31.7. More Details of the CROM Metamodel (from GRK Role-based Software Infrastructures RoSI)

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DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

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Friedrich Steimann
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[3] **Role model based framework design and integration**
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[4] **A relational model of object collaborations and its use in reasoning about relationships**
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[7] **A precise model for contextual roles: The programming language ObjectTeams/Java**
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[8] **powerJava: ontologically founded roles in object oriented programming languages**
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[9] **Towards safe and flexible object adaptation**
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Literature

- Regina Hebig and Andreas Seibel and Holger Giese. On the Unification of Megamodels. Proceedings of the 4th International Workshop on Multi-Paradigm Modeling (MPM 2010). Electronic Communications of the EASST Volume 42 (2011). ISSN 1863-2122. Guest Editors: Vasco Amaral, Hans Vangheluwe, Cecile Hardebolle, Lazlo Lengyel
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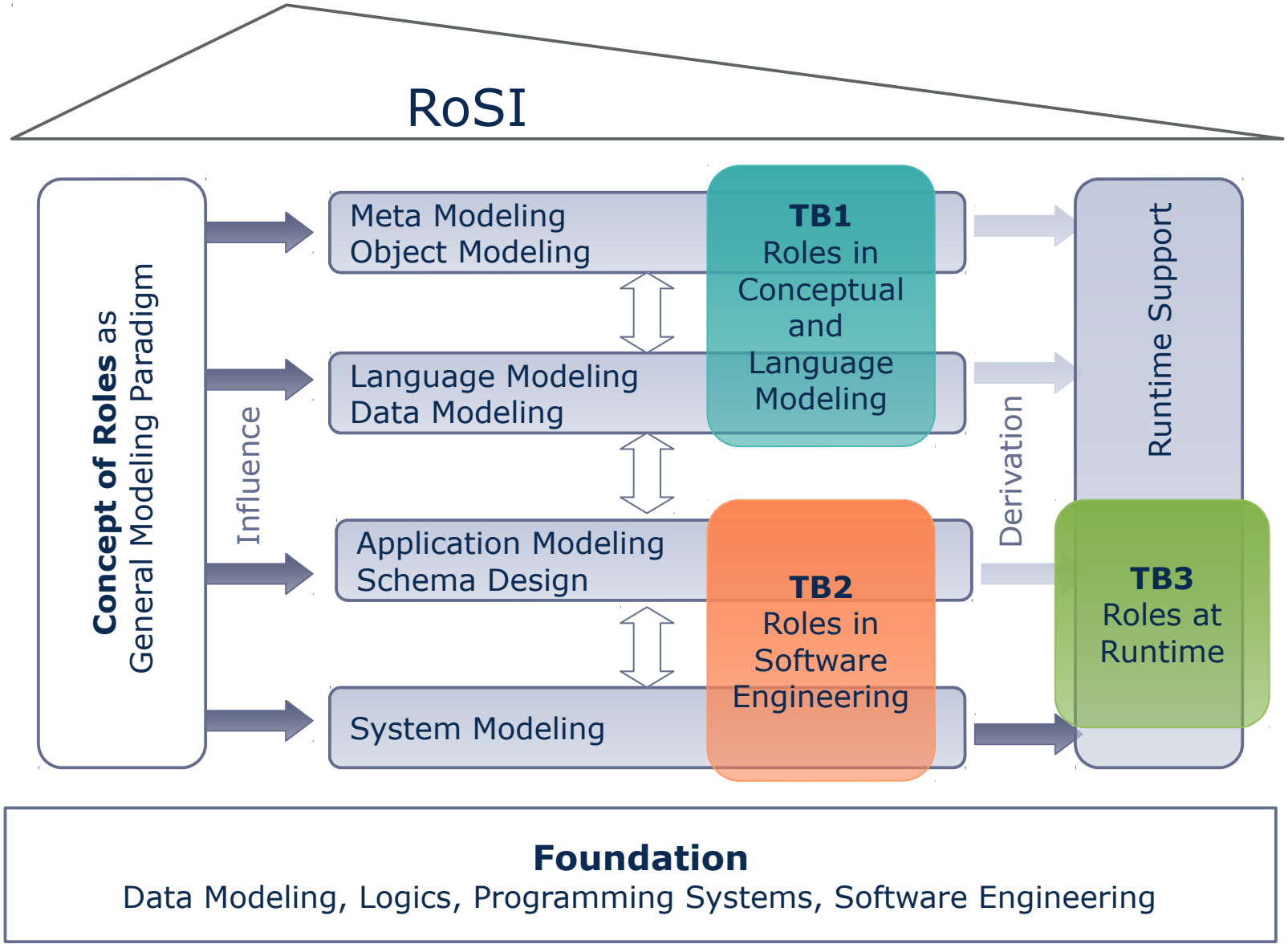
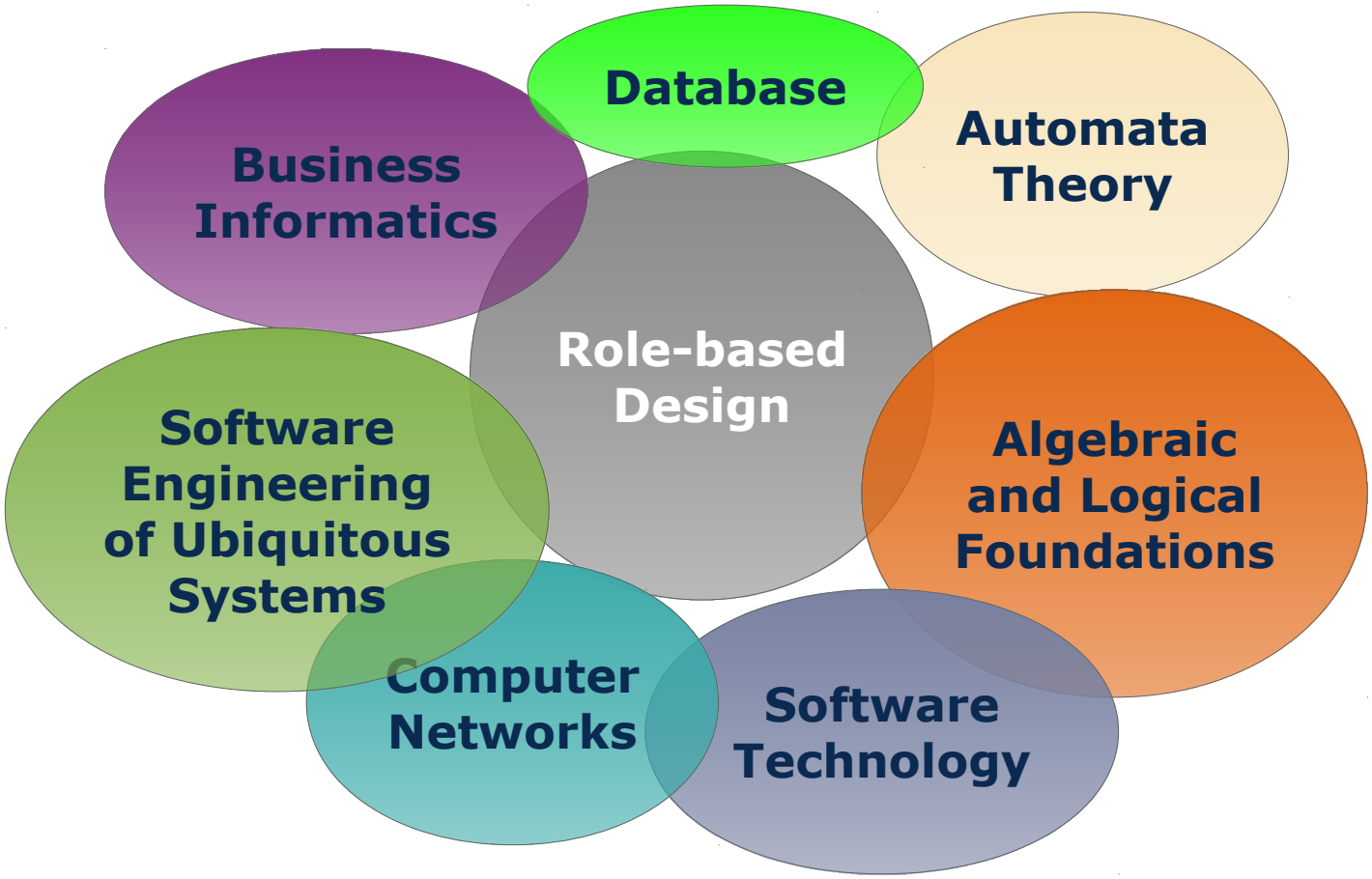
The RoSI Research Training Group



