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Semantic-Based Aspect Interaction Detection with Goal Models

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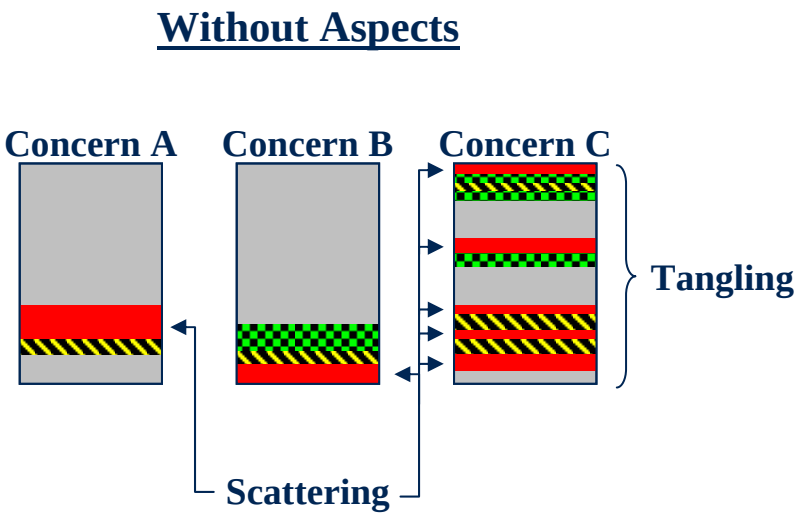
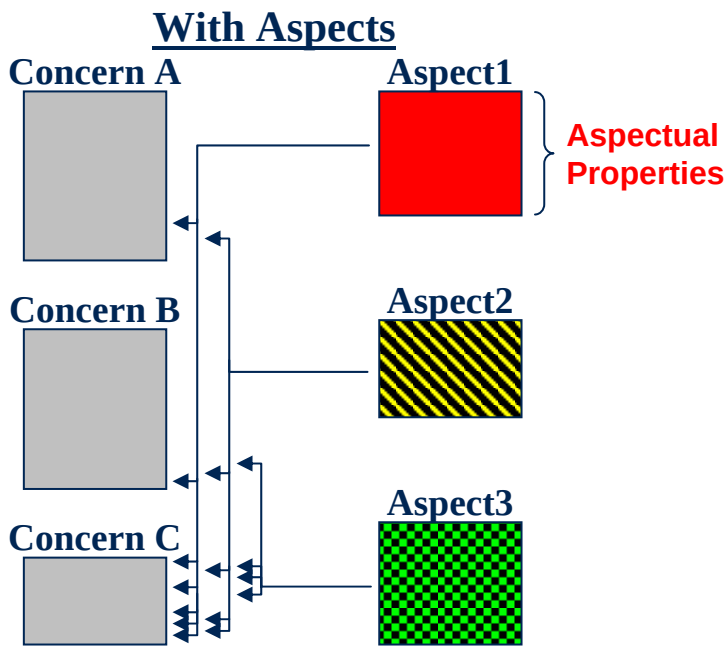
June 12, 2009

