



OPC UA, TSN & 5G

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OPC DAY FINLAND 2020

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#OPCUA #OPCDAY #OPCDAYFINLAND #AUTOMAATIO

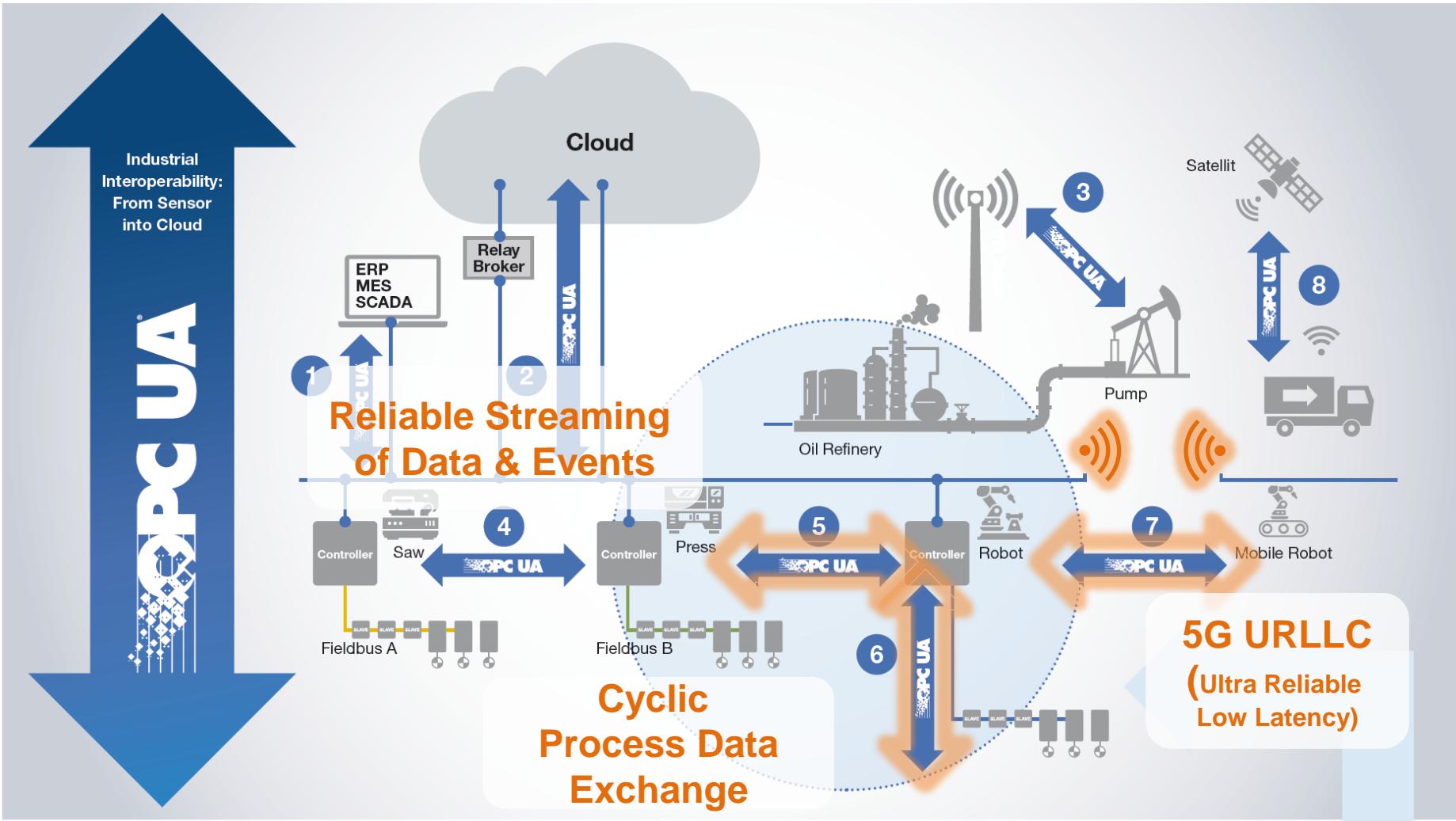


OPA TSN & 5G

Agenda

- ▶ OPC and QoS in Industrial Networks
- ▶ Integratian of QoS / TSN / 5G in OPC UA
- ▶ Configuration Workflows
- ▶ Drafting and Prototyping Activities around OPC TSN

Examples of OPC Applications with QoS Requirements



- 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

Quality of Service for OPC UA

Design goal: Flexibility and interoperability through separation of concerns

- ▶ **Machine- / Application Builders:**

Focusing on application QoS requirements:

