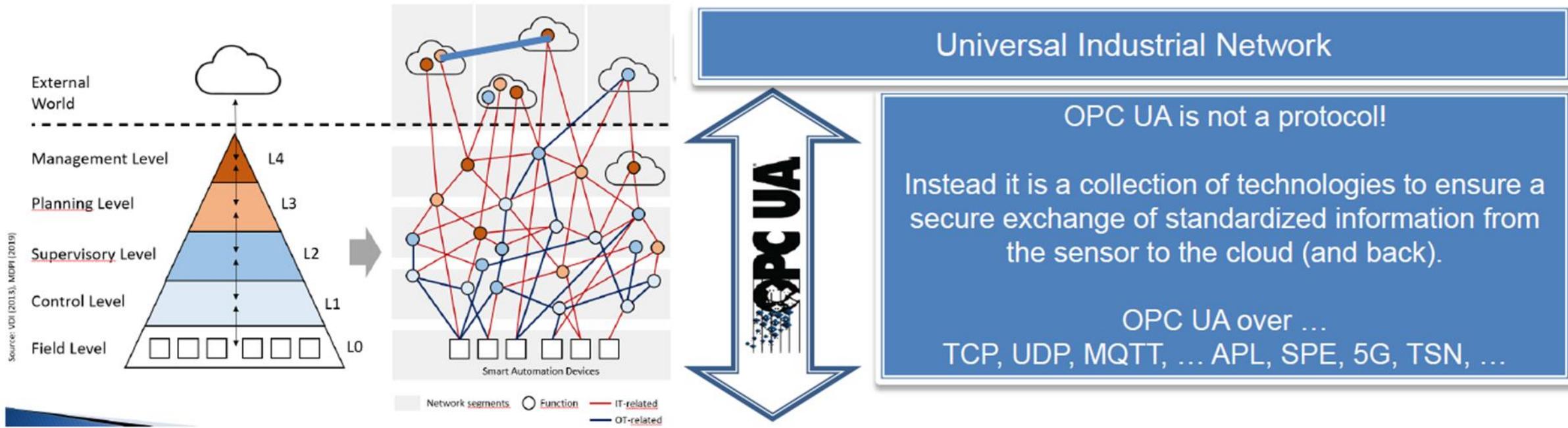


# OPC UA – Overview

Rainer Schiekofer

# From Automation Pyramid to Information Network



- Challenge to transformation from an Automation Pyramid (with proprietary protocols between all layers) to an Information Network (providing standardized information exchanged secured end-to-end and be able to bypass layers)
- OPC UA is an open framework delivering end-to-end secured, standardized information exchange  
Openness is key: Open Specs, Open source (GitHub) and Open Labs for certification (without being a paying member)
- OPCF defines with 63+ partners standardized information models for various like pumps, motors, robots, coffee machines,
- OPC Foundation is the „Collaboration Organization“

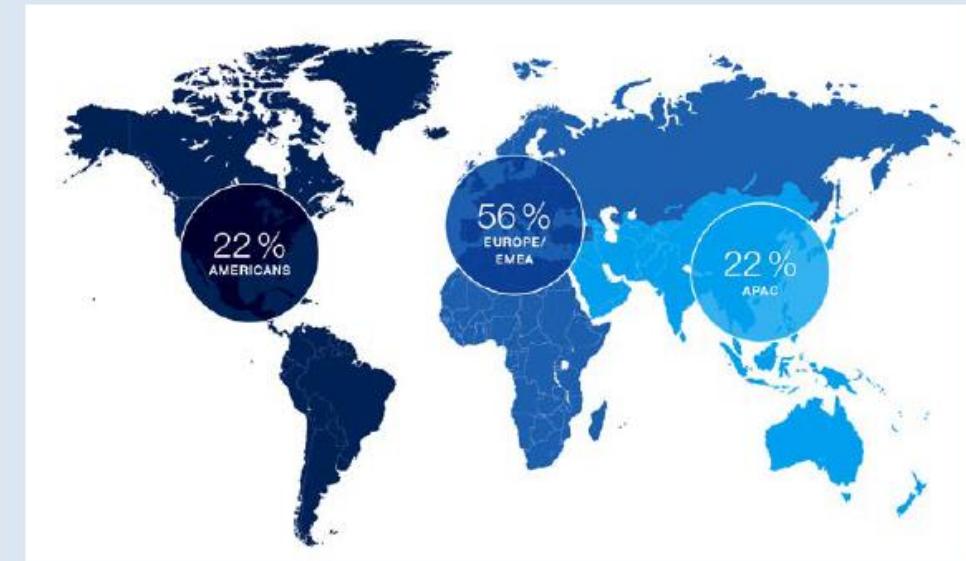
# OPC Foundation <https://opcfoundation.org>

- ▶ Vision
  - Secure & reliable
  - Vendor, platform, and domain agnostic
  - interoperability from sensor to enterprise and beyond
- ▶ Global Profile
  - Non-profit organization (founded 1995)
  - Companies from Automation & IT
  - Internationally recognized: OPC UA is IEC62541
- ▶ Deliverables
  - Specifications: openly available
  - Tools and code examples: open source for faster, easier adoption (AnsiC/C++, C# .NET Standard, Java)
  - Certification: OPC Labs open to everyone
  - Marketing: Evangelize solution in various markets
- ▶ Ecosystem with toolkits and education
- ▶ Modern IPR policy



## Organizational Overview

**Membership:** 820 (Status: June 8<sup>th</sup>, 2021)



## Board of Directors (elected for 2021/2022)

Microsoft	Honeywell	Rockwell
SAP	Yokogawa	Schneider
Siemens	Mitsubishi	ABB
Beckhoff	Ascolab	Emerson

# OPC Foundation: Why to joint as member?



**Volkswagen**

“Being a member of the OPC Foundation guarantees early information to upcoming key technologies like the OPC UA Companion specifications which provide secured and standardized information and interfaces for assets.”

Michael Schweiger, Volkswagen

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## OPC Foundation: Largest Eco System for „Secured Industrial Interoperability“

Hyperscale / IT Amazon Web Services (AWS), Google Cloud, Microsoft Azure / SAP

Chipset Intel, Microchip, NXP, Qualcomm, ...

