

A UML Profile for Goal-Oriented Modeling

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SDL Forum 2009, Bochum, Germany

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Why Goal-oriented Modeling (GoM)?

- Goals are important drivers for requirements elaboration
 - Stakeholders goals are complex and often conflict
- GoM is meant to express and clarify tentative, ill-defined and ambiguous requirements (especially non-functional ones)
- GoM supports argumentation, negotiation, and conflict detection & resolution
- GoM captures decision rationale and criteria (documentation!)
- GoM provides traceability from strategic objectives to technical requirements, enabling consistency and completeness analysis
- GoM provides a basis for validation, performance management and adaptation
- ***Nothing like this in UML...***

Problem

- UML (Unified Modeling Language) does not address explicitly the modeling of goals.
- Can UML be profiled to support goal-oriented modeling with a semantics rooted in a standard metamodel such as that of URN's Goal-oriented Requirement Language (**GRL**)?
- Can such a profile be supported by a commercial UML tool?

Contributions

- The creation of a UML profile for GRL (URN standard), where UML metaclasses are stereotyped and mapped in detail to GRL's metaclasses. Standard guidelines (ITU-T Z.119) have been followed while defining this profile.
- A proof of concept implementation, which demonstrates the feasibility of supporting such profile in Telelogic Tau G2 4.x
- Illustration of typical usage of this profile with examples where GRL is used standalone in a model, and then where GRL diagrams are combined with selected UML diagrams in a model.

Rest of the Presentation...

- Requirements and background work
- GRL and current tool support (jUCMNav)
- UML profiles
- GRL profile in Tau: Stereotype Mechanism
- GRL profile in Tau: Metamodel Extension Mechanism
- Example
- Evaluation and Conclusions

Requirements

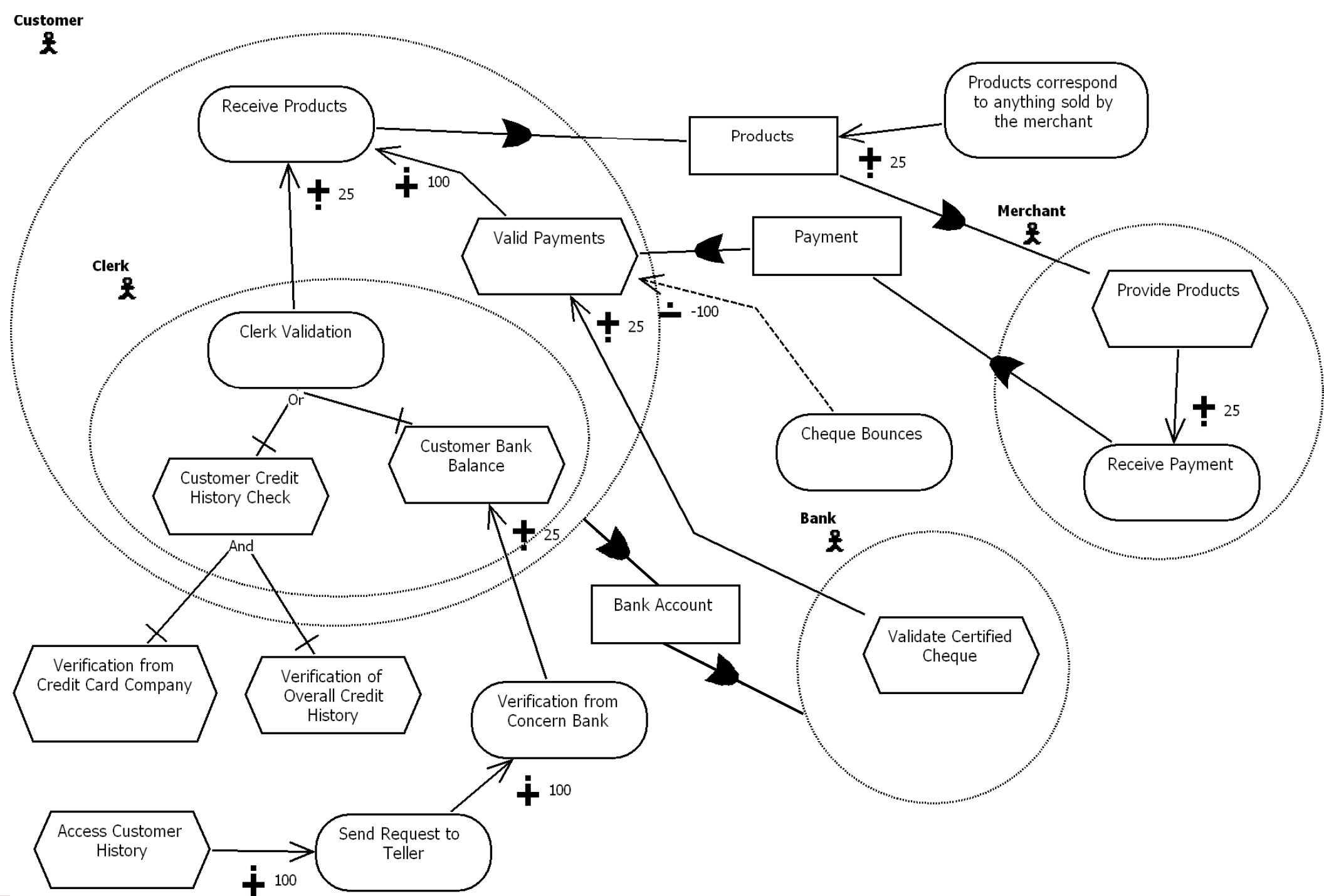
- Some work in the area of UML profiles for goal modeling exist, but the solutions proposed suffer from many shortcomings, including non-compliance to minimal requirements such as:
 - **R1**: Integration with UML
 - **R2**: Diagram pollution avoidance
 - **R3**: Metamodel stability
 - **R4**: Implementability of the profiling mechanism

