HANNOVER MESSE 2018, 23 – 27 April

Strategic implementation of smart manufacturing ecosystem by IVRA-Next framework

23 April 2018

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Industrial Value Chain Initiative
Hosei Unversity

Outline

IIoT/Smart Manufacturing Initiatives in Japan

Industrial Value Chain Initiative Membership (as April, 2018):
244 Members

Manufacturing member
91 Large enterprises
67 SMEs

Supporting member
31 Large enterprises
41 SMEs

Sponsor member
14 Organizations

SMEs are **47%** of the total

IoT for all Industries and Society

IoT Acceleration Consortium — IoT Acceleration Lab

Robot revolution society

Robot Revolution Initiative(RRI)

- WG3 Robot Innovation
- WG2 Robot Usage Promotion
- WG1 IoT-driven Transformation in Manufacturing

Smart Manufacturing

Industrial Value Chain Initiative(IVI)

Interrelated

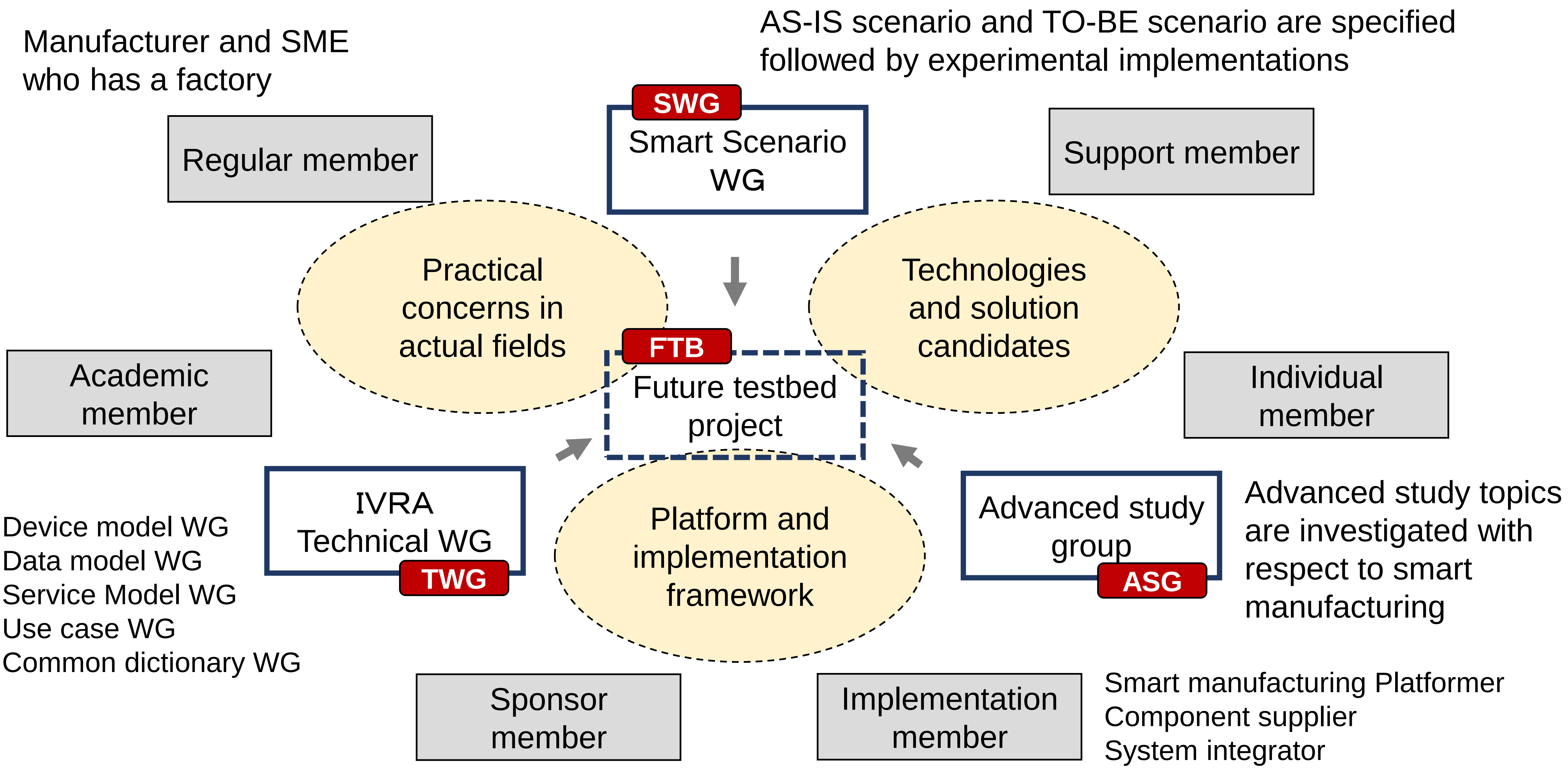
Some Members of IVI

240+ companies, 600+ individuals

Some Members of IVI

240+ companies, 600+ individuals

General structure of IVI organization



Outline

1. Introduction to IVI
2. Scenarios of Smart manufacturing
3. Outline of the IVRA Next
4. Ecosystem of IVI platform
5. Inter-enterprise manufacturing integration
6. Connected industries open framework

67 Smart manufacturing scenarios on IVRA

20 Smart Scenarios in 2015

- Cloud enabled monitoring platform for global distributed factories. [WG-101]
- Global B2B After-sales service for remote location with call center. [WG-402]
- One-stop portal and collaborative quotation management by connected SMEs. [WG-306]
- Cyber physical production and logistics systems with common interface. [WG-309]
- Risk management by connected production information in global SCM. [WG-310]
- Interoperable life cycle management for equipment and production line. [WG-105]
- Dynamic production optimization by simulation integrated CPPS. [WG-106-1]
- Real-time sensor data acquisition and analysis using multi-vendor network. [WG-106-2a]
- Maintenance operation and prediction by failure based data analytics. [WG-106-2b]
- Cloud based simple monitoring scalable for legacy production line. [WG-106-3]
- Knowledge of bill of production process for E-BOM to M-BOM traceability. [WG-208]
- Cyber dashboard for design and engineering of unexpected design change. [WG-108-3]
- Mass-customization for end users directory connected to factories. [WG-403]
- Agent based location free manufacturing in dynamic supply chain. [WG-207]
- Communication robot for autonomous MES connected among factories. [WG-108-2]
- Robotics line building for SMEs using cloud knowledge database. [WG-204]
- Proactive machine communicating with workers in IoT environment. [WG-108-1]
- Advanced quality assurance by connecting data - Toward 0 failure production. [WG-201]
- Standardization of working styles in "Man-Machine collaborative factories". [WG-211]
- Remote consulting service of production engineering by bill of process information.

67 Smart manufacturing scenarios on IVRA

25 Smart Scenarios in 2016

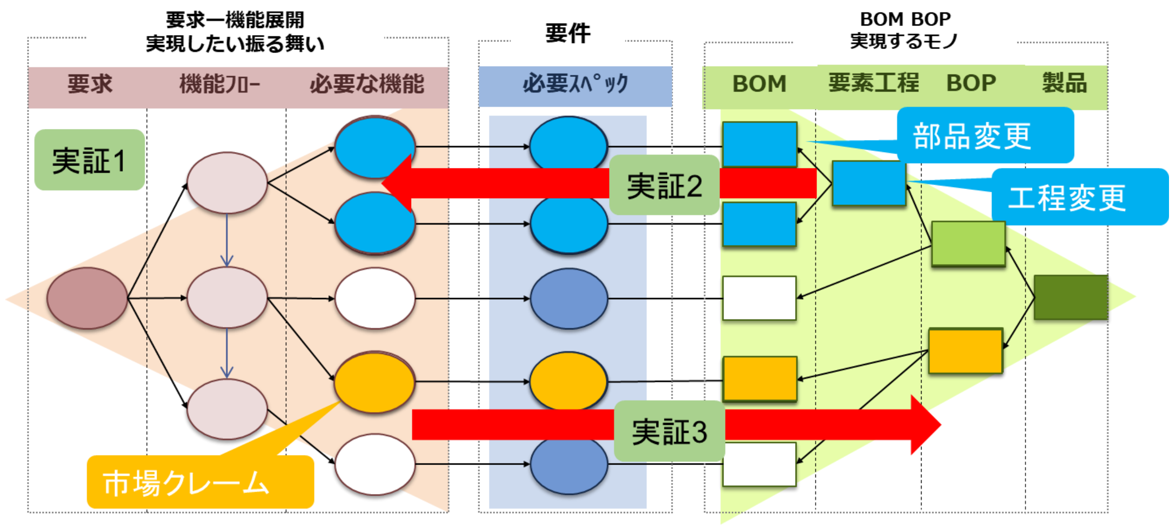
- Digitalization of process information and know-how on manufacturing [2A01]
- Connection of information on production preparation at design change [2A02]
- Utilization of robot program assets by CPS [2B01]
- Agile planning of production with real-time data on workers and things [2C01]
- Position control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

67 Smart manufacturing scenarios on IVRA

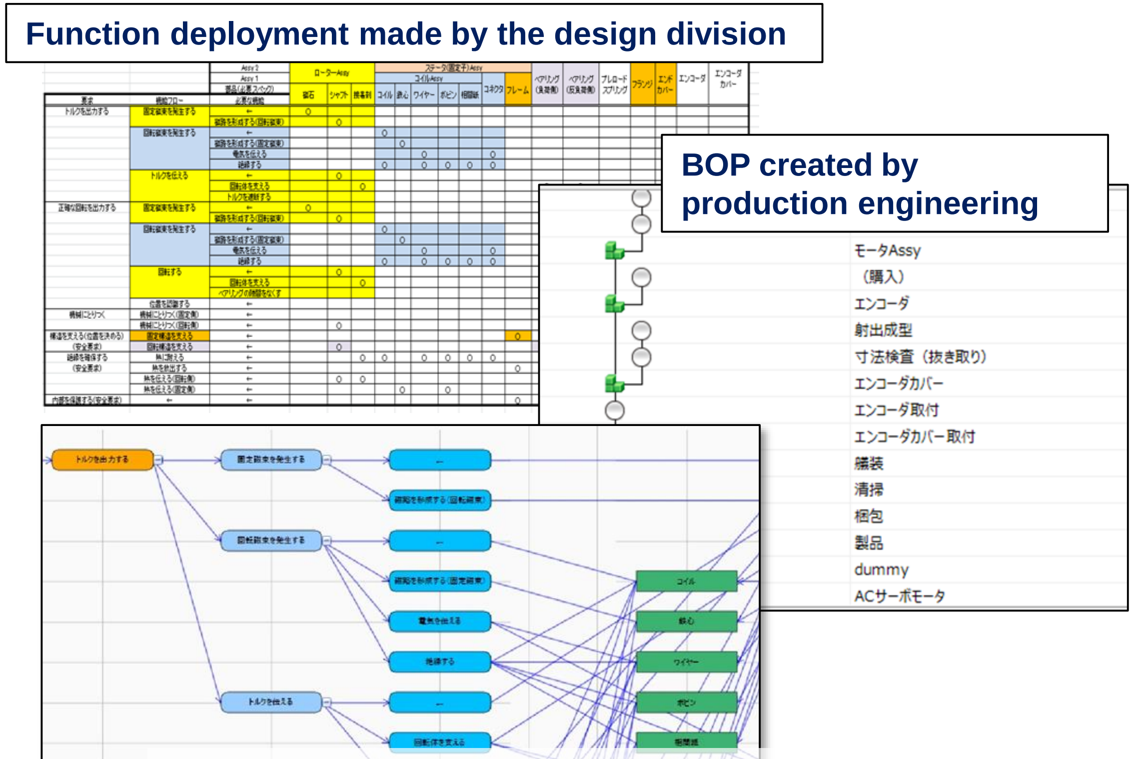
22 Smart Scenarios in 2017

- Quality data connected with things [3A01]
- Data connection between design department and production department for realization of CPS [3A02]
- **Connection of product design information and production technology information utilizing BOP via cloud [3A03]**
- **Realtime management of visual inspection process [3A04]**
- Traceability of quality data (IoT utilizing Raspberry Pi and cloud) [3A05]
- **Improvement of productivity and quality stability by visualization of operation result of equipment and human [3B01]**
- **Predictive maintenance and quality improvement in forging press line [3B02]**
- **Predictive maintenance and quality control for everybody [3B03-1]**
- Predictive maintenance of equipment and real-time control of processing quality [3B03-2]
- Next-Generation IoT enabling predictive maintenance and real-time quality control [3B03-3]
- Improvement of overall equipment efficiency [3B04]
- Productivity improvement and automation of production lines by AI - Stage 1: inspection process - [3C01]
- **Interactive growth of human and equipment in manufacturing [3C02]**
- Manual for digitalization of skilled workers' technics - Don't let its digitalization be technics of skilled workers - [3C03]
- Improvement of robot facilities from launch through operation to maintenance by CPS [3C04]
- Improvement of production efficiency and ensuring delivery date by realtime process progress management and location management [3D01]
- Cyber-physical production by simulation for dynamic optimization [3D02]
- Visualization and reduction of short-time facility stops in SMEs by utilizing IoT [3D03]
- **Production kaizen (improvement) by extended MES [3E01]**
- Optimization of customers' operations by utilization of analyses on operation and material information [3E02]
- Comparison on Stage of Manufacturing Transformation Using IoT and Digitization [3E03]
- Connection of manufacturing and logistics [3E04]

3A03: Connection of product design information and production technology information utilizing BOP via cloud



Verification 1	Can BOM (parts) and BOP (manufacturing process) be associated with functions?
Verification 2	On what kind of functions do changes in assembly process and parts have effects?
Verification 3	In case of market complaints (malfunction), which part or process has the cause?



By combining the function deployment request chart and BOP, unify the linkage of functions from function design to production design

Results of experiments

① By connecting from demands through functions, parts to production process, visualized elements which are organically related.
② Solution of parts problems became more speedy by using the relation chart.
③ Solution of problems in product functions became more speedy by using the relation chart.
④ In experiments of two different types of products, the validity was verified.

