

**ETFA 2020**

# **Real-time OPC UA over TSN applications for next generation machine- & factory automation**

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# Agenda

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- OPC UA
- TSN
- Use Cases
- OPC Foundation initiative for Field Level Communication
- OPC UA over TSN@ B&R
- Conclusion
- Q&A



# OPC UA

The standard for industrial  
interoperability

# Value creation through semantic information



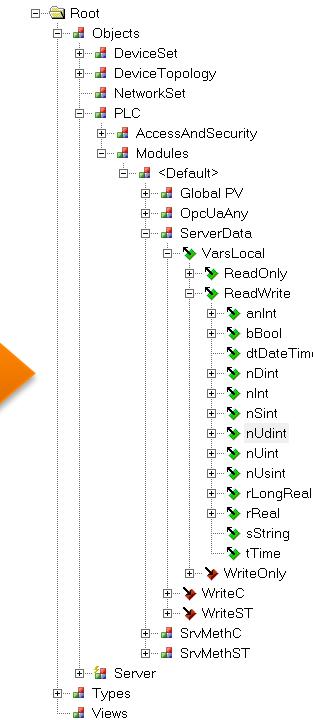
## Data

only machine readable

## Information human readable

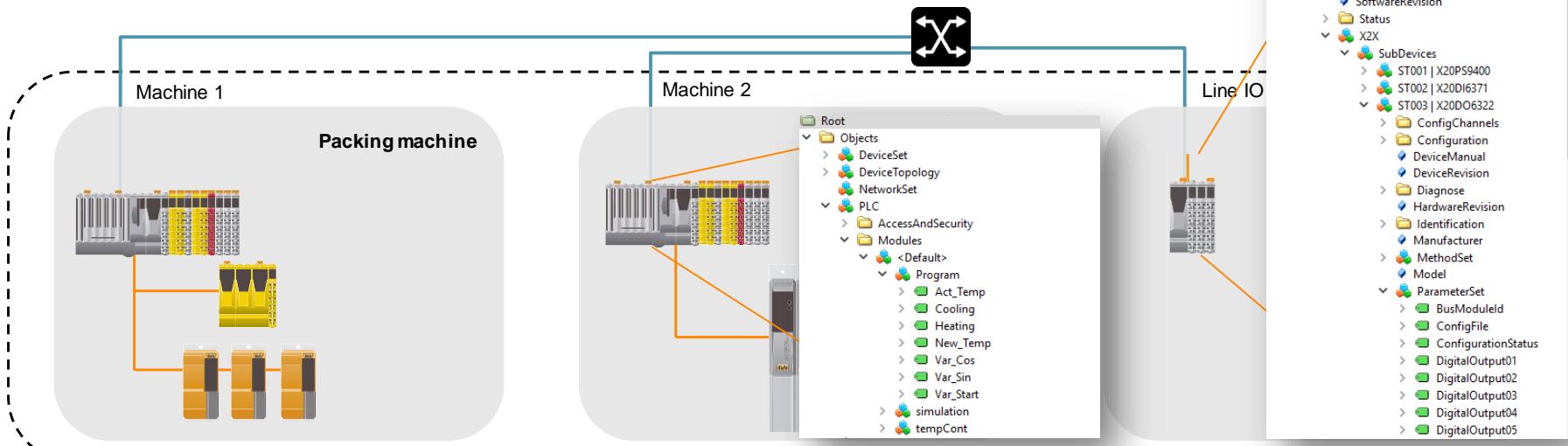
Nominal value speed axis 1  
Nominal value speed axis 2  
Nominal value speed axis 3  
ACTUAL value Speed axis 1  
ACTUAL value Speed axis 2  
ACTUAL value Speed axis 3  
Asset status  
Status axis 1  
Status axis 2  
Status axis 3  
Temperature axis 1  
Temperature axis 2  
Temperature axis 3  
Status door switch 1  
Status door switch 2  
Status door switch 3  
Limit switch 1  
Limit switch 2

# Semantic Information (OPC UA Information Model) Human + machine interpretable



# Information Model

- ...is a standardized structure for information of assets
  - Variables, functions (methods), events
- ...used for description of assets
- ...accessed online and offline
  - representation in the network (browsing the information model)
  - Importing and manipulation via NODESET-file

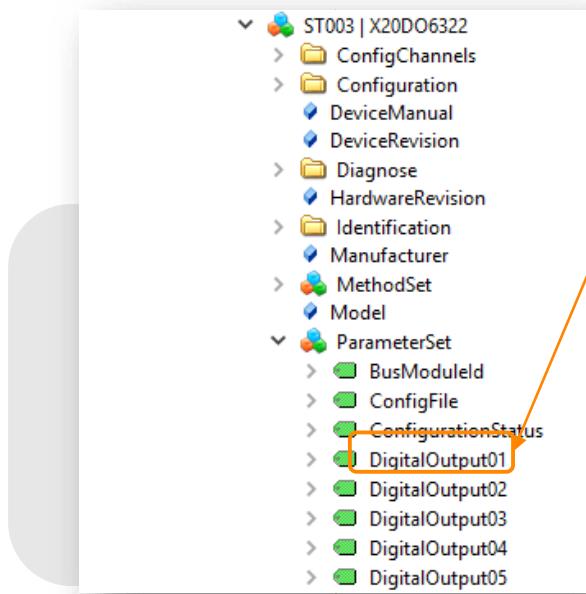


# Information Model – Node Description

1. Provides detailed information for each node

2. Included semantics:

- Description
- DataType
- Timestamp
- UserAccessLevel
- Samplingintervall



Attribute	Value
NodeID	NodeID
NamespaceIndex	2
IdentifierType	Numeric
Identifier	212992
NodeClass	Variable
BrowseName	2, "DigitalOutput01"
DisplayName	"", "DigitalOutput01"
Description	"", "24 VDC / 0.5 A"
WriteMask	0
UserWriteMask	0
Value	
SourceTimestamp	03.01.2017 02:50:31.031
SourcePicoseconds	0
ServerTimestamp	03.01.2017 02:50:31.031
ServerPicoseconds	0
StatusCode	Good (0x00000000)
Value	false
DataType	Boolean
NamespaceIndex	0
IdentifierType	Numeric
Identifier	1 [Boolean]
ValueRank	-1
ArrayDimensions	Null
AccessLevel	CurrentRead, CurrentWrite
UserAccessLevel	CurrentRead, CurrentWrite
MinimumSamplingInterval	10
Historizing	false

# TSN

The standard for deterministic and  
real-time industrial communication

# Main advantages for the user

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## OPC UA over TSN

OPC UA over TSN extends the benefits of OPC UA to the field level !

