

OPC DAY FINLAND 2017

WEDNESDAY, OCTOBER 11TH 2017 @MESSUKESKUS HELSINKI

Reference Architecture Model Industry 4.0 (RAMI4.0) and International Collaboration

Viite Arkkitehtuuri Malli Teollisuus 4.0 (RAMI 4.0)
ja kansainvälinen yhteistyö

Martin Hankel
Bosch Rexroth AG



FINNISH SOCIETY OF AUTOMATION
SUOMEN AUTOMAATIOSEURA RY

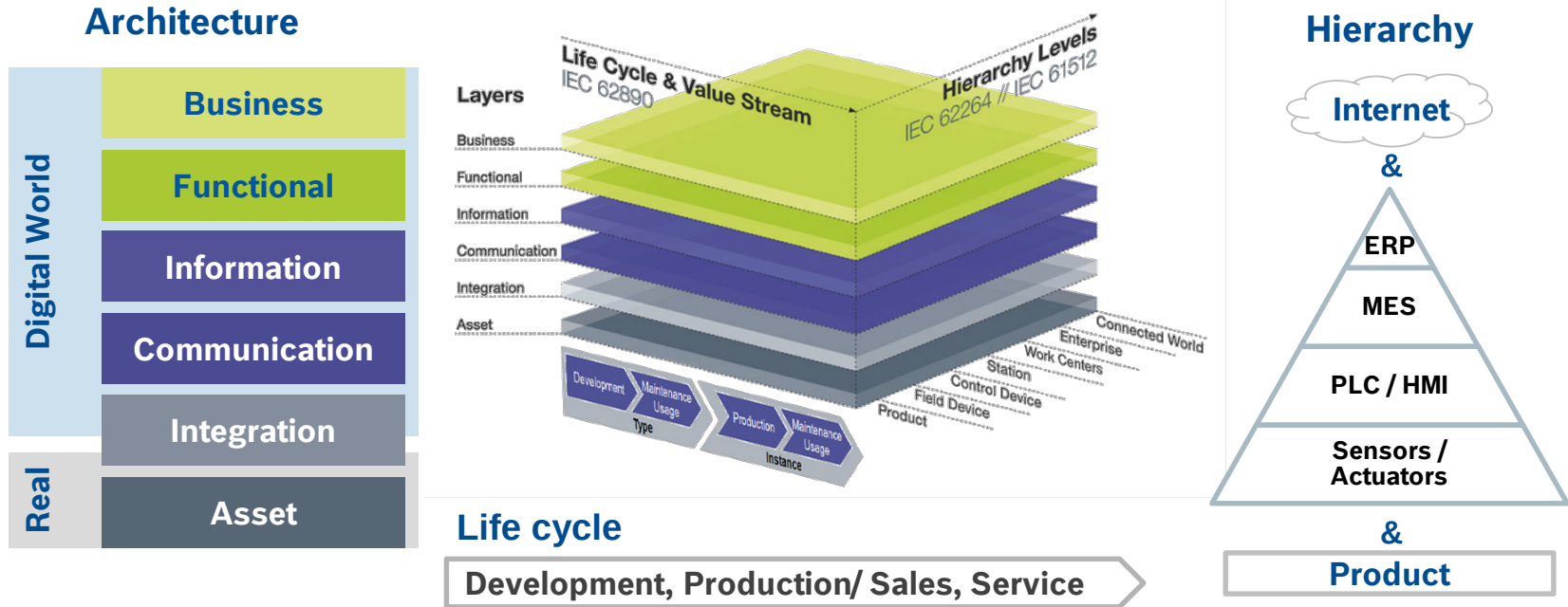
Agenda

RAMI 4.0 and I4.0 Component

International Comparison

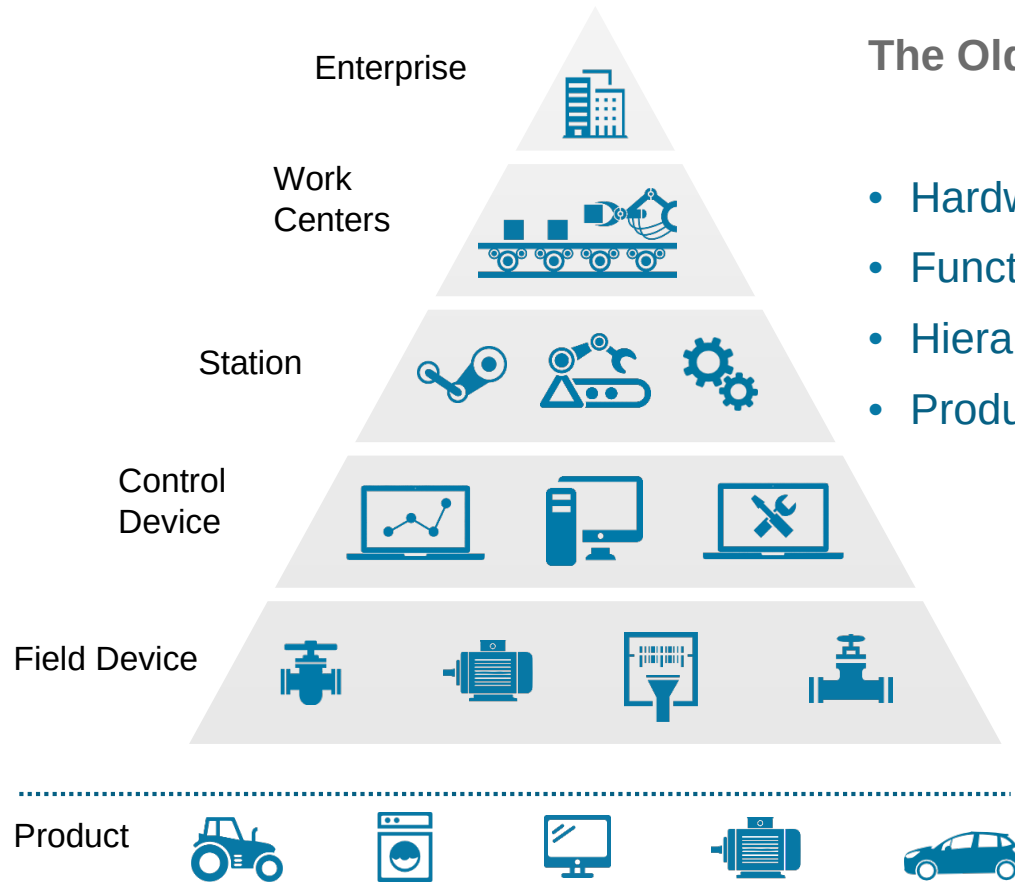
Product Criteria Industry 4.0

Reference Architecture Model Industry 4.0 (RAMI4.0)



The solution space with coordinate system for Industry 4.0

Industry 4.0 Communication



The Old World: Industry 3.0

- Hardware-based structure
- Functions are bound to hardware
- Hierarchy-based communication
- Product is isolated

