DAIMLERCHRYSLER

# Modellaustausch mit dem OMG *XML Metadata Interchange Format* (XMI)

## Workshop I: Meta Knowledge & Linguistic Engineering

Mario Jeckle
DaimlerChrysler Research and Technology
FT3/EK
mario.jeckle@daimlerchrysler.com

DaimlerChrysler

**TOC**

Motivation: *Heterogenität als Herausforderung*

Lösungsansatz:

- Philosophie: *Metamodellierung*
- Technik: *OMG's four layer Metamodel Architecture*
- Realisierung: *XML Metadata Interchange*

Existierende Implementierungen

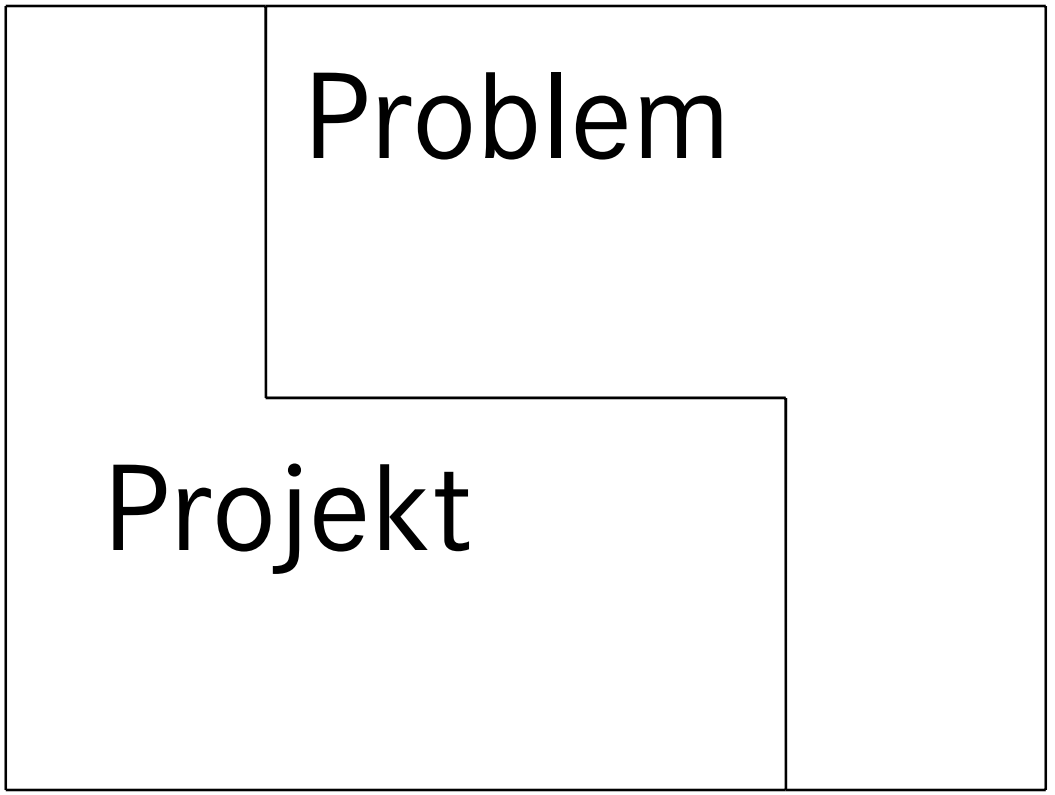
XMI mehr als „nur" Modellaustausch...

Chancen und Risiken?!

