Lessons Learned with Data, Requirement, and Model Exchange

A Talk in the Park
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Our Mission

- Sodius' mission is to ease the flow of engineering data across the extended design and implementation team
- Our vision is to be a reliable provider of products and services across the engineering team that enables them
  - to connect bespoke sources of information
  - navigate the relationships between these sources
  - transform otherwise useless data into actionable information
  - and open work artifacts for formal feedback and cross team collaboration.
Who is Sodius?

- A 20+ person *technology company* with representation in France, Switzerland and the U.S.
- Founded in 1999 as *Systems Engineering* training and consulting company
- Specialized in *complex data integration* solutions with a goal to ease and accelerate collaboration processes
- Experts in design data such as *requirements*, architecture *models*, engineering models, software *development artifacts*
- Provider of critical components to *several Software OEMs*
- Delivers *solutions world-wide at large accounts* with stringent quality requirements in markets such as Defense, Aerospace, Automotive
Sodius’ Layered Technology

Get Your Data to Where it is Needed

**Data Integration**

- RLIA Windchill®
  Integrates Windchill PLM with CCM ALM via OSLC
- SE-Collab®
  Share and annotate complex systems engineering artifacts
- **Engineering Knowledge Integration**
  Store and spread systems engineering artifacts securely

Reuse Your Data in the Format You Need

**Data Transformation**

- MDWorkbench®
  Eclipse-based development environment for custom Model-to-Text and Model-to-Model transformation
- **DXL Editor®**
  Unique Eclipse plug-in editor for DOORS DXL programming and debugging
- **IBM Rhapsody OEM**
  Model-based transformation and code generation capabilities

Get Your Data No Matter Where it was Authored

**Data Access**

- MDAccess®
  EMF-based Java libraries for R/W access to format-specific files, e.g. DOORS, Enterprise Architect, MagicDraw, etc.
- MDConnect®
  Offers content in Eclipse (e.g. - DOORS in IBM RSA tools)
Example Information Exchanges
Requirement Negotiation between an OEM and Supplier
Requirement Synchronization

- Automotive OEMs, Tier 1s and suppliers are continuously exchanging requirements/stakeholder requests.
- Requirements Management Tools and processes vary considerably from BU to BU (internally) and between organizations. It requires support teams in each BU (5 peoples min.) to import and check requirements exchanges.
- A harmonized automated tooling & method is significantly help to remove this drawback and enable sync with the corporate RM/CM system
Typically, the exchange is based on custom attributes that have to be fed (create and update) from both parts to feasibility/maturity/acceptance of items.

How to automate?

Mapping Rules

Doors
Get Your Data No Matter Where it was Authored
Data Access

Integrity
Get Your Data No Matter Where it was Authored
Data Access

Reuse Your Data in the Format You Need
Data Transformation
Example of Automated Collaboration Service
DOORS to Integrity Synchronization

1. "Input" DATA
2. Select Service and enter Arguments
3. Progress on Remote Execution
4. "Output" DATA

Client Side

Server Side

DOORS CLIENT

DOORS SERVER

Integrity SERVER

MDWorkbench Web Services Layer

Run Mapping Rules

Doors2Integrity

HTTP/HTTPS
Mapping between APIs

SODIUS Mapping Processor

DOORS Structure
- Formal Module
- Object
  - System Attributes
    - Object Heading
    - Object Text
    - ...
  - Custom Attributes
    - ObjClass
    - Safety Level
    - ...

Integrity Structure
- Requirements Document
  - Requirement
    - Category
    - Title
    - Content.fva
    - Safety
    - ...
  - Stakeholder Request Document
    - Stakeholder Request

executes
DOORS to Integrity Exchange Platform

Web Application that executes synchronization tasks on a dedicated server
Mapping features

Configurable Mapping (conditions, enums, computed values)

TABLE & Rich Text

Computed Fields by scripts (e.g. set DOORS Web Access Link)
Defect Reporting Between an OEM and Supplier
Defect Reporting Example

- **Synchronization between XML defect reporting and Jazz Applications**
  - External Data: Various XML files formats from OEMs
  - Corporate System: JAZZ CCM
Model Exchange for Defense Systems

Diagram:
- DoD
- Prime
- Create Model of Defense System
- Define Scope of Review
- Loop:
  - doReview()
  - [condition]
  - CommentsProvided()
Shared System Model

PTC Windchill

mega

ARIS

sodius
System Architect / Mega

Diagrams and Data can be exchanged between tools
Common Themes

• Iterative Exchanges
  – Repetitive transfer until agreement
• Information flows both directions
  – Additive / corrective
• Information is split into public (exchanged with partner) and private (internal dialog / additional data)
• Controlled by process on each side
Common Pains