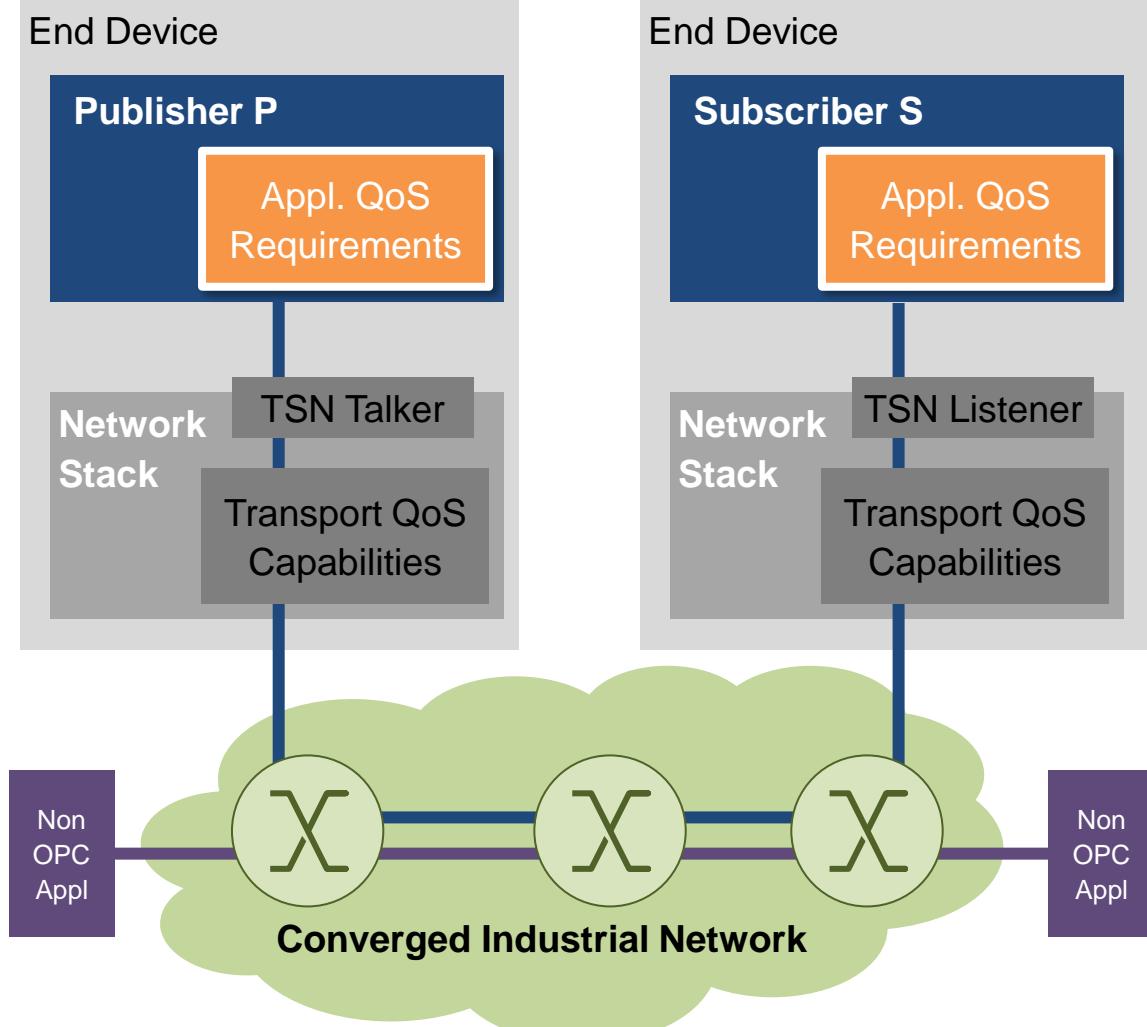
"My Application needs to transfer 120 bytes payload data from Publisher P to Subscriber S with a 4 ms period and a maximum latency of 2 ms."

- ▶ **Device Vendors:**

Providing devices with transport QoS capabilities based on profiles (e.g. IEC/IEEE 60802: "TSN Profile for Industrial Automation")

- ▶ **Industrial Network Vendors:**

Providing a converged industrial network based on profiles (e.g. IEC/IEEE 60802)



