Introduction to Open Services for Lifecycle Collaboration (OSLC)

Axel Reichwein
Consultant, Koneksys
January 25, 2015
Axel Reichwein

- As PhD student and postdoc: UML-based and SysML-based integration solutions to bridge the gap between systems engineering and discipline-specific engineering

- As consultant: Implementation of (open-source) OSLC-based solutions including OSLC adapters for MagicDraw SysML, Simulink, AMESim, and PTC Integrity

- Co-Chair of the OMG OSLC4MBSE Working Group to apply OSLC beyond software engineering
• Consultants specializing in providing integration solutions based on OSLC

• Develop OSLC solutions including OSLC adapters, clients, synchronization middleware, triple stores, SPARQL endpoints

• Contribute open-source OSLC solutions to Eclipse Lyo

• Provide consulting for developing OSLC solutions

• Provide OSLC training ranging from 1-day tutorials to advanced 4-day courses
Models for Architectural Design

Many Relationships between Models

- System Architecture
- Dynamic system models
- Computer-Aided Design (CAD) (e.g. 3D models, 2D drawings)
- Meshed Analysis Models (e.g. FE, CFD, Thermo)
- Requirements

And more...

INCOSE IW2015
Problem: Rollover Risk of SUVs

- Higher center of gravity -> higher risk of rollover
- More than a third of all fatal crashes in the US are rollovers!

Static Stability Factor Test

System Engineer defines SSF Test Case

Center of Gravity

Mechanical Engineer computes center of gravity height of new vehicle through geometric model

«requirement»
Static Stability Factor (SSF)
Id = "1.1"
Text = "SSF shall be higher than 1.3. SSF is a factor based on a vehicle's track width and center of gravity height"

«verify»

«testCase»
SSF Test

INCOSE IW2015
Fishhook Maneuver Simulation

System Engineer defines simulation test case

Mechanical Engineer performs simulation with dynamic system model

http://www.mathworks.com/tagteam/49380_2008-01-0579_Cherian_Final_1.10.08.pdf
Link between COG Parameter of Geometric Model and Simulation Model

Center of gravity in geometric model

Center of Gravity + Moments of Inertia

Center of gravity in simulation model
Relationships between Engineering Data

Requirements

- **Static Stability Factor (SSF)**
  - Id = "1.1"
  - Text = "SSF shall be higher than 1.3. SSF is a factor based on a vehicle's track width and center of gravity height."

- **Vehicle in motion rollover test**
  - Id = "1.2"
  - Text = "The vehicle shall not "tip-up" during fishhook maneuver. If the vehicle lifts two wheels off the ground during a quick left-right turn at 50 mph, it's considered a "tip-up" and the test failed."

Test Cases

- **SSF Test**
- **Vehicle Fishhook Maneuver Simulation**

Simulation Model

Geometric Model
Reality in Complex System Design: (Too Many) Relationships between Engineering Data
Network of Relationships
Impact Analysis

Change here

INCOSE IW2015
Query: Which elements are related to this requirement?
Good Overview => Better Decisions
Relationships on the Web

Linked Web Pages
(Unstructured Data)

Linked Data
(Structured Data)

http://www.wikipedia.org/
https://www.google.com/
http://www.cnn.com/
http://espn.go.com/

"Lod-datasets 2010-09-22 colored" by Anjeve, Richard Cyganiak - Own work. Licensed under Creative Commons Attribution-Share Alike 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Lod-datasets_2010-09-22_colored.png#mediaviewer/File:Lod-datasets_2010-09-22_colored.png
Linked Data Example

Example DBPedia Query: Cities in Germany with population larger than 1Mio?

```sql
SELECT ?City ?Population
WHERE {
  ?City dbpedia:country dbpedia-res:Germany.
  ?City rdf:type dbpedia:City.
  FILTER (?Population > 1000000)
} order by ?Population
```

