

CASE Tool Integration mit XMI

DAIMLERCHRYSLER



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Inhaltsübersicht

Motivation:

Herausforderungen in Methoden- und Werkzeugeinsatz

Zusammenspiel: Werkzeug – Modellierungssprache

Ziele von SMIF/XMI

Technische Umsetzung

Metamodellierung

eXtensible Markup Language

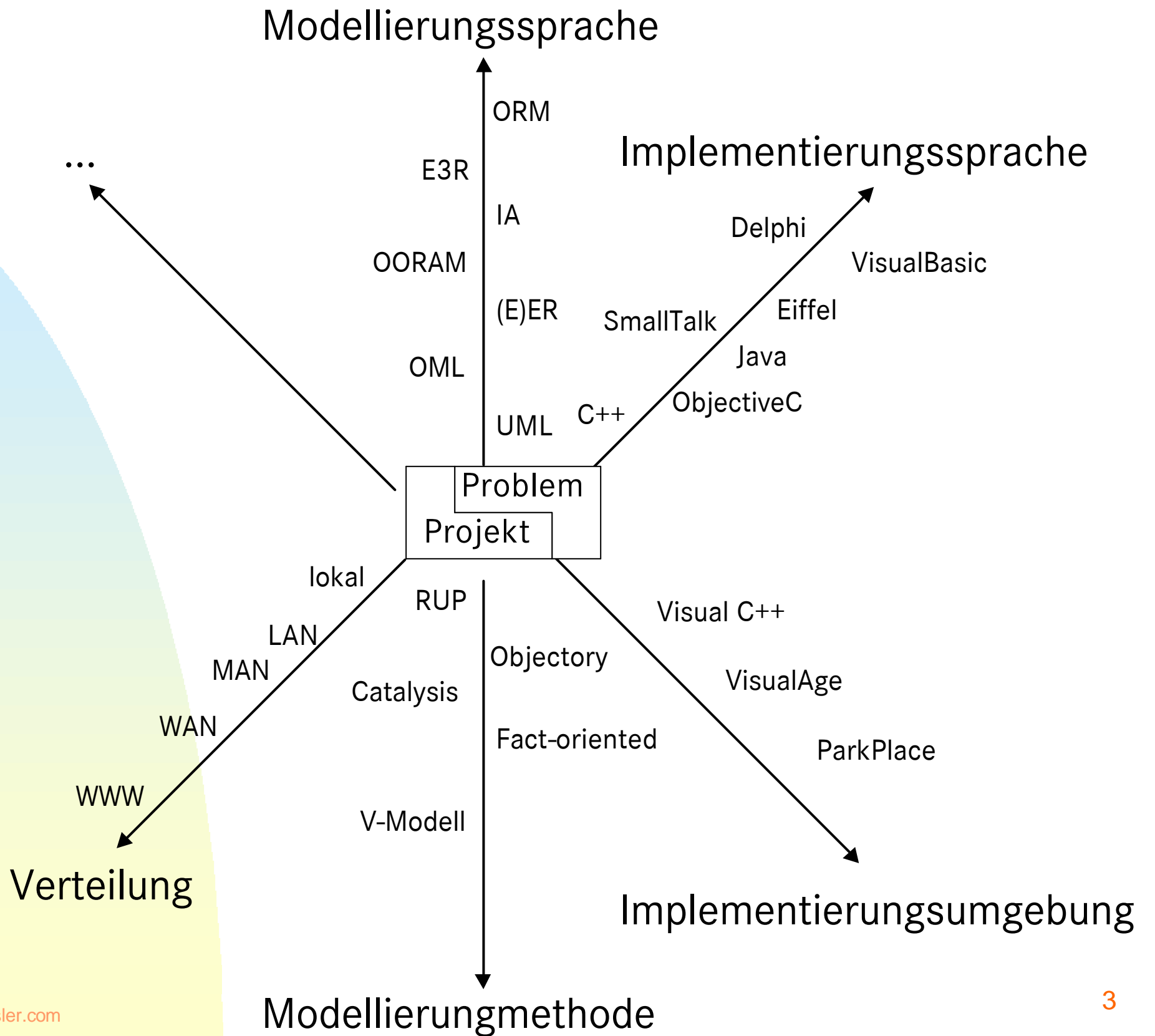
Beispiel

Existierende Anwendungen (proof of concept)

