KUKA

Standardization Activities in Industry 4.0

Heinrich Munz

Lead Architect Industry 4.0

Germany's Platform Industry 4.0

- Industry 4.0 is one of ten „Future Projects" of the German Government

- 1000 Mio. € grants

- Controlled by the German Government
  - Supervised by Chancellor Angela Merkel (visited KUKA in 03/15)
  - Minister for Economic Affairs & Energy Brigitte Zypries
  - Minister for Education & Research Johanna Wanka

- KUKA is a member of the "Reference Architecture and Standardization" working group (Heinrich Munz)
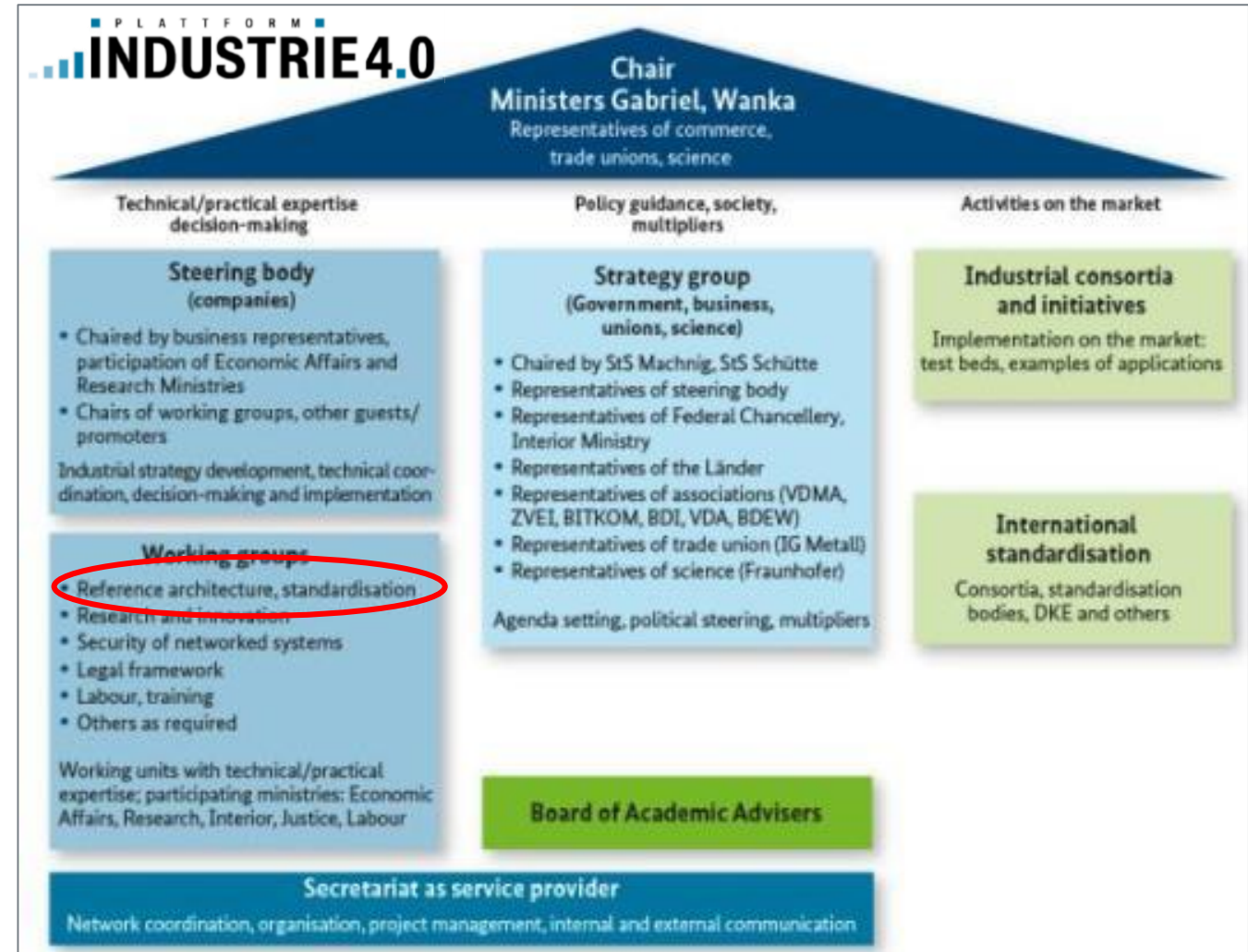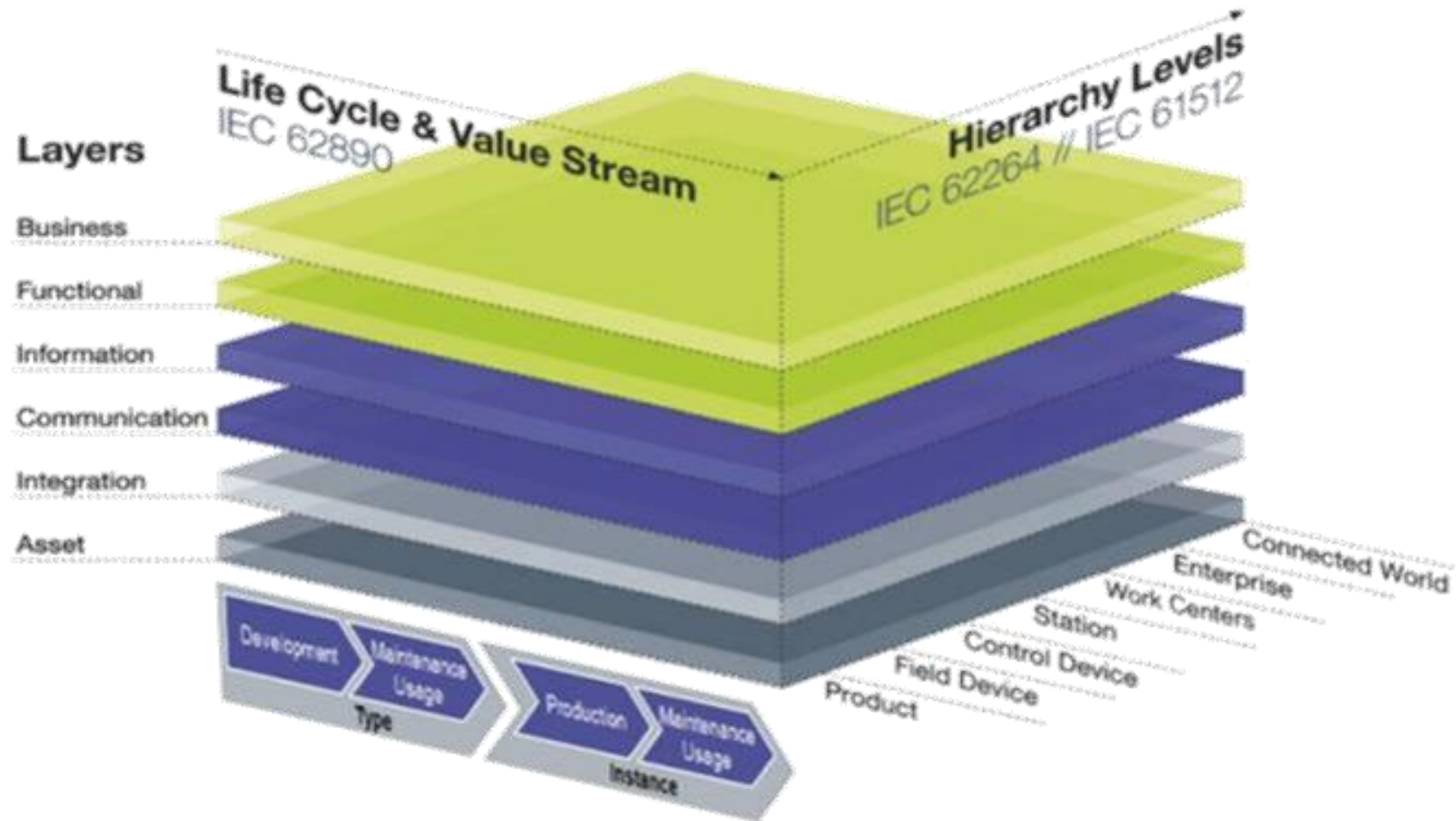
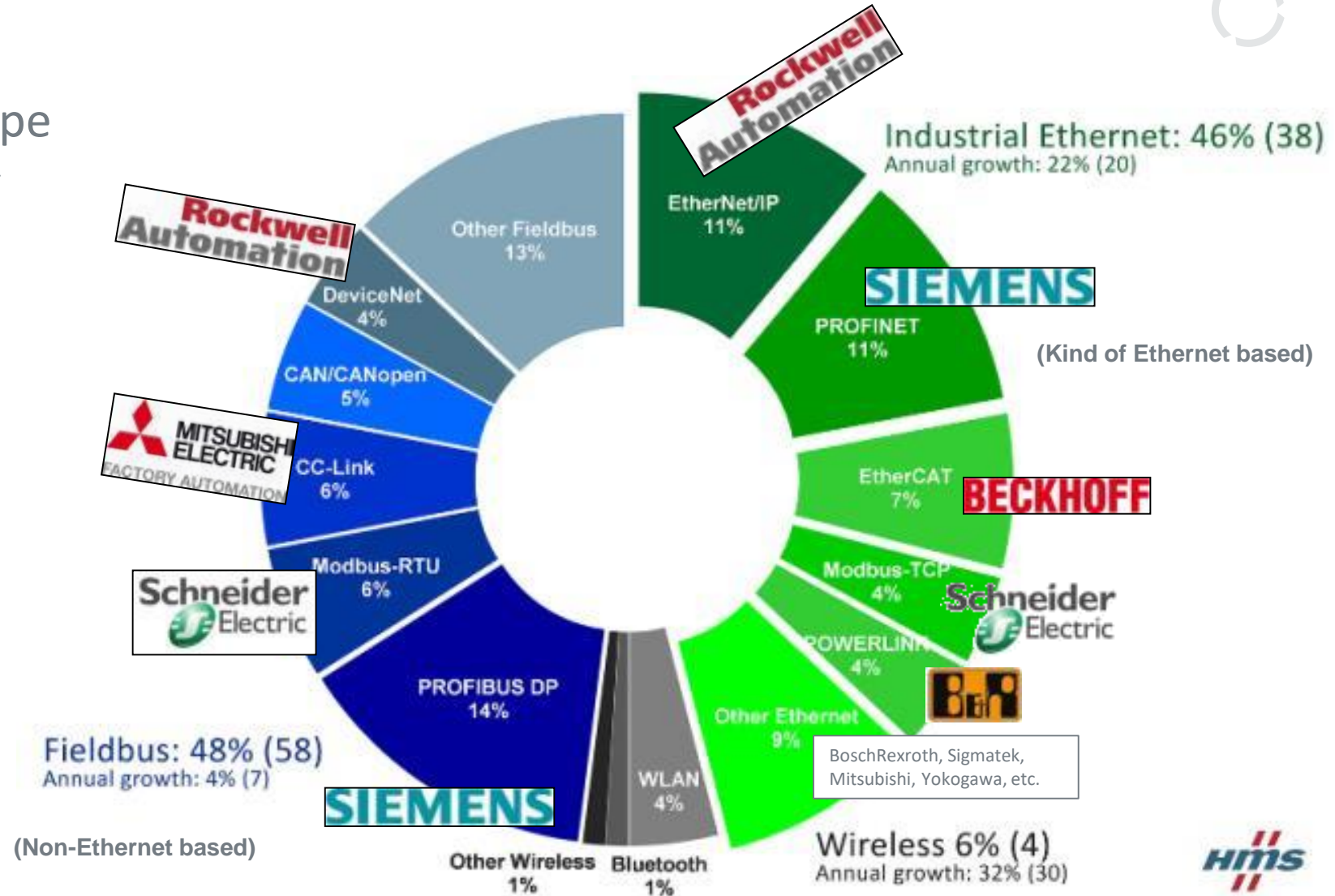# Relations between Platform Industry 4.0 / LNI 4.0 / Standardization Council
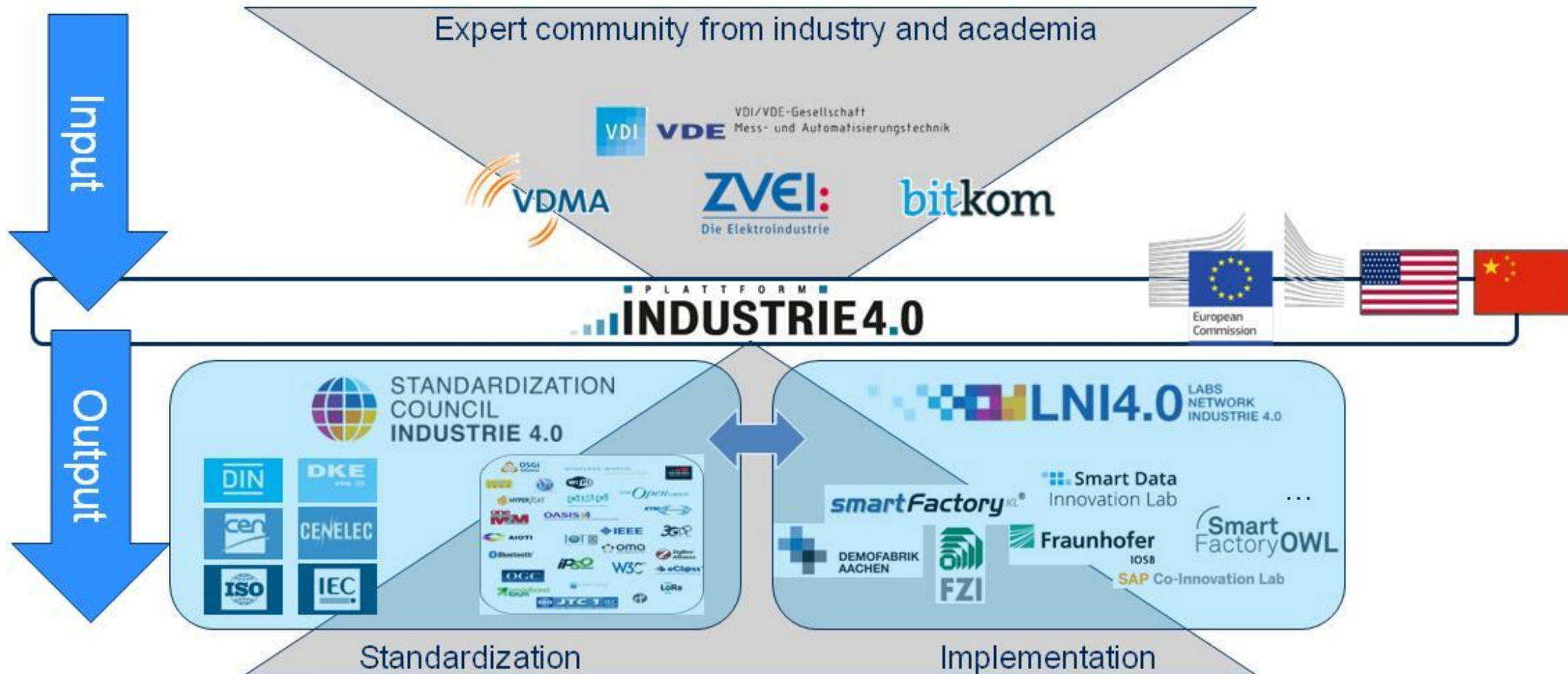
Reference Architecture Model Industry 4.0 (RAMI 4.0)