3A04:Realtime management of visual inspection process

Simple collection of operation history using Raspberry Pi

Digitalize detailed history without changing inspection operation. Difference of time for inspection between workers can be analyzed from the collected data and utilized as standards for a training purpose.

- ① Low cost
- ② No need for changing operations
- ③ Able to reduce variation between workers

Digitalization of visual inspection results with speech-recognition technology

Register instruction on visual inspection and the results in real time. Collected data is calculated, analyzed and used as an indicator of skills in order to help education of workers.

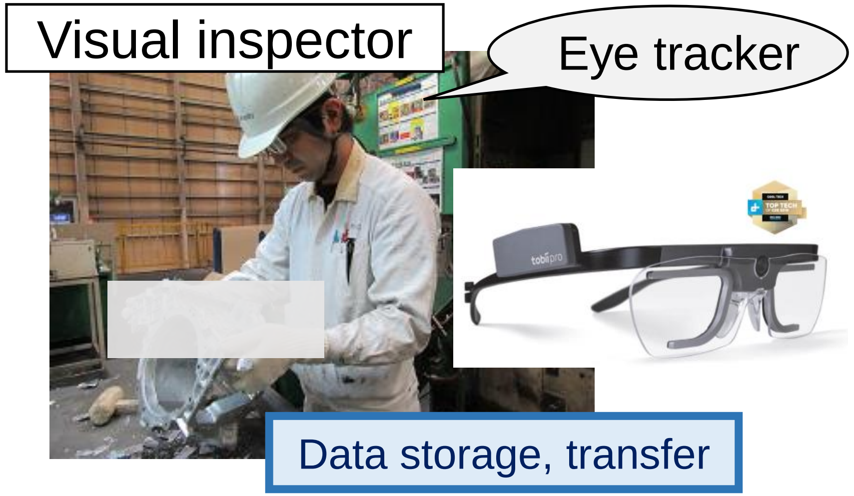
- ① Hands-free entry
- ② Operation management by voice (handover, discontinuation)
- ③ Speeding up Kaizen cycle

Eye tracker's support of visual inspectors

Eye tracker enables to take movies of visual inspection operation as well as data on eye gaze. It clarifies difference of visions and its duration between experts and new workers. Time needed for OJT can be shortened.

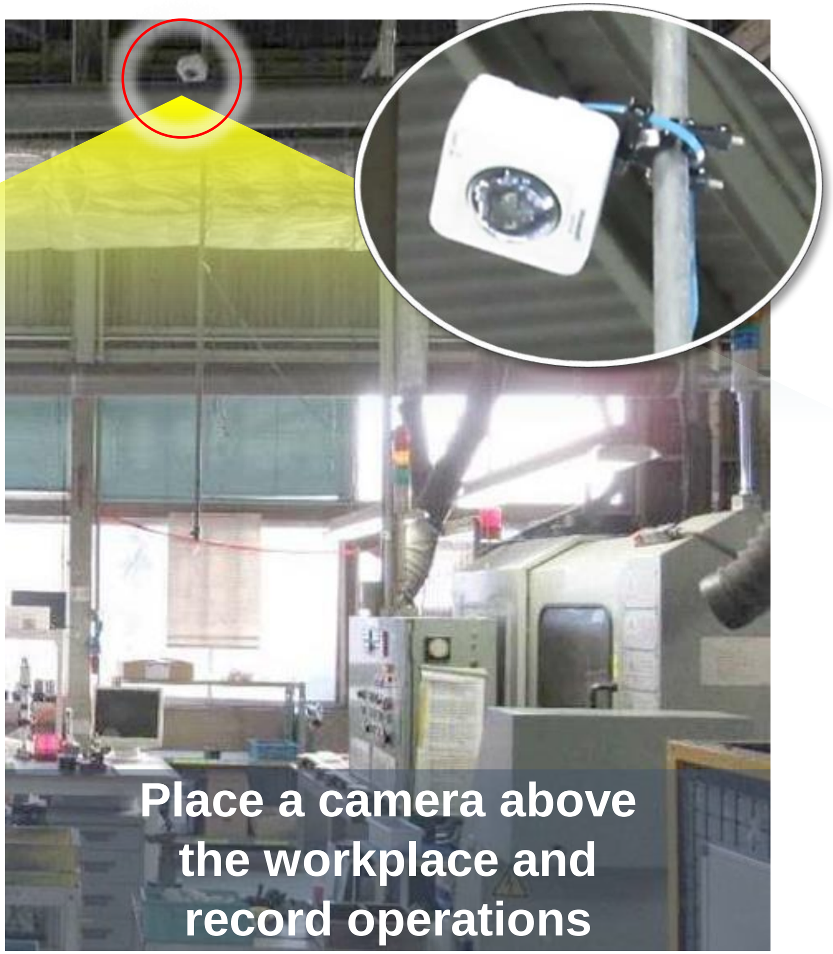
- ① Hands-free entry
- ② Able to store information as images and voice
- ③Speeding up Kaizen cycle

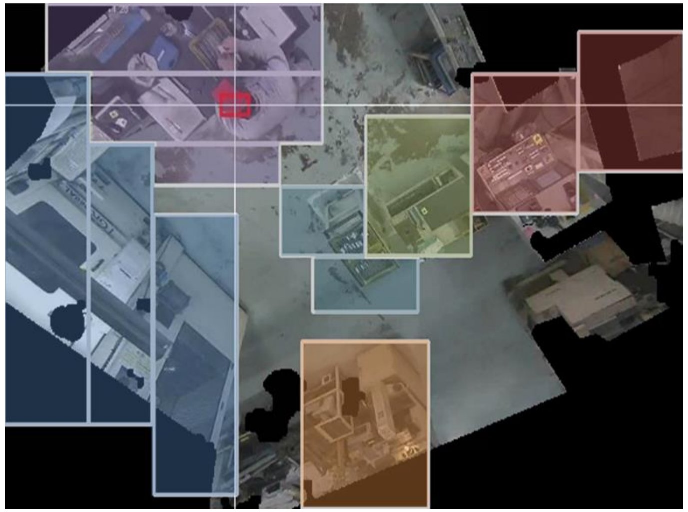
- Hands-free operation using a headset
- Possible to enter without looking at the monitor by instruction and answer by voice



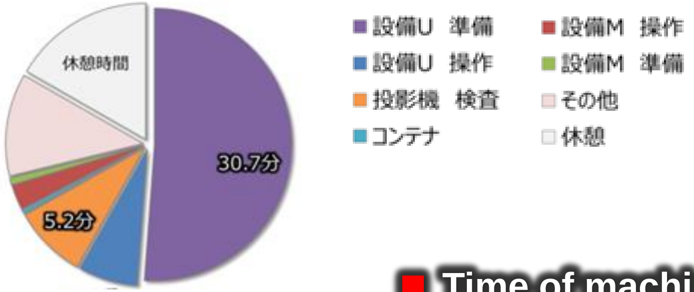
3B01: Improvement of productivity and quality stability by visualizing operation results of equipment and human

Optimized way of collaboration between equipment and workers are visualized to improve productivity with IoT.

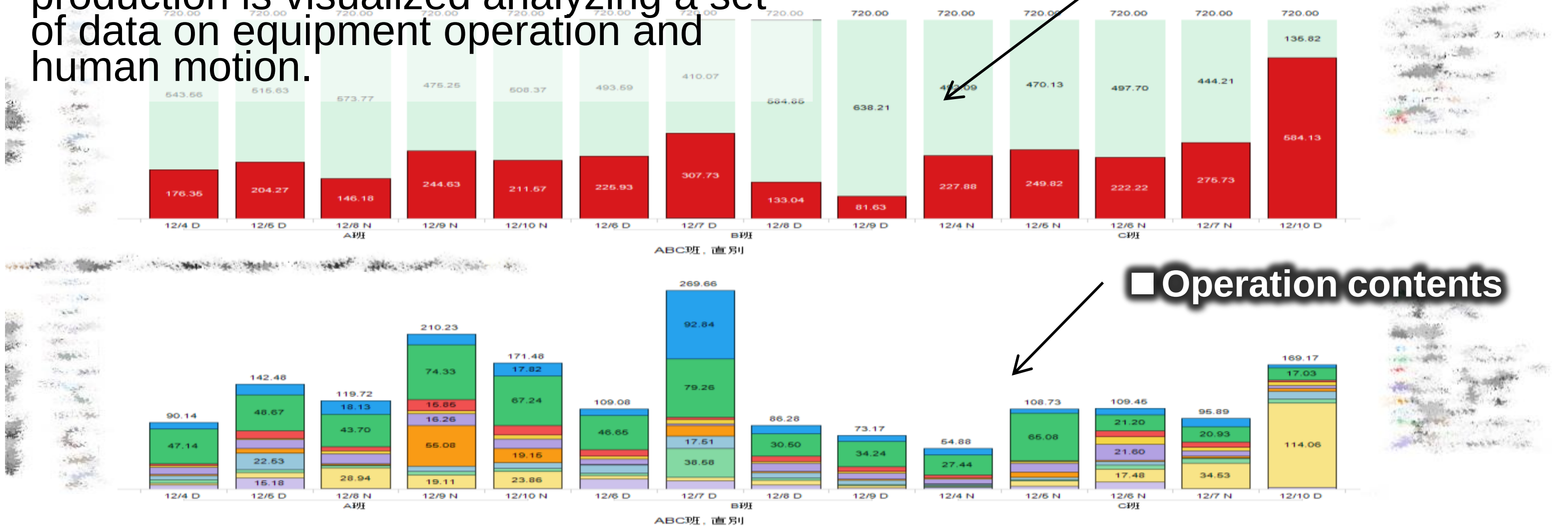




Set operation spaces on axes of movies to track movement of workers (shown in red)
→ Acquire data on when and where the worker is



Techniques of exerts' efficient production is visualized analyzing a set of data on equipment operation and human motion.



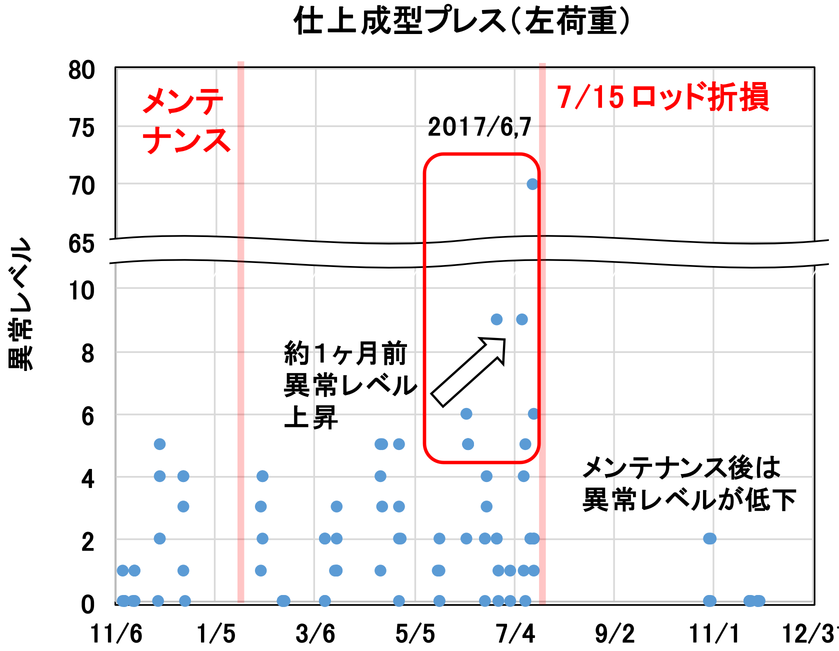
3B02: Predictive maintenance and quality improvement in forging press line

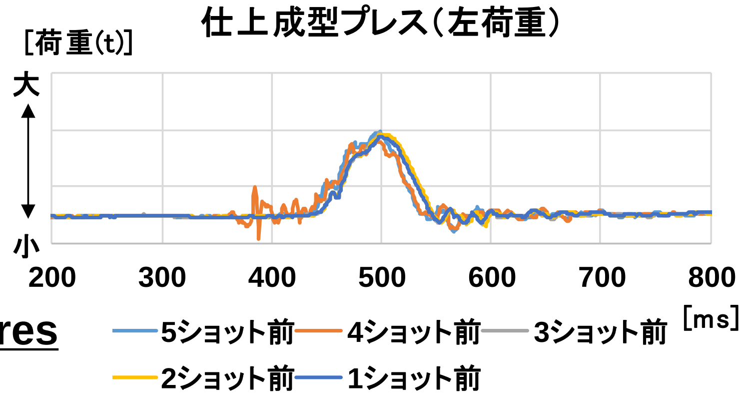
【Predictive maintenance for equipment failure: breakage of balancer rods】

◆ **Analyze time series variation of press load**

◆ **Detected signs of abnormalities about one month before**

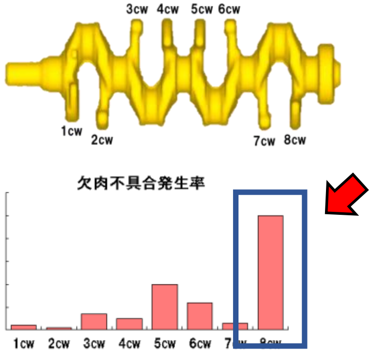
Place: Mazda Motor, forging plant
Target facility: 6,000 t forging press line
Parts produced: Crankshafts





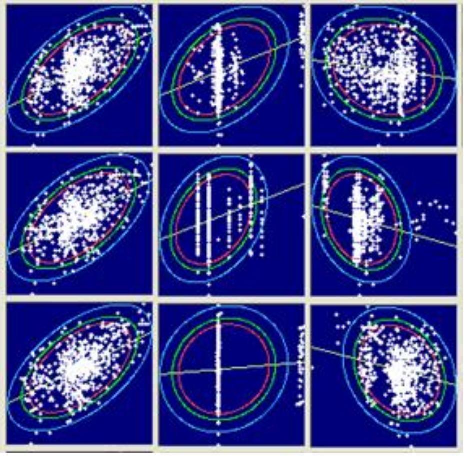
<u>**Detect signs of failures from disturbance in waveform of the load**</u>