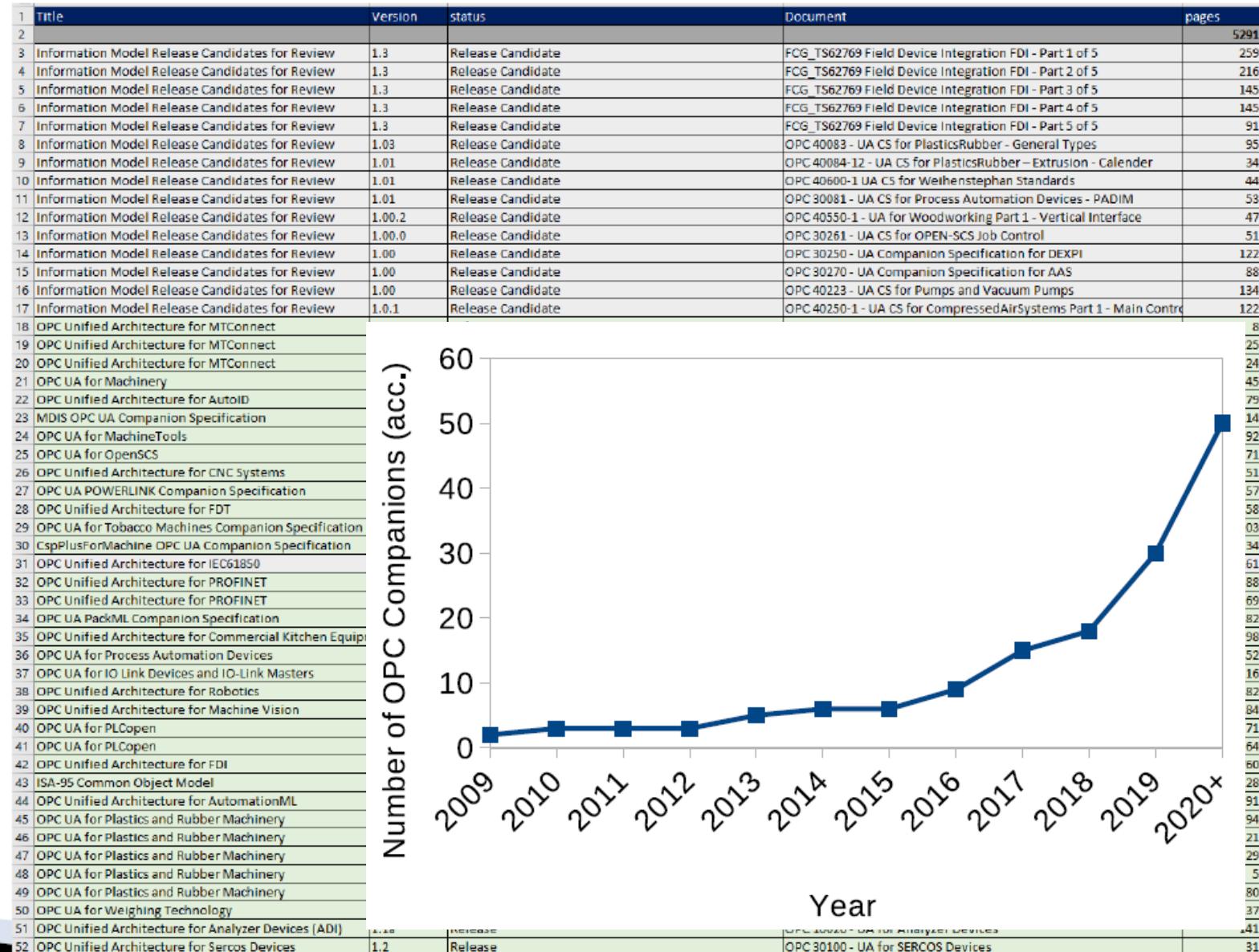
Vendors Mostly all are OPC members: 80% world-wide revenue of Top 50 Automation vendors

End Users equinor, Foxconn (FII), L'Oréal, Miele, Pfizer, Samsung, Volkswagen, ...

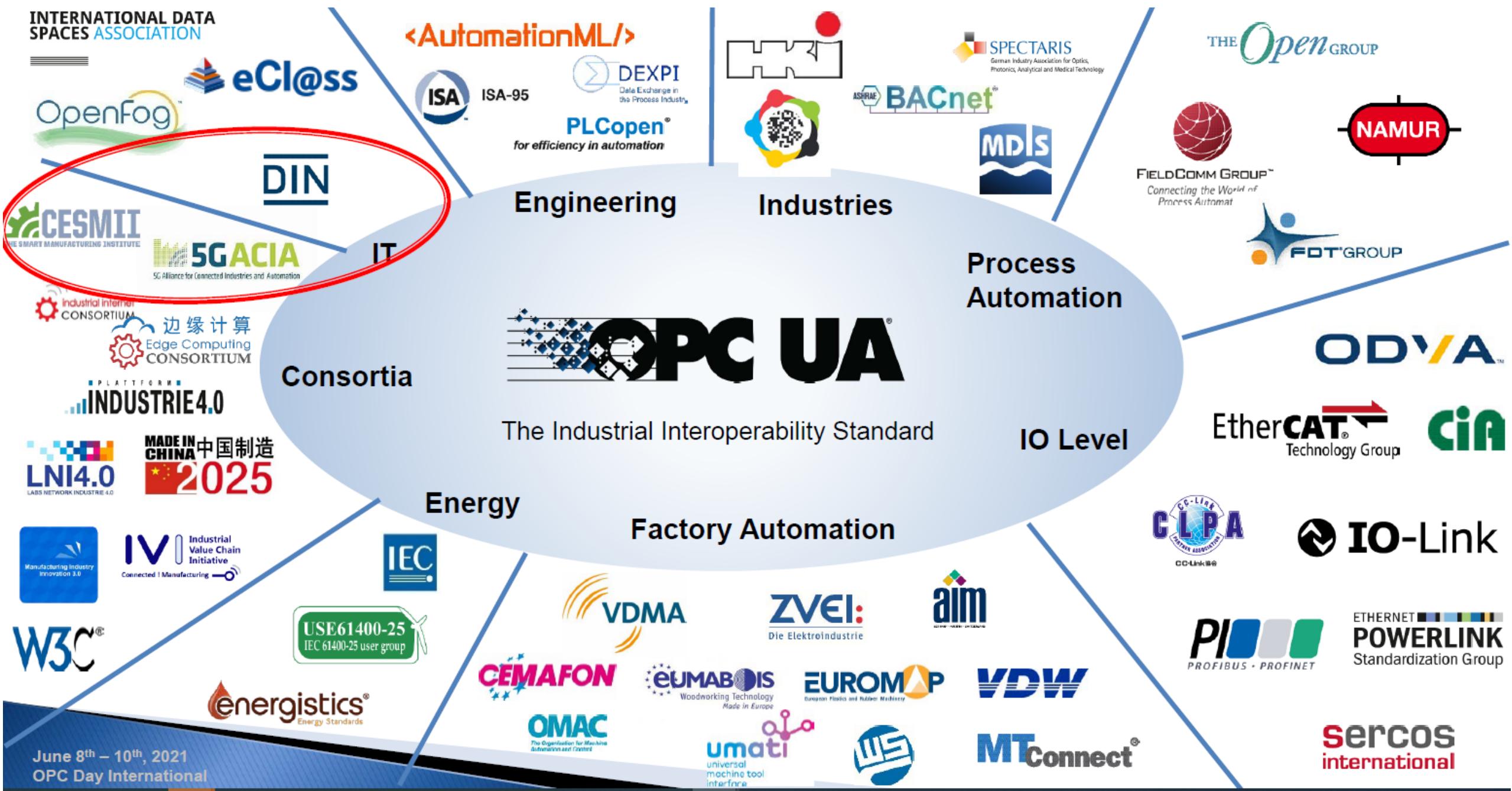
# OPC Foundation: News on Collaborations

The screenshot shows the OPC Foundation's website navigation bar. The main menu items are 'Resources', 'News & Events', 'Material', 'Multimedia', 'Wiki', 'Security', 'Specifications', and 'Samples and Tools'. Under 'Samples and Tools', the 'OPC UA Information Models' link is highlighted with a red box.

