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Semantic-Based Aspect Interaction Detection with Goal Models

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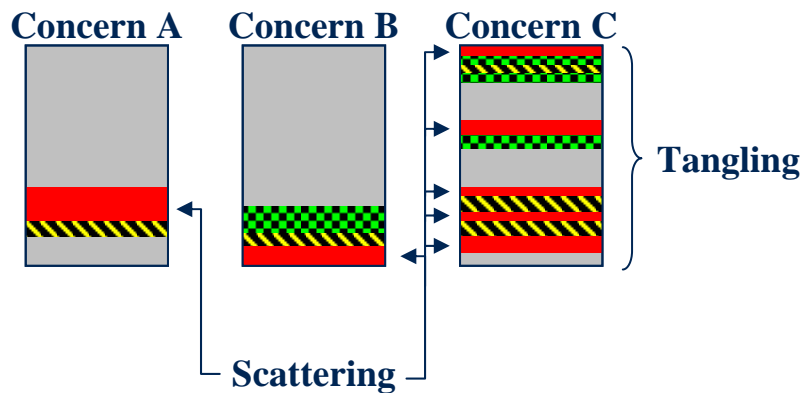
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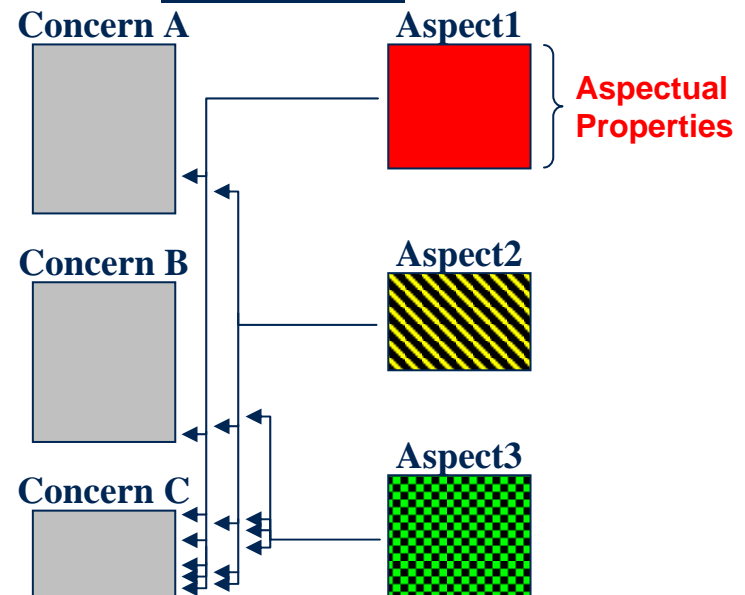
Background: Aspect-oriented Modeling

- Aspects address the problem of one concern **crosscutting** other concerns in a system or model
- Aspects can encapsulate concerns even if they are crosscutting

Without Aspects



With Aspects



(each aspect contains a **composition rule** illustrated by the arrows that defines where to add the aspect)

   ... 3 Crosscutting Concerns (Aspect1, Aspect2, Aspect3)

Motivation

- Aspect Interaction Problem is closely related to the Feature Interaction Problem
 - Multiple aspects may be applicable at a given point in the base model
- Syntactic Interactions can be detected by comparing syntax
 - In the best case, aspects may simply be ordered (e.g., an aspect may assume certain modeling elements in the base are introduced by another aspect)
- Semantic Interactions require a context-based interpretation of the meaning of models
 - In the worst case, there may be deep semantic conflicts (e.g., inherent trade-offs between two non-functional aspects such as security and performance)
 - Security mechanisms must be enforced → performance impact
 - Performance aspect may cache results → security implications



Motivation (2)

- Our approach to address semantic interactions
 - Lightweight **semantic annotations** of aspect models
 - Model the semantic impact of aspects on each other in a goal model called an **influence model**
 - Identify and trade-off semantic aspect interactions with influence model
 - Reason about stakeholder needs and aspect interactions with the help of qualitative or quantitative evaluation mechanisms
 - Novel research direction

