TECHNISCHE UNIVERSITÄT DRESDEN

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Design and Prototypical Implementation of a Pivot Model as Exchange Format for Models and Metamodels in a QVT/OCL Development Environment

Großer Beleg – Final Presentation

Dresden, May 10, 2007

Contents

- Introduction
- Research Methodology
- Results
- Evaluation

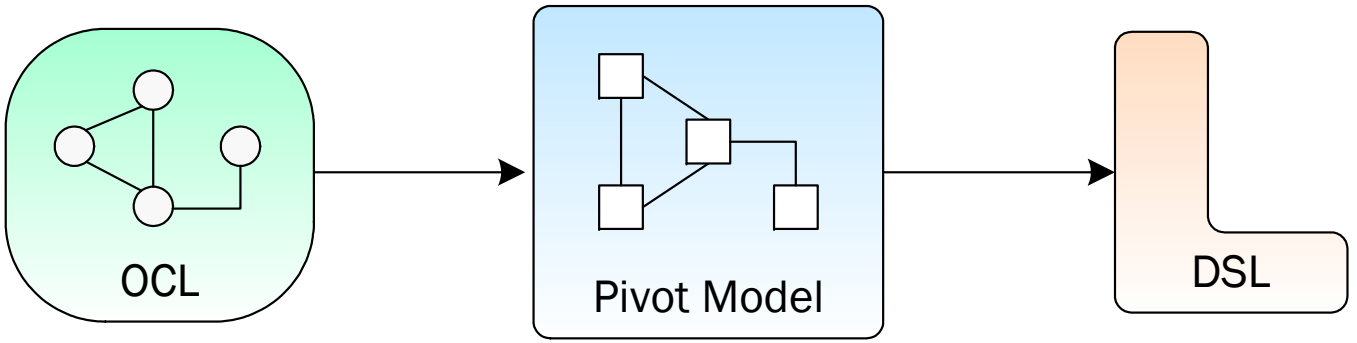
Contents

Motivation

- Model-driven Software Development (MDSD)
  - emerging paradigm for higher productivity and quality in software engineering
- increasing importance of domain-specific modeling languages (DSL)
  - on meta layers M2 and M3
- requires precise models, model transformations
- idea: use a standard constraint and model query language like OCL on instances of arbitrary DSLs

Goals

- design of a pivotal metamodel to integrate OCL with multiple DSLs



- implement an approach to realize the mapping between the Pivot Model and the target DSL

Example

- EMF Ecore
  - small and specialized language for defining object-oriented metamodels
  - meta-metalanguage (M3)
- Benefits of integration with OCL:
  - express wellformedness rules over Ecore models
  - transform Ecore models using QVT
- Example language defined with Ecore:
  - Plugin Modeling Language (PML)

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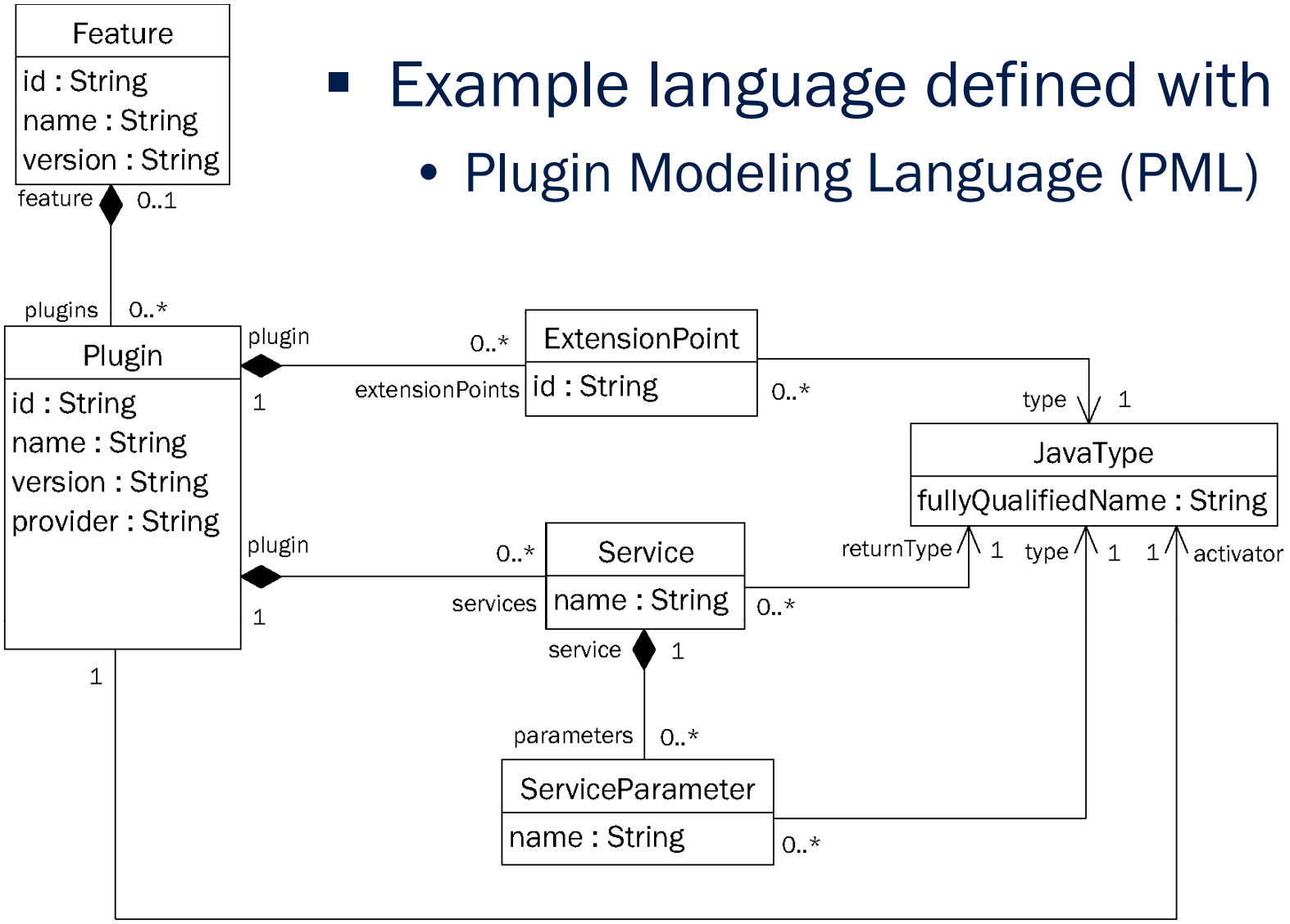
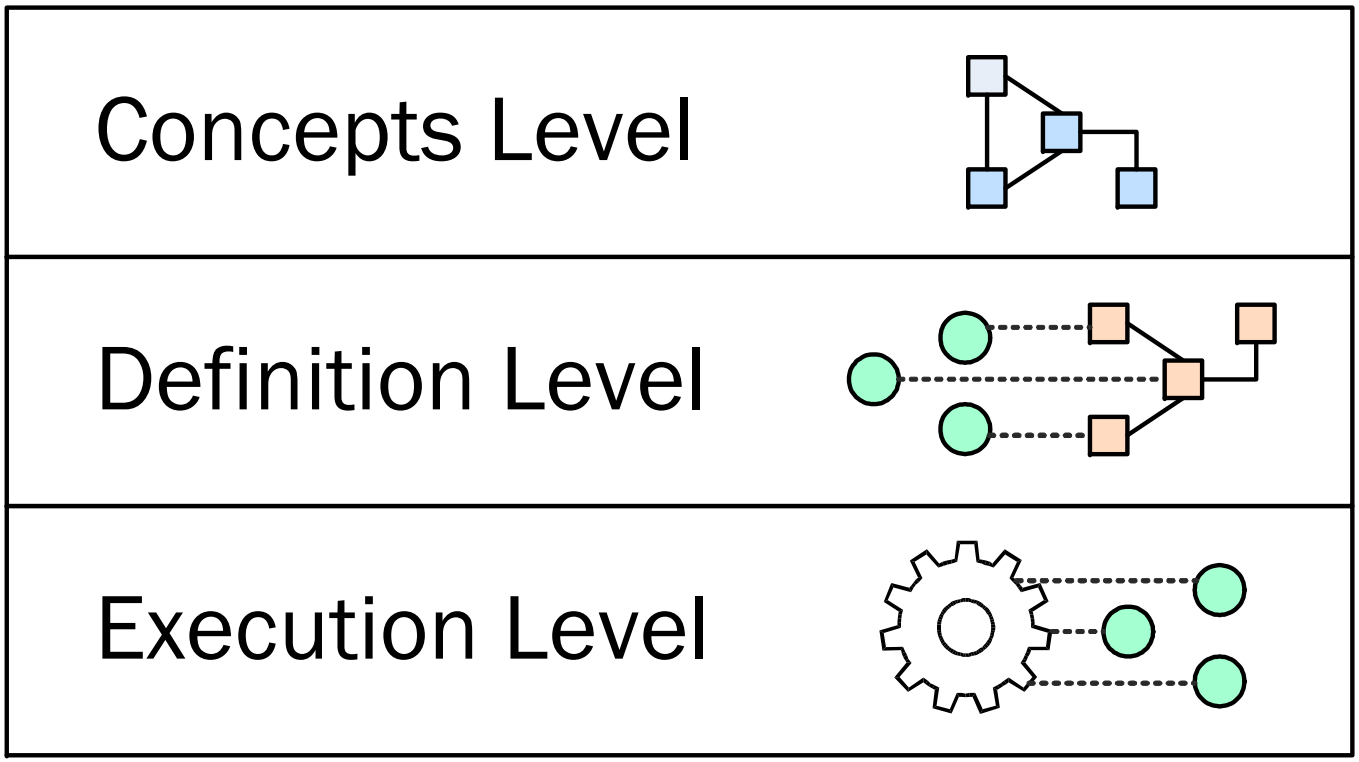