The RoSI Project Areas of Research



Motivation

*„All the world's a stage, and all the men and women merely **players**: they have their exits and their entrances; and one man in his time **plays many parts**, his acts being seven ages.“*

– William Shakespeare

The Role Concept

- *Relatively* old, e.g. Bachman 1977 *[1]*
- Since then many different approaches emerged
- They do not share a common understanding (or formalism)
- There might be **no** common universal role concept

Each approach can be classified along design decisions

Classification

Asking 15 Questions

Classification of Roles

(1) Roles have properties and behaviours

(2) Roles depend on relationships

(3) An Object may play different roles simultaneously

(4) An Object may play the same role (type) several times

(5) An Object may acquire and abandon roles dynamically

(6) Sequence of role acquisition and removal may be restricted

(7) Unrelated objects can play the same role

(8) Roles can play roles

(9) Roles can be transferred between objects

(10) The State of an object can be role-specific

(11) Features of an object can be role-specific

(12) Roles restrict access

(13) Different roles may share structure and behaviour

(14) An Object and its roles share identity

(15) An Object and its roles have different identities

– Friedrich Steimann (2000) *[2]*

Classification

Asking 15 Questions

Evaluation of Current Approaches

1. Lodwick *[1]*
2. Rava *[6]*
3. Object Teams / Java *[7]*
4. powerJava *[8]*
5. NextEJ *[9]*

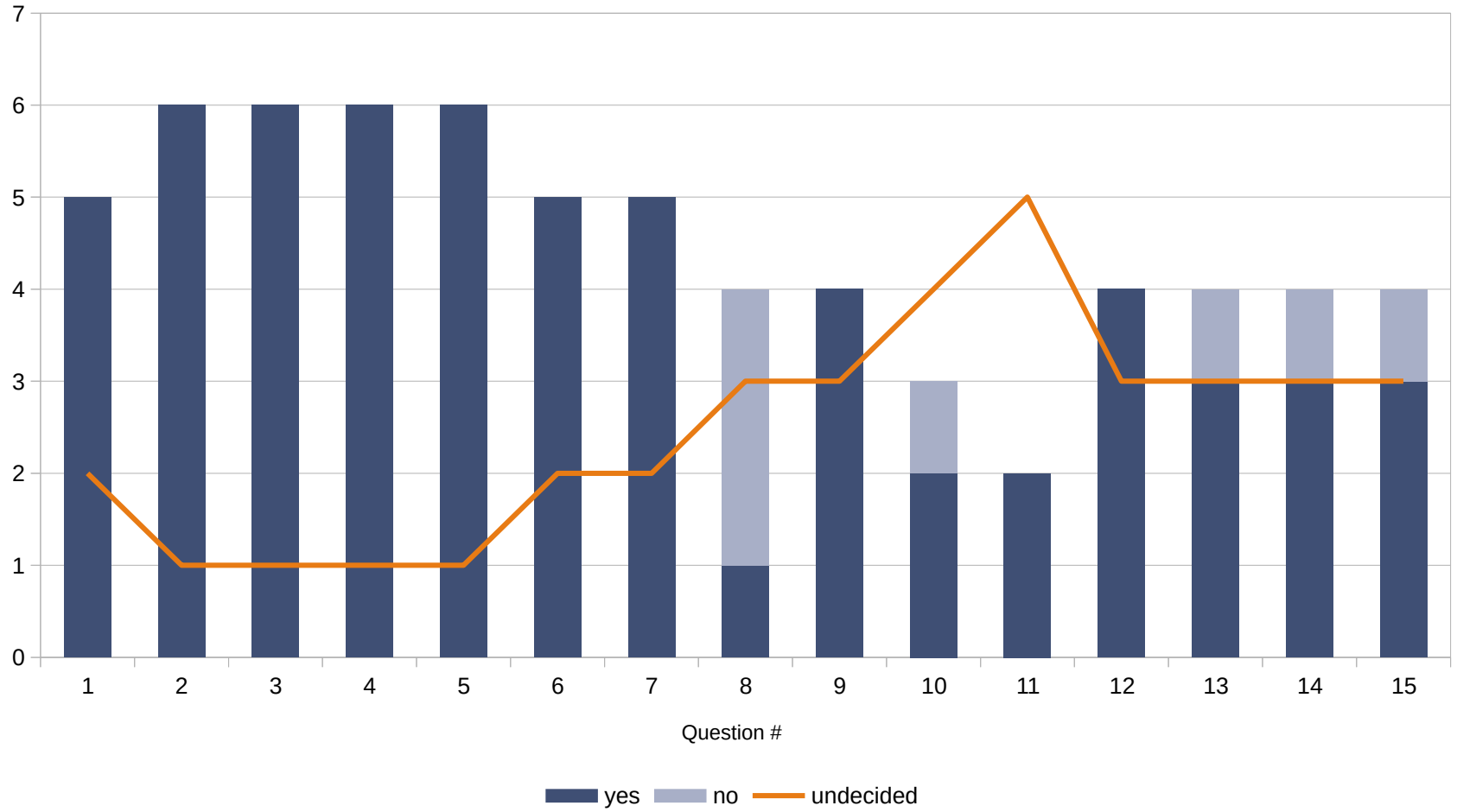
Approach	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	+	+	+	+	+	?	+	-	?	?	?	/	?	+	-
2.	+	-	+	-	+	-	+	-	-	+	+	+	+	-	+
3.	+	?	+	+	+	+	/	+	-	+	+	+	+	?	+
4.	+	?	+	+	?	+	+	+	+	+	+	+	+	-	+
5.	+	?	+	+	+	-	+	+	+	+	+	+	-	?	+