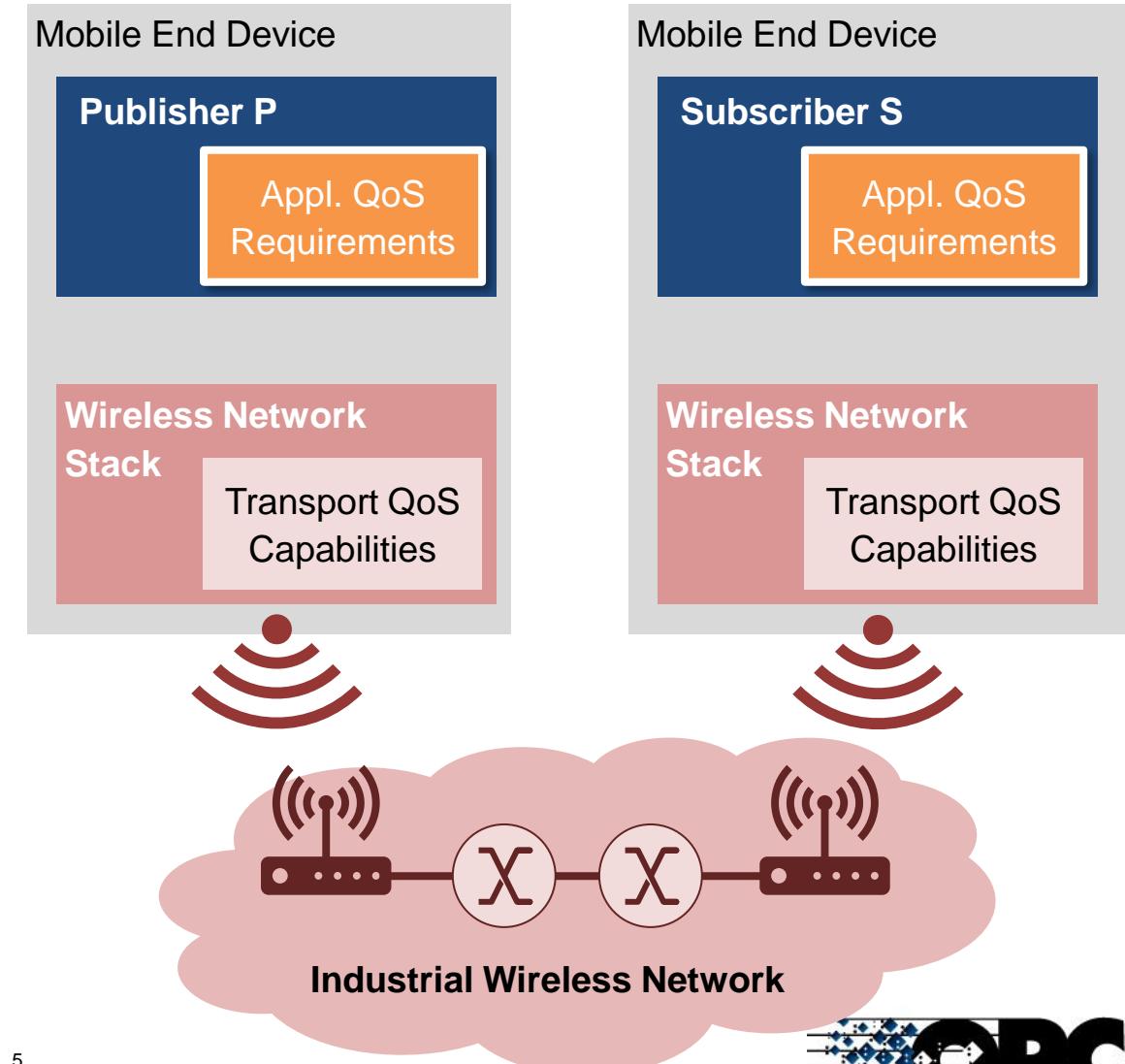
Quality of Service for OPC UA

Design goal: Flexibility and interoperability through separation of concerns

Machine- / Application Builders:

“No need to redesign my application ...”

“... when the network infrastructure
is changing.”