Industry 4.0 Communication

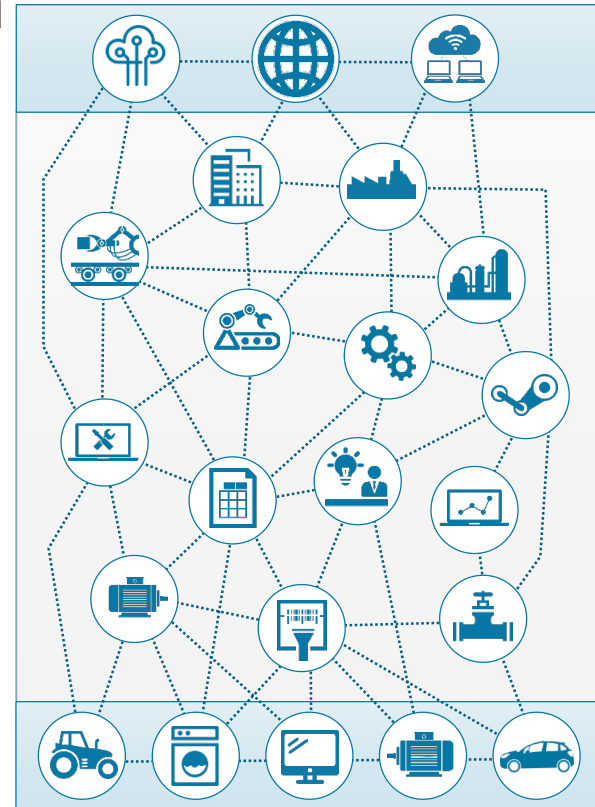
The New World: Industrie 4.0

- Flexible systems and machines
- Functions are distributed throughout the network
- Participants interact across hierarchy levels
- Communication among all participants
- Product is part of the network

Connected
World

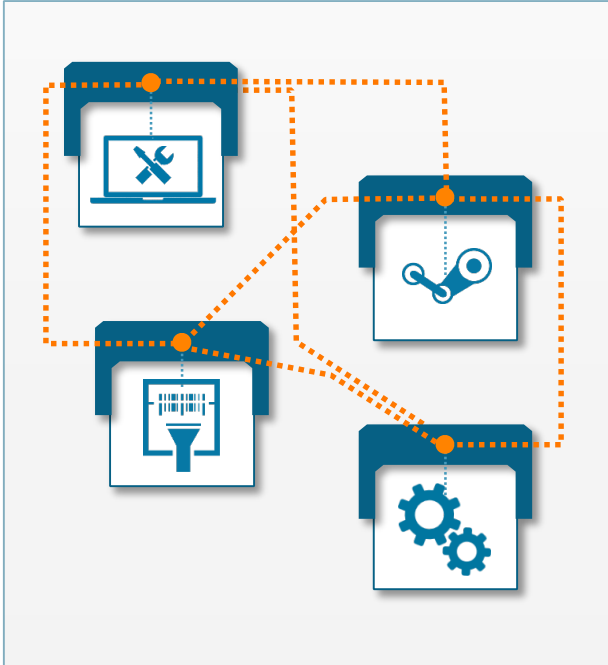
Smart
Factory

Smart
Products



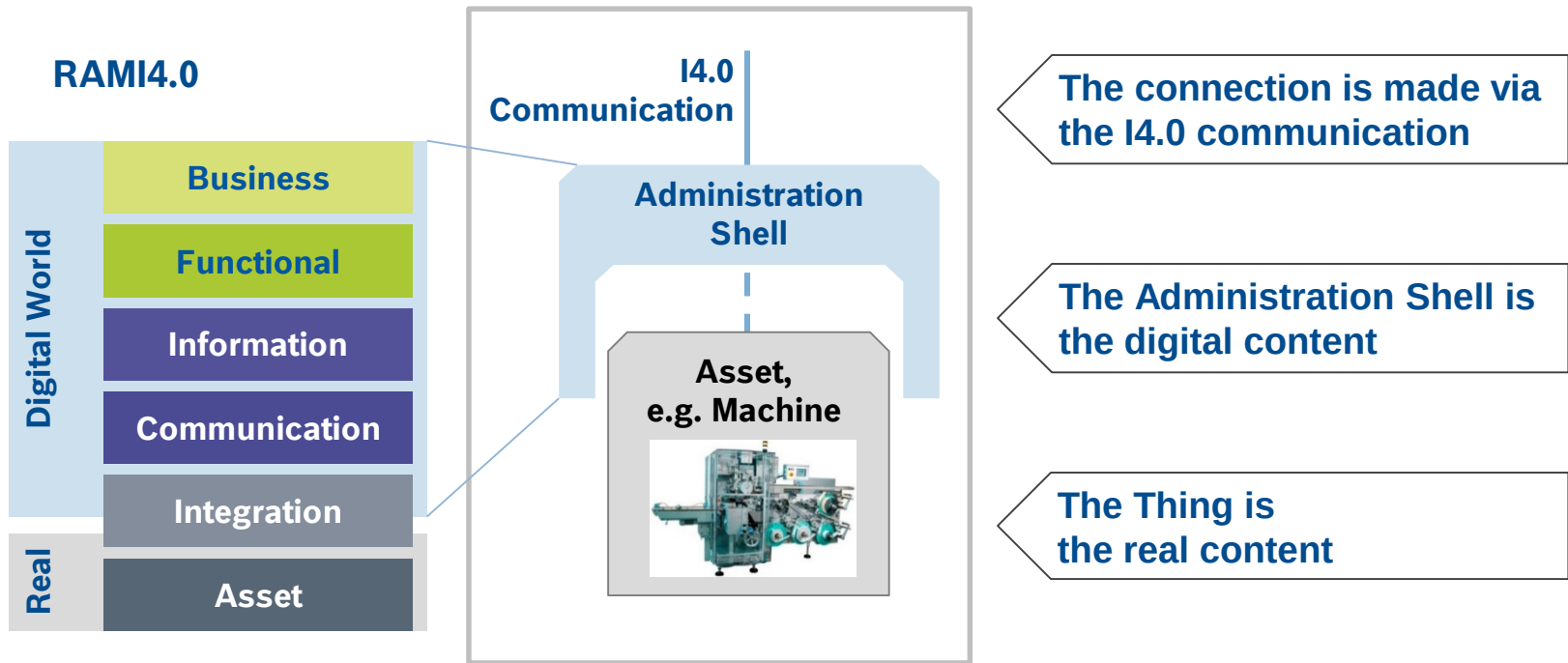
Graphics © Anna Salari, designed by freepik

Who Is Responsible for Interpreting? The Administration Shell.....