- ▶ Determinism is necessary at the field level (controllers, I/O, motion control, etc.)
- ▶ TSN is an evolution of the Ethernet standard, thanks to which Ethernet becomes deterministic (this is an international IEEE standard and not a proprietary solution)

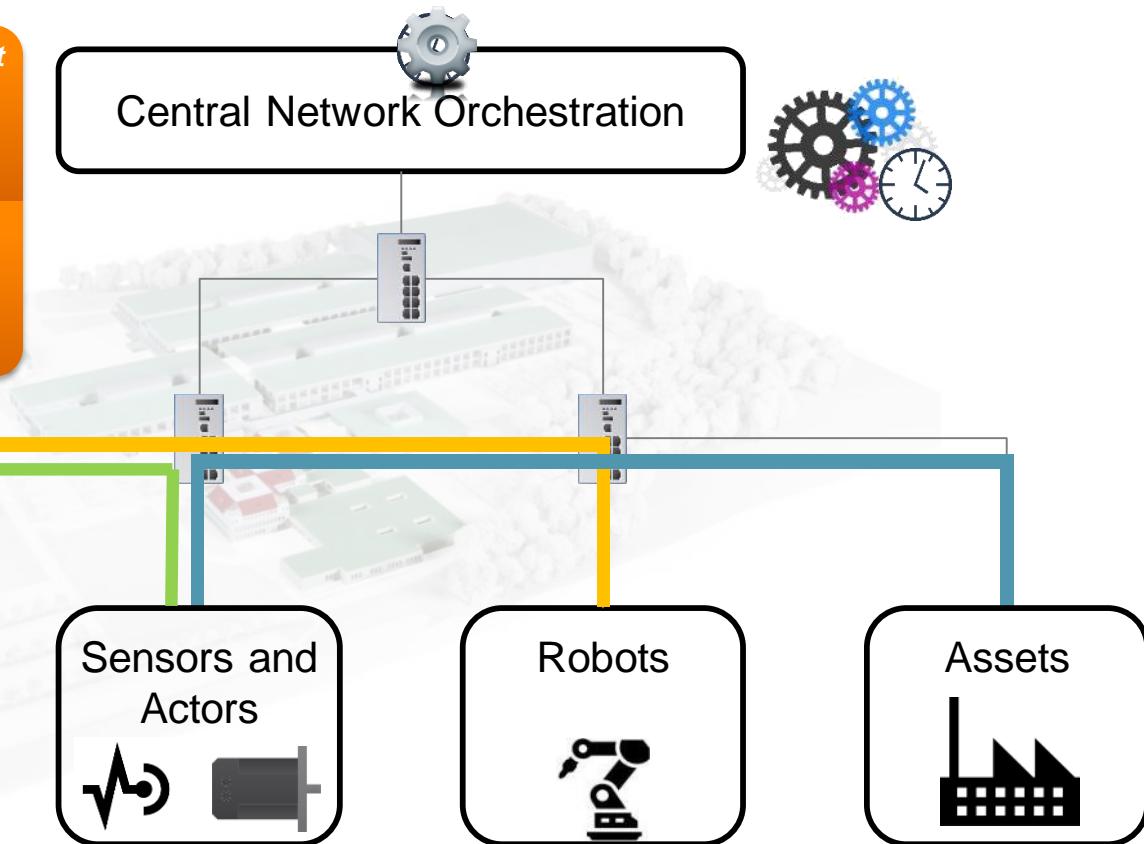
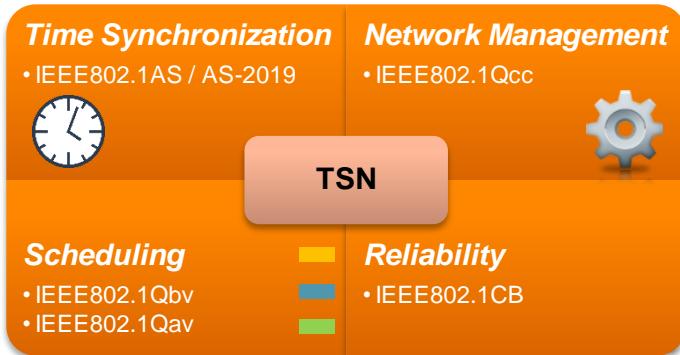


# Time Sensitive Networking (TSN)

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## IEEE 802.1 Standards





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**OPC UA over TSN**

# **Use Cases and example values**

# Applications

- Factory: Direct Access to process data from devices and machines
  - Condition Monitoring
  - Predictive Maintenance
  - Process Optimization
- Line: Connecting machines via Companion Specifications
  - ...over one converged network
  - OEM: Less time for engineering
  - ECU: less time for deployment, maintenance
  - More flexibility
- Machine: Controller to Controller Synchronization
  - coupling of machines or machine modules
  - e.g. bending machine coupled with robot

