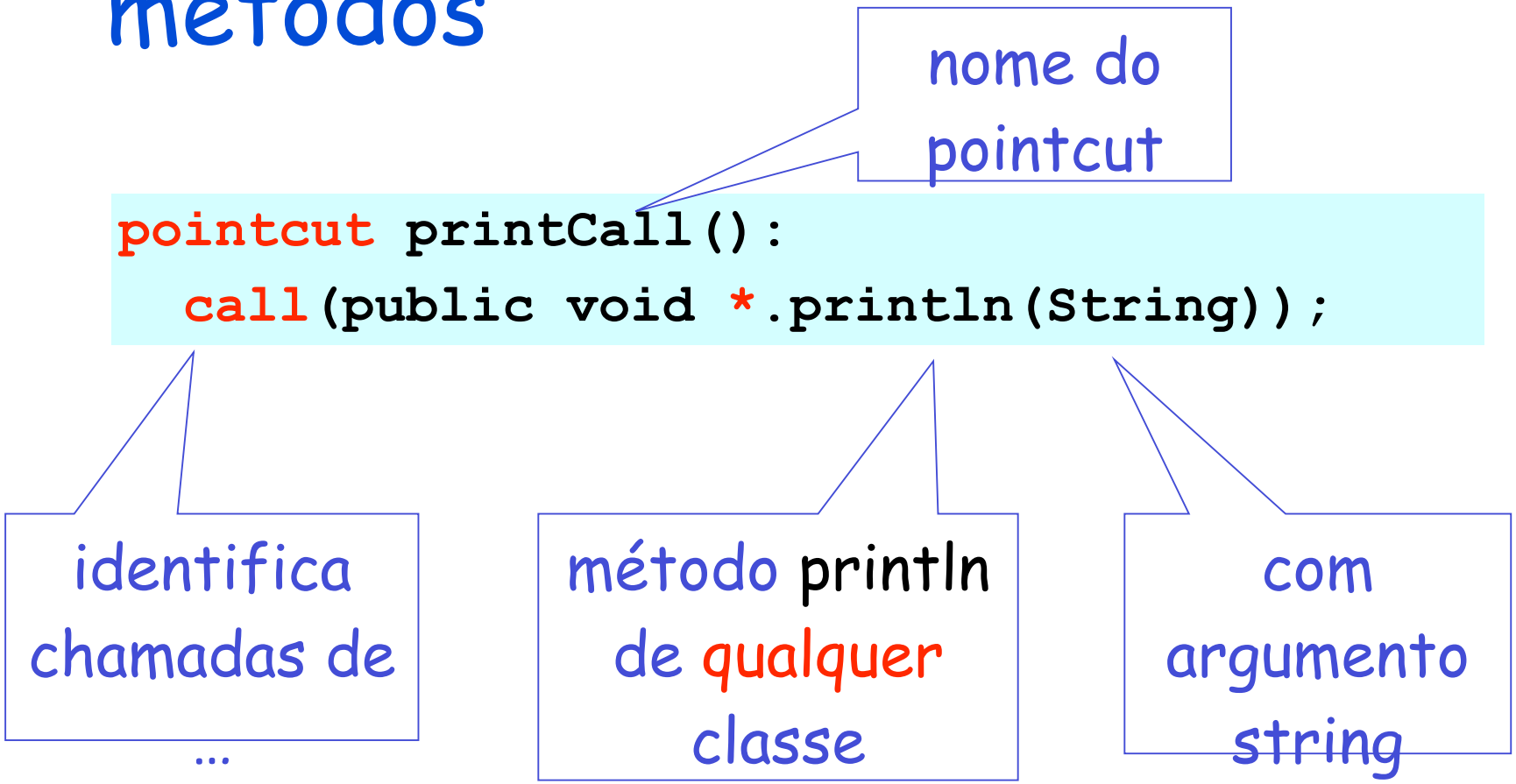
Comportamento pode ser alterado nos join points...

Fonte: AspectJ Programming Guide

Pointcuts especificam join points

- Identificam joint points de um sistema
  - chamadas e execuções de métodos (e construtores)
  - acessos a atributos
  - tratamento de exceções
  - inicialização estática e dinâmica
- Composição de joint points
  - `&&`, `||` e `!`

Identificando chamadas de métodos



Advice especifica comportamento nos join points

- Define código que deve ser executado...
  - `before`
  - `after`
    - `after returning`
    - `after throwing`
  - `ou around`

  join points

Alterando o comportamento de chamadas de métodos

qualquer chamada a Write dentro de HelloWorld

após...

```
after(): printCall() && within(HelloWorld) {
   System.out.println(" AOP World");
}
```

a ação especificada será executada

Changing class hierarchy

```
declare parents: HealthWatcherFacade
     implements IFacade;

declare parents: Complaint || Person
     implements java.io.Serializable;

public static void
  HealthWatcherFacade.main(String[] args){
  try {...
    java.rmi.Naming.rebind("/HW")
  } catch  ...
}
```

Alterando a hierarquia de tipos

Adicionando o método main na classe fachada

Aspectos agrupam pointcuts, advices, etc.

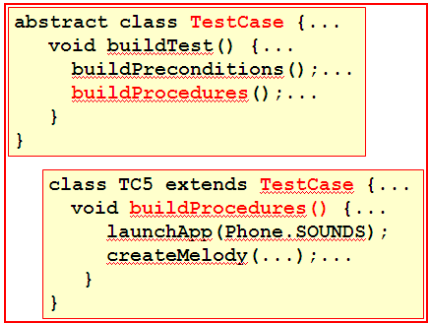
```
aspect HelloAOPWorld {
  pointcut printCall():
    call(public void *.print(String));
  after():
    printCall() && within(HelloWorld) {
    System.out.println(" AOP World!");
  }
  ...
}
```

Hello AOP World!

```
public class HelloWorld {
  public static void Main(string[] args) {
    System.out.println(“Hello");
  }
}
```


Chamada afetada pelo advice, caso `HelloAOPWorld` tenha sido composto com `HelloWorld`

Aspects for variations



```
abstract class TestCase {...
   void buildTest() {...
     buildPreconditions();...
     buildProcedures();...
   }
}

class TC5 extends TestCase {...
  void buildProcedures() {...
     launchApp(Phone.SOUNDS);
     createMelody(...);...
   }
}
```

```
privileged aspect Bluetooth {
   pointcut bluetooth(BaseTestCase test):
      execution(void TC5.buildProcedures(..))
      && this(test);
   after(BaseTestCase test):bluetooth(test){
      setBluetooth(ON);...
   }
}
```

Variations interaction, and precedence

```
privileged aspect Transflash {
  pointcut transflash(BaseTestCase test):
     execution(void TC5.buildProcedures(..))
     && this(test);
  after(BaseTestCase test):transflash(test){
     storeMultimedia(...);...
  }
}
```

```
public aspect TransflashBluetooth {
  declare precedence: Transflash,Bluetooth;
}
```

Analyzing aspects

- Variation point
  - joinpoints
- Variation
  - behavior, methods and fields, hierarchy
- Mechanism
  - variation separation, behavior modification, structure transformation

Aspects and binding time

- Compilation time, based on makefile choice
  - but can be used to implement variation 1, 2, and dynamic decision about 1 and 2
- Execution time
  - with dynamic aspect loading
  - based on user, developer, or environment choice, depending on decision mechanism

Variability implementation mechanisms, part II

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