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





(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

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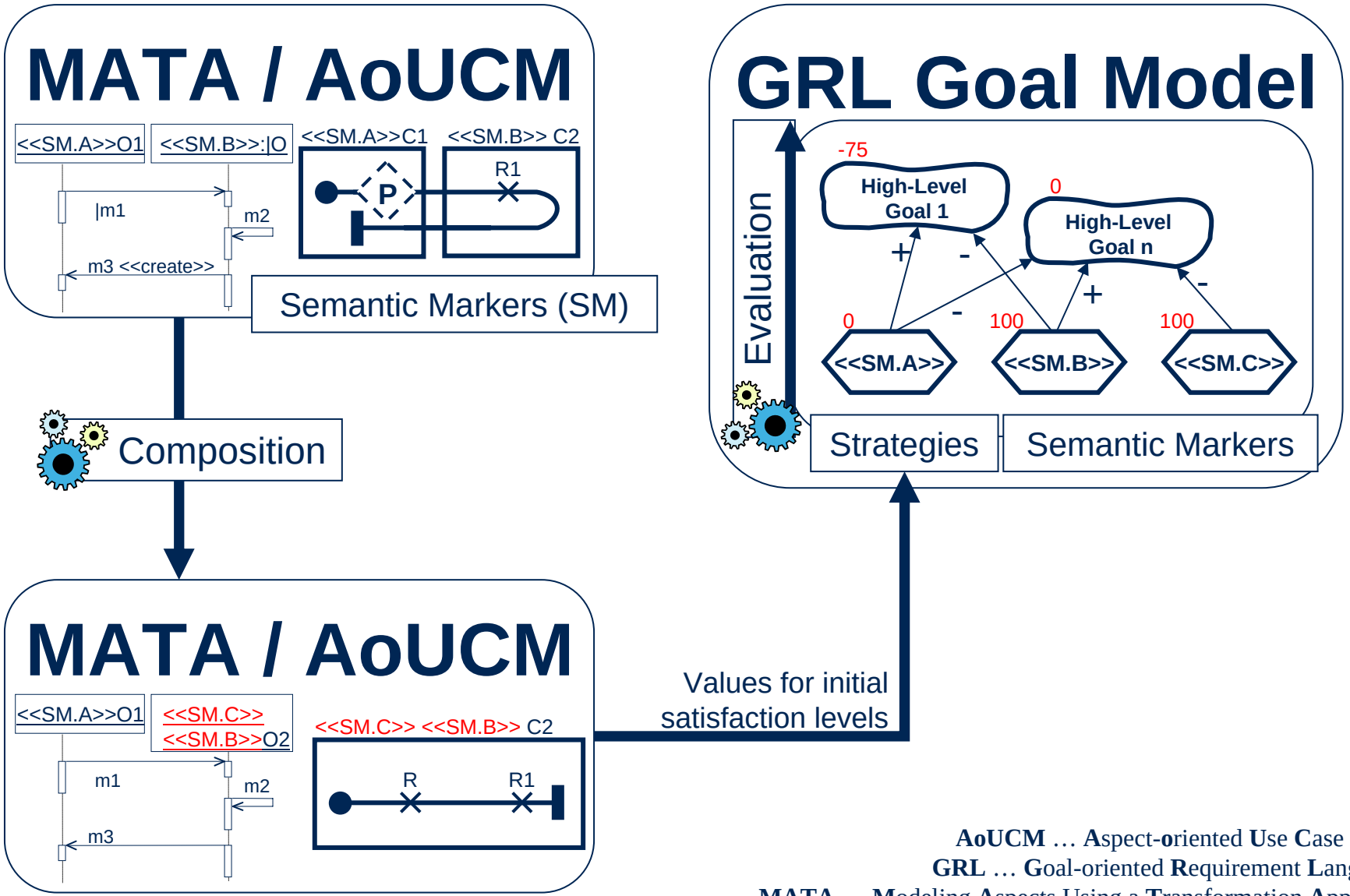
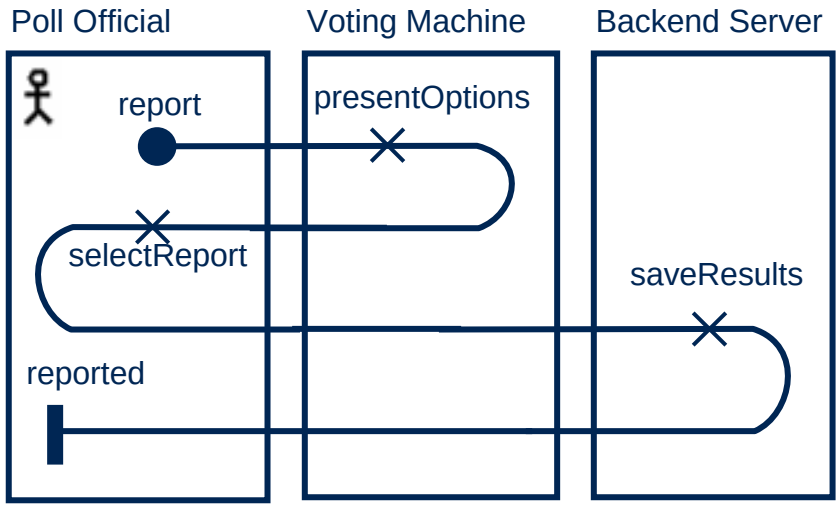
- Goal Model for Electronic Voting Machine
- Conclusion and Future Work

