Enabling Collaborative Asset Life-cycle Management using System of Systems Interoperability

The Open Industrial Interoperability Ecosystem and the Oil and Gas Interoperability Pilot

Standards Leadership Council
BP
Houston, Texas
March 20, 2015

Alan Johnston
MIMOSA President
ISO TC 184/WG 6 Convener

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Key Objective
Transforming the Industry Solutions Model
From Systems Integration to System of Systems Interoperability

Custom Systems Integration
- Custom development
- Application Specific data adapters
- Owner/operator responsible for sustainment

Open Industrial Interoperability Ecosystem (OIIE™)
- Cloud Friendly Solutions Architecture
- Configuration rather than development
- Based on supplier neutral open standards
- Standardized SoS Adapters (Plug and Play)
- Commercial off the Shelf (COTS) Applications
- Suppliers responsible for sustainment

OGI Pilot™
Building an OIIE Instance
Key OIIE & OGI Principles and Methods

• Not specific to any one industry or supplier
  – Not just a set of reference standards
  – Directly reuses a non-proprietary ecosystem

• Focus on open standards-based interoperability
  – Reuse existing standards in a repeatable, scalable portfolio
  – Stop “re-inventing wheels”
  – **Incorporate standards by reference**
  – Find and fill gaps through collaboration

• The OGI Pilot is simply an instance of the OIIE
  – Industry Standard Use Cases & Solutions Architecture
  – Using Oil and Gas Industry Asset Classes
  – Supplier neutral industry interoperability test-bed
An IEEE Interoperability Definition

- **IEEE**: The capability...
  - of two or more systems or elements to exchange information and to use the information that has been exchanged.
  - for units of equipment to work together to do useful functions.
  - that enables heterogeneous equipment, generally built by various vendors, to work together in a network environment.
  - of two or more systems or components to exchange information in a heterogeneous network and use that information.
System of Systems

A System of Systems (SoS) is a collection of task-oriented or dedicated systems that pool their resources and capabilities together to create a new, more complex system which offers more functionality and performance than simply the sum of the constituent systems. – Wikipedia

- SoS has been developed and is widely used in the aerospace and defense community, but it is now being adopted by many other industry groups.
- SoS terminology is linked to the systems engineering community and the International Council on Systems Engineering (INCOSE).

Interoperability is considered to be an intrinsic part of SoS

- Proprietary Interoperability Schemes usually fail as no single company knows everything about everything.
- Standards-based Interoperability now provides a rational alternative to the status quo.
The Role of Standards in Sustainable Enterprise Solutions

- **Standards help rationalize chaos into widely accepted good practices**
- NGO Standards Organizations such as ISO and IEC
- Industry Standards Organizations – API, ISA, OPC, MIMOSA…
- Asset Management Practice Standards
  - Such as PAS 55 and ISO 55000
  - Define good asset management practices to be followed
- IT Oriented Standards
  - Such as ISO 15926, OPC, ISA 95/88, ISO 18101 and MIMOSA
  - Enable SoS to properly support PAS 55 and ISO 55000 series good practices
HISTORY OF CROSS INDUSTRY COLLABORATION

Cross Industry standards-based Interoperability programs
MIMOSA Information Network (MIN)

June 21, 2000
MIN-Viewer
OSA-CBM Presentation
Alan T. Johnston
MIN Project Director
U.S. Army CECOM Collaborative Telemaintenance Project

Phase I Demonstration Briefing – July 31, 2002
Alan Johnston – MIMOSA
Kenneth Bever – MIMOSA
Bob Walter – Penn State ARL

CMA Showing Measurement Events In Alarm
The OpenO&M™ Initiative
Enabling Open Standards-based O&M Interoperability

Enterprise Business Systems
Enterprise Resource Planning (ERP)

OpenO&M™

Operations

Maintenance

Physical Asset Control
Real-time Systems

Formed 2006
Critical Intersection for a Supplier Neutral Ecosystem Enabling Multi-domain Systems Interoperability

