"Belgisch-Nederlandse Evolution Workshop"
July 8-9, 2004 @ University of Antwerp

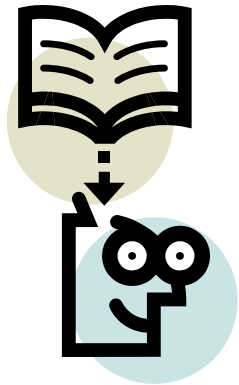
The "Write Once, Deploy N" MDA Case Study

Pieter Van Gorp, Dirk Janssens
Formal Techniques in Software Engineering
Pieter.VanGorp@ua.ac.be , *Dirk.Janssens@ua.ac.be*
http://www.fots.ua.ac.be/

UNIVERSITEIT
ANTWERPEN

Presentation Roadmap

- Problem, Context and Solution in a nutshell
- Solution Space: MDE & MDA
- The "WODN" MDA Case Study
  - ✓ Concrete example requiring more reuse in code generators
  - ✓ Could be used as benchmark for presented techniques on/after workshop…
- Conclusions & Future Work



Part I:

Problem, Context and Solution in a nutshell

Problem Statement

Optimizing the performance of distributed database applications is ***hard*** to combine with middleware ***vendor independence*** since cache, transaction and cluster configuration is database and ***application server specific***.

Vendor Independence?

EJB Essentials

- Distributed Server Components
  - ✓ Memory Management, Persistence, Caching, Connection Management, Transaction Management, Object Distribution, …
- Enterprise JavaBeans
  - ✓ Java sources inherit / implement certain interfaces
    - Remote Home Intf, Local Home Intf
    - Remote Bean Intf, Local Bean Intf
    - Bean Class (focus on business logic)
  - ✓ Deployment Attributes for code generators / compilers
    - XML Deployment Descriptors
  - ✓ Final component accesses server specific API
    - Callbacks to Bean Class

Proposed Solution

1. **Model** platform independent business components
   - ✓ PIMs
2. **Generate** platform specific implementations
   - ✓ May be interactive wizard (e.g. point to database)
   - ✓ PSMs, "PSC"
3. **Generate** platform independent "wrapper" code
   - ✓ Generate "PIC"
4. **Write** applications using these components
   - ✓ Plain Java (depends on your high-level API) or SDM
5. **Analyze** access scenario of such applications
   - ✓ Model analysis
6. **Generate** delegation code

Part II:

Solution Space: MDE & MDA

Model-Driven Engineering

- Definition

  In MDE, developers use a set of *domain specific* modeling languages with *adaptable* relationships managed by an architect.

- Goals

  1. More intuitive software specifications
     - ✓ Less experts required
  2. Encapsulate best practices (Performance, Modularity)
     - ✓ More productive for developers
     - ✓ Stricter architecture conformance
  3. Bypass vendor lock-in
     - ✓ Optimizations in mappings instead of specifications

MDA

- Definition
  - Model-Driven Engineering with UML and MOF
    - ✓ UML: Widely known notations for diagrams (Visualize your models)
    - ✓ MOF: Repository standard (Store your models)
    - ✓ QVT: Model transformation standard
    - ✓ M2T: Code template standard
- Goal
  - Standard MDD
    - ✓ Tools
    - ✓ Education, …
  - Managing Evolution of Framework Standards
    - ✓ Beyond J2EE
      - Best practices as first class programming artifacts before in standard
      - Your *company standards* for what IBM, BEA, SUN, … should not standardize
    - ✓ Beyond MOF (!)

Part III:

The "WODN" MDA Case Study

Write Once, Deploy N

- Online Data Access Scenario's
  - 85% Read for Display:
    - » Lazy Loading
    - » Invalidations from Writers
    - » No Transactions
  - 10% Read-Write:
    - » Aggressive Loading
    - » Transaction Support
  - 5% Batch Update:
    - » Lazy Loading
    - » Transaction Support

  - A "Deploy 1" Component would need conservative deployment attributes and waste resources!

  - A "Deploy 3" Approach boosts performance.
    - ✓ Manual Implementation is tedious => Generate It!
    - ✓ Attributes vary per vendor => Generate It!
- Beyond standardized J2EE framework!