+ yes − no ? possible / not applicable

Classification

Asking 15 Questions

Evaluation of a Small Poll within the Research Group (n=7)



Classification

Asking 15 Questions

Results

- Concensus in several questions (1-7)
- Controversal parts start from question (8)
- Maybe the following questions will become V*ariation Points*

Debated Questions

(8) Roles can play roles

(10) The State of an object can be role-specific

(11) Features of an object can be role-specific

(13) Different roles may share structure and behaviour

(14) An Object and its roles share identity

(15) An Object and its roles have different identities

Additional Questions retrieved from the Literature *[3-9]*

(16) Relationships between Roles can be constrained

(17) There may be constraints between relationships

(18) Roles can be grouped and constrained together

(19) Roles depend on Compartments

(20) Compartments have properties and behaviors

(21) A Role can be part of several Compartments

(22) Compartments may play roles like objects

(23) Compartments may play roles which are part of themselve

(24) Compartments can contain other compartments

(25) Different compartments may share structure and behavior

(26) Compartments have their own identity

– Thomas Kühn (2014)

Classification
Conclusion

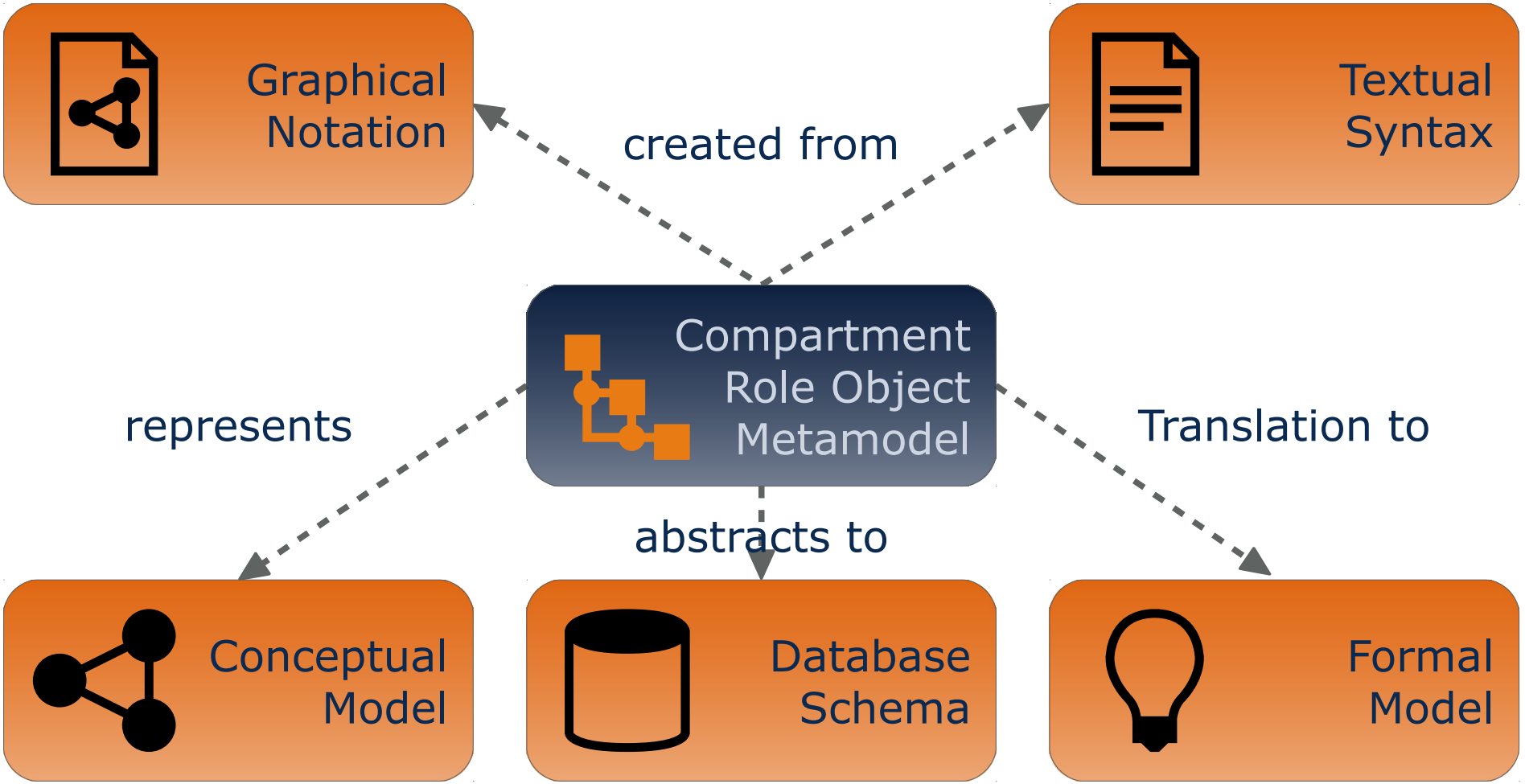
„[...] there is no single definition of roles integrating all of [the classifying Questions]“