Enterprise Business Systems

Big Data and Analytics

Supplier Neutral Open Specifications

Automation and Control Systems

LIFE CYCLE ENGINEERING Systems
OGI Pilot Business Use Cases Roadmap - Part 1

Enterprise Capital Project Data Management Standards

Enterprise Standards and Project Execution Template for all projects

Plan / Program / Contract  Engineer / Design  Procure  Fabricate / Construct  Complete / Commission / Startup  Operate / Maintain  Decommission / Dispose

Continuous Handover of Structured Digital Assets
Establishing an Environment for Lifecycle System of Systems Interoperability

Sustained Lifecycle Digital Asset Management

OGI Use Case 1: Capital project handovers to O&M
OGI Use Case 4: Enterprise Product Data Library Management
OGI Use Case 10: Automated provisioning of O&M systems
OGI Use Case 11: Enterprise Reference Data Library (RDL) Management

Fiatech EDRC Use Case 1: Pump Replacement Specification Handover (O/O to EPC)
Fiatech EDRC Use Case 2: Field Instruments & Control System (EPC to Supplier)

Levy contractual requirements on suppliers at start of specific projects
USPI CFIHOS Collaboration

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OGI Pilot Business Use Cases Roadmap - Part 2

Enterprise Capital Project Data Management Standards

Plan / Program / Contract  Engineer / Design  Procure  Fabricate / Construct  Complete / Commission / Startup  Operate / Maintain  Decommission / Dispose

Continuous Handover of Structured Digital Assets

Sustained Lifecycle Digital Asset Management
Sustaining the Interoperable O&M Environment

- OGI Use Case 2: Recurring Engineering Updates to O&M
- OGI Use Case 3: Field Changes to Plant/Facility Engineering
- OGI Use Case 4: Enterprise Product Data Library Management
- OGI Use Case 5: Asset Installation/Removal Updates
- OGI Use Case 6: Preventive Maintenance Triggering
- OGI Use Case 7: Condition-Based Maintenance Triggering
- OGI Use Case 8: Early Warning Notifications
- OGI Use Case 9: Incident Management/Accountability
- OGI Use Case 10: Provisioning of O&M systems
- OGI Use Case 11: Enterprise Reference Data Library (RDL) Management

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Simplified OIIE Systems Architecture

Enterprise Business Systems
(Enterprise Resource Planning, Enterprise Risk Management, Supply Chain Management)

- Planning
- Standardized Interoperability Registers
- Construction Procurement
- Operations Management
- Operations Risk Management
- Maintenance Management

OpenO&M Information Service Bus Model

- Automation and Control
- Safety, Health, Environment and Operations Monitoring
- Prognostic and Health Management
- Automation and Control Bus
- Sensor/Transducer

Enterprise Mirrored Reference Data Library
Enterprise Specific Reference Data Library
PCA Reference Data Library
EPC/OEM Reference Data Libraries

ISBM publish/subscribe or request/response services
ISO 15926-based SPARQL interface
OPC interface (Classic and UA)
Automation & Control deterministic Fieldbus interface
Restricted data flows
Downstream (Plant) OGI Pilot
2 of 4 Debutanizer Tower P&IDs
OGI Pilot Near Term Additions

• OGI Pilot
  – Downstream-Phase 2 - 2015
    • Add Increased Datasheet Information – ISDD Project
    • Updated Implementation of O&M Use Cases
      – Key MMS Suppliers (SAP, IBM Maximo…)
      – More Automation and Control Suppliers (GE, Emerson Process Management, Yokogawa, Schneider Invensys)
  – Upstream
    • Increased Alignment with Standards Leadership Council
    • Proper Infrastructure Asset Class Selection for Upstream
MIMOSA Led Joint Project