【Determine the causality between crankshaft underfill and equipment data】

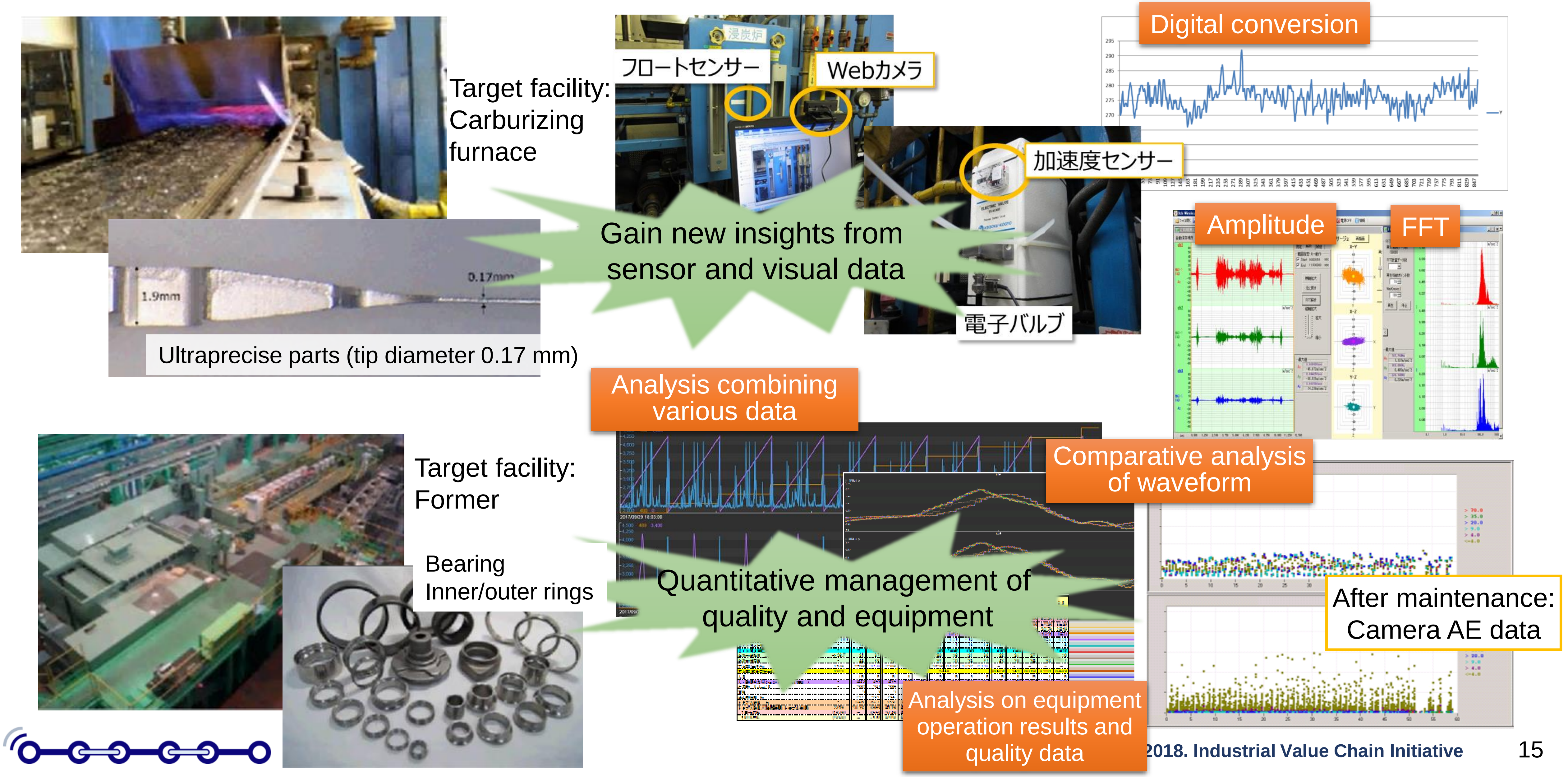


<u>There was a new finding on correlation between a process and quality data.</u>

As instant analyses based on statistics have became possible, operators can use the results for quality improvement.



3B03-1: Predictive maintenance and quality control for everybody



3C02: Interactive growth of human and equipment in manufacturing

The number of processing times increase due to clogging of grindstone (e.g. because of insufficient dressing)

Focus on relation between variation in processing and vibration of the grindstone while dressing

Assess the number of time of processing with a focus on acceleration of vibration (RMS)

［Target facility］
Internal grinding machine

［Workpiece］
Spindle

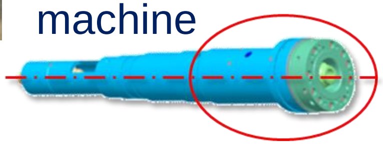


図3．ドレス作業時の振動センサ
（生データ）

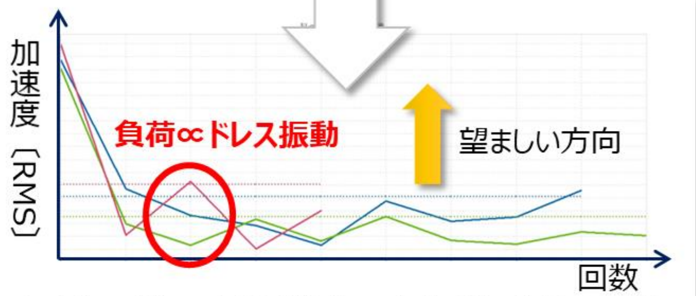
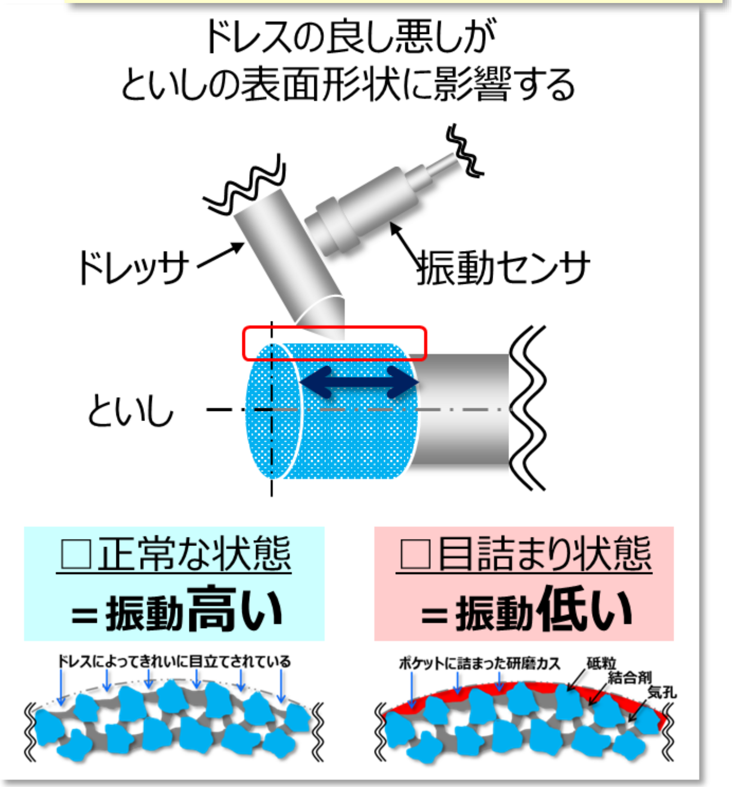


図4．ドレッサ振動をエネルギー量に変換

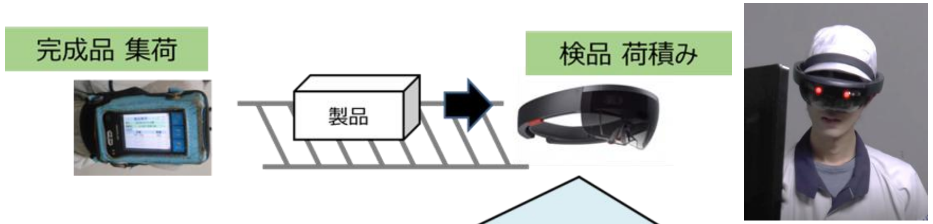


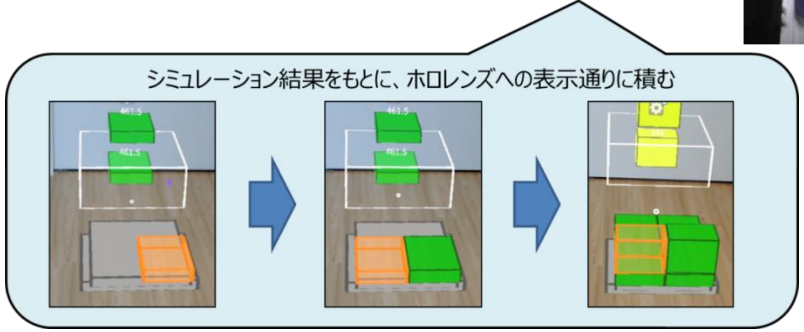
- Using IVI platform component, developed a system in which data is collected and analyzed to provide advices, and furthermore types of advices can be added.
- Converted technics of experts into explicit knowledge that can be accumulated and utilized in logics.

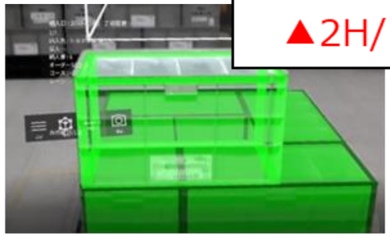
3E01: Production kaizen (improvement) by extended MES

Concern in the shipping field

・There are many know-hows in loading operations, so productivity is dependent on individual skills. It is difficult to hand down such know-hows.
・It was not possible to prove the results of shipping, although there was data on inspection before shipping.



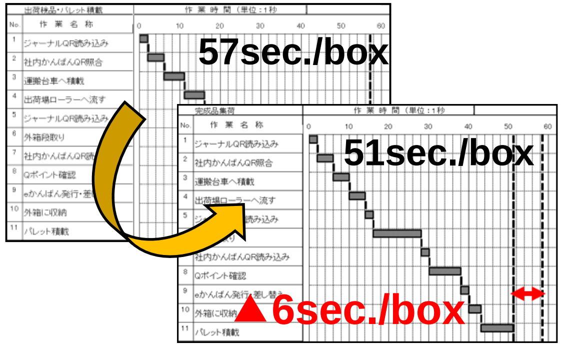




荷積み完了を画像保存

Experiment result

Product collection ～
Inspection, loading



Loading simulation & support by AR

集荷・出荷:1,200箱/日

▲2H/日の工数削減

Loading proof data

顧客への荷積み証明説明
(1回/年　約2H×3人)
▲6H/年の工数削減見込み

Analysis on human motion

Digitalize and record workers' motion in order to use it for training, quality assessment when there is unstandardized motion, and investigation of defect causes.

Through quantitative evaluation of workers' motion data taken with optical sensors, it is verified that the method can be utilized for training and consideration on operation standards.

Segment of concerns on system exploration

4A : Quality Assurance

4B : Plant Maintenance

4C : Optimization and Improvement

4D : Vertical integration

4E : Horizontal integration

Industrial Needs from manufacturer’s side

Needs from solution and methodology side

4F : data collection and analysis

4G : visualization and notification

4H : Acquisition and standardization

4J : Real-time monitoring and control

4K : security related technologies

Outline

IVRA-Next: Strategic implementation framework

Industrial Value Chain Reference Architecture-Next

Strategic implementation framework of industrial value chain for connected industries

