Semantics Mediation

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• SPRINT Use Cases & Challenges
  – Heterogeneous modeling tools, semantics, MOCs
  – Distributed modeling
  – Over the internet design & integration
• State of the Art in the distributed Systems engineering
  – Transformations
  – Heterogeneous model exchange
    • Point-To-Point Integration, Star Integration
    • Common Meta Model (Speeds, Cesar)
    • Transformation Chains (ModelBus, iFest)
  – Comparison
• Knowledge management
  – Open World Assumption (OWA)
  – Closed World Assumption (CWA)
  – Example
• Semantic Mediation
  – Technological approach
• Conclusions
SPRINT Use Cases & Challenges

- Distributed, over the cloud design & integration
- Heterogeneous design
  - Different tools
  - Different semantics (Multi domain, aspect, MoC modeling)
- Continuous design (design teams all over the globe: 24/7 availability)
- Support data-model evolution
  - Flexibility on the data representation
  - Data migration of the evolving data representations
- Assert models & data consistency

- Represent information to the user in his format of choice
  - Avoid introduction of additional tooling (extra skills & costs)
  - Data has to be mediated and not just link tools
Heterogeneous modeling “intersection”

View A /Tool A

View B /Tool B

View C /Tool C

Domain transformations

Inter tool commonalities

universally common modeling info

Support ad-hoc semantics mediation

Facilitate the transition of the commonly understood parts

Facilitate the transition of the commonly understood parts
State of the Art (SPRINT D3.1)

• Transformations
  – Important Characteristics
    • Multidirectional
    • Incremental
    • Conservative (no duplication on subsequent transformations)
    • Traceability capability
  – Model Transformation Languages
    • ATL
    • QVT

• Heterogeneous models-information integration
  – Point-To-Point Integration, Star Integration
  – Common Meta Model (Speeds, Cesar)
  – Transformation Chains (ModelBus, iFest)
Point-to-point semantic mediations

• Each tool imports/exports models on its own meta-data
• Semantic mediation relations established between each pair of meta-data

→ To cover all transformations, we need \( \frac{N(N-1)}{2} \) relations
Common Meta Model (Speeds, Cesar)

- Each tool imports/exports models on the universal, commonly agreed meta-data
- Semantic mediation is guaranteed by the usage of the unique meta-data for the exchange of models
Transformation Chains (ModelBus, iFest)

- Each tool imports/exports models on its own meta-data
- Rules are employed for mediating semantics between different meta-models
- Inheritance of rules is possible

Tools

MD1

MD2

MD3

MD4

Domain 1-2

Domain 3-4

Abstractions

Model Repository

T1

T2

T3

T4

Tool Understanding

Transformation (data import/export)

Understanding

Dependency (inheritance)
• **Closed World Assumption (CWA)**
  – Everything (currently) not known to be true, is false
    • Assumption: you know everything of relevance and have modeled it
  – Advantages:
    • Easier to compute
    • Quicker to model (less information needed)
  – Disadvantages:
    • Limited expressiveness (“no modeling of the unknown”)

• **Open World Assumption (OWA)**
  – Adding new knowledge or information never falsifies previous assumptions.
  – Assumption: you don’t know everything of relevance and have to explore and incrementally model
  – Advantages:
    • Easy to extend
    • It is possible to ‘Represent’ unknown knowledge
  – Disadvantages:
    • Hard to retrieve/compute final conclusions/data
    • Adding information may lead to conflicts
    • More information needs to be modeled
CWA vs. OWA Example

- CWA
  - Knowledge
    - Michael is Swimmer
    - Christian is Swimmer
  - Query
    - is Sandra Swimmer?
  - Answer
    - No!

- OWA
  - Knowledge
    - Michael is Swimmer
    - Christian is Swimmer
  - Query
    - is Sandra Swimmer?
  - Answer:
    - Unknown!

More Computation
CWA vs. OWA Example

- **CWA**
  - Knowledge
    - Michael is Swimmer
    - Christian is Swimmer
    - Sandra is Swimmer
  - Query
    - is Sandra Swimmer?
  - Answer
    - No -> Yes!

- **OWA**
  - Knowledge
    - Michael is Swimmer
    - Christian is Swimmer
    - Sandra is Swimmer
  - Query
    - is Sandra Swimmer?
  - Answer:
    - Unknown -> Yes!
CWA vs. OWA Example

**CWA**

Knowledge
- Michael is Swimmer
- Christian is Swimmer

Query
- is Sandra Swimmer?

Answer
- No!

**OWA**

Knowledge
- Michael is Swimmer
- Christian is Swimmer
- Sandra is Non-swimmer
- Non-swimmer and Swimmer are disjoint

Query
- is Sandra Swimmer?

Answer:
- Unknown -> No!
Main concepts
- Tools & Tools Vocabularies
  - Authoring/editing information & representing it
- Domain Vocabularies (tools vocabularies are specific cases of these)
- Rules relating vocabularies (all permutations of vocabulary types)
  - OWL language (first-order logic formulae) to describe these rules \(\text{ongoing research - stay tuned for concrete examples}\)
- External “classical” point-to-point transformation

Semantic Mediation application
- \textit{On demand} application of a rule or a classical transformation
- Semantic Mediation Delegator to pick which semantic mediation to apply
- Traceability of Mediations
  - Establishing a relation creates has a pointer to the applied rule

Knowledge base
- Populated by tools (commit/publish models)
- Populated by Semantic Mediation application
Which SM to choose?

- Rule-based description is the OWL: mainly set inclusion
  - Simpler rules
  - Active research topic
  - Exploit the reasoning RDF(S)/OWL capabilities

- Model-transformation: richer expressiveness of the mediation
Conclusions

• Semantic Mediation in SPRINT
  – Enable distributed, over the internet authoring, editing & exchanging of models
    • “over the internet” is native in our RDF-based solution
  – Allow the flexibility of evolution of data and data representations
  – Mediating data in a flexible, reusable fashion
  – Currently vivid research topic
  – Support the wide-spread and adopted meta-meta-modeling facility EMF Eclipse Framework (dissemination, exploitation & development efficiency)

• Implementation Plan (approx. & to be validated by the SPRINT consortium)
  – EMF↔RDF Mapping Implementation (M14)
  – Definition of the Semantic Services Integration Layer (M17)
  – Semantic Mediation First Prototype Implementation (M19)
  – Semantic Mediation Implementation (M22)
  – Implementation of SSI Layer (M22)
Thank you!

Questions?
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