Einsatzspektrum von XMI

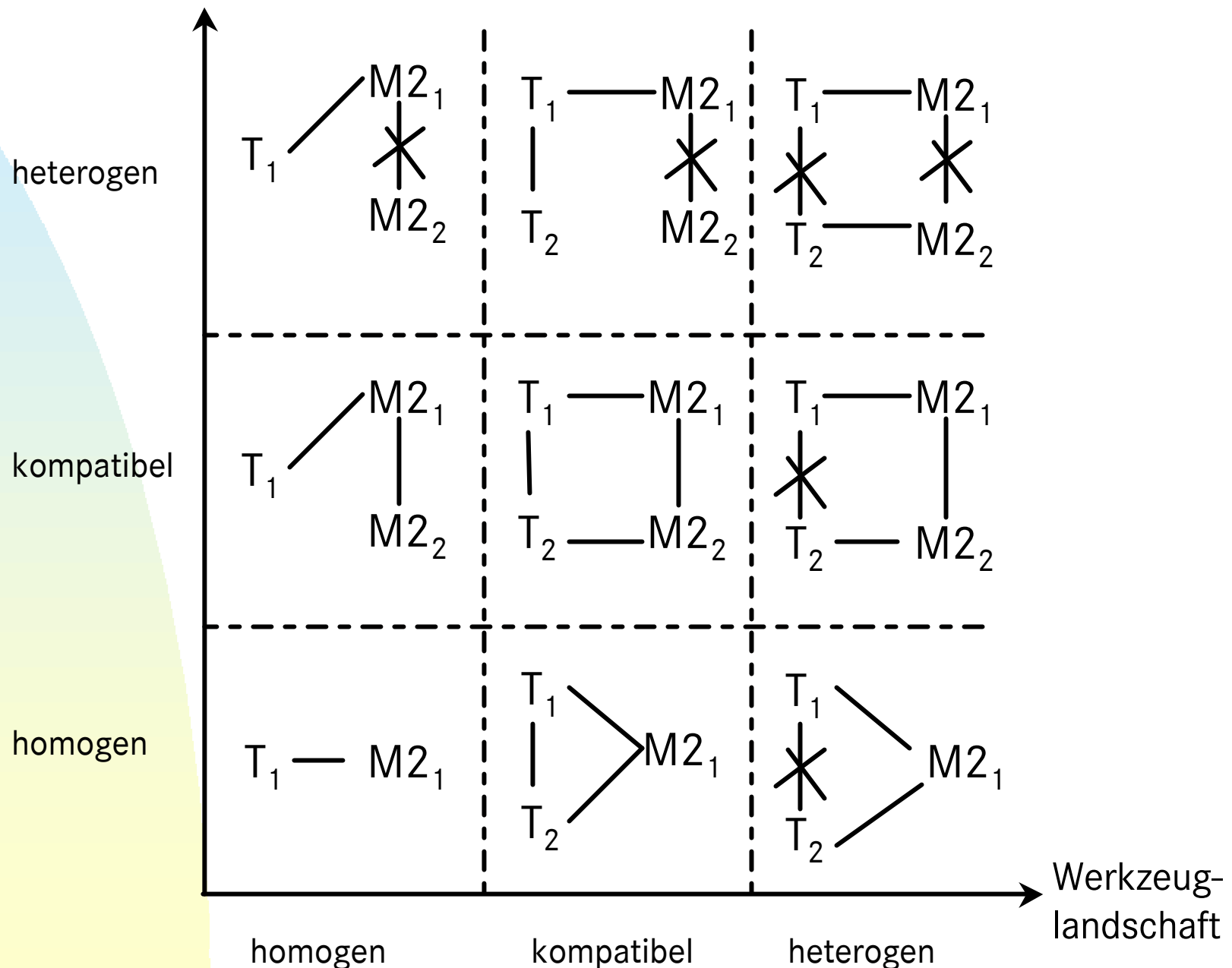
XMI in der Praxis

XMI heute (verfügbare Werkzeuge)



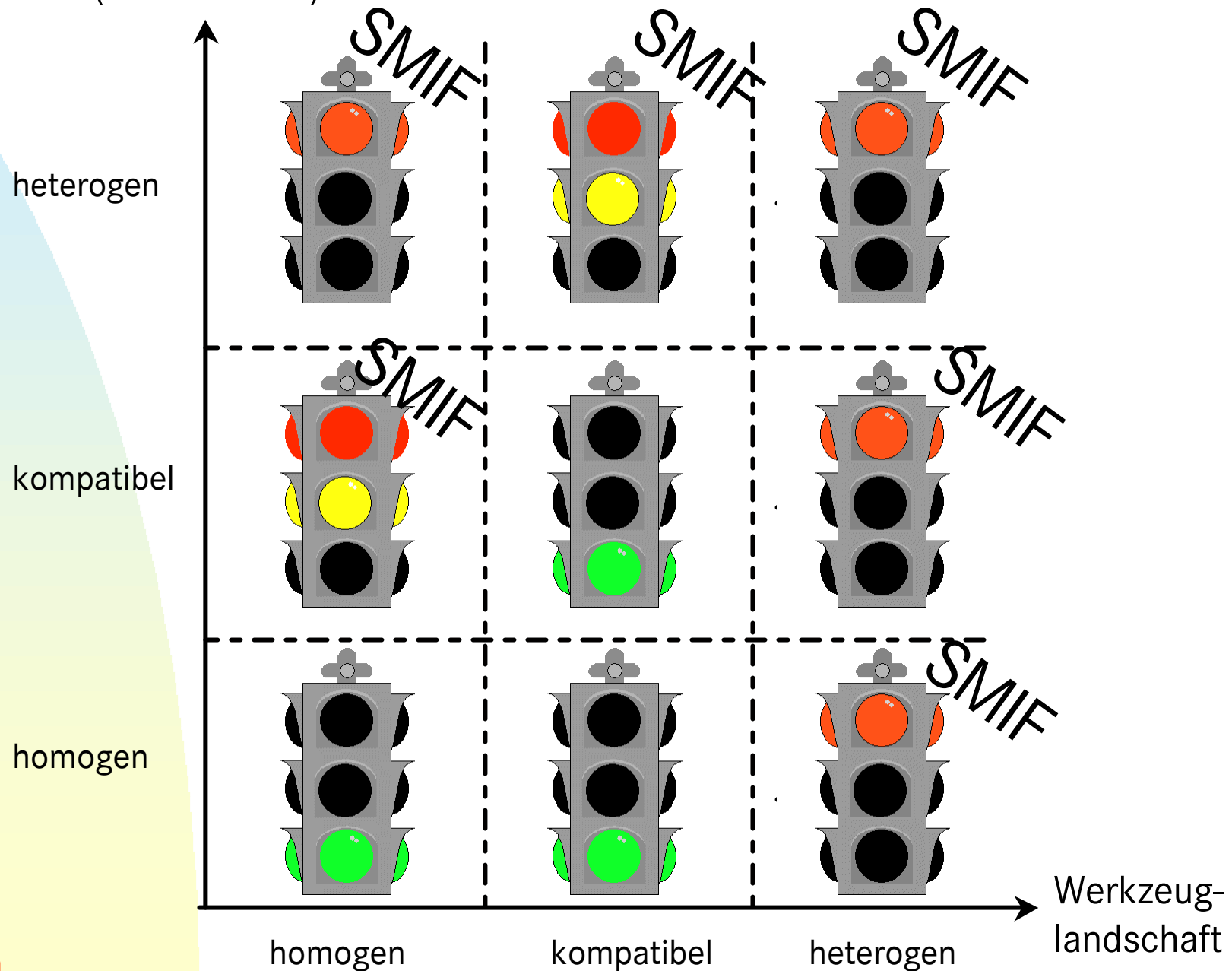
Zusammenspiel: Werkzeug – Sprache

Modellierungssprache
(Meta-Modell)



Zusammenspiel: Werkzeug – Sprache

Modellierungssprache
(Meta-Modell)



SMIF/XMI

Ziele

- Herstellerunabhängiges Transferformat
- Instriestandard-Formatfestlegung
- generisches Format
- Modellaustausch
 - MOF-basierter Modelle
 - UML
 - Work-Flow Management Facility
 - Business Objects Facility

