Towards a Comparative Analysis of Meta-Metamodels

Heiko Kern, Axel Hummel, and Stefan Kühne
University of Leipzig

11th Domain-Specific Modeling Workshop
October 23, 2011, Portland, Oregon

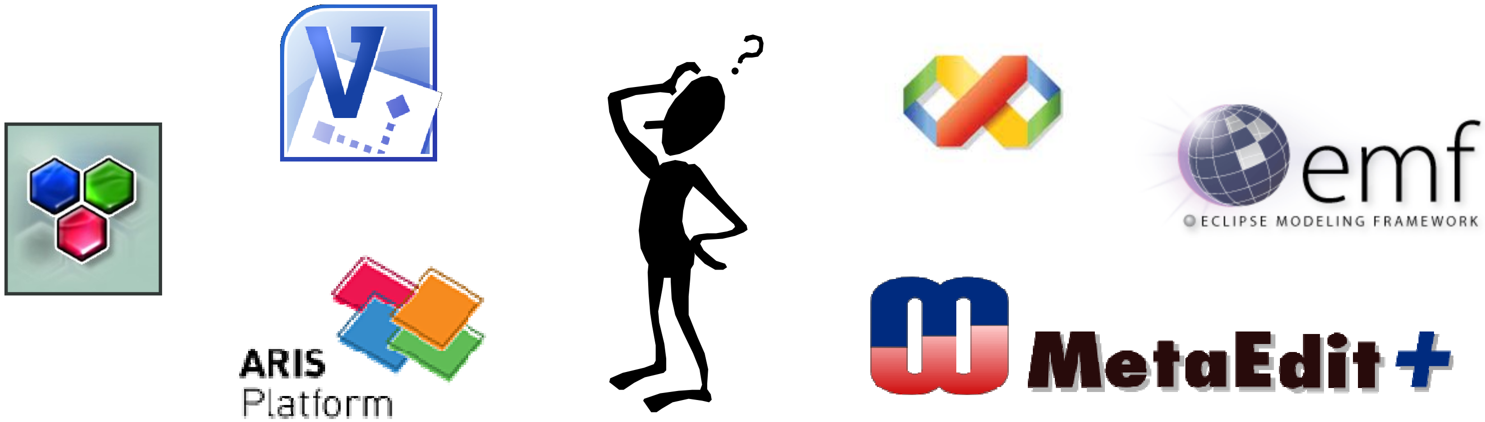
Motivation

Current Situation

- There are many meta-modeling languages

Problem

- Choice of a suitable meta-modeling language
- Model interoperability



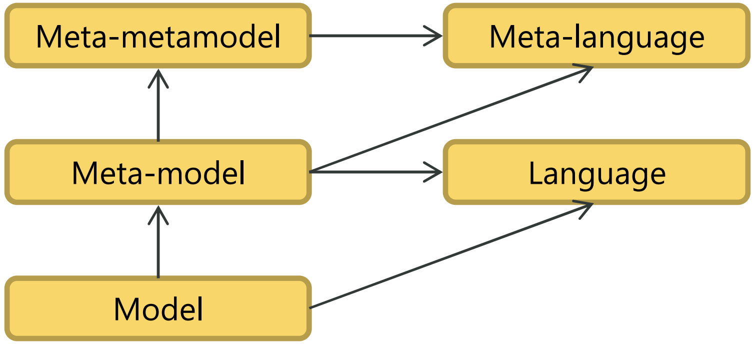
Solution

- Comparison of meta-modeling languages

Design of the Comparison

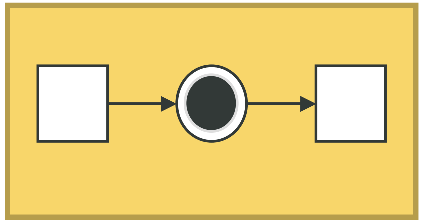
- **Objectives of the study**
  - What are typical concepts in meta-modeling languages?
  - What are the properties of these meta-modeling concepts?

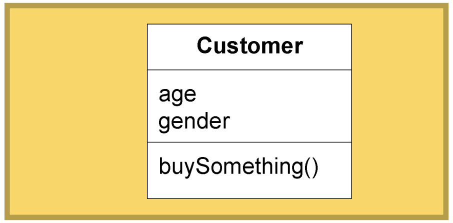
- **Selection of meta-metamodels**
  - Meta-modeling approach
    - **Heavyweight**
    - **3-Level model hierarchy**



  - Concrete syntax: graphical syntax with textual annotation

```
for (i=0; i<10; i++) {
    doSomething();
}
```