Sample Related Work

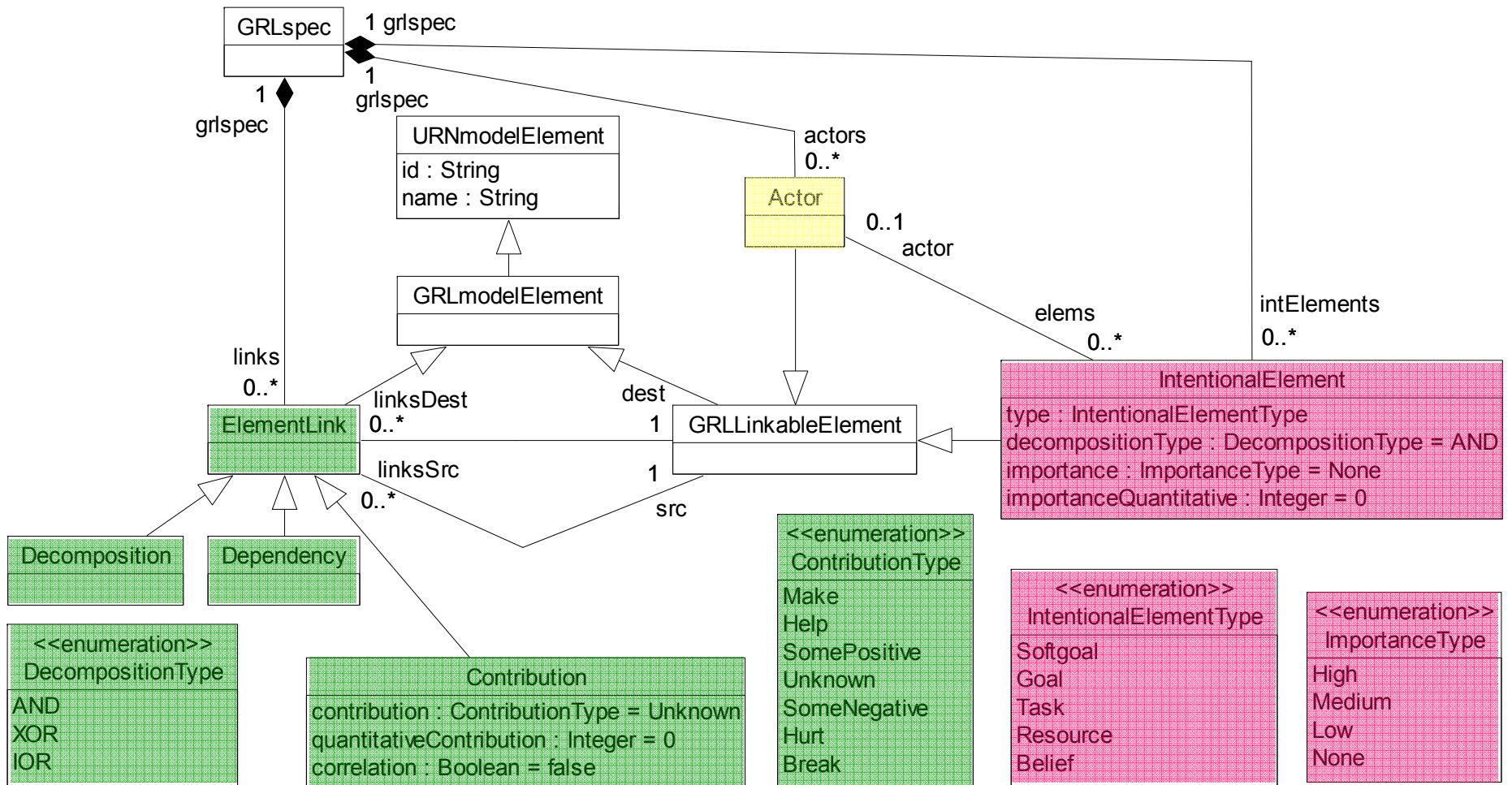
- *Cysneiros et al. (2001): Using UML to Reflect Non-Functional Requirements*
 - Does not satisfies R1 and the remaining requirements are not applicable
- *Supakkul and Chung (2006): UML Profile for Softgoal by Use Case Driven Approach*
 - Satisfies R2, partially satisfies R3, and R4 is not applicable
- *Grangel et al. (2008): UML Profile for Enterprise Goal Modeling*
 - Satisfies R1 and partially satisfies R4
- *Van Lamsweerde (2009): Requirements engineering: From System Goals to UML Models to Software Specifications*
 - Partially satisfies R1 and R3, and R4 is not applicable.

Goal-oriented Requirement Language

- Part of ITU-T's User Requirements Notation (**URN** - Z.151)
- Three main categories of concepts:
 - Actors
 - Intentional elements
 - Links



GRL's Metamodel (Extract)



Current GRL tool: jUCMNav

- An Eclipse-based GRL editor:
 - Supports the User Requirements Notation (GRL + UCM)
 - Allows users to create and maintain GRL models
 - Supports the analysis of GRL models
 - Supports the creation of links and annotations
 - Supports OCL-based constraints and metrics
 - Exports to various formats
 - Open source (EPL)
- Version 4.0 to become available soon.
 - <http://jucmnav.softwareengineering.ca/jucmnav/>

View all elements

jUCMNav Debug

Navigator

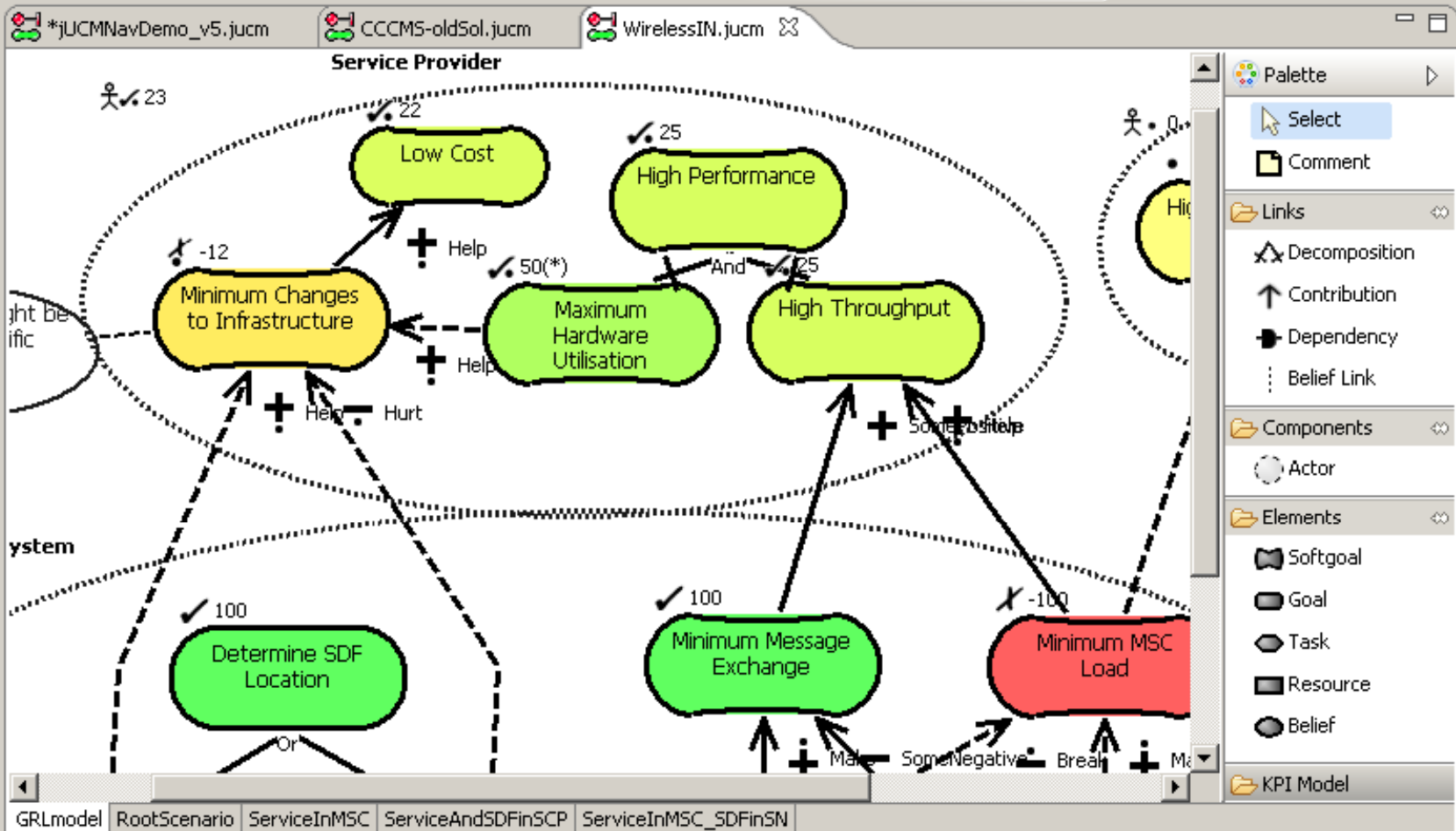
- MCEtech09.jucm
- radio 4-gM.jucm
- WirelessIN-inMSC.jucm
- WirelessIN-inSCP.jucm

Outline

- GRLmodel
 - Vendor
 - Service Provider
 - User
 - System
 - Belief76
 - Low Cost
 - High Performance
 - High Evolveability
 - Minimum Changes to

Elements

- Low Cost
- High Performance
- High Evolveability
- Minimum Changes to Infra
- Maximum Hardware Utilis
- High Throughput



Scenarios and List of Key Pe

- GRL Evaluation Strategies
 - ArchAlternatives
 - GRL ServiceAndSDFinSCP
 - GRL ServiceInMSC
 - GRL ServiceInMSC_SDFinSN
 - Enumerations
 - Variables

Standard Name: ServiceInMSC_SDFinSN

Metadata

Advanced

Description:

A UML Profile Can...

