Industrial Value Chain Reference Architecture

24 April 2017 at Hall 8 Stand D19
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Industrial Value Chain Initiative
Outline

1. Scenario-based Use Case for Practical Concern
2. Kaizen Approach Using Loosely Defined Standard
3. IVRA: Industrial Value Chain Reference Architecture
4. IVI Platform for Smart Manufacturing Ecosystem
IIoT/Smart Manufacturing Initiatives in Japan

Industrial Value Chain Initiative Membership (as of Apr. 20, 2017):
- 77 Large manufacturers
- 51 Small and midsized manufacturers
- 62 Supporting member organizations
- 15 Sponsor member organizations
- 19 Academic members
- 552 Individuals

IoT for all Industries and Society
- IoT Acceleration Consortium
- IoT Acceleration Lab

Robot revolution society
- Robot Revolution Initiative
- WG3 Robot Innovation
- WG2 Robot Usage Promotion

Smart Manufacturing
- WG1 IoT-driven Transformation in Manufacturing
- Interrelated

Industrial Value Chain Initiative
IIoT/Smart Manufacturing Initiatives in Japan

IoT for all Industries and Society
- IoT Acceleration Consortium
- IoT Acceleration Lab
- IoT Acceleration Consortium

Robot revolution society
- Robot Revolution Initiative
- WGA
- WGB
- WGZ

Smart Manufacturing
- Industrial Value Chain Initiative
- WGJ
- WGG

Committees
- Business Cooperation
- Future Project
- Standard Model
- Platform
- IIoT Infrastructure
- SME Networking
- Cross Industry
- Data Sovereignty
- IP Promotion
- Awards Advisory
- Publicity

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Scenario working groups and use cases 2016

- **2A01**: Digitalization of process information and know-how on manufacturing
- **2A02**: Connection of information on production preparation at design change
- **2B01**: Utilization of robot program assets by CPS
- **2C01**: Agile planning of production with real-time data on workers and things
- **2C02**: Position control system for things at low cost
- **2D02**: IoT to support workers in flexible manufacturing in kinds and volume
- **2E01**: Traceability of quality data
- **2E02**: Real-Time Management of Quality Data
- **2F01**: Promotion of CPS in supply chain with standard interface
- **2F02**: Promotion of CPS in supply chain with standard interface (shipping logistics)
- **2G01**: Collaboration among companies through shared process information
- **2G02**: Managing manufacturing progress and delivery time among plants
- **2H01**: Sharing technical information for horizontal integration of SMEs
- **2H02**: Horizontal integration of SMEs and visualization of process information
- **2H03**: Service for SMEs to notice information on manufacturing progress
- **2J01**: Manufacturing innovation for interactive growth between human and plant equipment
- **2K01**: Predictive maintenance of presses and panel transportation devices
- **2K02**: Inclusive PM / Predictive maintenance for ALL
- **2K03**: Predictive maintenance system to detect signs of equipment abnormality at low cost
- **2L01-1**: Smart maintenance with machine IoT data
- **2L01-2**: Smart maintenance with digitalization of knowledge
- **2L04**: Productivity improvement by visualization of equipment and workers
- **2L05**: Mutual accommodation of facilities through shared production information
- **2L06**: Managing Actual Operation Status of all Equipment in a Plant
- **2M01**: Increasing added value of after-sales service

**Production engineering information**

**Quality management information**

**Production planning and control**

**Supply chain management**

**SME all-in-one information**

**Preventive maintenance**

**Asset and equipment management**

**Maintenance service management**
Scenario categories in smart manufacturing

Single process

Multiple process

Production Engineering
- Production engineering information
- Production planning and control
- Supply chain management

Quality Management
- Quality management information
- Preventive maintenance

Production Management
- SME all-in-one information
- Asset and equipment management
- Inclusive preventive maintenance

Maintenance Management
- Preventive maintenance
- Asset and equipment management
- Maintenance service management

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2K02: Inclusive Predictive Maintenance

Welding is one of many processes we verified

**Current issues**

- Weld testing:
  - Now: Destructive sampling
  - Want: Non-destructive testing on all pieces
- Welding torch replacement:
  - Now: Replace torch after a number of pieces
  - Want: Reduce frequency by predicting its lifetime

**Goal**

- Determine good or bad on a real-time basis
- Improve lifetime

Welding of a fluid control valve
2K02: Inclusive Predictive Maintenance

Correlation between data and quality

Correlation between data and amount of weld penetration

Fluctuation

AE

Change

Welding defect

Welding defect

This is what we want to realize

Normal

Abnormal

Characteristic value

Defect

Lifetime

Past

Present

Time

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SMU and bottom up modeling

Management View
- Asset View
  - Plant / Product / Process / Personnel
- Management View
  - Quality / Cost / Delivery / Environment
- Activity View
  - Plan / Do / Check / Action