Contents

Approach

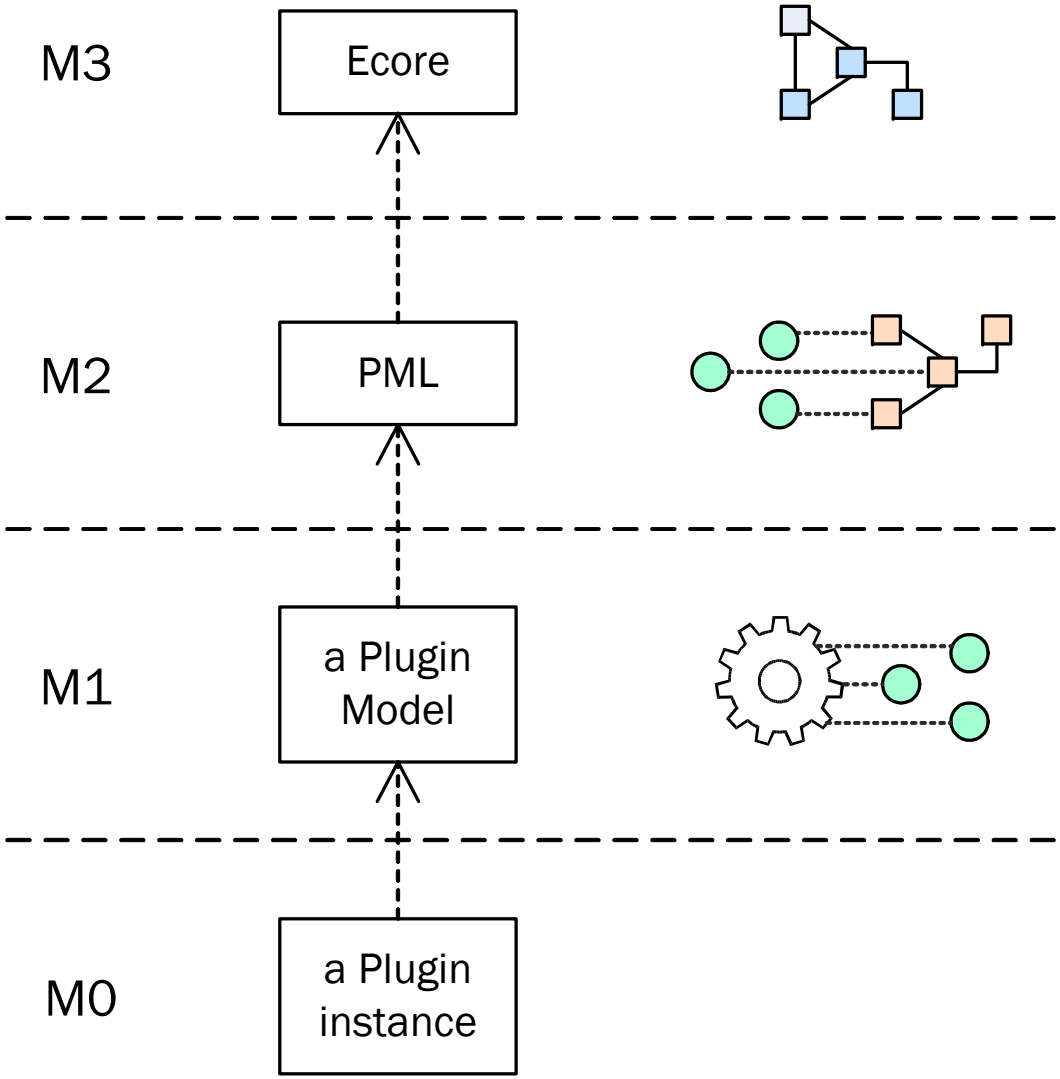
- analysis of literature about metamodeling to identify foundational challenges
- analysis of related work to identify respective strengths and weaknesses:
  - Dresden OCL2 Toolkit
  - Kent OCL Library
  - Epsilon Platform
- definition of a conceptual framework to guide research