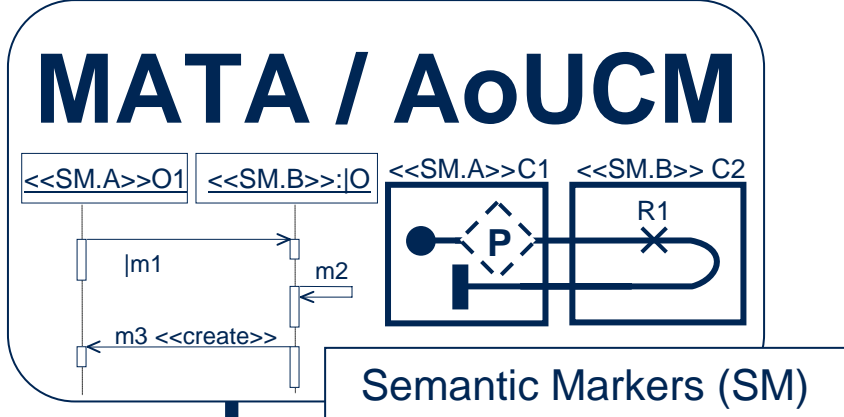


Table of Contents

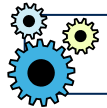
- Overview of our Approach
- Example: Electronic Voting Machine
 - Reporting Use Case (Base Model)
 - Aspects
 - Composed Model
- Goal-oriented Requirement Language (GRL)
- Goal Model for Electronic Voting Machine
- Conclusion and Future Work



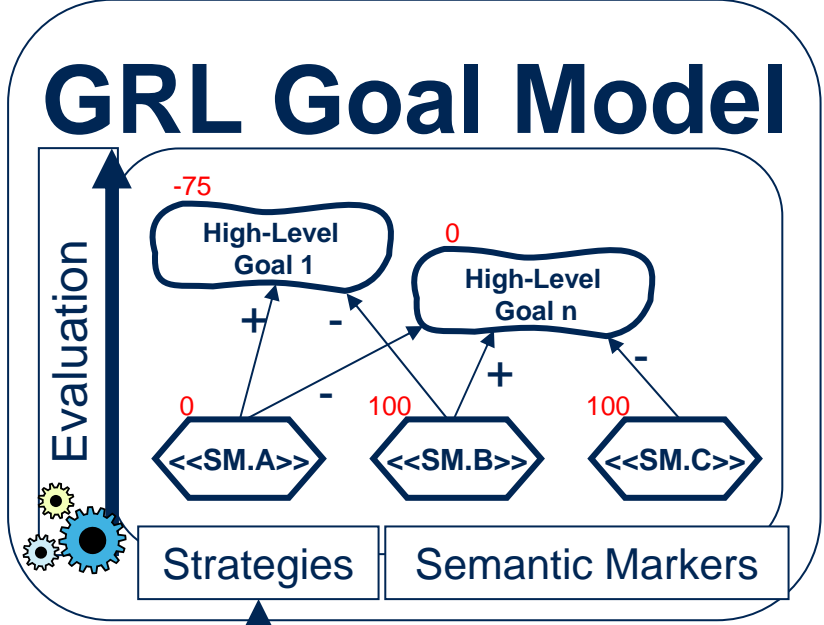
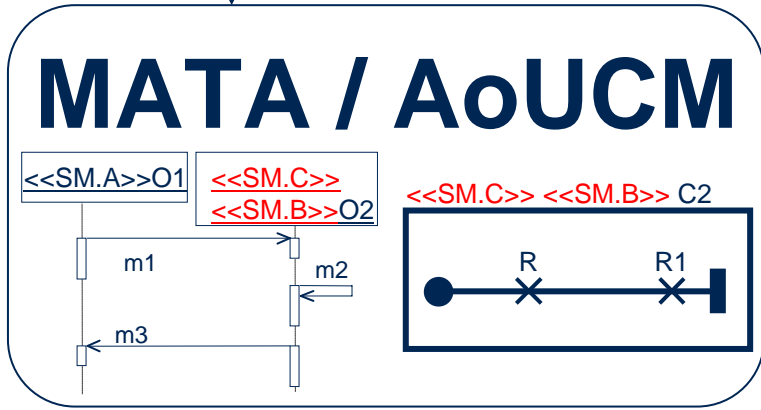
Overview