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

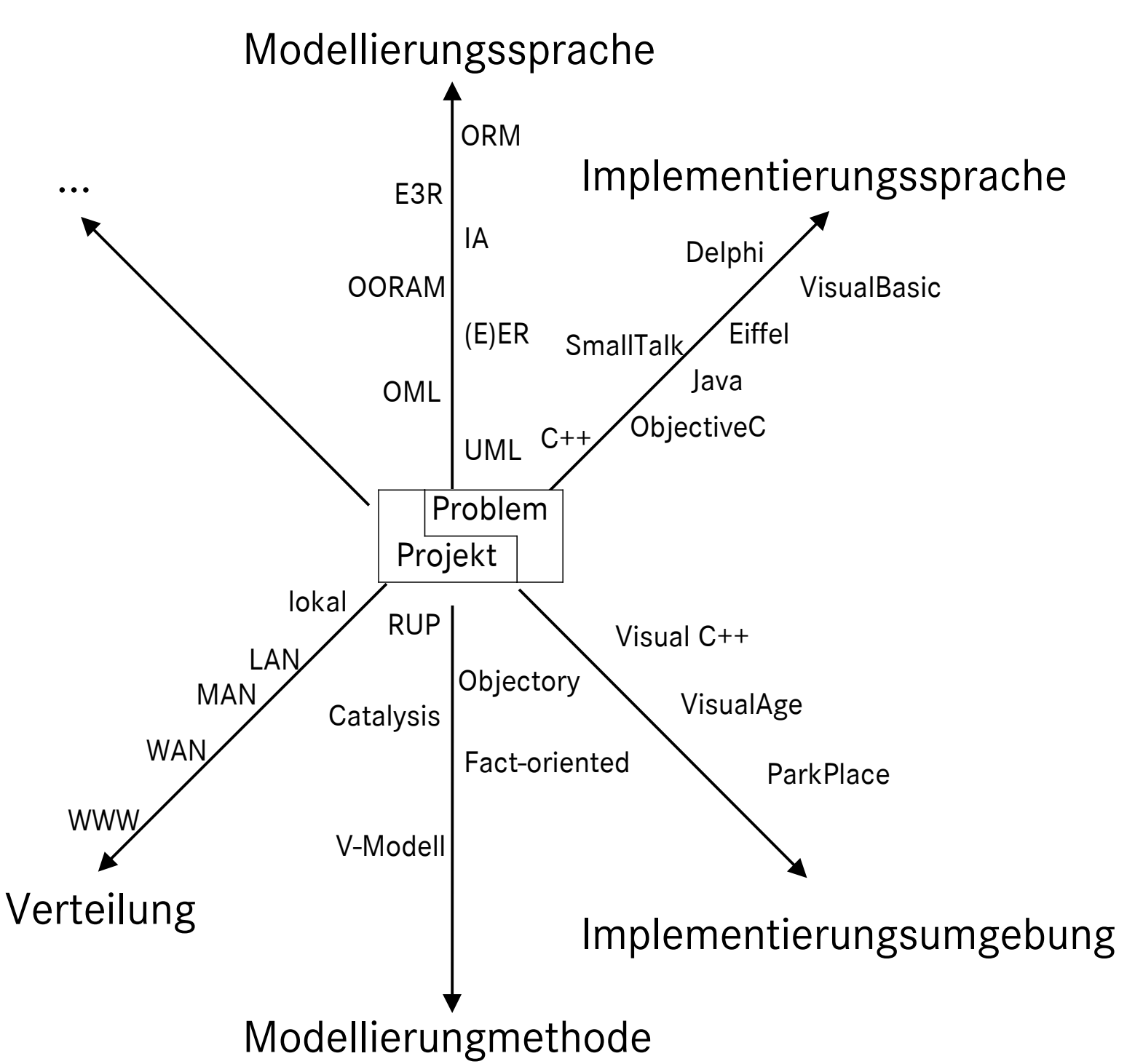
# Challenged by Heterogeneity




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

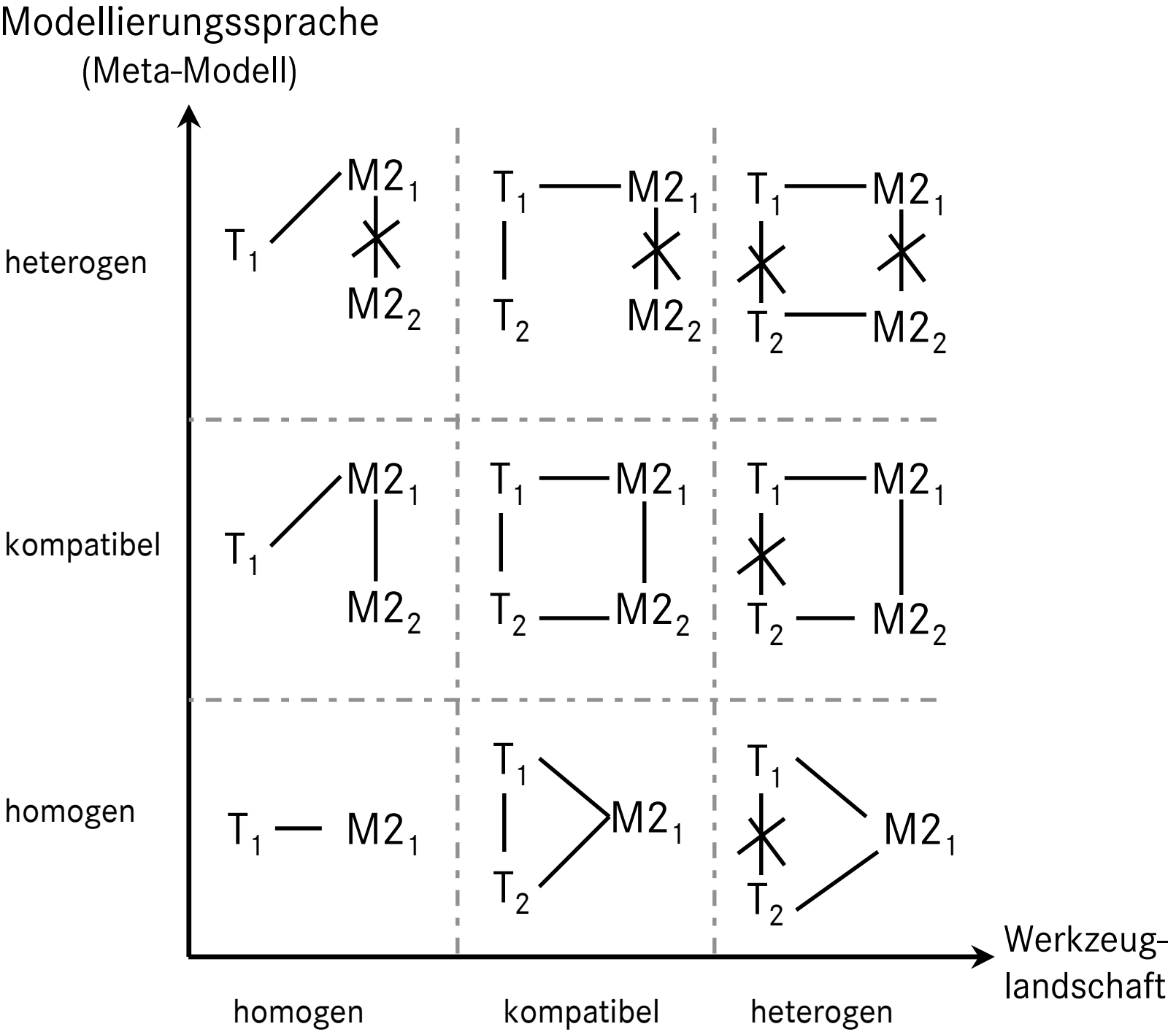
# Challenged by Heterogeneity




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

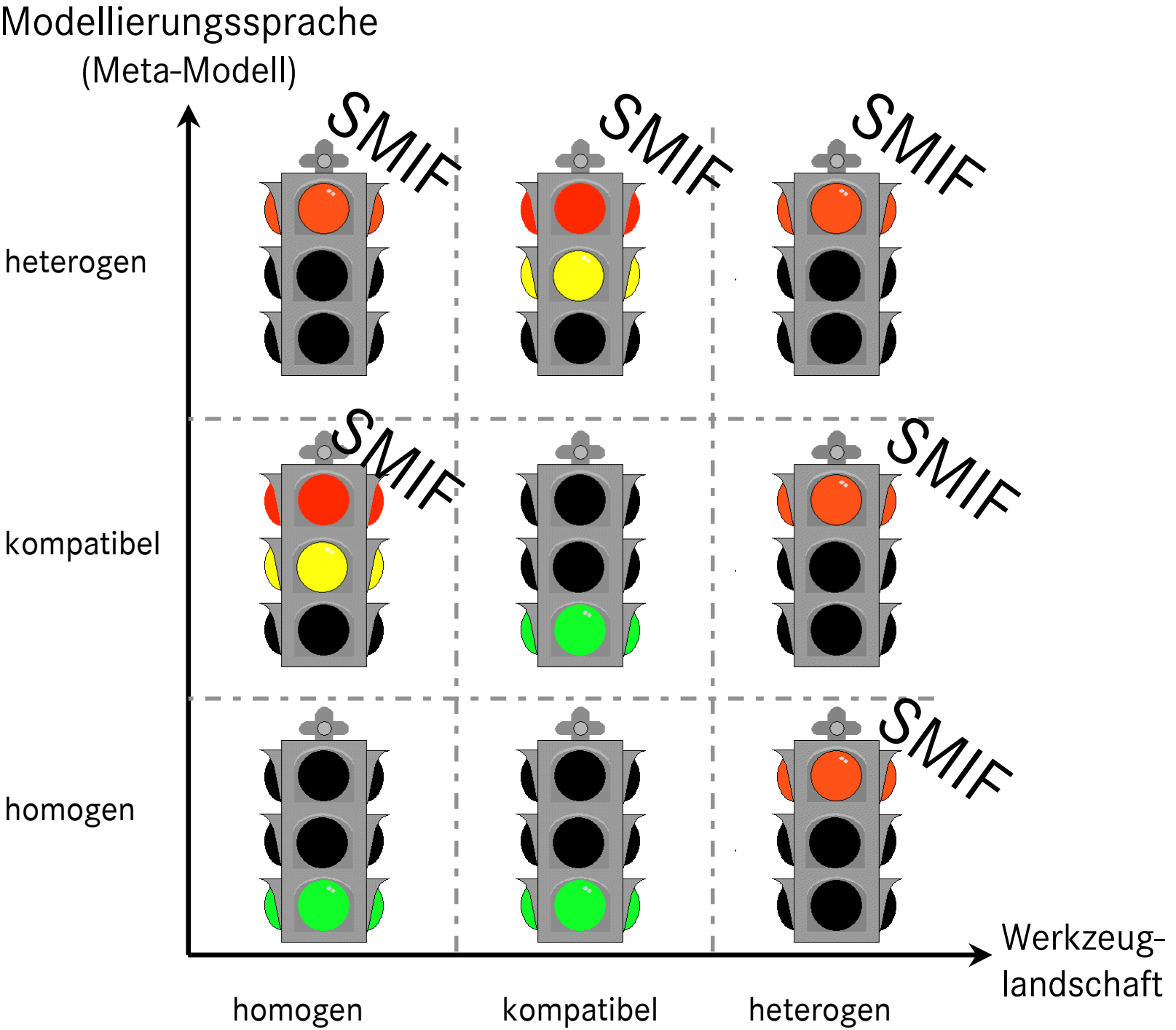
# Conjunction of different modeling languages (meta models) and modeling tools




