A Case for a SysML OWL Ontology

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Purpose of this call

• To facilitate better OSLC application to System Architecture design tools, this WG developed a standard OSLC Shapes definition based on SysML.

• I suggest to define a standard OWL ontology for SysML, to support better a formal semantics of SysML resources served by SysML tools.

• To support this need, I bring a use case of model transformation based on Semantic Mediation – developed in SPRINT and DANSE.
Agenda

• Is OSLC just all about linked data?
• What good is to have an OWL ontology?
• Why go beyond OSLC Shapes?
• Examples of using ontologies (semantic mediation in SPRINT/DANSE)
• Some ideas on how to go about that.
Is OSLC just about linked data?

- OSLC is mostly about linked data
- The specifications define only a limited number of concepts
- To my understanding, this work group was created to cope with the lack of system architecture concepts in OSLC
- Shapes, graphics, and RDF of resources seem to be enough for the OSLC linked-data goals.
Do we need ontologies in OSLC

- In fact, the different specialties of OSLC do have OWL ontologies
  - AM:
    - An RDF:

<table>
<thead>
<tr>
<th>num</th>
<th>resource</th>
<th>type</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><a href="http://open-services.net/ns/am#">http://open-services.net/ns/am#</a></td>
<td>owl:Ontology</td>
<td>Architecture Management(AM)</td>
</tr>
<tr>
<td>2</td>
<td><a href="http://open-services.net/ns/am#LinkType">http://open-services.net/ns/am#LinkType</a></td>
<td>rdfs:Class</td>
<td>Link Type</td>
</tr>
<tr>
<td>3</td>
<td><a href="http://open-services.net/ns/am#Resource">http://open-services.net/ns/am#Resource</a></td>
<td>rdfs:Class</td>
<td>Architecture Resource</td>
</tr>
<tr>
<td>4</td>
<td><a href="http://open-services.net/ns/am/am.rdf">http://open-services.net/ns/am/am.rdf</a></td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- And the HTML page:
## CM OWL Ontology

<table>
<thead>
<tr>
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<th>Comment</th>
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<tbody>
<tr>
<td>1</td>
<td><a href="http://open-services.net/ns/cm#">http://open-services.net/ns/cm#</a></td>
<td>owl:Ontology</td>
<td>Change Management(CM)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><a href="http://open-services.net/ns/cm#affectedByDefect">http://open-services.net/ns/cm#affectedByDefect</a></td>
<td>rdf:Property</td>
<td>affectedByDefect</td>
<td>Change request not necessarily the case.</td>
</tr>
<tr>
<td>3</td>
<td><a href="http://open-services.net/ns/cm#affectsPlanItem">http://open-services.net/ns/cm#affectsPlanItem</a></td>
<td>rdf:Property</td>
<td>affectsPlanItem</td>
<td>Change request</td>
</tr>
<tr>
<td>4</td>
<td><a href="http://open-services.net/ns/cm#affectsRequirement">http://open-services.net/ns/cm#affectsRequirement</a></td>
<td>rdf:Property</td>
<td>affectsRequirement</td>
<td>Change request necessarily the</td>
</tr>
<tr>
<td>5</td>
<td><a href="http://open-services.net/ns/cm#affectsTestResult">http://open-services.net/ns/cm#affectsTestResult</a></td>
<td>rdf:Property</td>
<td>affectsTestResult</td>
<td>Associated QM but that is not necessarily</td>
</tr>
<tr>
<td>6</td>
<td><a href="http://open-services.net/ns/cm#approved">http://open-services.net/ns/cm#approved</a></td>
<td>rdf:Property</td>
<td>approved</td>
<td>Whether or not</td>
</tr>
<tr>
<td>7</td>
<td><a href="http://open-services.net/ns/cm#blocksTestExecutionRecord">http://open-services.net/ns/cm#blocksTestExecutionRecord</a></td>
<td>rdf:Property</td>
<td>blocksTestExecutionRecord</td>
<td>Associated QM</td>
</tr>
<tr>
<td>8</td>
<td><a href="http://open-services.net/ns/cm#ChangeRequest">http://open-services.net/ns/cm#ChangeRequest</a></td>
<td>rdfs:Class</td>
<td>ChangeRequest</td>
<td>The CM Change</td>
</tr>
<tr>
<td>9</td>
<td><a href="http://open-services.net/ns/cm#closed">http://open-services.net/ns/cm#closed</a></td>
<td>rdf:Property</td>
<td>closed</td>
<td>Whether or not</td>
</tr>
<tr>
<td>10</td>
<td><a href="http://open-services.net/ns/cm#closeDate">http://open-services.net/ns/cm#closeDate</a></td>
<td>rdf:Property</td>
<td>closeDate</td>
<td>The date at which the requirement</td>
</tr>
<tr>
<td>11</td>
<td><a href="http://open-services.net/ns/cm#defect">http://open-services.net/ns/cm#defect</a></td>
<td>rdf:Property</td>
<td>defect</td>
<td>primarily used by QM</td>
</tr>
<tr>
<td>12</td>
<td><a href="http://open-services.net/ns/cm#fixed">http://open-services.net/ns/cm#fixed</a></td>
<td>rdf:Property</td>
<td>fixed</td>
<td>Whether or not</td>
</tr>
<tr>
<td>13</td>
<td><a href="http://open-services.net/ns/cm#implementsRequirement">http://open-services.net/ns/cm#implementsRequirement</a></td>
<td>rdf:Property</td>
<td>implementsRequirement</td>
<td>Implements association of the case.</td>
</tr>
<tr>
<td>14</td>
<td><a href="http://open-services.net/ns/cm#inprogress">http://open-services.net/ns/cm#inprogress</a></td>
<td>rdf:Property</td>
<td>inprogress</td>
<td>Whether or not</td>
</tr>
<tr>
<td>15</td>
<td><a href="http://open-services.net/ns/cm#planItem">http://open-services.net/ns/cm#planItem</a></td>
<td>rdf:Property</td>
<td>planItem</td>
<td>This relationship is currently not used</td>
</tr>
<tr>
<td>16</td>
<td><a href="http://open-services.net/ns/cm#relatedChangeRequest">http://open-services.net/ns/cm#relatedChangeRequest</a></td>
<td>rdf:Property</td>
<td>relatedChangeRequest</td>
<td></td>
</tr>
</tbody>
</table>
IBM RQM OWL Ontology