<table>
<thead>
<tr>
<th>City</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cologne</td>
<td>1010269</td>
</tr>
<tr>
<td>Munich</td>
<td>1420000</td>
</tr>
<tr>
<td>Hamburg</td>
<td>1796077</td>
</tr>
<tr>
<td>Berlin</td>
<td>3499879</td>
</tr>
</tbody>
</table>

http://liris.cnrs.fr/~pchampin/spark/gmapv3.html
Open Services for Lifecycle Collaboration

• OSLC = Reusing the Web for tool integration
• Based on Web standards (Linked Data and RESTful Web Services)
• Initiated by IBM
• Adopted by many tool vendors
• Managed by OASIS

http://open-services.net/wiki/communications/OSLC-Stickers/ licensed under CC BY 3.0 US
Overview of Operations on OSLC Resources

- **Publishing** OSLC resources
- **Retrieving** OSLC resources
- **Linking** OSLC resources across tools
- **Adding/Updating/Deleting** OSLC Resources
- **Viewing** OSLC resources of other tools
- **Interchanging** OSLC resources between tools
- **Tracking changes** to OSLC resources
Publishing OSLC Resources

Tool

OSLC Adapter

INCOSE IW2015
Linked Data Principle 1

Use **URIs** to denote things

Requirement in Systems Engineering Tool

**URI of Requirement**

http://myDomain/myTool/myProject/requirements/S5.4.1

INCOSE IW2015
Use **HTTP URIs** so that these things can be referred to and looked up.

**Requirement in Systems Engineering Tool**

```
«requirement»
Master Cylinder Efficacy

Id = "S5.4.1"
Text = "A master cylinder shall have a reservoir compartment for each service brake subsystem serviced by the master cylinder. Loss of fluid from one compartment shall not result in a complete loss of brake fluid from another compartment."
```

**URI of Requirement**

```
http://myDomain/myTool/myProject/requirements/S5.4.1
```
Provide useful information about the thing when its URI is dereferenced, leveraging standards such as **RDF**, **SPARQL**.

**Requirement in Systems Engineering Tool**

**URI of Requirement**

http://myDomain/myTool/myProject/requirements/S5.4.1

**HTTP**

**W3C standard for data interchange on the Web**
Statements in the form of subject-predicate-object expressions (triples)

**W3C standard** for data interchange on the Web

Used for semantic reasoning

Variety of serialization formats (e.g. JSON-LD)
RDF Example

RDF = subject-predicate-object statements (triples)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement “Master Cylinder Efficacy”</td>
<td>refinedBy</td>
<td>Use Case „Decelerate Car“</td>
</tr>
<tr>
<td>Requirement “Master Cylinder Efficacy”</td>
<td>satisfiedBy</td>
<td>Block „Brake System“</td>
</tr>
<tr>
<td>Requirement “Master Cylinder Efficacy”</td>
<td>derivedRqt</td>
<td>Requirement „Loss of Fluid“</td>
</tr>
<tr>
<td>Requirement “Master Cylinder Efficacy”</td>
<td>derivedRqt</td>
<td>Requirement „Reservoir“</td>
</tr>
</tbody>
</table>

INCOSE IW2015
RDF Graph Representation

- **Use Case** „Decelerate Car“
- **Block** „Brake System“
- **Requirement** „Master Cylinder Efficacy“
- **Requirement** „Loss of Fluid“
- **Requirement** „Reservoir“

**Properties**
- `refinedBy`
- `satisfiedBy`
- `derivedRqt`
Include links to other related things (using their URIs) when publishing data on the Web.
Retrieving Resources

HTTP Request
URL: http://.../requirements/S5.4.1
GET Method
Accept: application/rdf+xml
Master Cylinder Efficacy

Id = "S5.4.1"
Text = "A master cylinder shall have a reservoir compartment for each service brake subsystem serviced by the master cylinder. Loss of fluid from one compartment shall not result in a complete loss of brake fluid from another compartment."

MagicDraw Requirement S5.4.1

Description: A master cylinder shall have a reservoir compartment for each service brake subsystem serviced by the master cylinder. Loss of fluid from one compartment shall not result in a complete loss of brake fluid from another compartment.