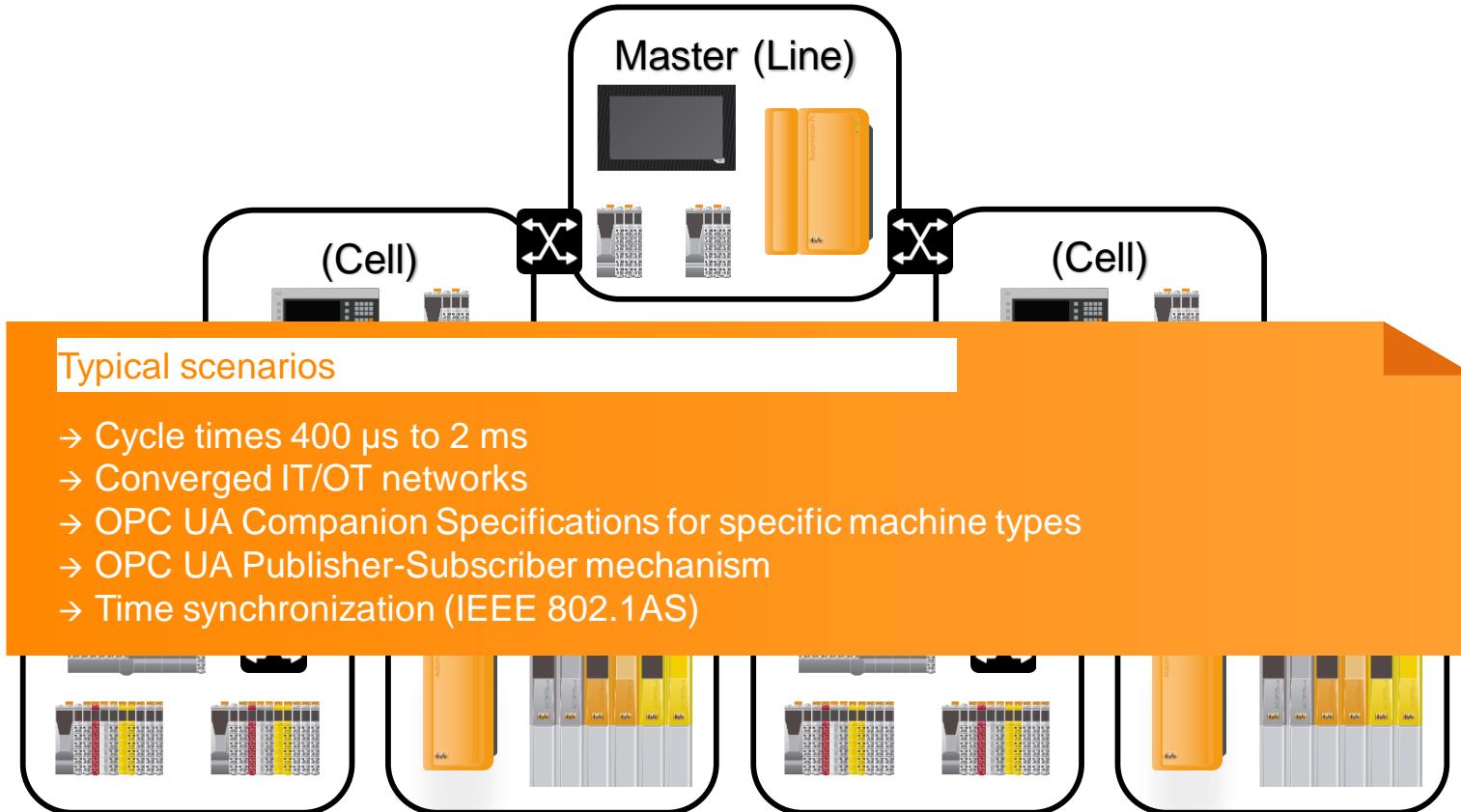


# 5 machine modules (controllers) with functional safety

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## Controller to Controller Communication (C2C)

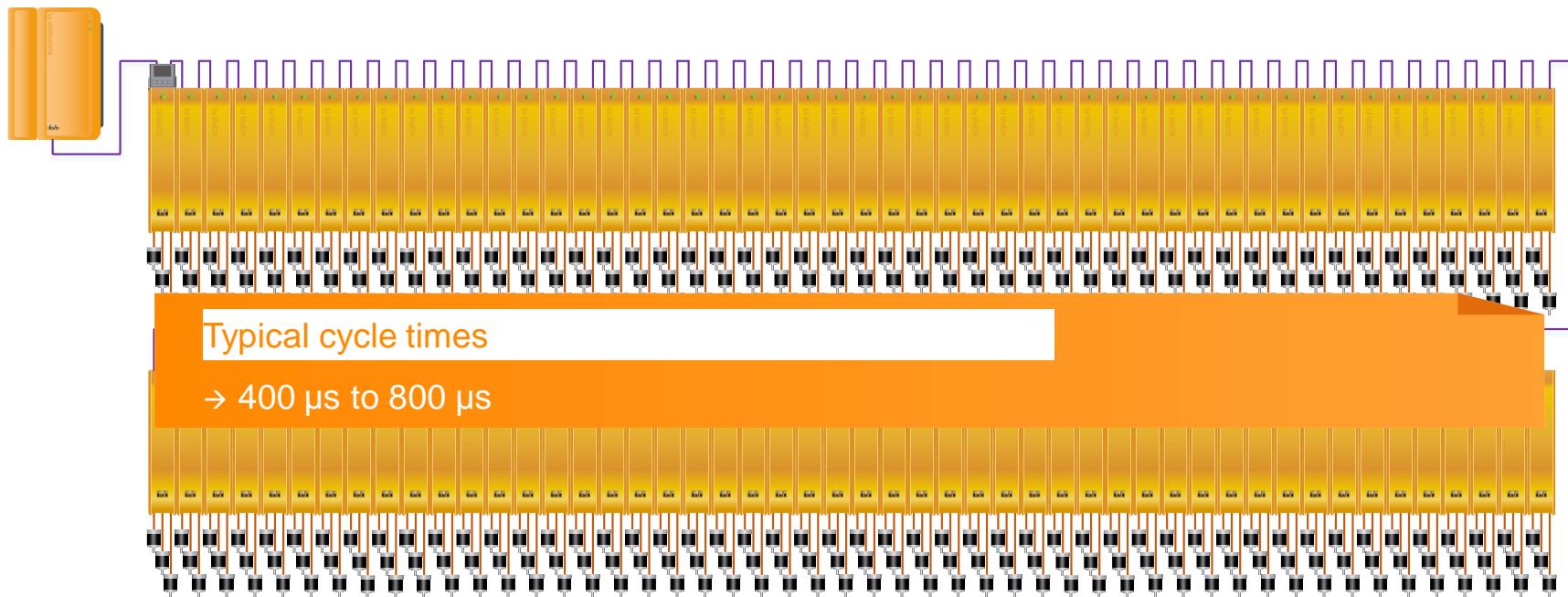


# 300 axis with functional safety

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## Field Level Communication (FLC)