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

# Assessing the interaction scenarios




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

**SMIF RFP**

**Addressed subject Areas**

**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

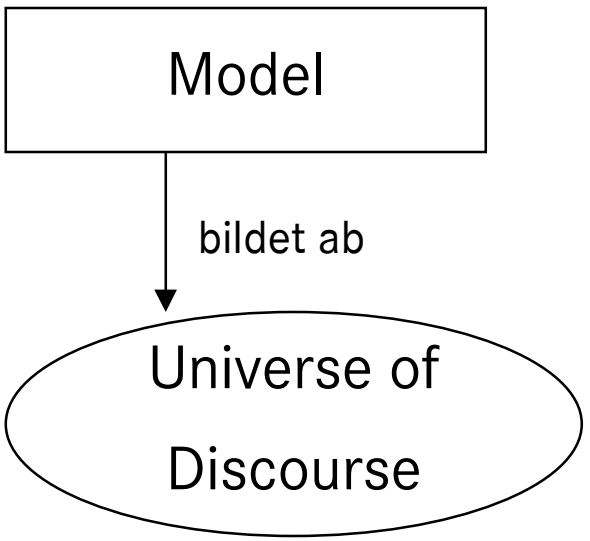
Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

**Multi dimensional Metamodeling Architecture**

Definition **Modell**:
(naturwissenschaftlich) Abbild der Natur unter Hervorhebung für wesentlich erachteterer Eigenschaften und unter Außer-acht-Lassen als nebensächlich angesehener Aspekte.

Das Modell in diesem Sinn ist ein Mittel zur Beschreibung der erfahrenen Realität,...

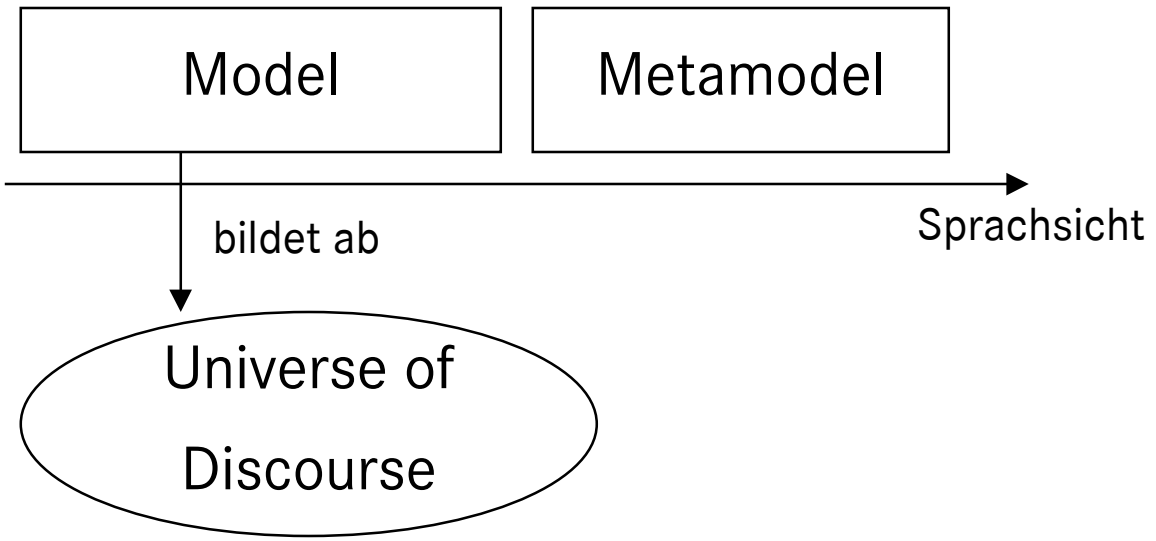



Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

# Multi dimensional Metamodeling Architecture

## Definition **Metamodell**: Modell eines Modells

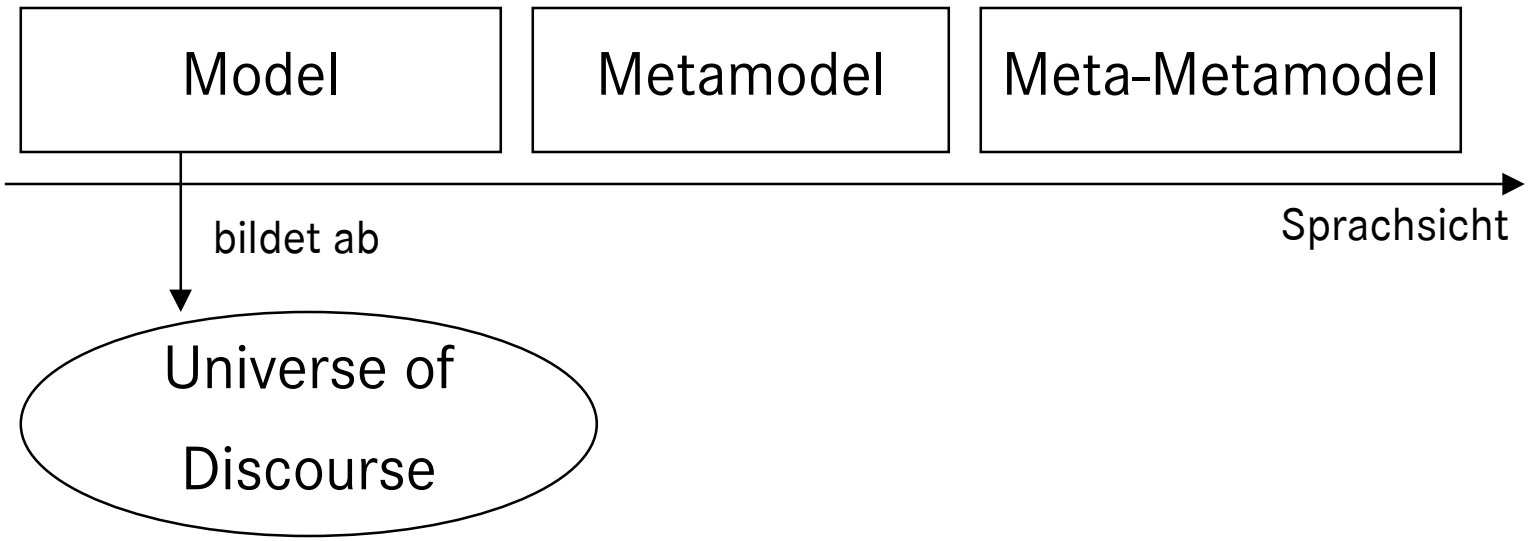



Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# Multi dimensional Metamodeling Architecture