- ▶ 63 Companion Specs (CS) in total
- ▶ 48 CS published (5291 pages)
  - 33 CS Released
  - 15 CS Release Candidate



Overview and details : <https://opcfoundation.org/markets-collaboration/>



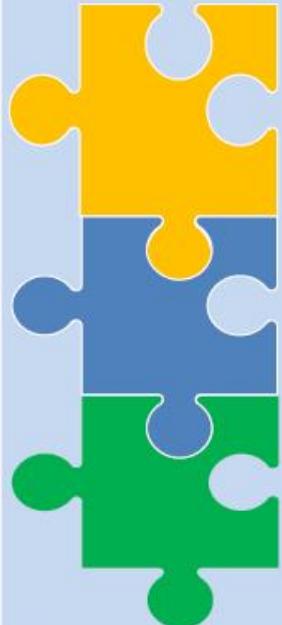
# OPC UA down to field for Process Automation - Combine strength



## OPC UA Framework:

- Information Models
- Semantic
- Security
- IT Connectivity

## Solution Approach



### Semantics

- Global Machine Language
- PA-DIM, NOA, MTP, FDI, FDT
- PRODML, WITSML, ...

### O-PAS Framework

### OPC UA FX extensions

### OPC UA

### Ethernet + APL

IEEE 802.1, 802.3



FIELDCOMM GROUP  
Connecting the World of Process Automation

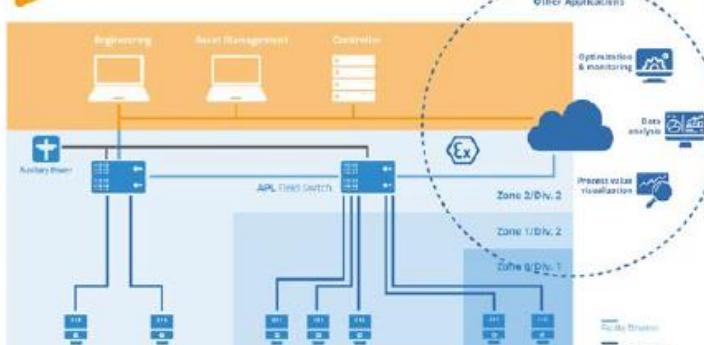


Collaboration: 60+ joint working groups

OPCF joined Ethernet APL group



Source: Ethernet APL White Paper



<https://www.ethernet-apl.org>

## World largest OPC UA Eco-System:

800+ Companies including the OPCF FLC Initiative

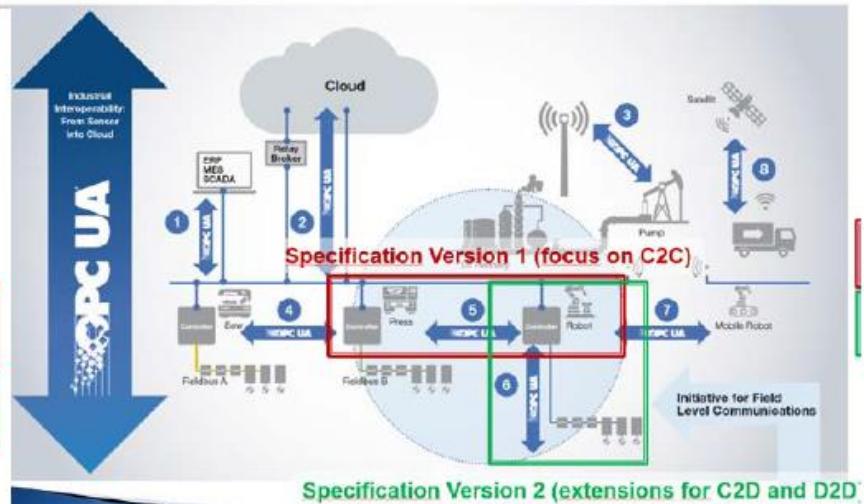
Largest Eco System for Industrial Interoperability



# OPC UA FX specifications: Extensions for harmonized process and factory automation



- 1 IT / OT Communication
- 2 Cloud Integration
- 3 Secure Remote Access
- 4 Local OT Communication
- 5 Controller to Controller
- 6 Controller to Field Device
- 7 Wireless Integration (5G)
- 8 Future Ready