OPC UA over TSN minimum cycle time: 260µs

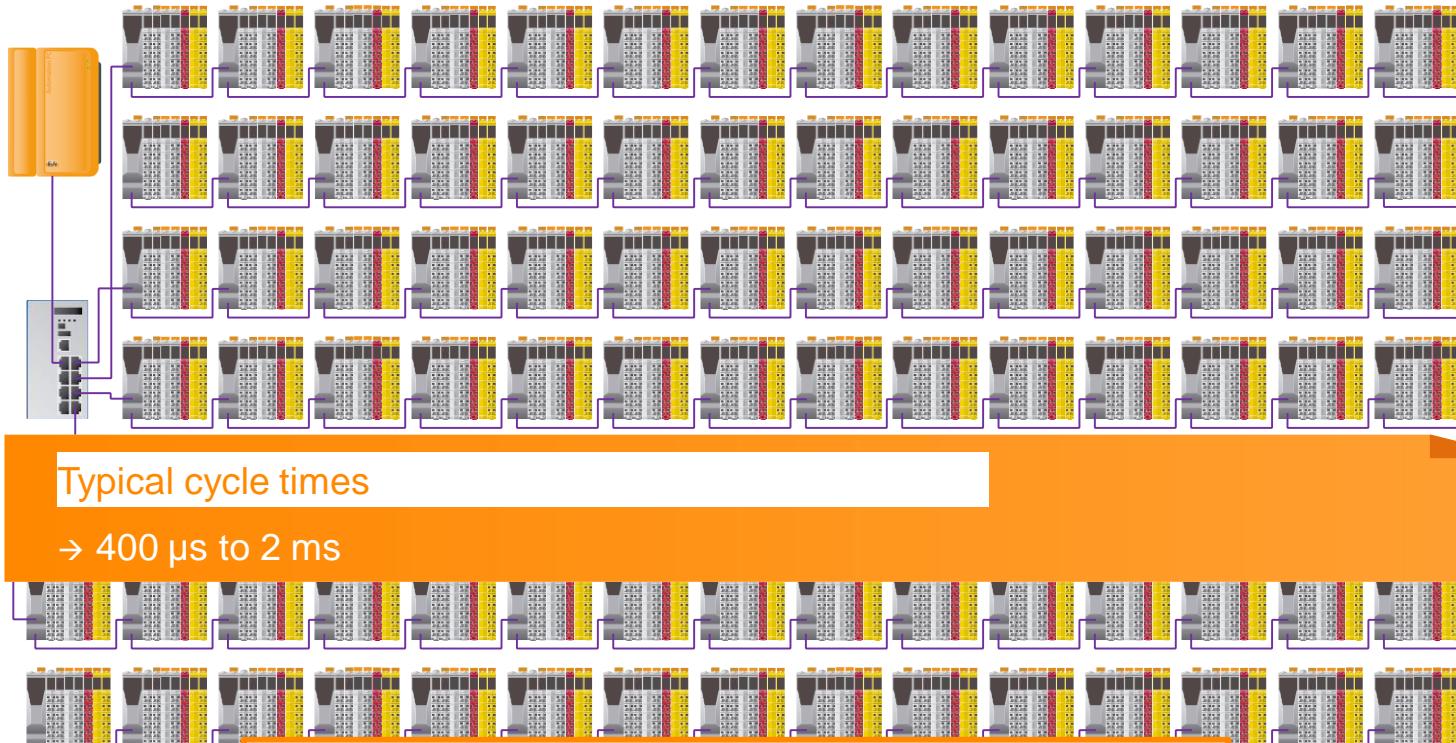
Parameters: 96B/302B payload/drive, 780ns forwarding latency, 10% cross traffic

# 100 IO blocks (OPC UA over TSN head station + slices)

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FLC



Parameters: 16B/24B payload/IO block, 780ns forwarding latency, 10% cross traffic