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td><a href="http://jazz.net/ns/qm/rqm#">http://jazz.net/ns/qm/rqm#</a></td>
<td>owl:Ontology</td>
<td>Rational Quality Manager</td>
<td>Category of the</td>
</tr>
<tr>
<td>2</td>
<td><a href="http://jazz.net/ns/qm/rqm#category">http://jazz.net/ns/qm/rqm#category</a></td>
<td>rdf:Property</td>
<td>category</td>
<td>The RQM Category</td>
</tr>
<tr>
<td>3</td>
<td><a href="http://jazz.net/ns/qm/rqm#Category">http://jazz.net/ns/qm/rqm#Category</a></td>
<td>rdfs:Class</td>
<td>Category</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.blocked">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.blocked</a></td>
<td>-</td>
<td>Blocked</td>
<td>Represents a blocked state.</td>
</tr>
<tr>
<td>5</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.deferred">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.deferred</a></td>
<td>-</td>
<td>Deferred</td>
<td>Represents a deferred state.</td>
</tr>
<tr>
<td>6</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.error">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.error</a></td>
<td>-</td>
<td>Failed</td>
<td>Represents a failed state.</td>
</tr>
<tr>
<td>7</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.incomplete">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.incomplete</a></td>
<td>-</td>
<td>Incomplete</td>
<td>Represents an incomplete state.</td>
</tr>
<tr>
<td>8</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.inconclusive">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.inconclusive</a></td>
<td>-</td>
<td>Inconclusive</td>
<td>Represents an inconclusive state.</td>
</tr>
<tr>
<td>9</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.inprogress">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.inprogress</a></td>
<td>-</td>
<td>In Progress</td>
<td>Represents an in progress state.</td>
</tr>
<tr>
<td>10</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.notrun">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.notrun</a></td>
<td>-</td>
<td>Not Run</td>
<td>Represents a not run state.</td>
</tr>
<tr>
<td>11</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.part_blocked">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.part_blocked</a></td>
<td>-</td>
<td>Partially Blocked</td>
<td>Represents a partially blocked state.</td>
</tr>
<tr>
<td>12</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.passed">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.passed</a></td>
<td>-</td>
<td>Passed</td>
<td>Represents a passed state.</td>
</tr>
<tr>
<td>13</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.paused">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.paused</a></td>
<td>-</td>
<td>Paused</td>
<td>Represents a paused state.</td>
</tr>
<tr>
<td>14</td>
<td><a href="http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.perm_failed">http://jazz.net/ns/qm/rqm#com.ibm.rqm.execution.common.state.perm_failed</a></td>
<td>-</td>
<td>Permanently Failed</td>
<td>Represents a permanently failed state.</td>
</tr>
<tr>
<td>15</td>
<td><a href="http://jazz.net/ns/qm/rqm#TestScriptStep">http://jazz.net/ns/qm/rqm#TestScriptStep</a></td>
<td>rdfs:Class</td>
<td>Test Script Step</td>
<td>An individual step.</td>
</tr>
<tr>
<td>16</td>
<td><a href="http://jazz.net/ns/qm/rqm#verdict">http://jazz.net/ns/qm/rqm#verdict</a></td>
<td>rdf:Property</td>
<td>verdict</td>
<td>Used to indicate the result of a test script step.</td>
</tr>
</tbody>
</table>