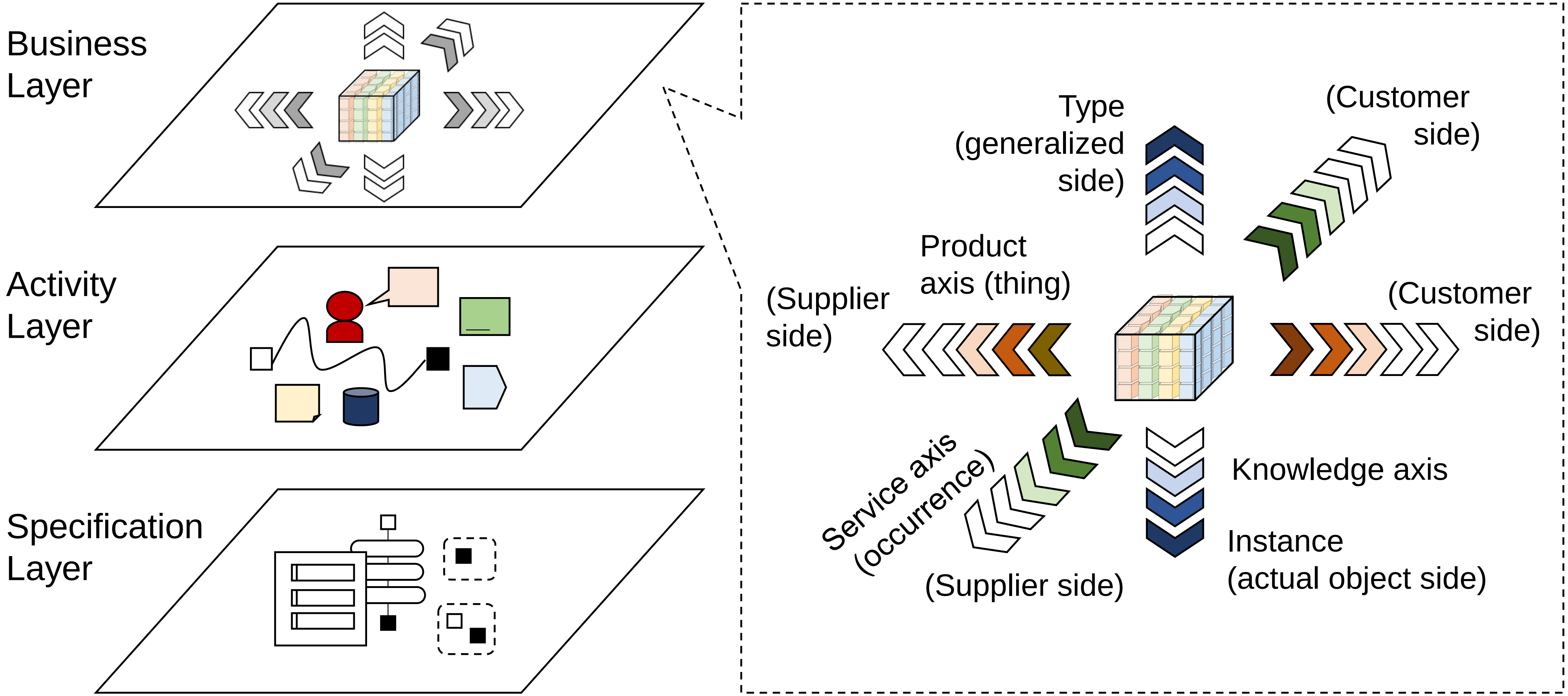
IVRA Next

Industrial Value Chain Initiative
Industrial Value Chain Reference Architecture

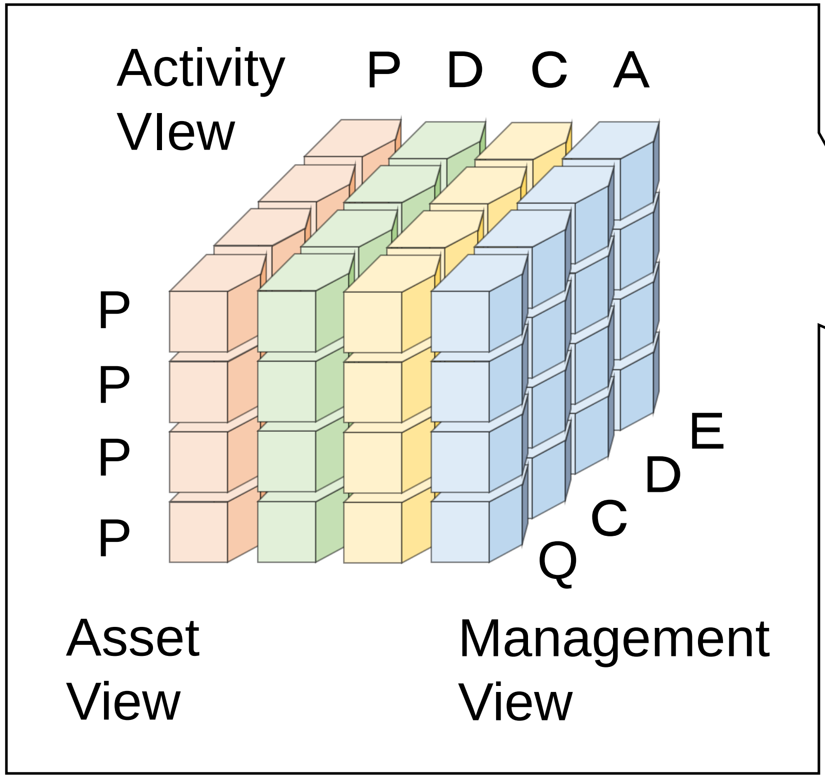
Download at http://iv-i.org/en/

CONTENTS

General views of smart manufacturing

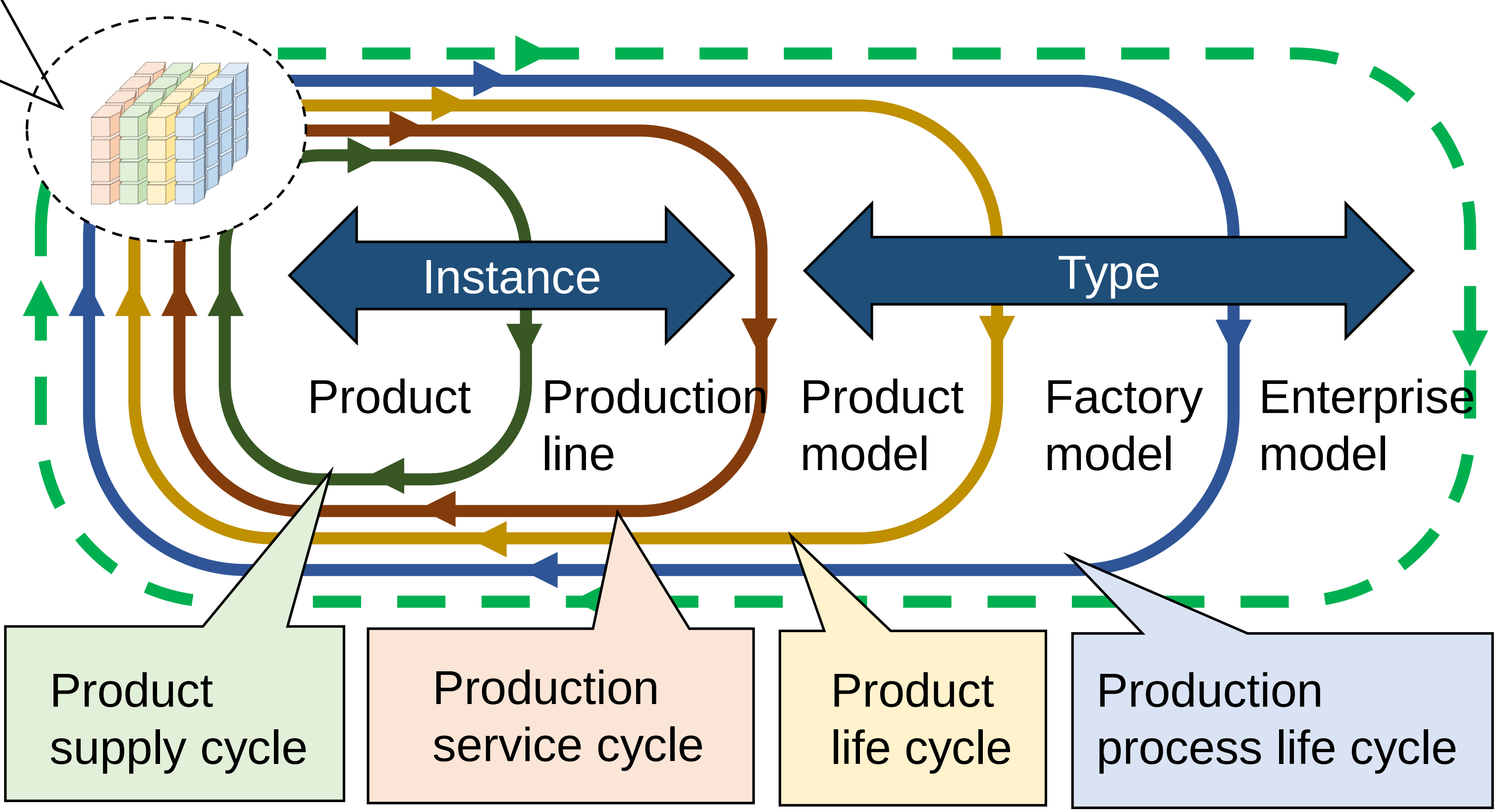


Smart manufacturing unit and cycles

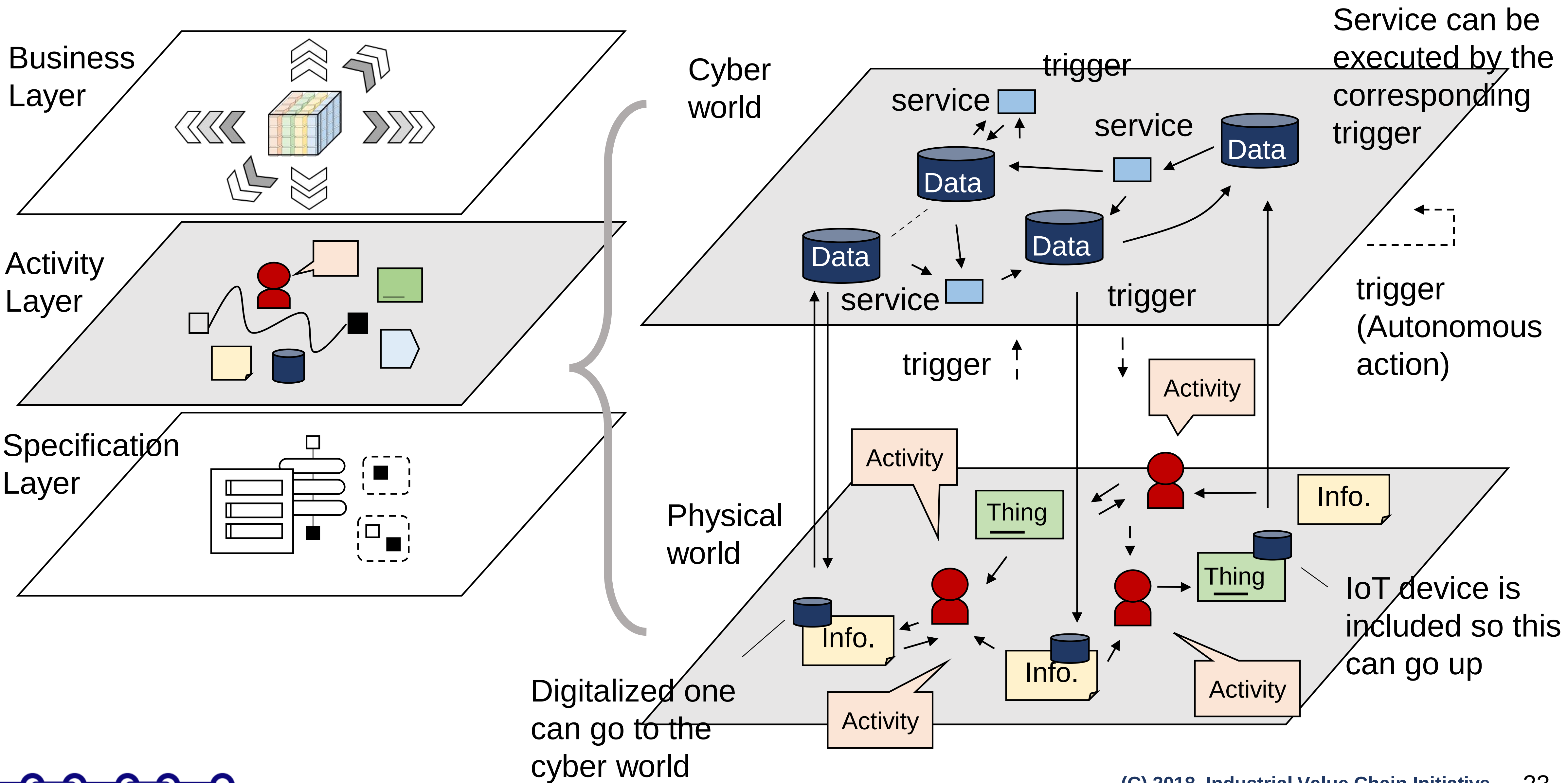


Smart Manufacturing Unit (SMU)

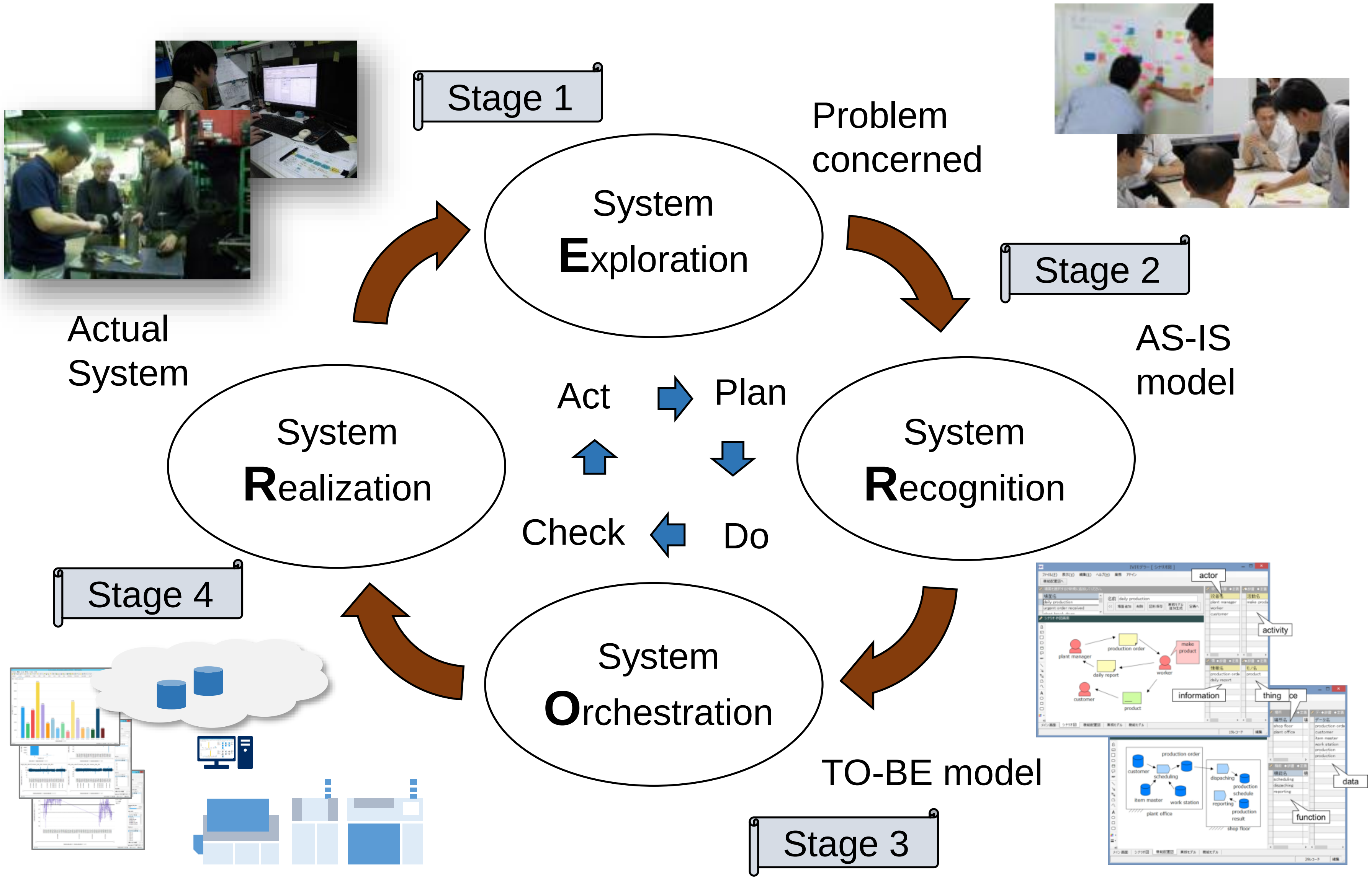
Activity View (Plan Do Check Act)
Asset View (Personnel, Plant, Product, Process)
Management View (Quality, Cost, Delivery, Environment)



Cyber world and physical world



Cyclic Process for self-improvement



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IVI Platform and Component 2018

IVI Component 2018

SoftBank

PATLITE®

Orchestrating a brighter world

ApstoWeb

LEXER
Virtual, powering everything.