3 kinds of DSLs

- Business analysts want to model **server components without platform details**
  => DSL

- Architects want to encode best practices in **code generator** with least effort and maximal effect (e.g., round-tripping)
  => DSL

- Application programmers want a **stable server component API (for "PIC")**
  => DSL

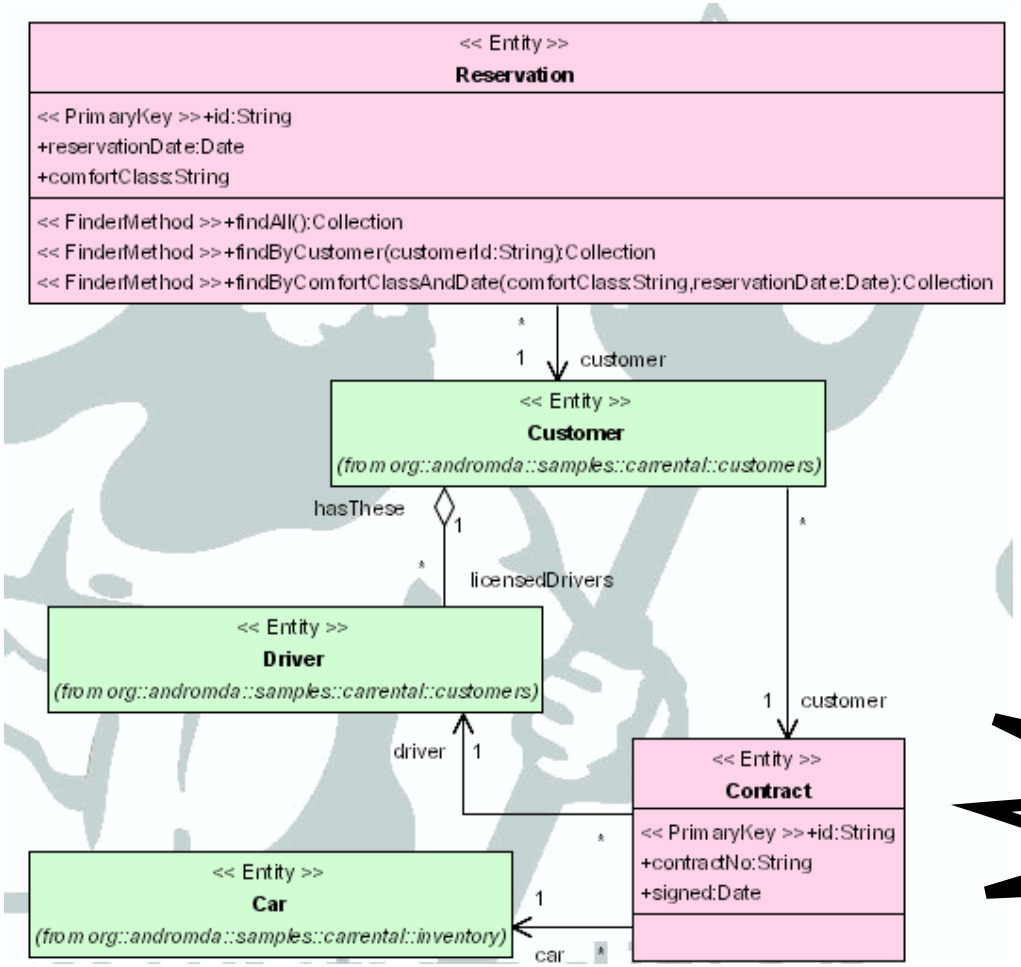
Future work, collaboration with company

Part III:

Suggested solution to the case study

Existing MDA Tools

Input Model for "contracts" package (PIM)