# OPC Foundation Field Level Initiative

# OPCF Field Level Communications Initiative

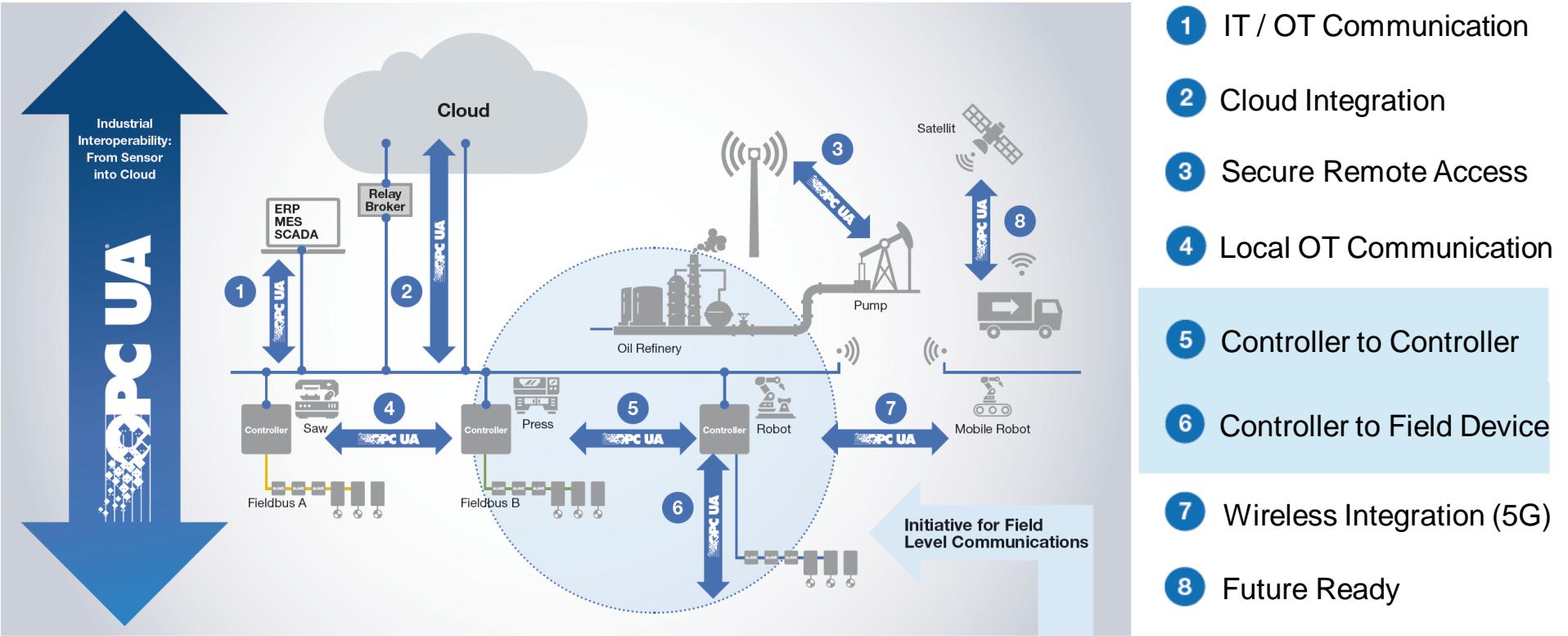
## Supporting Industry Players



**>85% global market share**



# OPC UA – from sensor to cloud



# Solving motion, safety & real-time challenges

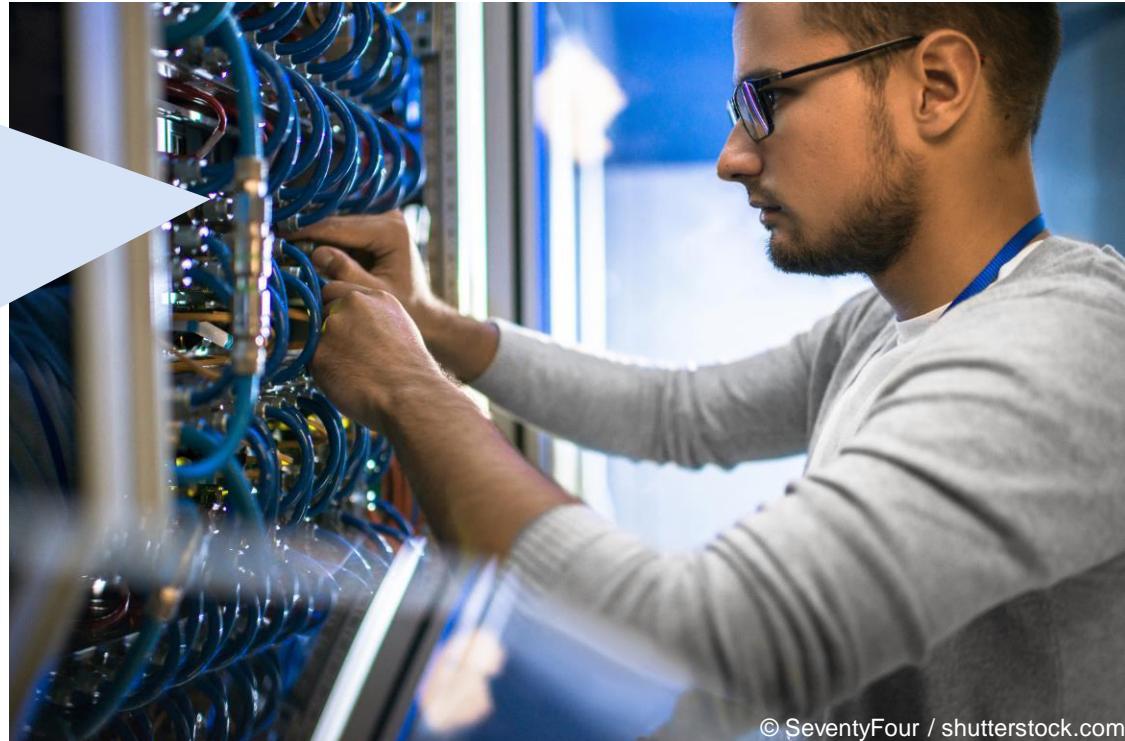
## Machine / Skid Builder

“I want ...

one vendor-independent communication standard

Useable for all kinds of different applications in discrete and continuous manufacturing like **motion, safety, remote I/Os**, etc.

Additional traffic (e.g. video) **may not impact machine performance”**



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# Solving motion, safety & real-time challenges

## Plant Owner

"I want to...

**easily** and economically  
**integrate** and **connect**  
machines / skids  
from different suppliers."



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# Solving motion, safety & real-time challenges

## Data Scientist

"I want to...

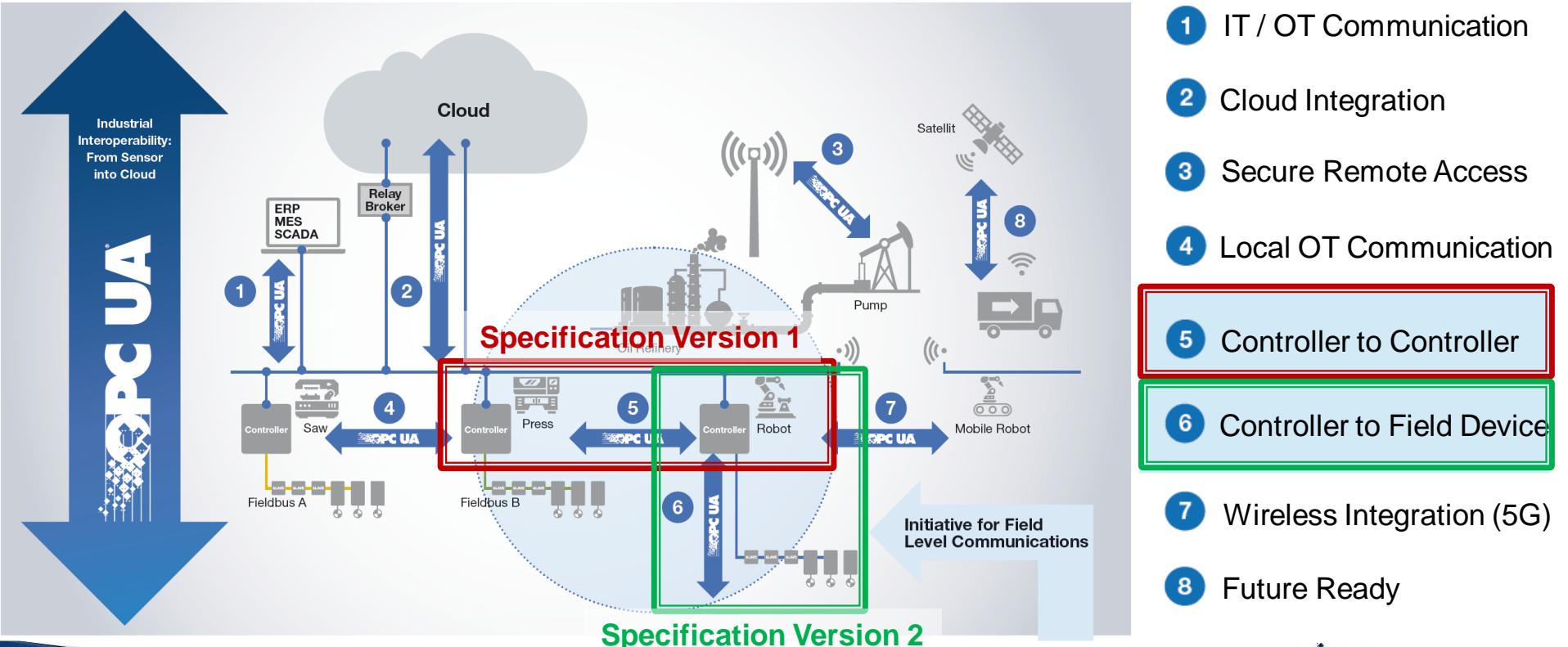
be able to **securely read data** from any controller and any device to identify opportunities for **optimization** of the production process.

be able to **adapt the data** set to my needs without support of the designer of the original equipment."