## OPCF FLC Initiative (Started Nov 2018)

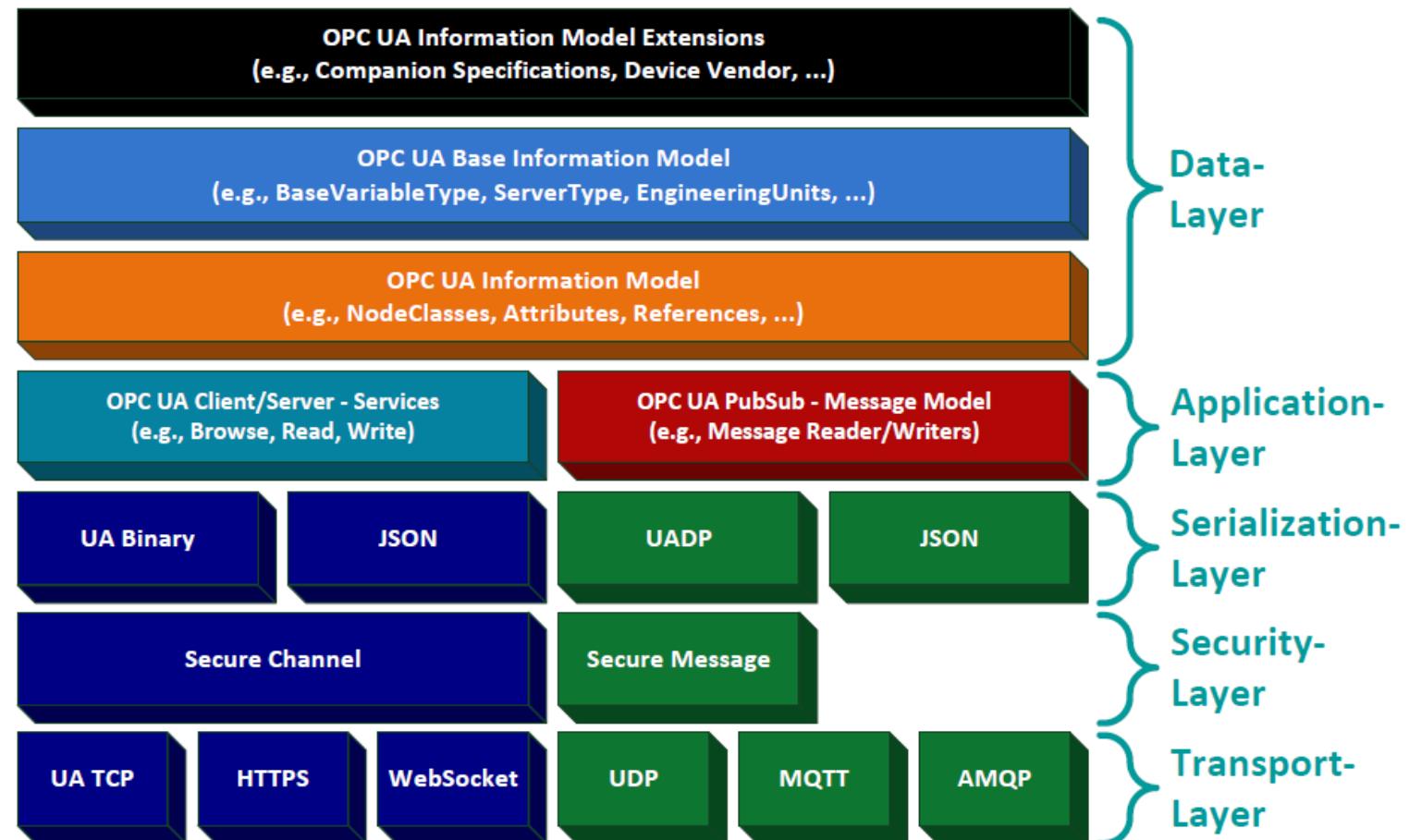
- Extra support from 27 leading automation companies & technology providers
- Overall, more than 300 technical experts from more than 60 member companies of the OPC Foundation are active in the different Technical Working Groups.

## OPC UA FX Specification extensions:

- Spec numbers „OPC 10000-080“ -81, -82, ...
- Extending OPC UA down to field level
- Extending Deterministic, Safety, Motion
- Including additional IT infrastructure like TSN and APL
- Offline / Online configuration
- Information models for interactions
  - Controller to Controller
  - Controller to Device
  - Device to Device
- and much more

First live demo at SPS in November 2021

OPC UA has a common data-layer and two communication patterns (Client/Server & PubSub)