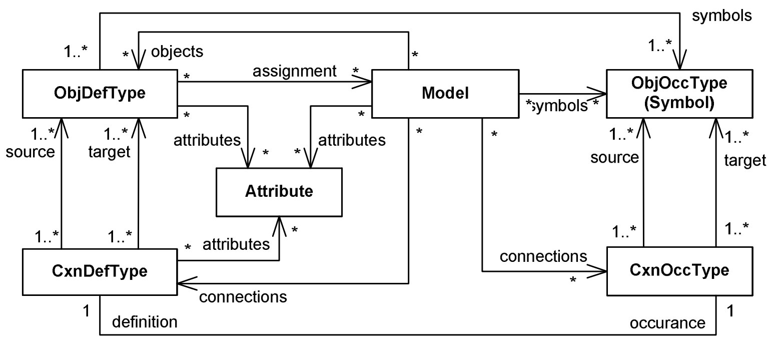




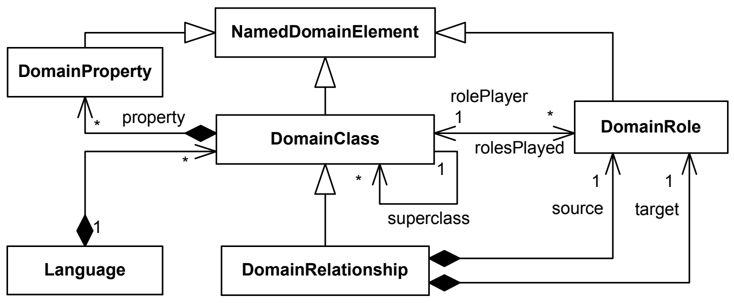
  - Available as tool

Meta-Metamodels under Study

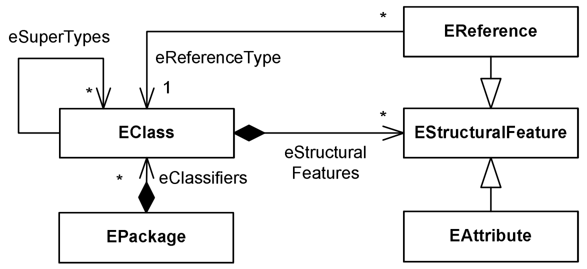
ARIS



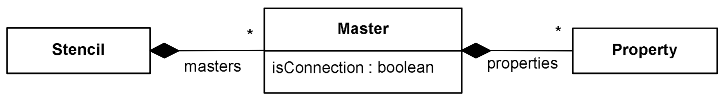
MS DSL Tools



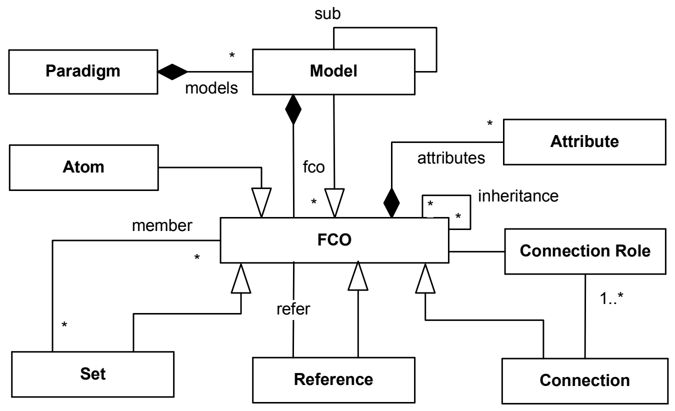
Ecore



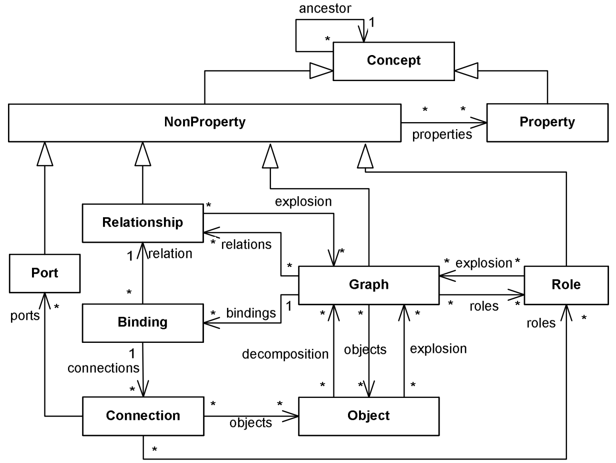
MS Visio



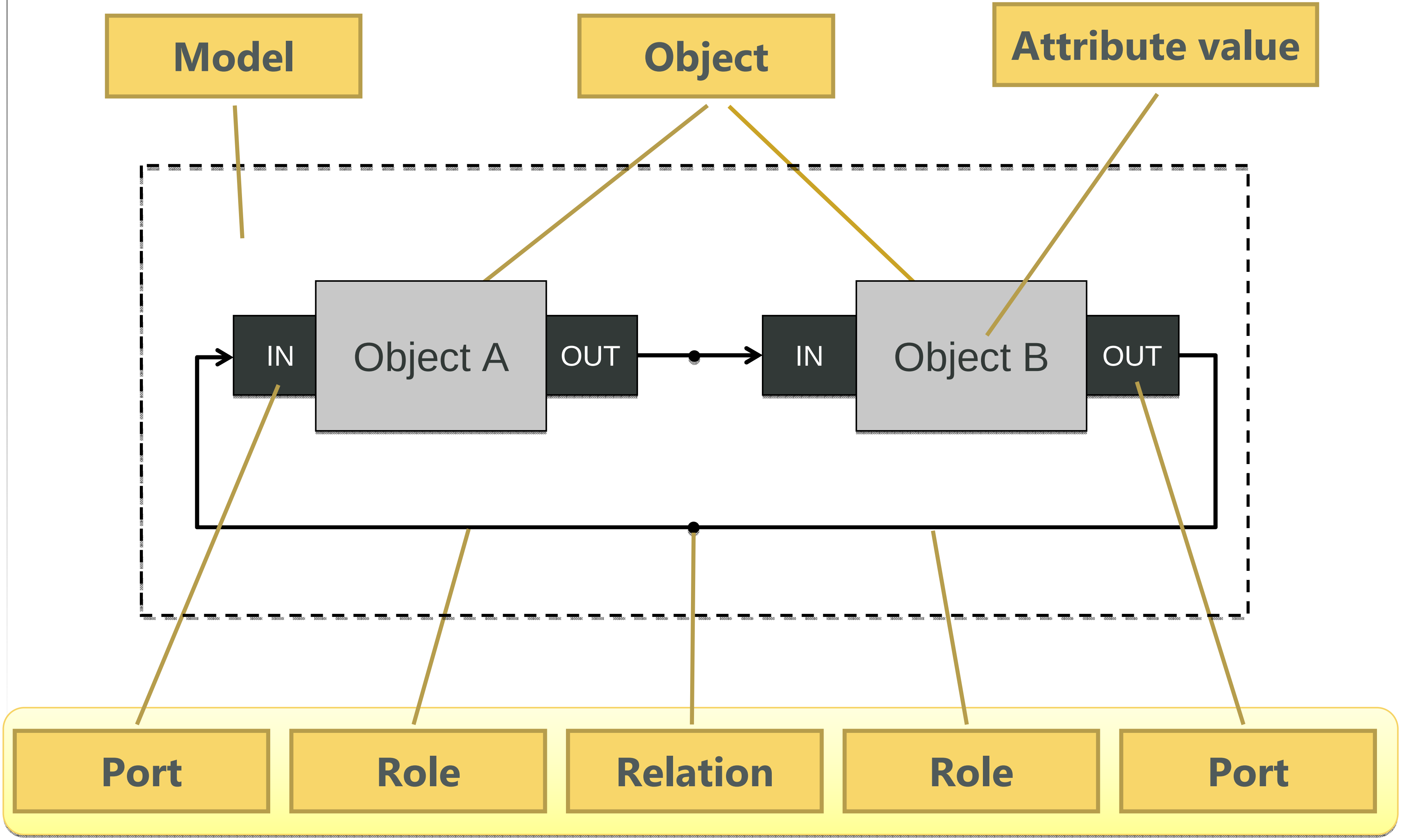
GME



GOPPRR



Some Modeling Concepts by Example



First Class Metamodeling Concepts

	ARIS	Ecore	GOPPRR	GME	MS DSL Tools	MS Visio
Object type	ObjDefType, ObjOccType	EClass	Object type	Atom, Model, Set	Domain Class	Master
Relation type	CxnDefType, CxnOccType	EReference	Relation type, Collection	Connection, Set, Reference	Domain Relationship	Master
Role type	-	-	Role type	Connection Role	Domain Role	-
Port type	-	-	Port type	Reference Port	-	-
Attribute	Attribute	EAttribute	Property	Attribute	Domain Property	Property
Model type	Model type	-	Graph type	Model	-	-

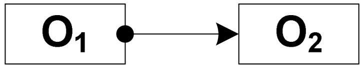
- **All meta-metamodels support object type, relation type, and attribute**
- **|Concepts|: GOPPRR = GME > MS DSL Tools > ARIS > Ecore = MS Visio**