– Friedrich Steimann (2000) [2]

A Metamodel for RoSI must

- Provide a common ground for role-based modeling
- Identify the constituents of the role concepts
- Capture the structure of the various role concepts
- Reflect the design decisions w.r.t. to the 26 questions
- Be a family of similar Metamodels

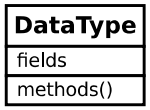
A Metamodel for RoSI



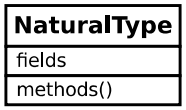
A Metamodel for RoSI
Graphical Syntax for RoSI

Entities

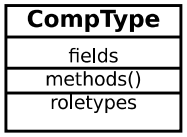
Data Types



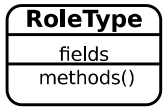
Natural Types



Compartment Types

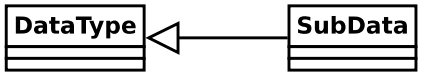


Role Types

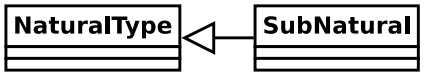


Static Relations

Data Type Inheritance

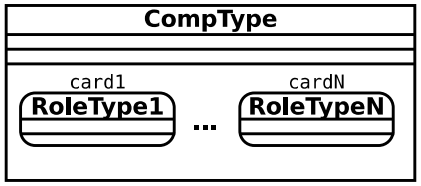


Natural Type Inheritance

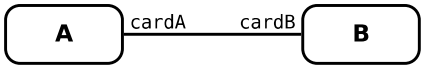


Dynamic Relations

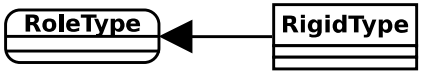
Participation (participates-Relation)



Binary Relationship

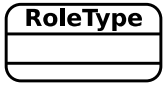


Fulfilment (fills-Relation)

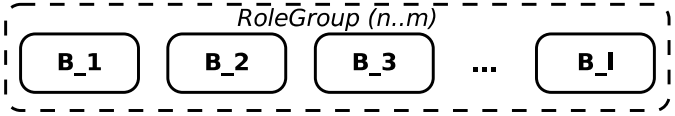


Constraint Atomes

Role Types



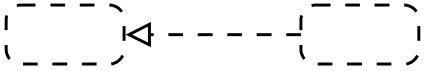
Role Groups



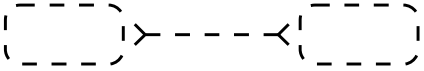
Note: Role Groups may contain other Role Groups with Role Types. However, all the relationships between them have to be retained!

Constraints

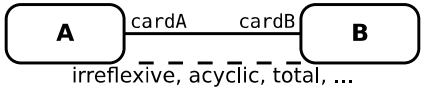
Role Implication *[3]*



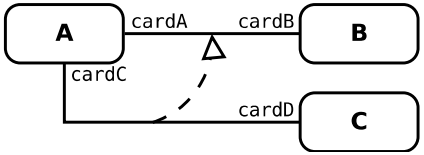
Role Prohibition *[3]*



Relationship Constraints *[4]*

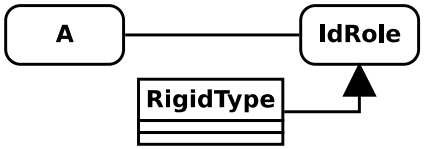


Relationship Implication *[5]*

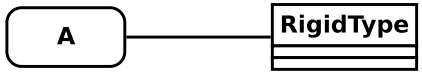


Dynamic Relations

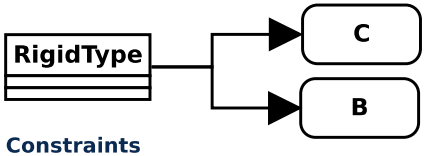
Classes with Relationships



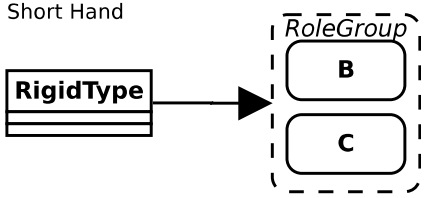
Short Hand (with Identity Role)



Fullfillment (fills-Relation)

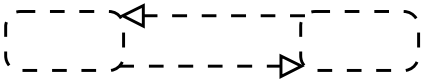


Short Hand



Constraints

Role Equivalence



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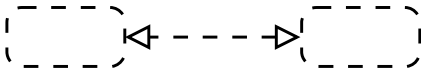
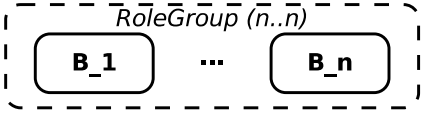


Constraint Groups

Grouping Roles with AND



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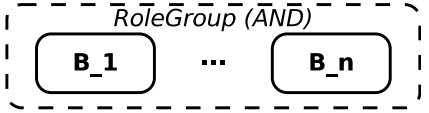
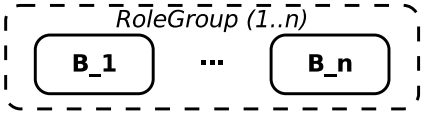