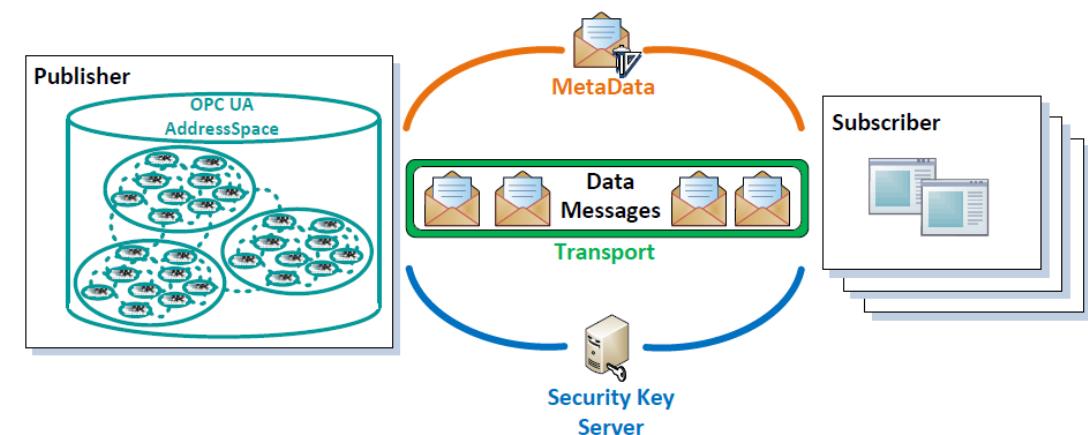


**OPC UA has a common data-layer and two communication patterns (Client/Server & PubSub)**

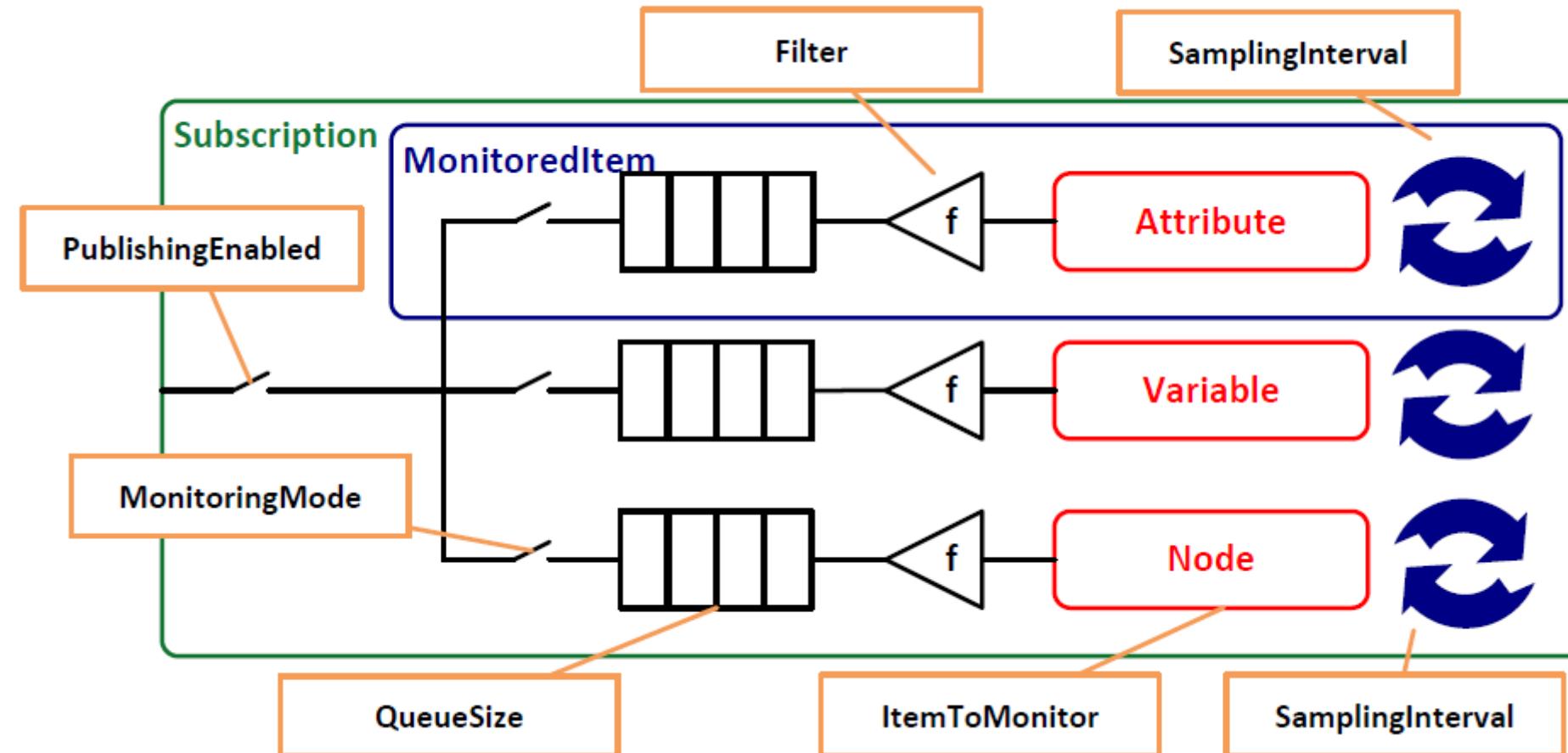
## Client/Server

Service Set	Description
Discovery	Offers services to find servers and the corresponding endpoints.
SecureChannel	Is used to establish secure connections between server and clients.
Session	Contains all services which are related to sessions (e.g., authentication).
NodeManagement	Includes services to alter the graph-based information model.
View	Offers services to explore the information model..
Query	Introduces a OPC UA query language and the necessary services to execute queries against OPC UA information model.
Attribute	Can be used to read and write <i>Attributes</i> .
Method	Exposes the <i>Call</i> service which is used to invoke OPC UA <i>Methods</i> .
MonitoredItem	Contains services for creation and modification of <i>MonitoredItems</i> , which can be used in combination with the <i>Subscription Service Set</i> to monitor, for example, sensor values for changes.
Subscription	Is used in combination with the <i>MonitoredItems</i> to create notifications for events and value changes.

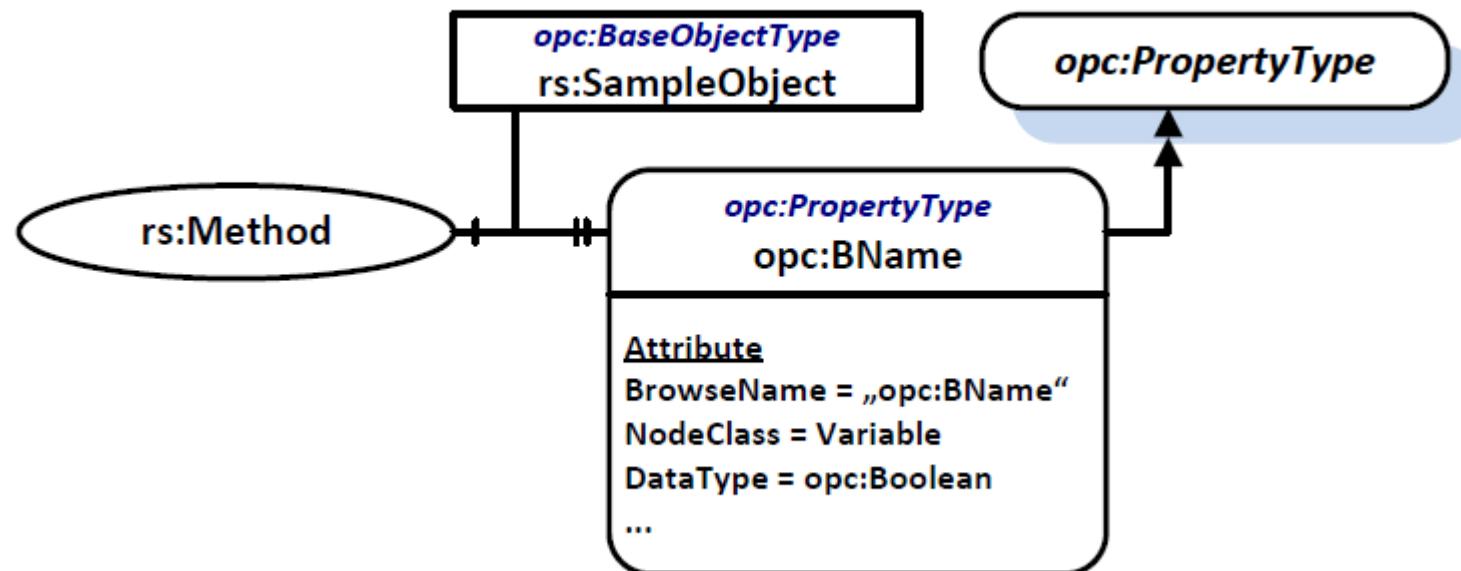
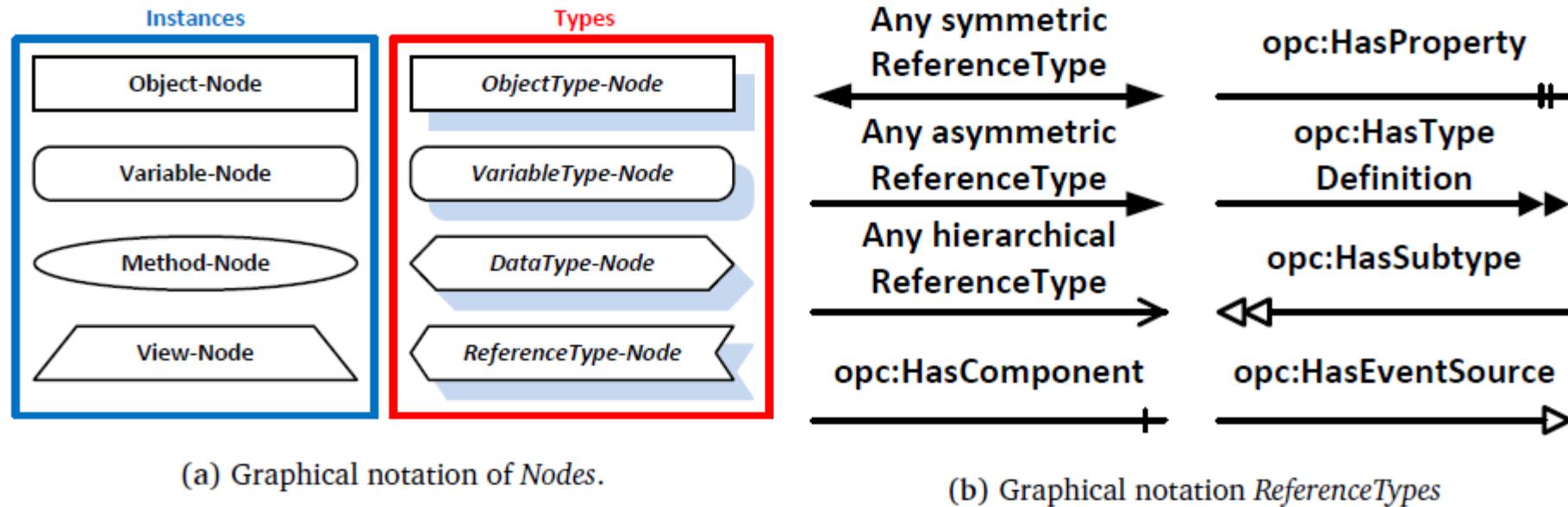
## PubSub