- Ein **Modell** ($M^1$) modelliert die Realität ($M^0$)
- Ein **Metamodell** ($M^2$) modelliert ein Modell
- Ein **Meta-Metamodell** ($M^3$) modelliert ein Meta-Modell

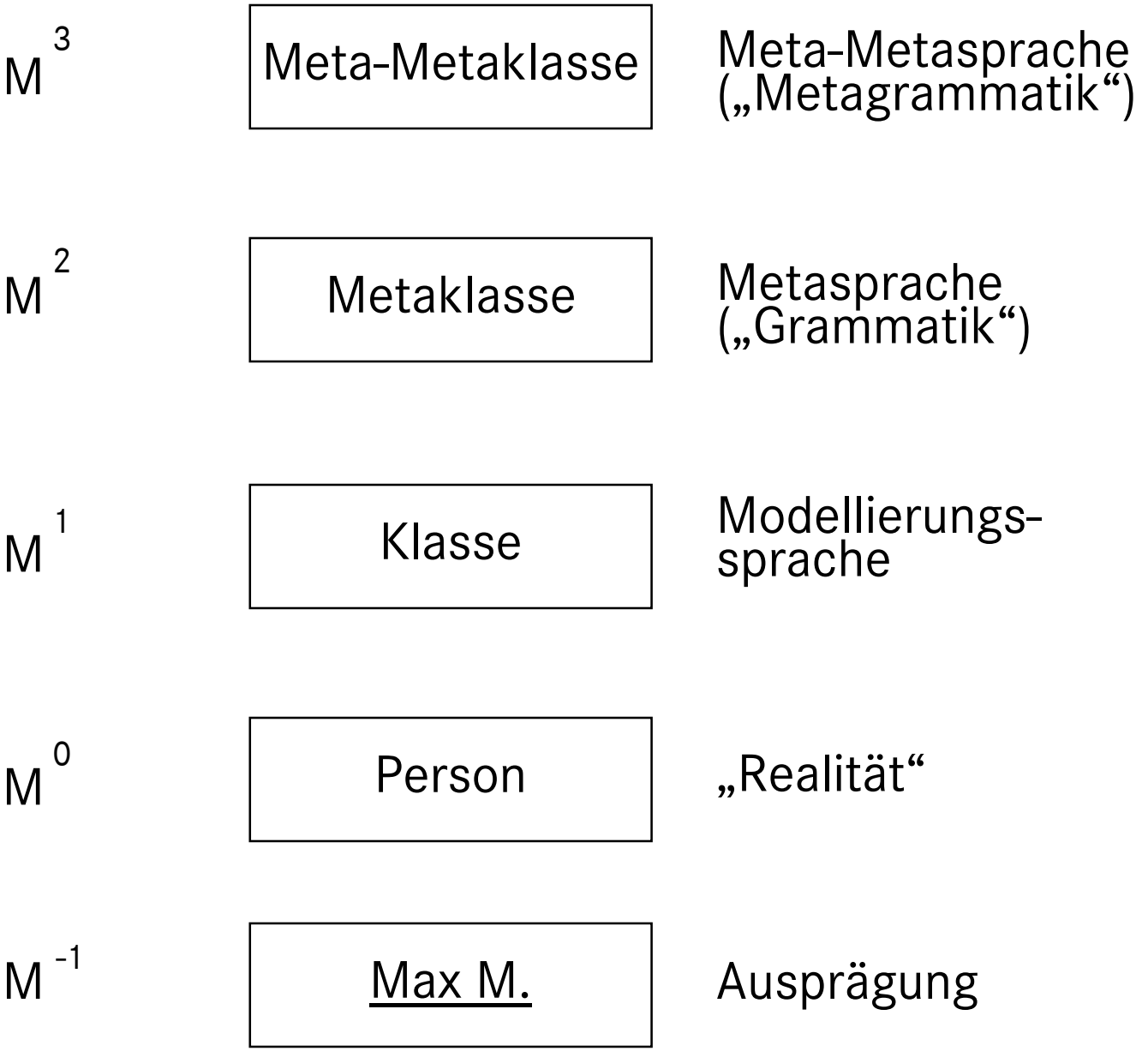



Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