Conceptual Framework



Applying the Framework

- requires integration of Ecore with OCL



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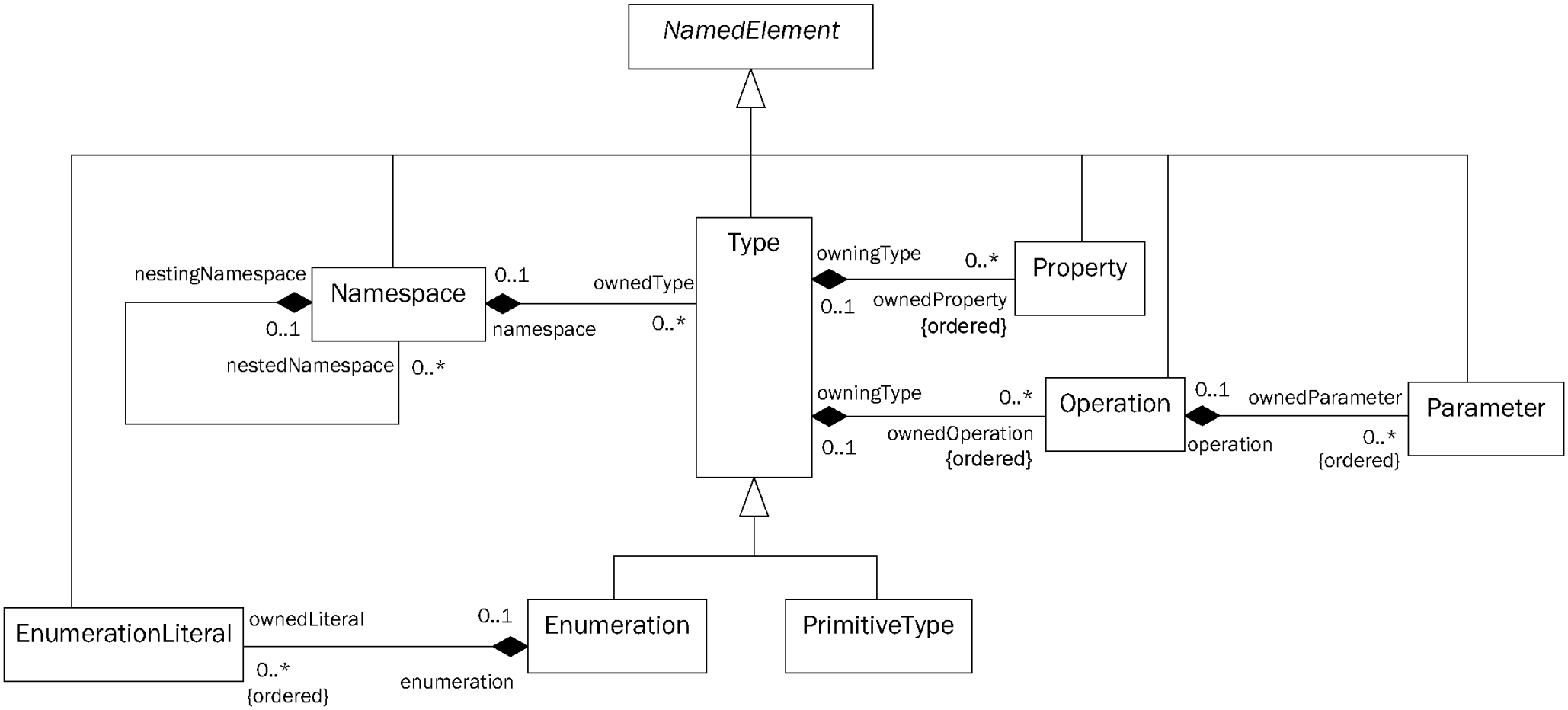
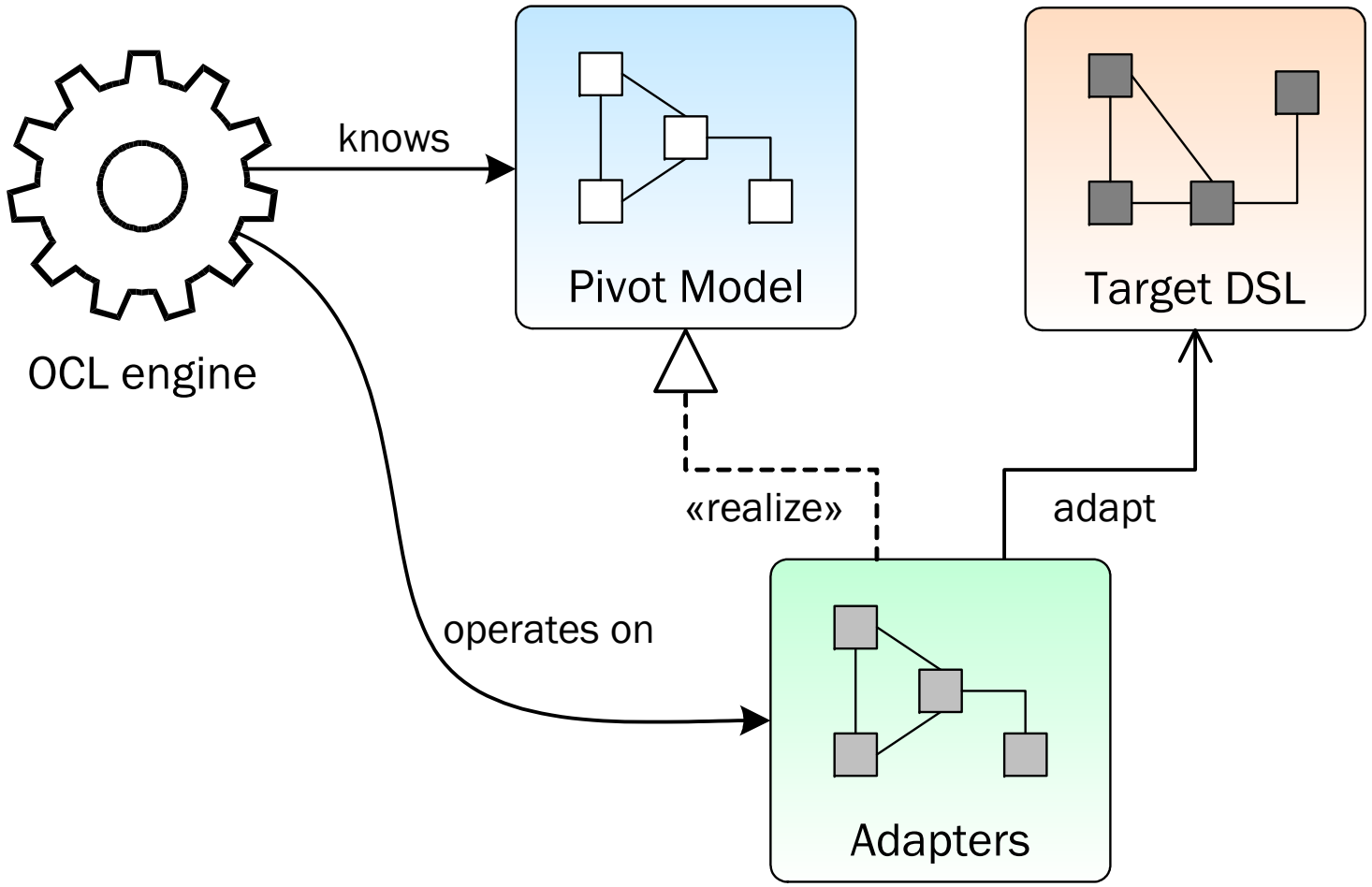
Design of the Pivot Model