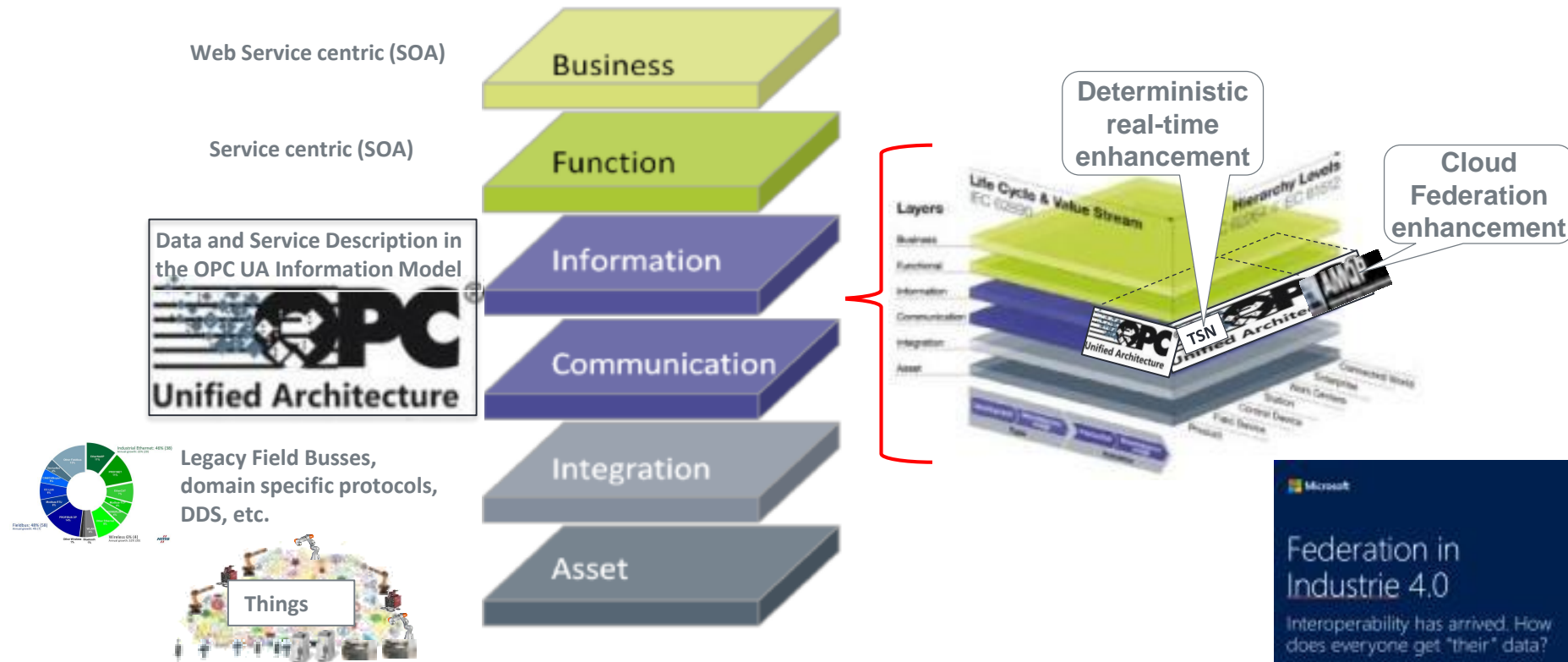# M2M Communication Landscape in Industrial Automation today