Generated Source for ContractBean.java (PSC)

```
/* Autogenerated by AndroMDA (EntityBean.vsl) - do no
package org.andromda.samples.carrental.contracts;
/**
 * ...
 * @ejb.interface generate="false" local-class="org.a
 * @ejb.home generate="false" local-class="org.androm
 * @ejb.pk generate = "false" class = "java.lang.Stri
 *
 * @ejb.persistence table-name="CONTRACT"
 */
public abstract class ContractBean
        extends java.lang.Object
        implements javax.ejb.EntityBean {
 /**
 * Get the driver
 *
 * @ejb.interface-method
 * @ejb.relation
 *     name="Contract->Driver"
 *     role-name="Contract->Driver:TheContract"
 *     target-ejb="Driver"
 *     target-role-name="Contract->Driver:driver"
 *     target-multiple="true"
 *     * @jboss.relation
 *      fk-column = "DRIVER"
 *      related-pk-field = "id"
 */
public abstract org.andromda.samples.carrental
                .customers.Driver getDriver();

}
```

Code Templates

Access to model elements
WYSIWIG Code

```
package $packagename;

import javax.ejb.EntityContext;
import javax.ejb.RemoveException;

public abstract class ${entityname}BeanImpl extends ${entityname}Bean
{
    private EntityContext context;

    public void setEntityContext(EntityContext ctx)
    {
        //Log.trace("${class.name}Bean.setEntityContext...");
        context = ctx;
    }

    public void unsetEntityContext()
    {
        //Log.trace("${class.name}Bean.unsetEntityContext...");
        context = null;
    }

    public void ejbRemove() throws RemoveException
    {
        //Log.trace(
        //    "${class.name}Bean.ejbRemove...");
    }
```

Code Templates

Too Abstract Input Models
=> Complex scripting

```
#foreach ( $op in $class.operations )
#if ($transform.getStereotype($op) == "FinderMethod")
 * @ejb.finder signature="${transform.findFullyQualifiedName($op.getType())}
${transform.getOperationSignature($op)}"
#set($viewtype = "")
#set($viewtype = $transform.findTagValue($op.taggedValues, "@andromda.ejb.viewType"))
#if($viewtype == "local" || $viewtype == "remote" ||  $viewtype == "both")
 *     view-type="$viewtype"
#end
#set($querystring = "")
#set($querystring = $transform.findTagValue($op.taggedValues, "@andromda.ejb.query"))
#if($querystring == "")
#set($querystring = "SELECT DISTINCT OBJECT(c) FROM $class.name AS c")
#if($op.parameters.size() >0 )
#set($querystring = "${querystring} WHERE")
#foreach($prm in $op.parameters)
#set($querystring="${querystring} c.$prm.name = ?$velocityCount")
#if($velocityCount != $op.parameters.size())
#set($querystring = "${querystring} AND")
#end
#end
#end
#end
 *     query="$querystring"
```

Evolving today's MDA tools

- Problem

  Input Metamodel (UML) is too General Purpose

  (Too abstract for code generation)

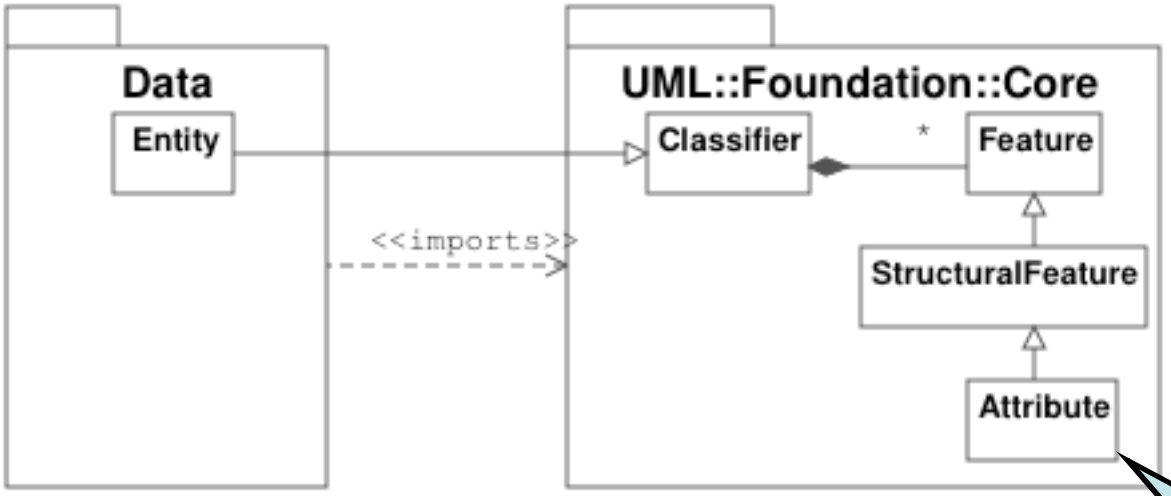
- Solution:

1. Code Templates on very concrete Metamodels
   - ✓ Refactor input metamodel to stack of metamodels
2. Solution: Stepwise refinement
   - ✓ Refactor code templates to model transformations

Domain Specific Metamodels

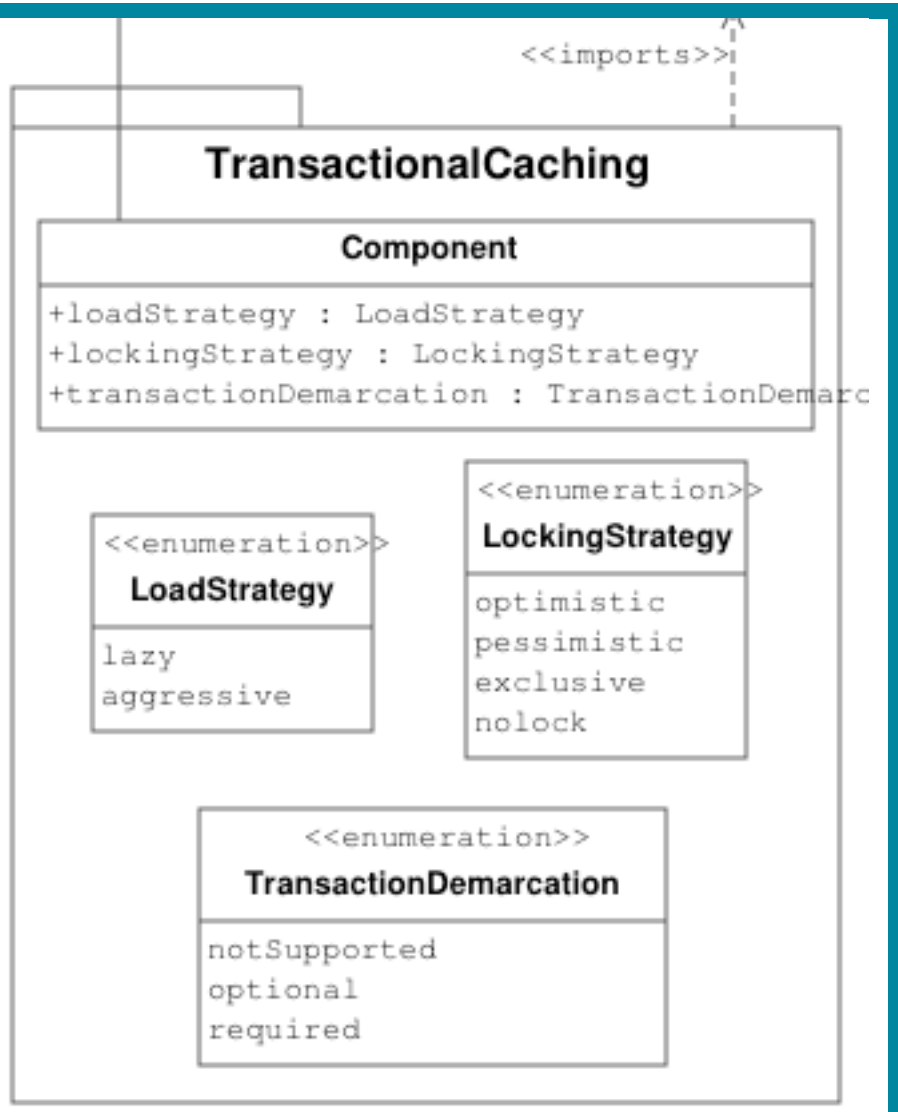
- Metamodel for business analysis
- Metamodel for transactional caching
- Metamodel for object-to-relational mapping
- Metamodel for WL EJB
- Metamodel for JBoss EJB