OPC UA offers a lot of features around notifications for value changes



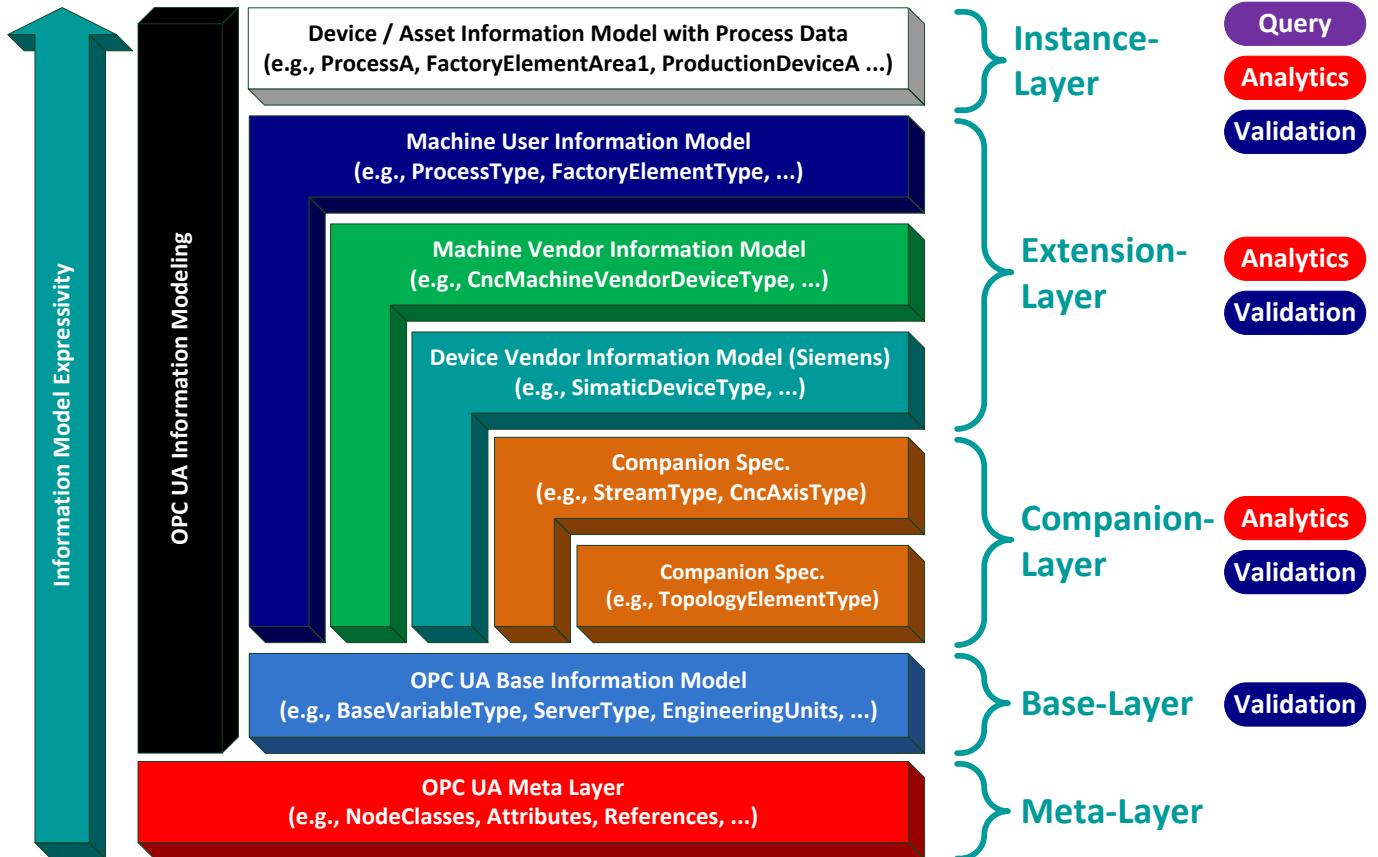
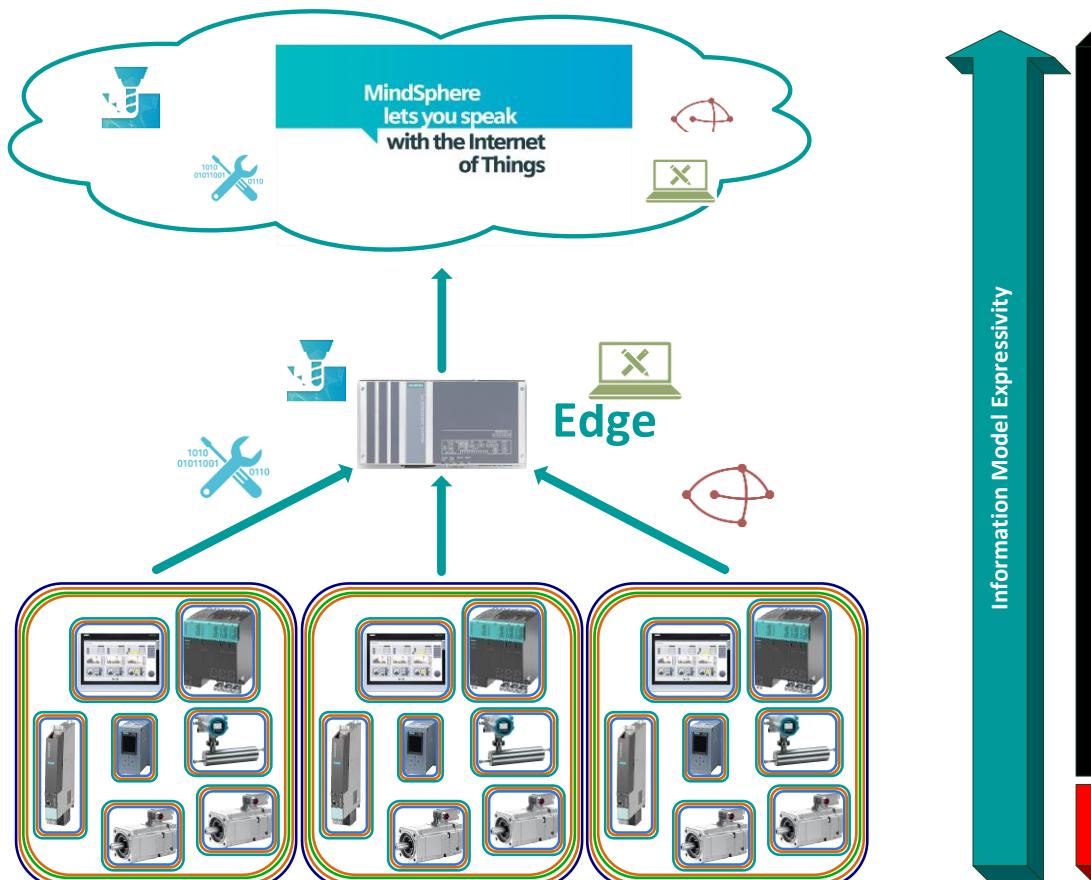
# OPC UA – Information models