Lösung für

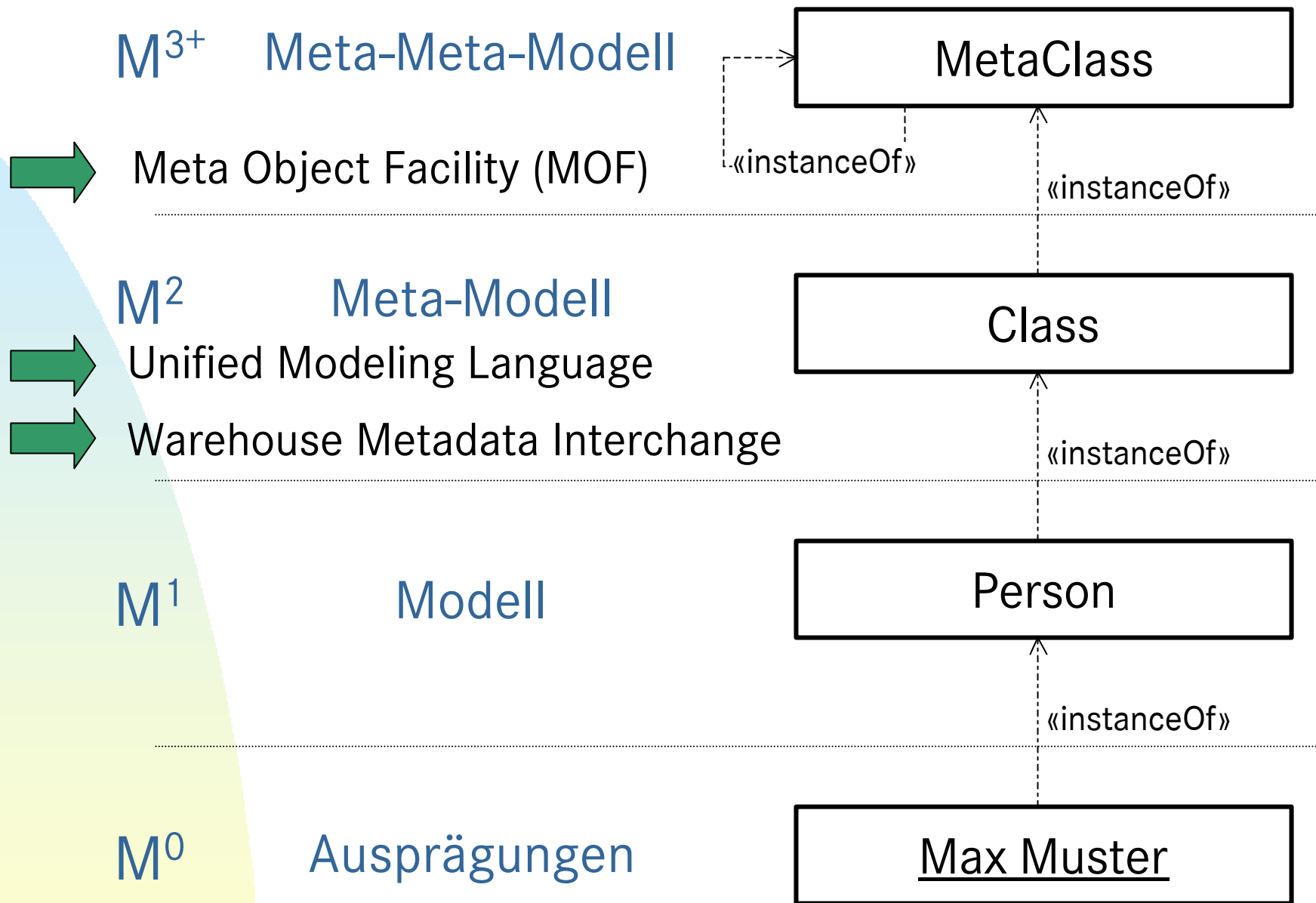
- Transferspezifikation
 - MOF basierter Modelle
 - CDIF codierter Modelle
 - STEP/EXPRESS Modelle
- Metamodell-Versionierung

Umsetzung:

- Web-Technologien (W3-Standards)
 - XML liefert Syntax und Encoding Standard
- MOF liefert Metadaten Definition