Semantic Markers (SM)



Composition



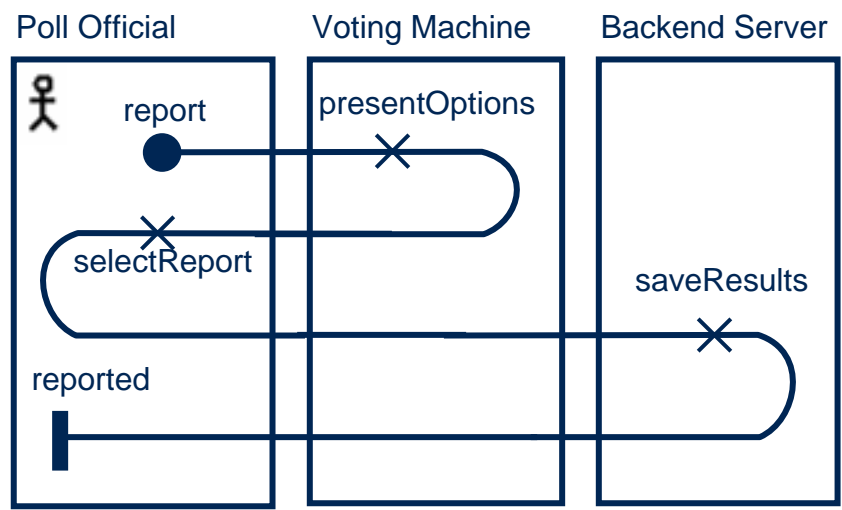
Evaluation

Values for initial satisfaction levels

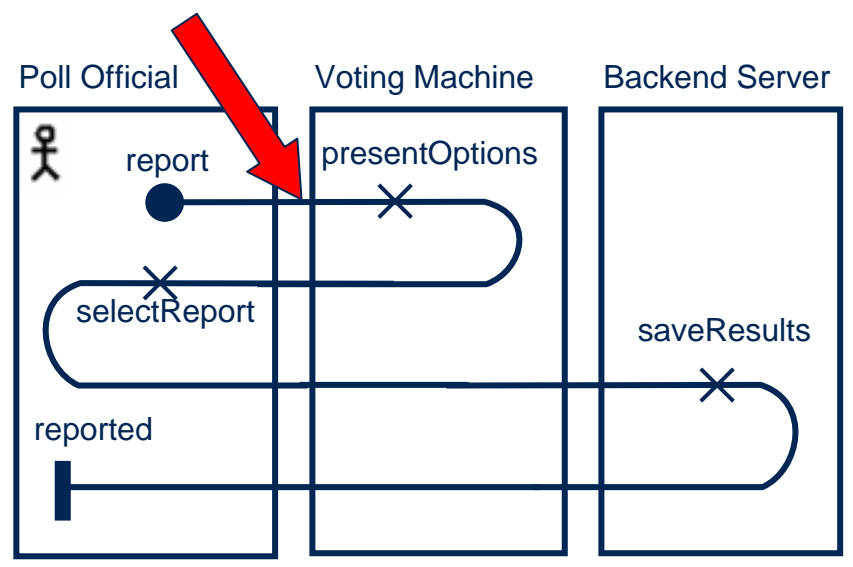
AoUCM ... Aspect-oriented Use Case Maps
 GRL ... Goal-oriented Requirement Language
 MATA ... Modeling Aspects Using a Transformation Approach