**Multi dimensional Metamodeling Architecture**

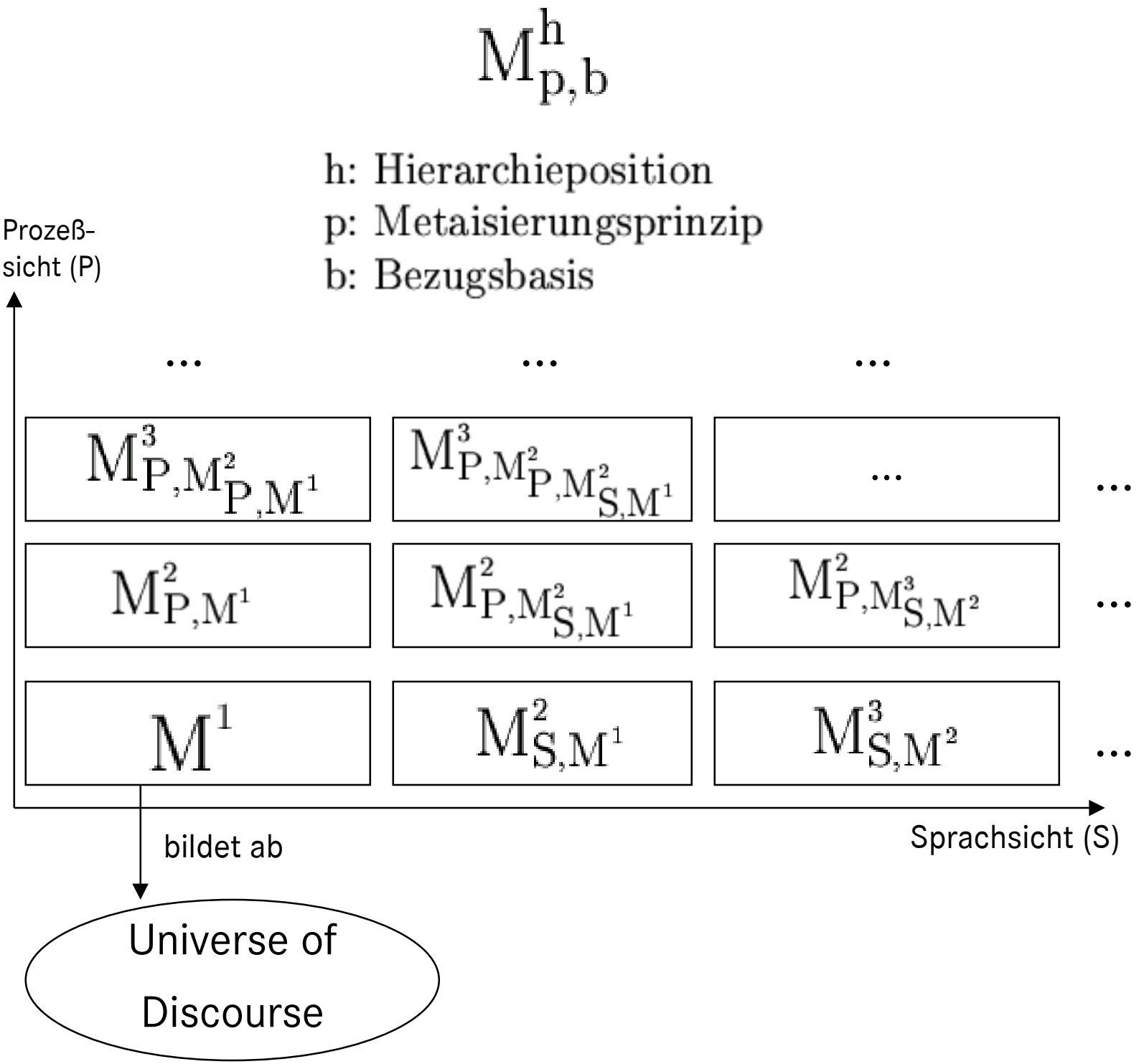
## Ein Beispiel




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

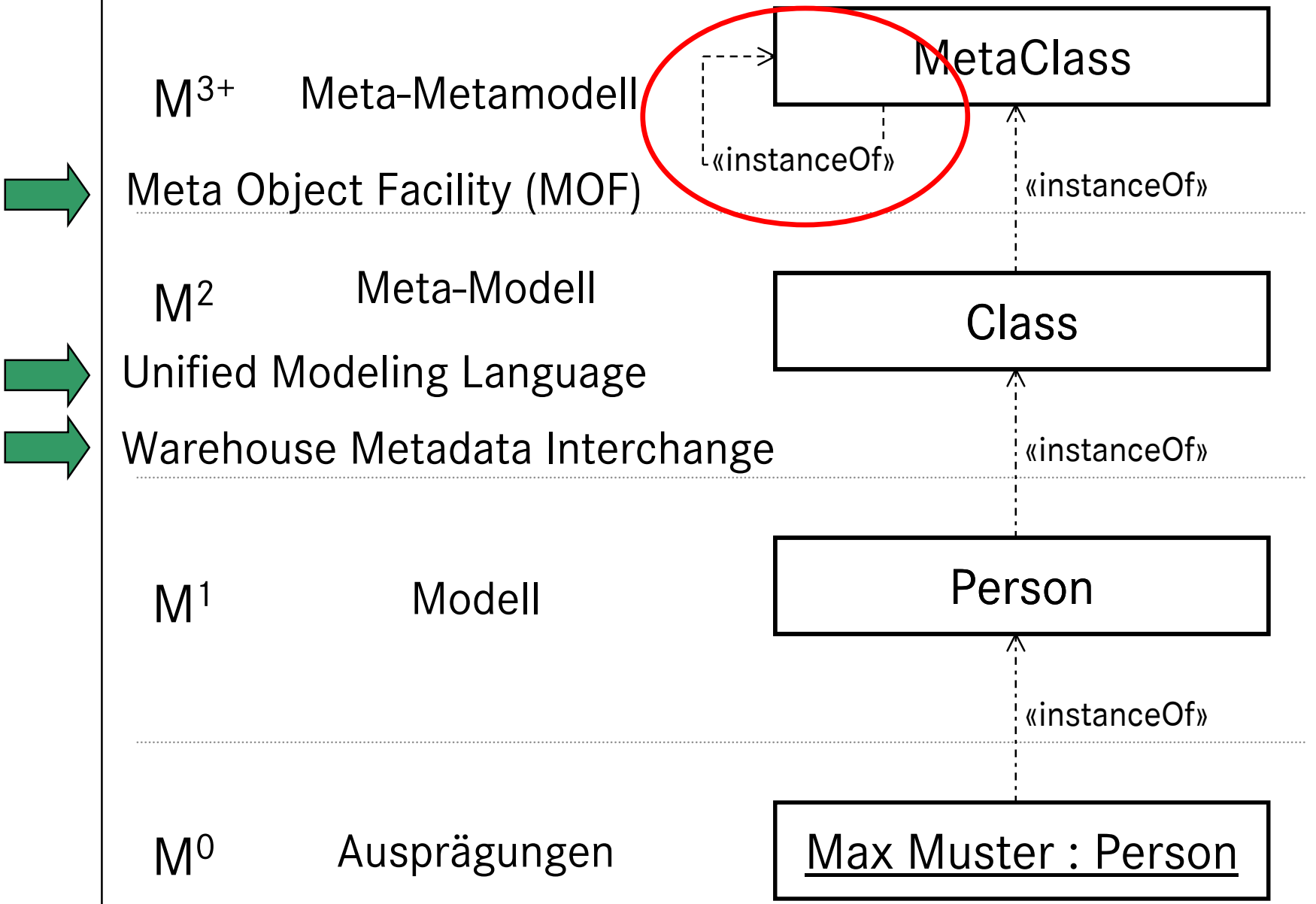
# Multi dimensional Metamodeling Architecture




