Design for Reliability Operations and Maintenance in Capital Projects
Standards-based Interoperability

• **MIMOSA Vision** - Interoperable Components, Systems, Systems of Systems and Networks of Networks composed into adaptable, scalable, secure and sustainable Digital Business Ecosystems

**Industry Path Forward:**

• Simplify
• Standardize
• Digitalize
• Interoperate

**Alan Johnston**: MIMOSA President, ISO TC 184/WG 6 Convener

• 35 years of expertise designing reliability into industrial IT/IM/IS systems supporting asset, reliability and condition management.
The Open Industrial Interoperability Ecosystem

The Standards-based Digital Business Ecosystem for Reliability Centered Design

International Maintenance Conference

Dec 12, 2017

Bonita Springs, FL
What Is MIMOSA?

• A non-profit industry standards organization organized as a 501 (c) 6 Mutual Benefit Association

• Funded and managed by members for mutual benefit
  • Owner/Operators (Dow, BP, Southern Company, US Army/DoD)
  • OEMs
  • Major Software Suppliers
  • EPCs
  • Academia

• Builds, publishes and maintains supplier-neutral, open standards addressing Life-cycle Asset Management

• Manages the definition, validation and evolution of the Open Industrial Interoperability Ecosystem (OIIE) and the associated interoperability testbed.
Analytical Framework

• **What** are the key IT/IM/IS related problems impacting reliability?
  • Many inherently complex processes and systems, which are constantly evolving
  • Many people, processes and systems exist in silos
  • IT Security is an increasing threat to all aspects of Critical Infrastructure
  • **Industrial IT/IM/IS solutions still follow an artisan model, rather than the industrial model**

• **Why** do they matter?
  • Industries must gain efficiencies, while improving risk management and sustainability
  • Custom systems integration increases costs and risks, while decreasing adaptability and sustainability

• **How** do we address them?
  • Standards Based Interoperability Framework
  • Standard asset information models incorporating Reliability, Condition and Maintenance Management
  • Standard Use Cases and Scenarios covering complete Asset Life-cycle
  • Digital Business Ecosystems
  • **The Open Industrial Interoperability Ecosystem (OIIE)**
Standards-based Interoperability

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**Path Forward:**
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Ecosystems and Interoperability-Concept

• Supplier-specific Interoperability
  • Lego
  • Enterprise Resource Planning (ERP)
  • Apple Ecosystem

• Open Source
  • Linux
  • Android

• Standards-based Interoperability
  • Intermodal Transport
  • Internet
  • Industrial Internet of Things (IIOT)

➢ Open Industrial Interoperability Ecosystem (OIIE) – Embraces COTS & Open Source
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.
Critical Infrastructure: Key Sectors

- Manufacturing
- Transport-ation
- Government
- Defense
- Energy
- Water
- ICT
- Food and Agriculture
- Health
- Banking
Critical Infrastructure Definition

What Is Critical Infrastructure?

Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. - Wikipedia

Critical infrastructure are the assets, systems, and networks, whether physical or virtual, so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.

Last Published Date: November 1, 2013
US Department of Homeland Security
A “simple” System of Systems

Engineering Design Centre
Newcastle University
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.
Industrial Interoperability and Digitalization

Potential Paths

- Single Supplier/Single Platform
  - Supplier/Product-centric Design
  - Single supplier or cartel of suppliers impose their own product “standards” on industry
  - Problems:
    - No single supplier or cartel controls a critical mass of the entire market
    - No single supplier or cartel understands every important aspect of the entire market

- Open, Supplier-Neutral Specifications
  - Industrial Solutions Architecture Centric Design
  - Follow broadly accepted industrial IT Solutions Architecture (TOGAF)
  - Interoperability Specifications informed by Industrial Use Cases and Scenarios
  - Incorporate multiple, existing standards
  - Standardized Enterprise Solutions Architecture which is cloneable, rather than custom built
Systems of Systems and Individual Enterprise Ecosystems Must Interoperate In Digital Business Ecosystems

The Open Industrial Interoperability Ecosystem (OIIE) defines the basis for Supplier Neutral Digital Business Ecosystems composed of Enterprise Ecosystems which share the required standards.
Digital Ecosystem

Wikipedia:

• A digital ecosystem is a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems.

• Digital ecosystem models are informed by knowledge of natural ecosystems, especially for aspects related to competition and collaboration among diverse entities.

• The term is used in the computer industry, the entertainment industry, and the World Economic Forum.

Major IT/IS firms (Apple, Google, Microsoft, SAP and many others) have all been developing and promoting their own proprietary digital ecosystems for over 10 years.
Digital Business Ecosystem-Why?