Relationship Type

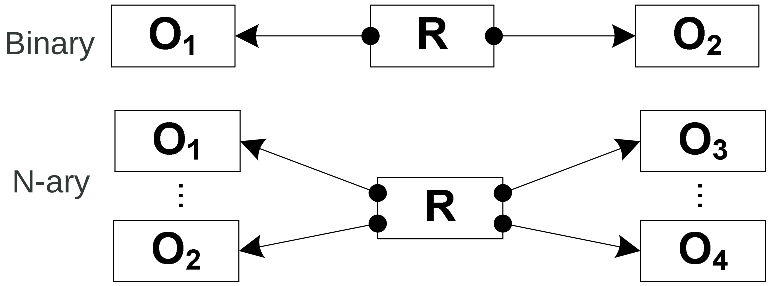
	ARIS	Ecore	GOPPRR	GME	MS DSL Tools	MS Visio
Arity	Binary	Binary	N-ary	Binary	Binary	Binary
Multiplicity	Default (0..n)	Yes	Yes	Yes	Yes	Default (0..n)
Object-Set	Yes	No	Yes	No	No	No
Inverse	No	Yes	No	No	No	No
Composition	No	Yes	No	Yes	Yes	No
Relationship Dependency	Method	EClass	Project	Paradigm	Domain Class	Stencil
Role Dependency	-	-	Project	Connection	Domain Relationship	-

Relationship Type

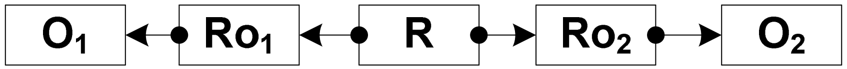
- Reference-Relation



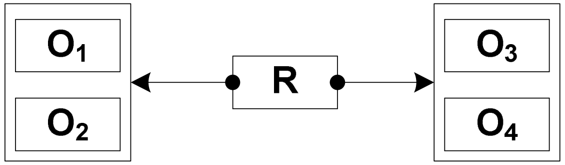
- Object-Relation



- Role-Relation



- Set-Relation



	ARIS	Ecore	GOPPRR	GME	MS DSL Tools	MS Visio
Reference		X	X	X		
Binary object	X		X	X	X	(X)
Set	X		X			
Role			X	X	X	
N-ary object			X			

- GOPPRR > GME > MS DSL Tools > ARIS > Ecore > MS Visio

Attribute

	ARIS	Ecore	GOPPRR	GME	MS DSL Tools	MS Visio
Multiplicity	Single-value	Multi-value	Multi-value	Single-value	Single-value	Multi-value
Unique	-	Yes	Yes	-	-	No
Ordered	-	Yes	No	-	-	Yes
Default value	No	Yes	Yes	Yes	Yes	Yes
Dependency	Method	EClass	Project	Paradigm	Domain Class, Domain Relationship	Master
Attributable object	Yes	Yes	Yes	Yes	Yes	Yes
Attributable relationship	Yes	No	Yes	Yes	Yes	Yes
Attributable role	-	-	Yes	No	No	No
Attributable port	-	-	Yes	No	No	No
Attributable model	Yes	-	Yes	Yes	-	-
Simple datatype	Yes	Yes	Yes	Yes	Yes	Yes
Metamodel element datatype	No	No	Yes	No	No	No

Other

	ARIS	Ecore	GOPPRR	GME	MS DSL Tools	MS Visio
Inheritance	No	Multiple	Single	Multiple	Single	No
Object	-	Yes	Yes	Yes	Yes	-
Relationship	-	No	Yes	Yes	No	-
Role	-	-	Yes	No	No	-
Port	-	-	Yes	No	-	-
Model	-	-	Yes	Yes	-	-

Links to sub model types	Yes	-	Yes	Yes	-	-
Grouping	Method, Model	EPackage	Project, Graph	Folder, Paradigm	Language, Namespace	Stencil
Constraint language	No	OCL	proprietary	OCL dialect	Programming language	No

Conclusion and Future Work

- **Comparison of six meta-metamodels**
  - Definition of comparison criteria
  - ARIS, Ecore, GOPPRR, GME, MS DSL Tool, MS Visio
- **Some observations**
  - Object type, relation type, and attribute are core concepts
  - There are different realizations of relation type
  - No extraordinary concepts such as clabjects
- **Some (unproved) statements**
  - GOPPRR and GME has a great practical expressiveness
  - Visio has a limited practical expressiveness
- **Future Work**
  - Improvement of the comparison
    - **Comparison criteria**
    - **More meta-metamodels**
      - Modeling space: MOFv1.4, KM3, ADONIS
      - Other spaces: XML Schema, OWL, Grammarware
  - Model interoperability
    - **Transformation between meta-modeling concepts**

Thank you for your attention.