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# Roadmap for FLC Specifications



# Roadmap Field Level Communications Initiative (2)

	Specification Version V1	Specification Version V2
<b>Use Cases (main focus)</b>	Controller-to-Controller (C2C)	Controller-to-Controller (C2C) Controller-to-Device (C2D)
<b>Safety</b>	Client-Server & PubSub	Client-Server & PubSub Parametrization
<b>Security</b>	Adoption of existing OPC UA Security mechanisms	Adoption of existing OPC Security mechanisms + extensions (if needed)
<b>Configuration</b>	Online & Offline Basic TSN Configuration	Online & Offline Extended TSN Configuration
<b>Conformance Testing</b>	Test plan for controllers	Test plan for controllers & devices
<b>Timeline</b>	Technical paper / Release candidate (Quarter 4 2020)	t.b.d



# Use Cases

# Spec v1: High Level Objectives

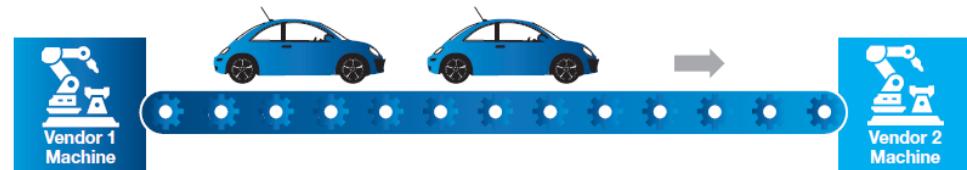
- ▶ **Interoperability** of controllers from different vendors and ecosystems
  - Reduces hardware component count
  - Reduces duplicate engineering work
- ▶ **Offline exchange** of information before system commissioning
  - Reduces commissioning time and risk
- ▶ **System commissioning** without the need for Engineering Tools
  - Reduces commissioning skill needs
- ▶ **Abstraction** of interfaces from underlying hardware
  - Increased flexibility of control strategies



# Machine to Machine

- ▶ Each machine contains at least one controller
- ▶ Information from Machine 1 may include:
  - Time to product delivery
  - Product information
  - Emergency Stop
- ▶ Information from Machine 2 may include:
  - Conveyor Speed
  - Ready to receive product
  - Production and Emergency Stop

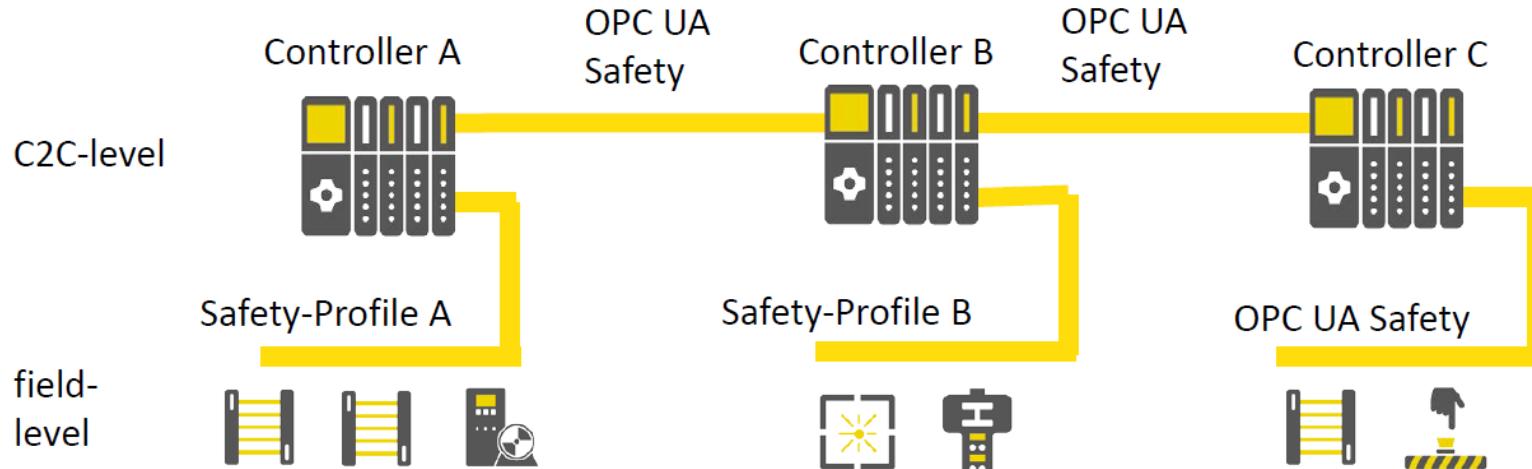
Example: a car body moving from one cell to another in an automotive body shop



# OPC UA Part 15: OPC UA Safety

## Functional safety communication on all levels

- ▶ Goal 1: functional safety for communication between controllers (C2C)
- ▶ Goal 2: standardized functional safety for communication on the fieldbus (C2D)





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## OPC UA over TSN @ B&R

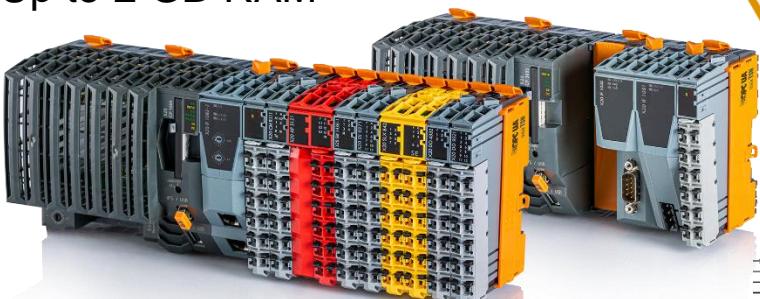
# New automation hardware

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PC performance on DIN-rail

Up to 2 GB RAM



Fast machine boot-up

Automatic configuration

OPC UA®  
OVER TSN

Flexible and modular

Gigabit Ethernet



## Fully integrated

Drag-and-drop of automation components

Automatic setup of all parameters

Co-existence of POWERLINK and OPC UA over TSN

## Onboard OPC UA companion specifications

### Integrated cybersecurity

Secure machine networks

Role and rights management

Certificate handling

## Consistent communication from sensor to cloud



PackML



EUROMAP 77



79

83

88



# Solving IoT, motion, safety & real-time challenges

open, faster, consistent and secure information

## OPEN

Supported and driven by all major automation suppliers – largest ecosystem in industrial automation.

## FASTER

Meets performance needs of today's and tomorrow's applications.

## CONSISTENT

Delivers information in a consistent way from device (field level) to cloud.

## SECURE

Allows implementation of systems that are secure by design.

