Antwerp 2018 – Tutorial – EUR18_35

Standards Review in Connection with Industrie 4.0

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Agenda

- Industrie 4.0 History

- Digitization in the World

- Industrie 4.0 Management

- Cyber Physical Systems and Reference Architecture Model Industrie 4.0 (RAMI 4.0)

- Standardization Bodies

- Industrie 4.0 Global Adoption

- Industrie 4.0 and International Standards for:
  - Functional Safety
  - Products Qualification
  - Communication Protocol
  - Interface Configuration
  - Engineering
  - Digital Factory Reference Model
  - Architecture
  - Cybersecurity

P C I C   E u r o p e

Industrie 4.0 History

- 2006   German Industry wonders how to maintain the « Made in Germany » competitive advantage in front of the low costs « World Factory » (China)

- 2008   Financial crisis highlight the role of the industry as key resilience factor against financial crisis

- 2010   Cyber Physical Systems (CPS) appear as the potential answer to the German industry question

- 2014   Angela Merkel releases officially the German digital program Industrie 4.0 at Hannover Fair

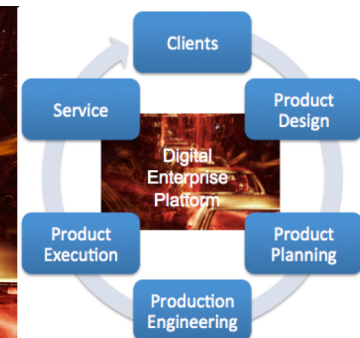- 2017   Industrie 4.0 gets global recognition at Hamburg G20 Summit
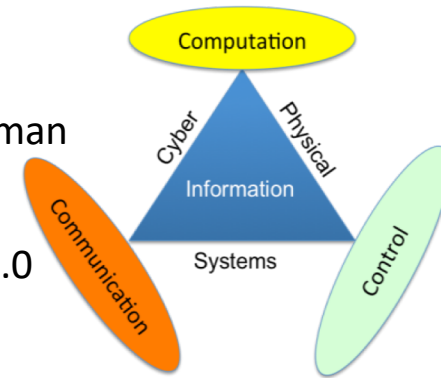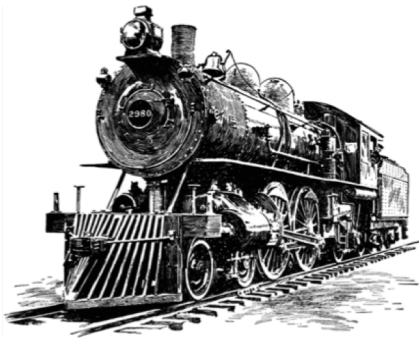
Steam   **Electricity - Series**   **Robotization**   **Digitization**

Digitization around the World

- Asia
  - China: "Smart Automation 2.0" ➔ Industrie 4.0
  - The "World factory" acquires German Kuka robots to take a leap to Industrie 4.0
- India: "Make it in India"
  - The "software office" to deploy "digital corridors" across the country
- Japan : "IVI" ➔ Industrie 4.0
  - Develop the Industry Value Chain Initiative (IVI) aligned with German Industrie 4.0 architecture
- South Korea : "Creative Economy"
  - To finance start up ecosystem to develop the future South Korean "Engine"
- North America
  - USA : "Industry Renaissance" ➔ Internet of Things (IoT) ➔ OPC Foundation ➔ Industrie 4.0
  - Originally, to let GAFAM and shale gas low cost to change game, today to align on Industrie 4.0 (April 2018)
- Europe
- Europe Community (2014): "Horizon 2020"
  - To secure Europe global competitiveness with €80 billion funding
- France (2014): "Usine du Futur" ➔ "Industrie du Futur" (Industrie 3.0) ➔…. Industrie 4.0
  - Robotization plan presented in September 2013 moving toward digitalization
- Germany (2010): "Industrie 4.0"
  - To keep world leadership in manufacturing and exporting funded by €20 billion from Government
- Italy (2016): "Industria 4.0"
  - SPS Parma 2016 Italy adopted Industrie 4.0 and put in place aggressive tax intensive program
- UK: "Future of Manufacturing" ➔ ??
  - To re-balance economy between financial economy and real economy