Wikipedia:

• The concept of Digital Business Ecosystem was put forward in 2002 by a group of European researchers and practitioners, including Francesco Nachira, Paolo Dini and Andrea Nicolai, who applied the general notion of digital ecosystems to model the process of adoption and development of ICT-based products and services in competitive, highly fragmented markets like the European one.
Digital Business Ecosystem-Status

• The challenge is to find pragmatic ways of implementing Digital Business Ecosystems which are supplier neutral and adaptive enough to sustainably span the industrial sectors included in for Critical Infrastructure.

• The OIIIE provides such an approach where:
  • OIIIE provides a standardized intra and inter-enterprise Solutions Architecture fully composed of published, supplier-neutral standards
  • OIIIE Instances are Cloneable
Systems of Systems and Individual Enterprise Ecosystems Must Interoperate In Digital Business Ecosystems

The Open Industrial Interoperability Ecosystem (OIIE) defines the basis for Supplier Neutral Digital Business Ecosystems composed of Enterprise Ecosystems which share the required standards.
OIIE Features
- Supplier-Neutral Systems of Systems & Networks of Networks
- Collections of which can form Digital Business Ecosystems

OIIE Includes
- Industry 4.0 Workflows
- PERA and SCM with IIOT
OIIE Simplified Systems Connectivity and Services Architecture

Enterprise Business Systems

- OIIE Administration
- Planning
- Engineering Design
- Construction Management
- Operations Management
- Operations Risk Management
- Maintenance Management

OpenO&M Information Service Bus Model (ISBM)

IloT and Industrie4.0
Event-driven solutions architecture for Asset Management

- IloT Connections
  - OPC UA (AMQP, MQTT, DDS)
- ISBM Web Services
- Field Networks
- SPARQL

Connected Device

Automation and Control

HSE and Operation Monitoring

Prognostic & Health Management

Automation Control Bus

Device

Sensor/Transducer

Industry Reference Data Libraries
- (PCA, USPI, IEC, ISO…)
- IloT Device Metadata

Enterprise Reference Data Libraries
- IloT/Industrie4.0 Device Metadata

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OIIE Pilot Business Use Cases Roadmap - Part 1

Continuous Handover (Structured Digital Assets, Tags, Docs)
Establishing an Environment for Lifecycle System of Systems Interoperability

Sustained Lifecycle Digital Asset Management

- OIIE Use Case 1: Capital project handovers to O&M
- OIIE Use Case 4: Enterprise Product Data Library Management
- OIIE Use Case 10: Automated provisioning of O&M systems
- OIIE Use Case 11: Enterprise Reference Data Library (RDL) Management
### OIIE Pilot Business Use Cases Roadmap - Part 2

| Use Case 1: Recurring Engineering Updates to O&M<br>Use Case 2: Field Changes to Plant/Facility Engineering<br>Use Case 4: Enterprise Product Data Library Management<br>Use Case 5: Asset Installation/Removal Updates<br>Use Case 6: Preventive Maintenance Triggering<br>Use Case 7: Condition-Based Maintenance Triggering<br>Use Case 8: Early Warning Notifications<br>Use Case 9: Incident Management/Accountability<br>Use Case 10: Provisioning of O&M systems | **Sustained Lifecycle Digital Asset Management**<br>**Sustaining the Interoperable O&M Environment**<br>Continuous Handover of Structured Digital Assets | Plan<br>Program<br>Contract<br>Engineer<br>Simulate<br>Design<br>Procure<br>Fabricate<br>Construct<br>Complete<br>Commission<br>Startup<br>Operate<br>Maintain<br>Decommission<br>Dispose |
OIIIE Standardized Use Case Architecture
Standardized Methodology to Define and Re-use OIIIE Components

Use Case = 11+4
- Background
- Scope
- Preconditions
- Successful End Condition
- Actors
- Triggers
- Process Workflow
- Scenarios

Scenario (OIIIE Event/Micro Service Definition for Adaptors) = 32
- Actors
- Data Content
- Data Formats
- Reference Data
- Information Service Bus Configuration
ISDD Project Build and Use Processes

**ISDD BUILD**

- **EXISTING INDUSTRY STANDARD DATA SHEETS (ISD)**
- **API**
- **ASME**
- **ISA**
- **PIP**

**BUILD Process**

- Discipline Engineers
- Information Engineers
- SUBJECT MATTER EXPERTS

- **INDUSTRY STANDARD DATA SHEET DEFINITIONS (ISDD)** (Version Managed)

- Standard Mappings
  - 15926 RDL2
  - CFIHOS
  - ECCMA EOTD

**ISDD USE**

- **An Industry Rosetta Stone**
- Custom Mappings which enable normalization for property sets “on the wire” in M2M exchanges

- **XML**
- **CCOM**

- Version Managed ISDDs
- Owner/Operators Map Elements
- EPCs Map Elements
- Capital Equipment Suppliers Map Elements