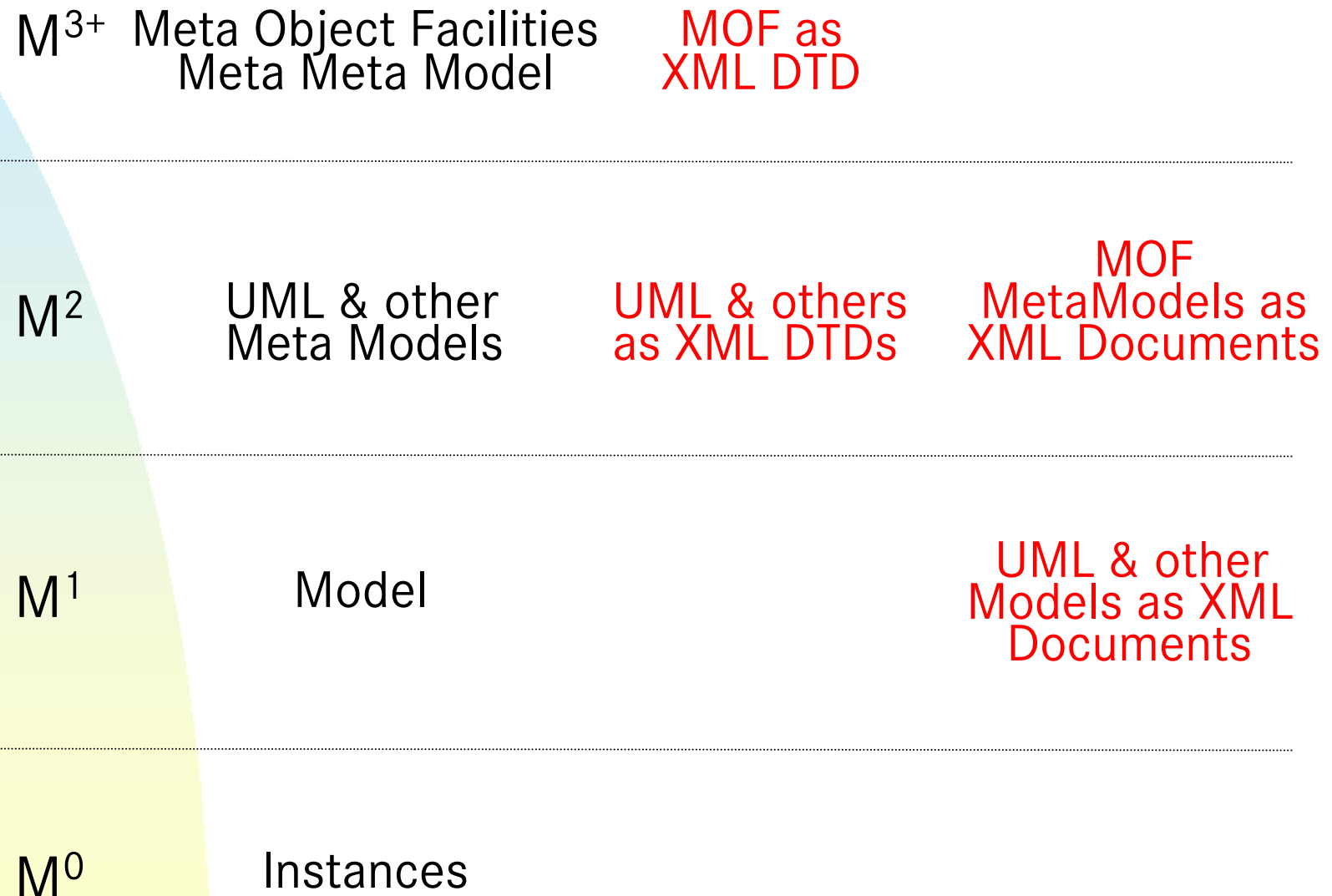
XMI ist eine Sprache der XML-Familie

Metamodellhierarchie der OMG

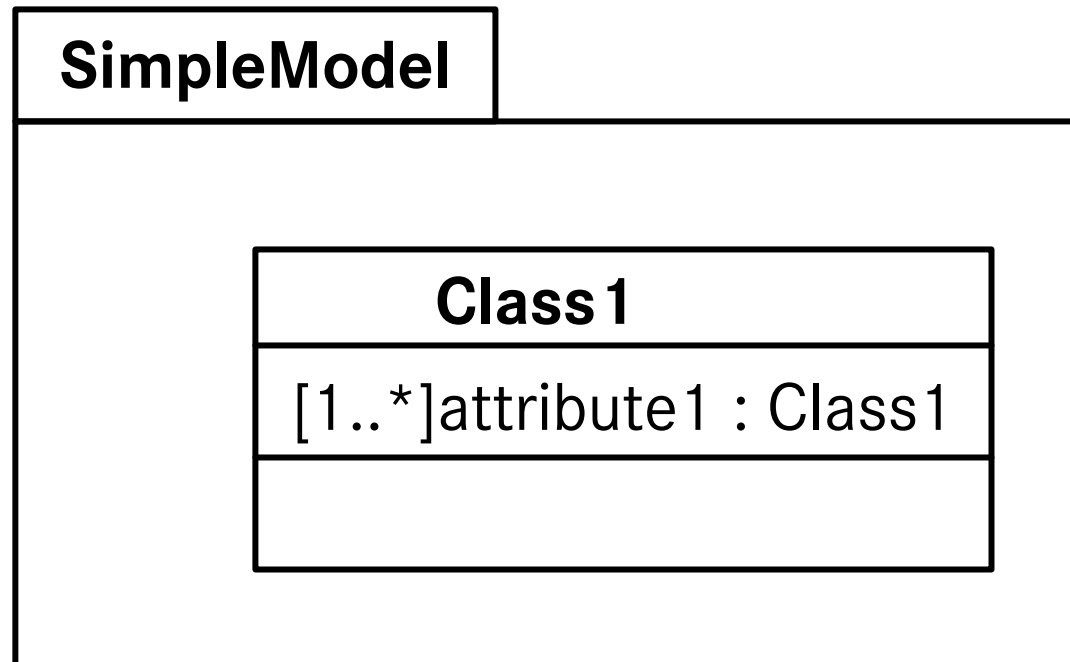


Umsetzung mit XML

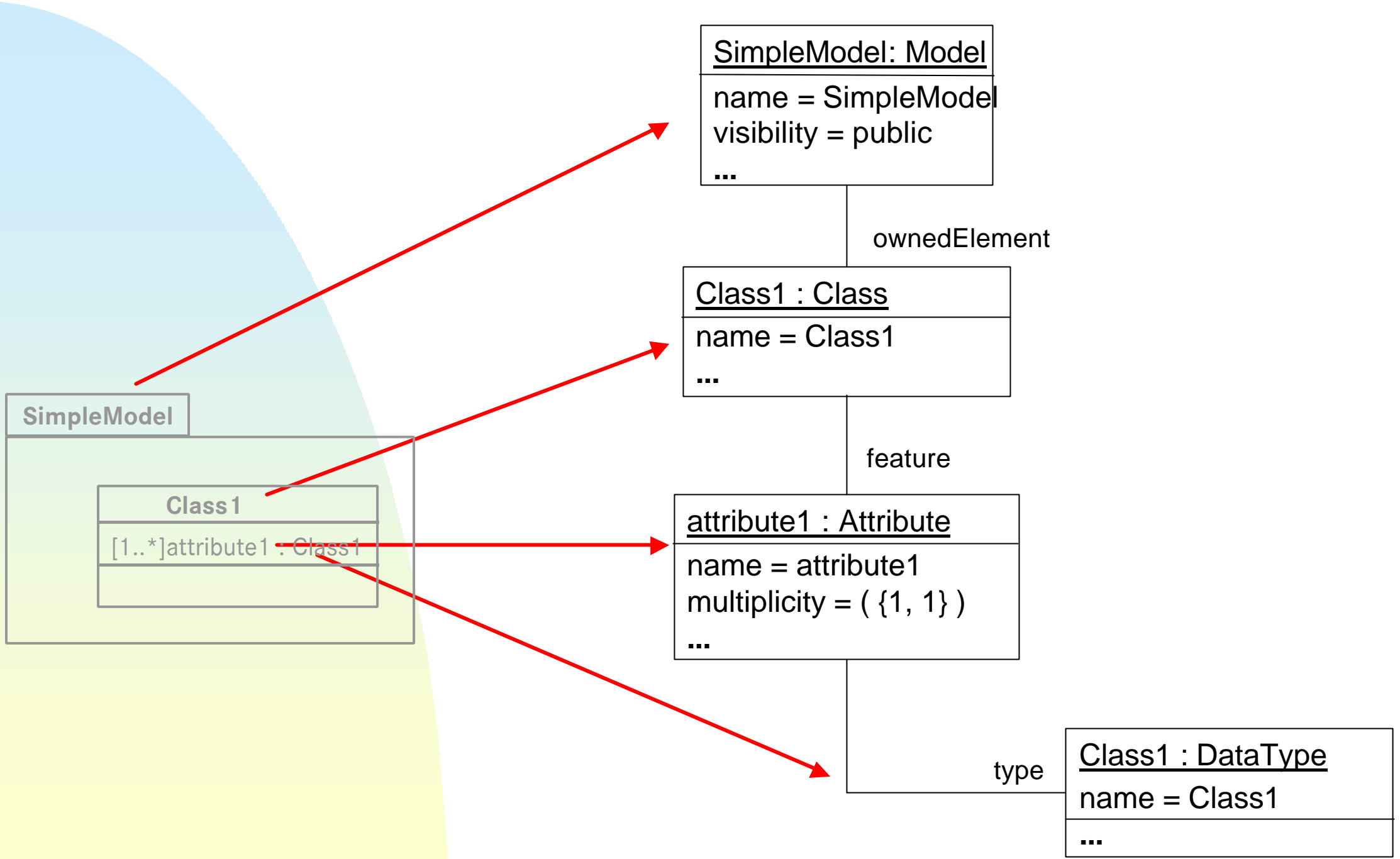
Die Struktur von XMI



Beispiel

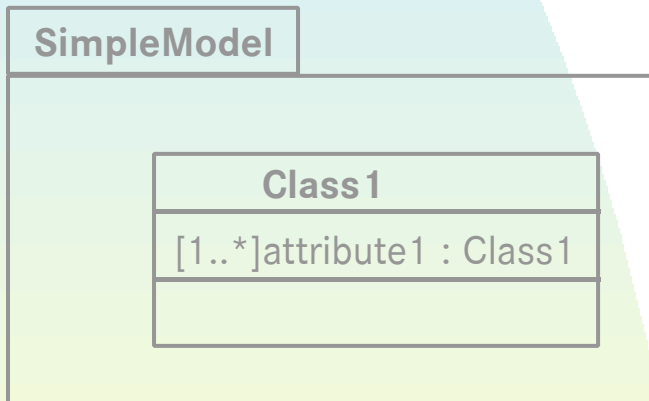


...Umsetzung in MOF



...Generierung der XMI-Darstellung

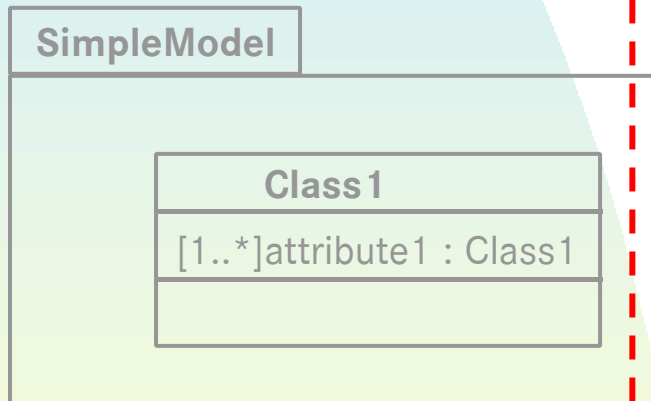
- XMI-Header



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
  </XMI.header>
  <XMI.content>
    <Model_Management.Model xmi.id="i00000001">
      <Foundation.Core.ModelElement.name>
        SimpleModel
      </Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value="public"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
      <Foundation.Core.Namespace.ownedElement>
        <Foundation.Core.Class xmi.id="i00000002">
          <Foundation.Core.ModelElement.name>
            class1
          </Foundation.Core.ModelElement.name>
          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
          <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```

...Generierung der XMI-Darstellung

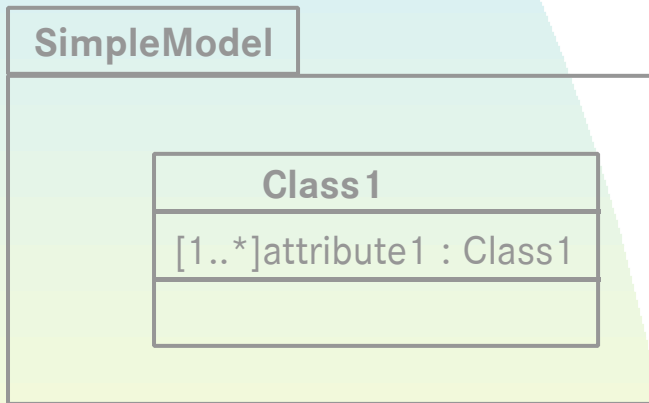
- XMI-Body



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
  </XMI.header>
  <XMI.content>
    <Model_Management.Model xmi.id="i00000001">
      <Foundation.Core.ModelElement.name>
        SimpleModel
      </Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value="public"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
      <Foundation.Core.Namespace.ownedElement>
        <Foundation.Core.Class xmi.id="i00000002">
          <Foundation.Core.ModelElement.name>
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          </Foundation.Core.ModelElement.name>
          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
          <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```

...Generierung der XMI-Darstellung

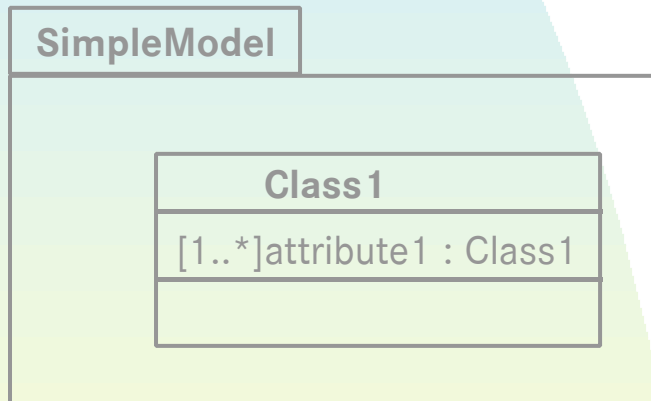
- DTD-Verweis



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