- Automations
- Data Format
- Process
Automations

• Everything is manual
  – Data selection
  – Exporting
  – Transferring
  – Explaining
  – Importing

• Periodic, human-intensive meetings
The Cost of Manual Effort

Value-pricing the Sodius MDWorkbench™ (Subscription Model)

Expenses

<table>
<thead>
<tr>
<th>Label</th>
<th>Expense Item</th>
<th>Min</th>
<th>Max</th>
<th>Probable</th>
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<tr>
<td>Lbr1</td>
<td>Fully Loaded Cost of Engineering Labor per Hour (GSA 871-1,2,3,6)</td>
<td>$110</td>
<td>$140</td>
<td>$131</td>
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<tr>
<td>Lbr2</td>
<td>Fully Loaded Cost of Architecture Framework Knowledge Engineer</td>
<td>$250</td>
<td>$450</td>
<td>$390</td>
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<td>Cns1</td>
<td>Fully Loaded Cost of Tool Trainer</td>
<td>$300</td>
<td>$400</td>
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<tr>
<td>Prd1</td>
<td>Cost of MDWorkbench™</td>
<td>$15,000</td>
<td>$30,000</td>
<td>$25,500</td>
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<td>TrmU</td>
<td>Cost of MDWorkbench™ User Training</td>
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<td>TrmD</td>
<td>Cost of MDWorkbench™ Developer Training</td>
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<tr>
<td>Mnt</td>
<td>Cost of MDWorkbench™ Maintenance</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>Rnt</td>
<td>Cost of MDWorkbench™ Monthly Lease</td>
<td>$15,000</td>
<td>$20,000</td>
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</table>

Scenario A (Business as Usual)

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<th>Month</th>
<th>1</th>
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<th>3</th>
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<th>7</th>
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<td>😐</td>
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<tr>
<td></td>
<td>Lbr2</td>
<td>😐</td>
<td>😐</td>
<td>😐</td>
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</tr>
</tbody>
</table>

PV

$516,346.73

$491,603.10
Drawback with Manual Exchanges

• Lack of timely information
• Introduction of errors
• Lack of traceability
• Lack of consistency across projects
Advantages with Manual Exchanges

- Broader communication
- Complete independence of partner tooling
Data Formats

• Need consistent data formats between partners
  – Force both sides to use the same tool
    • Force both sides to use same version of the same tool
      – DOORS Archive / Restore
  – Rely on exchange standards
    • Standards evolve
    • Standards are not implemented consistently
    • Standards rarely incorporate process
Lowest Common Denominator Always Wins

- PDF’s
- Word / Excel
Data Formats – Requirements

- ReqIF
  - Wide-spread industry adoption
  - Little evolution between versions
    - Facilitates consistency between vendor implementations
  - Open-source implementation
  - Includes process!

- STEP AP233

- Word
Data Formats - Defects

• Excel
• XML
• ASAM ISSUE
• Daimler DanTe

• Still need to import / export from internal development defect trackers
Data Formats - Models

• UML, CAD, STEP

• Littered with issues
  – Non-standard implementation across tools
  – References to unavailable resources (internal profiles or libraries)
  – Lossy exchange formats
    • UML: No diagrams
Process

• Three processes need to be considered
  – Owner process
  – Exchange Process
  – Partner Process

• Each Partner has internal and public process
  – Need to map private process to public process
Mapping Process
Proposed Architecture

Intelligent queries only update defects when appropriate, and only publish allowed information.
Exchange Maturity Level

0. No Exchanges

1. Manual Exchange of Defects, Requirements

2. Automatic Exchange of Defects, Requirements

3. Model Exchange
The Future of Exchanges

Present

A few narrow, late design, development exchanges
The Future of Exchanges

Early concept to post-production exchanges
The Future of Exchanges

• Simple database records aren’t enough
The Future of Exchanges

• Advanced concepts will require supplier expertise
  – Early delivery of functional models
  – Increasing model fidelity for performance analysis
  – Real-time data analytics

• Code will not longer be the deliverable
Model Exchange

• Most complex artifact to exchange
  – How to limit visibility to parts?
  – What to do with dangling references?
  – How to resolve conflicts?
Strategies For Model Exchange

• Divide your models
  – Different teams should own different parts
Strategies For Model Exchange

- Expose as little as possible
  - Each owner should explicitly expose elements for others to use
Strategies For Model Exchange

- Control dependencies
  - Two-way bad, one-way good
Collaborative Model Sharing

• Heterogeneous engineering toolset (tools, version of tools and their customizations) exists inside organization and their partners

• SE activities for sharing, traceability and collaboration on architectures requires complex efforts in this context
  – Export (Documents, HTML)
  – Reviews gathered using mails, Document (PDF/Word) comments or Excel sheets
  – Many tools, licenses, custom workbench settings
  – Need to train reviewers on design/req. tools

• We work on capabilities to simplify/enhance collaboration in this context

Unlock domains/teams silos to share engineering knowledge inside an organization
Publishing and Reviewing Workflows

- Data are published in the context of CM projects enabling authors to aggregate required information for a specific context and link feedbacks with the change management environment.