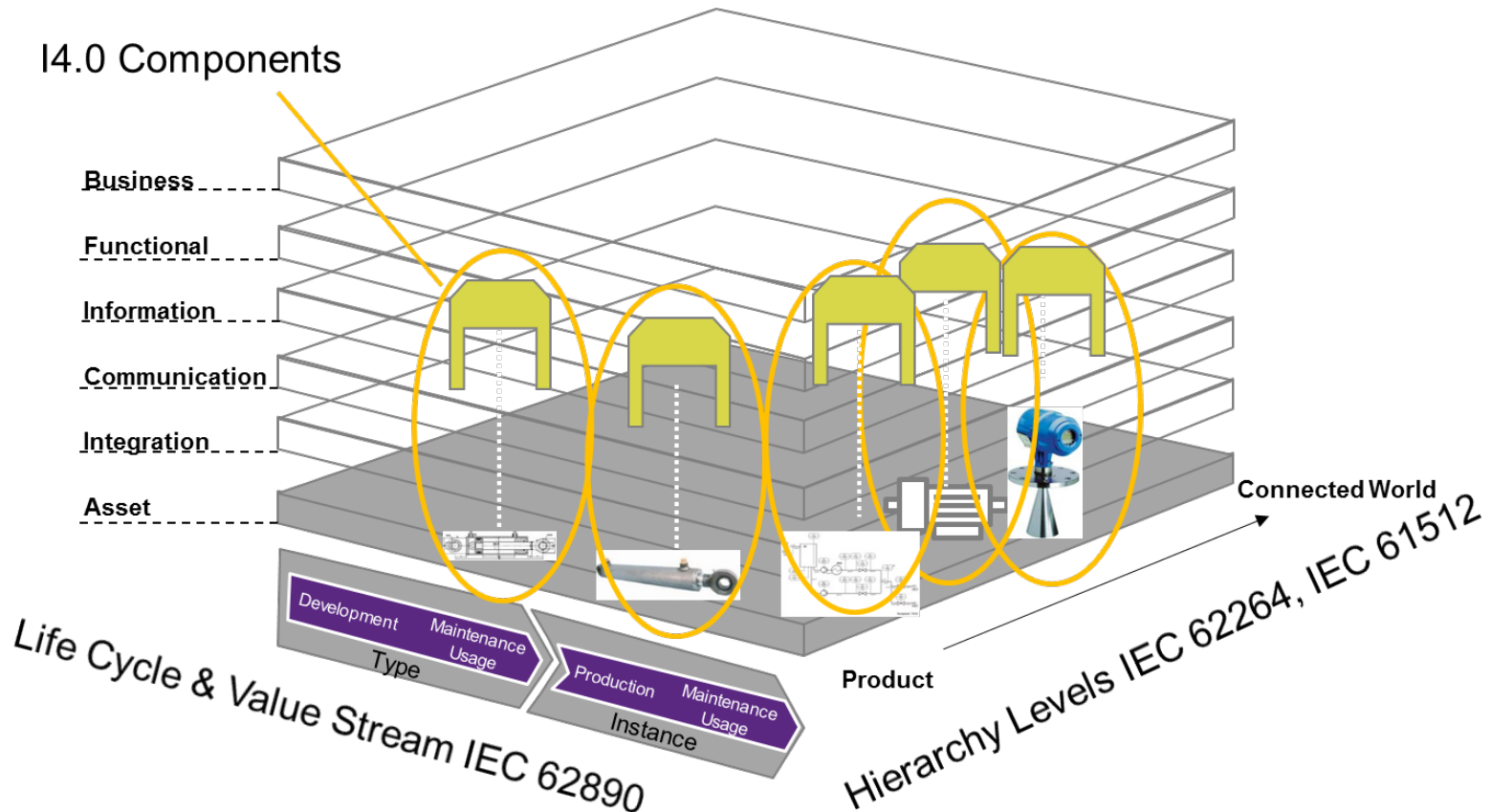
- ... is the interface connecting I4.0 to the things
- ... stores all data and information about the asset
- ... serves as network's standardized com interface
- ... can integrate **passive things** into I4.0 networks
- ... could be used for **migration of existing equipment**

The Industry 4.0 Component



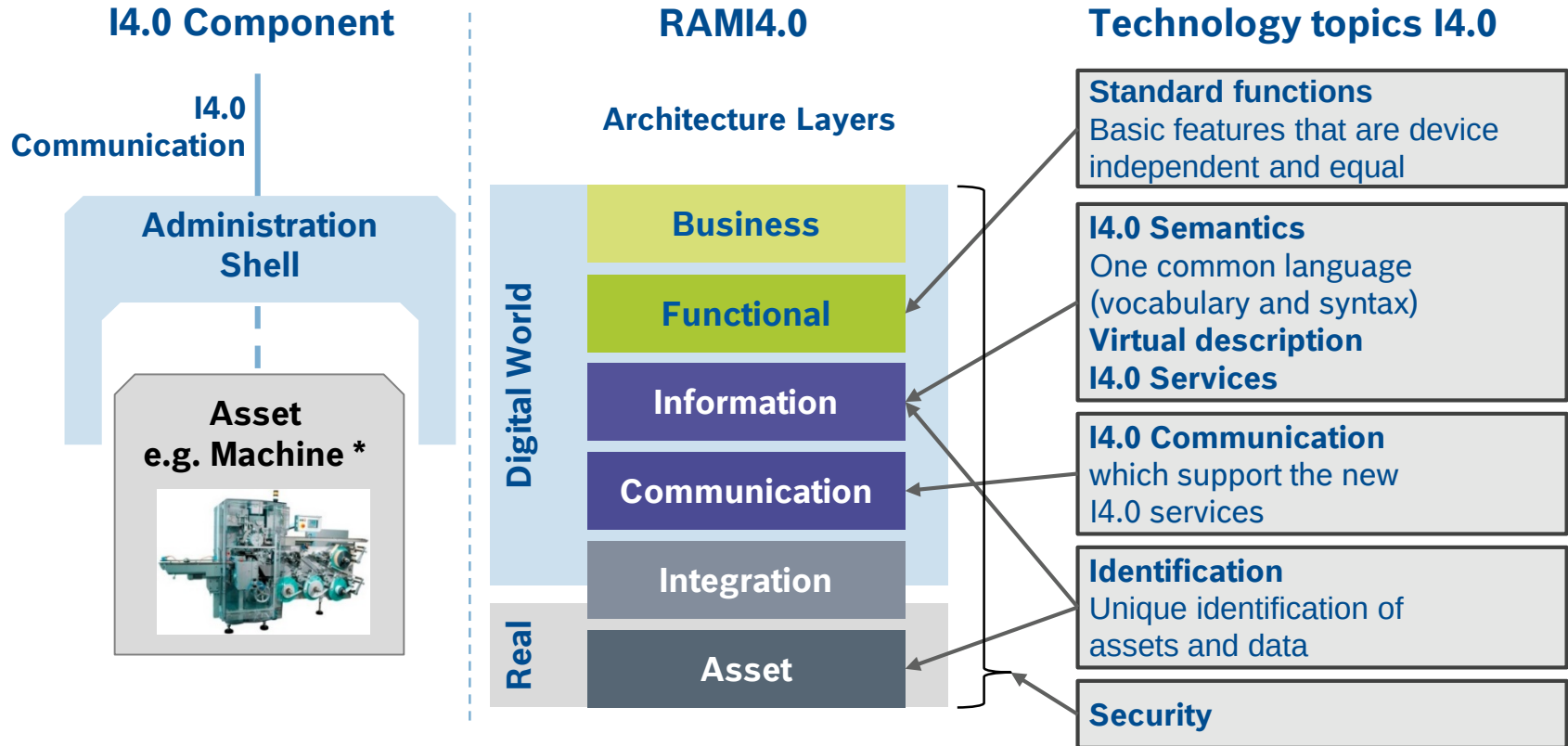
Each product need his Administration Shell, to be integrated into the Industry 4.0 network

I4.0 components inside RAMI4.0



Quelle: Prof Eppe, openAAS

Important topics for Industry 4.0



Worldwide standards for the main technology topics are needed

* Refers to individual components such as Sensors, actuators, controllers, software, ...