Standardized Data Sheet Definitions

- Major Functional Objectives
  - Capture Industry Standard Datasheets as Industry Standard Datasheet Definitions
    • Based fully on existing industry datasheets (API, ISA, IEC, ISO, NORSOK...)
    • Fully machine interpretable, with UUIDs assigned to each meaningful element
    • Directly reusable by both Owner/Operators and suppliers (mapable & extensible)
  - Align
    • Aligned with PCA, PCA SV 15926 Property Classes and/or IEC Property Classes
    • Aligned with Energistics Units of Measure
    • Aligned with ECCMA Material Procurement Codes
  - Publish
    • Published both as MIMOSA CCOM XML and Standards Excel Spreadsheets (IEC Format)
    • To be included in ISO 18101
    • Will be available to fill gaps and rationalize 15926 RDLs
Simplified OIIIE Systems Architecture

Automation and Control

Safety, Health, Environment and Operations Monitoring

Prognostic and Health Management

Automation and Control Bus

Sensor/Transducer

Sensor/Transducer

Sensor/Transducer
Connected Sensor & Devices

Information flow from connected devices...

Optimize equipment and process performance

Capture granular data and monitor real-time performance

Deliver proactive & predictive services (e.g. predictive maintenance)

Product and Support Teams
- Design & Engineering
- Design optimization
- Remote Monitoring
- Customer Support

New service capabilities
Resource optimization

Equipment Builder
Component Manufacturer

IoT - Definition
Into Controller: Information model

- Connection **to the controller**
- Integrated: PLC and OPC-UA in embedded device
- Mapping: Support official mapping IEC61131-3 to OPC-UA
- Benefit: Secured, semantic interoperability

**Diagram:**
- OPC-UA namespace
- Standard
- Vendor specific
- MES
- ERP
- Visu
- PLC
- RFID

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Connection >from the controller< Controller initiating communication

- Vertical & Horizontal
- Fieldbus independent
- It’s fast – but not a fieldbus

From Controller: PLCopen FB

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SCADA

Requests for process values and state changes

elevated reservoir

level reached

stop pumping

due to problems at group1 supplier of freshwater has changed to group 2

Requests for process values and state changes

please overtake filling of elevated reservoir

Challenge:
- 500 devices
- pumps
- waterboilers

1400 km²
MDIS
MCS-DCS Interface Standardization ("MDIS")

Information model
• Well
  – Pump
  – Choke Valve
  – Valve
  – Instruments
  – EPU
• SEM
• Motor
• Manifold
• CIMV
• DHPT
• MPFM
• Subsea Field bus
1. Easy file/folder deployment

Download of
- e.g. of PLC binary code
- e.g. of recipes
- e.g. Operating System components

2. Easy management for Upload

- e.g. measurement data

Target markets
- Building automation
- Water treatment
- Wind parks
- General device management
IoT or Industrie 4.0
OPC-UA is the enabler

**Communication infrastructure**
- Secure, interoperable, reliable, high performance, scalable
- Platform-independent (OS, language, vendor)
- Technology:
  - Service-oriented
  - Provide technology independent from services
- Small set of easy to use services
  - 37 operations
  - Grown up in Automation market - (e.g. time stamp, status) but neutral for other vertical markets

**Information modeling**
- Rich, object oriented and extensible type model
- Type model in address space
- Full mashed network
- Scalable:
  - Support simple and complex models
- Standardized Information models based on OPC UA
  - PLCopen, BACnet, MTConnect…
Simplified OIIE Systems Architecture

Adapters – Convert from / to OPC UA and CCOM
OGI Project Updates
Reference Data Services

SLC Forum
Houston 19 March 2015

Nils Sandsmark
Simplified OIIIE Systems Architecture

Enterprise Business Systems
(Enterprise Resource Planning, Enterprise Risk Management, Supply Chain Management)

Planning
Standardized Interoperability Registers
Construction Procurement
Operations Management
Operations Risk Management
Maintenance Management