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

**OMG's Four layer Metamodel Architecture**




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

# XMI within the four layer Metamodel Architecture

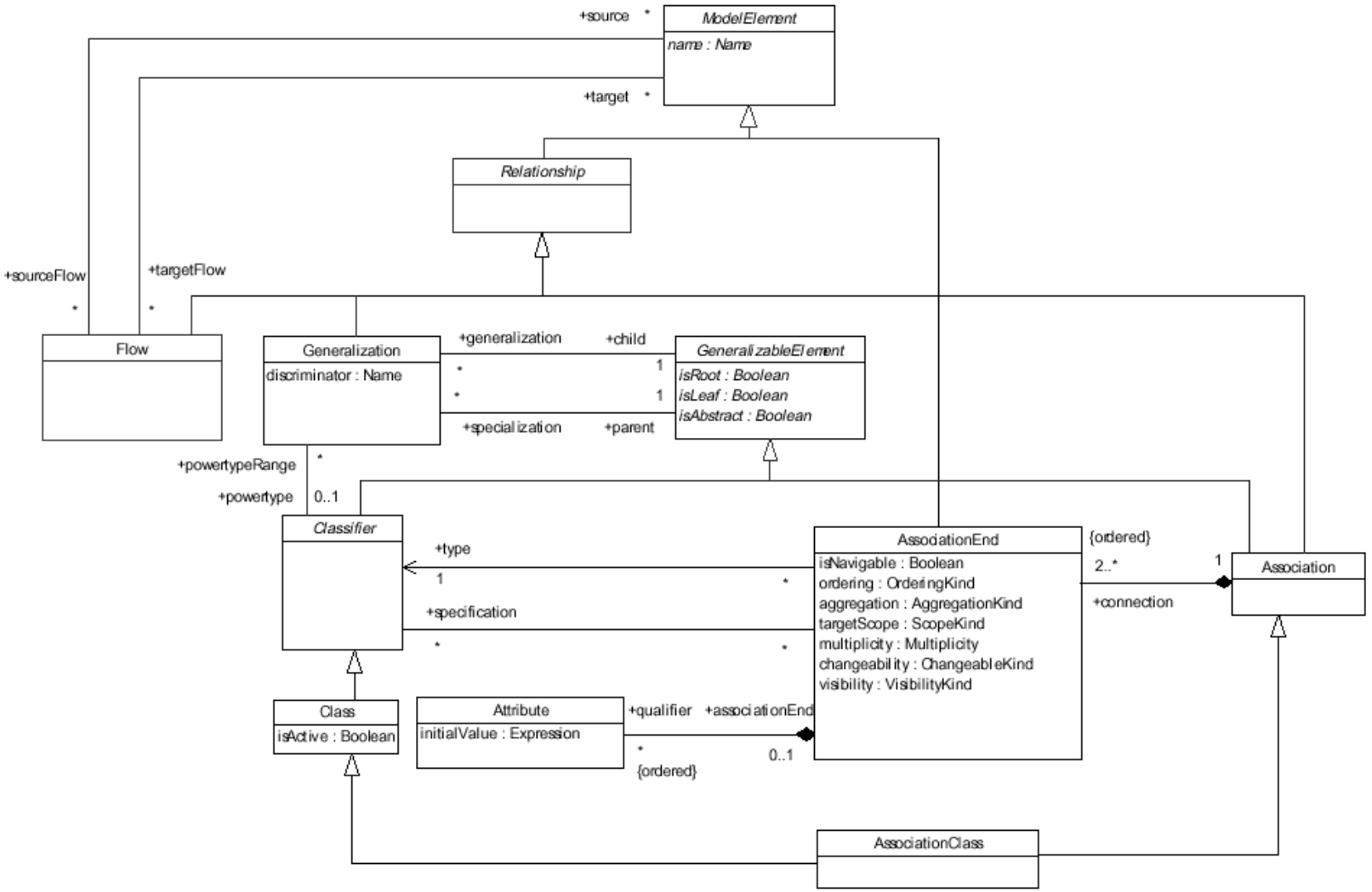
| | | | |
|---|---|---|---|
| $M^{3+}$ | Meta Object Facilities<br>Meta Meta Model | MOF as<br>XML DTD | |
| $M^{2}$ | UML & other<br>Meta Models | UML & others<br>as XML DTDs | MOF<br>MetaModels as<br>XML Documents |
| $M^{1}$ | Model | | UML & other<br>Models as XML<br>Documents |
| $M^{0}$ | Instances | | |