Grouping Roles with OR



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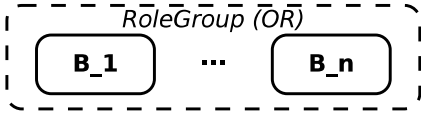
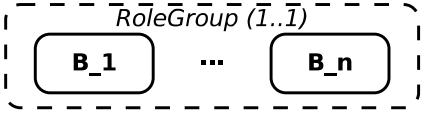


Grouping Roles with XOR



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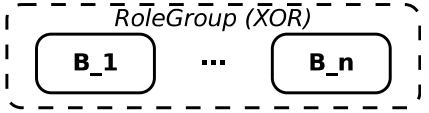
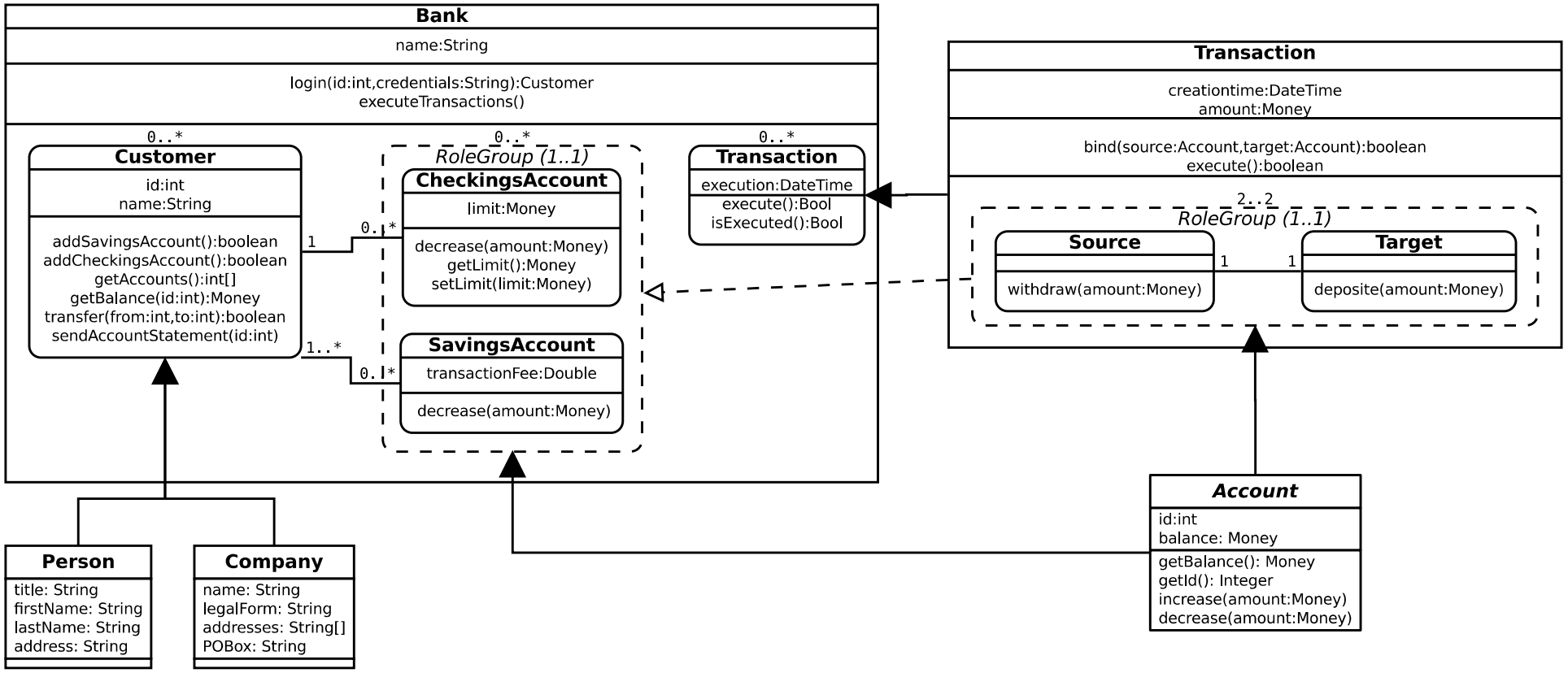
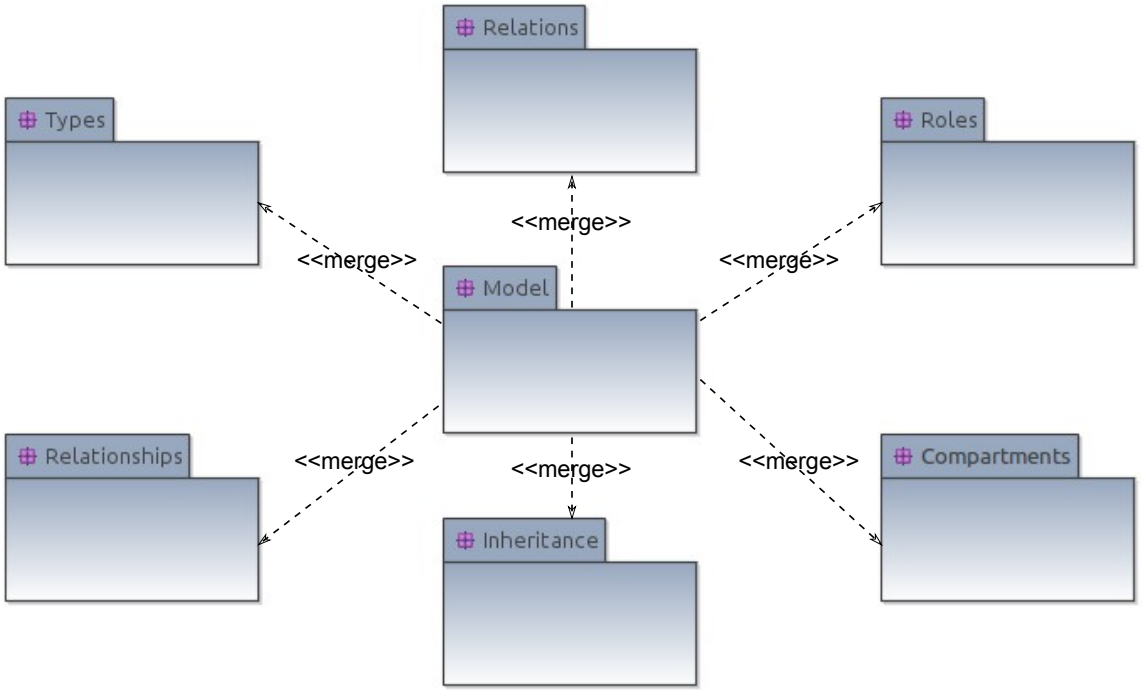