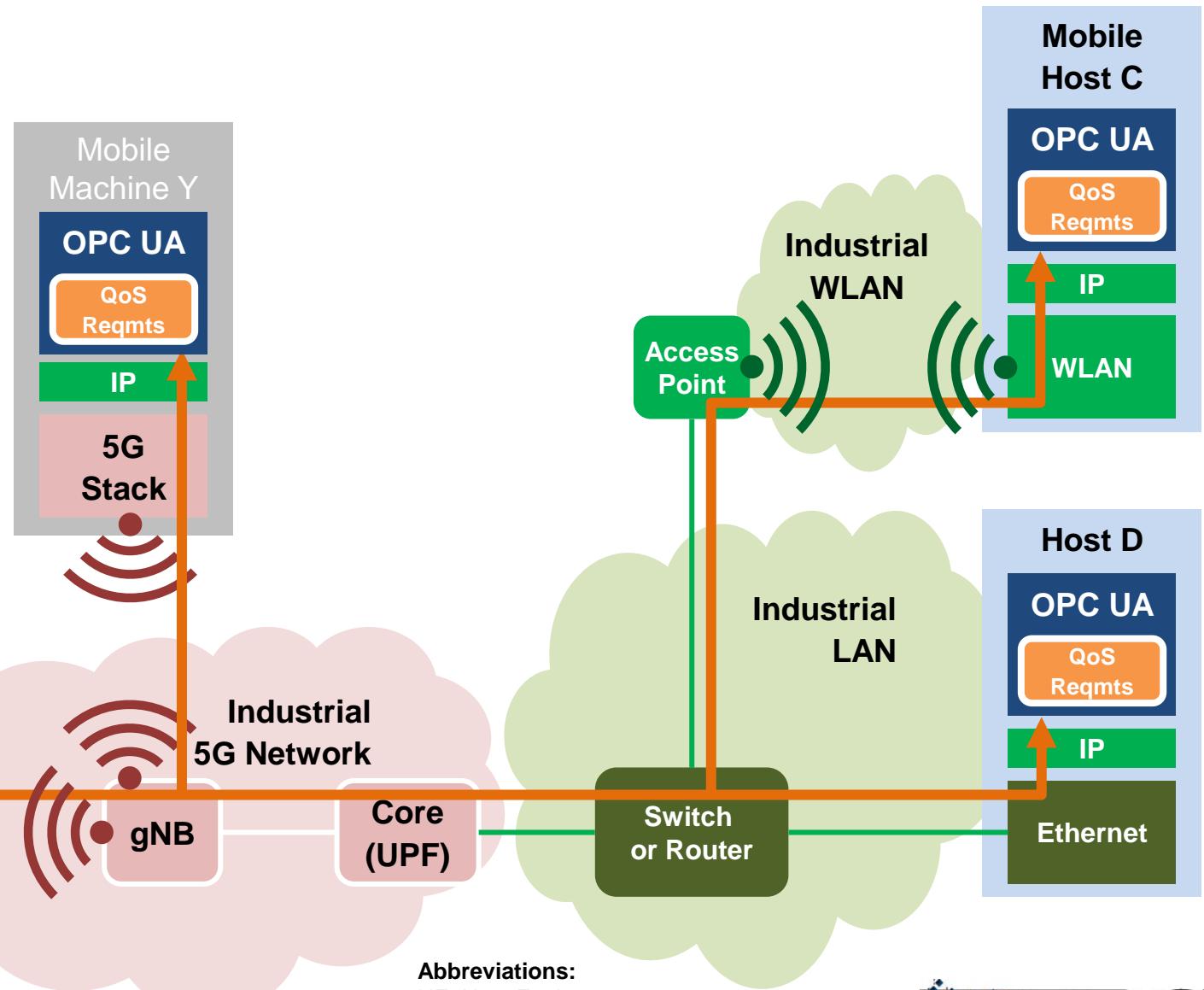
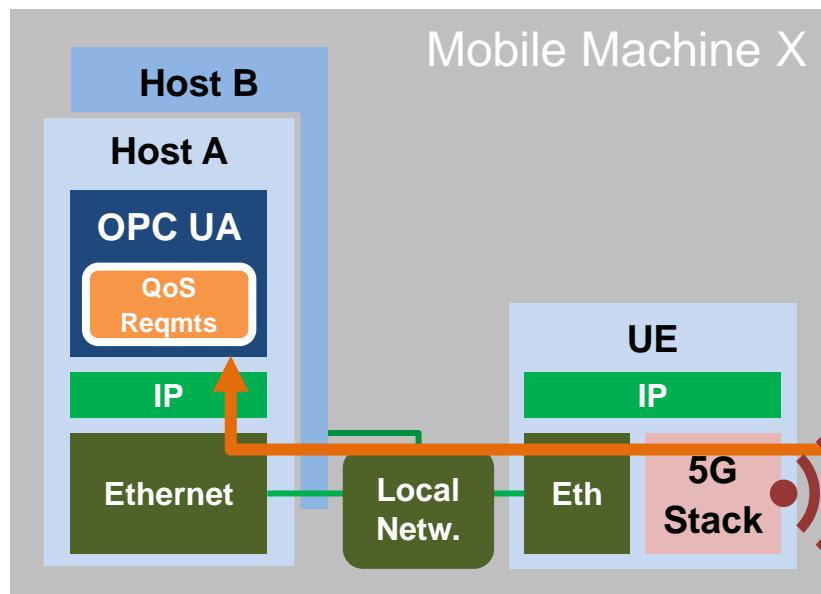


Quality of Service for OPC UA

Industrial Network Scenarios

Requirements:

- ▶ Easily establish E2E-QoS over a chain of network segments of different technologies
- ▶ Support different deployment options