Communication Layer as ISO/OSI Model

OSI Layers

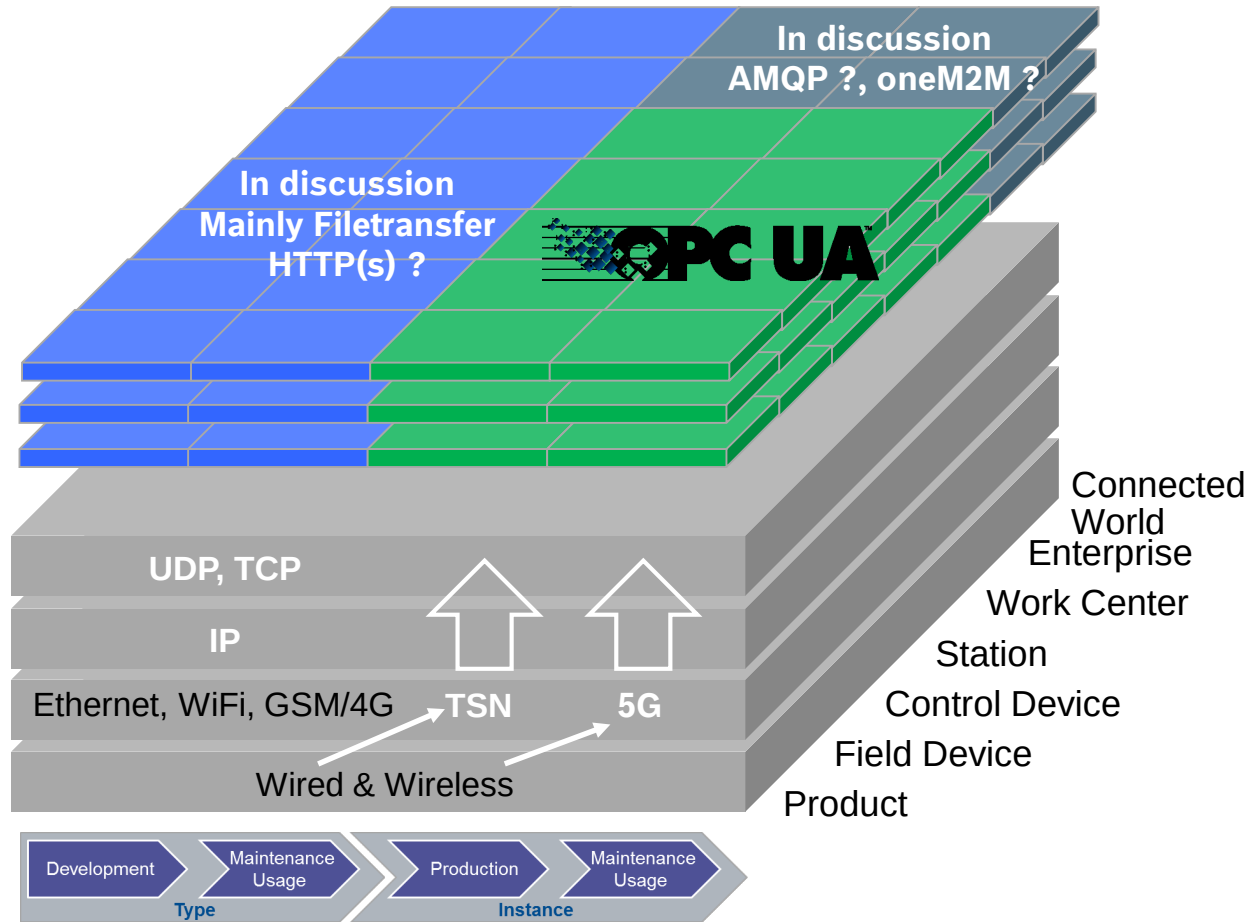
7 Application
6 Presentation
5 Session

4 Transport

3 Network

2 Data Link

1 Physical

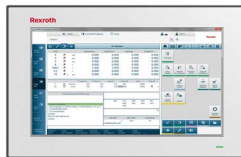


Example: I4.0 Component – Electrical Drives Converter

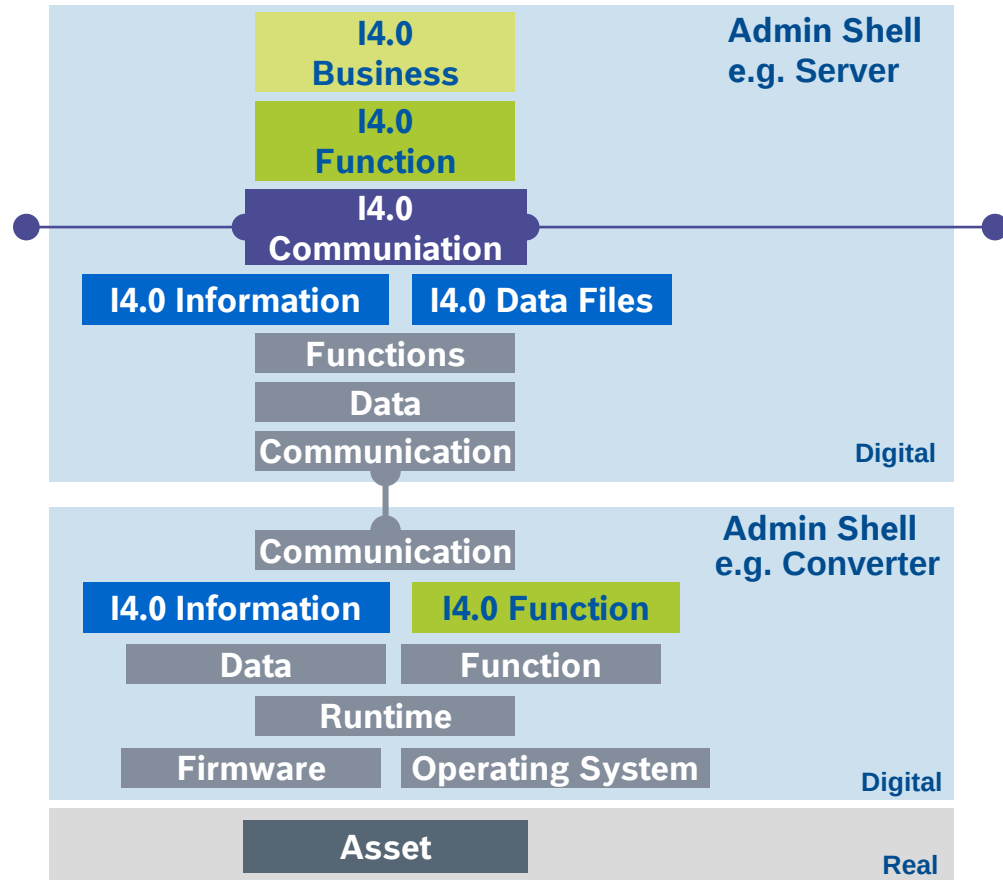


- Project Planning
- Service Info
- Load characteristic
- ...