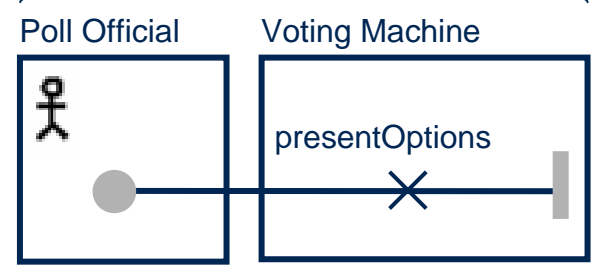
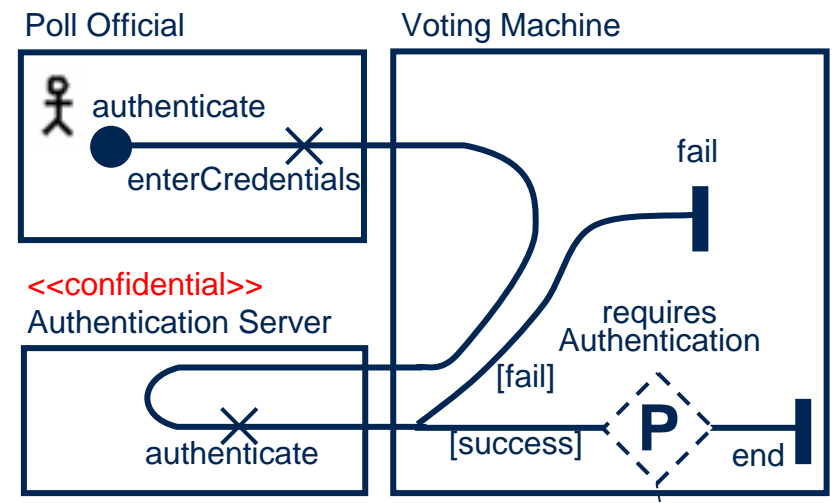
Electronic Voting Machine: Reporting Use Case



Electronic Voting Machine: Authentication Aspect



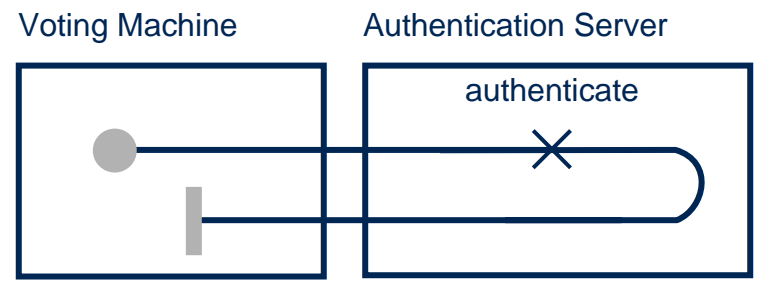
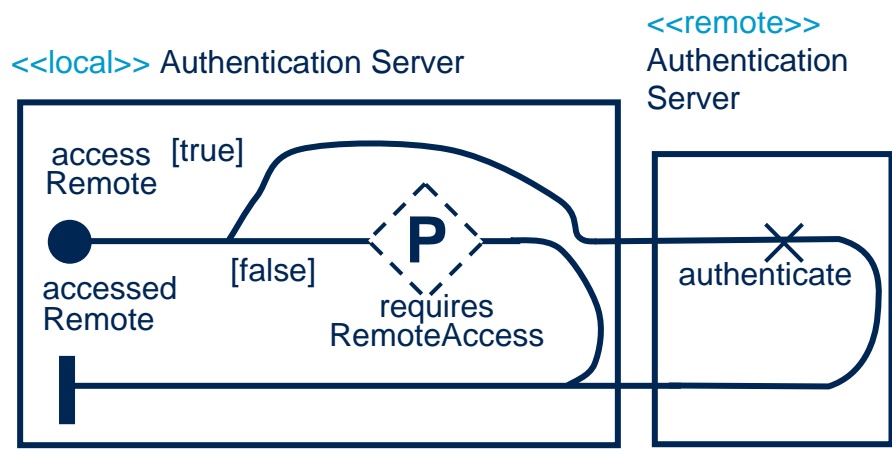
Aspectual Properties (Behavior & Structure)