Industrie 4.0 Management
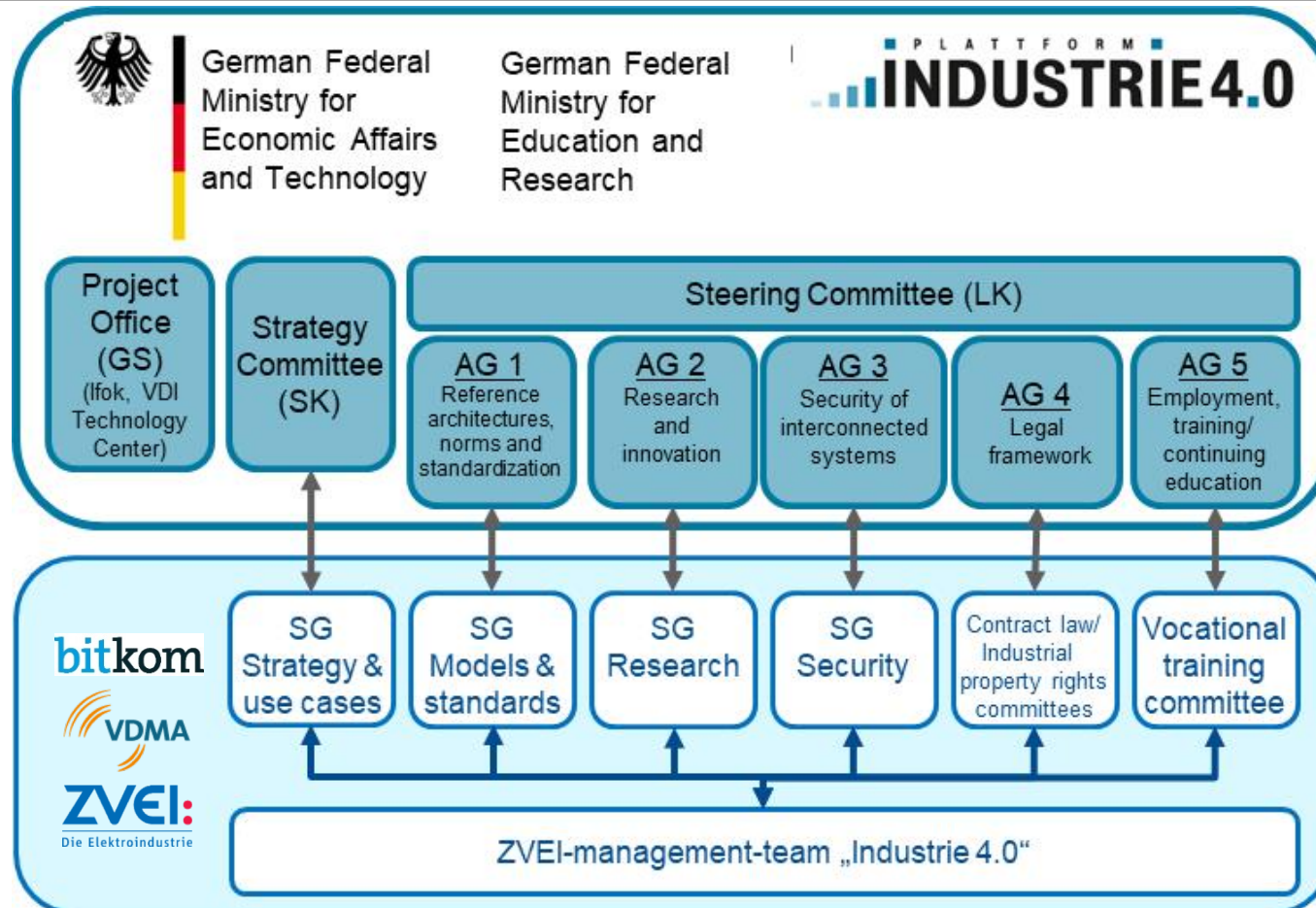
AG: Arbeitsgruppe – Working Group
SG: Spiegelgremium – Mirror Group

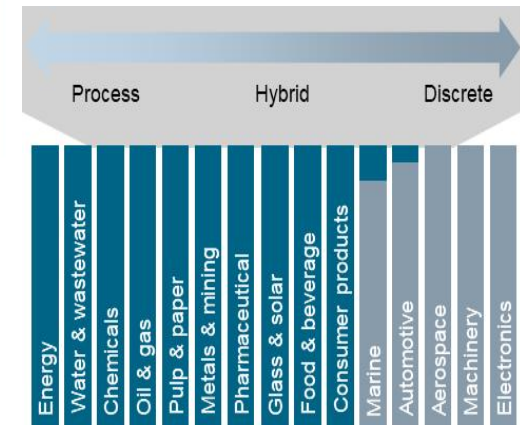PCIC Europe

I4.0 Cyber Physical System (CPS)

Cyber-physical system (CPS)
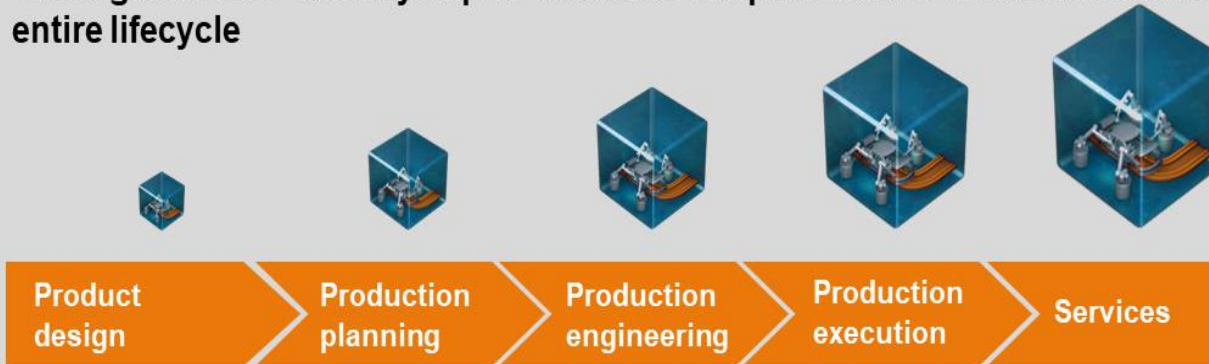
Physical production facility **+** Digital model

Contains all the information about…

- software / IT
- mechanics
- electrics, electronics
- automation, HMI
- safety, security
- maintenance