- Enable the tailoring of UML to a particular domain.
- Specify new “standard elements”.
 - Addition of new stereotypes and attributes
- Specify “well-formedness rules”.
 - Addition of new constraints without violating existing/inherited constraints
- Specify semantics
 - Decisions on semantics variation points.

Profiling Mechanisms

Profiles can usually be created in one of two ways:

- 1) Stereotype Mechanism (**SM**)
- 2) Metamodel Extension Mechanism (**MEM**)

Stereotype Mechanism

- Very straightforward way of customizing UML.
- Extension of basic UML elements.
- Allows simple customizations (names, attributes, appearance).
 - For instance, GRL's *task* intentional element can be represented as a stereotype of UML's *class*.
- Limitations
 - GRL elements that are just stereotypes of existing UML elements can only be used in regular UML diagrams.
 - Non-GRL elements can be included in GRL diagrams.
 - Pollution! Tend to violate R2 and leads to unfriendly editors and confusing models.

Metamodel Extension Mechanism

- More robust extension mechanism.
- Includes all functionalities of stereotype mechanism.
- Also allows to customize non-basic UML elements such as *diagrams*.
 - E.g., a GRL diagram can be represented as a metaclass extension of UML's class diagram and then restrictions on the GRL diagram can be added to allow only GRL elements.
- More flexible but more complex way of profiling.

UML Profile for GRL: Highlights

Stereotype	Stereotyped metaclass (UML)
GRLspec	Model
GRLmodelElement	NamedElement
GRLLinkableElement	Class
Actor	Class
IntentionalElement	Class
IntentionalElementType	Enumeration
ImportanceType	Enumeration
ElementLink	Relationship
Contribution	Association
ContributionType	Enumeration
Dependency	Association
Decomposition	Association
DecompositionType	Enumeration

Tool Support: Telelogic/Rational Tau G2 4.0

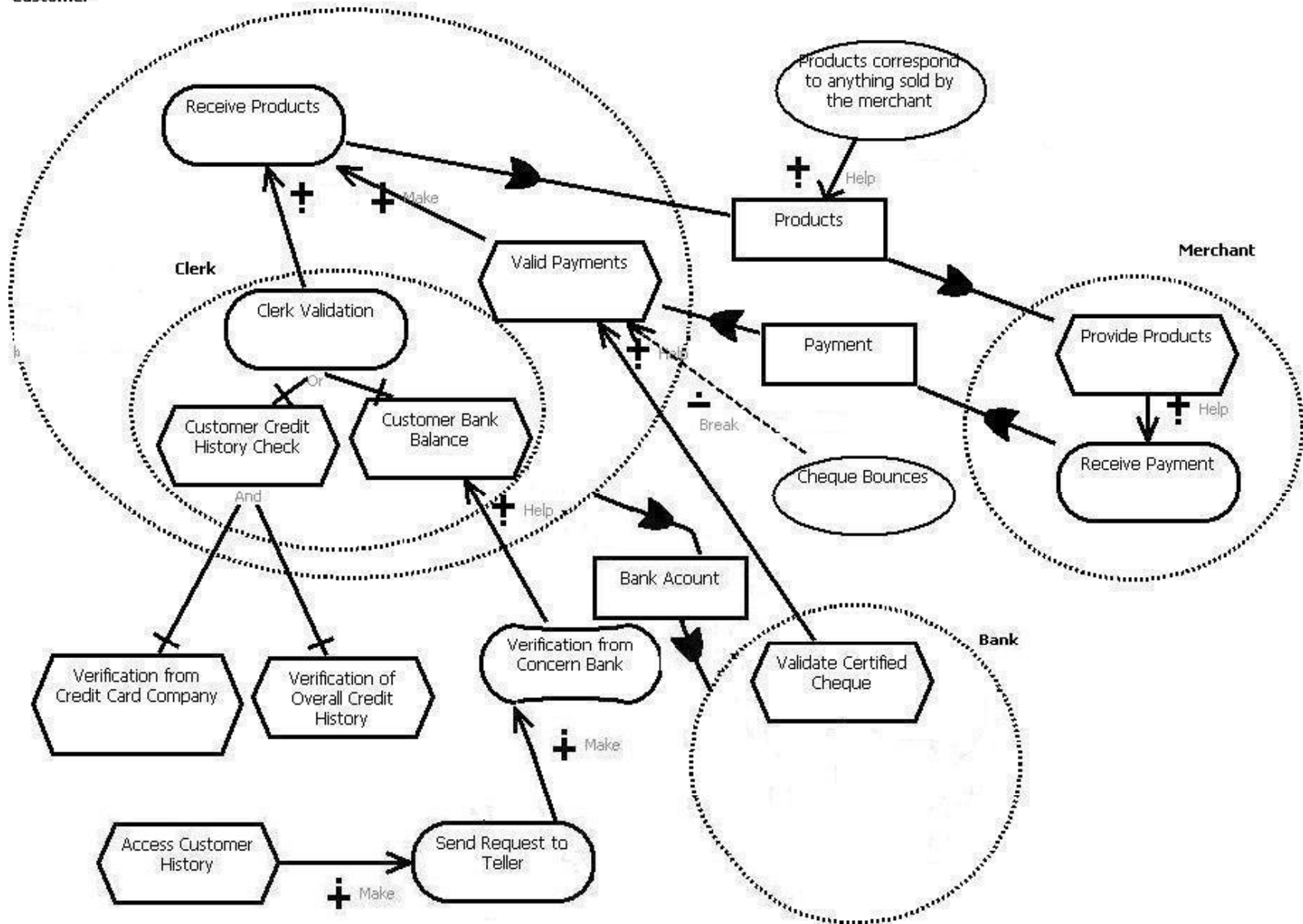
- Supports Model Driven Development (MDD) in a UML-based environment
- Supports both Stereotype Mechanism and Metamodel Extension Mechanism for UML profile creation
 - Both approaches were tested for the GRL profile
- Allows the tailoring of the editor