  </XMI.header>
  <XMI.content>
    <Model_Management.Model xmi.id="i00000001">
      <Foundation.Core.ModelElement.name>
        SimpleModel
      </Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value="public"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
      <Foundation.Core.Namespace.ownedElement>
        <Foundation.Core.Class xmi.id="i00000002">
          <Foundation.Core.ModelElement.name>
            class1
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          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
          <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```

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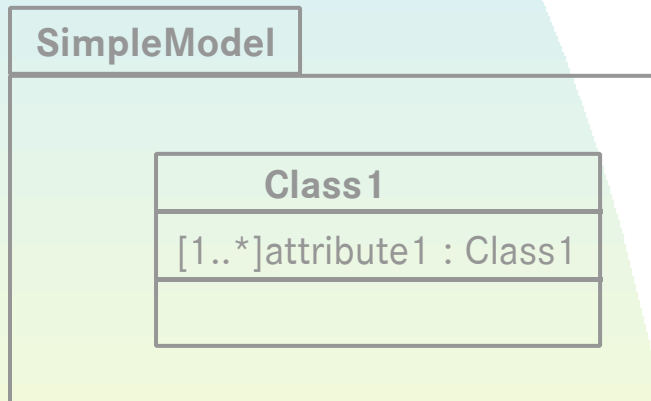
- Metamodell-Identifikation



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
  </XMI.header>
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      <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
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          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
          <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```

...Generierung der XMI-Darstellung

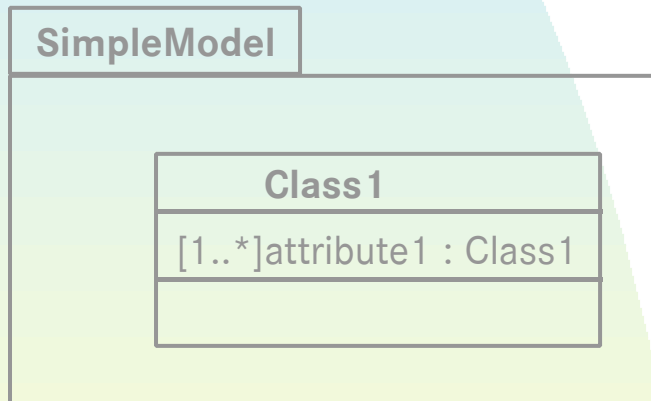
- Implizite Modellinformation



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
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  <XMI.content>
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      </Foundation.Core.ModelElement.name>
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      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
      <Foundation.Core.Namespace.ownedElement>
        <Foundation.Core.Class xmi.id="i00000002">
          <Foundation.Core.ModelElement.name>
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          </Foundation.Core.ModelElement.name>
          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
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          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```