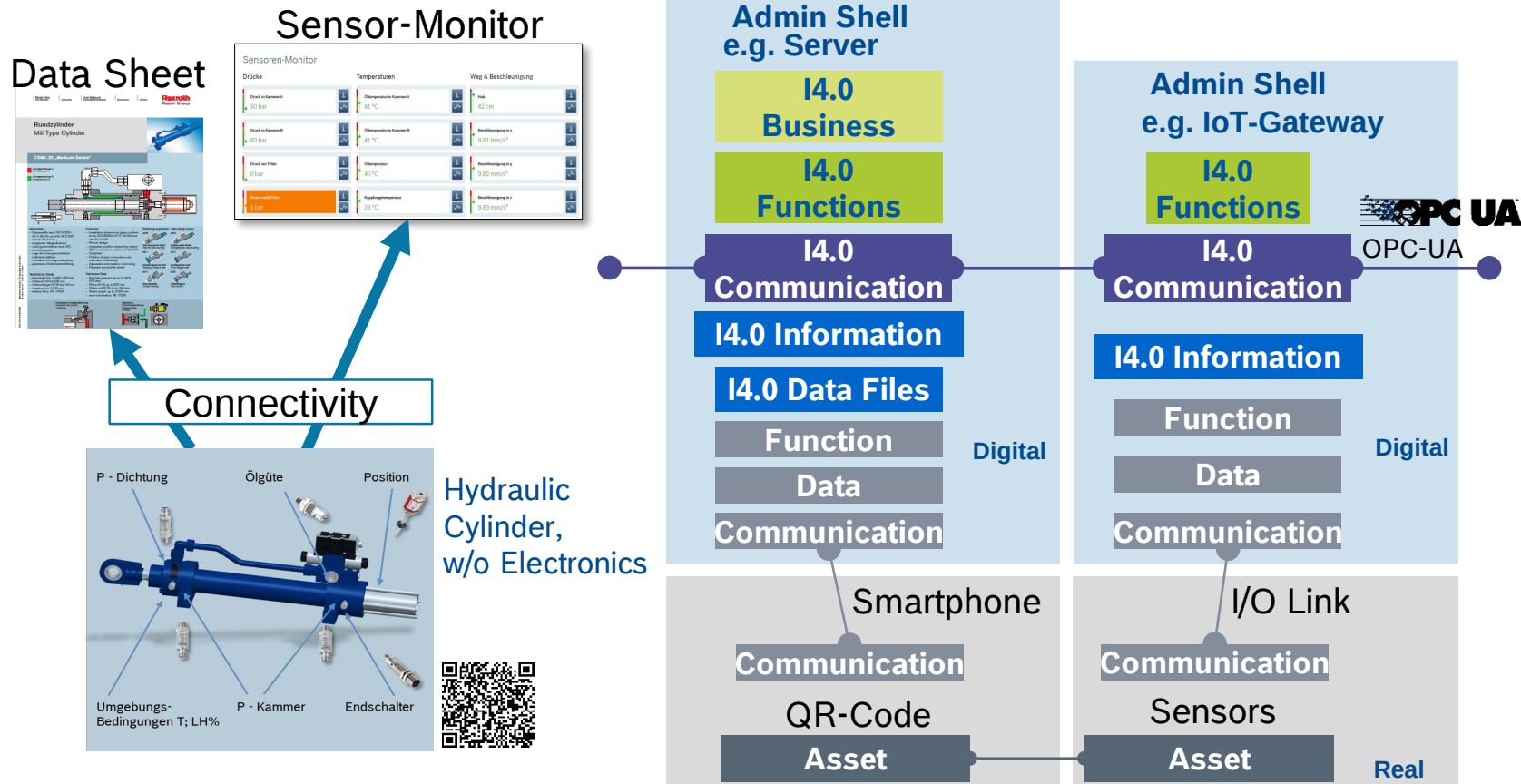
Connectivity



- Energy Optimization
- Startup Feature
- Condition Monitoring
- ...