OpenO&M Information Service Bus Model

Engineering Design
Construction Management

Automation and Control

Automation and Control Bus
Sensor/Transducer

Safety, Health, Environment and Operations Monitoring

Enterprise Mirrored Reference Data Library
Enterprise Specific Reference Data Library
PCA Reference Data Library
EPC/OEM Reference Data Libraries

ISO 15926-based SPARQL interface
OPC interface (Classic and UA)
Restricted data flows

ISBM publish/subscribe or request/response services

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ISO 15926 Reference data architecture

Capital Project and Operations & Maintenance
PCA Reference Data Services (RDS) Include

1. ‘Wrapper’ Services
   → Everything required to provide relevant offerings with predictable quality on Internet scale

2. CONTENT
   → The PCA Reference Data Library

3. Technical Platform
   → Everything required to underpin points 1 and 2

4. Governance
   → Everything required to manage above aspects as one
EPIM Standardization Initiative (STI)

- The EPIM STI project has started addressing standardized information for Standard Equipment
- Harmonized technical requirements for Standard Equipment will be a result of the project
Standardize data from datasheets

Data sheets
Common set of classes and properties

ISO 15926

Terminology used by Norwegian Offshore Industry (STI project)

<table>
<thead>
<tr>
<th>NORSOK</th>
<th>Operators</th>
<th>Contractors</th>
<th>Other suppliers</th>
</tr>
</thead>
</table>

Creating data sheets based on today’s practices

Terminology used by standard organizations (ISDD project)

<table>
<thead>
<tr>
<th>API</th>
<th>ISA</th>
<th>IEC</th>
<th>ISO</th>
</tr>
</thead>
</table>

PCA RDL
STI: NORSOK standard datasheets

- I-001 is the NORSOK Standard for Field Instruments
- The main chapters covers ‘Functional Requirements’ and ‘Installation’, while Annex C includes all the Datasheets.
# STI Pilot using Pressure Transmitter

<table>
<thead>
<tr>
<th>Classes</th>
<th>Property 1</th>
<th>Property 2</th>
<th>Property 3</th>
<th>Property 4</th>
<th>Property N</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Eq. Gr. 1</th>
<th>Eq. Gr. 2</th>
<th>Eq. Gr. L</th>
</tr>
</thead>
</table>

## 200+ NORSOK Data Sheets
Status

- Systematization of NORSOK standard datasheets and standard equipment is completed
- Pressure Transmitter is completely modelled
- Prototype is implemented, allowing:
  - Importing datasheet (XML format)
  - Representing according ISO 15926 model
  - Querying and displaying datasheet in chosen terminology (e.g., NORSOK, ISA)
  - Exporting to third party XML format
EPIM STI RDL Linked Data Architecture

ISO TC184/SC4/WG3+22 ISO 15926 Reference data architecture
<table>
<thead>
<tr>
<th>Default RDS ID</th>
<th>R-1a3c9749-85af-406e-a2c9-294771911ee3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ici:assembledPartOf</td>
<td></td>
</tr>
<tr>
<td>Body material</td>
<td></td>
</tr>
<tr>
<td>Coplanar Flange</td>
<td></td>
</tr>
<tr>
<td>Electrical Module</td>
<td></td>
</tr>
<tr>
<td>Pressure Module</td>
<td></td>
</tr>
<tr>
<td>Ici:identifiedBy</td>
<td>3051S2TG5A3E11A1KI1M5P1Q4Q8QTT1Q15</td>
</tr>
<tr>
<td>Ambient Operating Temperature Range</td>
<td>-20 - 80</td>
</tr>
<tr>
<td>CE Identification code</td>
<td>CE1180</td>
</tr>
<tr>
<td>Installation and removal procedures</td>
<td>Not available</td>
</tr>
<tr>
<td>Manufacturing Company</td>
<td>EMERSON PROCESS MANAGEMENT</td>
</tr>
<tr>
<td>Measurement and arrangements drawing</td>
<td>Not available</td>
</tr>
<tr>
<td>Operation and maintenance instructions</td>
<td>Not available</td>
</tr>
<tr>
<td>Power Consumption Range</td>
<td>500 - 500</td>
</tr>
<tr>
<td>Product description and ordering information</td>
<td>Not available</td>
</tr>
<tr>
<td>Sectional drawing</td>
<td>Not available</td>
</tr>
</tbody>
</table>
Integrated Lifecycle Asset Planning