Diagram:

- **Authors**
  - Associate CM Project
  - Publish Data
  - Create Review
  - Feedback linked to CM system

- **Stakeholders/Reviewers**
  - Review and provide comments

- **CM**
  - Requirements
  - Architectures
Web-based publish/feedback collaboration platform for the French Ministry of Defense (DGA)

- Proving access to model information across organizational boundaries allows managers to gather efficient stakeholder feedback.
SE Collaborative Solutions

- **SE-Collab Connectivity**
  - Connect to main SE tools used by DGA
    - Connectors on various SE tools can be plugged on the platform to extract data and diagrams.
    - New extensions can be developed to add other tools
      - Handle « neutral » data extracted from the various tools including diagrams for modeling
        - OSLC AM Ontology used to expose any kind of data to external systems
      - Categorize and organize data

- **SE-Collab Review Capability**
  - Our connectors enable extraction of data AND diagrams allowing visual reviews of data, conforming native tool navigation or specific one
  - One unique web interface for all the users
  - Review stakeholders do not need desktop clients or reviewers web access
Share and review models

- SE Collab helps extended team members to share and review their modeling or requirement work published from heterogeneous engineering toolset. It connects authors, reviewers, and stakeholders on a web platform.

- It provides capabilities that allow graphically commenting models instead of providing just textual feedback.

- It can support advanced review workflows with its optional integration with Change Management (CM) system.
2 modes for sharing data

Publisher to select data

- « My ToolSet »

AUTHORING AREA

- CM System

Optional Link

ARCHIVE

- Archive

Connected or disconnected mode allow different mode according network continuity configurations

HTTPS

REVIEWS AREA
Web Portal Content (1/6)

- A main dashboard per project

Data are stored into container Projects

We share Designs

We contribute to Reviews

We can see last Comments
Data can be navigated with custom **Categories**

**Navigable Links** among the whole design

Diagrams are imported with **active Diagram Areas**
### Module Maritime Search and Rescue

<table>
<thead>
<tr>
<th>ID</th>
<th>1 Search and Rescue (SAR)</th>
<th>Approval Status</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1 Program Definition</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The primary goal of the Search and Rescue Program is to save lives at risk and involves federal departments, volunteers, organizations, municipalities, provinces and territories, working together to provide this service.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.2 Capabilities</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1.2.1 Recovery</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Operations, which include search, rescue and incident co-ordination, form the heart of the marine SAR system.</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>1.2.2 Search</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Frequent operational exercises ensure a high level of readiness and proficiency.</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>1.2.3 Alert</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Visual, audible and electronic methods are used by vessels to indicate distress.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>1.2.4 Assistance</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Volunteer assistance is a key element in maximizing the efficiency of SAR operations, prevention and safety-related activities.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.3 Program Delivery</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>The Maritime SAR Program is a full time program activity. Its main goal is to reduce the loss of life in the maritime environment. The program has four important elements: management and monitoring; operations; volunteers and Global Maritime Distress and</td>
<td></td>
</tr>
</tbody>
</table>

« Text » Data can be navigated with **Table Views** (here DOORS requirements)
A Review defines Contributors and Resources

Collaboration with the configured external CM System (OSLC CM)
Graphical Annotations on Diagrams

Collaborative Discussions on Design items
Reviews can be exported as Reports.
Architecture Overview

- Full HTTPS/REST, RDF + OSLC Implementation (Open-Services for Life Cycle Collaboration)
- Connector Extensibility / Web UI Navigation Customization
- Repositories
  - RTC Repository (at DGA)
  - Standalone Apache Jena Repository
- Add Links between artifacts by content analysis (e.g. DOORS/MEGA/SA Links)
During design, the data exchanged between partners throughout external interfaces of a system are described by a set of XML files. They have to be integrated in the SysML models manually. Impact Analysis for each iteration step is complex to handle.
SysML & XML-Based Tooling Interoperability

- Integration of XML data and assistance to iterations

Impact analysis when importing a new version of datatypes libraries

Use of specific imported datatypes

Libraries of types

OEM 1

OEM 2

Impact

Direct Impact

Suspected Impact
SysML & XML Impact Analysis

Import/Export XML Formats

Analyze the model according to domain rules

Manage Iterations
Conclusion

• Process drives everything
• Exchanges will increase in complexity
• Exchanges will increase in frequency
• Models will rule the world