Example I4.0 Component: Hydraulic Cylinder



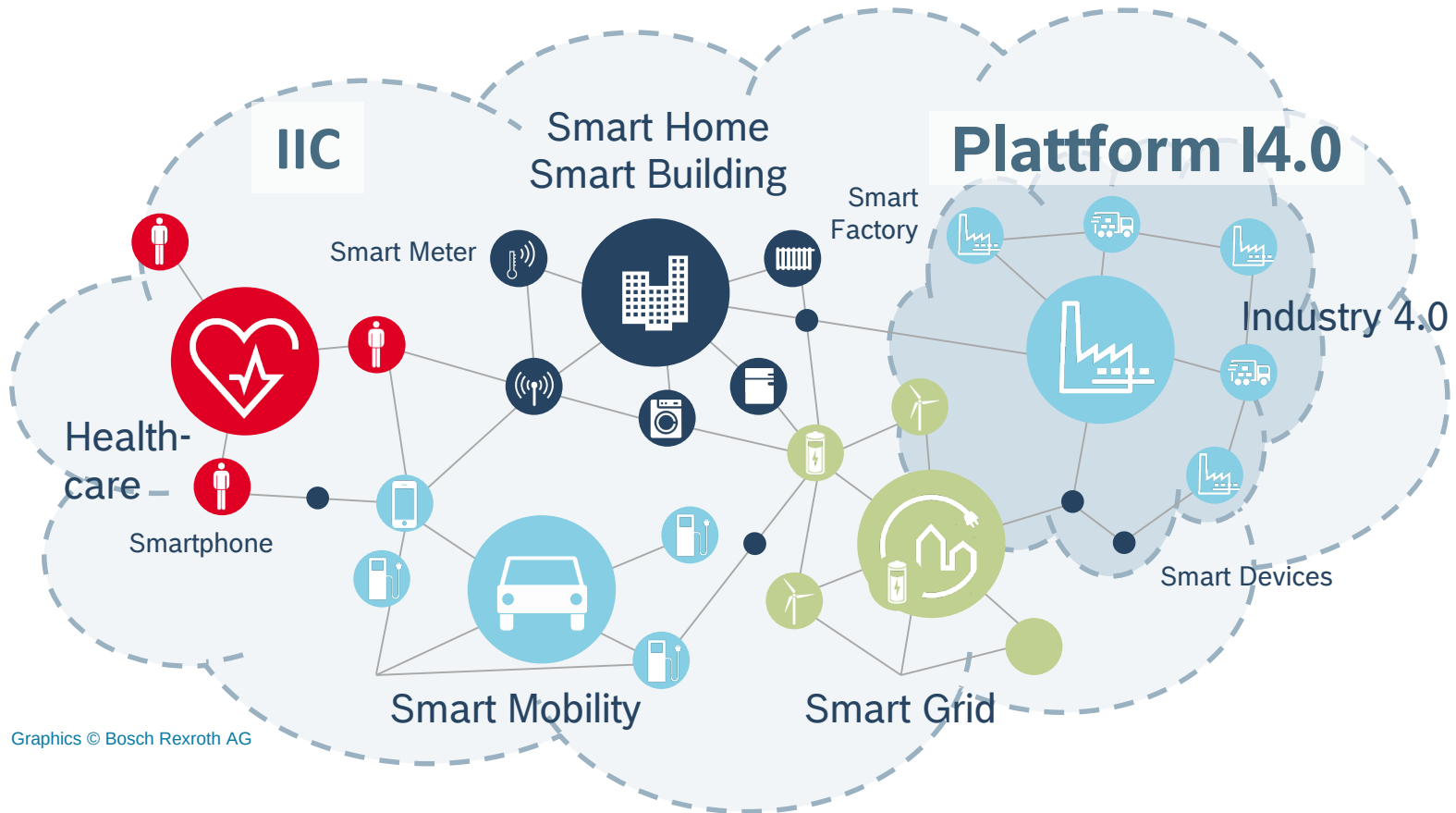
Agenda

RAMI 4.0 and I4.0 Component

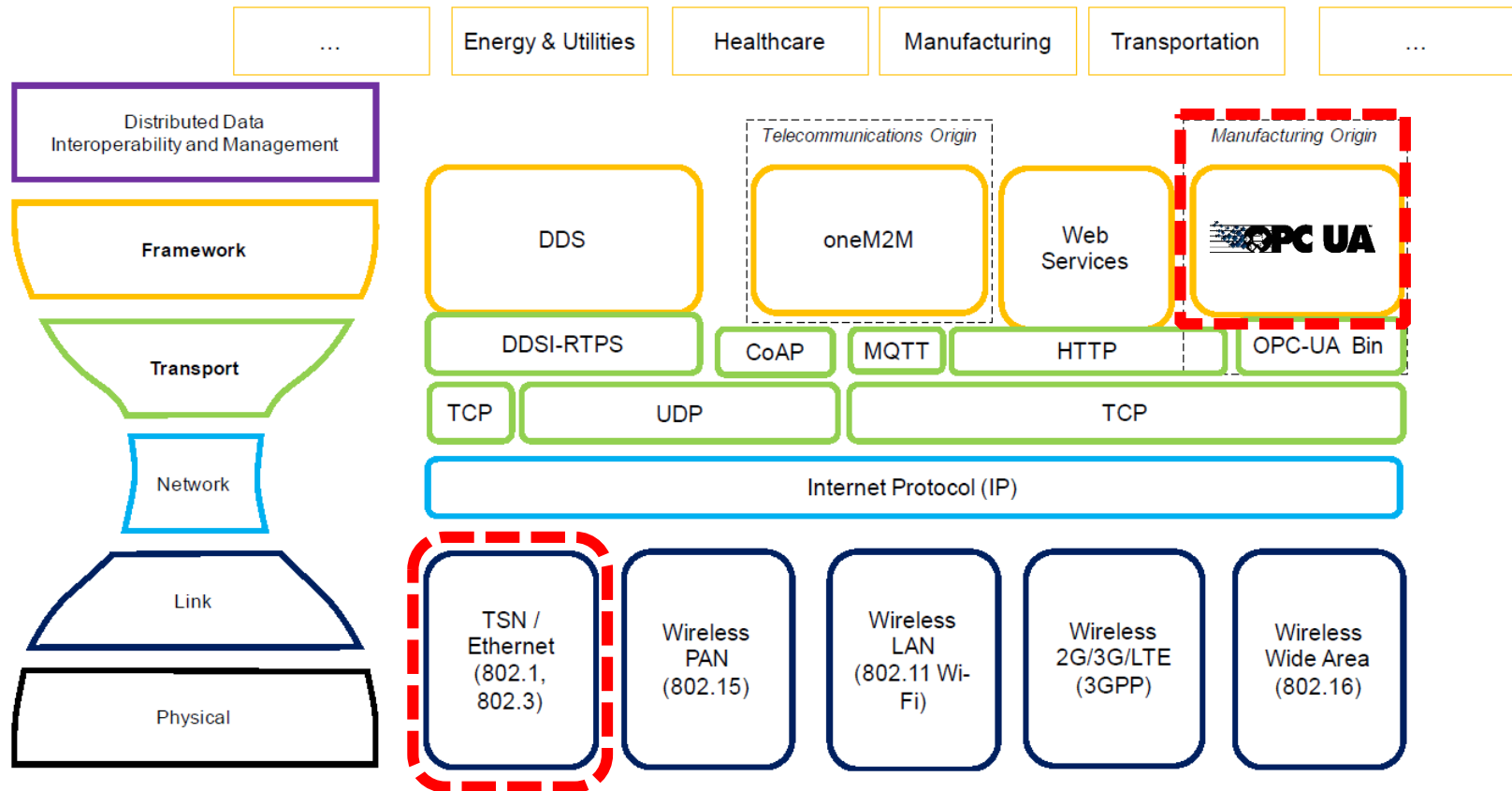
International Comparison

Product Criteria Industry 4.0

The Internet of Things and Services



IIRA - Vertical Connectivity



Source: IIC „Connectivity Framework“

Comparison RAMI 4.0 – IIRA: First common Definition

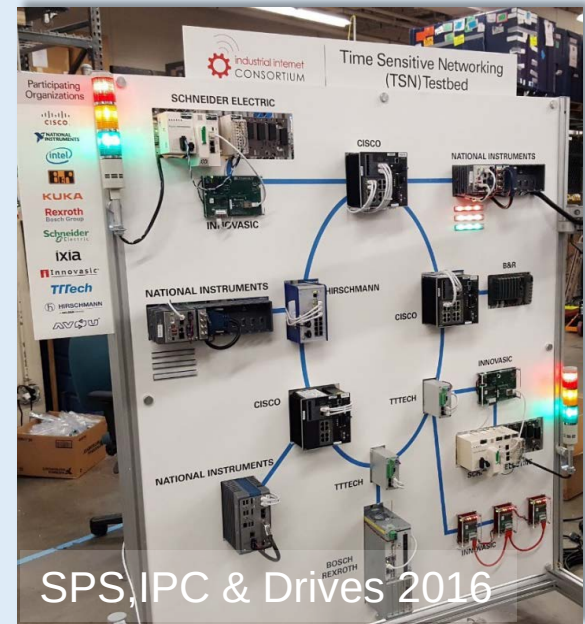
- Transmission based on TCP/UDP/IP today, later TSN or 5G possible
- OPC-UA based communication protocol