- location, identity
- status
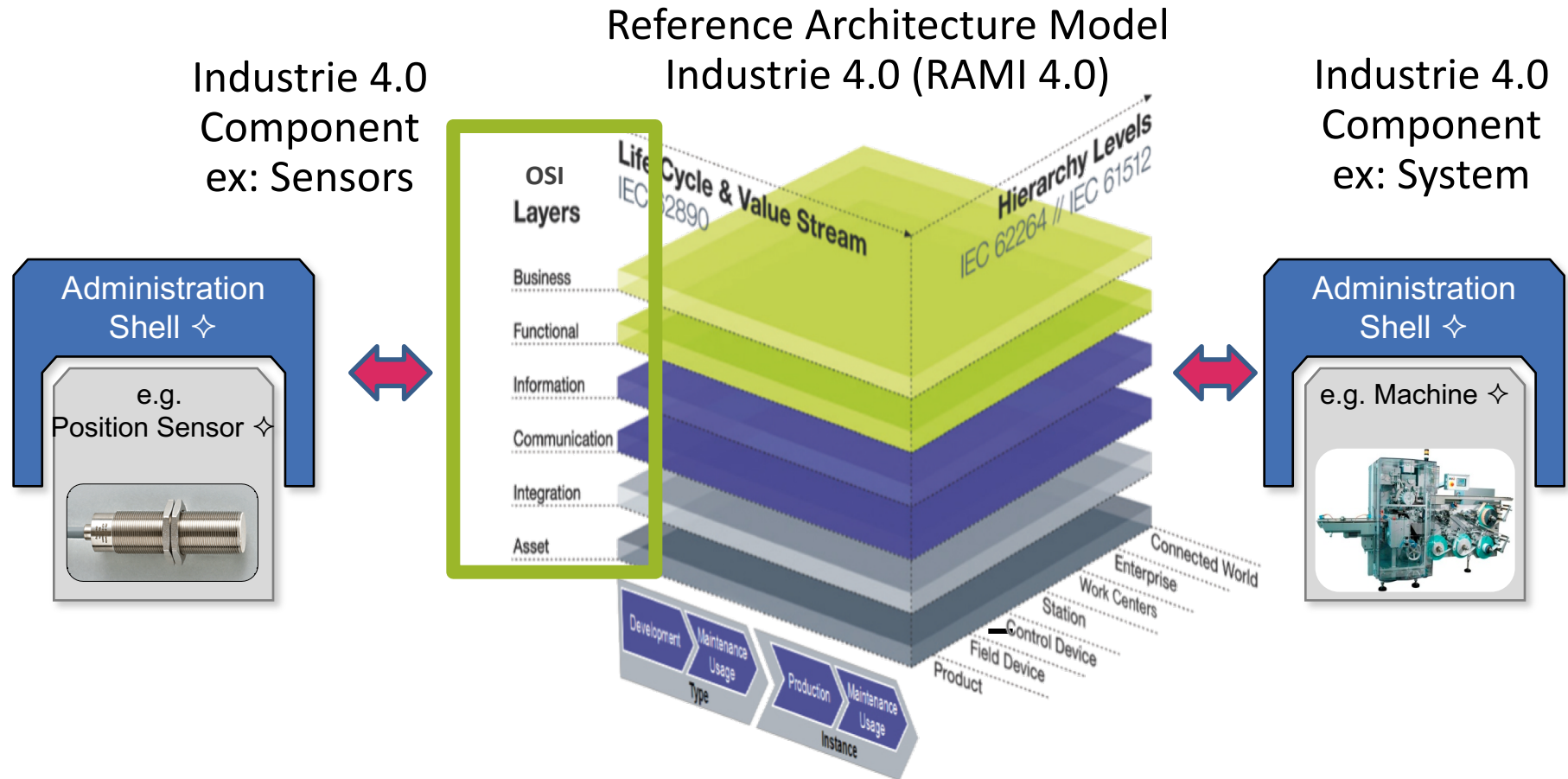- SW version
- interfaces
- …

Each industry is different

Process — Hybrid — Discrete

Energy | Water & wastewater | Chemicals | Oil & gas | Pulp & paper | Metals & mining | Pharmaceutical | Glass & solar | Food & beverage | Consumer products | Marine | Automotive | Aerospace | Machinery | Electronics

But it requires a common connectivity

The digital model is always up-to-date and is expanded over the course of the entire lifecycle

Product design → Production planning → Production engineering → Production execution → Services

Digital Twin

Industrie 4.0 Technological Concepts

Reference Architecture Model
Industrie 4.0 (RAMI 4.0)

Industrie 4.0
Component
ex: Sensors

Industrie 4.0
Component
ex: System

Administration Shell ✧

e.g.
Position Sensor ✧

Administration Shell ✧

e.g. Machine ✧

OSI Layers

Life Cycle & Value Stream
IEC 62890

Hierarchy Levels
IEC 62264 // IEC 61512

Business

Functional

Information

Communication

Integration

Asset

Connected World

Enterprise

Work Centers

Station

Control Device

Field Device

Product

Development · Maintenance Usage — Type

Production · Maintenance Usage — Instance

RAMI 4.0 – A Standards-based Architecture to enable connectivity between Industrie 4.0 Components

Communication Layer Possible Standards

OSI Layers

7 Application
6 Presentation
5 Session

4 Transport
3 Network
2 Data Link
1 Physical

OPC-UA
DDS, LWM2M, …

UDP, TCP

IP, IPsec

Ethernet, WiFi, GSM/4G   TSN, 5G

Wired & Wireless

Develop.   Usage   Production   Usage

Communication Layers

Product
Field Device
Control De...
Station
Wo...
En...
Co...
Wo...