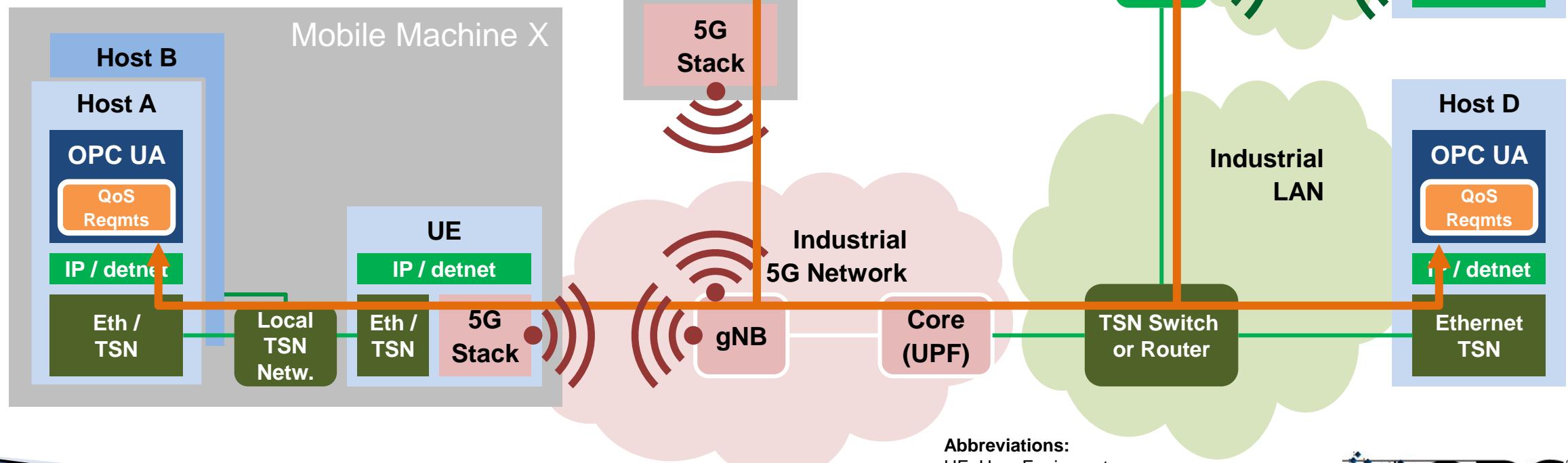
Abbreviations:

UE: User Equipment
UPF: User Plane Function

Quality of Service for OPC UA

Example shows Layer 3 Transport Mapping

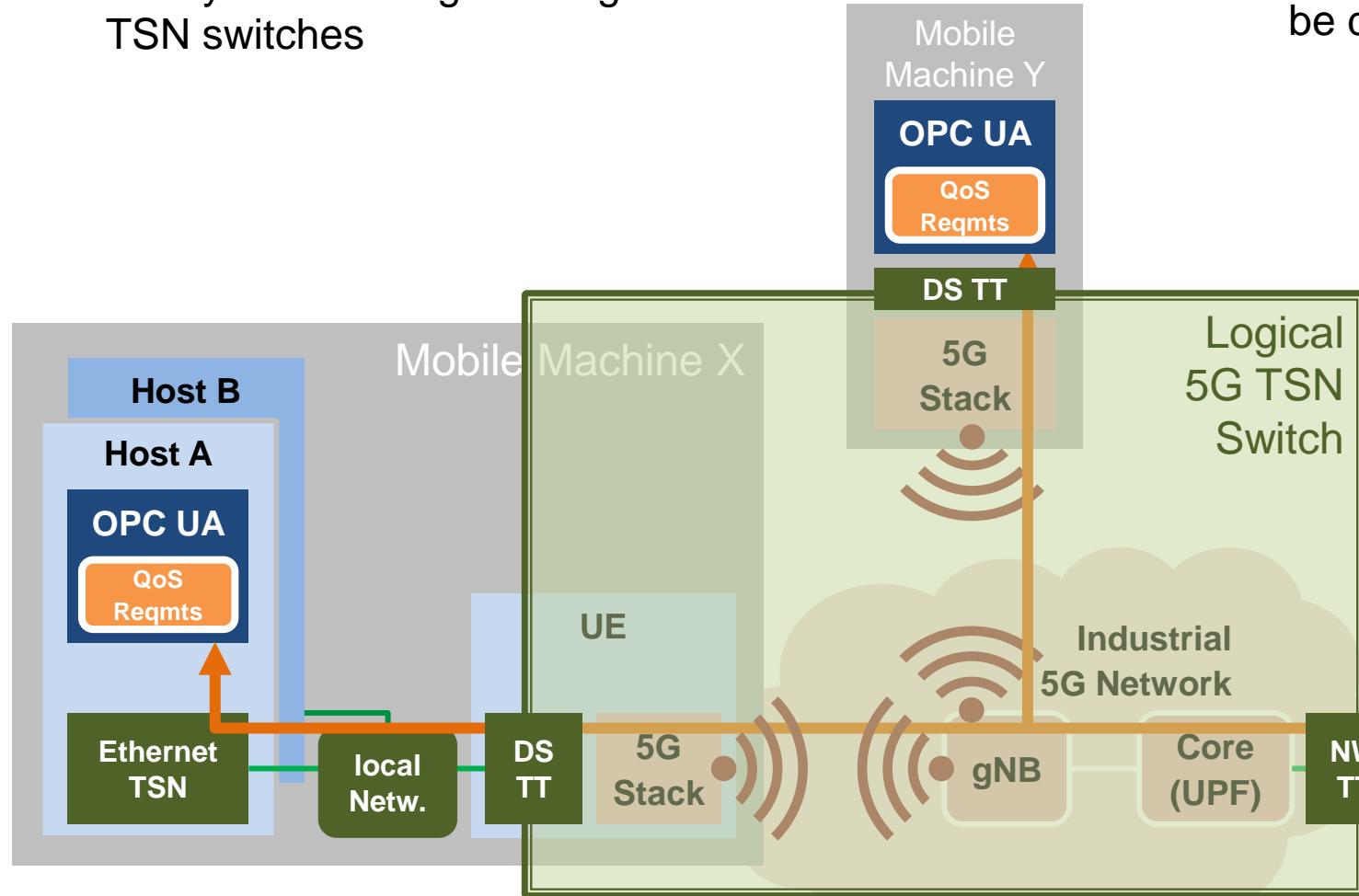
- Detnet is the umbrella technology to provide E2E QoS over routed IP networks.
- E2E Signaling and QoS control mechanisms should be application independent.