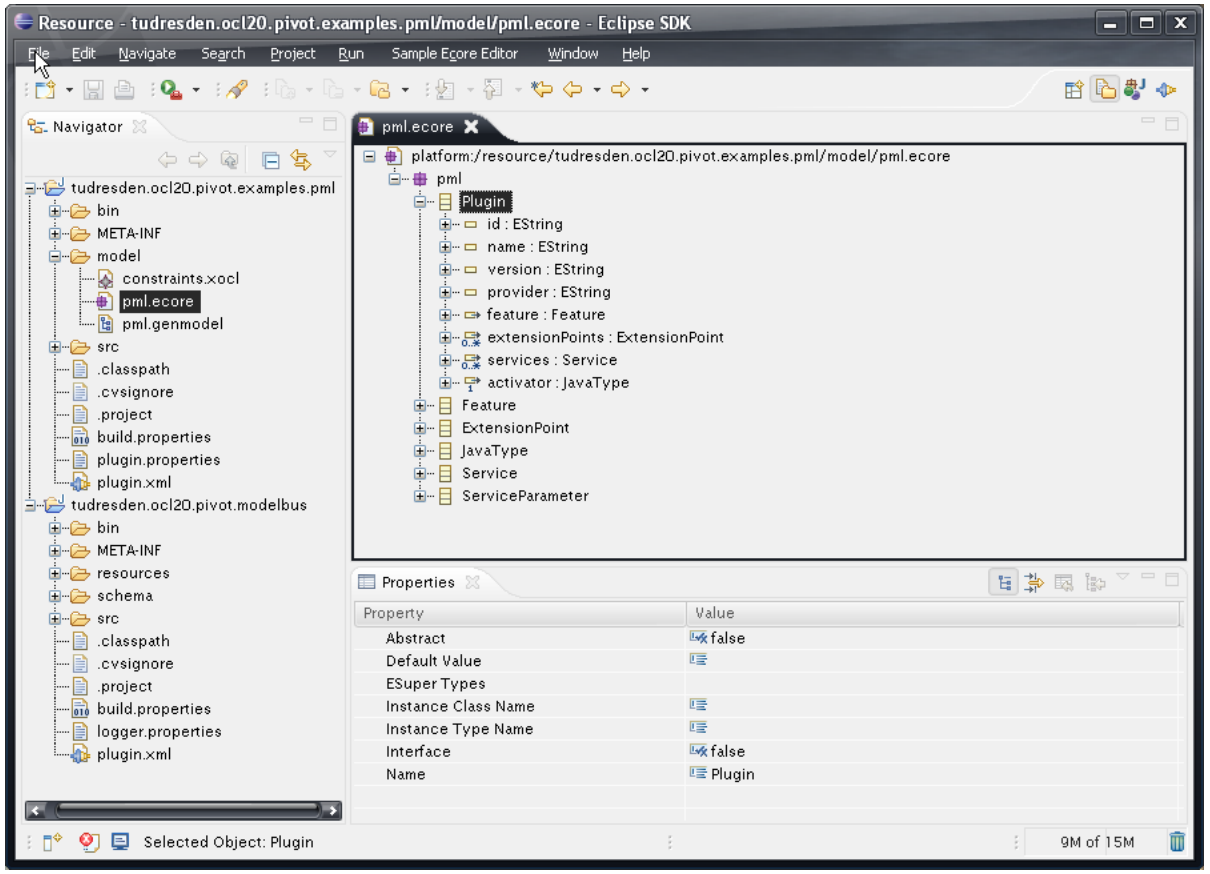


Implementation of Model Adaptation



Presentation

- generically displaying Ecore models through the Pivot Model interface



Integrating the OCL Standard Library

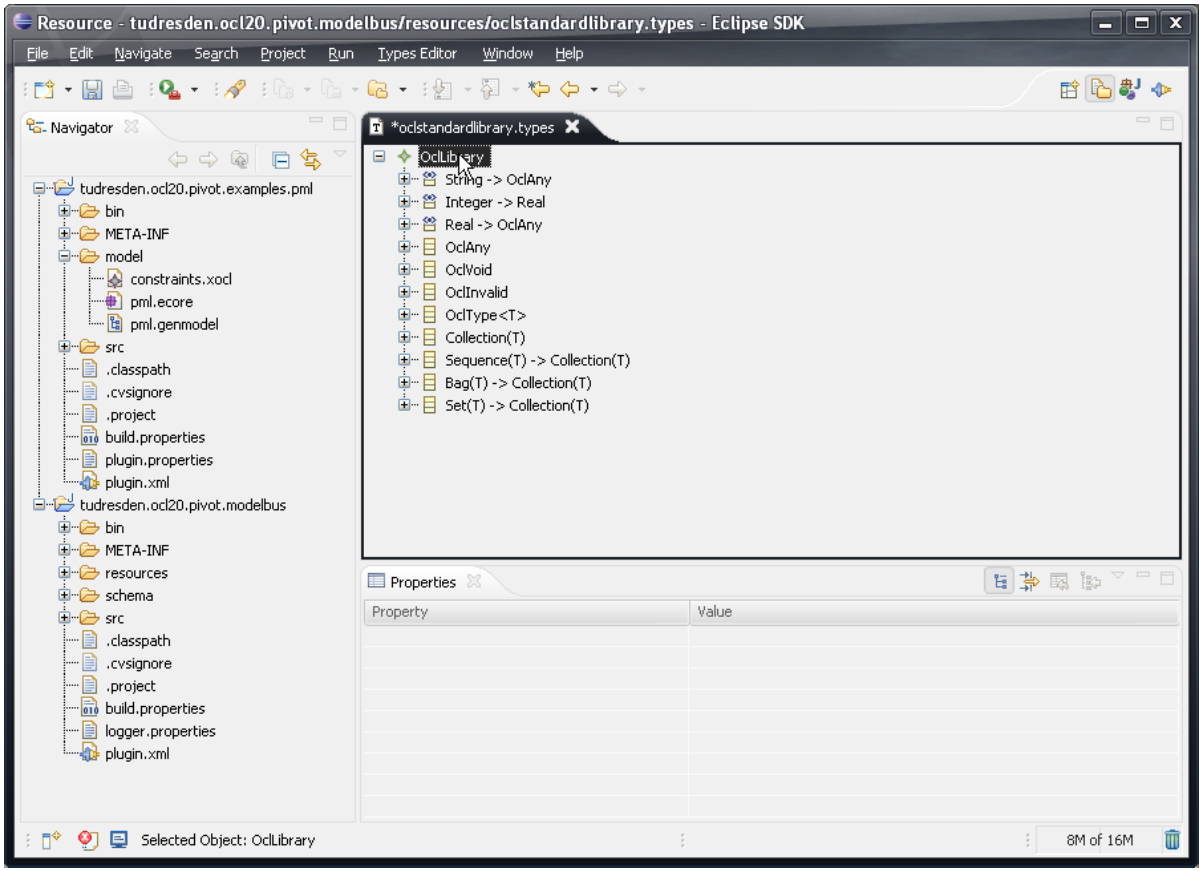
- OCL Standard Library
  - predefined types and operations
- some problems with integration:
  - infinite number of OCL collection and tuple types
  - all model types implicity derive from `OclAny`
- existing OCL engines:
  - dynamic creation of Standard Library in the code
  - complex, error-prone

Integrating the OCL Standard Library

- my solution:
  - support templates (generics) in the Pivot Model
  - model Standard Library as instance of Pivot Model
  - integrate by loading serialized XMI and bind generic types when necessary

Presentation

- modeling the OCL Standard Library



Writing OCL expressions for Ecore models

- example: a wellformedness rule for PML

```
-- a Plugin must have a valid id
context Plugin
inv: self.id->notEmpty()
```

- problem:
  - existing OCL parser needs adaptation
- solution:
  - alternative concrete syntax for OCL based on XML
  - use EMF for serialization / deserialization

