Achieving the digital thread through PLM and ALM integration using OSLC

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- Developer of multiple data integration solutions based on Open Services for Lifecycle Collaboration (OSLC)
- Background in aerospace engineering
- Since PhD, focus on data integration
- Since Koneksys, focus on OSLC
- Previously involved in standardization efforts related to SysML (Systems Modeling Language)
- Presented OSLC at multiple conferences: INCOSE, OMG, SAE International Automotive, North American Modelica Users Group, IBM InterConnect, IBM Innovate, NoMagic World Conference, CIMdata Systems Engineering Workshop
Status Quo of Collaboration

According to David Meza, Head of Knowledge Management at NASA

“Most engineers have to look at 13 different sources to find the information they are looking for”

“46% of workers can’t find the information about half the time”

“30% of total R&D funds are spent to redo what we’ve already done once before”

“54% of our decisions are made with inconsistent, or incomplete, or inadequate information”

https://www.youtube.com/watch?v=QEBVoultYJg
Consequences of Bad Collaboration

Cost

Time

Failure
Distributed Engineering Information

One technical system described from different perspectives

One technical system, but a lot of distributed information

Distributed information is challenging for collaboration
Overlaps and Relationships in Engineering Information

Overlaps due to data duplication (e.g. same parameter used in different models or reports)

Logical relationships such as a requirement verified by a test case

The more complex a system is, the more relationships exist between engineering information
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

- 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"

- System Engineer defines SSF Test Case

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

Center of Gravity
+ Moments of Inertia

Center of gravity in geometric model

Center of gravity in simulation model
Relationships between Engineering Data

Test Cases:
- SSF Test
- Vehicle Fishhook Maneuver Simulation

Simulation Model

Geometric Model

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 km/h, it's considered a "tip-up" and the test failed."
Reality: Many Relationships between Engineering Data
Example Digital Thread of PLM vendor

Problems
- **Limited integration** of specific disciplines and software applications
- **No mix-n-match** as needed by your organization (No ad-hoc integration)
- **Custom integration development is expensive**
- **Locked in by vendor**
Crosscutting Concerns Across Disciplines

- Requirements Engineering
- Design
- Manufacturing
- Operation

- Traceability
- Configuration management
- Trade-off studies
- Problem resolution
Collaboration Challenges in Designing Systems

Increasing system complexity

How can I establish traceability

Increasing number of meetings

Increasing number of partners

How do I know what is related to what?

Increasing costs

Increasing number of versions of data

How can I assess the impact of a change?

Increasing frustration

How can I manage changes/updates?
Data Integration Benefits

- Understanding the context of information
- Understanding the ripple effects of changes
- Understanding the origin of product failures
- Performing consolidated reporting
- Performing data analysis
- Performing better decisions
- Predict ripple effects!

Change here
Key Data Integration Concepts and Standards

1. Standard machine-readable data format = **RDF**
2. Standard to identify data = **URL**
3. Standard to access data = **HTTP**

- No license costs
- No vendor lock-in
- Mature and widely adopted infrastructure
- Abundance of Web specialists/developers
Hypertext + Internet = Web

BEFORE THE WEB

Hypertext System 1  Hypertext System 2

Problem: No Compatibility between hypertext systems + different protocols to access and connect documents on the internet (Gopher, WAIS, etc...)

WITH THE WEB

One global hypertext system = Web
One protocol to access and connect documents
Extending Web of documents to a Web of Data

Web of Documents

Documents spread across multiple machines

Note: a lot of information accessible through the Web is private!

Web of Data

Data spread across multiple databases

Facebook Server  Wikipedia Server  Gmail Server

Requirements  PLM  ERP
URLs = Common Global Information Identifiers

Web of Documents

- wikipedia.org
- facebook.com
- myblog.com

Web of Data

- https://private.myorg.com/req123
- https://private.supplier.com/part123

Data Repository 1
Data Repository 2
Data Repository 3
HTTP = Common Protocol to Access Information

Web of Documents

Web of Data

OSLC specifies how to perform CRUD operations on data using HTTP

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HTML + RDF = Common Web Data Formats