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# The UML Metamodel

## (Core-Package Relationships)



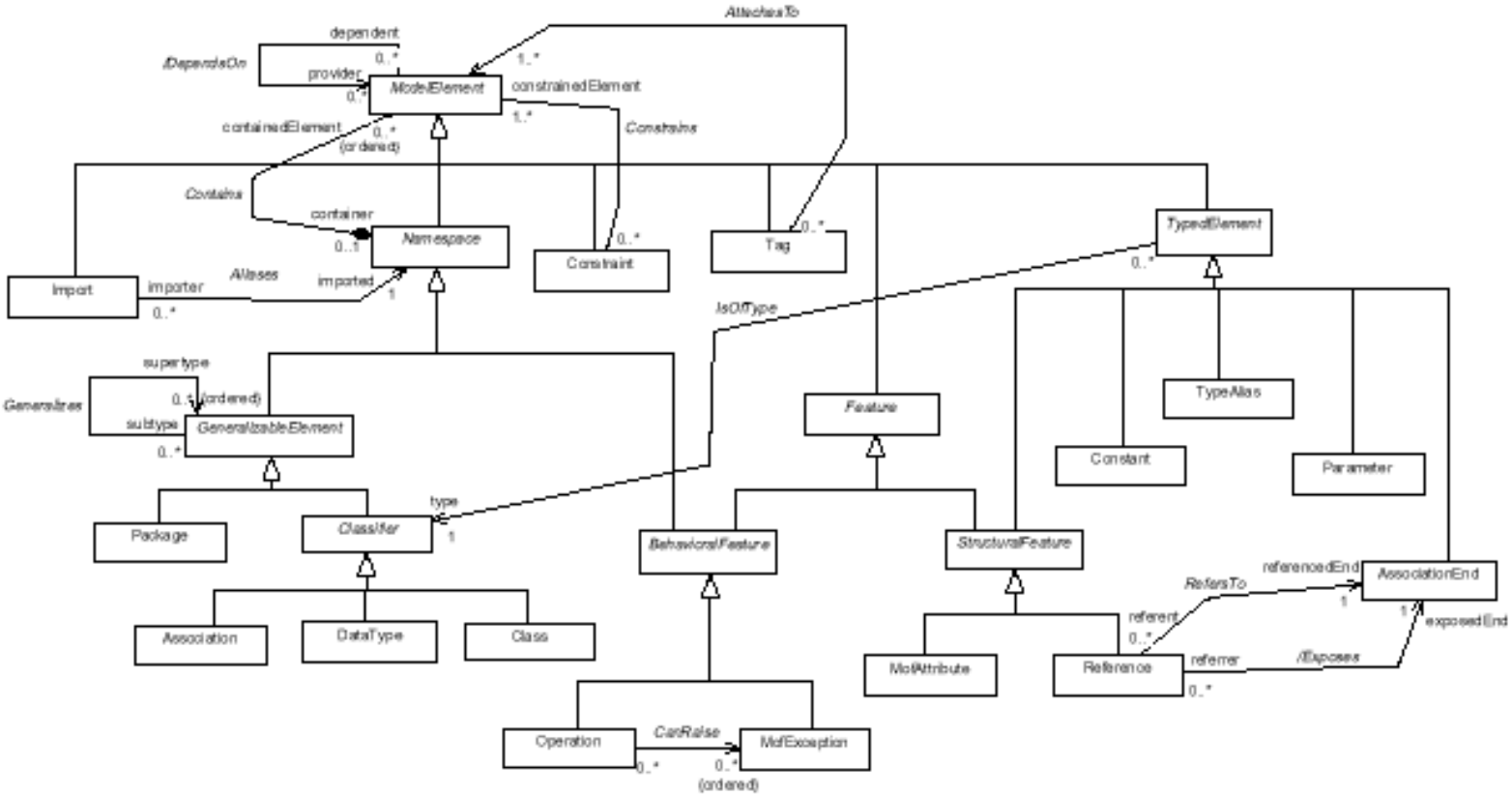


Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# Meta Object Facilities

## (Model Package)

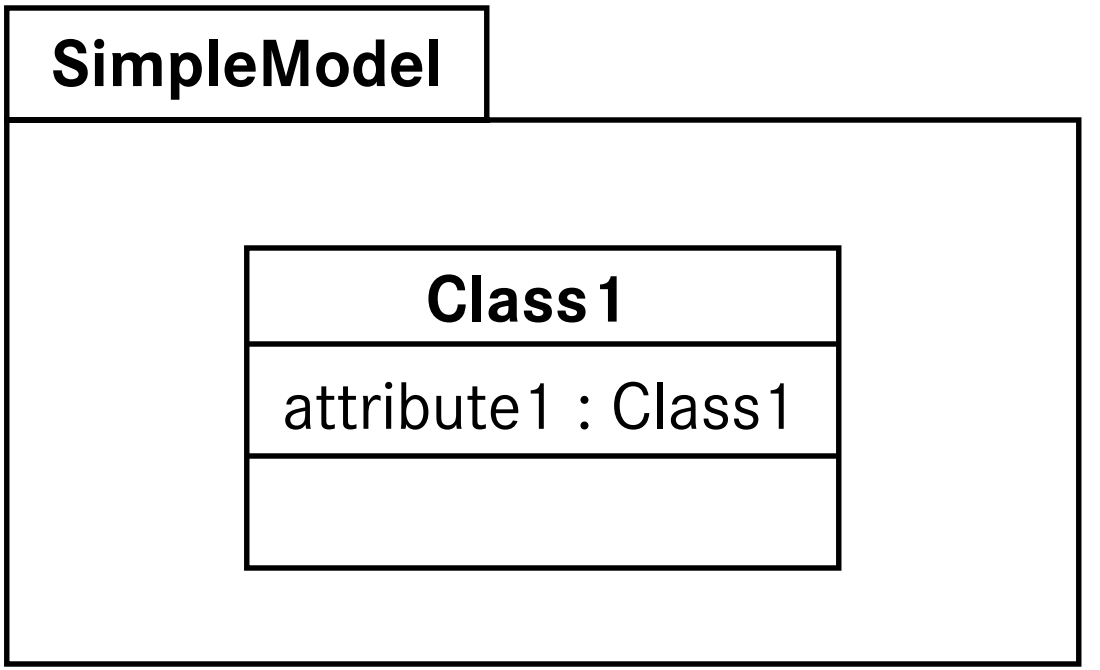



Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

# XML Metadata Interchange by Example

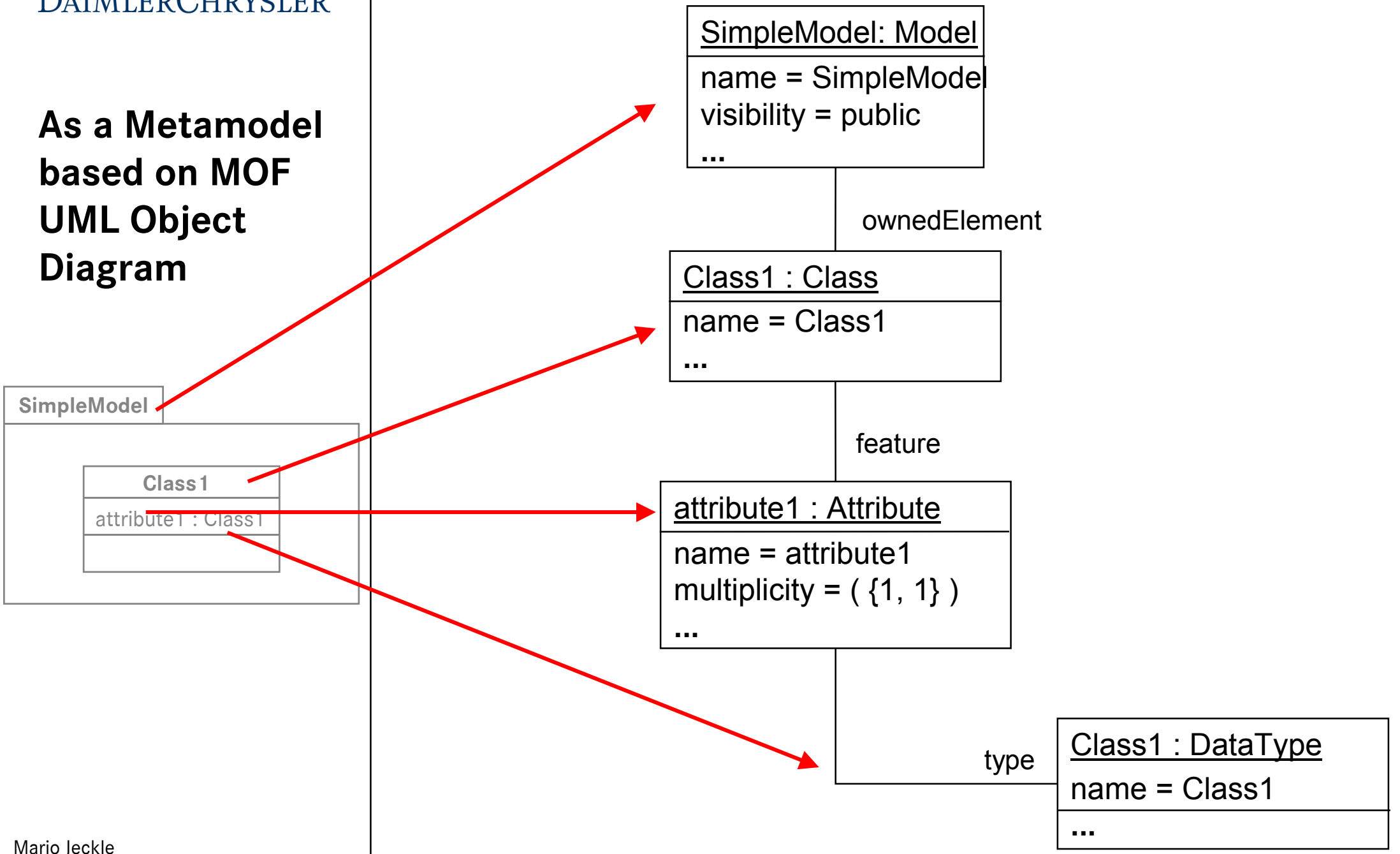
## (UML Model)




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# As a Metamodel based on MOF UML Object Diagram

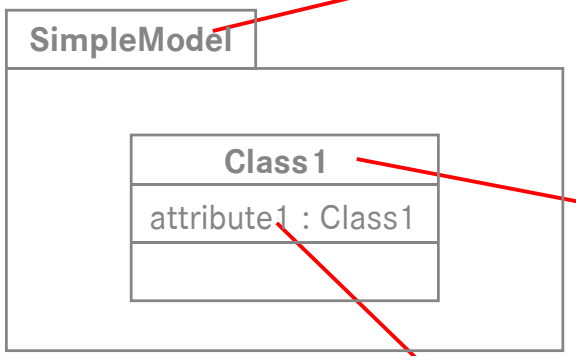



Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# XML Metadata Interchange by Example