Overview

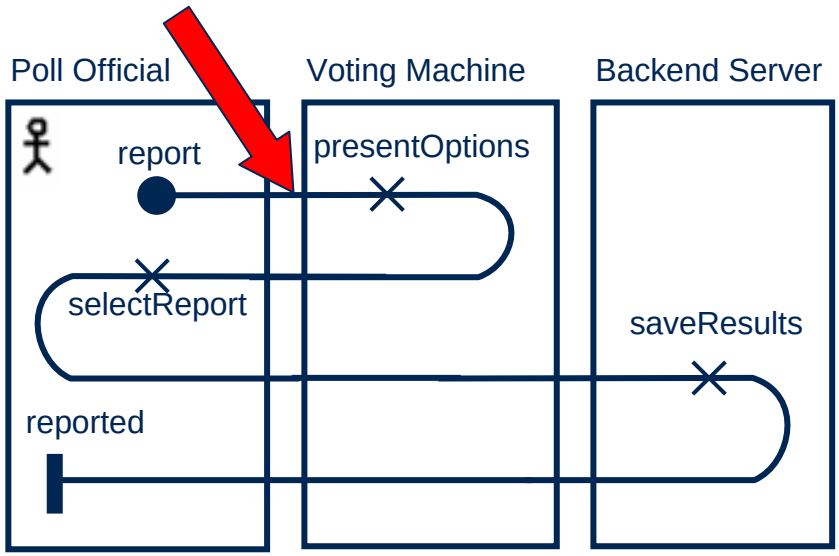


AoUCM … **A**spect-**o**riented **U**se **C**ase **M**aps
GRL … **G**oal-oriented **R**equirement **L**anguage
MATA … **M**odeling **A**spects Using a **T**ransformation **A**pproach

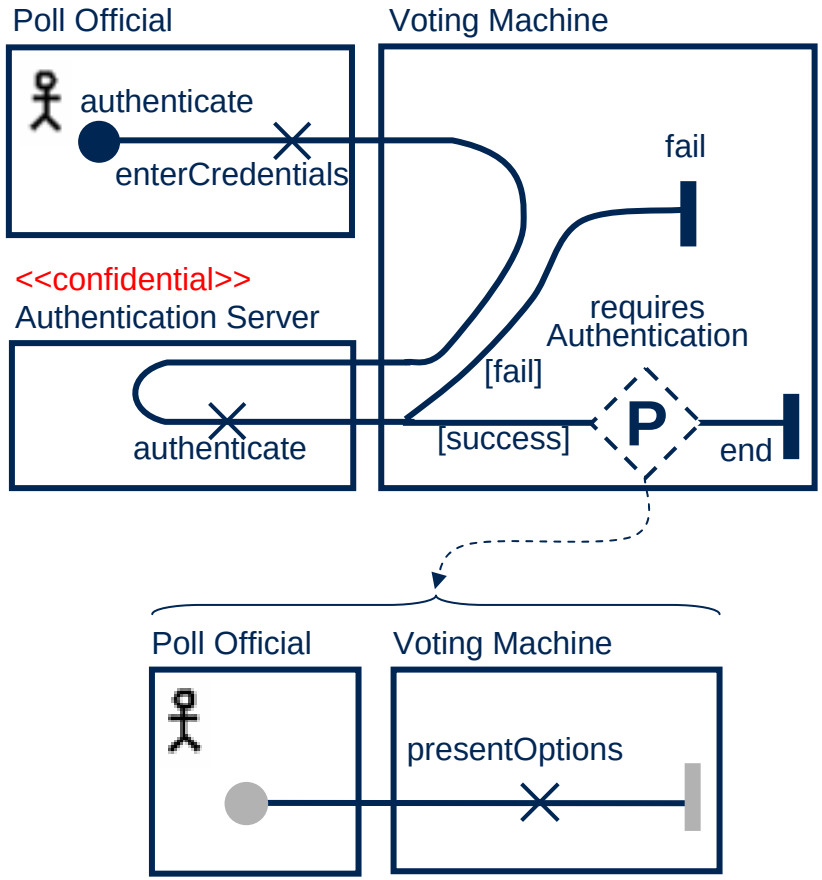
Electronic Voting Machine: Reporting Use Case