openAAS project:
Implementation of the administration shell using OPC UA
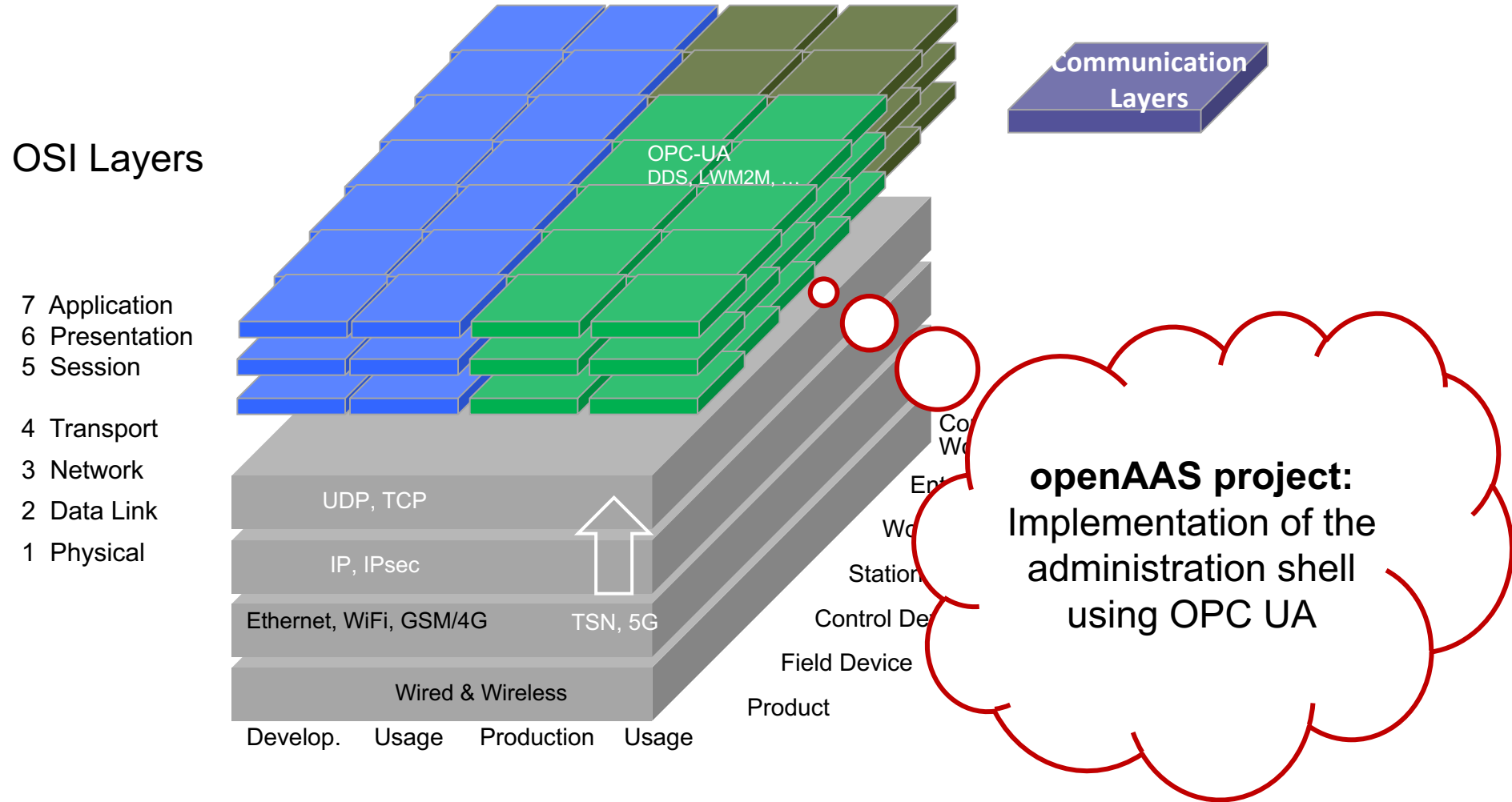
Normungslandschaft (Standardization Bodies)

		Nationale Ebene Bsp. Deutschland	Regionale Ebene Bsp. Europa	International
bitkom	Tele-kommunikation	DKE VDE DIN	ETSI	ITU
VDMA	Allgemein	DIN	cen	ISO
ZVEI	Elektrotechnik	DKE VDE DIN	CENELEC	IEC

Quelle: DIN und eigene Grafik

Digitalization Guidances at European Level

- June 2016 – Intellectual Property (IP)
  - Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure.
  - The Directive harmonizes the definition of trade secrets in accordance with existing internationally binding standards. It also defines the relevant forms of misappropriation and clarifies that reverse engineering and parallel innovation must be guaranteed

- September 2016 – Creating a Digital Single Market by 2025
  - Publication of the EU Guidelines for Creating a Digital Single Market
    The European Commission proposes to create a gigabit society by 2025.
  - We (read EU) encourage investment in high capacity networks with a new regulatory framework, the European Electronic Communications Code, and a 5G Action Plan.
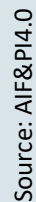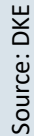
Digitalization Initiative at Global Level

G20 Initiative

- April 2017 – Digital Ministers Meeting – Düsseldorf – Germany
    - The G20 Digital Ministers' meeting in Düsseldorf agreed on a roadmap for joint policies for a digital future.
    - Preparatory meeting to Hamburg G20 Summit