Hyperlink: http://en.wikipedia.org/wiki/Master_cylinder

Derived Elements
S5.4.1b
S5.4.1a

Satisfied By
Blocks::BrakeSystem
«requirement»
Master Cylinder Efficacy
Id = "S5.4.1"
Text = "A master cylinder shall have a reservoir compartment for each service brake subsystem serviced by the master cylinder. Loss of fluid from one compartment shall not result in a complete loss of brake fluid from another compartment."

Tool-specific

Representation Examples

```xml
<rdf:Description rdf:nodeID="A1">
  <rdfs:nodeID rdf:resource="http://ogm/sysml/rdf#Requirement"/>
  <sysml:requirement:derived rdf:resource="http://localhost:8080/oslc4jmagicdraw/services/TestProject2/restrictions/S5.4.1b"/>
  <oslc_rm:elaboratedBy rdf:resource="http://localhost:8080/oslc4jmagicdraw/services/TestProject2/usecases/Requirements::BrakeSystem"/>
  <oslc_rm:satisfiedBy rdf:resource="http://localhost:8080/oslc4jmagicdraw/services/TestProject2/blocks/Requirements::BrakeSystem"/>
  <rdfs:nodeID rdf:resource="http://open-services.net/ns/rm#Requirement"/>
  <dcterms:description rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#XMLEntity">A master cylinder shall have a reservoir compartment</dcterms:description>
  <dcterms:resource rdf:resource="http://localhost:8080/oslc4jmagicdraw/services/TestProject2/restrictions/S5.4.1a"/>
  <dcterms:title rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#XMLEntity">Master Cylinder Efficacy</dcterms:title>
  <dcterms:identifier rdf:resource="S5.4.1"/>
</rdf:Description>
```
Demo
Defining Links
Between OSLC Resources of Different Tools

Tool A
OSLC Adapter for tool A

Link Tool

OSLC Adapter for tool B

Tool B

OSLC Adapter for tool C

Tool C

INCOSE IW2015
Adding/Updating/Deleting Resources Through RESTful OSLC Web Services

- Publishing, Querying, Creating, Updating, Deleting Resources
- Aligned with W3C Linked Data Platform

Client

HTTP

OSLC Adapter for Tool C

Tool C

INCOSE IW2015
Overview of Operations on OSLC Resources

- Publishing OSLC resources
- Retrieving OSLC resources
- Linking OSLC resources across tools
- Adding/Updating/Deleting OSLC Resources
- Viewing OSLC resources of other tools
- Interchanging OSLC resources between tools
- Tracking changes to OSLC resources
Overview of Operations on OSLC Resources

- **Publishing** OSLC resources
- **Retrieving** OSLC resources
- **Linking** OSLC resources across tools
- **Adding/Updating/Deleting** OSLC Resources
- **Viewing** OSLC resources of other tools
- **Interchanging** OSLC resources between tools
- **Tracking changes** to OSLC resources
Use Case Scenario of OSLC Tutorial

Bugzilla: web-based bug tracking tool

CRM system: lists bugs/defects associated with an incident reported by a customer

A user needs to list bugs that correspond to an incident of a customer. The listed bugs of the CRM should correspond to the Bugzilla bugs.
Incident #676

Customer: Totally Fictional Corporation, Inc.
Created: Feb. 15, 2012
Updated: Feb 21, 2012
Status: OPEN

Description: Lorem ipsum et cum fabulas indoctum consequuntur, te eum habeo eleifend.Usu cetero scribentur no, ius ad nominati accusamus accommodare. Dolorem appellantur te mel, nihil latin expetendis usu at, mel ei prima graeco. Harum scribentur est in. Mel cu naturum interesset, suas menandri salutatus at est, debet ignota qui an. Epicurei scribentur ei pri. Cu utroque vituperata cum, agam invidum ei nec, eum eu sonet possit.

[Buttons: Add Link, Select Defect to Link to, Create Defect to Link to]

Related Defects
- Bug #2
- Bug #1
- Bug #8
Adding a Bug to the CRM System

A user would like to add a bug to the CRM system by manually indicating its URI. The URI should match the URI of a bug in the Bugzilla repository.