Electronic Voting Machine: Authentication Aspect

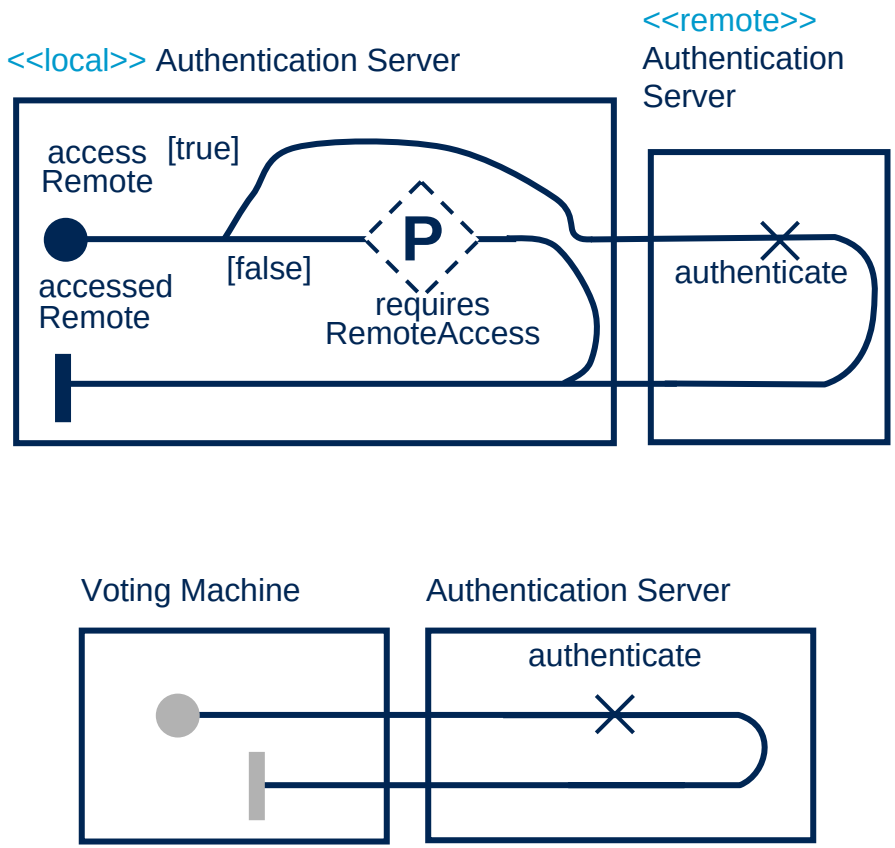


Aspectual Properties (Behavior & Structure)