A Metamodel for RoSI
Usage Scenario



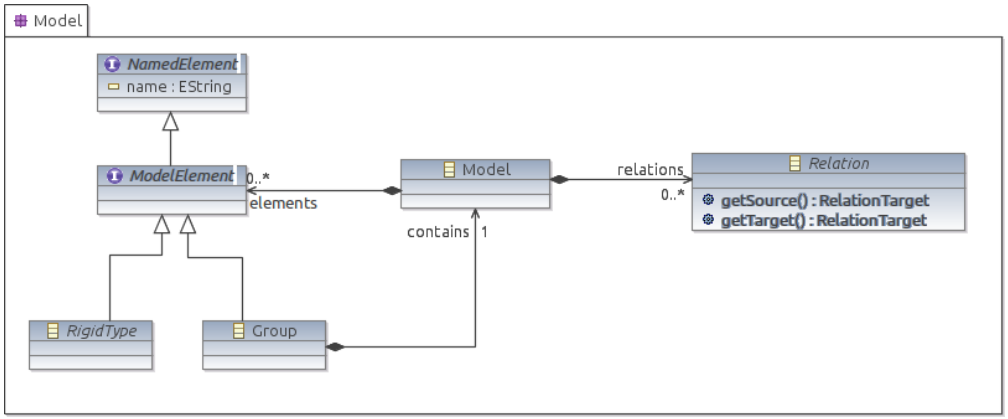
A Metamodel for RoSI
EMOF/Ecore Model

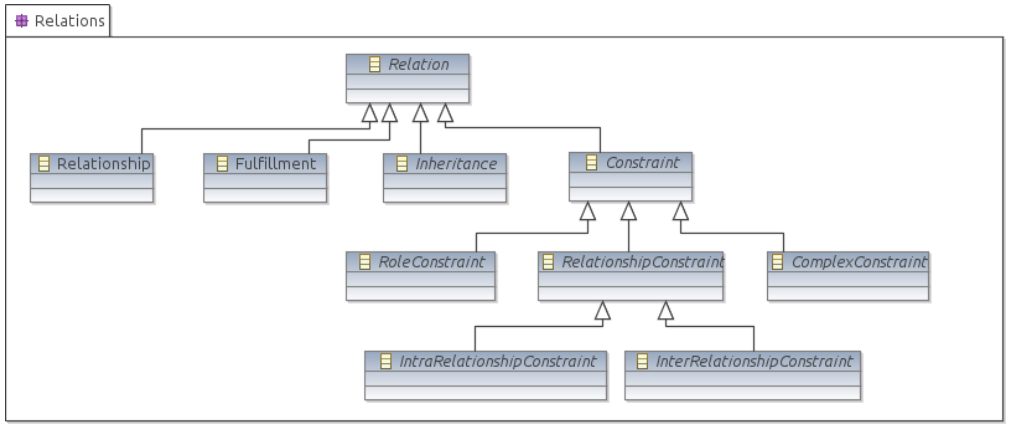


Aspects of the meta model

- Types
- Relations
- Kinds of Inheritance
- Relationships
- Concept of Roles
- Concept of Compartments

A Metamodel for RoSI
Model and Relations





Model

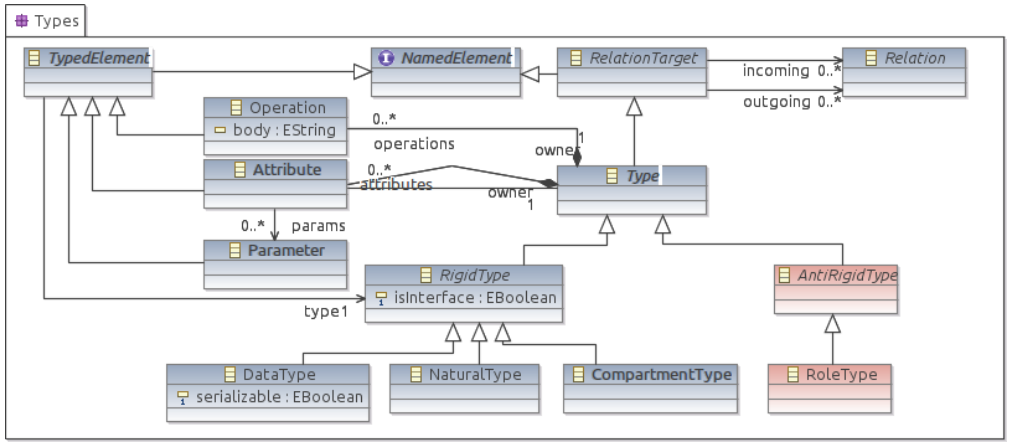
- Base of each CROM Model
- Contains *ModelElements* and *Relations*
- *ModelElements* are either *RigidTypes* or *Groups*

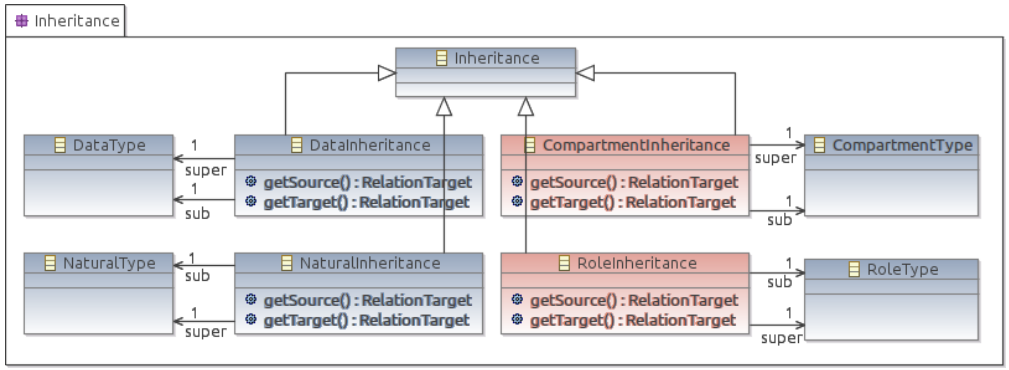
Relations

- Discerns all the different kinds of relations
- Contains formal, material, and constraint relations