...Generierung der XMI-Darstellung

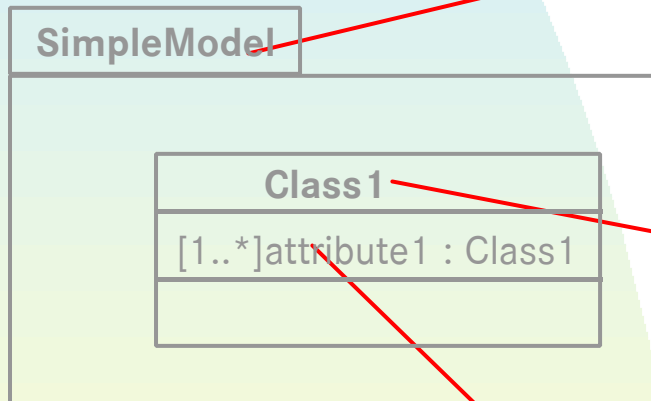
- Nicht in UML dargestellte Vorgabewerte



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
  </XMI.header>
  <XMI.content>
    <Model_Management.Model xmi.id="i00000001">
      <Foundation.Core.ModelElement.name>
        SimpleModel
      </Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value="public"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
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      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
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        <Foundation.Core.Class xmi.id="i00000002">
          <Foundation.Core.ModelElement.name>
            class1
          </Foundation.Core.ModelElement.name>
          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
          <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```


...Generierung der XMI-Darstellung

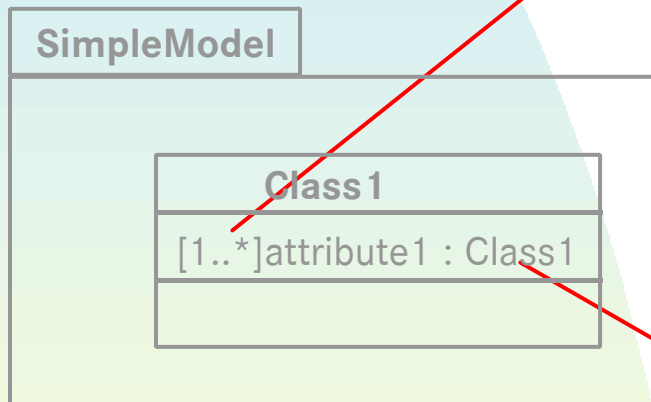
- Umsetzung der UML-Konstrukte



```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
  </XMI.header>
  <XMI.content>
    <Model_Management.Model xmi.id="i00000001">
      <Foundation.Core.ModelElement.name>
        SimpleModel
      </Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value="public"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
      <Foundation.Core.Namespace.ownedElement>
        <Foundation.Core.Class xmi.id="i00000002">
          <Foundation.Core.ModelElement.name>
            class1
          </Foundation.Core.ModelElement.name>
          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
          <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
          <Foundation.Core.Class.isActive xmi.value="true"/>
          <Foundation.Core.Classifier.feature>
            <Foundation.Core.Attribute xmi.id="i00000003">
              <Foundation.Core.ModelElement.name>
                attribute1
              </Foundation.Core.ModelElement.name>
```

...Fortsetzung

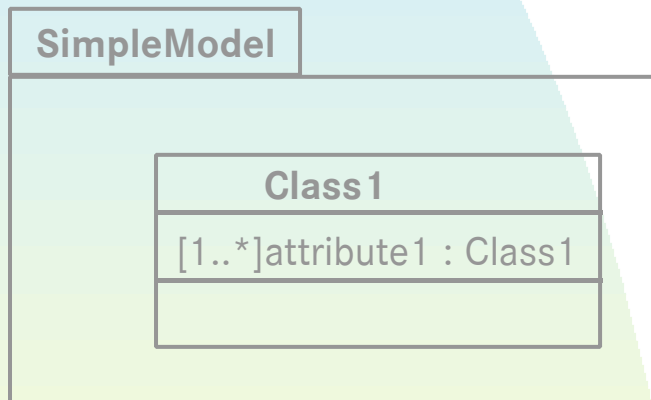
- Umsetzung der UML-Konstrukte



```
<Foundation.Core.ModelElement.visibility xmi.value="public"/>
</Foundation.Core.Feature.ownerScope xmi.value="instance"/>
<Foundation.Core.StructuralFeature.multiplicity>
  1..*
</Foundation.Core.StructuralFeature.multiplicity>
<Foundation.Core.StructuralFeature.changeable xmi.value="none"/>
<Foundation.Core.StructuralFeature.targetScope xmi.value="instance"/>
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    </Foundation.Data_Types.Expression.body>
  </Foundation.Data_Types.Expression>
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</Foundation.Core.StructuralFeature.type>
</Foundation.Core.Attribute>
</Foundation.Core.Classifier.feature>
</Foundation.Core.Class>
<Foundation.Core.DataType xmi.id="i00000004">
  <Foundation.Core.ModelElement.name>
    Class1
  </Foundation.Core.ModelElement.name>
  <Foundation.Core.ModelElement.visibility xmi.value="public"/>
  <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
  <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
  <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
</Foundation.Core.DataType>
</Foundation.Core.Namespace.ownedElement>
</Model_Management.Model>
</XMI.content>
</XMI>
```