TOSHIBA
Leading Innovation >>>

NEC

YDC

iSiD
IT Solution Innovator

JNOVEL

b-en-g
Toyo Business Engineering Corporation

IVI Platform 2018

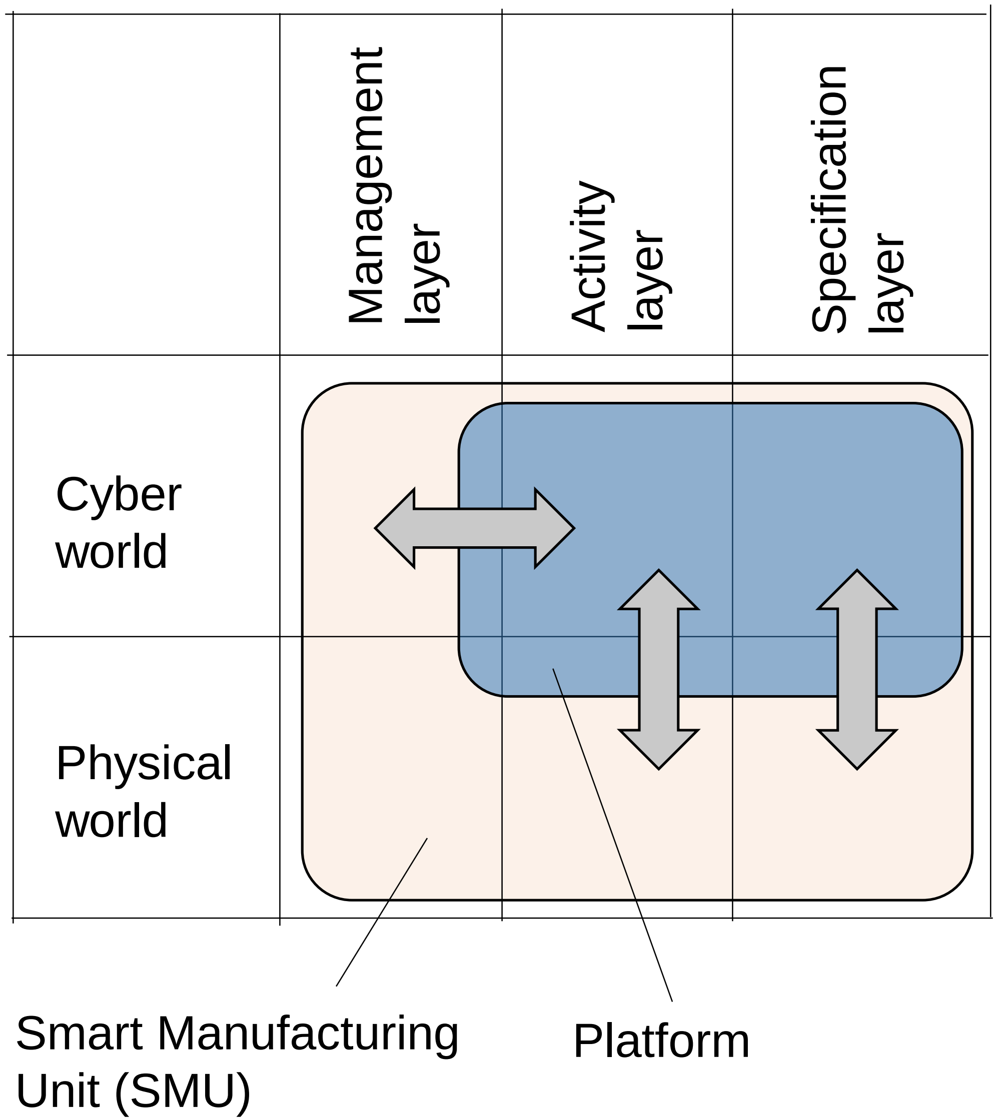
Micronet

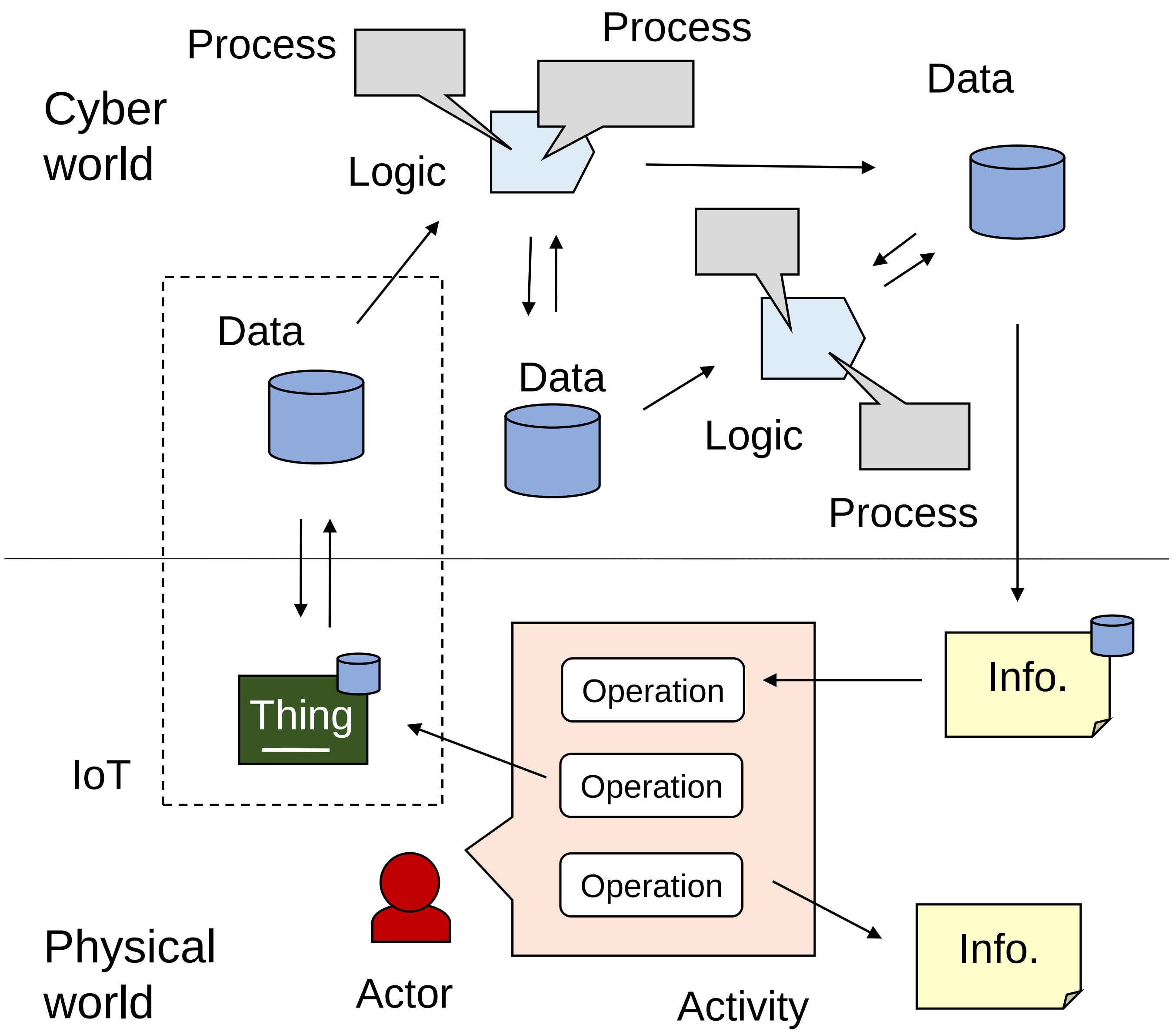
WingArc 1ST
Data Empowerment Company®

TIETECH

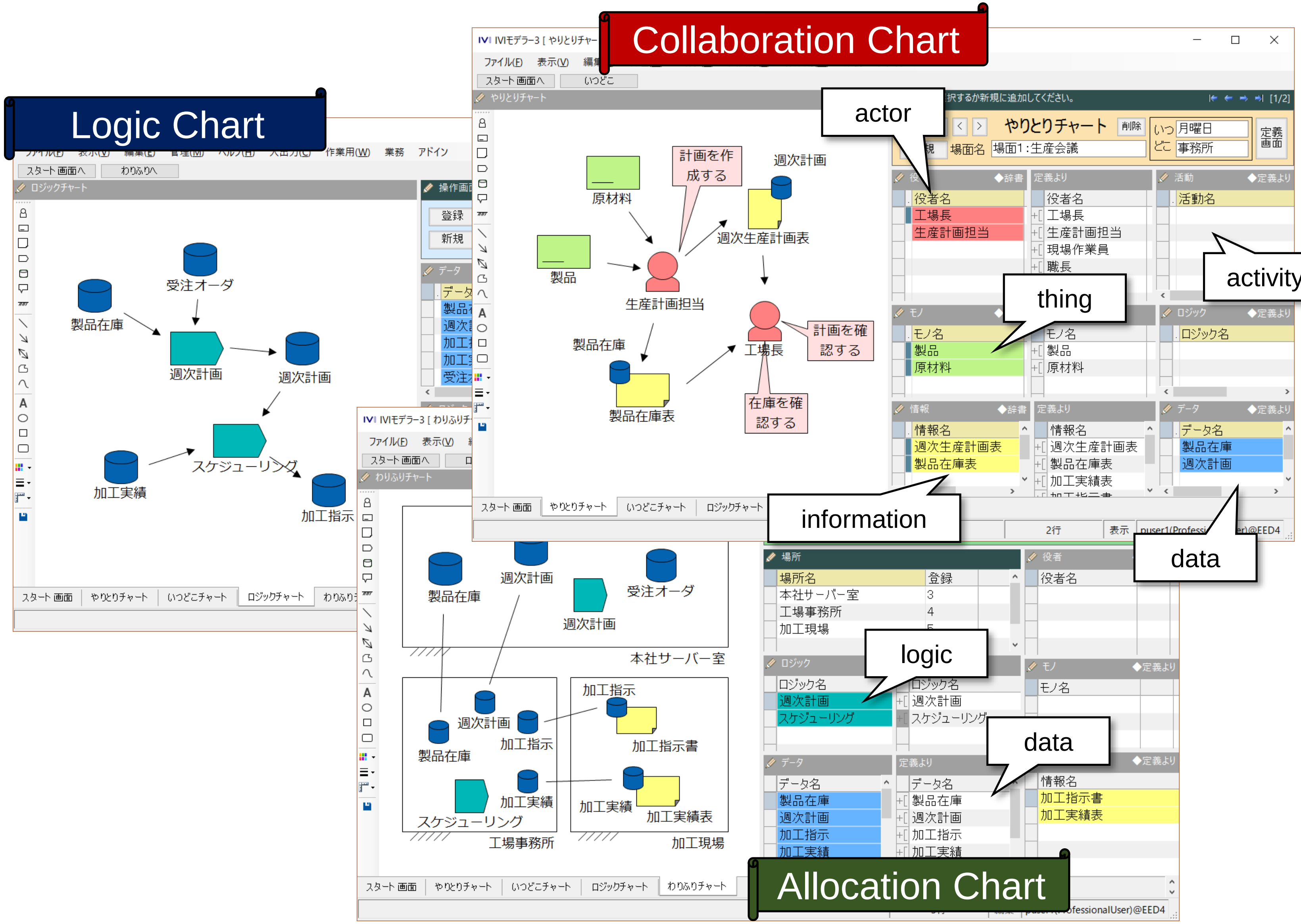
FRONTIER-ONE Inc.