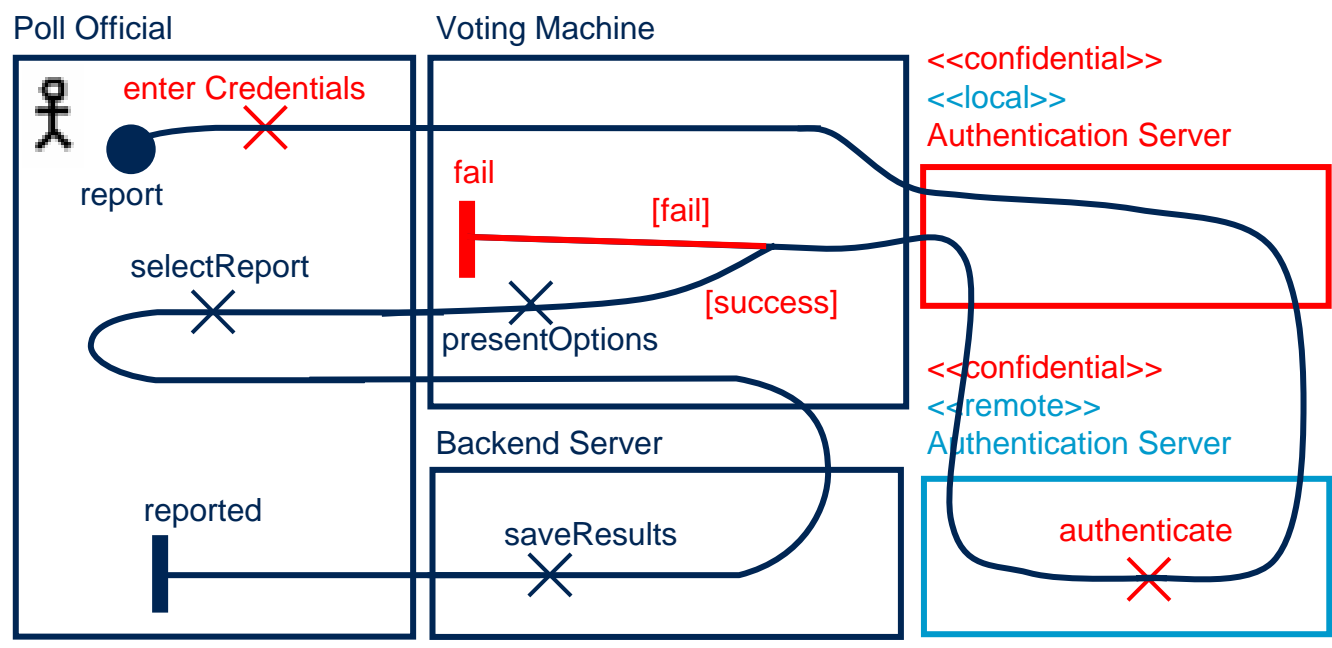
Pattern for Composition Rule



Electronic Voting Machine: Remote Service Aspect



Electronic Voting Machine: Composed Model



- █ Reporting Use Case
- █ Authentication
- █ Remote Service



Goal-oriented Requirement Language (GRL)

- GRL is integrated with Use Case Maps (UCM) in the User Requirements Notation (URN)
 - URN is the **first** and **currently only** standard which explicitly addresses goals in addition to scenarios in a graphical way in one unified language (International Telecommunication Union, ITU-T Z.150 series)
- GRL is based on i^* (concepts / syntax) and the NFR Framework (evaluation mechanism)
 - Ideally suited to capture **qualitative** relationships (as required by the influence model)
 - **Reason** about stakeholder needs and aspect interactions with the help of qualitative or quantitative evaluation mechanisms