A Metamodel for RoSI

Types and Inheritance





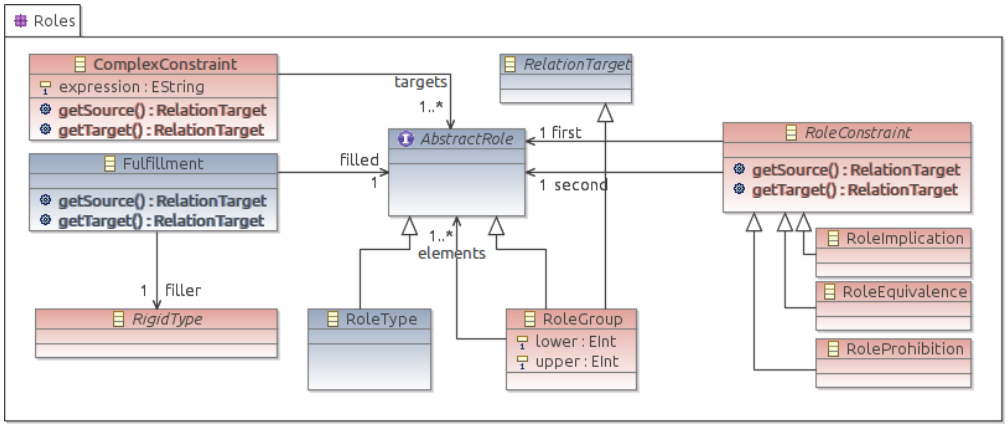
Types

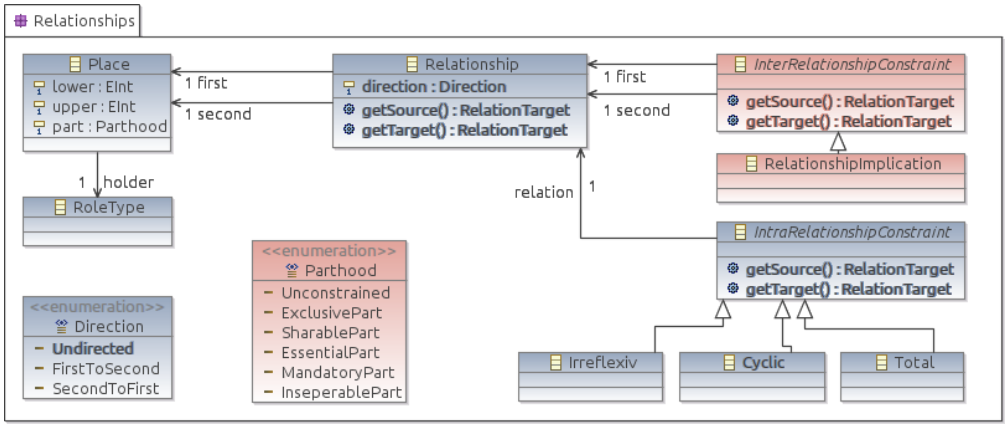
- Defines the fundamental Types
- Types have a name, attributes, and operations

Inheritance

- Defines the various inheritance relations for each concept
- Inheritance is prohibited between different concepts

A Metamodel for RoSI
Roles and Relationships





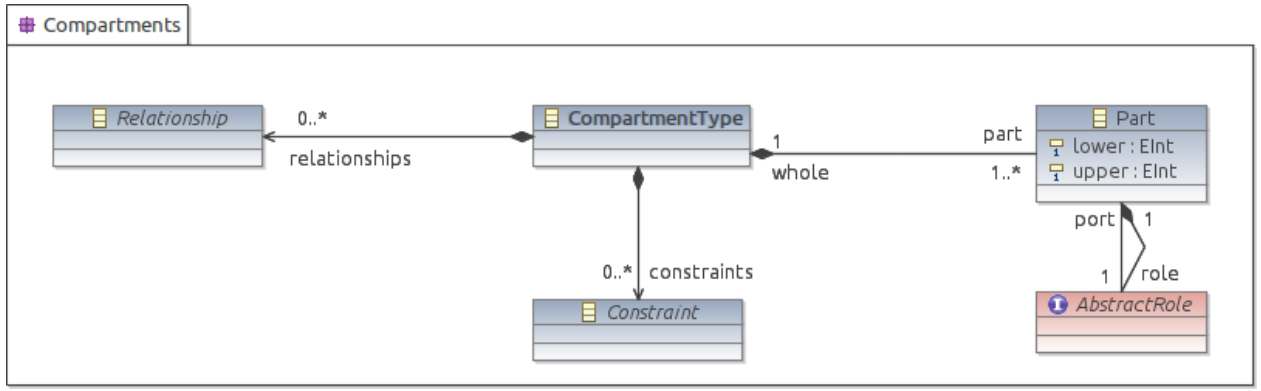
Roles

- Fulfillment relation specifies which *RigidType* can play (fill) an *AbstractRole*
- *AbstractRoles* can be further constrained
- An *AbstractRole* is either a *RoleGroup* or a *RoleType*
- *RoleGroups* contain several (at least on) *AbstractRole*

Relationships

- *Relationships* are defined between two *RoleTypes (via Place)*
- *Relationships* have multiplicities, parthood and relational constraints