IIC Testbed – TSN with OPC-UA



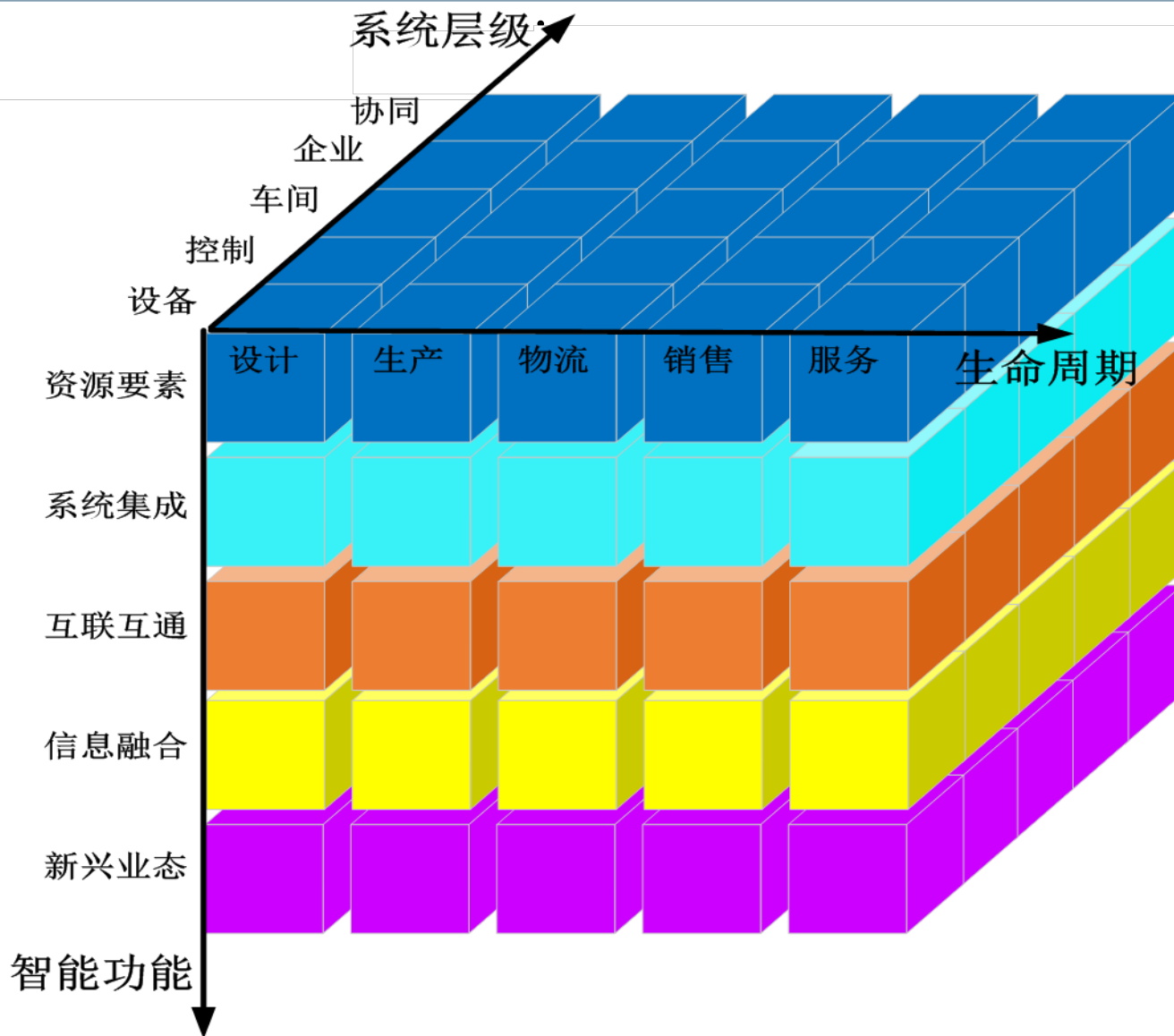
Additional companies promoting OPC UA over TSN:



Life Cycle Phase: Production and Service

Functional Hierarchy: from Product to Work Center Level

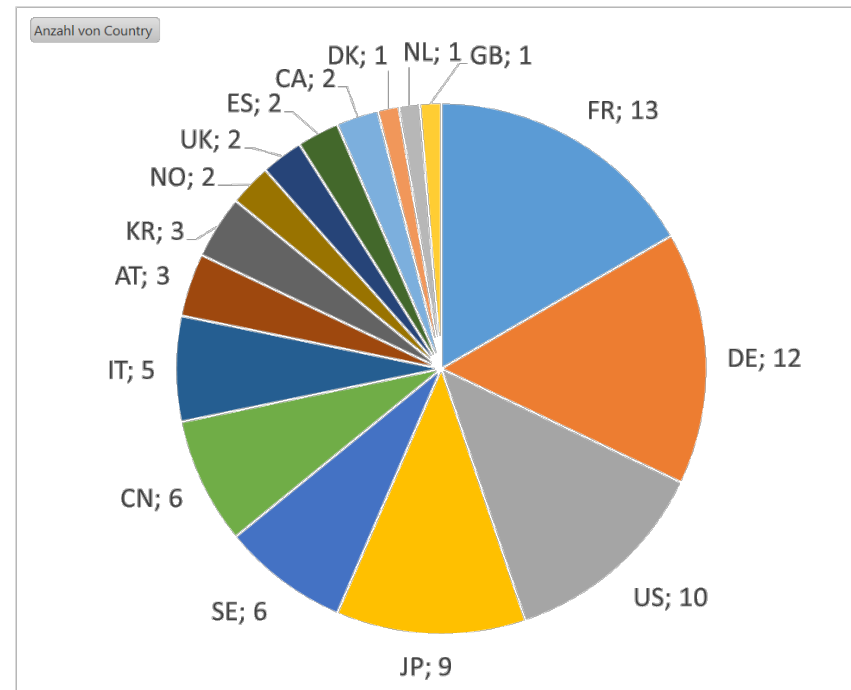
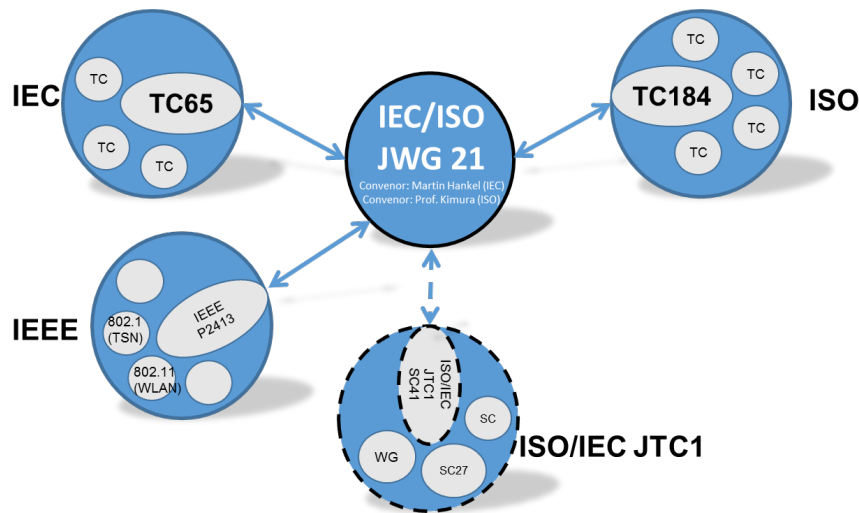
Industry 4.0 - International Collaboration



IEC TC65/ ISO TC184 Joint Working Group 21 Smart Manufacturing Reference Model(s)

- Co-Convenor: Prof. Fumihiko Kimura (ISO)
- Co-Convenor: Mr. Martin Hankel (IEC)
- Editor: Ms. Yan LU (NIST)
- Kickoff July 2017

80 Members from 16 countries



Unified Reference Model	Canvas	Use-case	Function	Data
 Model/Organization				
RAMPA 3 / Partners Initiative 4.0	→	→	→	→
IRIS / Industrial Internet Consortium	→	→	→	→
IRIS / Industrial Internet Consortium	→	→	→	→
Smart Manufacturing Consortium / NIST	→	→	→	→
Reference Architecture / I4.0/IIoT	→	→	→	→
Architectural Framework for IIoT/IIoT/IIoT	→	→	→	→
Architecture Reference Model / I4.0/IIoT	→	→	→	→
IIoT Reference Model / I4.0/IIoT	→	→	→	→
Big Picture / Big Data / IIoT / IIoT	→	→	→	→
Framework for the smart manufacturing standards landscape / IIoT	→	→	→	→
IIoT / IIoT	→	→	→	→
Domain/Provision / IIoT/IIoT	→	→	→	→
Use / IIoT	→	→	→	→

The diagram illustrates the layers of a product lifecycle, structured as a 3D stack of six layers. The layers, from top to bottom, are:

- Business**
- Functional**
- Information**
- Communication**
- Integration**
- Asset**

The top layer is labeled **Life Cycle & Value Stream** and **Hierarchy Levels**. The bottom layer is labeled **Product** and **Process**.