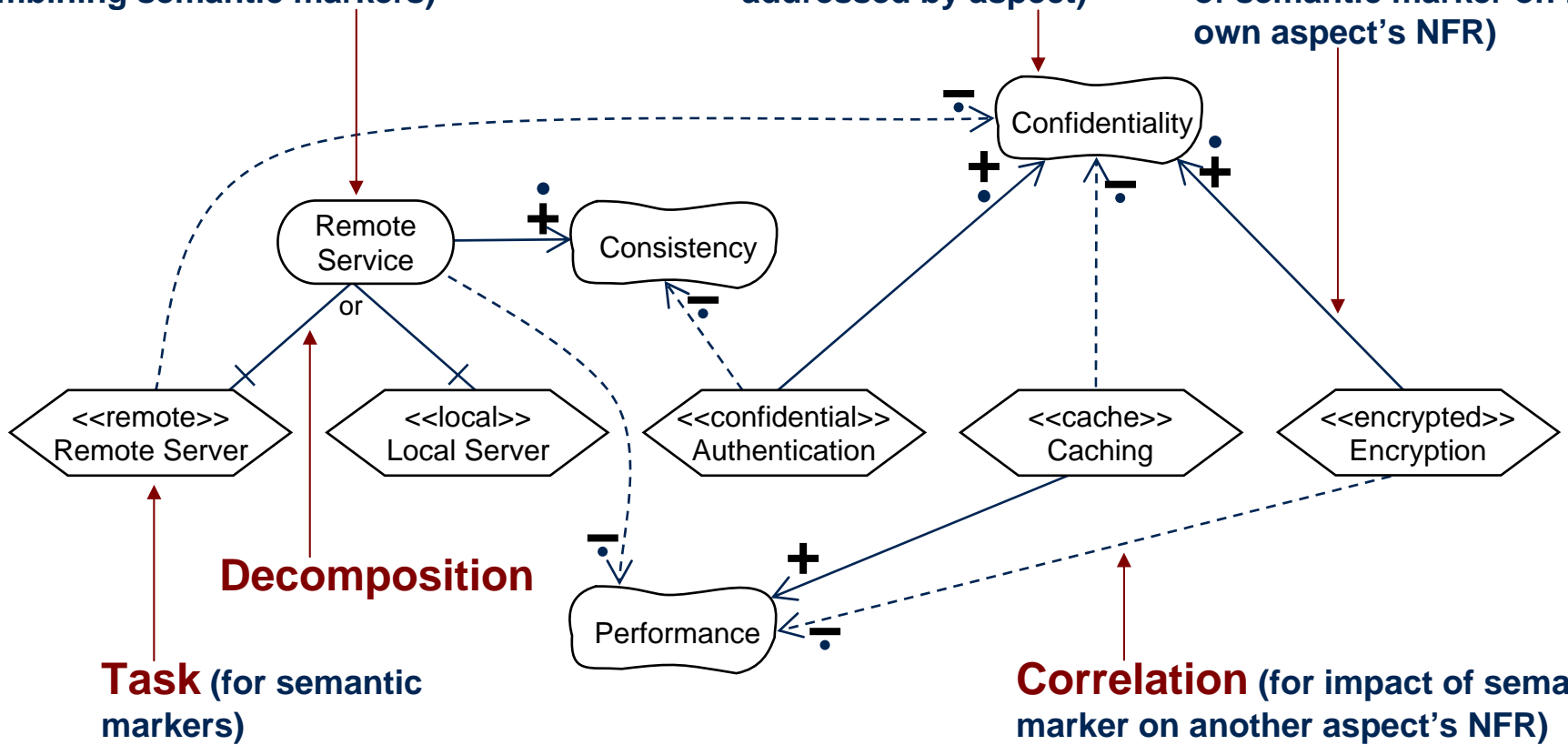


Electronic Voting Machine: Goal Model

Goal (intermediate node for combining semantic markers)

Softgoal (for NFR addressed by aspect)

Contribution (for impact of semantic marker on its own aspect's NFR)



Task (for semantic markers)