...Fortsetzung

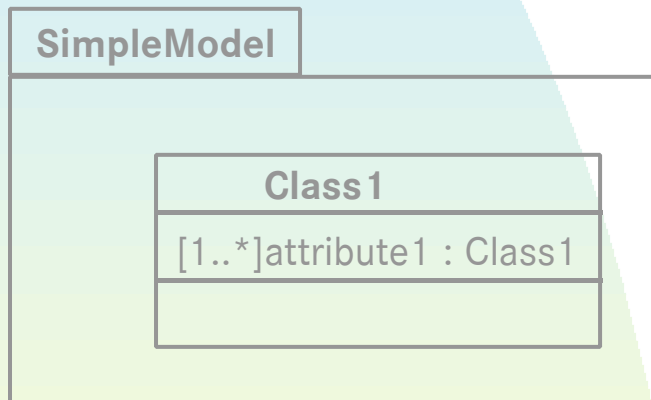
- Nicht in UML dargestellte Vorgabewerte



```
<Foundation.Core.ModelElement.visibility xmi.value="public"/>
  <Foundation.Core.Feature.ownerScope xmi.value="instance"/>
  <Foundation.Core.StructuralFeature.multiplicity>
    1..*
  </Foundation.Core.StructuralFeature.multiplicity>
  <Foundation.Core.StructuralFeature.changeable xmi.value="none"/>
  <Foundation.Core.StructuralFeature.targetScope xmi.value="instance"/>
  <Foundation.Core.Attribute.initialValue>
    <Foundation.Data_Types.Expression>
      <Foundation.Data_Types.Expression.language>
      </Foundation.Data_Types.Expression.language>
      <Foundation.Data_Types.Expression.body>
        0
      </Foundation.Data_Types.Expression.body>
    </Foundation.Data_Types.Expression>
  </Foundation.Core.Attribute.initialValue>
  <Foundation.Core.StructuralFeature.type>
    <Foundation.Core.DataType xmi.idref = "i00000004"/>
  </Foundation.Core.StructuralFeature.type>
</Foundation.Core.Attribute>
</Foundation.Core.Classifier.feature>
</Foundation.Core.Class>
<Foundation.Core.DataType xmi.id="i00000004">
  <Foundation.Core.ModelElement.name>
    Class1
  </Foundation.Core.ModelElement.name>
  <Foundation.Core.ModelElement.visibility xmi.value="public"/>
  <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
  <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
  <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
</Foundation.Core.DataType>
</Foundation.Core.Namespace.ownedElement>
</Model_Management.Model>
</XMI.content>
</XMI>
```