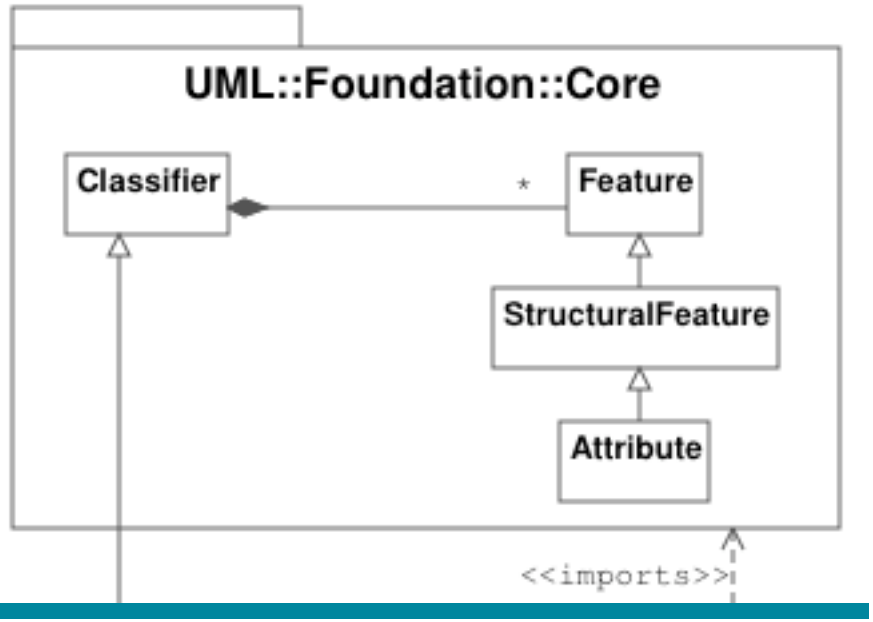
Metamodels for "WODN" (I/III)



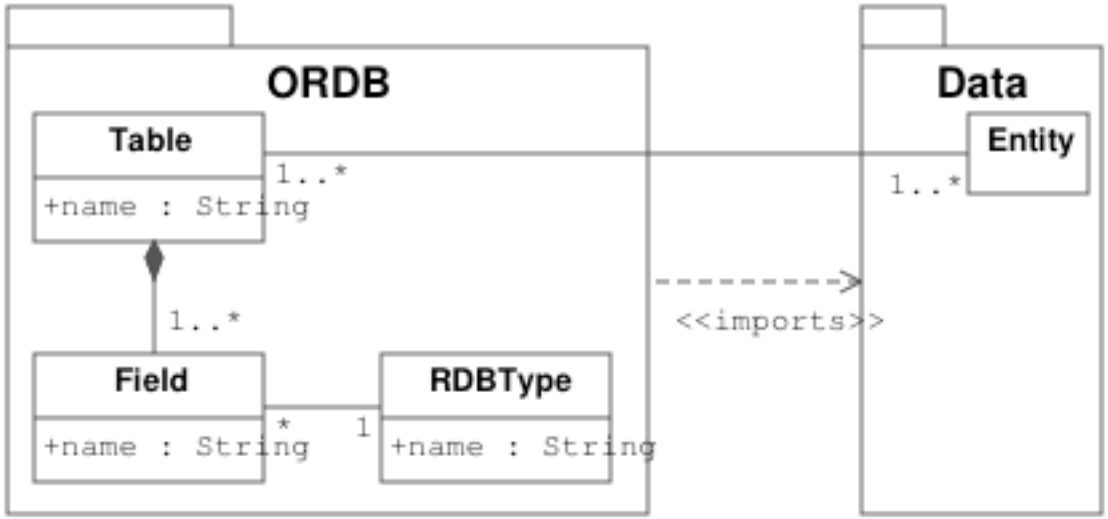
Note
Reuse

Metamodels for "WODN" (II/III)