Platform on the Cyber World and the Physical World



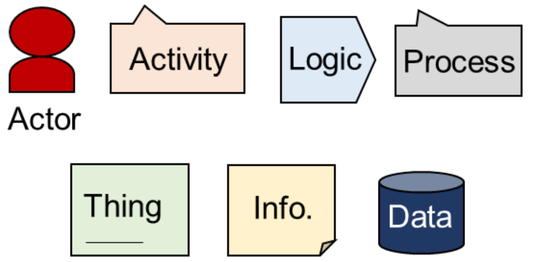


Tools and repositories for smart manufacturing

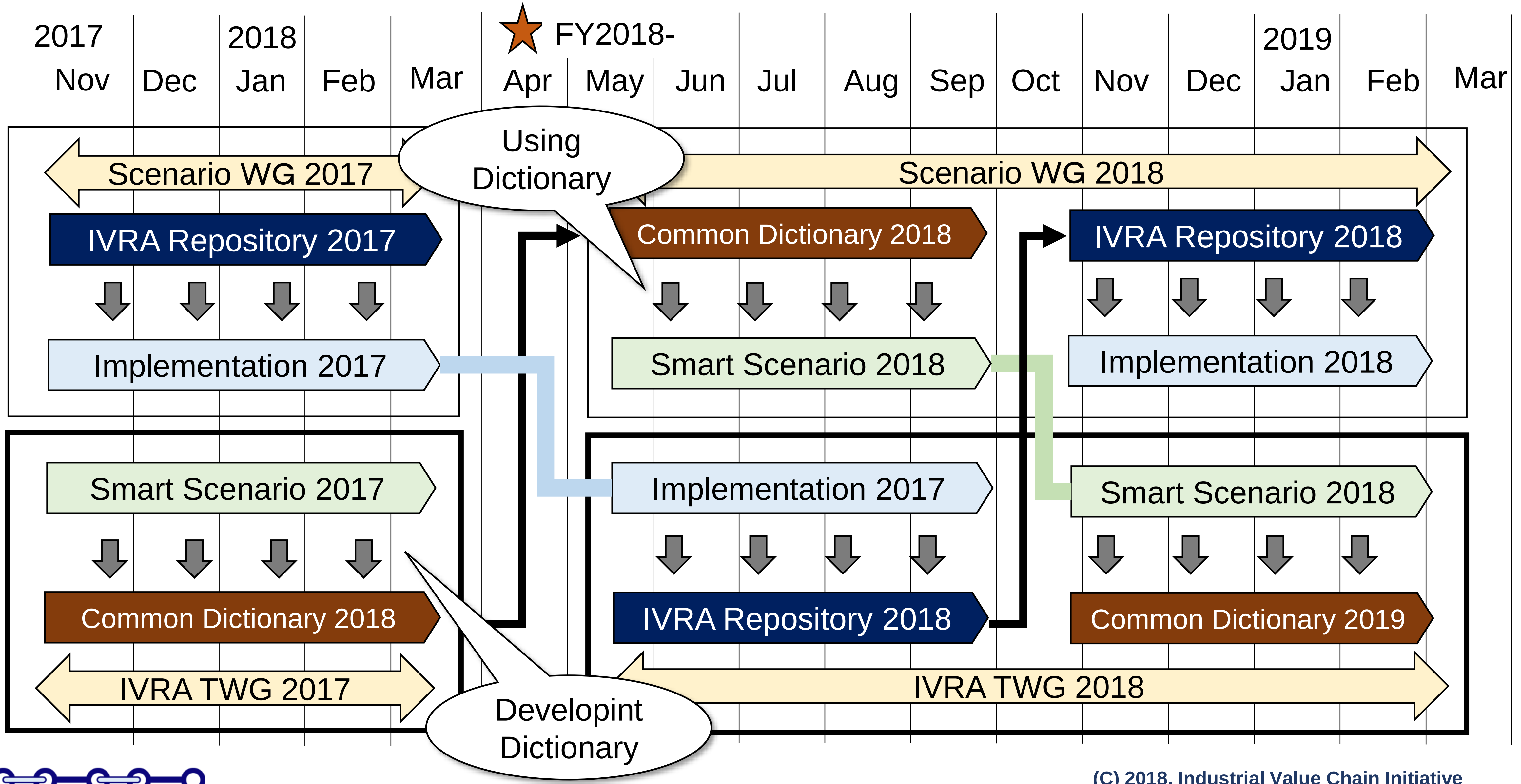


124 Scenarios
(292 scenes) in 2017

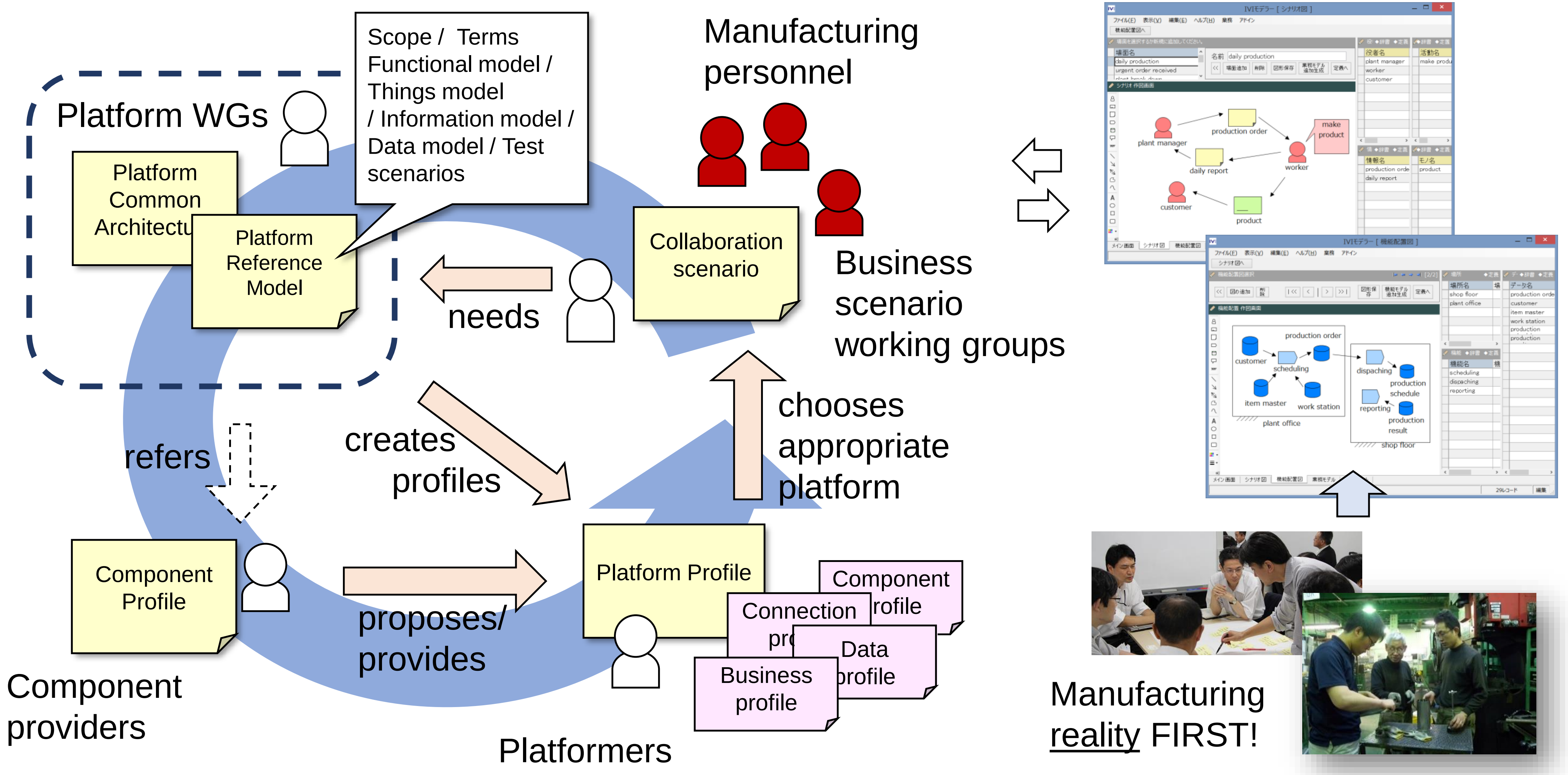
Actor	544
Activity	1391
Logic	373
Process	440
Thing	546
Information	829
Data	619