Smart Manufacturing Unit

[Asset View]
Plant / Product / Process / Personnel

[Management View]
Quality / Cost / Delivery / Environment

[Activity View]
Plan / Do / Check / Action

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PDCA cycle of continuous improvement
Design Tool for Cyber Physical System

Function chart editor

Scenario chart editor

Physical world

Cyber world

- actor
- activity
- information
- thing
- place
- data
- function

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Profile for system integration

<table>
<thead>
<tr>
<th>Level</th>
<th>Model</th>
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<tbody>
<tr>
<td>Common Reference Architecture</td>
<td>Unified Data Model</td>
<td>= 1 (standards body)</td>
</tr>
<tr>
<td>Platform Reference Model</td>
<td>Domain Data Model</td>
<td>= number of Categories (working group)</td>
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<td>Component Implementation</td>
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Unified Data Model (ontology)
Common data models
Platform profile
Common Data Model
X Platform Model
Y Platform Model
Z Platform Model

Implementation data models
Component profile

Site A
Implementation Data Model
Component

Site B
Component

Site C
Component

Site D
Component

Profile for system integration
Loosely Defined Standard (LDS)

- Interface is adjusted
- Specification is adjusted
- Reference model
- Interface

Connected operations in site A

Connected operations in site B

Loosely defined standard
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Smart Manufacturing Unit and General Function Blocks

- Activity View
  - Plan
  - Do
  - Check
  - Act

- Asset View
  - Personnel
  - Process
  - Product
  - Plant

- Management View
  - Environment
  - Delivery
  - Cost
  - Quality

- General Function Blocks (GFB) for smart manufacturing

- Knowledge / Engineering Flow
  - Marketing and Design
  - Construction and Implementation
  - Manufacturing
  - Execution
  - Maintenance and Repair
  - Research and Development

- Demand / Supply Flow
  - After Service
  - Sales and Logistics
  - Material Procurement
  - Manufacturing Execution
  - Master Planning

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Mapping from IVRA to RAMI 4.0

- Asset View
- Personnel
- Process
- Product
- Plant

- Activity View
  - Plan
  - Do
  - Check
  - Action

- Environment View
  - Delivery
  - Quality

- Management View

- Business Layer
  - Layers
    - Business
    - Functional
    - Information
    - Communication
    - Integration
    - Asset

- Asset Layer
  - Software, Physical assets
  - General, and Human

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Activity View of SMU
Administration Shell and IVRA
Industrial Data Space and IVRA

- Smart Manufacturing Unit (SMU)
- Portable Loading Unit (PLU)
- Reliable Connection Center (RCC)
- Security Gate

Traceability Types:
- Product/material traceability
- Machine/equipment traceability
- Data/Information traceability
- Technology (IP) traceability

Industrial Data Space

SMU: Stable Asset
PLU: Portable Asset

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Feature of IVI Platform

An IVI Platform is a system of systems for connected manufacturing, creating value for end-users by maintaining interoperability among platform components consisting of “Application”, “Devices”, “Infrastructure”, and “Tool”.

- The primary aim of the platform is to enhance the value for manufacturers by data interoperability.
- The platform is an open basis to create an ecosystem by providing profile specifications of each component.
- Manufacturer have the data ownership, in advance, so that system improvements are possible by themselves.
## Platform categories for scenarios

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### Diagram:

- **Production engineering information**
- **Quality management information**
- **Production planning and control**
- **Supply chain management**
- **SME all-in-one information**
- **Preventive maintenance**
- **Asset and equipment management**
- **Maintenance service management**
Platform selection and implementation

- Production engineering information
- Quality management information
- Preventive maintenance
- Supply chain management
- Asset and equipment management
- Production planning and control
- Small-enterprise information
- Maintenance service management

Next generation manufacturing solutions
- Meister Series
- TOSHIBA
- Fujitsu Smart Monozukuri Platform
- WingArc
- ApstoWeb
- FACTORY-ONE Inc.
- NEC
- LEXER
- SoftBank
- MCFRAME
- IoT Engineering Platform
- MONOZUKURI IoT Starter Kit
- Factory Conductor
- Digital Production Platform
- MC-Web CONTROLLER
- Hitachi
- Inspire the Next
- Frontier-One Inc.

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Ecosystem Management by Loosely Defined Standards

- Platform WGs
  - Platform Common Architect
  - Platform Reference Model

- Collaboration scenario
  - needs
  - creates profiles
  - proposes/ provides

- Business scenario workgroups
  - chooses appropriate platform

- Component profile
  - Component providers

- Platform Profile
  - Platformers
  - Component profile
  - Data profile
  - Business profile

- Manufacturing personnel

- Manufacturing reality FIRST!

Scope / Terms Functional model / Things model / Information model / Data model / Test scenarios

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Thank you!
Danke schön.

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