- IEC 61158 "standardizes" 19 different field buses
- Connectors, Cables, physical layer, other parts of the communication stack are different
- → No interoperability between different technologies ☹
- However: Interoperability is key to the success of Industry 4.0
  - Project components are put together on the plant floor by system integrators (not developers !)

- <u>Standard</u> Ethernet is missing!
  - Why? No deterministic real-time! (so far...)



Industrial Ethernet: 46% (38)
Annual growth: 22% (20)

(Kind of Ethernet based)

EtherNet/IP 11%
PROFINET 11%
EtherCAT 7%
Modbus-TCP 4%
POWERLINK 4%
Other Ethernet 9%

BoschRexroth, Sigmatek, Mitsubishi, Yokogawa, etc.

Wireless 6% (4)
Annual growth: 32% (30)

Other Fieldbus 13%
DeviceNet 4%
CAN/CANopen 5%
CC-Link 6%
Modbus-RTU 6%
PROFIBUS DP 14%
Other Wireless 1%
Bluetooth 1%
WLAN 4%

Fieldbus: 48% (58)
Annual growth: 4% (7)

(Non-Ethernet based)

Source: HMS

OPC UA in the RAMI4.0 (Reference Architecture Model Industry 4.0)

Web Service centric (SOA)

Service centric (SOA)

Data and Service Description in the OPC UA Information Model

Legacy Field Busses, domain specific protocols, DDS, etc.

Things

Business

Function

Information

Communication

Integration

Asset

Deterministic real-time enhancement

Cloud Federation enhancement

Federation in Industrie 4.0

Interoperability has arrived. How does everyone get "their" data?

Where does Time Sensitive Networking (TSN) come from and who else is using it?