**EXISTING INDUSTRY STANDARD DATA SHEETS (ISD)**

- **API**
- **ASME**
- **ISA**
- **PIP**

**INDUSTRY REFERENCE DATA LIBRARIES**

- CFIHOS
- ECCMA EOTD
Full Asset Life-cycle Management

Product/Model/Asset/Plant/Facility/Platform Life-Cycles

Derived from ISO TC 184 Manufacturing Asset Management Integration Task Force Final Report
MIMOSA CCOM Information Domains

- Configuration Management
- Resource Management
- Operation and Condition Management
- Work Management
- Reliability Management
- Reference Data and Meta Data Management
MIMOSA CCOM Information Domains

Configuration Management:
- Assets
- Asset Tracking
- Functional Locations

Reliability Management:
- Model Info
- Engineering Studies
- FMECA

Manufacturers Models
- Specifications
- Datasheets

Hierarchies
- Organizations Sites

Documents
- Mesh Networks
- Geospatial Tracking

Failure History

Work History
Recent Activities

- ISO TC 184/WG 6 Meetings
  - Nov 13-15, 2017- BP, Houston, TX

- MIMOSA Industry Digitalization Meetings
  - Nov 16, 2017-SAP America, Houston, TX
  - PCA – OIIE ILAP Pilot
  - Fiatech/MIMOSA JWG for Interoperability – Barbara Migl (Dow), Co-chair
  - Deb McNeil (Dow) – MIMOSA Board Chair
  - Ted Weitzman (Southern Company) – Joining Board
  - Jim Colson (US Army) – Joining Board

- Projects/Workstreams
  - ISDDs
  - RESTful Services
  - OPC UA
  - ECCMA
  - OIIE/OGI Pilot – Open Industrial Digital Business Ecosystem
OIIE Pilot Phase 3

- Covers entire asset life-cycle
- Builds on OIIE/OGI Pilot Phase 2 Engineering and Design Models
  - Debutanizer Tower
  - Adds More details to simulate a real project
- Adds major new participating members
  - OEMs
  - EPCs
  - Procurement Suppliers
  - Materials and Asset Management Suppliers
- Adds ISDDs and Updated OpenO&M ISBM Specification
- In cooperation with CII/Fiatech, ECCMA, PCA, USPI and OPC Foundation

➢ **Kicks off in January**- Join and participate or sponsor
1. We need to build a light ends unit to remove butane from our incoming crude supply.

2.a How Much Capacity Do We Need?

b. What will the incoming crude spec be?
1. We need to buy equipment and instruments meeting or exceeding functional requirements taken from PFD and P&IDs for the new Debutanizer Tower.

2. Send me the Requirements from those documents and I will check with our preferred suppliers.

Client Engineering Person

Requirements

Debutanizer PFD and P&ID

Client Purchasing (May be EPC)

Models Meeting Requirements

Requirements

3.P2M Dialog

Instrument or Equipment Supplier Portals
1. We need to have the instruments installed in the new Debutanizer Tower Unit.

2. We are generating Construction Work Orders to have this done on schedule.

3. Pick Instruments to Install on Functional Locations

4. Asset Install Events (Establish Relationship between Assets and Functional Locations

Debutanizer PFD and P&ID

Instrumentation Warehouse

Client Engineering Person

Client Construction Management

Client Instrument Fitters

Work Completion

Construction Work Order

Requirements
1. We have the new Debutanizer Tower As Built Information Ready for Handover

2. Ok, Send Me The Updated P&ID with the As Built Information
1. We need to have the Debutanizer Tower As-Designed and As-Built Information Provisioned into multiple O&M Systems.

2. The OIIE automated provisioning process will let the OIIE compliant systems provision themselves.

3. Tell me which systems need to be provisioned and I will set them up so the provisioning process will run.
OIIE Story M105: Unit Performance Management and CBM

1. We are not getting the quality of the Butane & Propane yields we expected from our light ends unit.

2. We may be having problems controlling some of the temperatures and pressures in the fractionation and condensation processes.

3. We are having a problem in Unit LE1. We suspect your Instruments in Functional Locations LE1-TT206 and LE1-PT113.

4. Our Support Contract lets us access your Unit LE1 to help you diagnose problems.

5. P2M Diagnostic Session

6. M2M Diagnostic Session

7. We have found a problem with the Instrument installed in LE1-TT206.
1. Our instrument supplier has helped us Diagnose a Problem with the Instrument Installed in LE1-TT206. We need the problem fixed ASAP.

2. We will remove the instrument and replace it if we have a replacement.


4. Looks Up Asset Tag XXX-TT-2350 to find Make and Model. Checks to see if an allowable replacement is in MRO Inventory.

5. Issues Work Order to remove Asset XXX-TT-2350 from LE1-TT206 and install Asset XXX-TT-1004

6. “Digital Twin” with As Operated and Maintained Information will be updated by the OIIE Compliant CMMS. This maintains the configuration of the Unit.