## (XMI Code Part I)



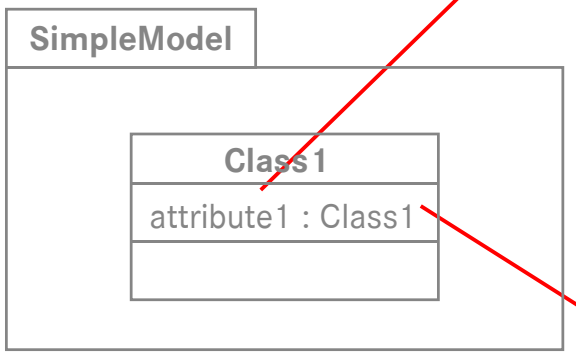

```
<?xml version = "1.0"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
 <XMI.header>
   <XMI.metamodel xmi.name="uml" xmi.version="1.1"/>
 </XMI.header>
 <XMI.content>
   <Model_Management.Model xmi.id="i00000001">
    <Foundation.Core.ModelElement.name>
      SimpleModel
    </Foundation.Core.ModelElement.name>
    <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>
```

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# XML Metadata Interchange by Example

## (XMI Code Part II)



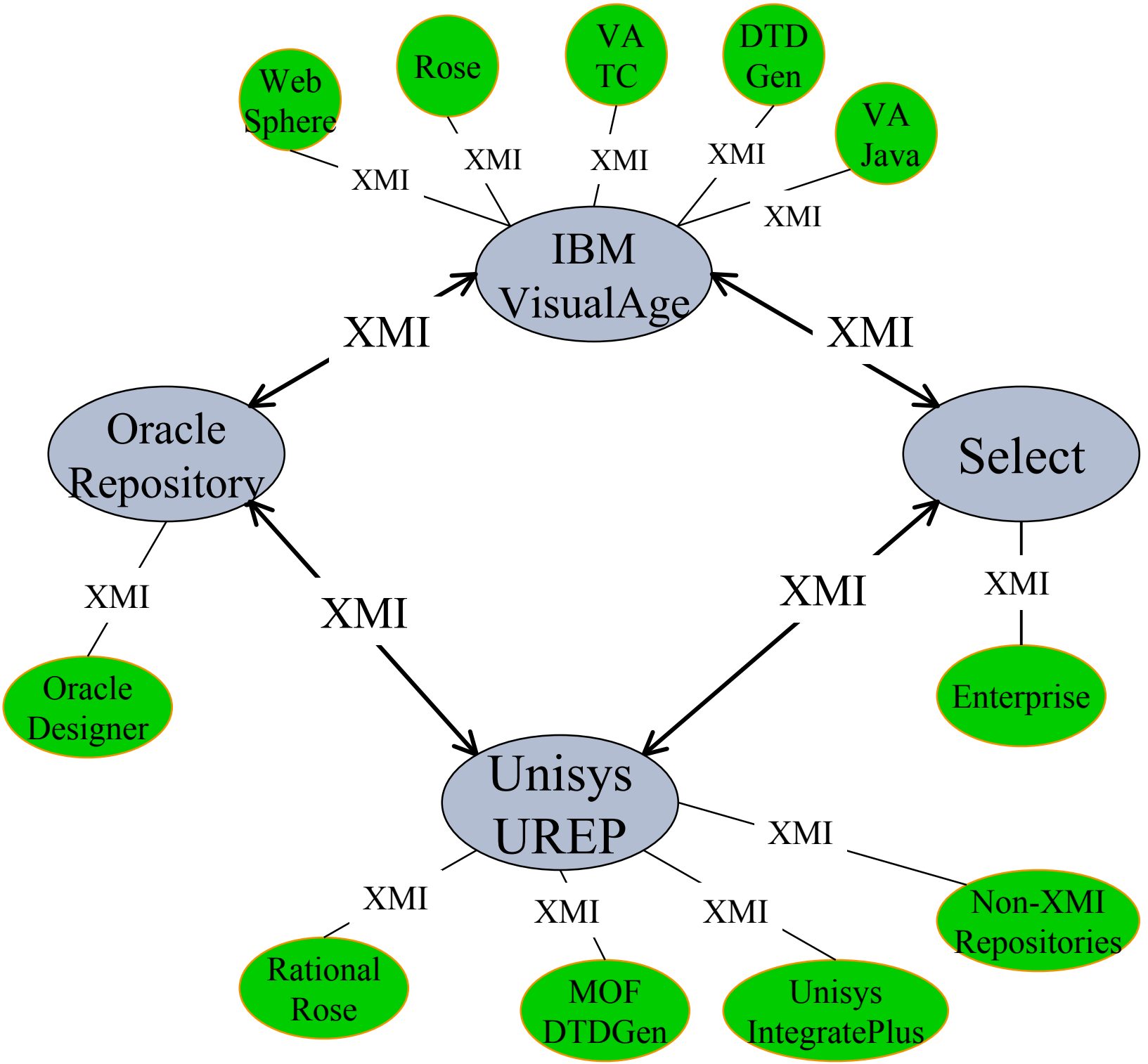

```
<Foundation.Core.ModelElement.visibility xmi.value="public"/>
<Foundation.Core.Feature.ownerScope xmi.value="instance"/>
<Foundation.Core.StructuralFeature.multiplicity>
  1
</Foundation.Core.StructuralFeature.multiplicity>
<Foundation.Core.StructuralFeature.changeable xmi.value="none"/>
<Foundation.Core.StructuralFeature.targetScope 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>
```

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

# XMI demo and proof of concept

**(in cooperation with XMI partners)**




Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

**XMI usage scenarios**

**available implementations**

*XMI ist CASE-Tool unabhängiges Modellieren, aber auch...*

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

CASE-Tools mit XMI-Unterstützung
(Stand: 12. Sept. 1999)

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

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DAIMLERCHRYSLER

## Results and Evaluation

+ 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

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

## Results and Evaluation

+ Breite Industrieunterstützung

+ Web-Technologie (W3-Standardfamilie)

+ Weiterführende Ansätze:
  - Delta-Interchange
  - Metamodellversionierung

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

## Results and Evaluation

+ Breite Industrieunterstützung

+ Web-Technologie (W3-Standardfamilie)

+ Weiterführende Ansätze:
  - Delta-Interchange
  - Metamodellversionierung

+ Gute Skalierbarkeit

$$D_s + D_d + n * C_s + \sum_{i=1}^{n}(C_d + m_i * A_s + \sum_{j=1}^{m_i} A_d) \ldots$$

| | |
|---|---|
| $D_s$ | statischer Anteil Dokument |
| $D_d$ | dynamischer Anteil Dokument |
| $n$ | Anzahl Klassen |
| $C_s$ | statischer Anteil Klasse |
| $C_d$ | dynamischer Anteil Klasse |
| $m$ | Anzahl Attribute pro Klasse |
| $A_s$ | statischer Anteil Attribut |
| $A_d$ | dynamischer Anteil Attribut |

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

## Results and Evaluation

+ 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

Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm

DaimlerChrysler

## References


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



Mario Jeckle
mario.jeckle@daimlerchrysler.com
DaimlerChrysler Forschungszentrum Ulm