- TSN is a working group within the IEEE 802.1 standardization group (Ethernet)
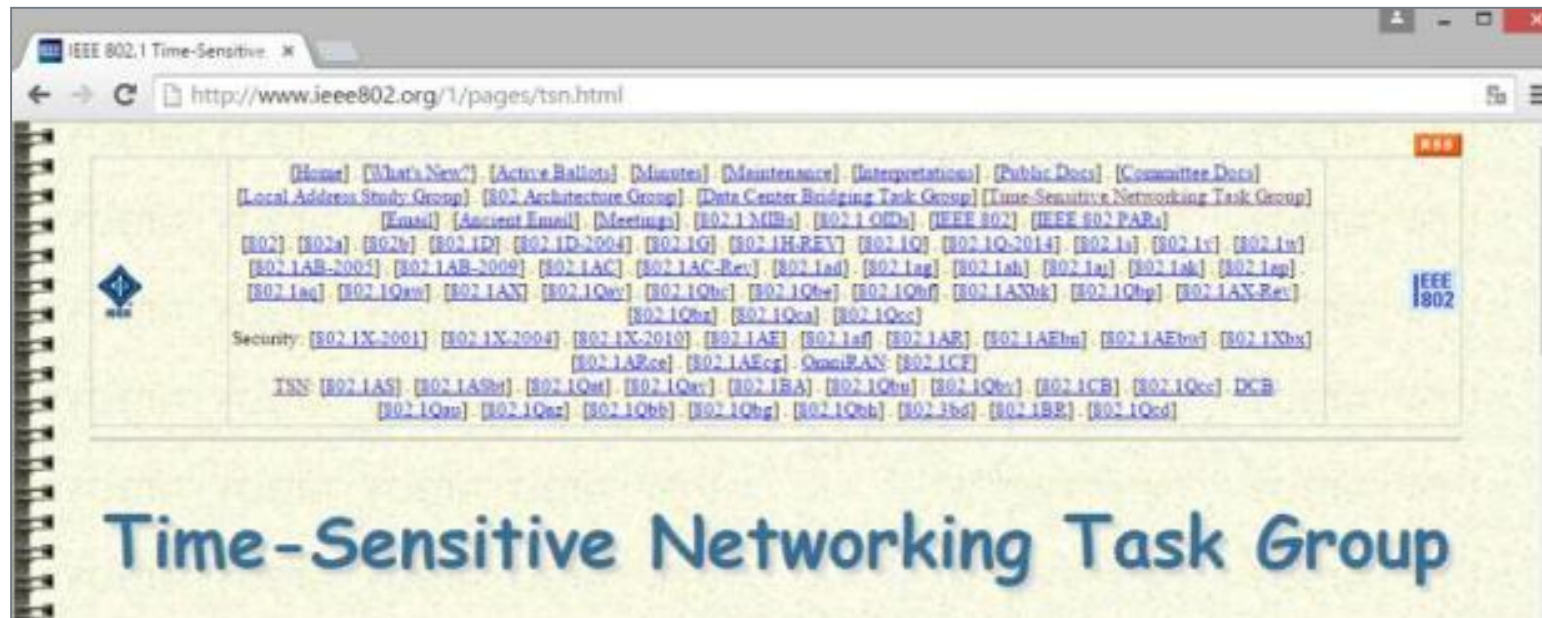
- TSN is the successor of AVB (Audio/Video-Bridging) and was renamed due its broader usage scope
- 1st Audio/Video, 2nd usage in cars, 3rd Industrial Automation

TSN activities around the world

- TSN Testbed in Austin, TX @NI within the Industrial Internet Consortium (IIC)
  - Clone in Erbach @ BoschRexroth

- OPC UA TSN Testbed @Fraunhofer ICGV in Augsburg (incl. Siemens)

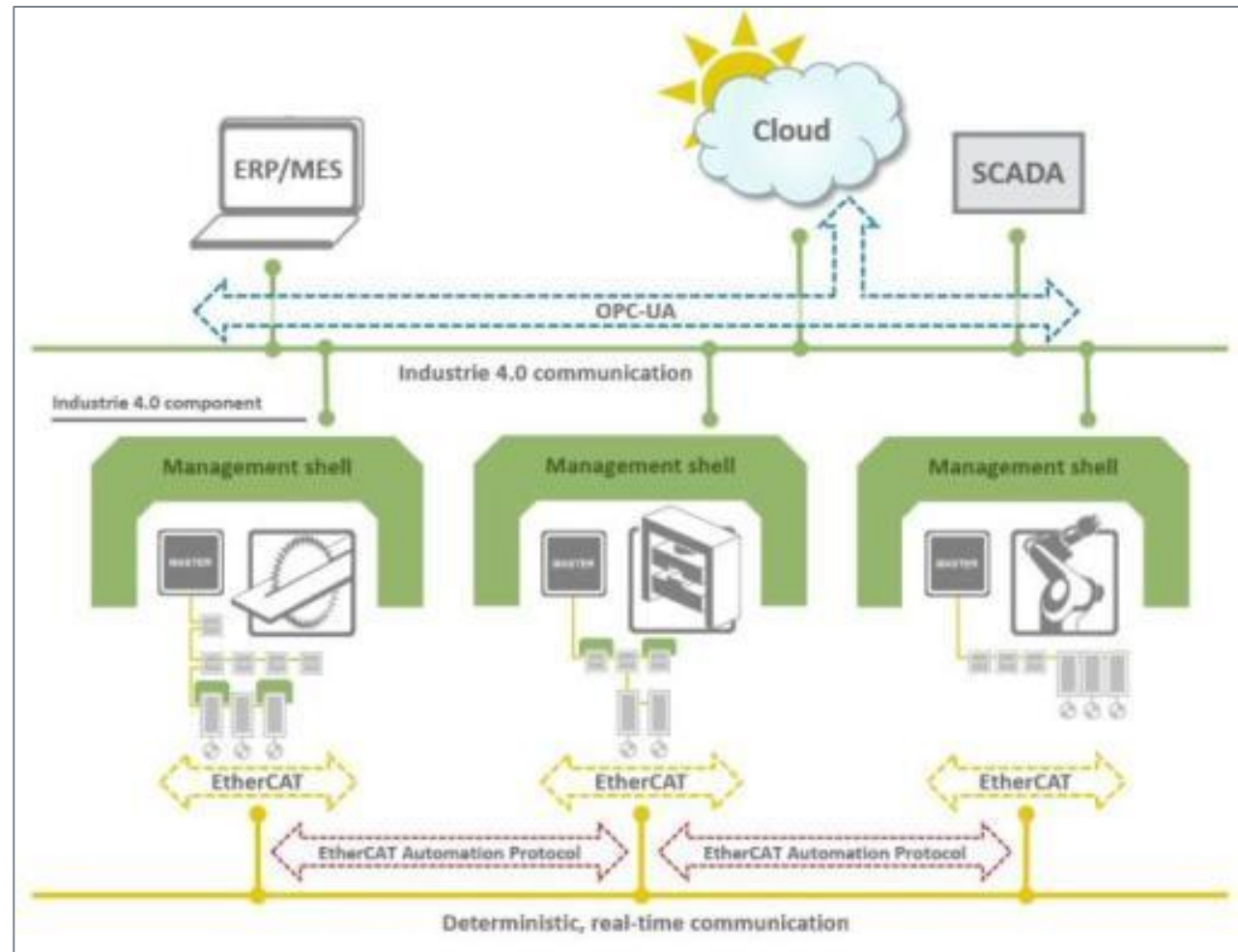- OPC TSN Shapers: Firmenkonsortium, welches sich zum Einsatz von OPC UA over TSN committet hat