Example of Profile Usage

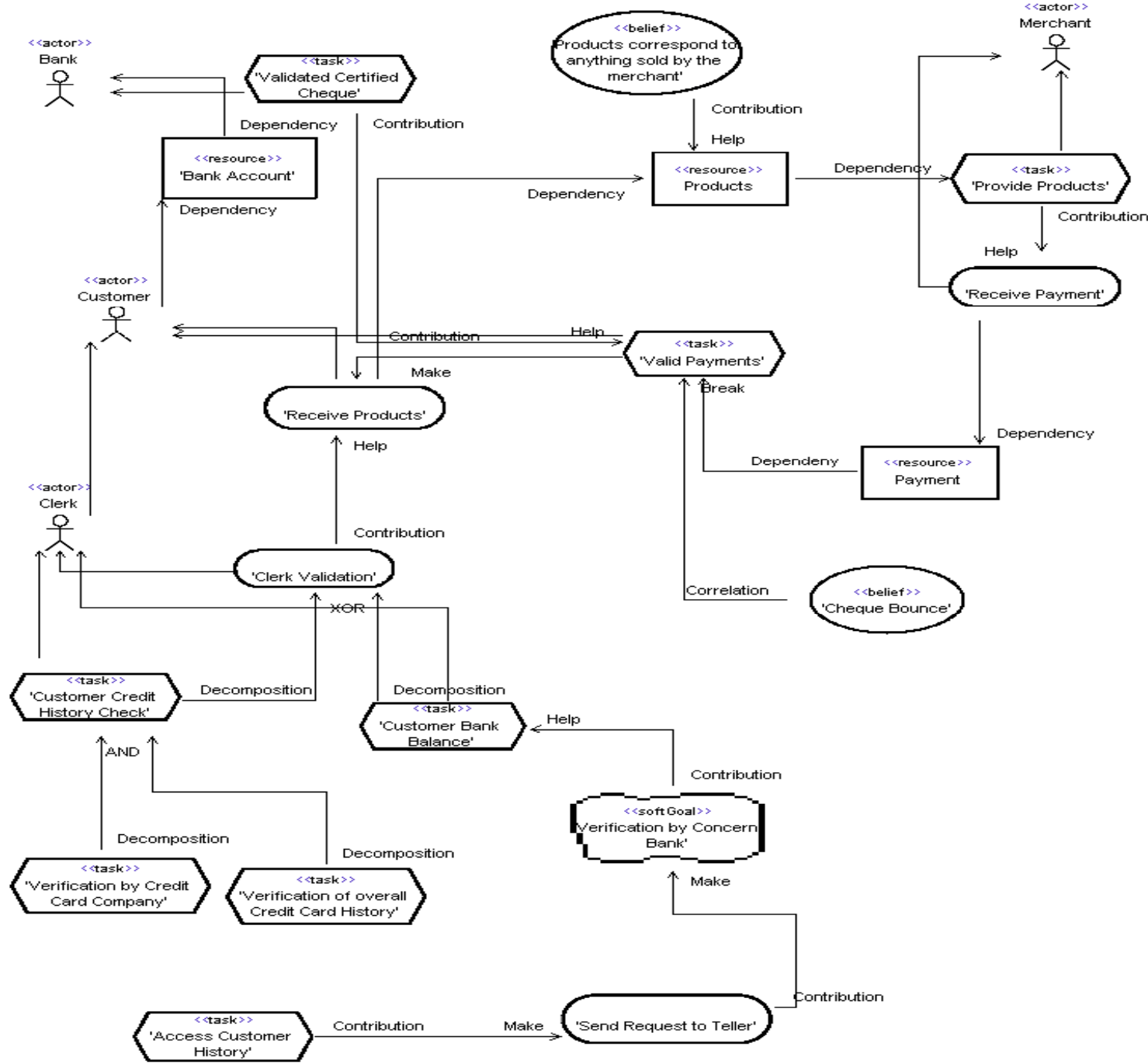
- Merchant and Customer Dependencies
 - Covers almost all the possible usage scenarios of GRL constructs
 - Includes GRL goal, softgoal, task, belief, resource, dependency, contribution, correlation, decomposition and actor
 - Includes four actors: Customer, Clerk, Bank and Merchant

Example in jUCMNav

Customer



Example in Tau G2 – GRL Profile



Tau Support for GRL Profiling

- Provides predefined stereotypes to obtain advanced profile functionalities.
- Many options are in property view
 - makes the environment easier to use.
- Supports the association of customized icon with Enumeration literals which enable us to assign customized icons.
- Allows to create a specific GRL editor with a customized tool palette.
- Provides start link and end link features that allows to navigate from one diagram construct to the other.
- Provides the re-usability of the constructs. A UML diagram can re-use a reference to a GRL construct from another diagram.

Tools Limitations (1/2)

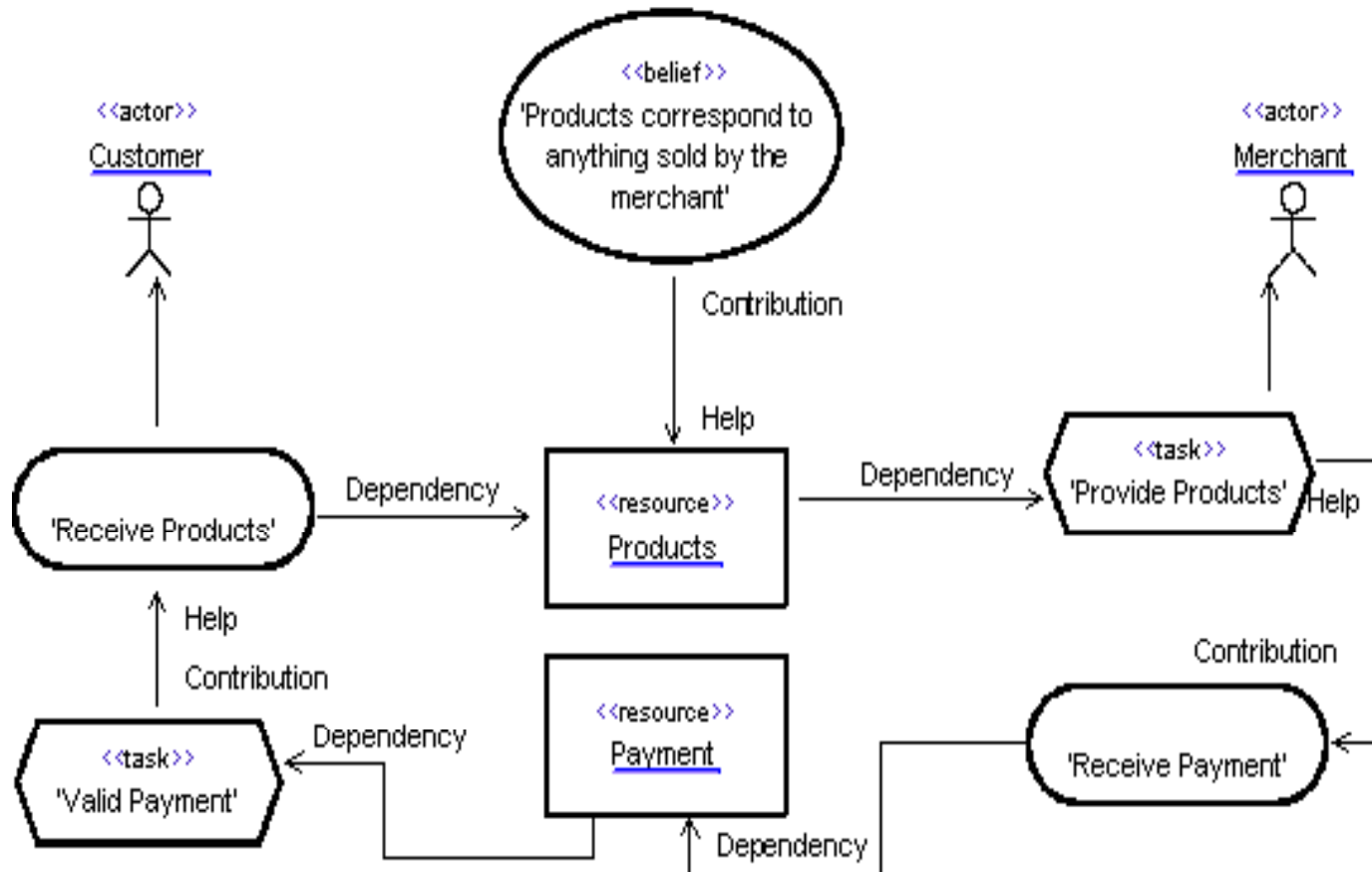
- Tau does not support all of the UML metamodel classes, e.g. Enumeration metaclass and the NamedElement metaclass.
- No construct or mechanism by which an Actor boundary can be created.
- Tau lacks support for the association of customized multiple icons with Enumeration literals.
- The stereotypes that are associated with metaclasses other than the Class metaclass are neither applied nor selected automatically by the tool at runtime.