- July 2017 – G20 Summit – Hamburg – Germany
    - High-speed Internet access for all by 2025
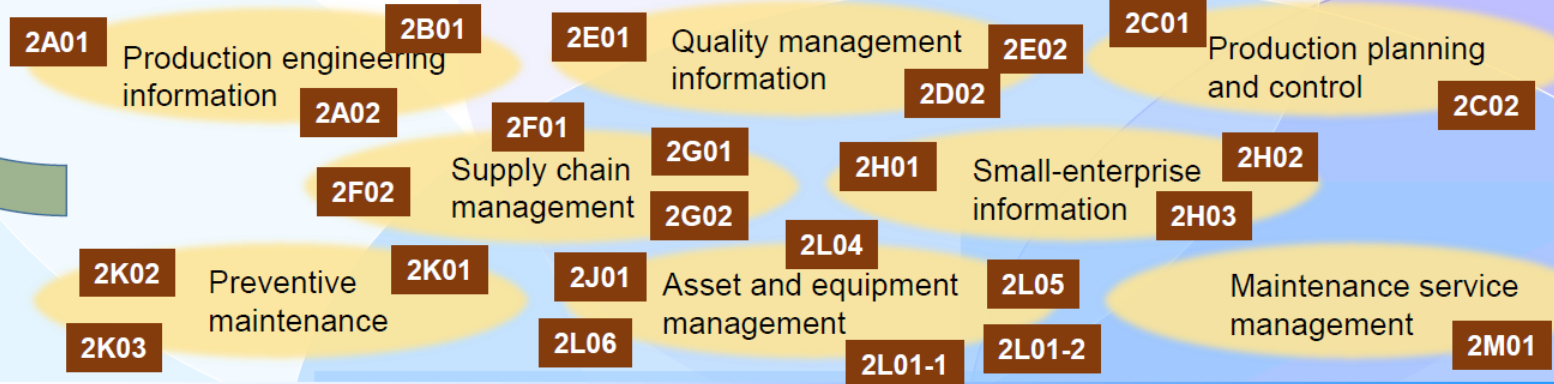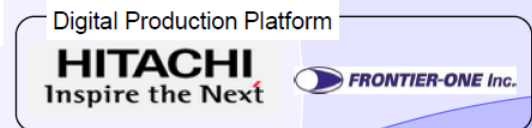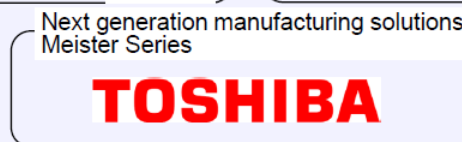   - Digitization requires international standards

Bilateral Collaboration

Source: DKE

Source: AIF&PI4.0

STANDARDIZATION
COUNCIL
INDUSTRIE 4.0

- **Connecting of the industry community**
- **Defining joint working items**
- **Setting up co-partnerships**
- **Setting up working groups**
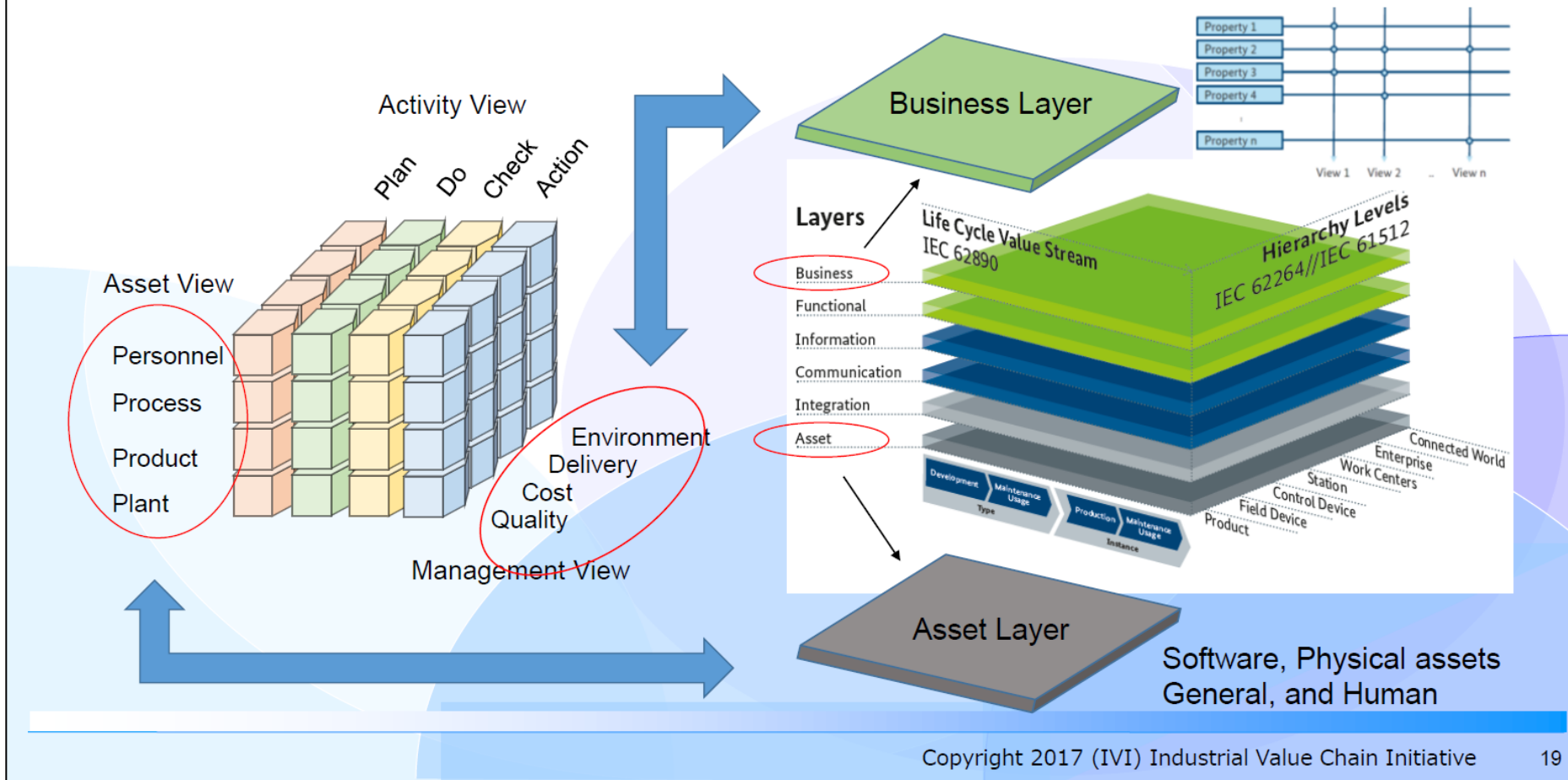- **Closer international cooperation**