The communication Stack which must go into each automation node

- TSN addresses only layer 2

- For full interoperability, all layers in all nodes must be the same

- Industry 4.0 platform WG1, ZVEI and VDMA officially recommend OPC UA as the higher layer protocol including the semantic service descriptions
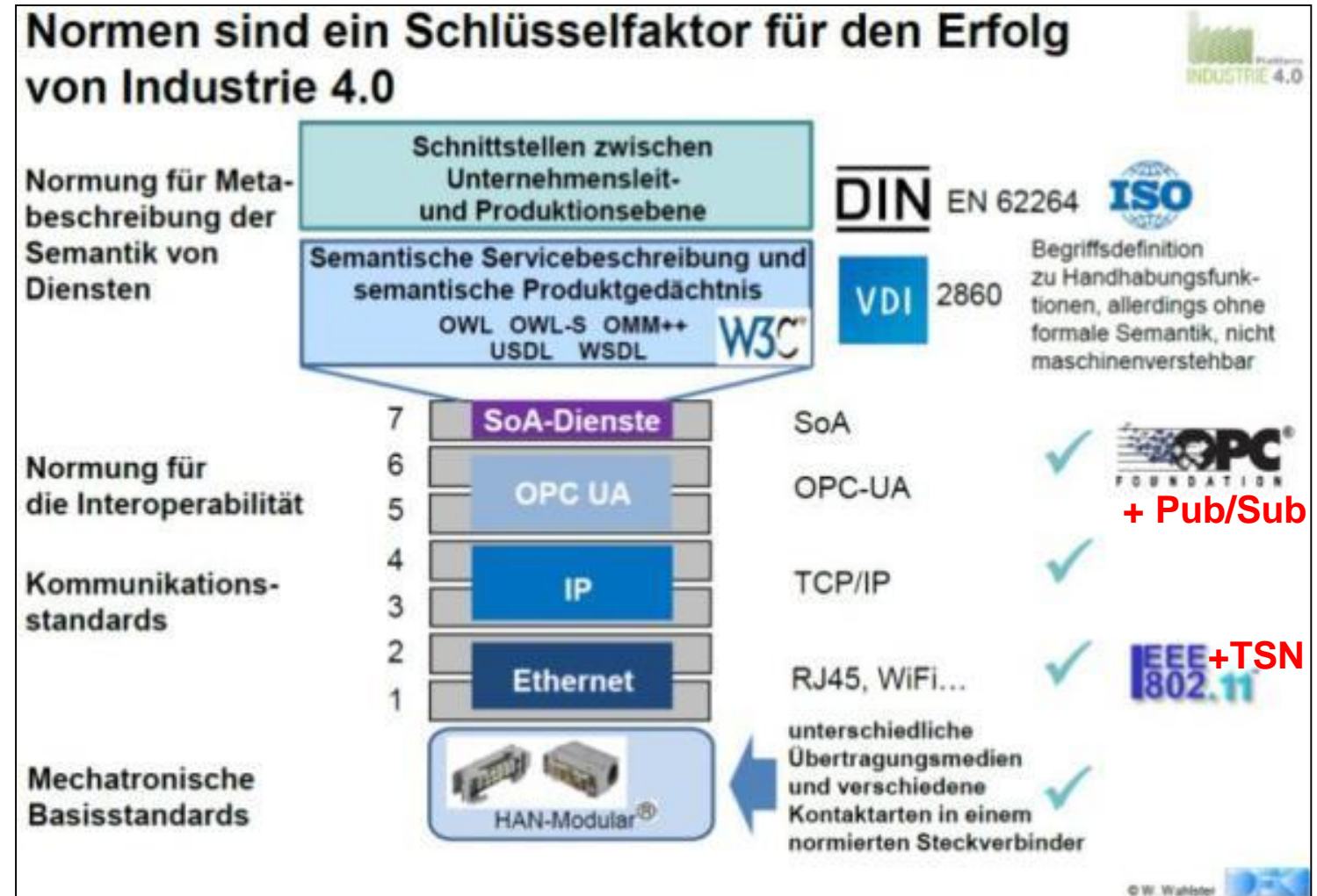
Typical Industry 4.0 architecture with OPC UA and field bus integration