Tools Limitations (2/2)

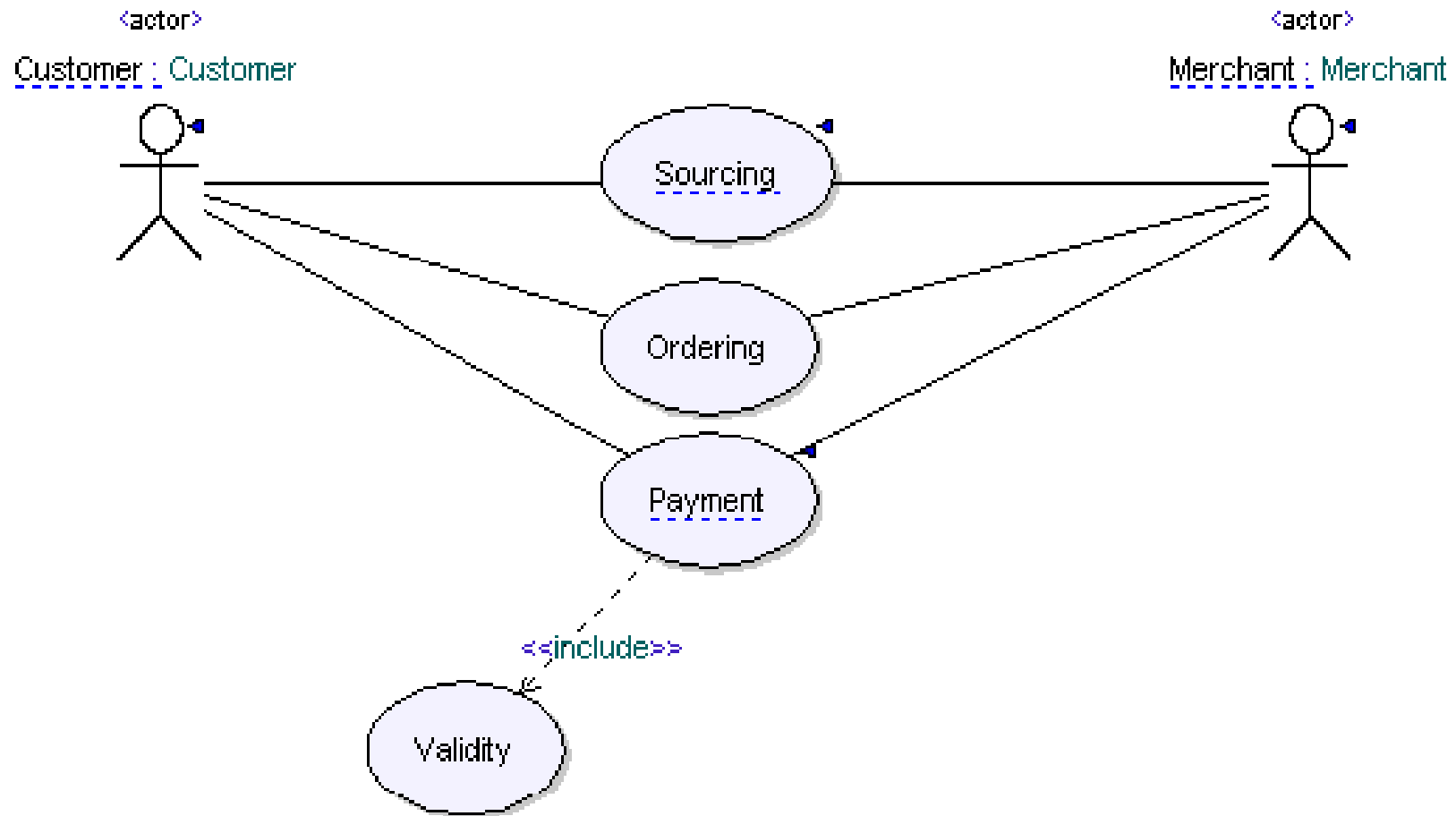
- Some limitations handling the “GRL view”
- Decompositions differ visually in the jUCMNav example from the Tau GRL profile. This is because there is no customized appearance for links in our Tau GRL profile.
- Tau does not support OCL validation for profiling. There is a notion of informal constraints in Tau that are limited to text.

Profile Analysis (1/4)

- Integration with UML *Satisfied*
 - UML diagram and GRL Diagram connected with each other
 - Reusability of constructs



Profile Analysis (2/4)



Profile Analysis (4/4)

- Metamodel Stability *Satisfied*
 - Considered metamodel is standard (ITU-T Z.151)

- Implementability of the Profiling Mechanism *Satisfied*
 - Implementation in both Stereotype Mechanism and Metamodel Extension Mechanism

Conclusions

- Tool-supported, UML Profile for Goal-oriented modeling will make GRL more accessible to UML users.
 - Satisfies the 4 requirements identified
 - Current editor has some visualization/usability limitations
- Thesis contains more examples and analysis results, as well as step-by-step instructions on profile creation
- Z.119 (02/07): *Guidelines for UML profile design*
 - Useful for the profile structure and documentation
 - Does not provide guidance on selecting appropriate UML metaclasses...

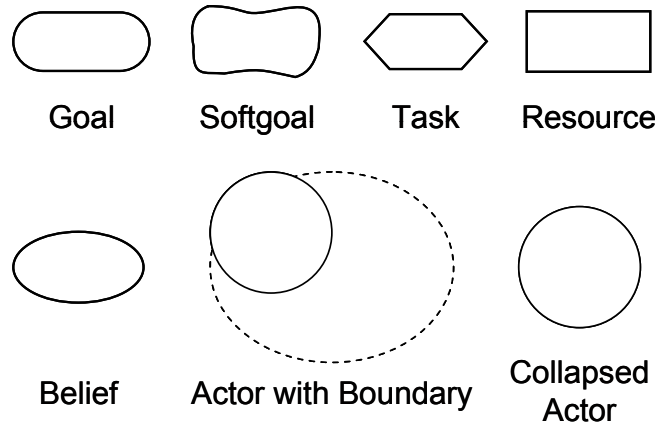
Future Work

- Support of GRL strategies (for analysis) in the profile.
- Usability / practice study.
- Support of UCM for complete URN profile?
 - Looking for volunteers 😊
 - Towards ITU-T Z.159 standard on URN *or* GRL profile

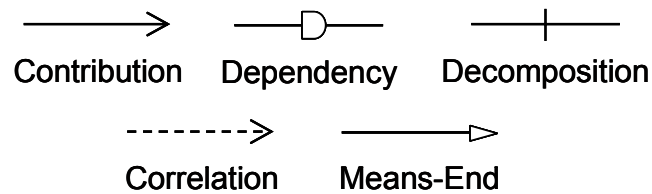
Thank you!