Annual cycle using dictionary and repository

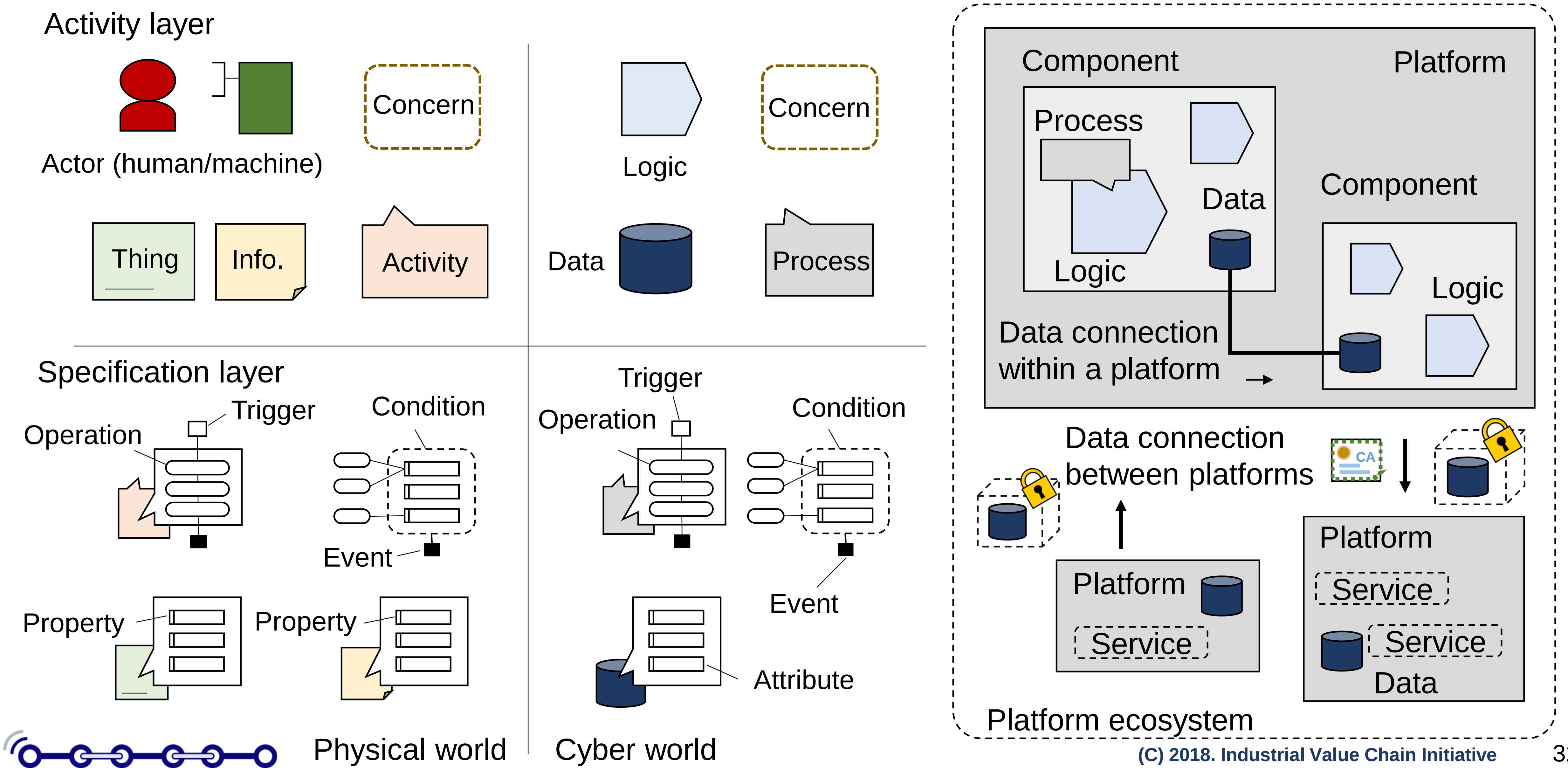


Ecosystem Management by Loosely Defined Standards

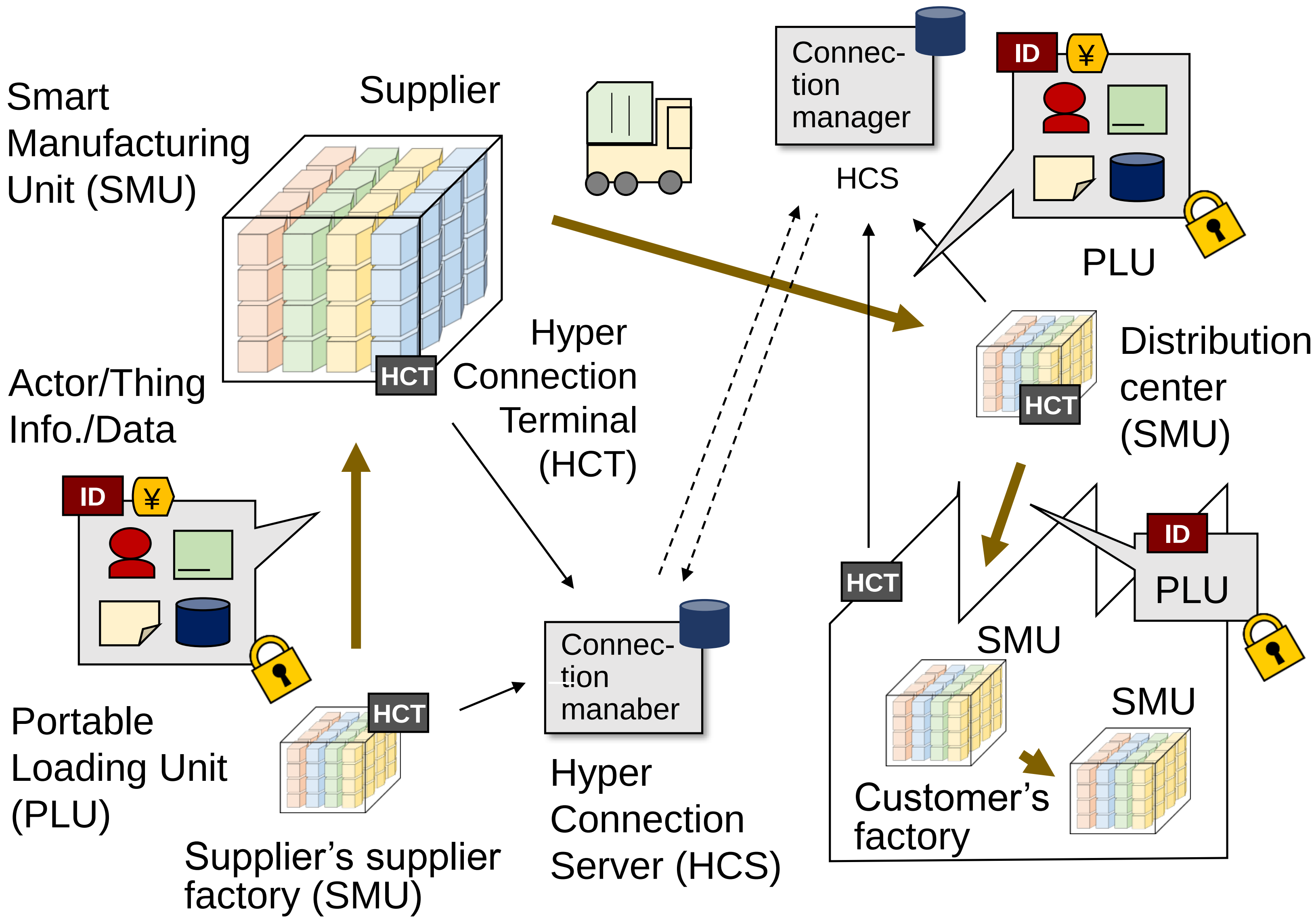


Outline

Relationship of Hierarchies and Cyber & Physical

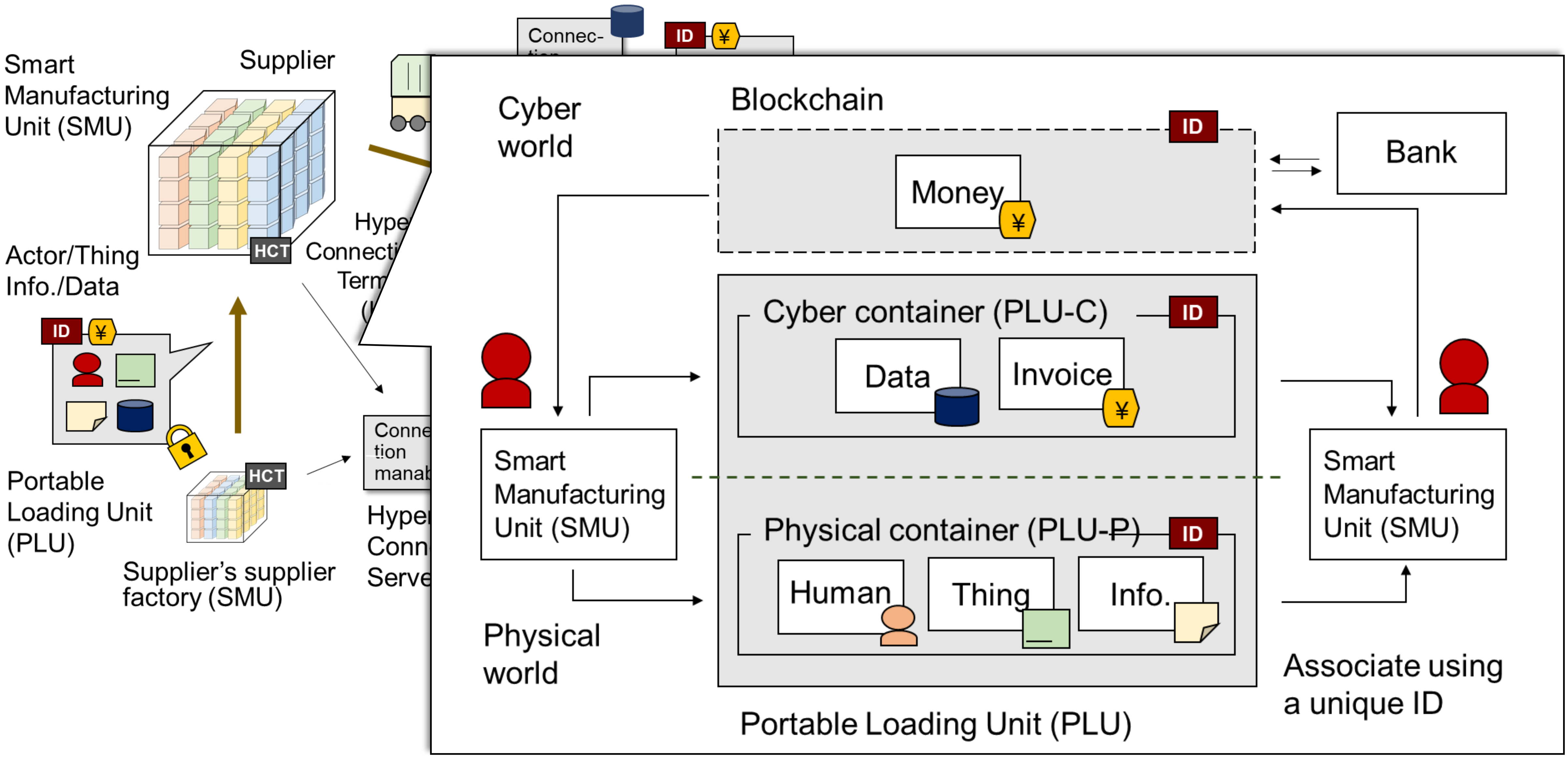


IVRA for Connected Industries

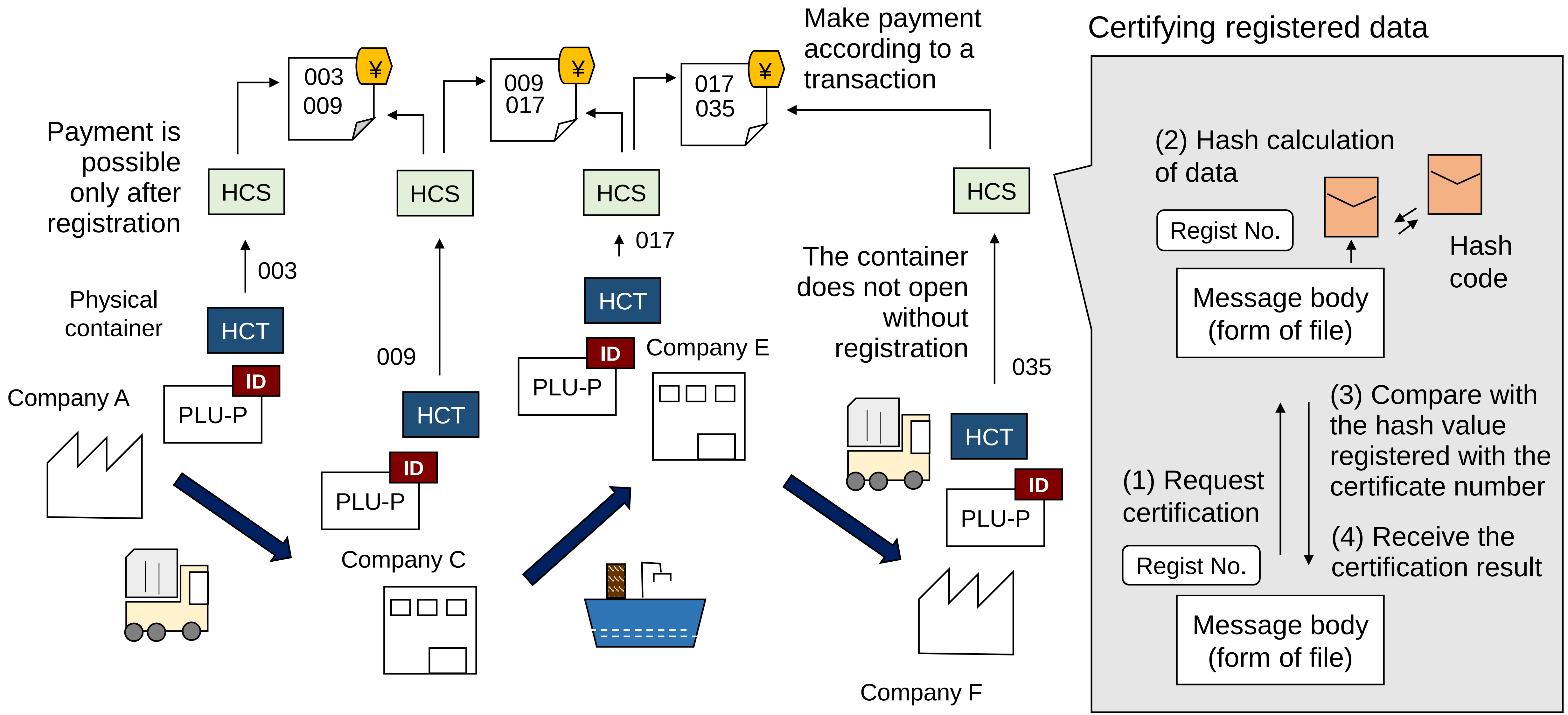


- ✓ Outside data can be obtained correctly ?
- ✓ Data is absolutely true without tampering?
- ✓ Right things can be identified by data?
- ✓ Heterogeneous semantics are acceptable?
- ✓ Data sovereignty and IPR are controlled?

Cyber Physical and Financial integration



Traceability of data and physical goods



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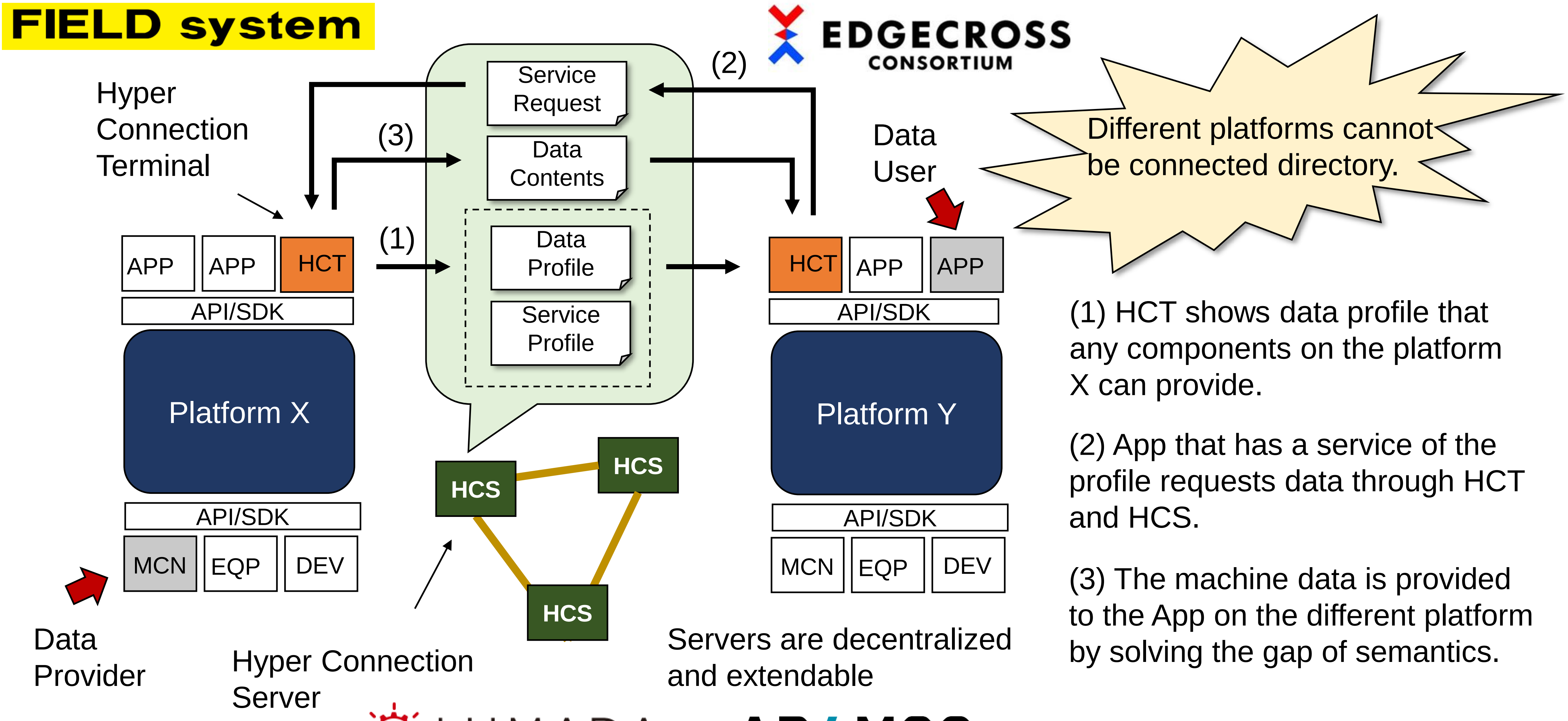
Data Interoperability among platforms