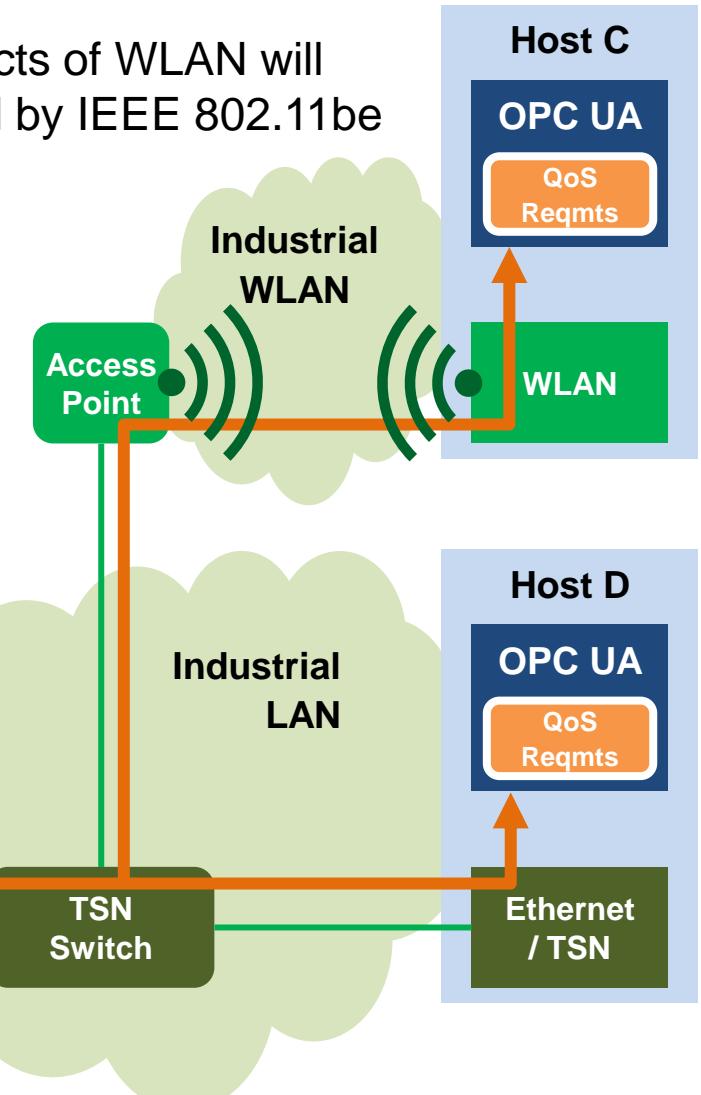
Quality of Service for OPC UA

Layer 2 Transport Mapping for TSN, Data Plane, Control Layer not included

- 5G Systems acting as a logical TSN switches



- TSN aspects of WLAN will be defined by IEEE 802.11be



Abbreviations:

UE: User Equipment
UPF: User Plane Function
DS TT: Device side TSN Translation
NW TT: Network TSN Translation

Configurable Application QoS Requirements in OPC UA

Initially developed by OPC UA TSN subgroup, integrated in next release of OPC UA PubSub

- ▶ Best Effort
 - No specific QoS requirements

Used Network Mechanisms

- ▶ Priority based QoS
 - Classification of data flows among each other (e.g. with “Urgent”, “Middle”, “Low”)
 - Data flow prioritization depends on network technology

IP / DSCP

Ethernet / PCP

- ▶ **Guaranteed QoS**
 - Guaranteed Bandwidth
 - Bounded Latency
 - Deadline
 - → **Needs signaling via UNI / QoS Service Interfaces**
 - → **Needs allocation of network resources**

Detnet

TSN

- ▶ Availability / Reliability
 - WiP, covered in follow up Version of Part 14 (PubSub) and Part 22 (Base Network Model)



Detnet
service protection
TSN / 802.1CB
“Seamless redundancy”