Status:

- Roadmap for future ILAP standards, IT infrastructure and adapter developed
- Proof of concept adapters developed and tested for SAP, Primavera and Safran developed and tested
- Main focus now is first version functional adapter for SAP, Primavera and Safran
- The ISO process is according to plan, “Committee draft” will be filed in June as planned
EPIM’s Business Model and IT architecture

All solutions based on ISO 15926 and Semantic Technology (W3C) and the databases are all **triplestores**.
INTERNATIONALIZATION VIA ISO

ISO TC 184/WG 6
Developing ISO 18101 (OGI Technical Specification)
Convener Alan T. Johnston
Co-Convener Nils Sandsmark
ISO TC184 Manufacturing Asset Management
Integration Task Force
Total Asset Life-Cycle Summary

Product/Asset/Plant/Facility/Vehicle Life-Cycles

Continuous Improvement Feedback Loops

SC1 & SC4
Other Standards
IEC TC 65 Standards
SC5, SC5-IEC/JWG5, SC4-SC5/JWG8 OpenO&M & Other Standards
Other Standards

DB 1  DB 2  DB 3  DB 4  DB N  DB N+1  DB N+2  ISO/IEC UID  DB N+4

Services Oriented Architecture Using Standards-based Federated Data Model
Some Relevant ISO Related Activities

ISO TC 67
Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries

ISO TC 108
Mechanical vibration and shock

ISO TC 184
Industrial automation systems and integration

SC5
Condition monitoring and diagnostics of machines

SC4
Industrial Data

SC5
Architecture, communications and integration frameworks

ISO 14224
Petroleum, petrochemical and natural gas industries -- Collection and exchange of reliability and maintenance data for equipment

ISO 13374
MIMOSA OSA-CBM
WG6
Formats and methods for communicating, presenting and displaying relevant information and data

15926-Data for Process Industries
10303-Product data representation and exchange
STEP/PLCS
OASIS
Collaborating on the deployment of an international standard for product data exchange (ISO 10303)

ISO 18435
MIMOSA OSA-EAI
WG7
Diagnostic and maintenance applications integration
Supporting National ISO TC184 Committees

• National TC 184 Representatives Currently Supporting OGI Project
  • Canada
  • Japan
  • Netherlands
  • Norway
  • United Kingdom
  • United States of America
  • Australia (Through Liaison with TC 108/SC 5)
    ➢ China (January 2015)
    ➢ France (January 2015)

• Established support from experts
  • TC108 SC5
  • TC184 SC4
  • TC184 SC5
The OpenO&M™ Initiative
Enabling Open Standards-based O&M Interoperability

Enterprise Business Systems
Enterprise Resource Planning (ERP)

Operations
Maintenance

Physical Asset Control
Real-time Systems

OpenO&M™

WBF
OAGi
OPC
ISA
MIMOSA™
OIIE and OGI Pilot To Be Featured At Future Events

- Fiatech Technology Showcase – April 13-15, Boca Raton Resort, FL
- Solutions 2.0 – August 3-7, 2015, Westin Galleria, Houston, TX

All OIIE and OGI Pilot Working Documents are available at www.mimosa.org

Paul Hunkar
OPC Foundation / DS Interoperability
Paul.Hunkar@DSInteroperability.com

Nils Sandsmark
POSC Caesar
nils.sandsmark@posccaesar.org

Alan T. Johnston
MIMOSA
atjohn@mimosa.org