# OPC UA – Overview information model stack

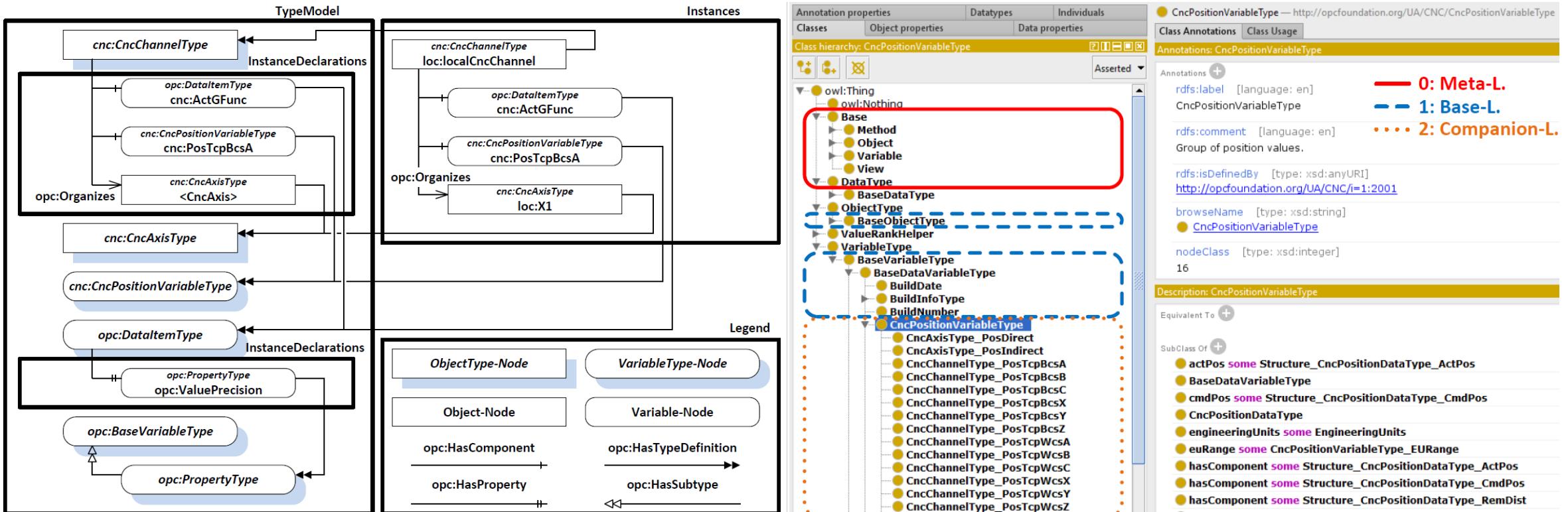


OPC UA information models can be categorized in several layers, which import each other<sup>1)</sup>



<sup>1)</sup> R. Schiekofer, S. Grimm, M. M. Brandt, and M. Weyrich, „A formal mapping between OPC UA and the Semantic Web“, IEEE INDIN’19

Each OPC UA concept must be transformed to the corresponding OWL concept<sup>1)</sup>



<sup>1)</sup> R. Schiekofer, S. Grimm, M. M. Brandt, and M. Weyrich, „A formal mapping between OPC UA and the Semantic Web“, IEEE INDIN’19