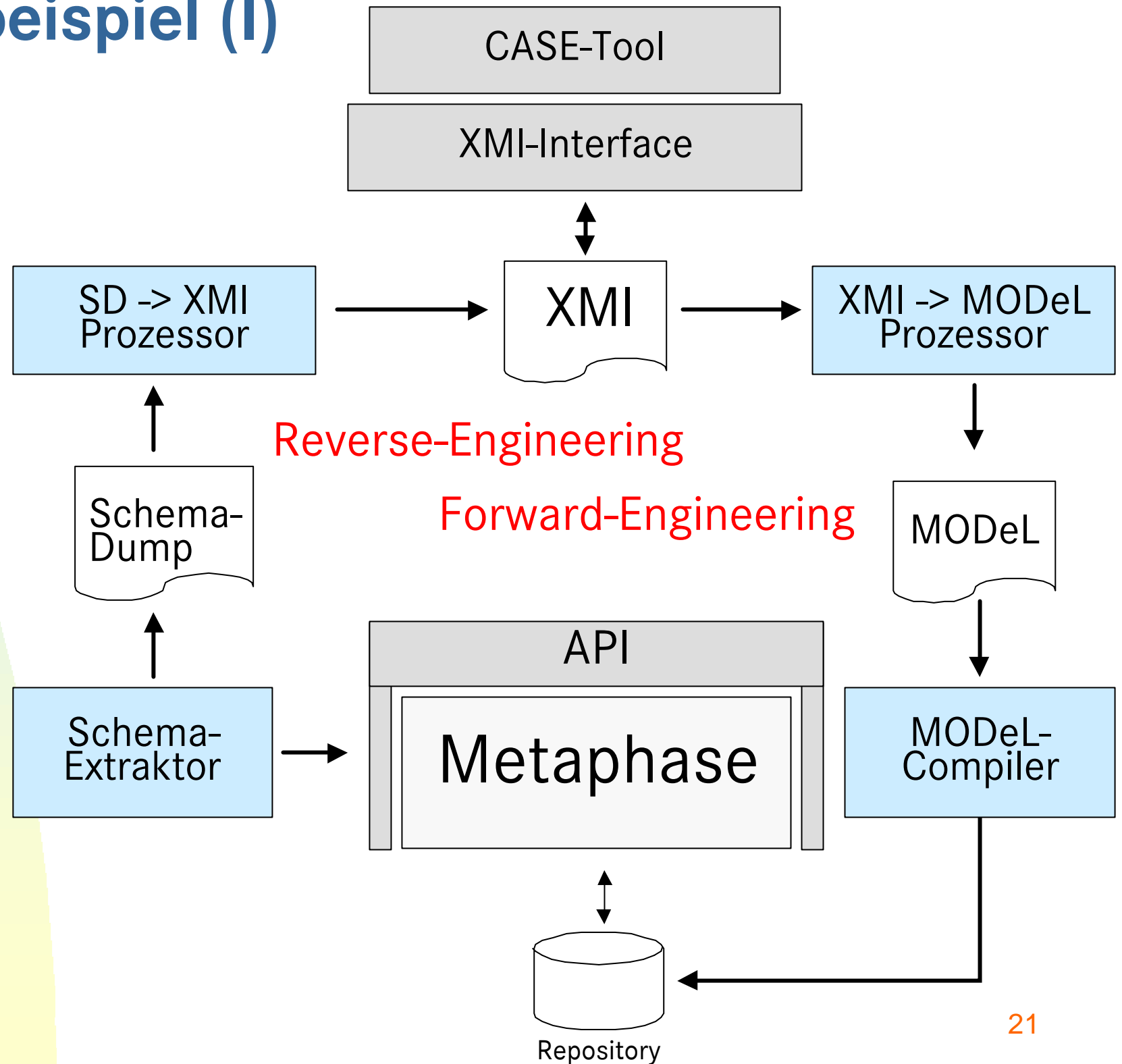
...Fortsetzung

- Automatische Generierung notwendiger Zusatzinformation

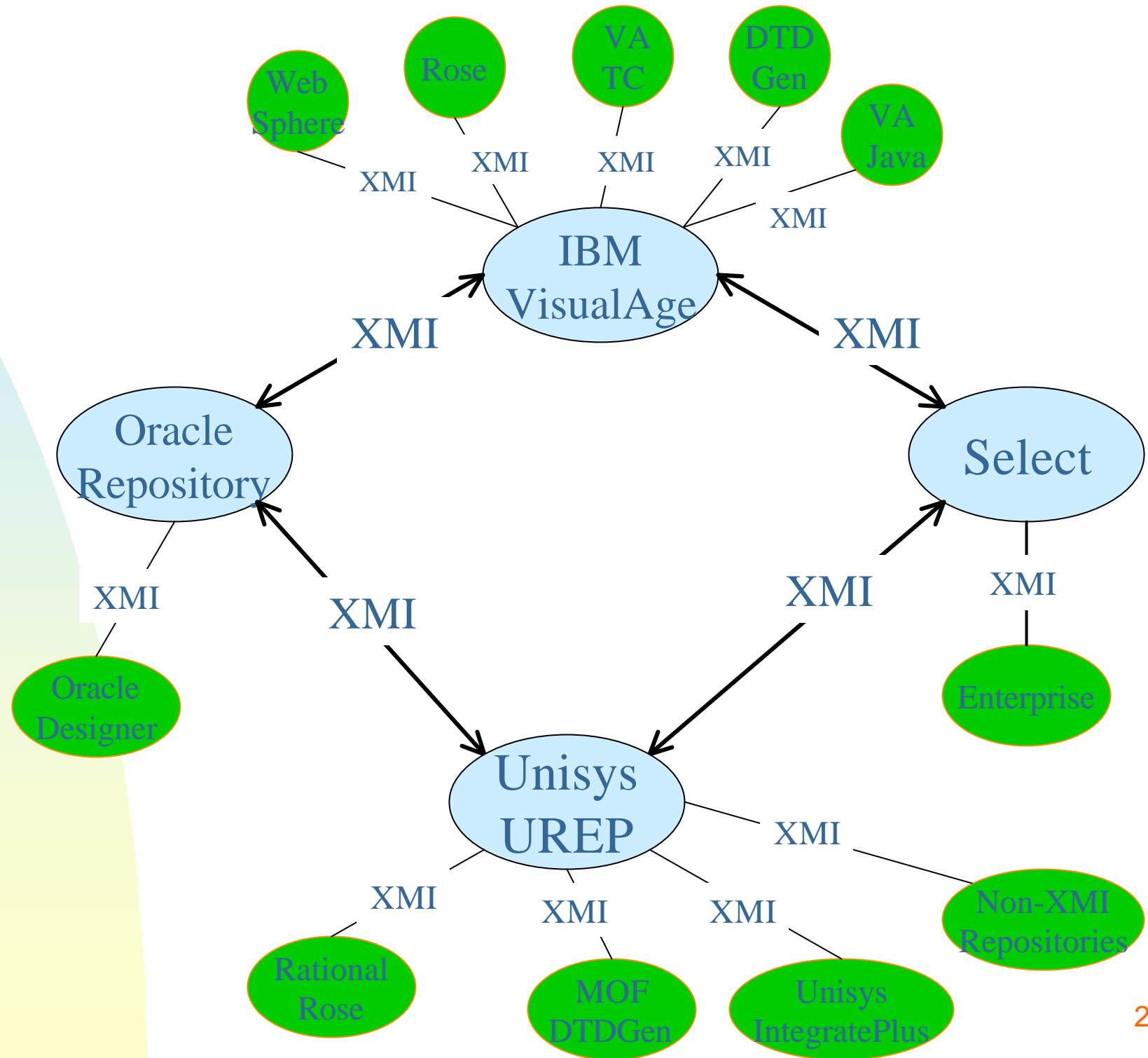


```
<Foundation.Core.ModelElement.visibility xmi.value="public"/>
  <Foundation.Core.Feature.ownerScope xmi.value="instance"/>
  <Foundation.Core.StructuralFeature.multiplicity>
    1..*
  </Foundation.Core.StructuralFeature.multiplicity>
  <Foundation.Core.StructuralFeature.changeable xmi.value="none"/>
  <Foundation.Core.StructuralFeature.targetScope xmi.value="instance"/>
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      </Foundation.Data_Types.Expression.language>
      <Foundation.Data_Types.Expression.body>
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      </Foundation.Data_Types.Expression.body>
    </Foundation.Data_Types.Expression>
  </Foundation.Core.Attribute.initialValue>
  <Foundation.Core.StructuralFeature.type>
    <Foundation.Core.DataType xmi.idref = "i00000004"/>
  </Foundation.Core.StructuralFeature.type>
</Foundation.Core.Attribute>
</Foundation.Core.Classifier.feature>
</Foundation.Core.Class>
<Foundation.Core.DataType xmi.id="i00000004">
  <Foundation.Core.ModelElement.name>
    Class1
  </Foundation.Core.ModelElement.name>
  <Foundation.Core.ModelElement.visibility xmi.value="public"/>
  <Foundation.Core.GeneralizableElement.isRoot xmi.value="true"/>
  <Foundation.Core.GeneralizableElement.isLeaf xmi.value="true"/>
  <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
</Foundation.Core.DataType>
</Foundation.Core.Namespace.ownedElement>
</Model_Management.Model>
</XMI.content>
</XMI>
```

Anwendungsbeispiel (I)



Anwendungsbeispiel (II)



XMI – mehr als „nur“ Modellaustausch

- Einsatz als Modellaustauschformat
- Transferformat für Data-Warehouse Applikationen
- Eindeutige textuelle Beschreibung von (Meta-)Modellen
- Toolunabhängige Code-Generierung
- Metriken
- Pattern Libraries
- Modellvalidierung
- Modellierungssprachen-unabhängige Modellbeschreibung
- ...

Warum XMI?!

+ Breite Industrieunterstützung

Unisys
IBM
DSTC
Oracle
Platinum Technology
Fujitsu
Softeam
Recerca Informatica
DaimlerChrysler

Cayenne Software
Genesis Development
Inline Software
Rational Software
Select Software
Sprint Communications
Sybase
Xerox
MCI Systemhouse
Boeing
Ardent
Aviatis
ICONIX
Integrated Systems
Verilog
Telefonica I+D
Universitat Politecnica de Catalunya
NCR
Nihon
NTT

Warum XMI?!

- + Breite Industrieunterstützung
- + Web-Technologie (W3-Standardfamilie)
- + Weiterführende Ansätze:
 - Delta-Interchange
 - Metamodellversionierung

Warum XMI?!

- + Breite Industrieunterstützung
- + Web-Technologie (W3-Standardfamilie)
- + Weiterführende Ansätze:
 - Delta-Interchange
 - Metamodellversionierung
- + **Gute Skalierbarkeit**

Warum XMI?!

- + Breite Industrieunterstützung
- + Web-Technologie (W3-Standardfamilie)
- + Weiterführende Ansätze:
 - Delta-Interchange
 - Metamodellversionierung
- + Gute Skalierbarkeit
- mangelnde Lesbarkeit (HUTN-RFP ad/99-03-12)
- Größe des XMI-Streams

XMI heute...

CASE-Tools mit XMI-Unterstützung

(Stand: 12. Sept. 1999)

- ArgoUML
- Rational Rose (IBM's XMI-Toolkit)
- Together/J
- Software through Pictures (StP) v7.x

sonstige Werkzeuge:

- IBM's XMI-Toolkit
- alle XML-Werkzeuge(!)

Weitere Informationen

Meta Object Facility (MOF): OMG Document ad/99-07-03

Bruce McLean: *Evaluation Report OMG OA&DTF RFP3*
Stream-based Model Interchange Format (SMIF), OMG A&D-TF

Revised Joint-Submission:

XMI Partners: *XML Metadata Interchange*,
OMG-Dokument ad/98-10-05

WWW:

- <http://www.software.ibm.com/ad/features/xmi.html>
- <http://www.alphaworks.ibm.com/tech/xmitoolkit>
- <http://www.omg.org>
- <http://www.krumbach.de/home/jeckle>