DSCP: Differentiated Service Code Point, see IETF diffserv

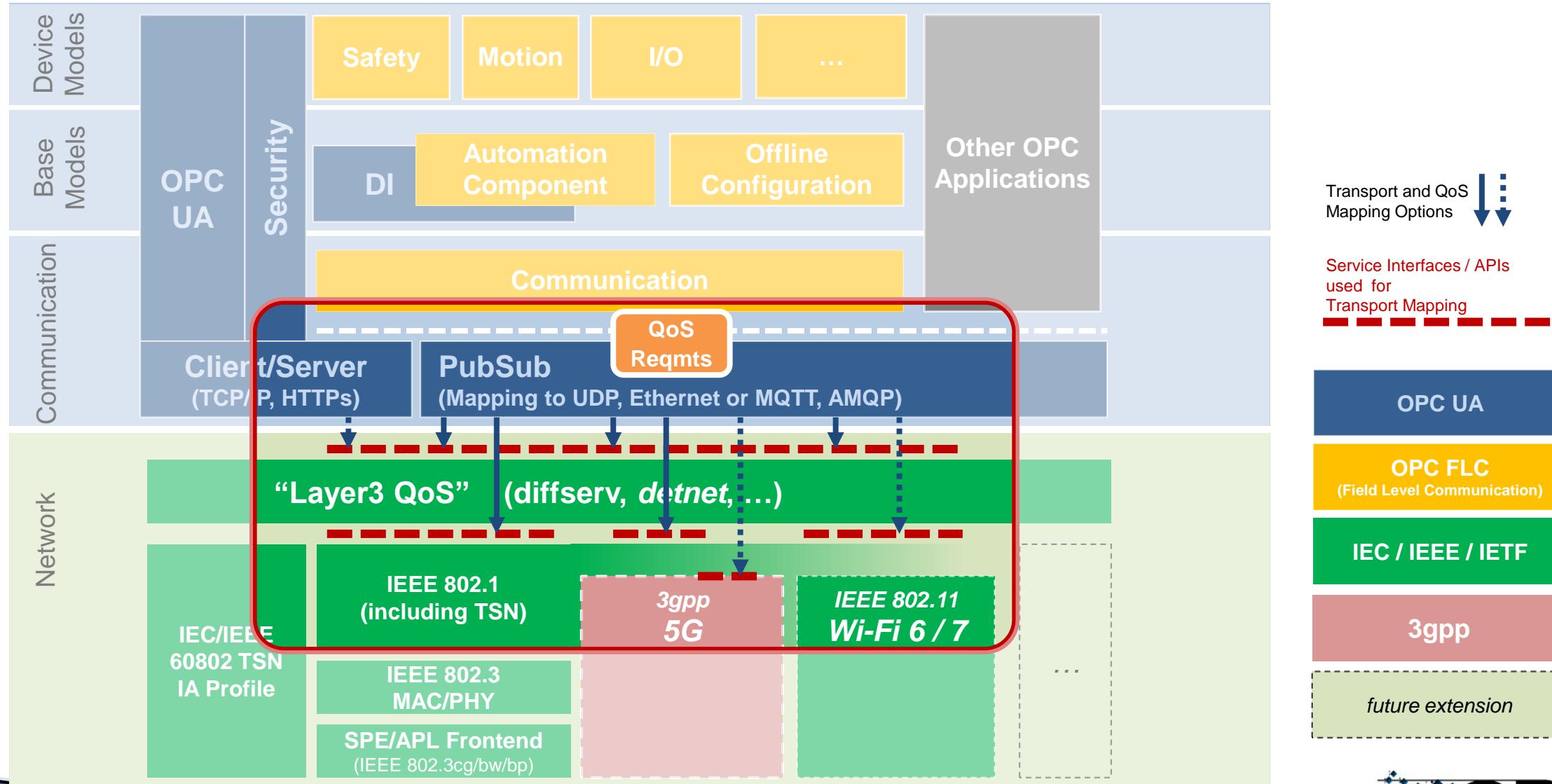
PCP: Priority Code Point, see IEEE 802.1Q