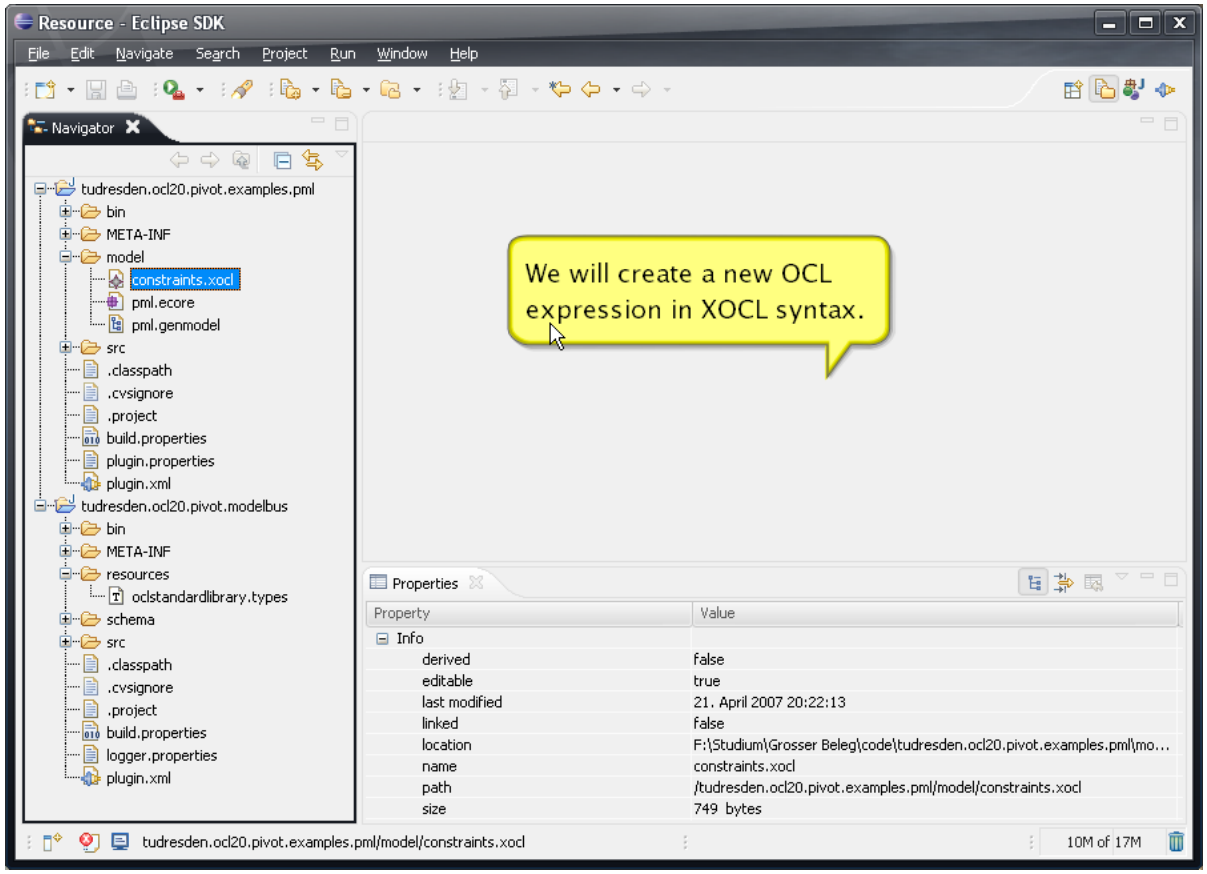
OCL in XML

- XOCL ... XML-based OCL

```
<xocl:NamespaceXS pathName="pml">
  <ownedRule name="idNotEmpty" kind="invariant" constrainedElement="Plugin">
    <specification body="self.id->notEmpty()">
      <bodyExpression xsi:type="xocl:CollectionOperationCallExpXS"
                      referredCollectionOperation="notEmpty">
        <source xsi:type="xocl:PropertyCallExpXS" referredPropertyName="id">
          <source xsi:type="xocl:VariableExpXS"
                  referredVariable="//@ownedRule.0/@specification/@context"/>
        </source>
      </bodyExpression>
    </specification>
  </ownedRule>
</xocl:NamespaceXS>
```

Presentation

- visually creating OCL ex-pressions

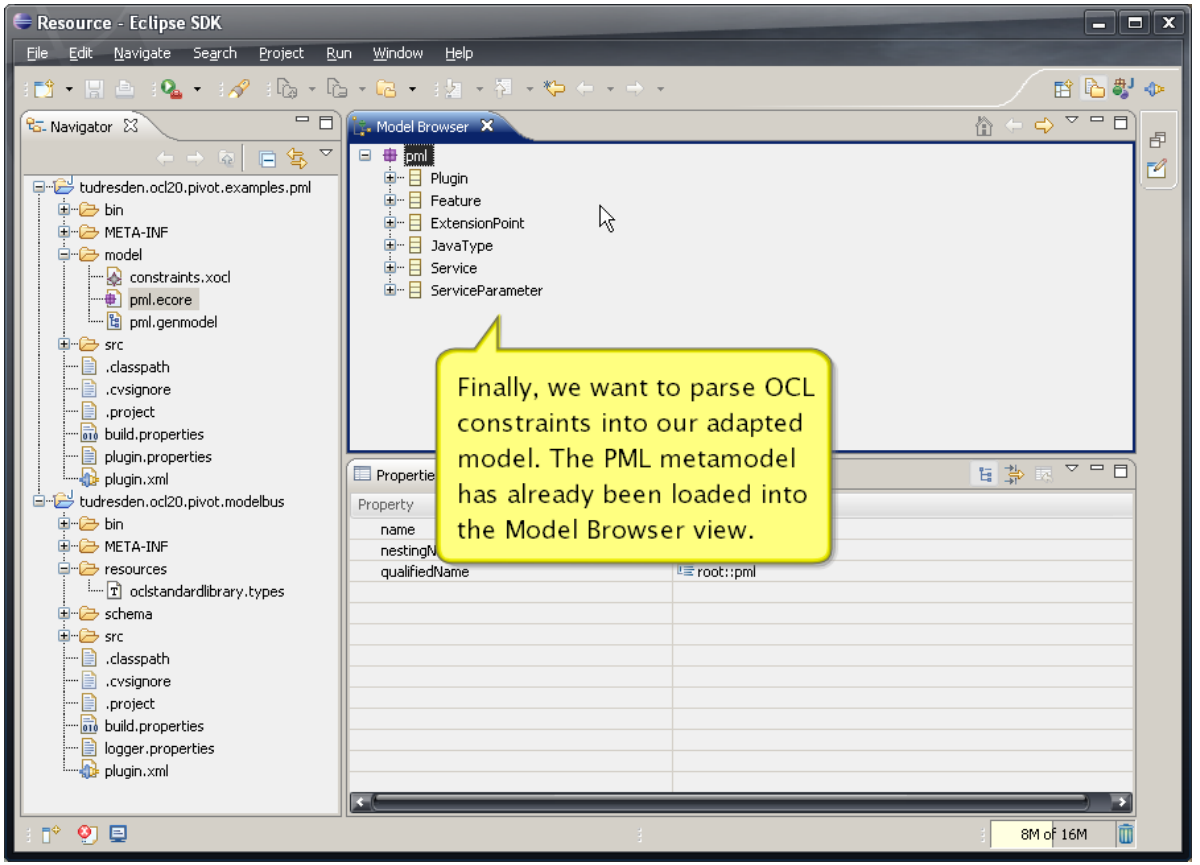


Parsing OCL expressions

- adapter layer allows to add transient elements to a domain-specific model
  - Constraint instances representing OCL expressions
  - properties and operations defined by OCL expressions

Presentation

- parsing an XOCL file



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Evaluation

- comparison of effort to integrate a DSL

	Dresden OCL2 Toolkit		Kent OCL	Pivot Model
Adapted metamodel	UML	MOF	Ecore	Ecore
Lines of code	2124	1657	685	554

- automatic generation of large parts of Pivot Model adapter layer possible

Contributions

- detailed analysis of conceptual challenges
- proposal of a conceptual framework
- thorough review of current Dresden OCL2 Toolkit
- carefully designed Pivot Model
- novel approach for integrating Standard Library
- clean and highly extensible design of an integration framework
- investigation of Execution Level in preparation of future developments (OCL interpreter)

The End

Thank you for your attention! ☺

Questions? Comments?