Could not get an ontology for the URL of RQM
http://open-services.net/ns/rqm#
OSLC Basic Concepts

• Bringing from the semantic web:
  – URL
  – RDF
  – RESTful
  – Linked Data

• Lacking
  – Formal Semantics such as with OWL
What about OWL?

- Arthur Ryman* claim that OWL is not a real type system such as OSLC shapes provides.
- The use of shapes in OSLC is such that:
  - it helps clients to navigate models in service providers
  - It helps clients to construct, modify and extend managed models in service providers
  - It is never fully available to the client as a formal “modeling language” of the server.

What with SysML?

- This WG extended OSLC AM when it comes to SysML models with an extended shapes specifications *.
- Based on the SysML standard formal eCore schema.
- Applying a significant automation in doing that.

Question is what now?

• Will all kind of SysML tools use that shapes to express their model contents?
• How about tools in related areas?
  – For instance OPM (Object Process Methodology),
  – Modelica tools
  – Rhapsody – is it pure SysML? What if not?
  – Others
The use case of SPRINT

Simplifying the Design of Complex Engineering

SPRINT is a collaboration between industry leaders and research institutes in the field of engineering. The SPRINT project, which stands for Software Platform for Integration of Engineering and Things, aims to overcome the challenges presented by today's engineering approaches. The project focuses on creating an integrated platform that unifies the diverse companies and engineering disciplines involved in various components of complex engineering projects. The SPRINT project is an initiative to create a unified engineering platform that will allow for seamless integration of engineering tools and data.

The SPRINT platform will connect the tools used by different companies to provide a single, unified view of the system being developed. For example, it will integrate tools such as IBM Rational's Rhapsody for design, Team Center for testing, DOORS for requirements engineering, Wolfram MathCore's SystemModeler, HP's Quality Center, Elvior's TestCast, as well as other proprietary tools. The consortium will use the Jazz technology from Rational as a foundation to create an integration layer that connects all the tools, teams, models, and methods.

SPRINT formally endorses OSLC (Open Services for Lifecycle Collaboration).

The project is funded by the European Union as part of the 7th framework project in Systems Engineering (2010-2013).
Multiple tools

• We needed to work with multiple tools:
  – Rhapsody (SysML)
  – SystemModeler (Wolfram) – a Modelica tool
  – Desyre (ALES – now UTC) – an analysis and simulation tool
• Besides that: each tool is a client and cannot be a service provider
• So: We used a Jazz-based platform in which RDF models where exported from tools.
• The platform provided OSLC access to resource in the RDF models.
• We call this “Semantic Mediation Container” – SMC.
Multiple Ontologies

• Each tool therefore had its **own** OWL ontology
  – Representing ITS “language”
  – Languages were not totally different
  – Languages had some valuable commonalities
    • Structure of components and connections.
  – The “common” structure could be defined in a basic structure ontology (BSO).
Putting it all together

• We could create this network of RDF repositories, each defined by an ontology:
Semantic Mediation

• Each RDF in one ontology could be mediated to an RDF in another ontology.
• The BSO served as a hub for any number of special ontologies of tools.
• Ideally, the BSO would be a SysML ontology.
Really powerful concept

Taking Rhapsody SysML:
Really powerful concept

To Modelica model in SystemModeler:
OMG overlapping standards:

SysML/AP233 Data Overlaps

- AP233
  - Lifecycle Stages
  - Eng Config Mgmt
  - Organizations
  - Schedule
  - Change Management
  - Approvals, Security, Status
  - Requirements Management
  - Property-based Requirements
  - Issue Management
  - Risk Management

- SysML
  - Classification
  - System Structures/Blocks
  - V & V
  - Activities
  - Text-based Requirements
  - Function Models
  - State Machines
  - Property & Units
  - Model Organization
  - Views and Viewpoints
  - Allocations
  - Parametrics
  - Diagrams
  - Interfaces/Ports & Flows

Slide 20
Questions