Metamodels for "WODN" (III/III)



Recall: 3 kinds of DSLs

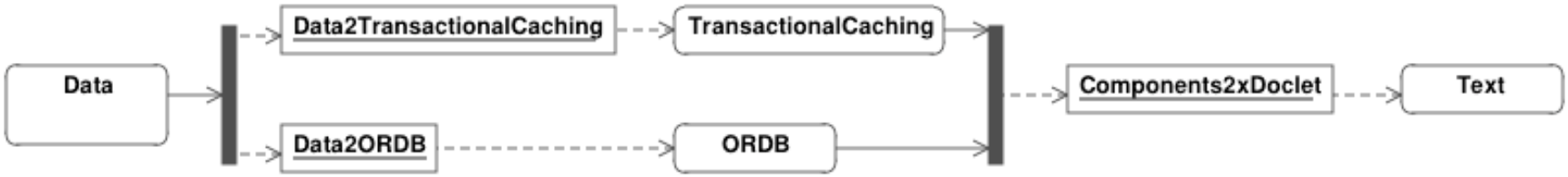
- Business analysts want to model **server components without platform details**
  => DSL

- Architects want to encode best practices in **code generator** with least effort and maximal effect (e.g. round-tripping)
  => DSL

- Application programmers want a **stable server component API**
  => DSL

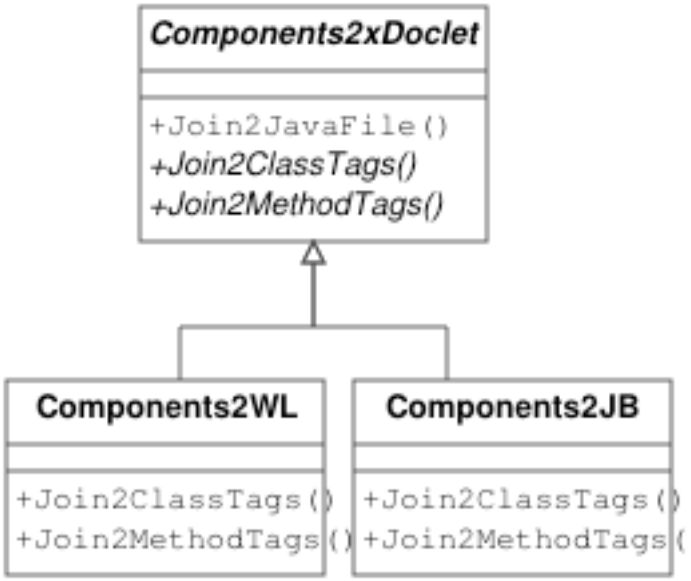
Future work

Decomposition of the code generator



- Reuse requirements for Evolution and of DSLs?
  - Reusable aspect modules
    - ✓ Contract: maintain consistency relation defined between metamodels
    - ✓ Parallellism to manage complexity
    - ✓ Sequencing to enable reuse of refinement of WODN pattern across JBoss and WebLogic cartridge
      - "Pipes & Filters"
    - ✓ Reuse with specialization of individual transformations
      - "Polymorphism"
      - Confirms observation from Marjan Mernik, Xiaoqing Wu, Barrett R. Bryant

Code Templates with Reuse & Specialization (I/II)