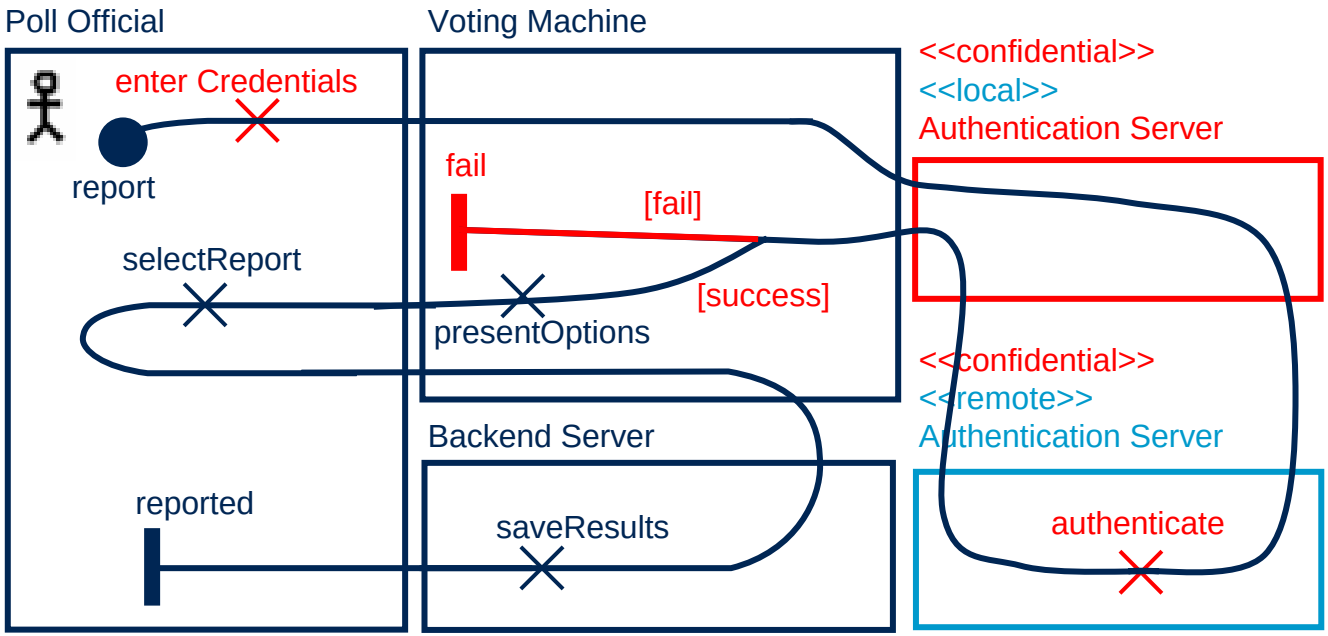


Pattern for Composition Rule

Electronic Voting Machine: Remote Service Aspect



Electronic Voting Machine: Composed Model

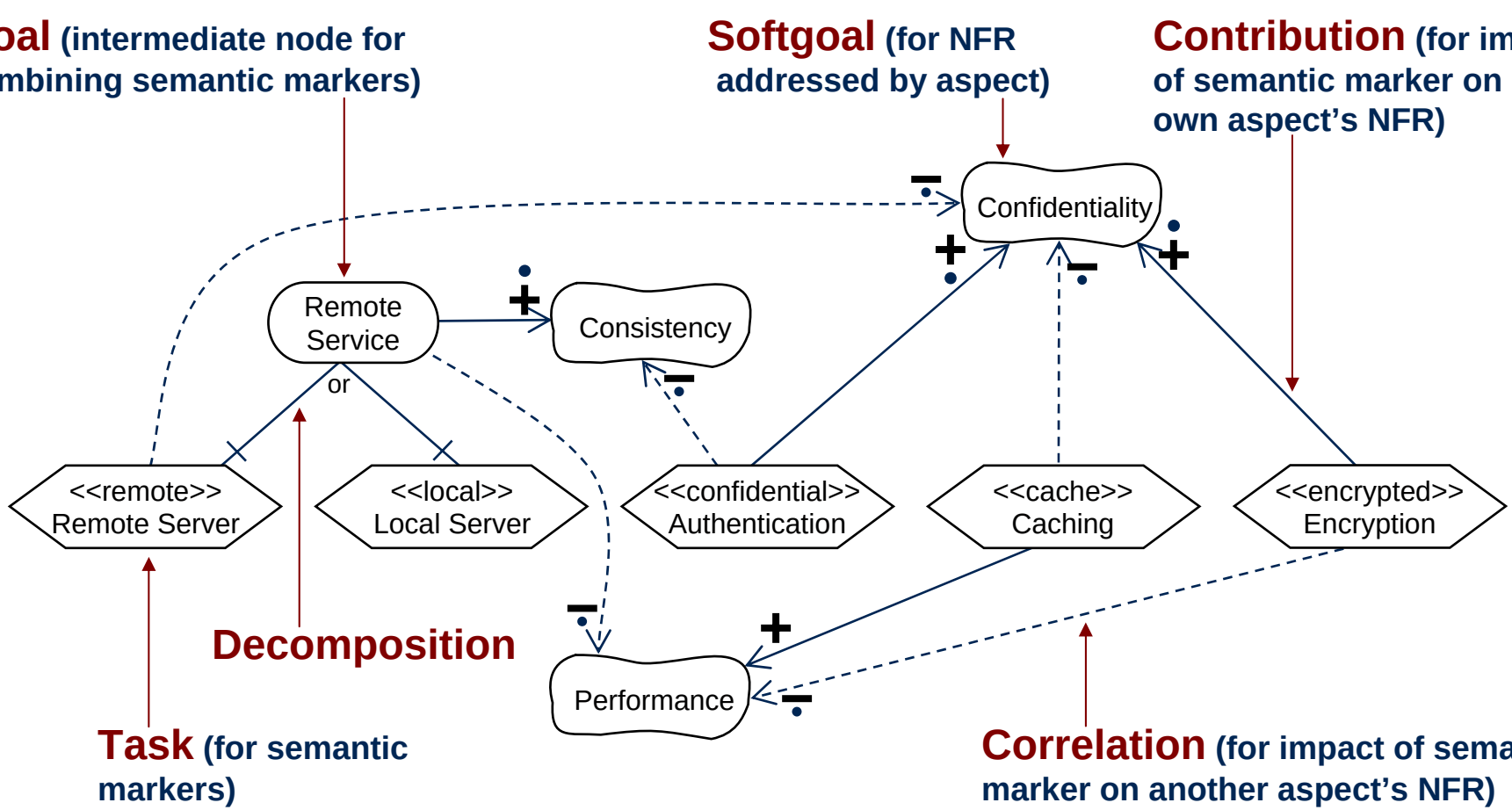