(Source EtherCAT Technology Group)
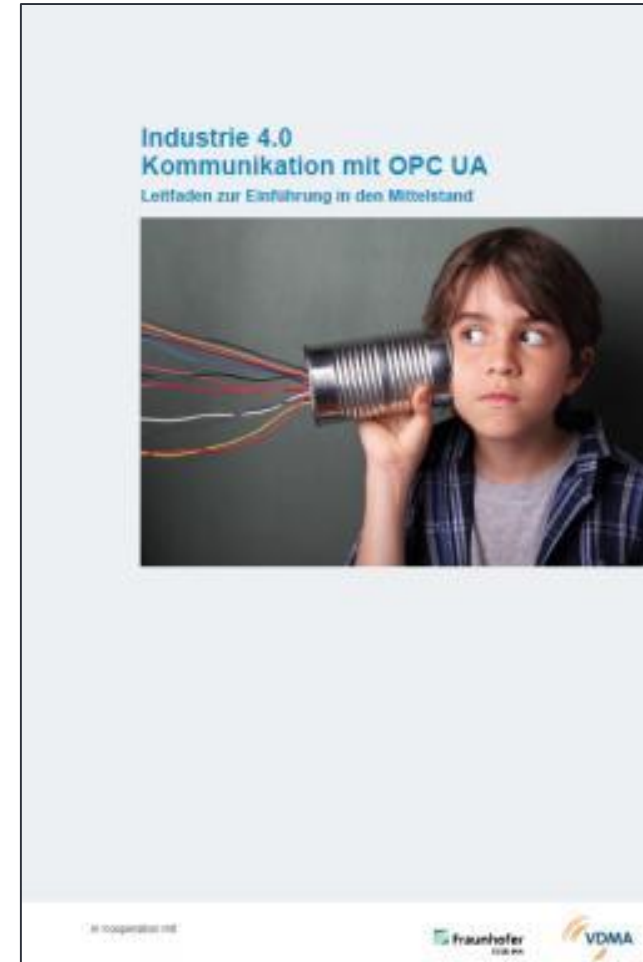
Legacy field buses on the integration layer are already building bridges to OPC UA

Industry 4.0 platform WG1, ZVEI and VDMA officially recommend OPC UA (only)

„Produkt online ansprechbar über TCP/UDP&IP mit mindestens dem Informationsmodell von OPC-UA"

https://www.zvei.org/fileadmin/user_upload/Presse_und_Medien/Publikationen/2016/November/Welche_Kriterien_muessen_Industrie-4.0-Produkte_erfuellen_/ZVEI-LF_Welche_Kriterien_muessen_I_4.0_Produkte_erfuellen_17.03.17.pdf

http://industrie40.vdma.org/documents/4214230/16617345/1492669959563_2017_Leitfaden_OPC_UA_LR.pdf/f4ddb36f-72b5-43fc-953a-ca24d2f50840

The German Engineering Association VDMA supports OPC UA as M2M Technology (only)

- Several Working Groups to develop OPC UA Companion Specifications for Machines and Devices already running under the roof of the VDMA

VDMA represents the broad manufacturer industry
VDMA has 3200 member companies

- Agricultural Machinery
- Air Conditioning and Ventilation
- Air Pollution Control
- Air-handling Technology
- Building Control and Management
- Cleaning Systems
- Compressors, Vompressed Air and Vacuum Technology
- Construction Equipment and Building Material Machines
- Drying Technology
- Electrical Automation
- Electronics, Micro and Nano Technologies
- Engine Systems for Power and Heat Generation
- Engines and Systems

- Fire Fighting Equipment
- Fluid Power
- Food Processing Machinery and Packaging Machinery
- Foundry Machinery
- Gas Welding
- Hydro Power
- Integrated Assembly Solutions
- Large Industrial Plant Manufacturing
- Lifts and Escalators
- Machine Tools and Manufacturing Systems
- Machine Vision
- Materials Handling and Intralogistics
- Measuring and Testing Technology

- Metallurgical Plants and Rolling Mills
- Metallurgy
- Micro Technologies
- Mining
- Plastics and Rubber Machinery
- Power Systems
- Power Transmission Engineering
- Precision Tools
- Printing and Paper Technology
- Process Plant and Equipment
- Productronic
- Pumps + Systems
- Refrigeration and Heat Pump Technology
- Robotics