OPC UA (over TSN) solves today's and tomorrow's industrial challenges

Standardization enables easier integration and secure access

Roadmap:

Feature	B&R system availability
Information modeling	From AS 4.7 (released)
Companion specifications	From AS 4.7 (released)
Alarms and Conditions	AS 4.9 (December 2020)
File Transfer	AS 4.9 (December 2020)
Method handling	AS 4.9 (December 2020)
Publisher-Subscriber	AS 4.9 (December 2020)
Time Synchronization (gPTP / IEEE 802.1AS)	AS 4.11 (December 2021)

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# Real-time OPC UA over TSN applications for next generation machine- & factory automation

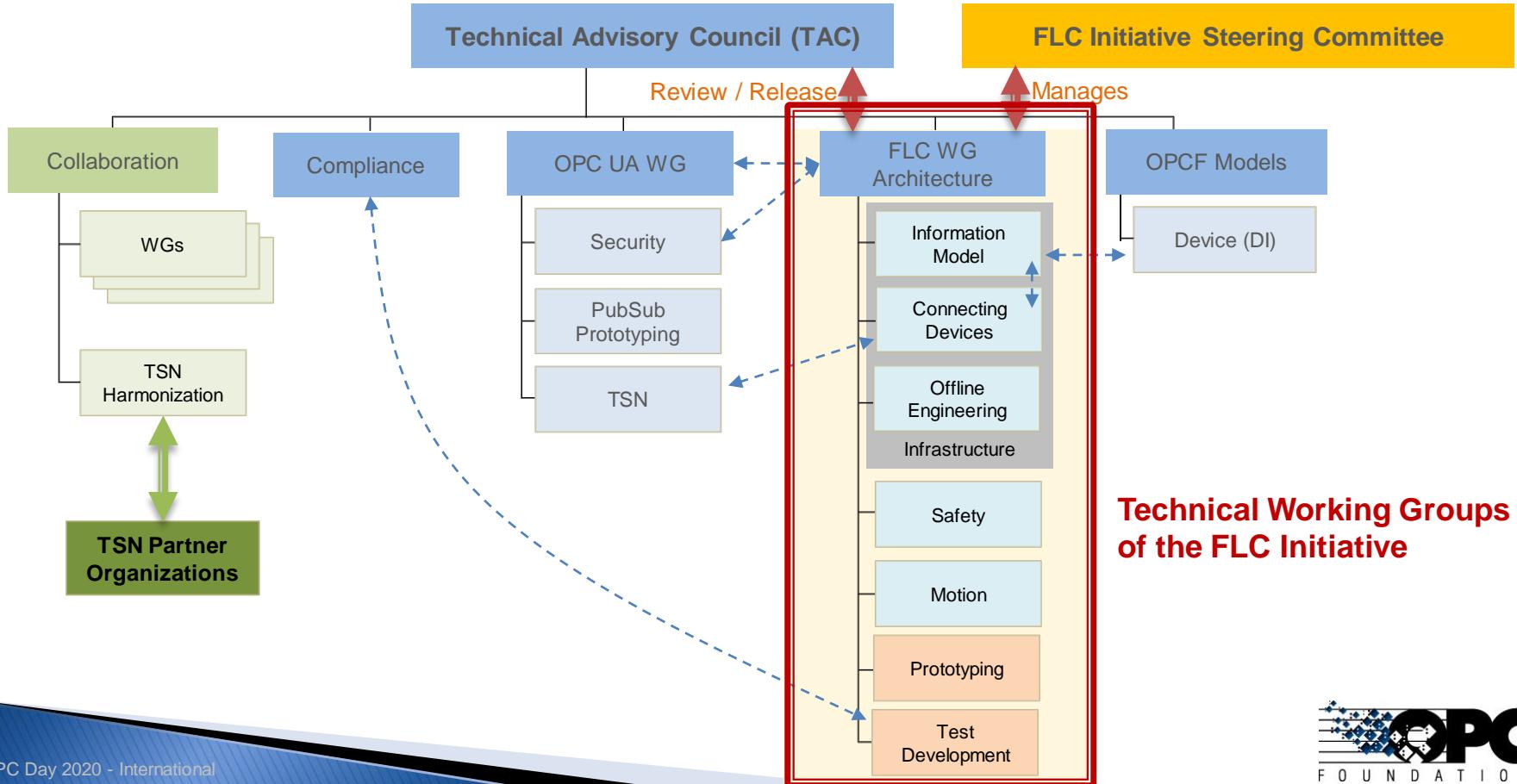
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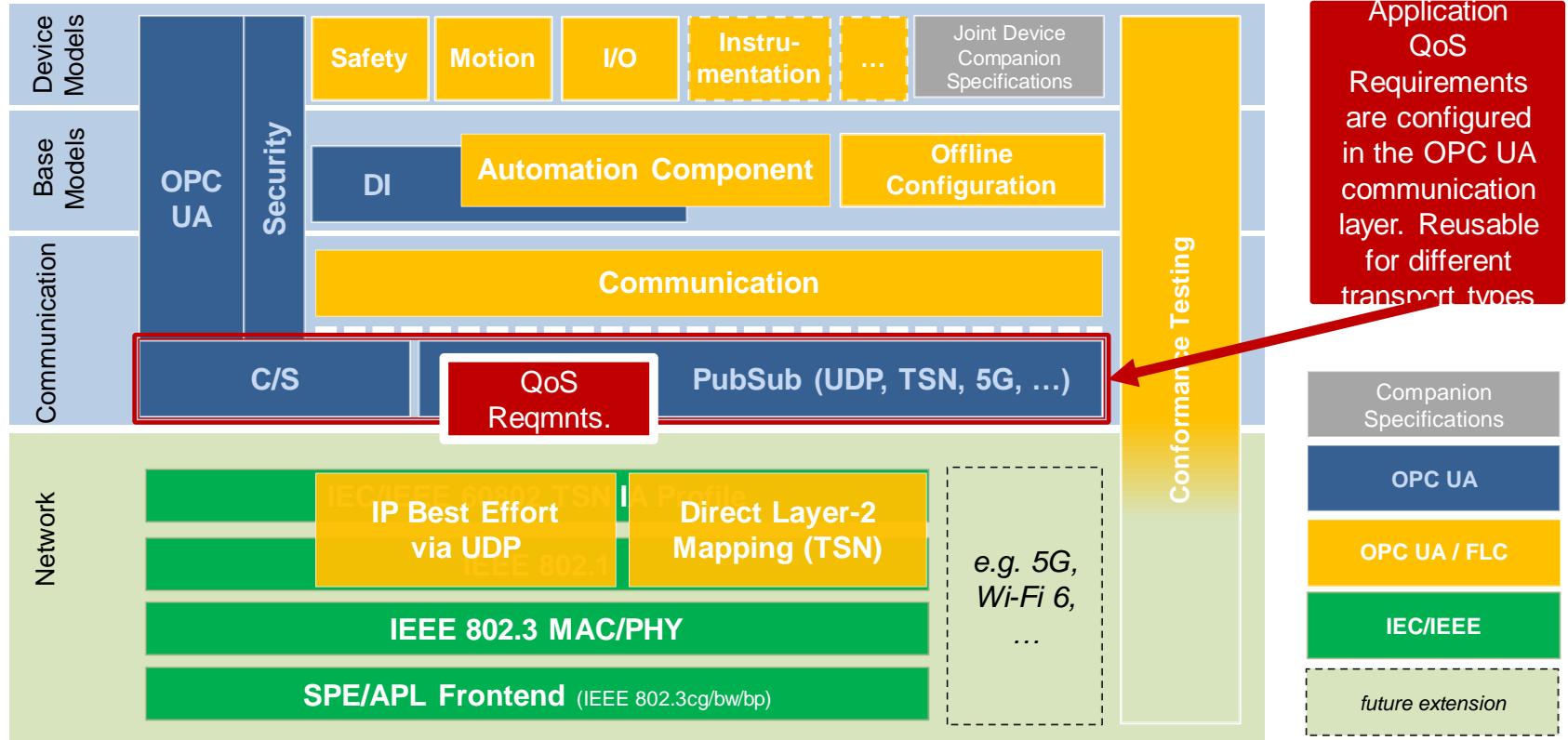