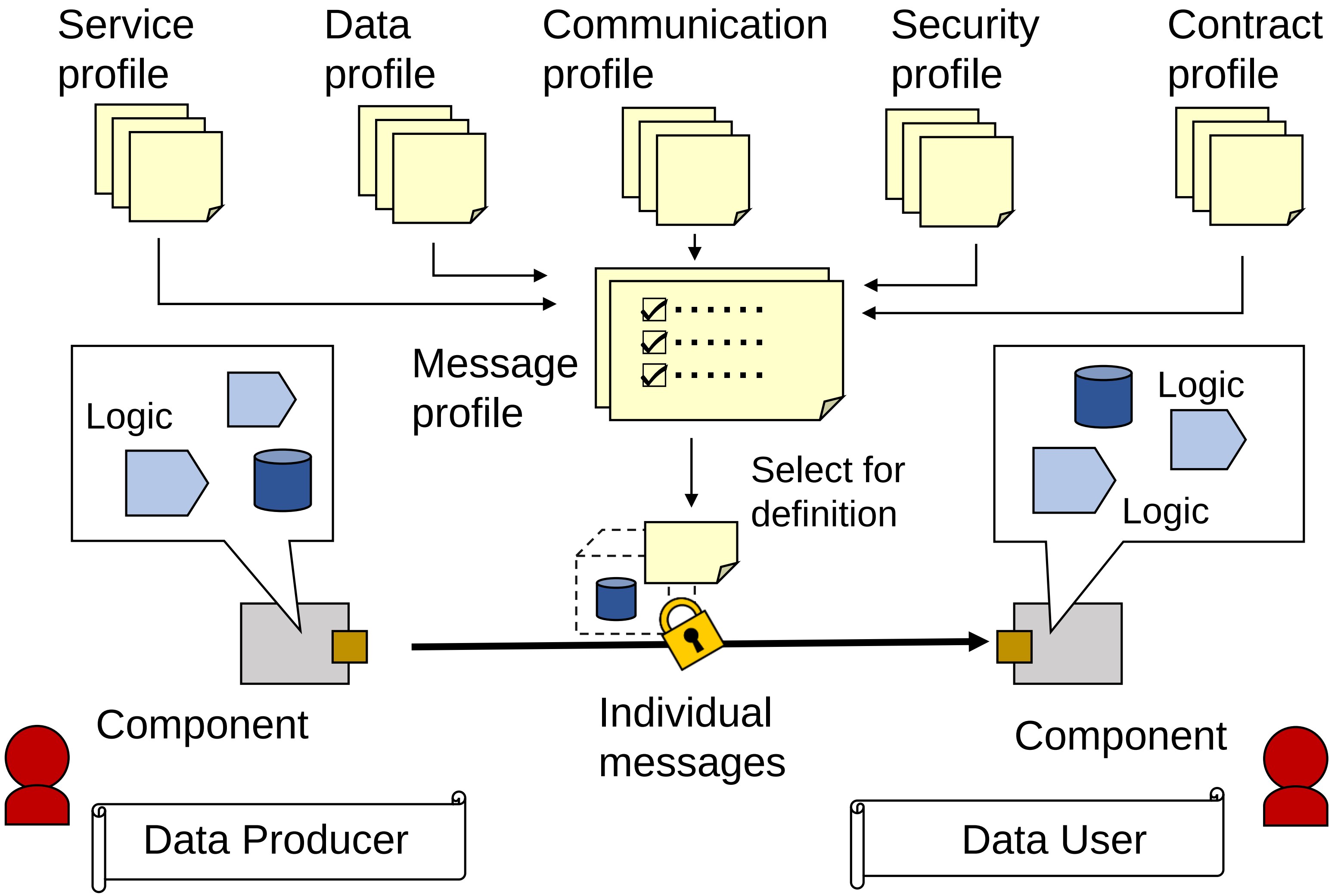


(1) HCT shows data profile that any components on the platform X can provide.

(2) App that has a service of the profile requests data through HCT and HCS.

(3) The machine data is provided to the App on the different platform by solving the gap of semantics.

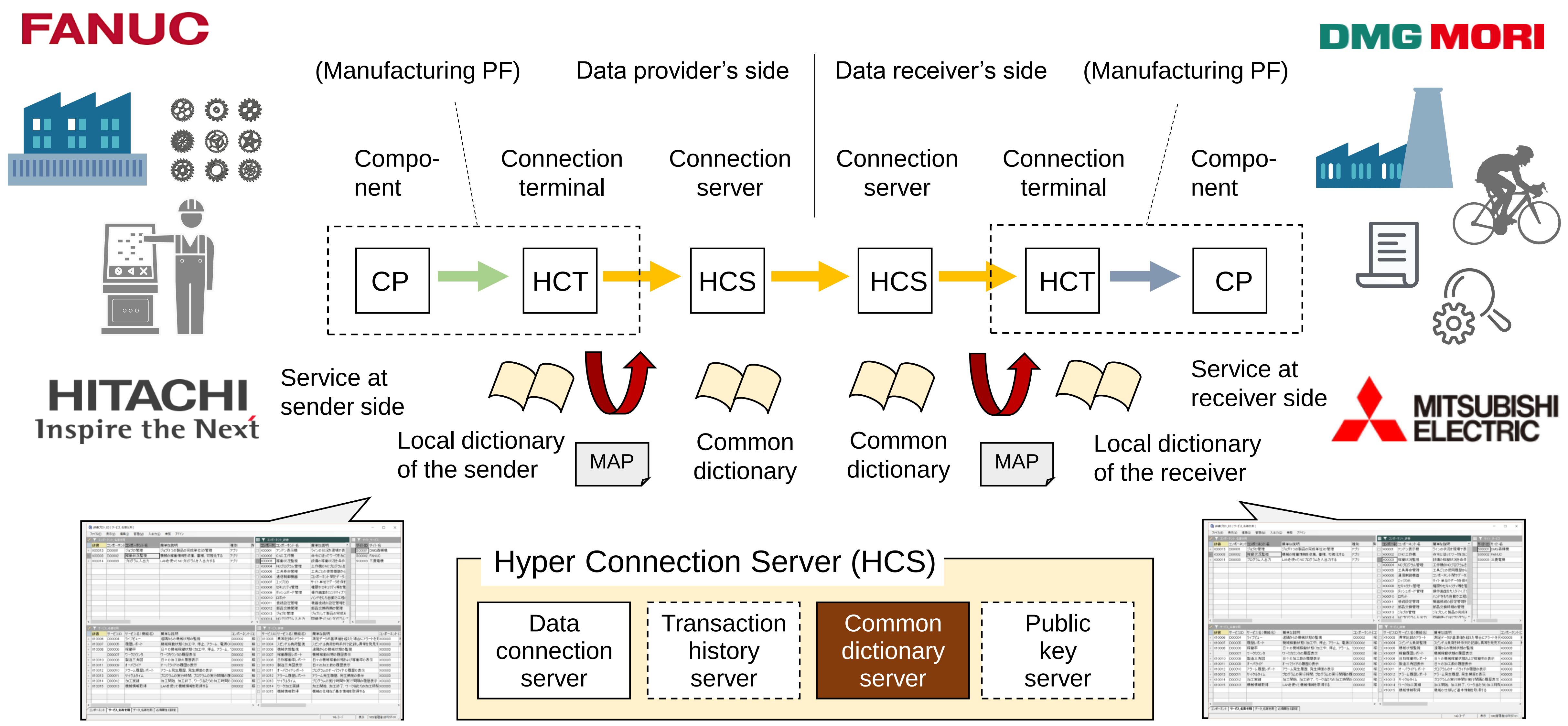
Data transfer with message profile



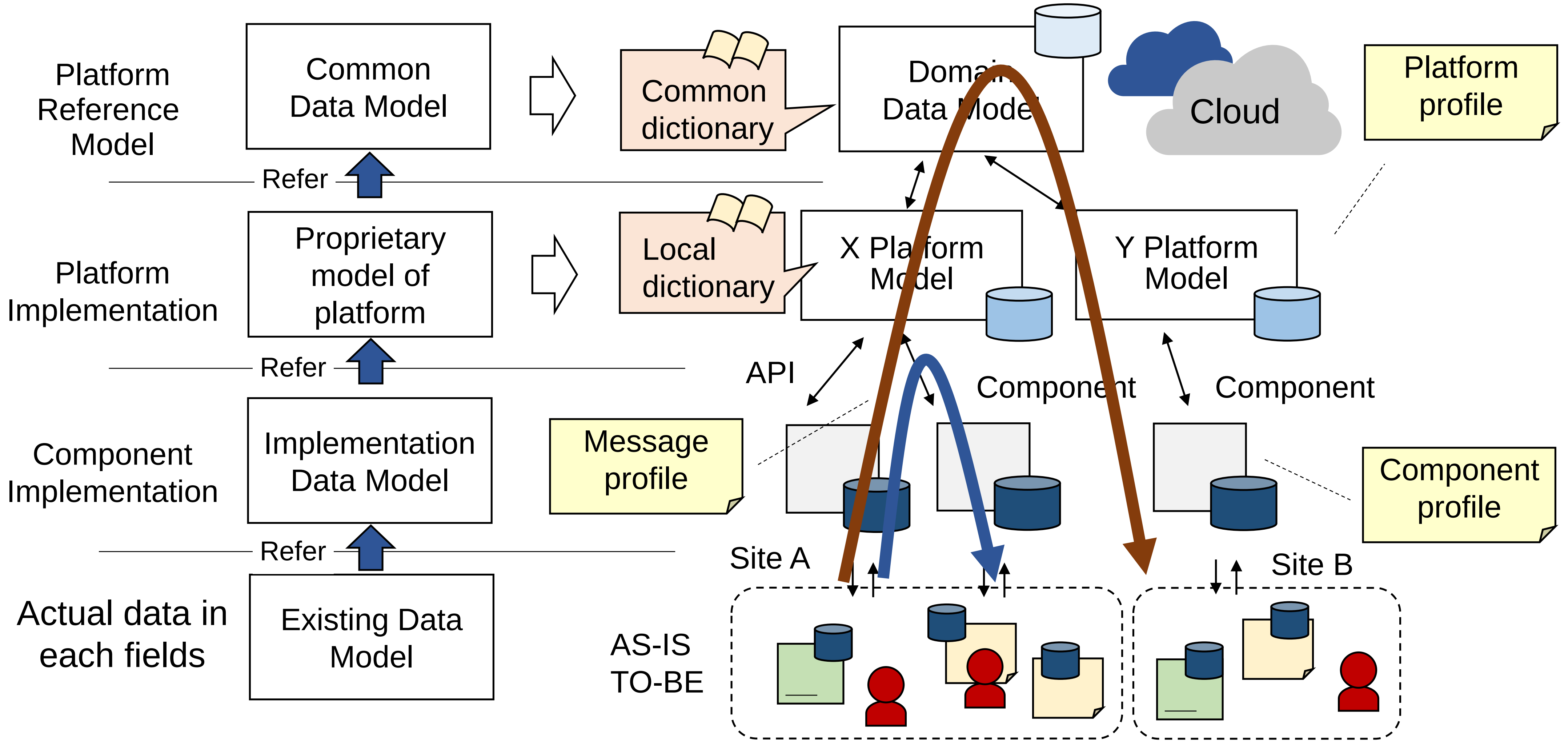
Profiles are created in off-line bases collaborating and negotiating value exchange between parties, whereas data transfer is fully available in the cyber world.

Inter enterprise data exchange needs commitment of data usage and warranty. CIOF allows the data receiver to use it only for the service described in the profile.

Connection using a common dictionary



Profile for System Integration



Life cycle management of common dictionaries

Competitive (Closed)

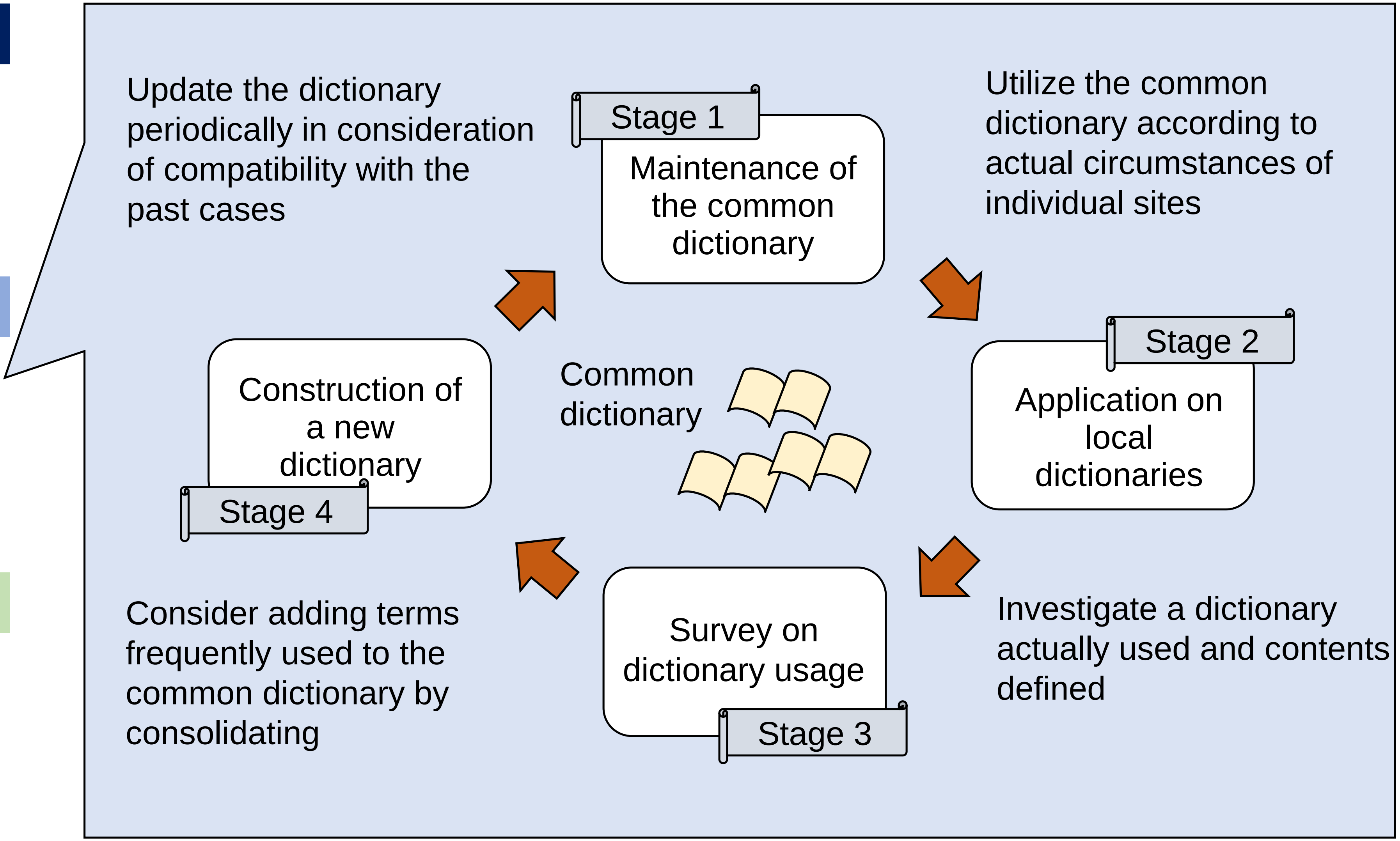
Content

Operative（Disclosed）

Index

Cooperative (Open)

Format



Thank you!
Danke schön.

Please visit us at
Hall 7 stand A31