- Robotics + Automation
- Security Systems
- Software
- Surface Treatment Technology
- Textile Care, Fabric and Leather Technology
- Textile Machinery
- Thermal Turbines and Power Plants
- Thermo Process Technology
- Valves
- Waste Treatment and Recycling
- Wind Energy
- Woodworking Machinery
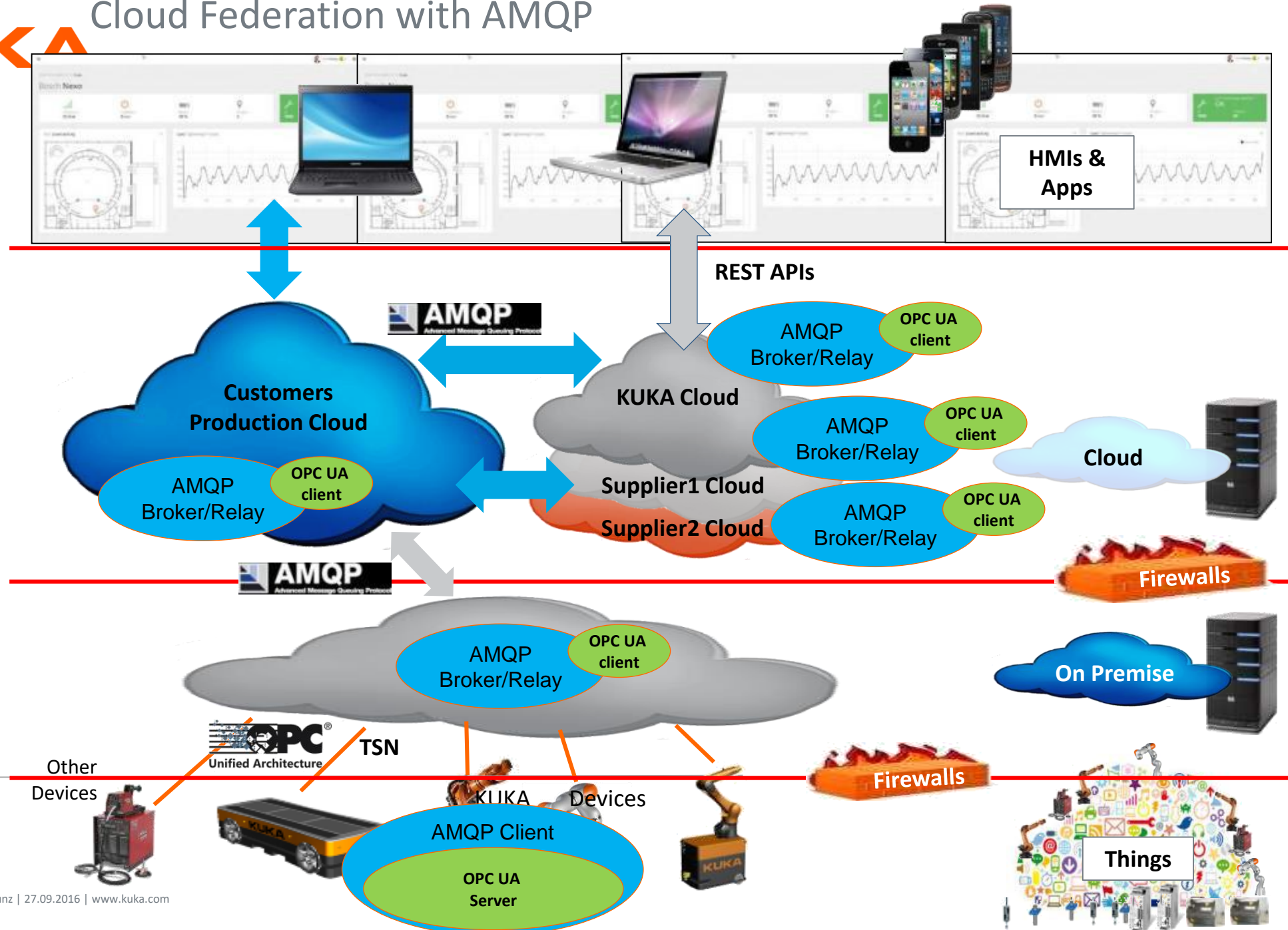
OPC UA CS under development

Awareness existent

VDMA | Dr. Christian Mosch

Seite 3 | 26.04.2017

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Thank you for your attention!

Backup: Outlook Technical Details

Cloud Federation with AMQP

Why Cloud Federation?

- Every automation device of the future must/will have a semantic service description (created in VDMA WGs)

- This precious <u>meta information</u> for data and services should also be kept on their way trough the firewalls/clouds (plural)

- If the device has a data point named "Motor2Temperature" we'd like to see the data of this data point in the cloud with exactly the same tag name, same for services…

- …without the need to manually configuring it in every cloud

- …without the need to configure its way through the clouds on every single hop

- ➜ The meta information sourcing in the OPC UA information model must be kept all along its way through the clouds

- Standard OPC UA cannot be transported through firewalls (Port # 4840), SOAP is outdated

- Client "above" initially must contact the servers "down" in the things ➜ "wrong" direction

- It takes a transport protocol which turns the initial direction around and can be used through firewalls, in the internet and between clouds

- Message Broker protocols like MQTT or AMQP can do this
  - Communication initialization is done from the things or the edge to the broker "above" ("outbound")
  - typically used for firewall/cloud, cloud/cloud communication

- Cloud "Routing" is needed for Cloud-to-Cloud communication ➜ "Cloud Federation"

Cloud Federation: Why AMQP and not MQTT?

- AMQP defines in the standard, how to add <u>meta information</u> to the data/services, MQTT does not

- MQTT just transports unstructured binary Byte packets

- Sender and receiver explicitly must know the semantic of the information

- JSON messages etc. could be added to the MQTT binary block "somehow", but this is not standardized

- The standardization how to transport of OPC UA over AMQP is already work in progress in a OPC Foundation working group

  - Finalization expected for May 2017

  - For MQTT this also <u>could</u> be done, but nobody is working on it yet

- Political: MQTT was developed and still is driven by IBM, AQMP was developed and still is driven by a consortia (similar to OPC UA and TSN)

- There are two possible ways to use AMQP as a transport layer for OPC UA

1. Simple Publish/Subscribe Pattern

  - What to publish must be configured somewhere else :-(

  - No discovery from Client to Server possible :-(

  - No subscription from the client on single data points possible :-(

  - Services not defined (yet?) via Pub/Sub :-(

2. Standard Client/Server Pattern

  - The whole OPC UA functionality also is possible through the cloud :-)

  - OPC UA Server in the devices, OPC UA clients in the clouds :-)

- See also this White Paper "A Comparison of AMQP and MQTT"
  https://lists.oasis-open.org/archives/amqp/201202/msg00086/StormMQ_WhitePaper_-_A_Comparison_of_AMQP_and_MQTT.pdf