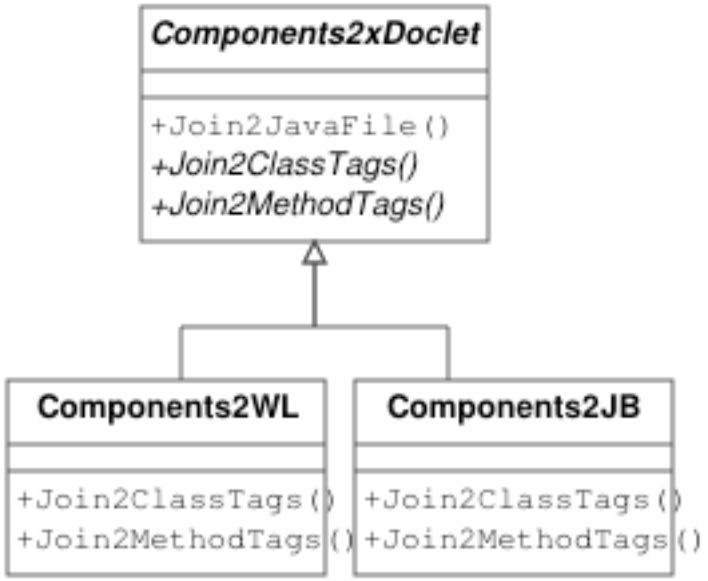
!!!! Explicit Variability of the Refinement Process (alternative to transformation parameters !!!

```
abstract Transformation Components2xDoclet
  from: {TransactionalCaching,ORDB},
  to: {Text} {

  Rule Generate() {
    postcondition:
      TransactionalCaching::Component.allInstances->forAll(
        c | ORDB::Entity.allInstances->forAll(
          e | (c.Classifier = e.Classifier)
              implies this^Join2JavaFile(c, e)
        )
      )
  }

  Rule Join2JavaFile (TransactionalCaching::Component c,
                      ORDB::Entity e) {
    // code template fragment for Java imports
    // code template fragment for conventional Javadoc
    #call Join2ClassTags(c,e);
    ...
    // code template fragment for iterating over methods
      ...
      #call Join2MethodTags(c,e);
      ...
    ...
  }
 …
}
```

Code Templates with Reuse & Specialization (II/II)




```
Transformation Components2WL
  inherits Components2xDoclet {

  // Join2JavaFile inherited, not overriden

  Rule Join2ClassTags (TransactionalCaching::Entity e1,
                       ORDB::Entity e2) {
    #call super.Join2ClassTags(e1,e2);
    // code template for WebLogic specific xDoclet class
    // tags like @weblogic.persistence, @weblogic.cache,
    // @weblogic.invalidation-target, ...
  }
  ...
}
```

Transformations ~ Classes

Rules ~ Methods

- Abstract transformations and rules
- Inheritance and Overriding
- Polymorphism

Model to Model Transformations as reused generator components

!!! Conflict Resolution (in first increment, during maintenance, …) !!!

```
Transformation Data2TransactionalCaching
  from: {Data},
  to: {TransactionalCaching} {
  ...
  Rule Entity2RO_Component () {
    postcondition:
      Entity.allInstances->forAll(e |
        Component.allInstances->exists(c |
          e.Classifier = c.Classifier and
          c.lockingStrategy = LockingStrategy::noLock and
          c.transactionDemarcation = TransactionDemarcation::optional
        )
      )
  }
  ...
}
```

Part IV:

Conclusions & Future Work

Conclusions

- Reuse in DSL MMs
  - Data (PIM), TransactionalCaching (PSM), … reuse from UML Core MM
  - Java (or C#, or sequence diagrams, …) syntax reused for application developers
- DSL supporting code generator evolution:
  - M2C
    - ✓ Integration with code templates
    - ✓ Inheritance with overriding (reuse, specialize)
  - M2M
    - ✓ **Engine** based on **Design By Contract (OCL')**
      - Generate constructive code from declarative (logic) rules (auto-satisfy postcondition)
      - Framework for launching manually written reconciliation code
- Code generation and architectural style checking can be integrated
- Activity Diagram & Class Diagram useful for documenting code generator design!
- Link to MDA: QVT Standard!

Future work on the case study: Refactoring Code Generators…

- PIM

  A model is said to be independent of a set of platforms

  1. if its metamodel abstracts from those platforms and
  2. if for each abstracted platform there is a sequence of mapping techniques from its metamodel to a metamodel describing this platform

- New Platforms

  1. New Mappings
     - Reuse of existing mappings is desirable
     - Refactor platform refinements
       - ✓ Remove Duplication
       - ✓ Improve Simplicity
       - ✓ …
     - Transformation Language Requirements
       - ✓ Inheritance with overriding
       - ✓ Stepwise Refinement (PIM and PSM per level)

  2. Adapt MM of PIM
     - Required for unanticipated platform characteristics
     - Backward compatibility with existing mappings!