A Metamodel for RoSI
Compartments

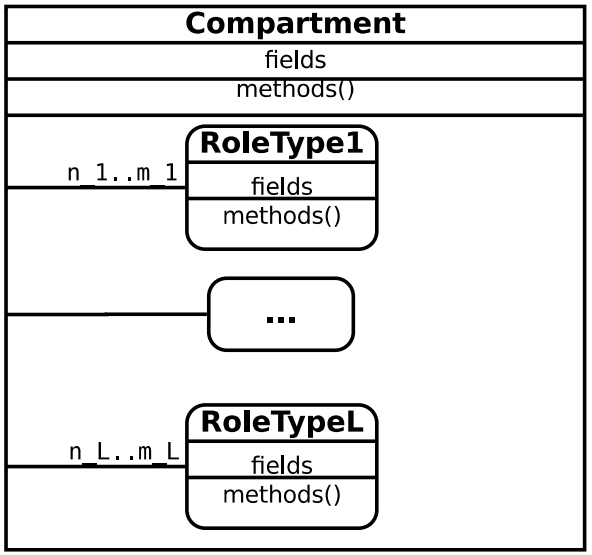


Compartments

- Each Compartments contains
  - at least one *AbstractRoles* (via Part),
  - Various Relationships and Constraints,
  - *But no Fullfillment relation.*
- Each *Part* of the *Compartment* carries a cardinality limiting the number of roles within this *AbstractRole*

A Metamodel for RoSI

Formal Definition of Compartments



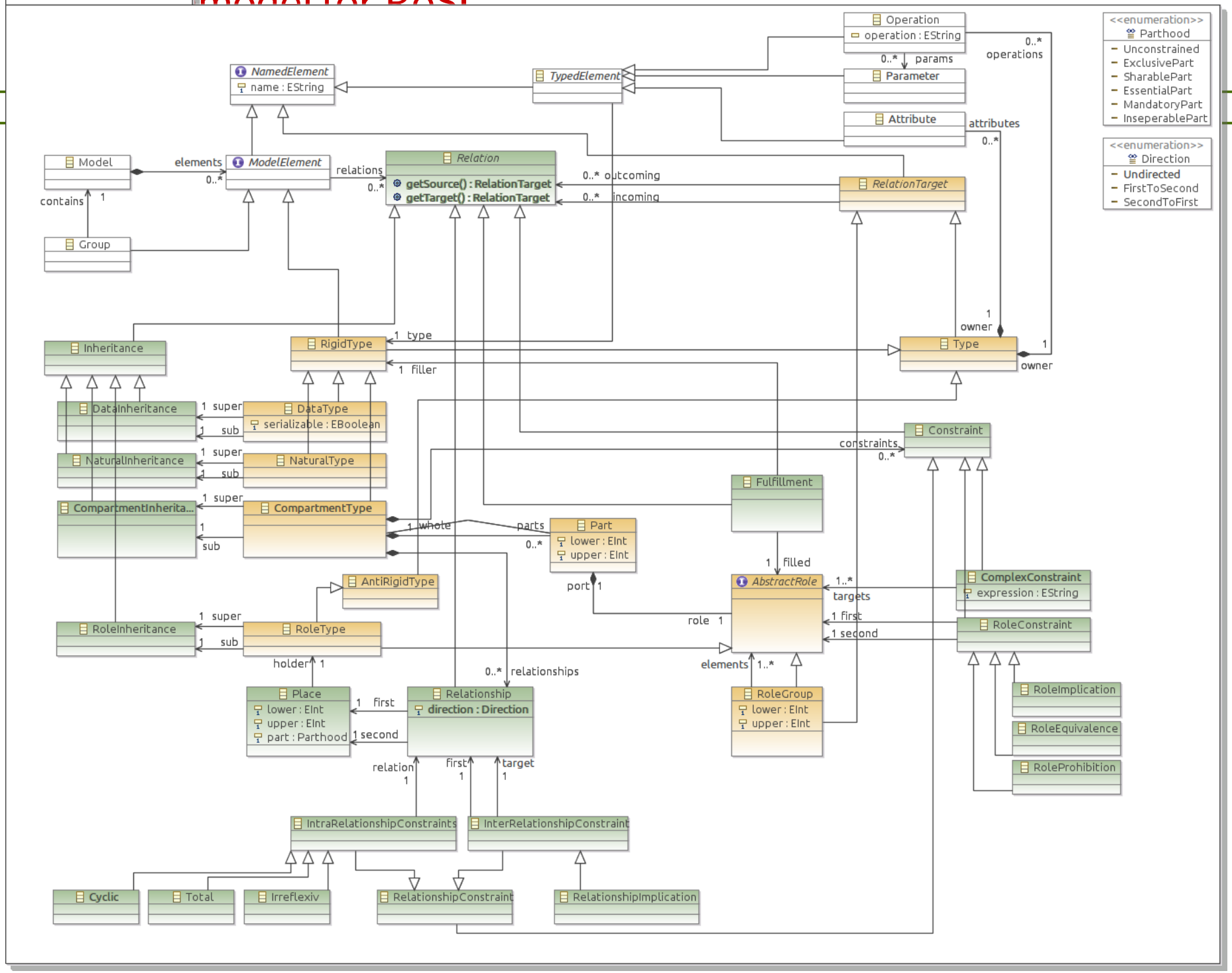
Let

- *N*... set of all NaturalTypes
- *C*... set of all CompartmentTypes

CompartmentType *C=(F,M,R,fills,Rel,card)* with:

- *F*... Set of fields
- *M*... Set of methods
- *R*... Set of contained RoleTypes
- Fills: $R \rightarrow N \cup C$
- $Rel \subseteq R \times R$... set of Relationships
- *card*: $(R \rightarrow N \times N) \cup (Rel \rightarrow N \times N \times N \times N)$
  - *card(r)=(l,u)* with $r \in R$ and *l* and *u* denotes the lower bound and upper bound
  - *card(rel)=(l1,u1,l2,u2)* with $rel \in Rel$ and *l1,u1,l2,u2* cardinalities of the relationship

CompartmentRoleObjectModel model for ReSI



The Metamodel Family

- The CROM Metamodel contains various Variation Points (VP)
- Each VP corresponds to one of the 26 classifying questions
- A Variant of the CROM Metamodel can be derived from answering these questions
- It becomes possible to define a common metamodel family for the various role-based modeling approaches

The End

- Thanks to Thomas Kühn for CROM and the slides
- Why is it hard to unify the role concept?
- Why are compartments necessary to group roles in metamodels?