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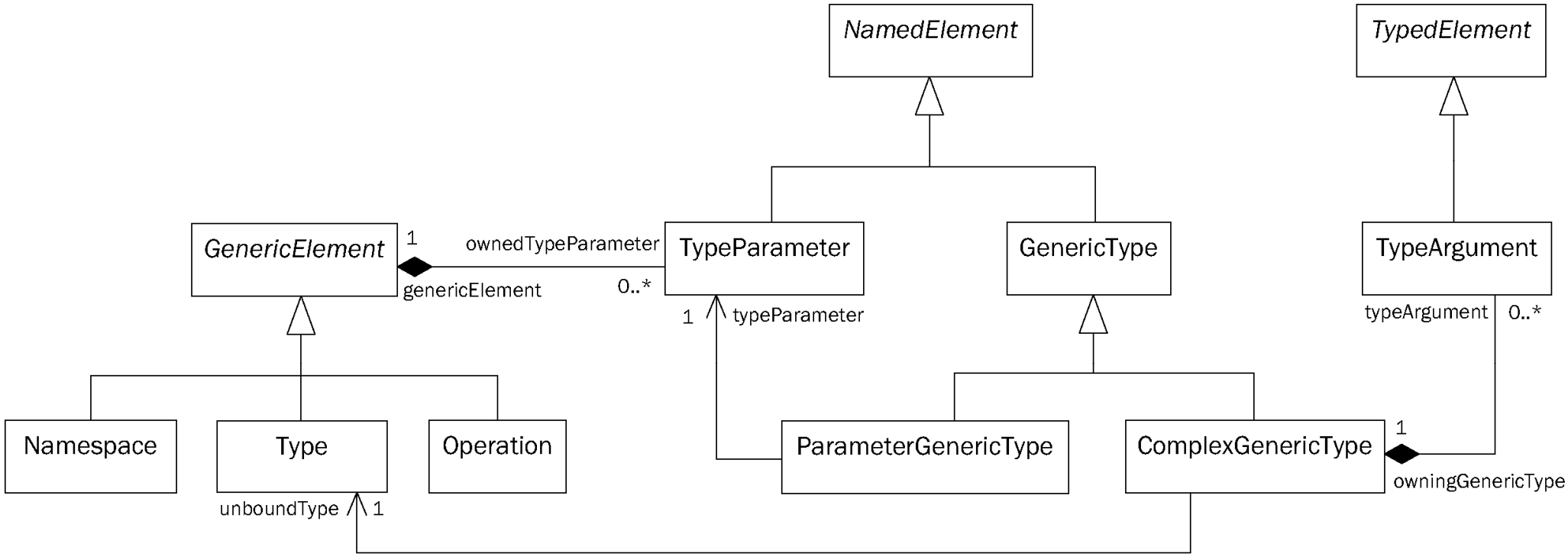
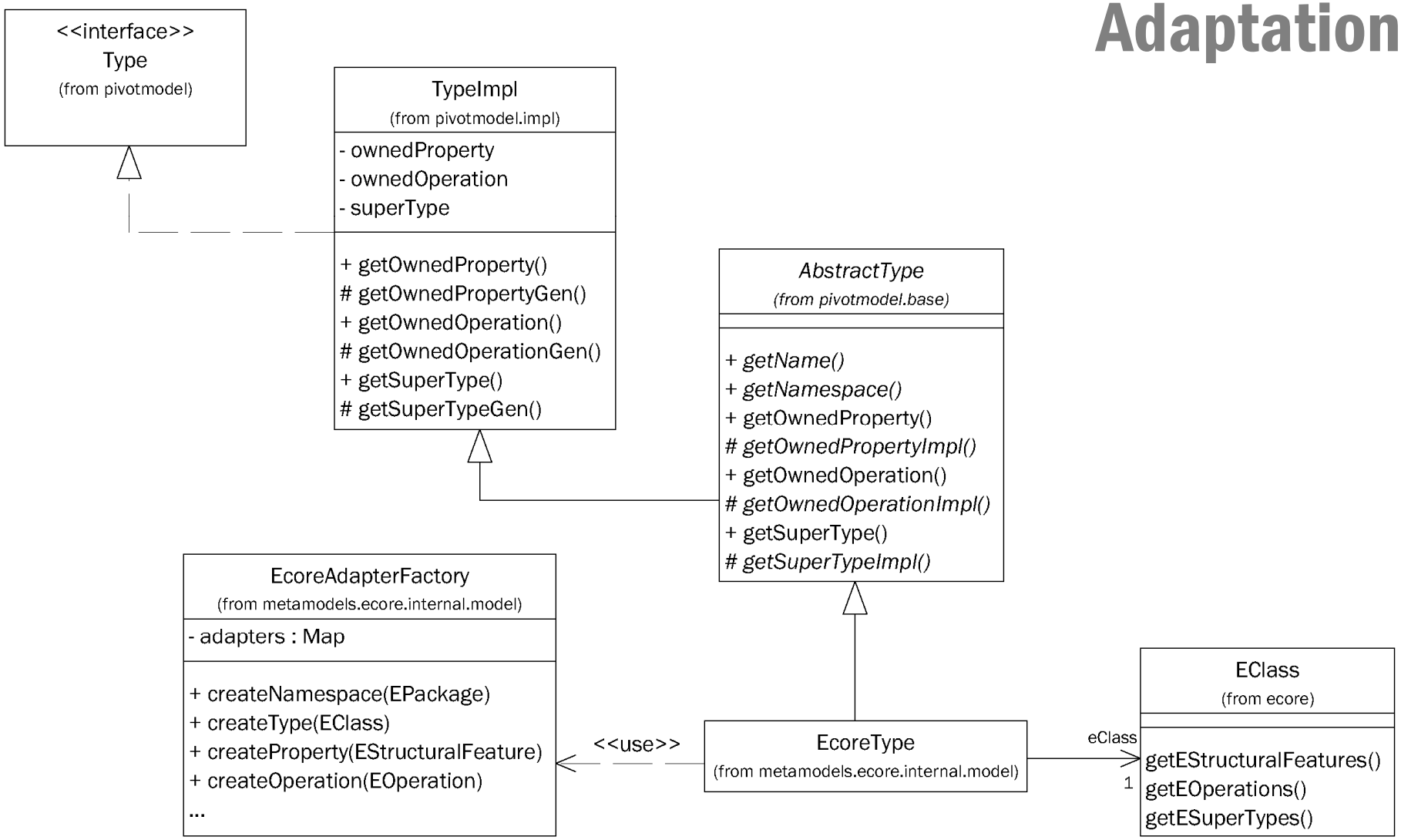
Backup

Generics

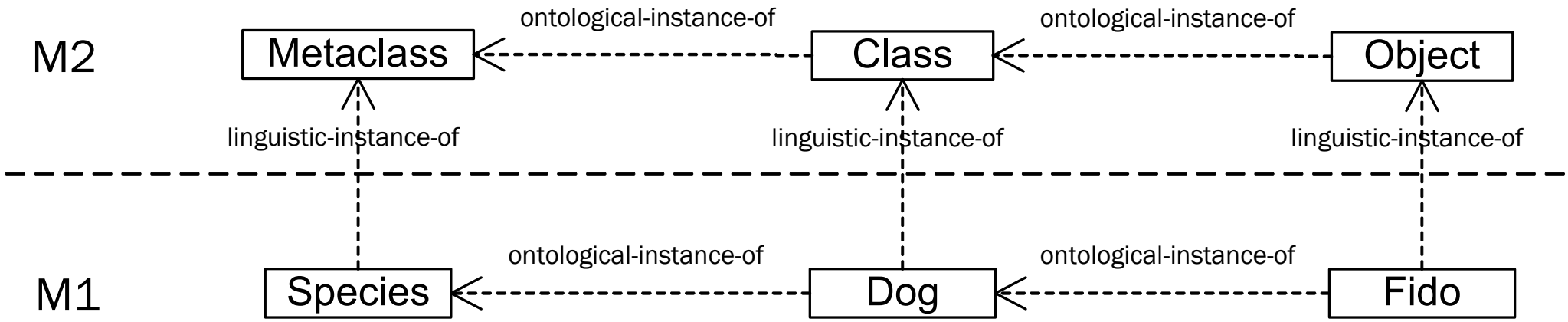

NamedElement
TypedElement
GenericElement
1
ownedTypeParameter
TypeParameter
GenericType
TypeArgument
genericElement
0..*
1
typeParameter
typeArgument
0..*
Namespace
Type
Operation
ParameterGenericType
ComplexGenericType
1
owningGenericType
unboundType
1