…for Standardization

Japan Industrial Value Chain Initiative (IVI)

with Courtesy of Yasuyuki Nishioka, Prof. Dr. Hosei University

Japan Model (IVRA) vs German Model (RAMI 4.0)

Mapping from IVRA to RAMI 4.0

with Courtesy of Yasuyuki Nishioka, Prof. Dr. Hosei University

PCIC Europe

US – German Inter-operability

- April 2018: Agreement signed in Hannover Fair
- Since 1996, the OPC Foundation has facilitated the development and adoption of the OPC information exchange standards in Microsoft Window operating System.
- OPC Foundation's mission is to maintain interoperability from embedded world to enterprise cloud.
- OPC Foundation serves over 580 members worldwide in the Industrial Automation, IT, IoT, IIoT, M2M, Industrie 4.0, Building Automation, machine tools, pharmaceutical, petrochemical, and Smart Energy sectors.
- IEC-62541: Open Platform Communication Unified Architecture (OPC UA)
- https://opcfoundation.org.

Industrie 4.0 and International Standards

STANDARDIZATION COUNCIL INDUSTRIE 4.0

| Topics	Standards supporting Industrie 4.0
Functional Safety	IEC-61511, IEC-62061
Products Classification	IEC-61360, ISO-13584
Communication Protocols	IEC-61784, IEC-62541
Interfaces Configuration	IEC-61804, IEC-62453
Engineering	IEC-61131, IEC-61987, IEC-62424, IEC-62714, ISO-17506
Digital Factory Reference Model	IEC-62794, IEC-62832
Architecture	IEC-61512, IEC-62850, IEC-62890, IEC-62264
Cybersecurity	IEC-27000 series, IEC 62443

Global Cooperation Industrie 4.0 ⬌ **International Technical Committees**

P C I C   E u r o p e

Functional Safety Standards
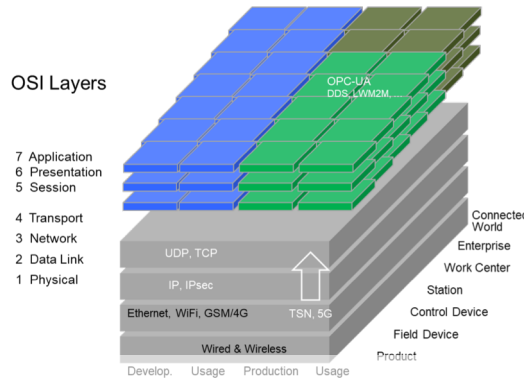
- IEC-61511: Safety Instrumented Systems for the process industry sector.
  - Apply to electrical, electronic, programmable electronic equipment
  - Valid from the initial concept to the decommissioning
  - Contains: framework, guidelines of applications, guidance to determine safety integrity levels
  - Request a minimum of safety performance

- IEC-62061: Safety of Machinery – Functional safety of safety-related electrical, electronic and programmable electronic control system
  - Apply to electrical, electronic, programmable electronic equipment for machine
  - Specify requirements and make recommendation for design, integration and validation
  - For a machine or a group of machine working together
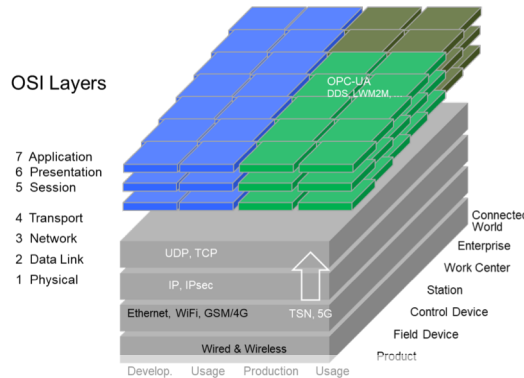 - Does not include the control system equipment itself, only its result