The diagram also shows the following stages and components:

- Development**, **Maintenance Usage**, **Production**, and **Maintenance Usage** as stages along the bottom.
- Connected World**, **Enterprise**, **Work Centers**, **Station**, **Control Device**, and **Field Device** as components on the right side.

The diagram illustrates the integration of Product Development, Business, and Production processes, centered around the **Mfg Pyramid**.

Product Development (Product):

- DFSCM** (Design for Supply Chain Management) connects Product and Business.
- CAD/CAE Design** leads to **Process Planning** and **Simulation**.
- Process Planning** leads to **Production Engineering**.
- Simulation** leads to **Design** and **Build**.
- Production Engineering** leads to **CAM**.

Business:

- Source** and **Plan** are key components.
- SCM** (Supply Chain Management) connects Business and Production.
- CPI** (Customer Process Integration) connects Product and Business.

Production:

- Design** and **Build** lead to **Simulation**.
- Simulation** leads to **Commission**.
- Commission** leads to **Deliver & return**.
- Deliver & return** leads to **Recycling**.
- Recycling** leads to **Use & Service**.
- Use & Service** leads to **QMS** (Quality Management System).
- QMS** leads to **PLM** (Product Lifecycle Management).
- PLM** leads to **O&M** (Operation and Maintenance).
- O&M** leads to **Decommission & Recycling**.

Central Elements:

- Mfg Pyramid** (Manufacturing Pyramid) with layers: ERP, SCM, MRO, MRO/CS, Field Service, and a base layer with icons for a factory, a person, and a truck.
- Fast Innovation Cycle** connects Product and Production.
- Digital Factory** connects Business and Production.
- CCX** (Customer-Centric Experience) connects Business and Production.

Rexroth
Bosch Group

Agenda

RAMI 4.0 and I4.0 Component

International Comparison

Product Criteria Industry 4.0

Criteria for Industry 4.0 Products - Motivation and Benefits

General

- Guidance, what is Industrie 4.0 AND what is not.
- Not every product is Industrie 4.0.
- Positioning for the market.

Customers

- Future proof cross-company set of terms.
- Manufacturer independent definition.

Manufacturer

- Guidance, what should be called Industrie 4.0.
- Properties as a guidance for the product development.

Implementing Entity

- Manufacturer independent.
- Knowledge of the current state of Industrie 4.0 standardization.
- The current state of Industrie 4.0 standardization is fed into the product implementation via the product criteria.

Important Prerequisite

- Self-audit, no certification.
- A company-own Industrie 4.0 label can be linked to the product criteria.
- Company decision of the placement (inside the catalogue, on the product, in the advertisement, etc.)
- Free of charge and available for everyone

First manufacturer-independent orientation for customers and manufacturers

2017 Properties / Criteria for I4.0 Products

	Criteria	Requirements	L	C	Product properties 2017
1.	Identification	Cross-manufacturer identification with unique identifier (ID) attached to the product, electronically readable. Identification in: 1) Development 2) Goods transport (logistics), production 3) Sales, service, marketing 4) Network	T	M	For 1) material number ^[1] (electronic) in accordance with ISO 29002-5 ^[2] or URI
			I	M	For 2) serial number or unique ID For 3) manufacturer + serial number or unique ID With 2) and 3) electronically readable, physical products via 2D code or RFID For 4) participant identification via IP network
2.	Industrie 4.0 communication	Transfer of product data and data files for interpretation or simulation, for example: product data in standardised form The product can be addressed via the network, supplies and accepts data, Plug & Produce via Industrie 4.0-compliant services	T	M	Manufacturer makes data that is relevant for the customer available/accessible online with the aid of identification, e.g. PDF via http(s)
			I	M	Product addressable online via TCP/UDP&IP with at least the information model from OPC-UA
3.	Industrie 4.0 semantics	Standardised data with manufacturer-independent unique identification in the form of characteristics with a syntax for, e.g.: 1) Commercial data 2) Catalogue data 3) Technical data: mechanics, electronics, functionality, location, performance 4) Dynamic data 5) Data regarding the lifecycle of the product instance	T	M	Catalogue data can be accessed online
			I	M	Catalogue data and data regarding the lifecycle of the product instance can be accessed online
4.	Virtual description	Virtual representation in Industrie 4.0-compliant semantics Virtual representation across the entire lifecycle. Characteristic attributes of the actual component, information regarding relationships between the attributes, production and production process-relevant relationships between Industrie 4.0 components, formal description of relevant functions of the actual component and its processes	T	M	Relevant information for customers can be accessed digitally based on the type identification (product description, catalogue, image, technical features, data sheet, security properties, etc.)
			I	M	Digital contact to service and information for product support incl. spare part information possible from in the field
5.	Industrie 4.0 services and conditions	Definition still open (service system) General interface for loadable services and messages regarding statuses Essential basic services that an Industrie 4.0 product must support and provide	T	O	Description of the device interface available digitally
			I	O	Information such as statuses, error messages, warnings, etc. available via OPC-UA information model in accordance with an industry standard
6.	Standard functions	Basic standardised functions that run on various products regardless of manufacturer and provide the same data in the same functions. These serve as the foundation for the functionality, on which all manufacturers can build their own enhancements.	T	N	Not defined
			I	N	Not defined
7.	Security	Minimum requirements to guarantee the security functionality.	T	M	A threat analysis has been performed. Appropriate security capabilities have been considered and publicly documented.
			I	M	The existing security capabilities are documented. Appropriately secure identities are available.

Table inside the guideline about:

- Criteria
- Requirements
- Product properties 2017



L: Lifecycle with T: Type and I: Instance, C: Coverage with M: Mandatory, O: Optional, use-case dependent, may be mandatory, and N: Not relevant
¹ Material number is used here as an umbrella term for the type designation, manufacturer part number, order number, product classification, etc.
² Generally, a manufacturer-specific identification should be required for the directly connected assets discussed above.
 As it currently stands, ISO29002-5 does not provide this.

Link: <https://www.zvei.org/presse-medien/publikationen/welche-kriterien-muessen-industrie-40-produkte-erfuellen/>

L: Life cycle with T: Type and I: Instance
 C: Coverage with M: Mandatory, O: Optional (Use Case dependant) and N: Not relevant

Summary

New
international
working group
IEC/ISO
JWG21

Standardized
properties for
Industry 4.0

Support
OPC-UA as the
communication
standard



Product
criteria
Industry 4.0

Thank you for
your attention

Rexroth booth
Hall 6 F50

Important Papers:

Platform: <http://www.plattform-i40.de/I40/Navigation/DE/In-der-Praxis/Online-Bibliothek/online-bibliothek.html>

- Discussion paper: Interaction Model for Industry 4.0 Components
- Discussion paper : Network-based Communication for I4.0: Proposal for an Administration Shell

ZVEI: <https://www.zvei.org/de/themen/industrie-40/>

- Whitepaper: Examples for the Admin Shell- Basic
- Guideline: What Criteria do Industrie 4.0 Products need to fulfil?

OPC DAY FINLAND 2017

11.10.2017 #OPCUA #OPCDAYFINLAND #AUTOMATION #OPCDAY