Correlation (for impact of semantic marker on another aspect's NFR)

GRL Contribution Types:

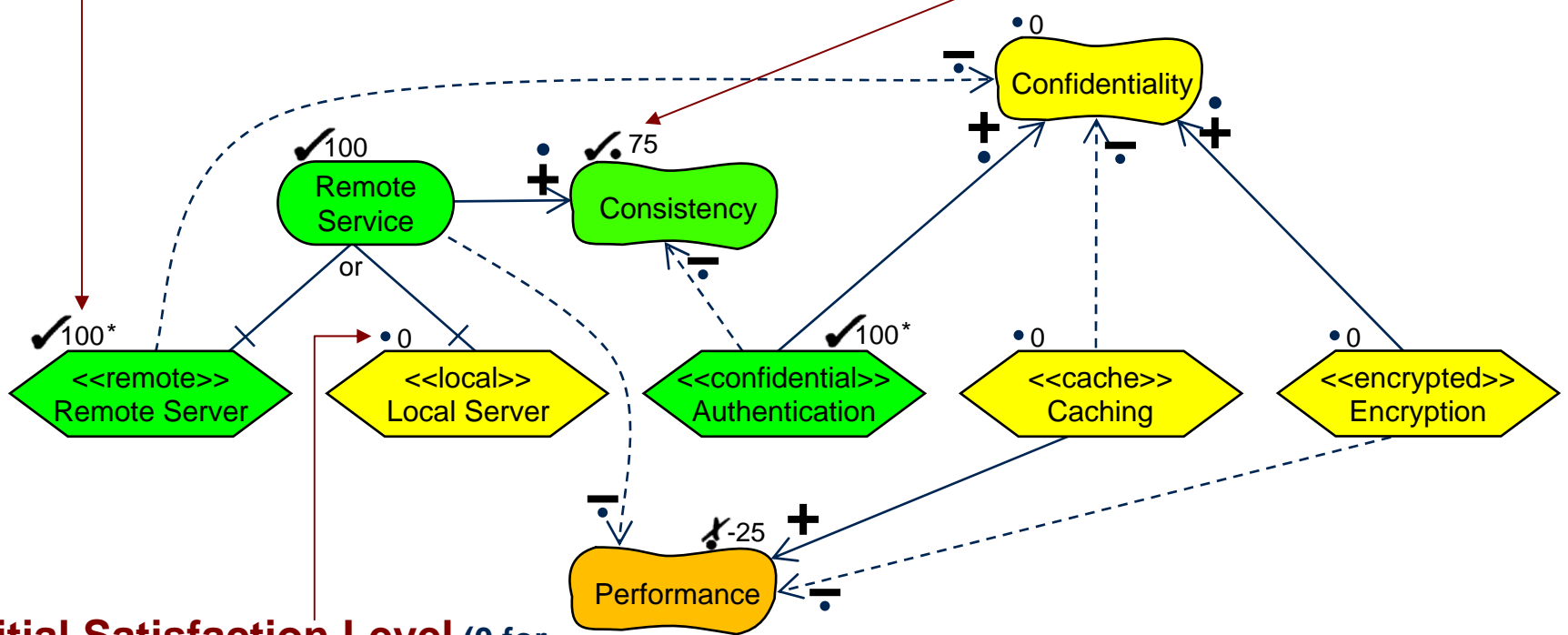
- 
 Make
- 
 Some Positive
- 
 Help
- 
 Hurt
- 
 Some Negative
- 
 Break



Electronic Voting Machine: Evaluated Goal Model

Initial Satisfaction Level (100 for semantic marker in use; indicated by *)

Propagated Satisfaction Level (for each aspect's NFR)