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 - Master of Computer Science thesis available online
 - <http://www.UseCaseMaps.org/pub>
- jUCMNav Tool
 - <http://jucmnav.softwareengineering.ca/jucmnav/>

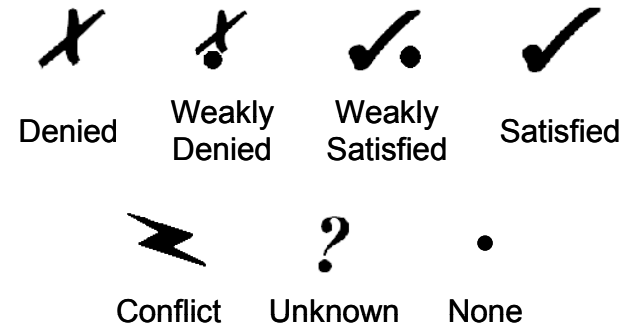
GRL Notation Elements



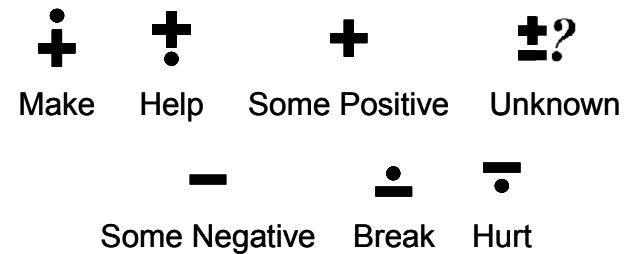
(a) GRL Elements



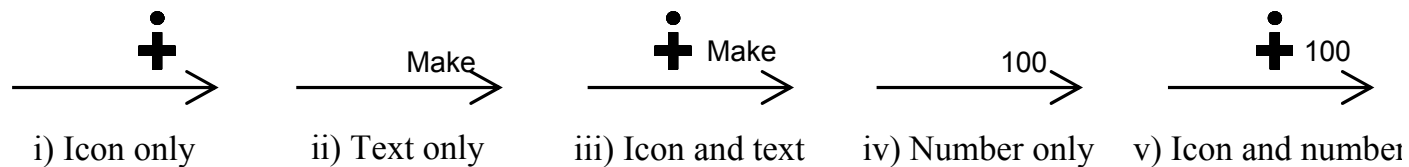
(b) GRL Links



(c) GRL Satisfaction Levels



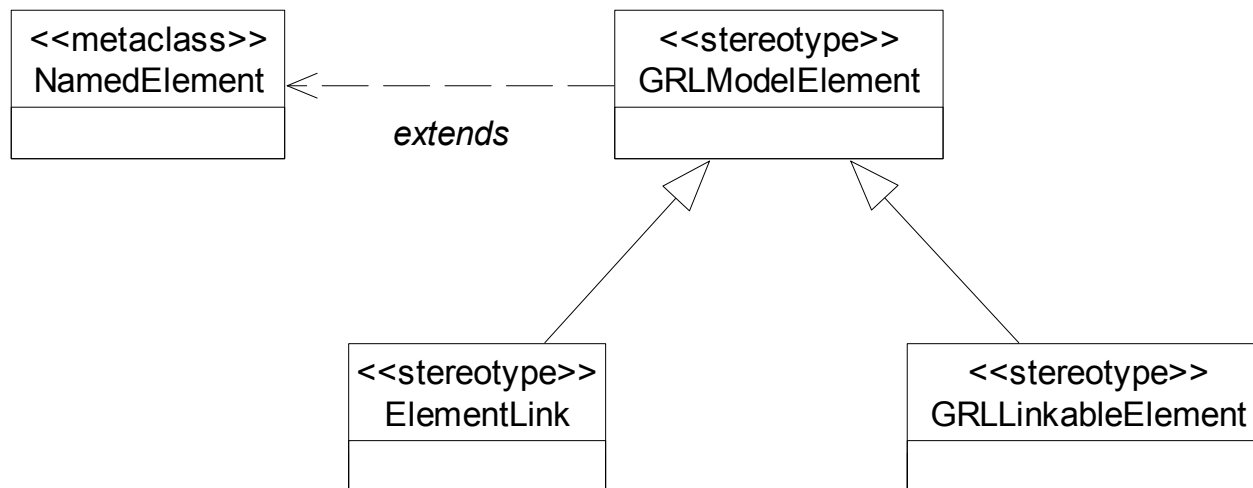
(d) GRL Contributions Types



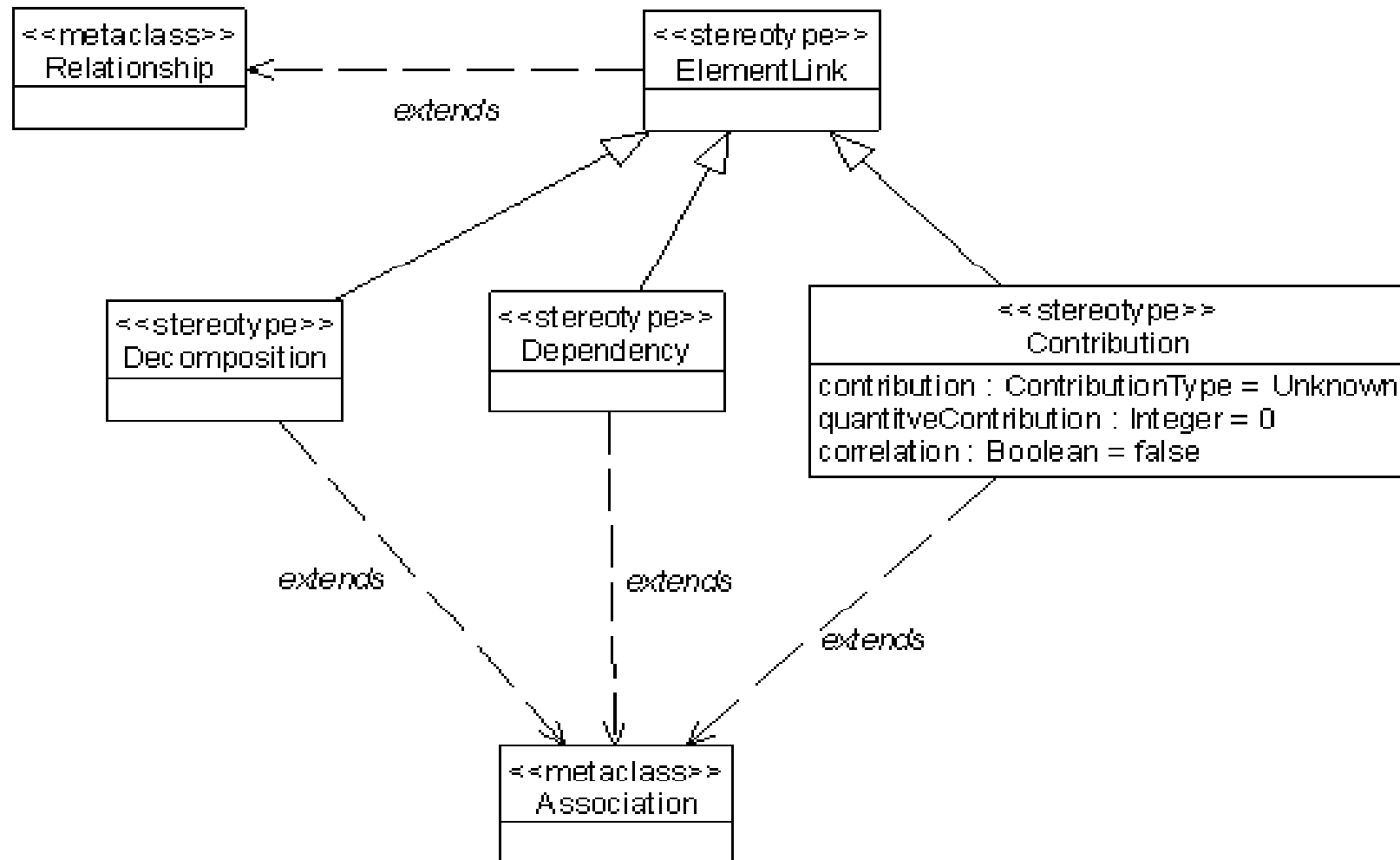
(e) Representations of Qualitative and Quantitative Contributions