# OPC UA – Process for creating Companion Specifications



Group of Domain  
Experts



Domain-specific  
Interfaces

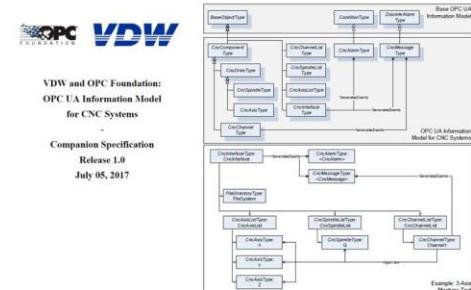
define

mapped to



OPC UA Modelling  
Know-How

used for



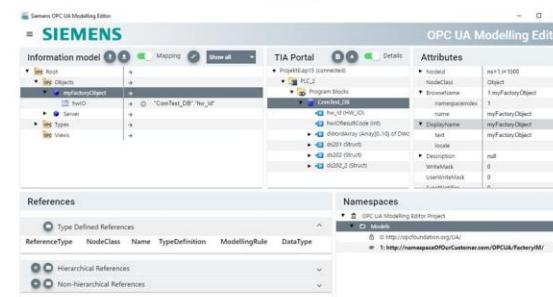
OPC UA Companion  
Specification

modelled  
with



Companion Specification  
OPC UA NodeSet File

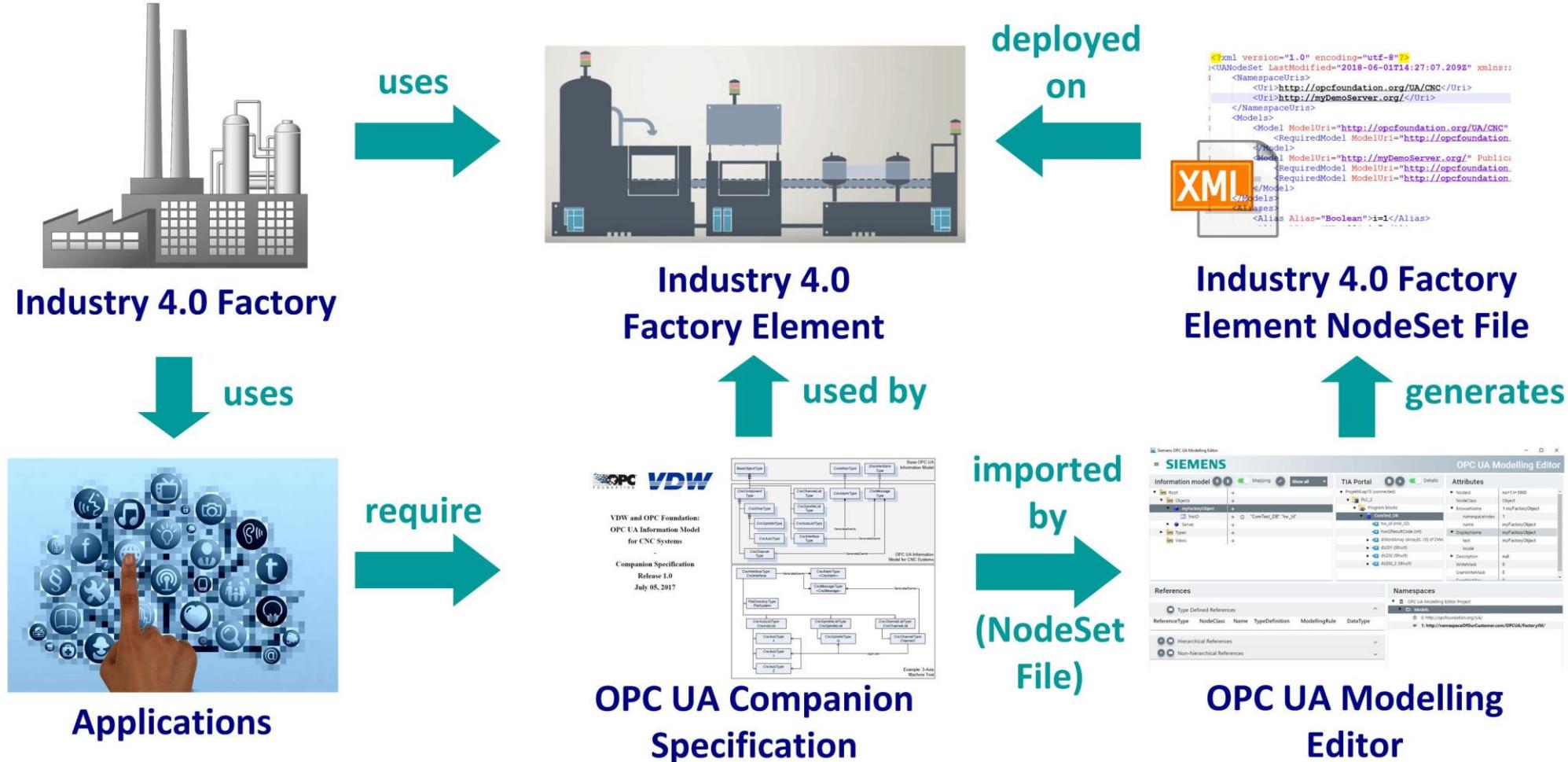
generates



OPC UA Modelling  
Editor

# OPC UA – Process for using Companion Specifications

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# Liaison & Plans

- W3C and OPCF already have a liaison
- Start to actively work together how TDs should be designed when it comes to describe OPC UA endpoints to integrate them for the promoted Web paradigms
- Common work items would be:
  - define a standardized way how Thing Description can be created from nodeset file (and vice versa) including the semantics if provided
  - define how the OPC UA specific endpoints can be described in TDs
  - define the (public) security metadata in TDs

→ Planning to setup a new OPC UA Companion Standard for OPC UA Binding



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News » OPC Foundation News » W3C and OPCF to integrate OPC-UA into the Web of Things

## W3C and OPCF to integrate OPC-UA into the Web of Things

05/09/2016

2016 | April – At the Hannover Fair, Thomas J. Burke, President and Executive Director of the OPC Foundation and Dave Raggett, W3C lead for the Web of Things signed a Memorandum of Understanding in which both organizations agree to closely cooperate to ensure interoperability for the Internet of Things (IoT).

OPC and W3C have mutual goals, requirements and use cases developing an infrastructure to promote and facilitate across domain applications for open markets for horizontal integration along the value chain and supply chain, and vertical integration from manufacturing cells to enterprise management systems. These integration opportunities are the infrastructure necessary for IoT.

This unique collaboration between the OPC Foundation and W3C provides a complete solution as the essence of IoT connectivity horizontally and vertically across a multitude of domains. The collaboration provides the infrastructure for the Industrie 4.0 reference architecture facilitating the vision and execution of a "Smart Factory".

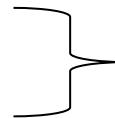
Read more [here](#)

<https://opcfoundation.org/news/opc-foundation-news/w3c-and-opcf-to-integrate-opc-ua-into-the-web-of-things/>

```
{  
  "@context": [ "https://www.w3.org/2019/wot/td/v1",  
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    {"schema": "http://schema.org/" } ],  
  
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  "title": "1:CNC-Drive-1",  
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        }  
      },  
      {  
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        "response": {  
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        }  
      }  
    }  
  }  
}
```

UA Context

Metadata for UA Security mode (e.g., sign&encrypted), security policies (e.g., Basic128Rsa15), and authentication modes (e.g., Certificate)



Metadata for UA Communication, e.g.,

- Addressing scheme and URL pattern
- Content types, e.g., for UA binary and XML
- Local security setup
- Custom UA Options

# Web of Things as Bridging Technology: A *Win-Win* Situation for OPC-UA and Web

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OPC UA

World Wide Web

Industry specific  
semantics

Rich tool  
landscape

Industry  
Expertise

OPC UA  
Developers

OPC UA IM +  
Companions

Web  
Technologies

Web  
Developer

Interoperability,  
Usability



Professional Industrial Engineering

Unrestricted © Siemens 2021

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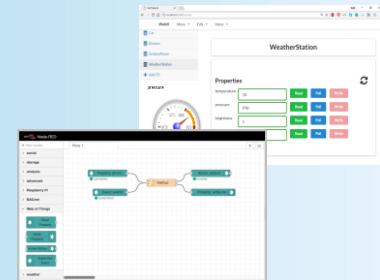
2021-01-21



Web of Things



<https://opcfoundation.org/news/opc-foundation-news/w3c-and-opcf-to-integrate-opc-ua-into-the-web-of-things/>



Web Tooling (rapid app dev, UI, AI,...) &  
Semantic Web (validation, querying,...)

Rainer Schiekofer / DI FA TI ART STD

**Thank you for your attention! Questions?**

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