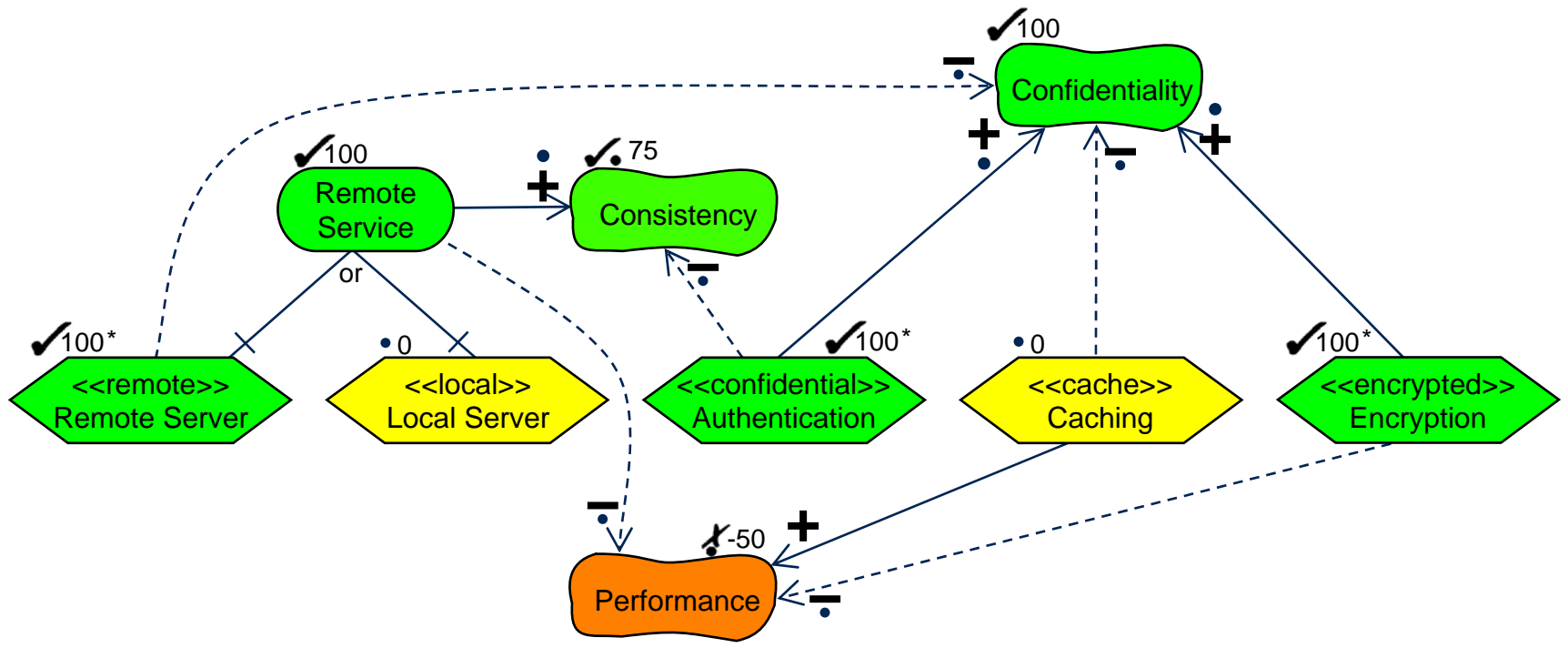
Initial Satisfaction Level (0 for semantic marker not in use; default value)

GRL Satisfaction Levels:

Denied	Weakly Denied	None	Weakly Satisfied	Satisfied



Electronic Voting Machine: Evaluated Goal Model 2



GRL Satisfaction Levels:

Denied	Weakly Denied	None	Weakly Satisfied	Satisfied



Conclusion and Future Work

- Presented the first steps towards an approach for semantically detecting interactions between aspect models based on lightweight semantic annotations
- Tool support
 - MATA tool for UML sequence diagrams
 - jUCMNav for AoUCM and GRL
 - not automated at this point: GRL propagation algorithms do not take semantic markers into account → initial satisfaction levels have to be assigned manually
- Empirical studies are needed to compare the benefits versus the additional effort required (one industrial case study exists)
- Use existing, domain-specific, standardized profiles for lightweight semantic annotations