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Products Qualification Standards
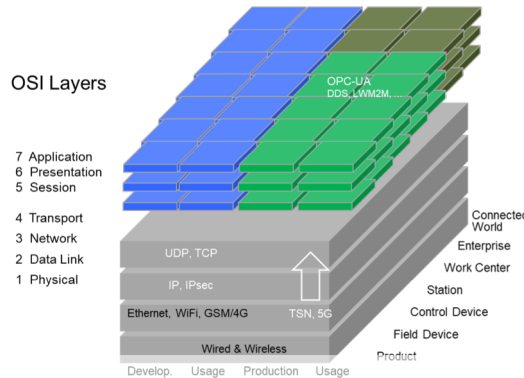
- **IEC-61360: Common Data Dictionary**
  - Apply to all electronical domains
  - Support the information transfer using common concepts
  - Target error-free information transfer
  - Define the company specific data structure for products, services and database

- **ISO-13584: Industrial automation systems and integration – Parts library (PLIB)**
  - Contains logical models for library, suppliers, data, identification
  - Furnish a methodology to structure part families
  - Define exchange protocol
  - Specify programming interfaces such as API

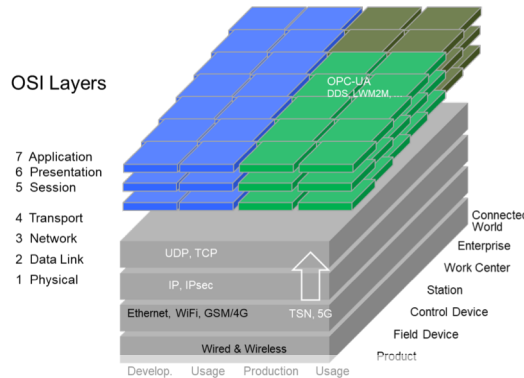**Global Cooperation Industrie 4.0** ⬌ **International Technical Committees**

Communication Protocol Standards

- **IEC-61784: Industrial communication networks**
  - Contain communication profiles families
  - Define fieldbus rules, profiles and installations for real time network
  - Step in at design phase
  - Created for factory manufacturing and process control

- **IEC-62541: Open Platform Communication Unified Architecture (OPC UA)**
  - Originally written by OPC Foundation to describe open platform interoperability in Windows environment
  - Extension of the OPC Unified Architecture Standards
  - Defines the information model associated with device
  - Provide a device model and its communication topology
  - Integrate the device into a host system
  - April 2018 OPC Foundation and ZVEI signed MOU to align Administration Shell

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# Interface Configuration Standards

- IEC-61804: Function Block for Process Control and Electronic Device
  - Describe the properties of an automation system component
  - Integrate real product with their details
  - Specify dependencies, parameters, simulation mode, data storage
  - Create an Electronic Device Description (digital twin)

- IEC-62453: Field device tool – Interface specification
  - Separate the "vertical" and "horizontal" data
  - Support life-cycle management of fieldbus in a plant
  - Provide a consistent life-cycle of data exchange within control system
  - Integration of sub-system in the Process Control

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Engineering Standards
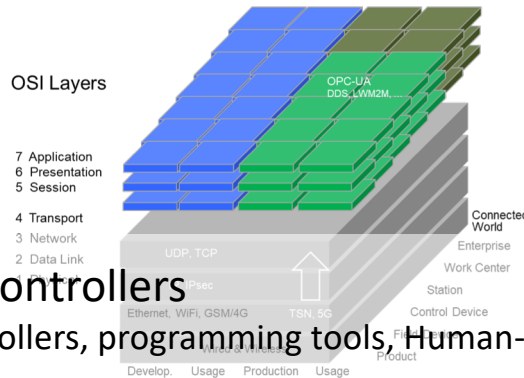
- ## IEC-61131: Programmable Controllers
  - Apply to programmable controllers, programming tools, Human-machine interface

- ## IEC-61987: Industrial-process Measurement and Control
  - Characterize industrial-process measuring equipment to integrate the Common Data Dictionary

- ## IEC-62424: Representation of Process Control Engineering
  - Specify how progress control requests are represented in a Piping and Instrumentation Diagram

- ## IEC-62714: Engineering data exchange format for use in industrial automation systems engineering
  - Define the data exchange format named "Automation Markup Language"

- ## ISO-17506: Industrial automation system and integration
  - Define the XML-based schema that enables the exchange of digital assets

Global Cooperation Industrie 4.0 ⟷ International Technical Committees

# Digital Factory Reference Model Standards
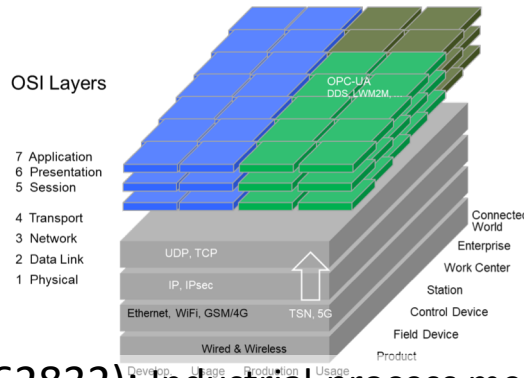
- IEC-62794 (replaced by IEC-62832): Industrial-process measurement, control and automation - Reference model for representation of production facilities
  - Describe a reference model for automation asset
  - Specify structural and operational relationships
  - Reference the aspect of a plant
  - Follow the plant life cycle

- IEC-62832: Industrial-process measurement, control and automation - Digital factory framework
  - Define the general principles of the Digital Factory framework
  - Apply to assets, relationship between systems, and flow of information
  - List a set of model elements
  - Explain the rules to modelling production systems