Web of Documents

Client

HTTP Request

HTTP Response

Server 1

HTTP Request

HTTP Response

Server 2

Web of Data

Client

HTTP Request

HTTP Response

Server 1

HTTP Response

Server 2

OSLC
Schemas for Data Interoperability

Web of Documents

Web of Data

OSLC domain-specific standards (e.g. for Requirements)
OSLC Domain-specific Standards

Core
(Configuration Management, Reporting)

- ALM-PLM
- Architecture Management
- Asset Management
- Automation
- Change Management
- Estimation & Measurement
- Performance Monitoring
- Quality Management
- Reconciliation
- Requirements Management
- Mobile
Links for Data Integration

Web of Documents

URL1
Facebook Server
Link
URL2
HTML
Link
URL3
HTML
Blog Server

Web of Data

URL1
RDF
Link
URL2
HTML
Link
URL3
RDF
Requirements
PLM
ERP

OSLC
Mashup Applications

**Web of Documents**

- **Search**
  - (e.g. Google, Bing)
- **Visualize**
  - (e.g. Chrome, Firefox)

- URL1
- URL2
- URL3

**Web of Data**

- **Search**
  - (e.g. IBM Lifecycle Query Engine and Mentor Graphics Context)
- **Visualize**
  - OSLC

- URL1
- URL2
- URL3

**Equal access to information - more competition amongst data management solutions**

Facebook Server  Wikipedia Server  Blog Server

Requirements  PLM  ERP
Mashup Application Example

Google-like Search

Private/public Data Web

Distributed Data Silos

Private/public Data Web

Distributed Data Silos
Mashup Application Example

Link Editor

Private/public Data Web

Distributed Data Silos

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Mashup Application Example

Tree (BOM-like) Viewers

Private/public Data Web

Distributed Data Silos
Mashup Applications for AI

AI for Generative Design

Equal access to information -> more data available to AI algorithms -> more interesting AI results
What happens if the private data Web consists of 10 billion resources? Can you still query it?

Solution: use scalable big data solutions used for example by Google and Amazon (e.g. Elasticsearch, Amazon Neptune)
Which version of a resource is linked with which version of the linked resource? Can you do version management at a global level?

Solution: use OSLC Config management standard for global version management.
How can I make sure that certain resources can only be accessed by certain users? How can the access management be more secure?

Solution: data access management at a global level + blockchain to record who gets access to what.
What does Koneksys do?

We offer **consulting services:**

- Create OSLC APIs for software applications and data stores not supporting OSLC natively
- Create integrations for OSLC-enabled applications (e.g. IBM DNG)
- Create mashup applications for OSLC data
- Offer OSLC training to developers and project managers
What does Koneksys do?

We perform internal **research** to address the challenges of future OSLC-based mashup applications:

- Running queries on OSLC data with Spark GraphFrames ([https://github.com/koneksys/SPARQL_to_GraphFrames](https://github.com/koneksys/SPARQL_to_GraphFrames))
- Configuration management of OSLC data ([https://github.com/koneksys/Git4RDF](https://github.com/koneksys/Git4RDF))
- Managing information in the blockchain using smart contracts ([https://github.com/koneksys/Blockchain4LinkedData](https://github.com/koneksys/Blockchain4LinkedData))
What does Koneksys do?

We help grow the OSLC community:

- Releasing open-source OSLC solutions ([https://github.com/ld4mbse](https://github.com/ld4mbse) + [https://github.com/oslc/](https://github.com/oslc/))
- Creating new OSLC web site ([http://oslc.co/](http://oslc.co/))
- Promoting OSLC at conferences ([https://koneksys.com/blog/](https://koneksys.com/blog/))
Koneksys helps organizations create data integration solutions using

- Linked Data
- Open Services for Lifecycle Collaboration (OSLC)
- Big Data frameworks
- Graph Databases

Located in San Francisco. In business since 2012.
Standards for servers hosting data (Hypermedia REST API + Linked Data REST API)

Standards for web-based data interoperability

Adopted so far mainly for Application Lifecycle Management (ALM), systems and requirements engineering

Open Community
OSLC to achieve the Digital Thread
We need you to help promote OSLC!

New OSLC Web site: http://oslc.co/

Adding your company logo to the list of supporters on the web site helps the OSLC community grow

If end user organizations show support for OSLC, then vendors, consultants, and developers will offer more support for OSLC
Thanks and get in touch!

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