Example:
Delegated UI for Resource Selection

A user would like to get from bugzilla a delegated UI for searching and selecting an existing Bugzilla bug.

Example:
Delegated UI for Resource Creation

A user would like to create a new bug within the Bugzilla repository

Example:
UI Preview

A user would like to hover over a bug with the mouse and get a small UI preview from Bugzilla

Example:
Overview of Operations on OSLC Resources

- **Publishing** OSLC resources
- **Retrieving** OSLC resources
- **Linking** OSLC resources across tools
- **Adding/Updating/Deleting** OSLC Resources
- **Viewing** previews of OSLC resources of other tools
- **Interchanging** OSLC resources between tools
- **Tracking changes** to OSLC resources
Data Interoperability

Tool A
OSLC Adapter for tool A

Tool C
OSLC Adapter for tool C
RDF Example

RDF = subject-predicate-object statements (triples)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement</td>
<td>refinedBy</td>
<td>Use Case &quot;Decelerate Car&quot;</td>
</tr>
<tr>
<td>&quot;Master Cylinder Efficacy&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirement</td>
<td>satisfiedBy</td>
<td>Block &quot;Brake System&quot;</td>
</tr>
<tr>
<td>&quot;Master Cylinder Efficacy&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirement</td>
<td>derivedRqt</td>
<td>Requirement &quot;Loss of Fluid&quot;</td>
</tr>
<tr>
<td>&quot;Master Cylinder Efficacy&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirement</td>
<td>derivedRqt</td>
<td>Requirement &quot;Reservoir&quot;</td>
</tr>
<tr>
<td>&quot;Master Cylinder Efficacy&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Interoperability Through Standardized Resource Properties and Resource Types

<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement „Master Cylinder Efficacy“</td>
<td>type</td>
<td>Requirement <a href="http://open-services.net/ns/rm">http://open-services.net/ns/rm</a> #Requirement</td>
</tr>
<tr>
<td>Any HTTP URI</td>
<td></td>
<td><a href="http://www.w3.org/1999/02/22-rdf-syntax-ns#type">http://www.w3.org/1999/02/22-rdf-syntax-ns#type</a></td>
</tr>
<tr>
<td>Requirement „Master Cylinder Efficacy“</td>
<td>description</td>
<td>„A master cylinder shall...“</td>
</tr>
<tr>
<td>Any HTTP URI</td>
<td></td>
<td><a href="http://purl.org/dc/elements/1.1/description">http://purl.org/dc/elements/1.1/description</a></td>
</tr>
</tbody>
</table>
## Snapshot of the OSLC Requirements Management Specification

### Standardized OSLC Requirement Properties

<table>
<thead>
<tr>
<th>Prefixed Name</th>
<th>Occurs</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>oslc_rm.elaboratedBy</td>
<td>zero-or-many</td>
<td>The subject is elaborated by the object. For example, a user requirement is elaborated by use case.</td>
</tr>
<tr>
<td>oslc_rm.elaborates</td>
<td>zero-or-many</td>
<td>The object is elaborated by the subject.</td>
</tr>
<tr>
<td>oslc_rm.specifiedBy</td>
<td>zero-or-many</td>
<td>The subject is specified by the object. For example, a requirement is elaborated by a model element.</td>
</tr>
<tr>
<td>oslc_rm.specifies</td>
<td>zero-or-many</td>
<td>The object is specified by the subject.</td>
</tr>
<tr>
<td>Domain</td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Architecture Management</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Asset Management</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Automation</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Performance Monitoring</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Quality Management</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Reconciliation</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Requirements Management</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Reporting</td>
<td>Converge</td>
<td></td>
</tr>
<tr>
<td>Estimation and Measurement</td>
<td>Converge</td>
<td></td>
</tr>
<tr>
<td>ALM/PLM Interoperability</td>
<td>Draft</td>
<td></td>
</tr>
<tr>
<td>Configuration Management</td>
<td>Scope</td>
<td></td>
</tr>
</tbody>
</table>