# Appendix

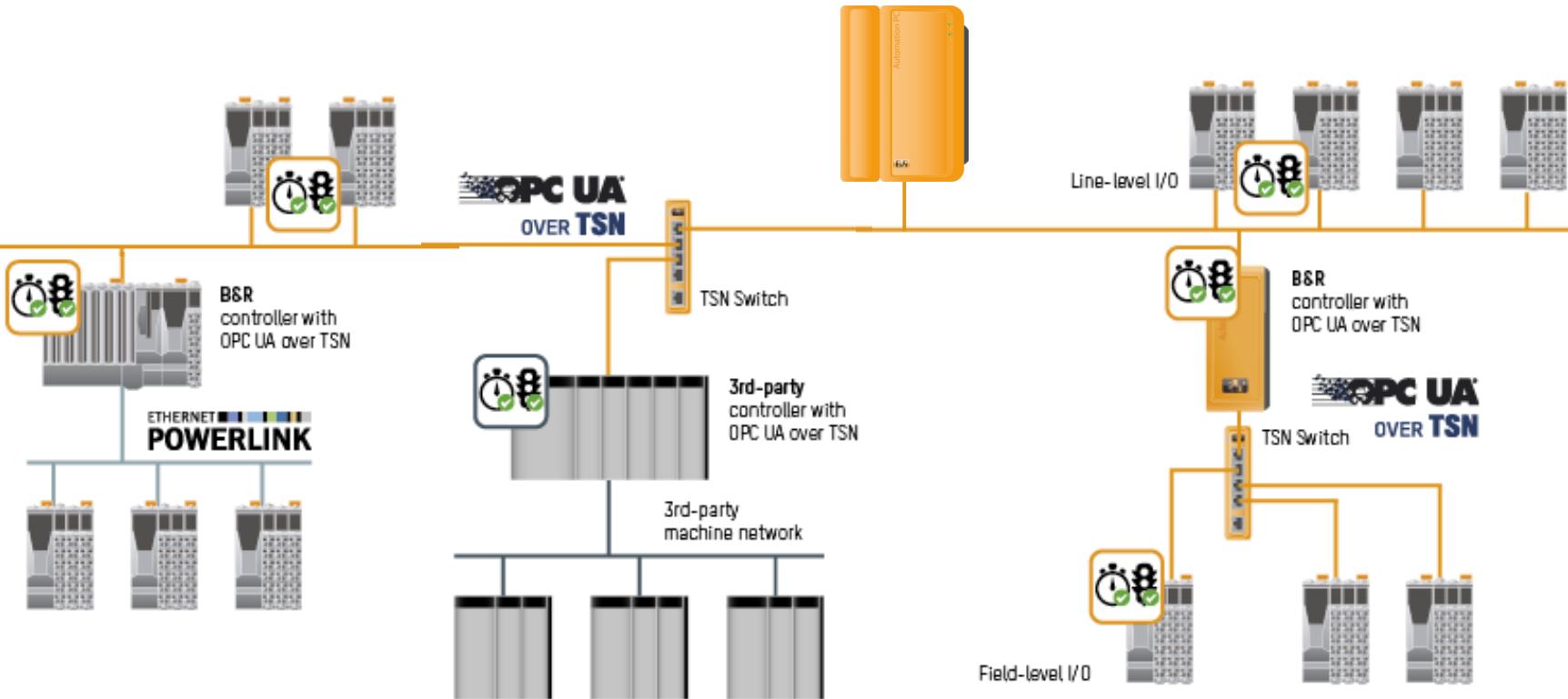
# FLC Initiative Working Groups



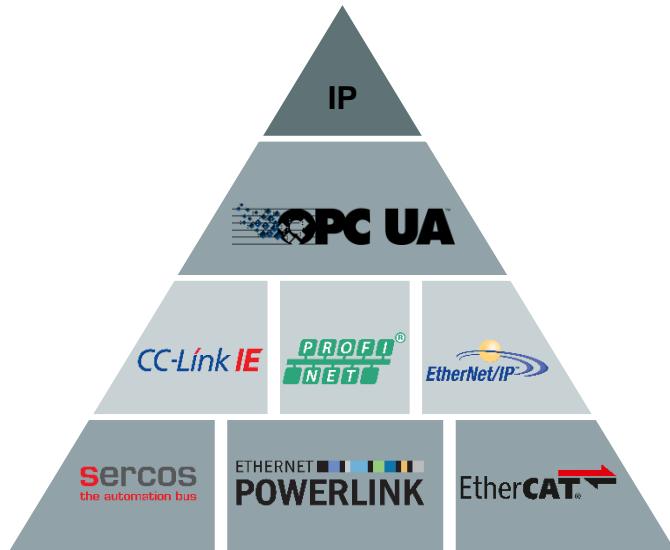
# Technology overview – FLC work items and dependencies



# Possible use cases summary



# Alternative approaches by various companies!



No interoperability  
No end-user benefits  
No IoT functionality  
No cloud connectivity  
No security