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Architecture Standards
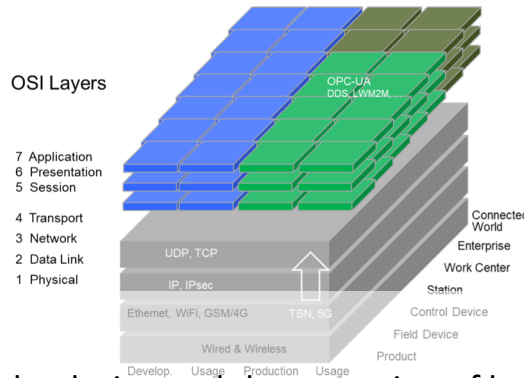
- IEC-61512: Batch Control
  - Emphasize good practices for the design and the operation of batch manufacturing plant

- IEC-62850: Safety requirements for electrical equipment for measurement, control, and laboratory use
  - Apply in educational establishments to people between 3 to 16 years old

- IEC-62890: Life cycle management for systems and products used in industrial-process measurement, control and automation
  - Describe operationnal state and performance parameters

- IEC-62264: Enterprise-control system integration
 - Describe the integration between the manufacturing operations and the control domain

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PCIC Europe

Cybersecurity Standards
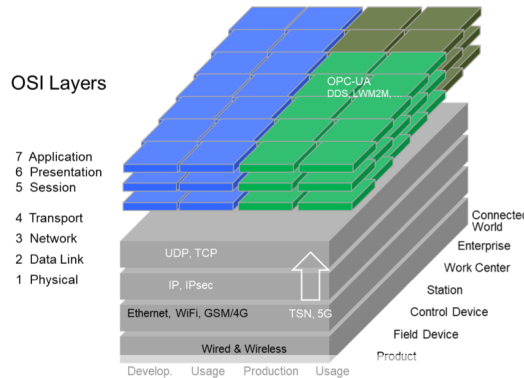
- IEC-27000 series: Information technology - Security techniques - Information security management systems
  - Give the overview of Information Security Management System (ISMS)
  - Apply to all size of organization
  - Cover used term and definitions
  - Provide support and guidance to establish, implement, maintain, improve an ISMS

- IEC 62443: Industrial communication networks - Network and system security
  - Define concepts and models for Industrial Automation and Control System (IACS) security
  - Oversee SCADA system
  - Cover all the systems that affect the safe, secure, reliable operation of industrial processes
  - Provide criteria for specifying activities associated with manufacturing operations
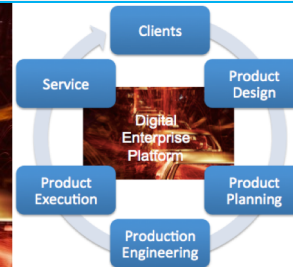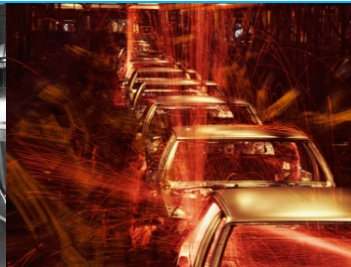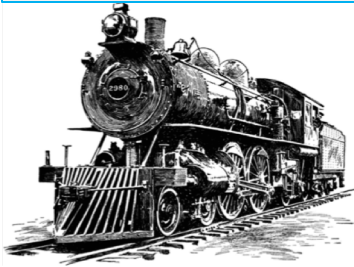
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Conclusions
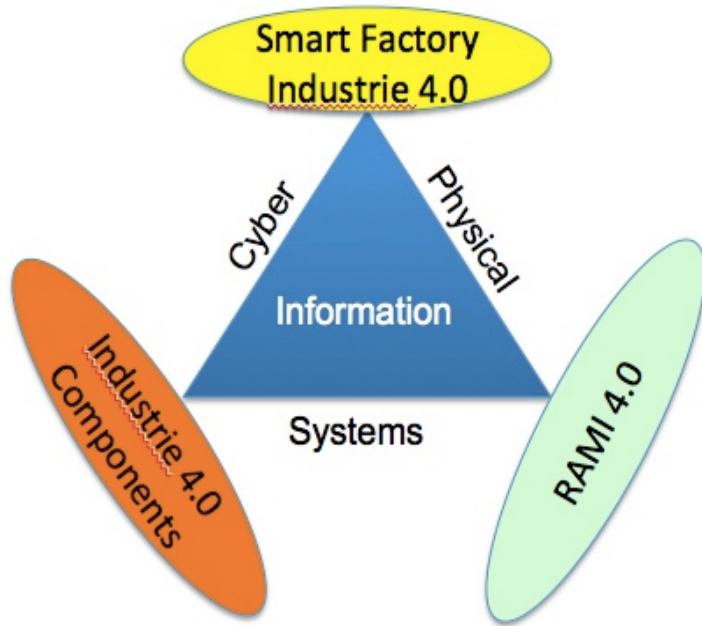
- Industrie 4.0 is not just a Tax Incentive Program

- Industrie 4.0 is about Digitization, not Robotization

- Cyber Physical Systems (CPS) support Digital Twin for Smart Factories and Smart Plants

- Industrie 4.0 relies on technologies and standards

- Standards International Committees and Industrie 4.0 Standardization Council work together

- Industrie 4.0 becomes a open platform by global recognition

Industrie 4.0 – 4th Industrial Revolution

Questions

PCIC Europe