Adaptation


<<interface>>
Type
(from pivotmodel)
TypeImpl
(from pivotmodel.impl)
- ownedProperty
- ownedOperation
- superType
+ getOwnedProperty()
# getOwnedPropertyGen()
+ getOwnedOperation()
# getOwnedOperationGen()
+ getSuperType()
# getSuperTypeGen()
AbstractType
(from pivotmodel.base)
+ getName()
+ getNamespace()
+ getOwnedProperty()
# getOwnedPropertyImpl()
+ getOwnedOperation()
# getOwnedOperationImpl()
+ getSuperType()
# getSuperTypeImpl()
EcoreAdapterFactory
(from metamodels.ecore.internal.model)
- adapters : Map
+ createNamespace(EPackage)
+ createType(EClass)
+ createProperty(EStructuralFeature)
+ createOperation(EOperation)
...
<<use>>
EcoreType
(from metamodels.ecore.internal.model)
eClass
1
EClass
(from ecore)
getEStructuralFeatures()
getEOperations()
getESuperTypes()

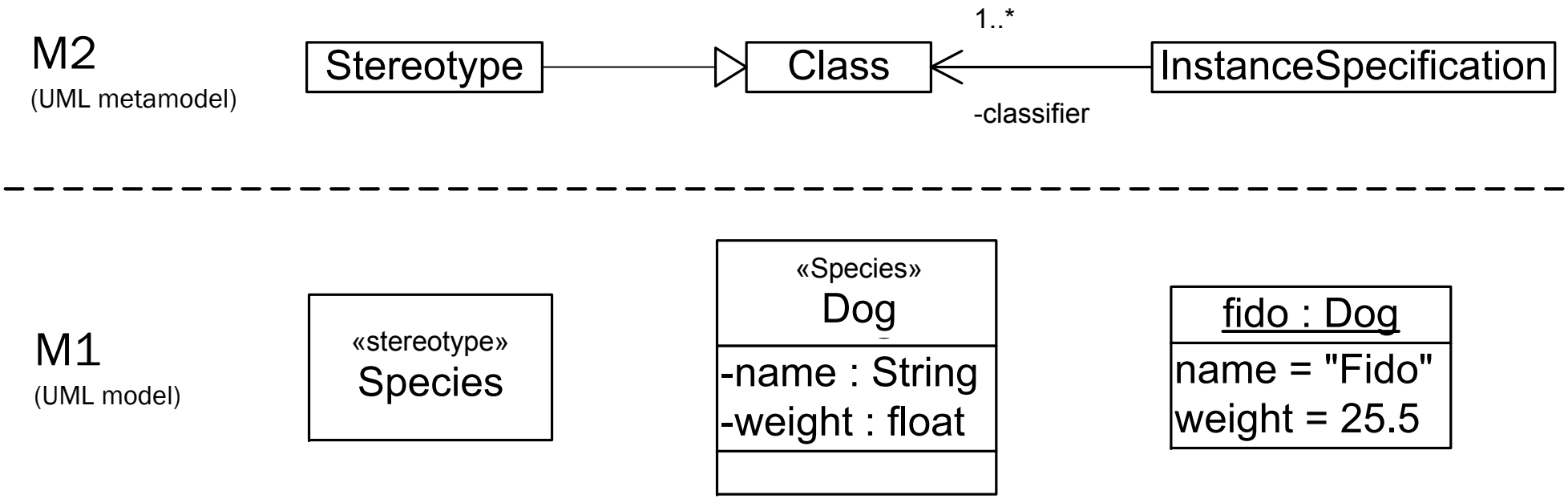
Ontological Classification Problem

- two dimensions of metamodeling



Ontological Classification Problem

- In UML: Stereotypes and Profiles extend M2 concepts
- DSLs define entirely new ontology concepts on M2

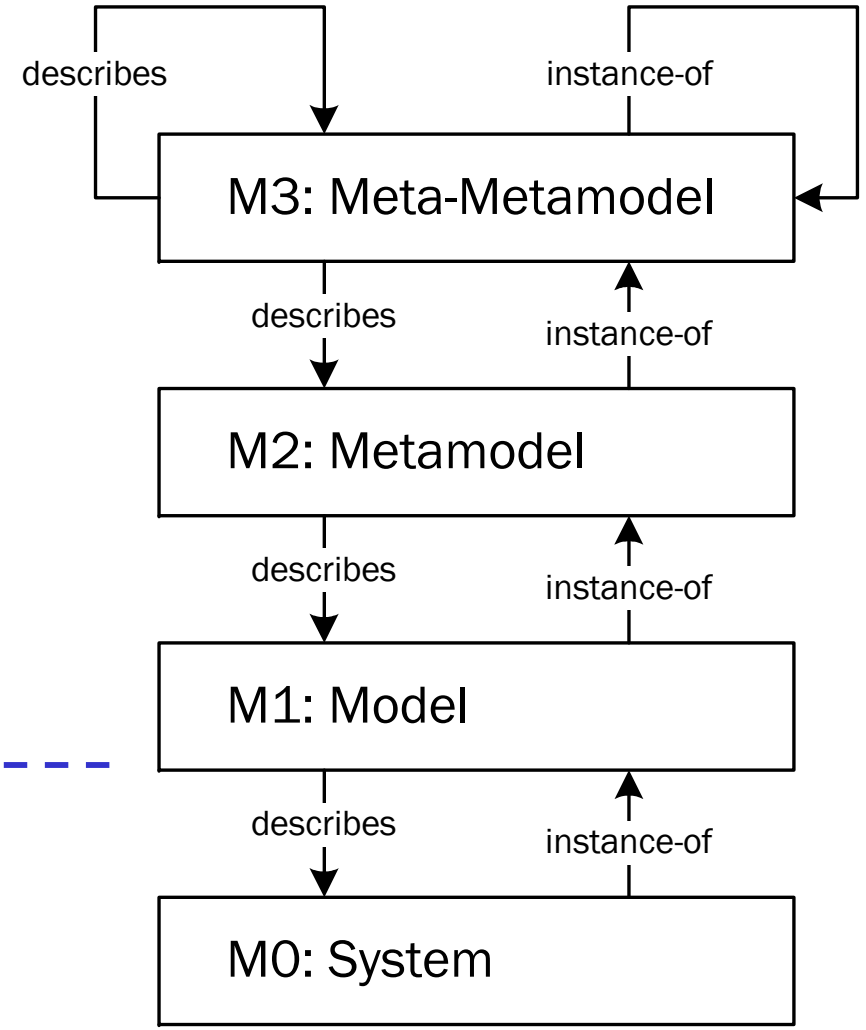


System Instantiation Problem

- Transformation on the System layer requires instantiation of new System elements
- Instantiation semantics?