Reporting Use Case
Authentication
Remote Service

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

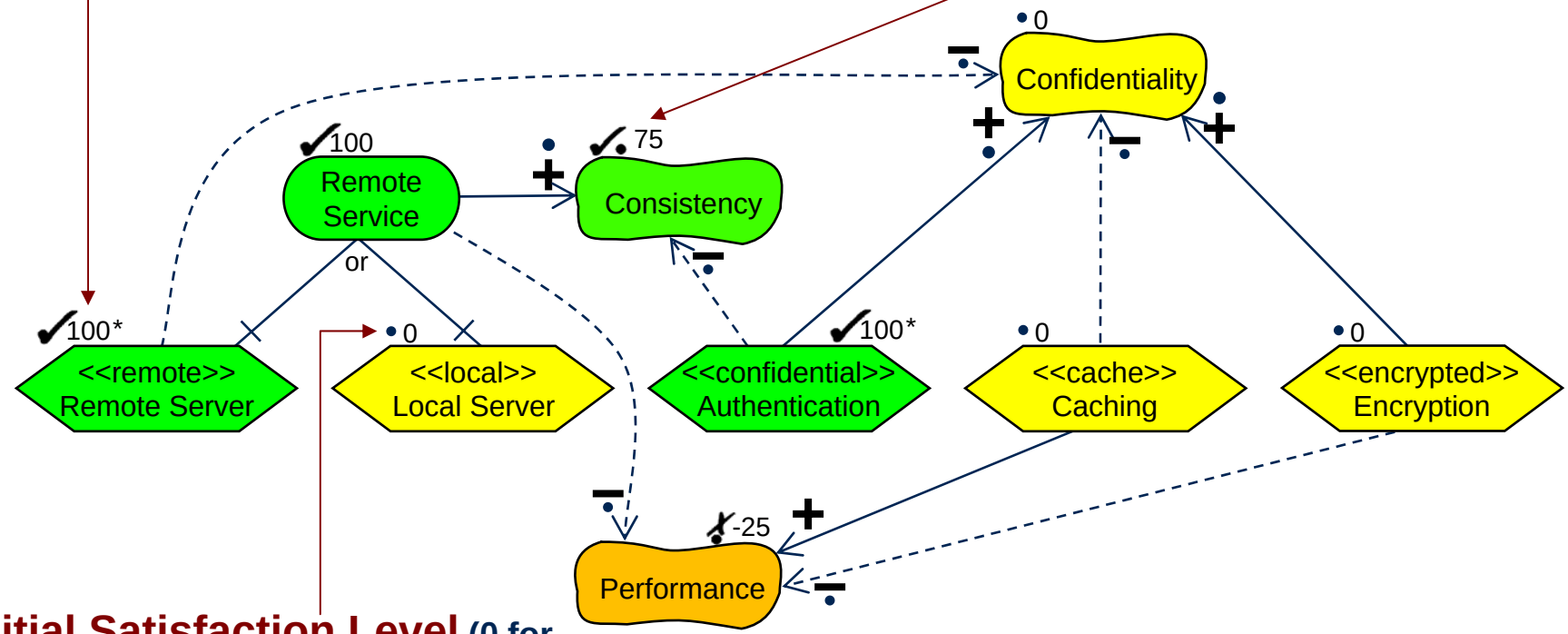


GRL Contribution Types:

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)

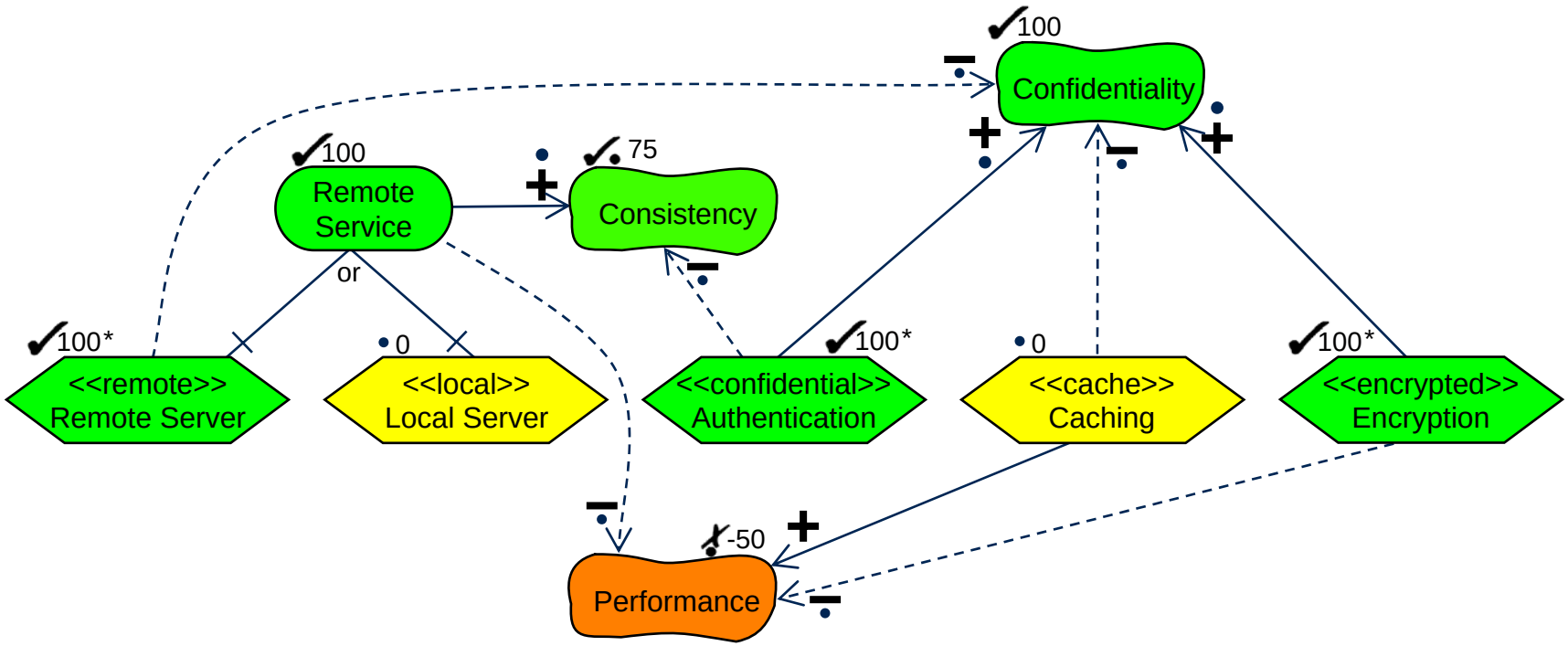


Initial Satisfaction Level (0 for semantic marker not in use; default value)

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