Overview of Profile

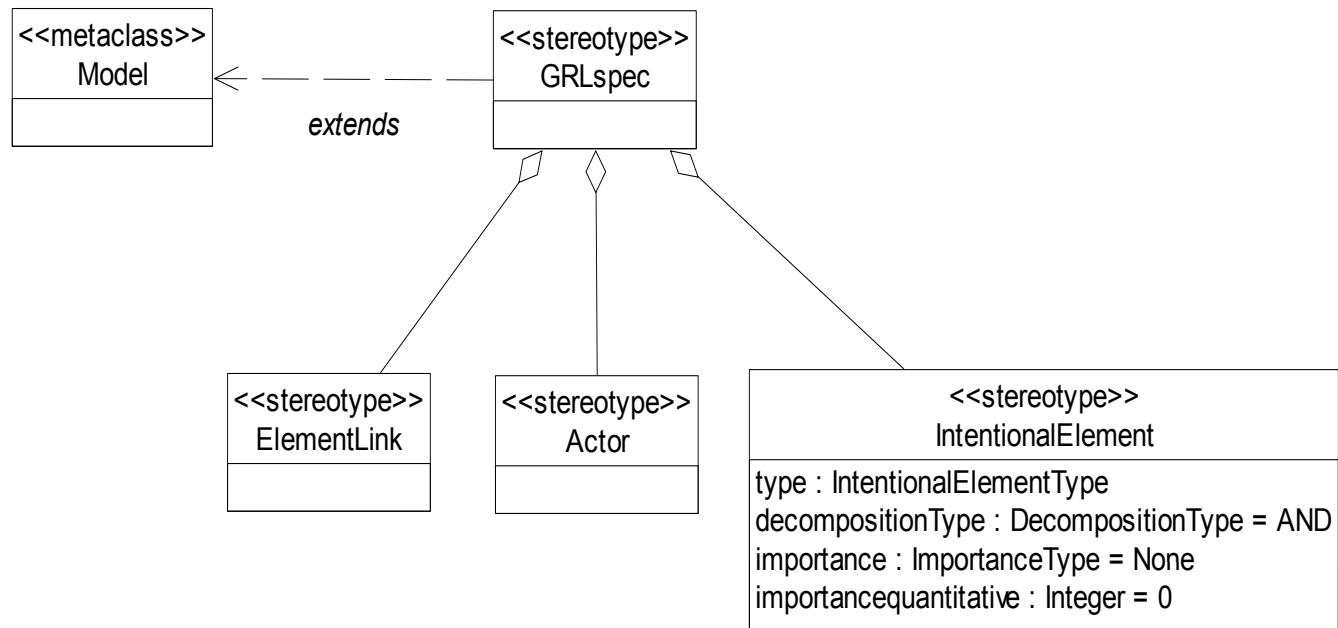
GRL Model Element



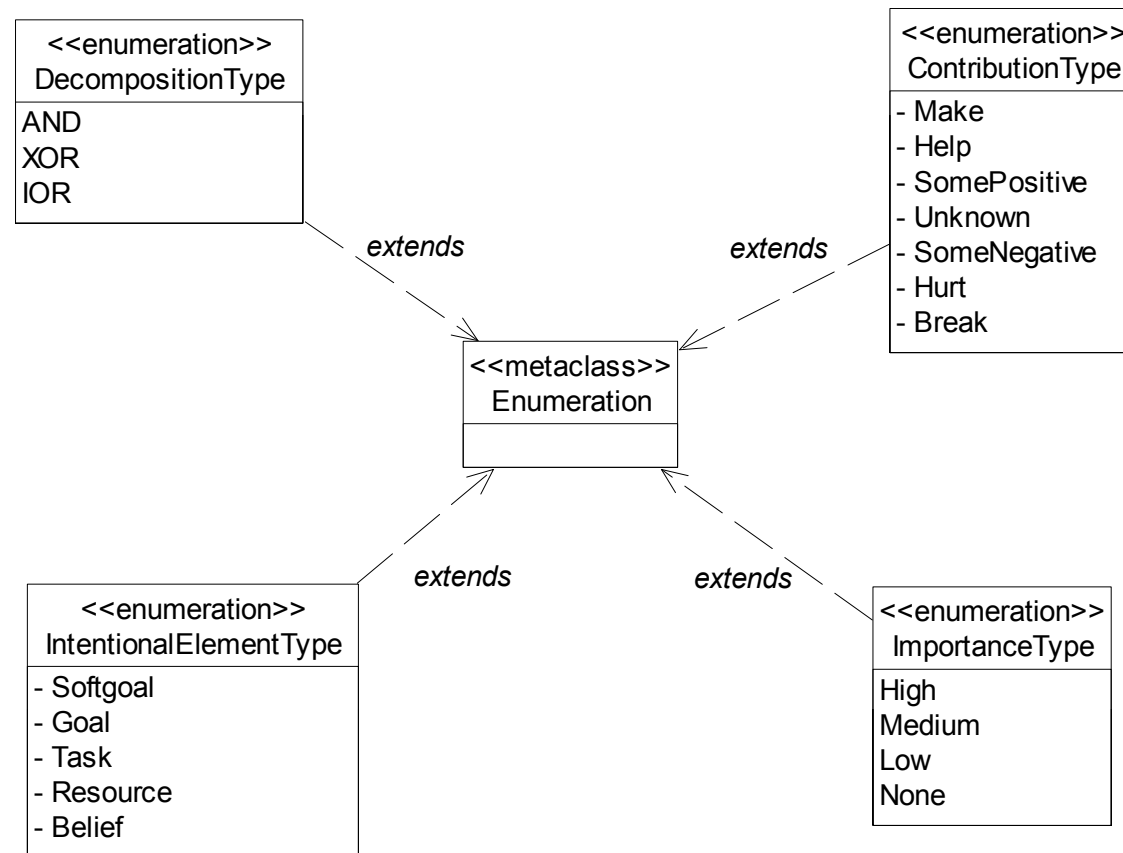
Element Link



GRL Spec

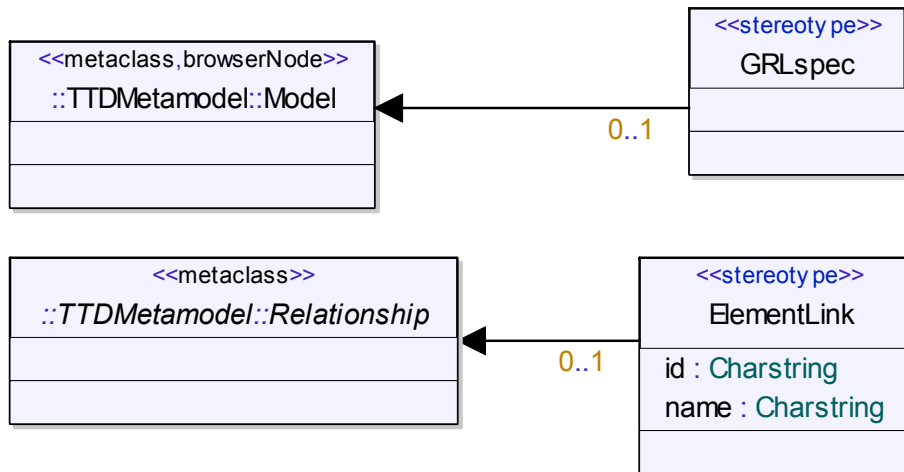
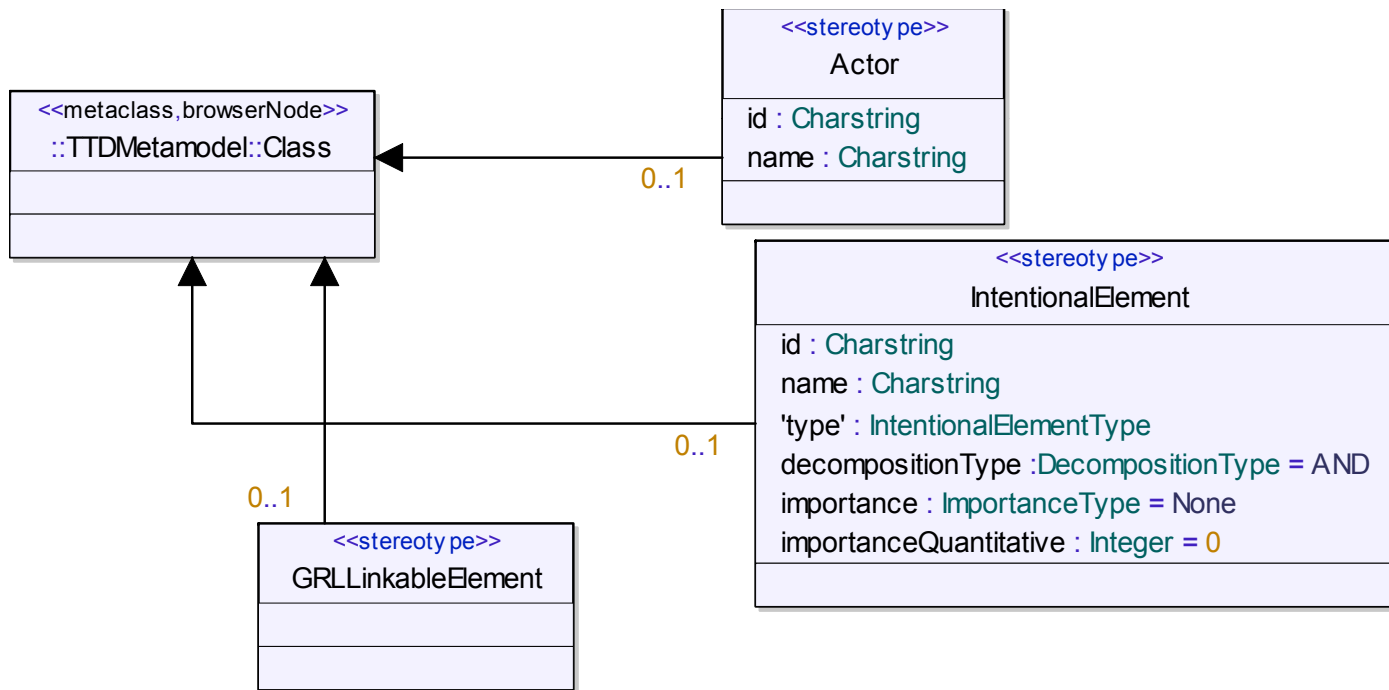


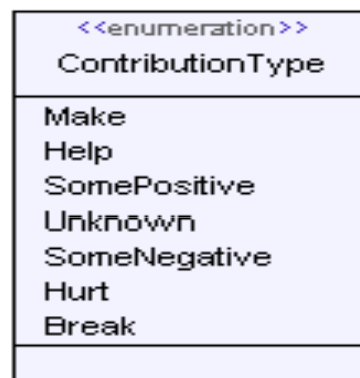
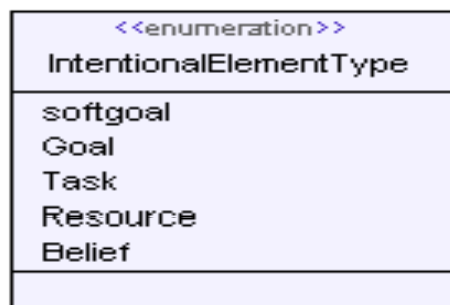
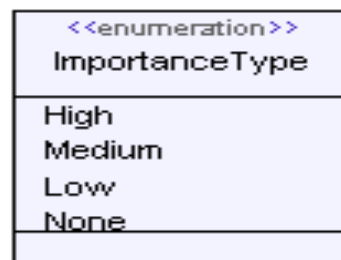
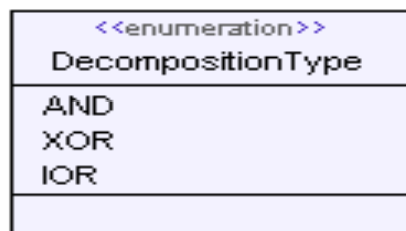
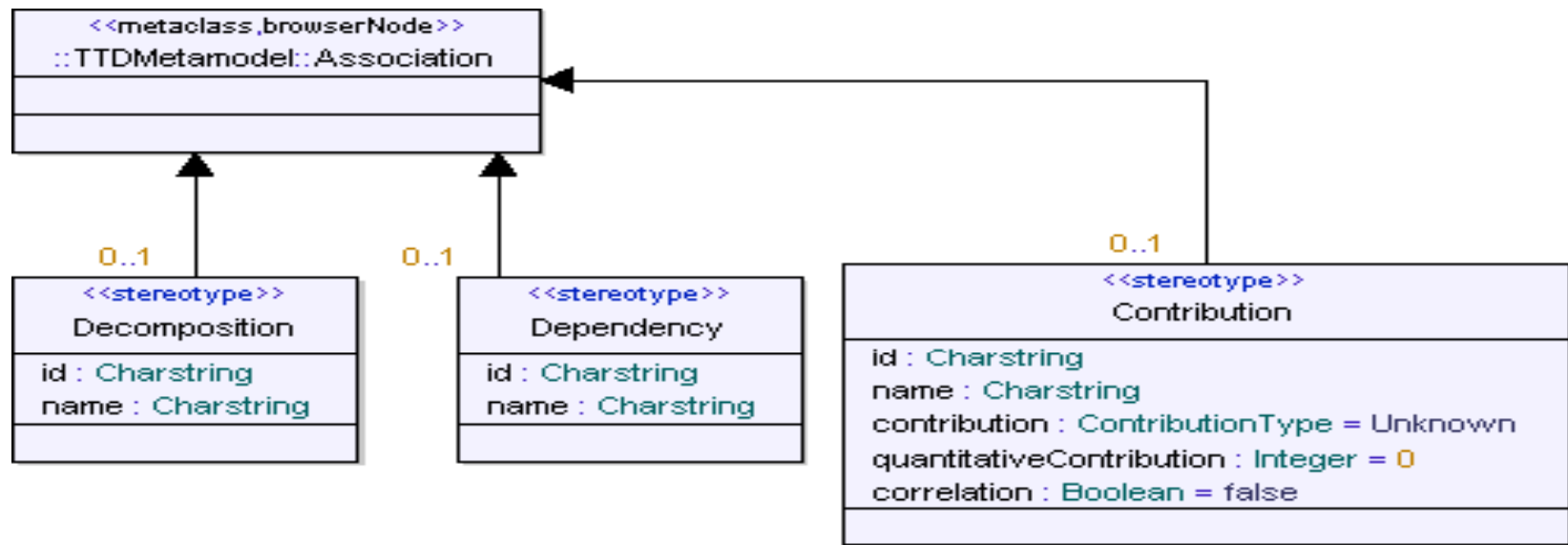
Enumerations



GRL Profile in TAU

Stereotype Mechanism





GRL Profile in TAU

Metamodel Extension Mechanism

Four Sub-Packages

- **GRL Model**
 - Contains all metaclasses used for GRL model creation.
- **GRL Editor**
 - Contains all of the information necessary to create a GRL editor, to specify which information can be kept by the editor, as well as to whom this information can be passed to.
- **GRL Concrete Elements**
 - Shows the metaclasses created for GRL elements. These metaclasses describe the actual GRL constructs.
- **GRL Abstract Elements**
 - Contains all of the stereotypes that represent the GRL profile elements.