OSLC Specifications for Interoperability and Information Discovery

Tool A ➞ OSLC Resource ➞ Tool B

INCOSE IW2015
Version Management of OSLC Resources

- OSLC Configuration Management Working Group

Configuration Version 1

Configuration Version 2

Configuration Version 3

Time

INCOSE IW2015
Closed World Standards
non-compatible with Linked Data

SysML

FMI

STEP
Open World Standards compatible with Linked Data
Advantages of Minimalistic Standards over „Universal“ Standards

<table>
<thead>
<tr>
<th></th>
<th>„Closed world“ Standards</th>
<th>„Open world“ Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>UML/SysML + STEP</td>
<td>OSLC Specifications</td>
</tr>
<tr>
<td>Scope</td>
<td>Large</td>
<td>Minimalistic</td>
</tr>
<tr>
<td>Size</td>
<td>Large</td>
<td>Minimalistic</td>
</tr>
<tr>
<td>Effort until release</td>
<td>High</td>
<td>Small</td>
</tr>
<tr>
<td>Time until release</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>Ease of implementation</td>
<td>Difficult</td>
<td>Easy</td>
</tr>
<tr>
<td>Ease of adoption</td>
<td>Difficult</td>
<td>Easy</td>
</tr>
</tbody>
</table>
OMG OSLC4MBSE Working Group

- **Define** OSLC Specification for describing system architectures
- **Collect** use case scenarios from the systems engineering community
- **Share** use case scenarios with OSLC community
- **Get** technical feedback from OSLC community

OSLC4MBSE Update - Axel Reichwein

- Parham Vasaieley, Jaguar Land Rover, UK
- Axel Reichwein, Koneksys, USA
- Allison Barnard Feeney, National Institute of Standards and Technology, USA
- Yves Bernard, Airbus, France
- Markus Brandstaetter, PROSTEP, Germany
- Roger Burkhart, Deere, USA
- Jim Conallen, IBM Rational, USA
- Harald Eisenmann, Airbus Defence and Space, Germany
- Amit Fisher, IBM, USA
- Gray Bachelor, IBM, USA
- Sandy Friedenthal, SAF Consulting, USA
- Nerijus Jankevicius, NoMagic
- Steven Jenkins, JPL NASA, US
- Sylvère Krima, Engisis, USA
- Mike Loeffler, General Motors, USA
- Eldad Palachi, IBM, Israel
- Chris Paredis, Georgia Institute of Technology, USA
- Ahsan Qamar, Georgia Institute of Technology, USA
- Sebastian Herzig, Georgia Institute of Technology, USA
- Nicolas Rouquette, JPL NASA, US
- Rick Steiner, (former Raytheon), USA
- Mark Schulte, Boeing, USA
- John Watson, Lockheed Martin, USA
- Ron Williamson, Raytheon, USA
Overview of Operations on OSLC Resources

- **Publishing** OSLC resources
- **Retrieving** OSLC resources
- **Linking** OSLC resources across tools
- **Adding/Updating/Deleting** OSLC Resources
- **Viewing** previews of OSLC resources of other tools
- **Interchanging** OSLC resources between tools
- **Tracking changes** to OSLC resources
Tracking Changes to a Base Resource Set

Resource Set
Version 1

Resource Set
Version 2

Resource Set
Version 3

INCOSE IW2015
Retrieving ChangeEvents Through OSLC TRS Protocol

Client

Only Change Events

HTTP

OSLC Adapter for tool C supporting Tracked Resource Set Protocol

Tool C

INCOSE IW2015
OSLC-Based Ecosystem

- **Registry** of OSLC Service Providers
- **Single Point of Entry** to OSLC Resources
- **Editors** to define Relationships between OSLC Resources
- **Views** for seeing Relationships between OSLC Resources
- **Synchronization** of OSLC Resources
- **Advanced workflows** based on Enterprise Service Bus

INCOSE IW2015
Implementing OSLC Adapters

http://www.eclipse.org/lyo/
Summary

• **OSLC** = Reusing the Web infrastructure for tool integration

• **Key OSLC advantages**
  – Open technologies
  – Scalability
  – Flexibility