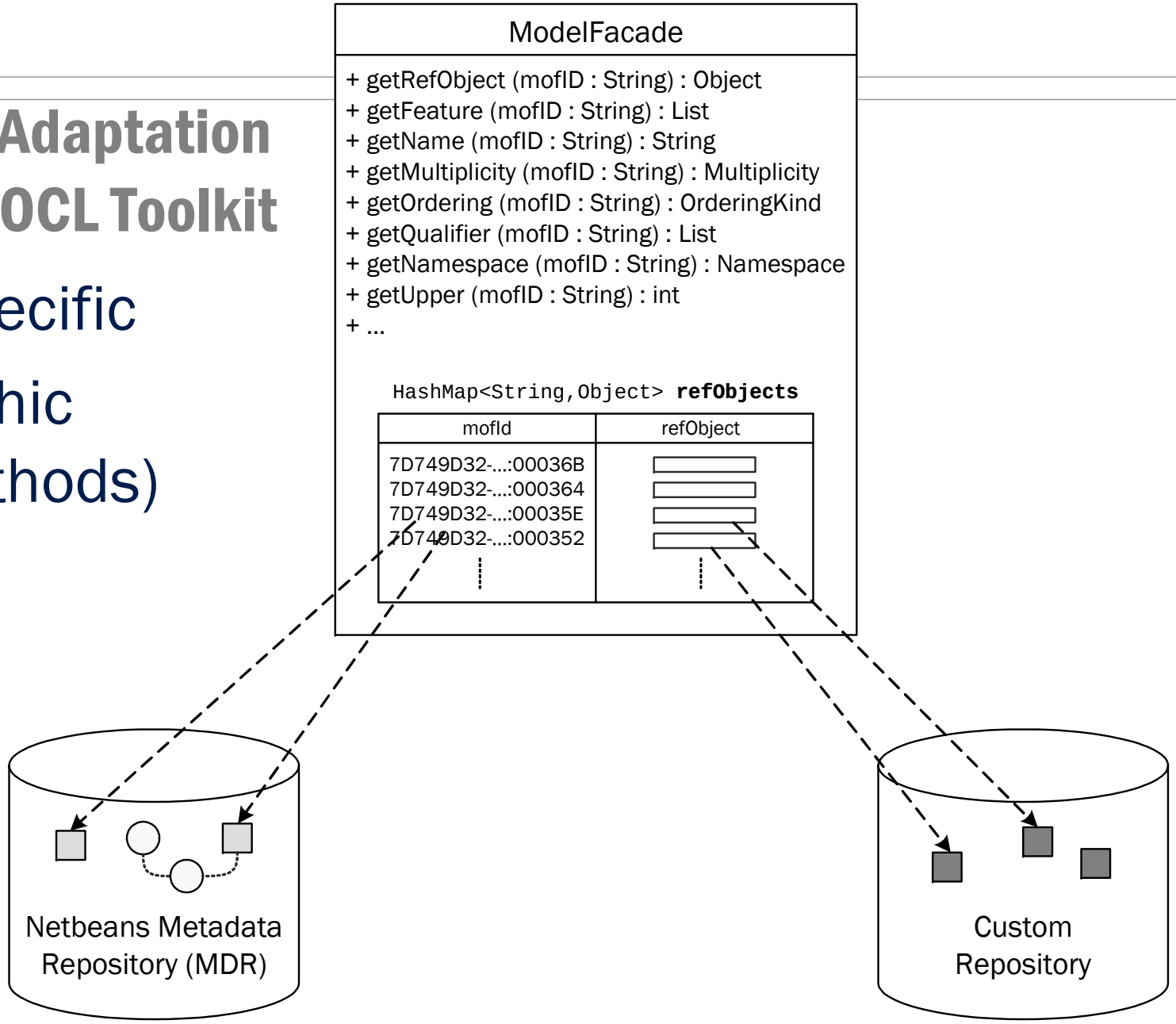
Model Space

System Space

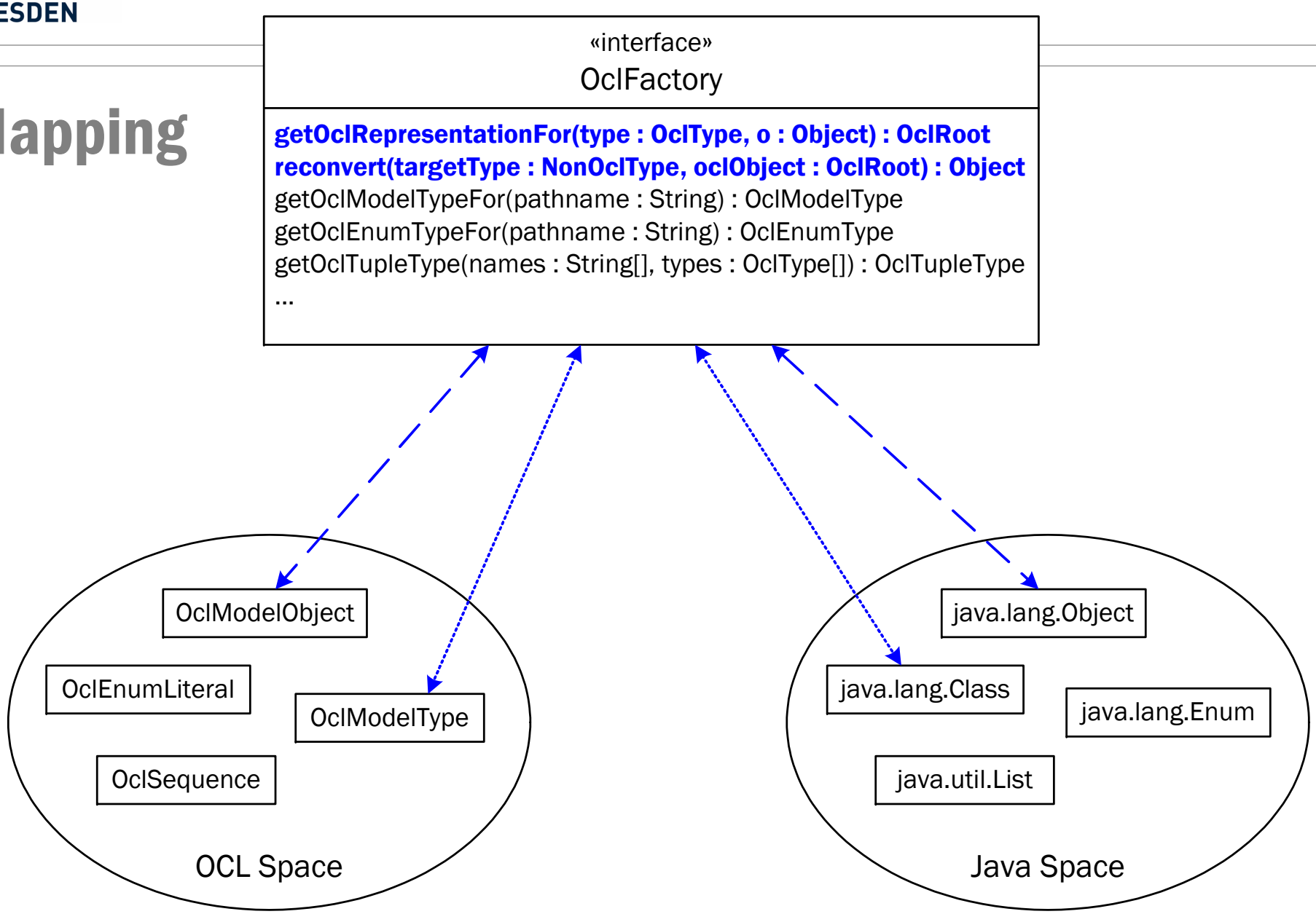


Repository Adaptation in Dresden OCL Toolkit

- UML-specific
- monolithic (33 methods)



Mapping


«interface»
OclFactory
getOclRepresentationFor(type : OclType, o : Object) : OclRoot
reconvert(targetType : NonOclType, oclObject : OclRoot) : Object
getOclModelTypeFor(pathname : String) : OclModelType
getOclEnumTypeFor(pathname : String) : OclEnumType
getOclTupleType(names : String[], types : OclType[]) : OclTupleType
...
OclModelObject
OclEnumLiteral
OclModelType
OclSequence
OCL Space
java.lang.Object
java.lang.Class
java.lang.Enum
java.util.List
Java Space