DetNet Deterministic Networking, see IETF

UNI: User / Network Interface, see IEEE 802.1Q

OPC UA Layered Stack architecture

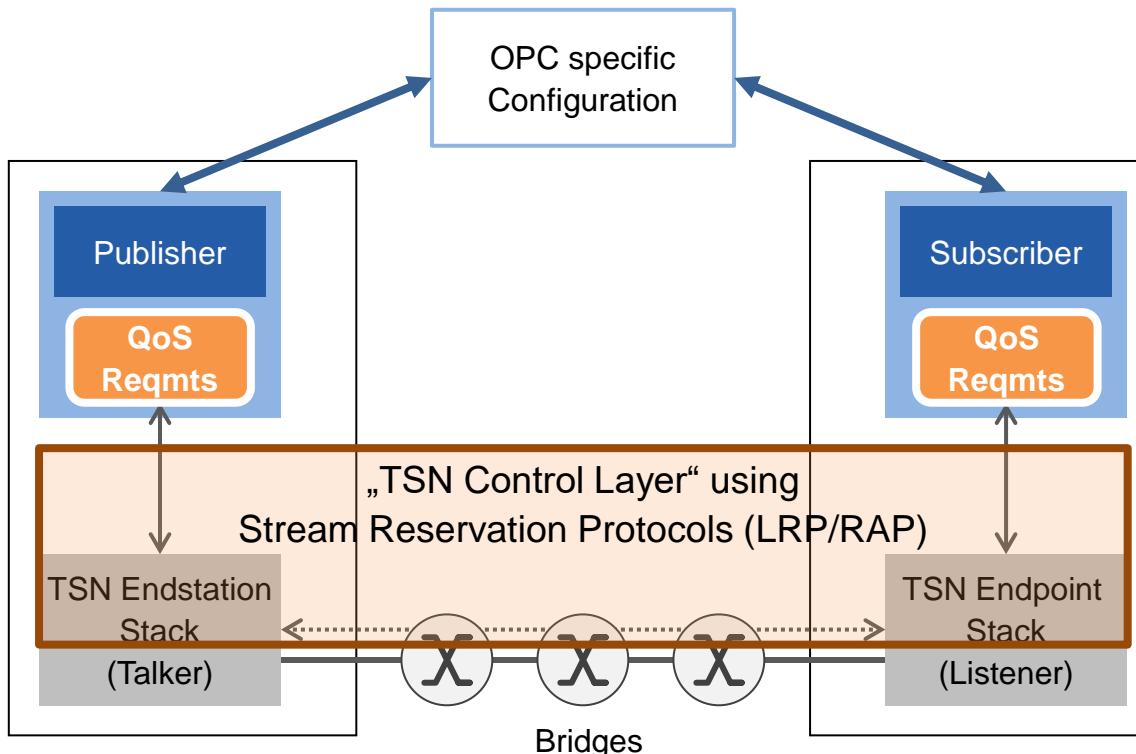
Focus on OPC UA with QoS



OPC TSN Configuration will run with Fully Centralized and Distributed TSN Configuration Models

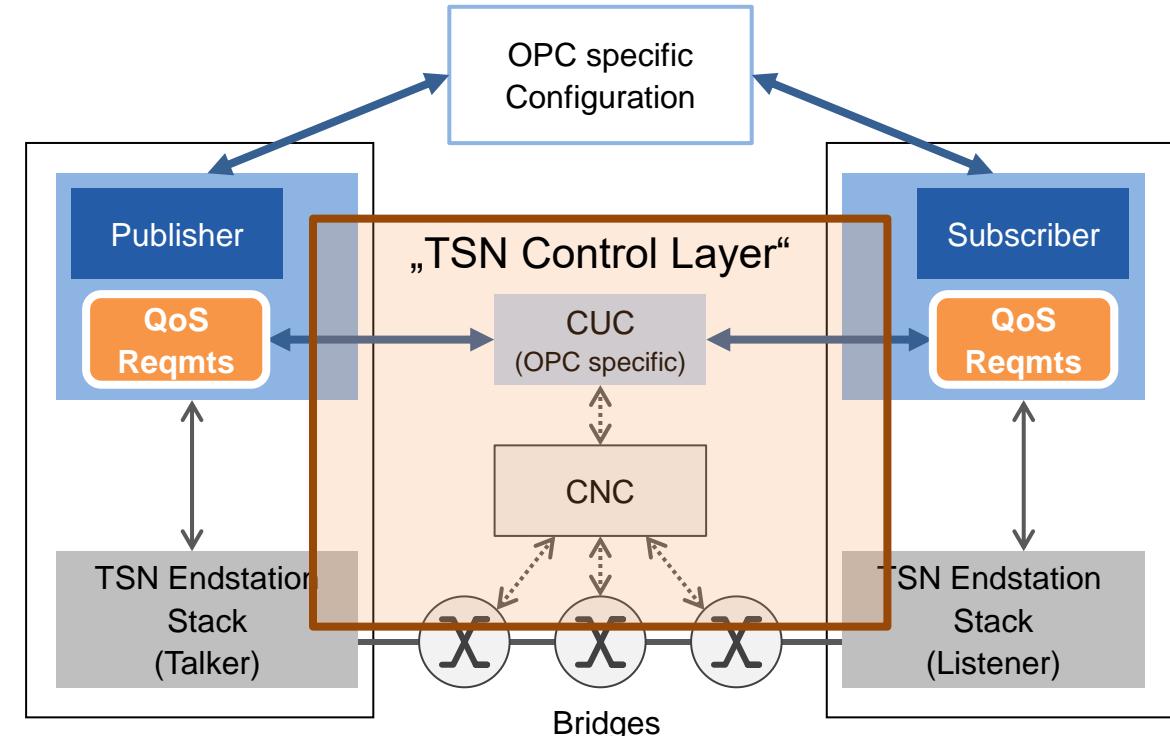
Configuration data flows:

- ↔ OPC specific (e.g. using Client Server Access)
- ↔ Network specific
- ↔ Device internal



Distributed Configuration

→ Prototyping in LNI Testbed (@Augsburg)



Fully Centralized Configuration

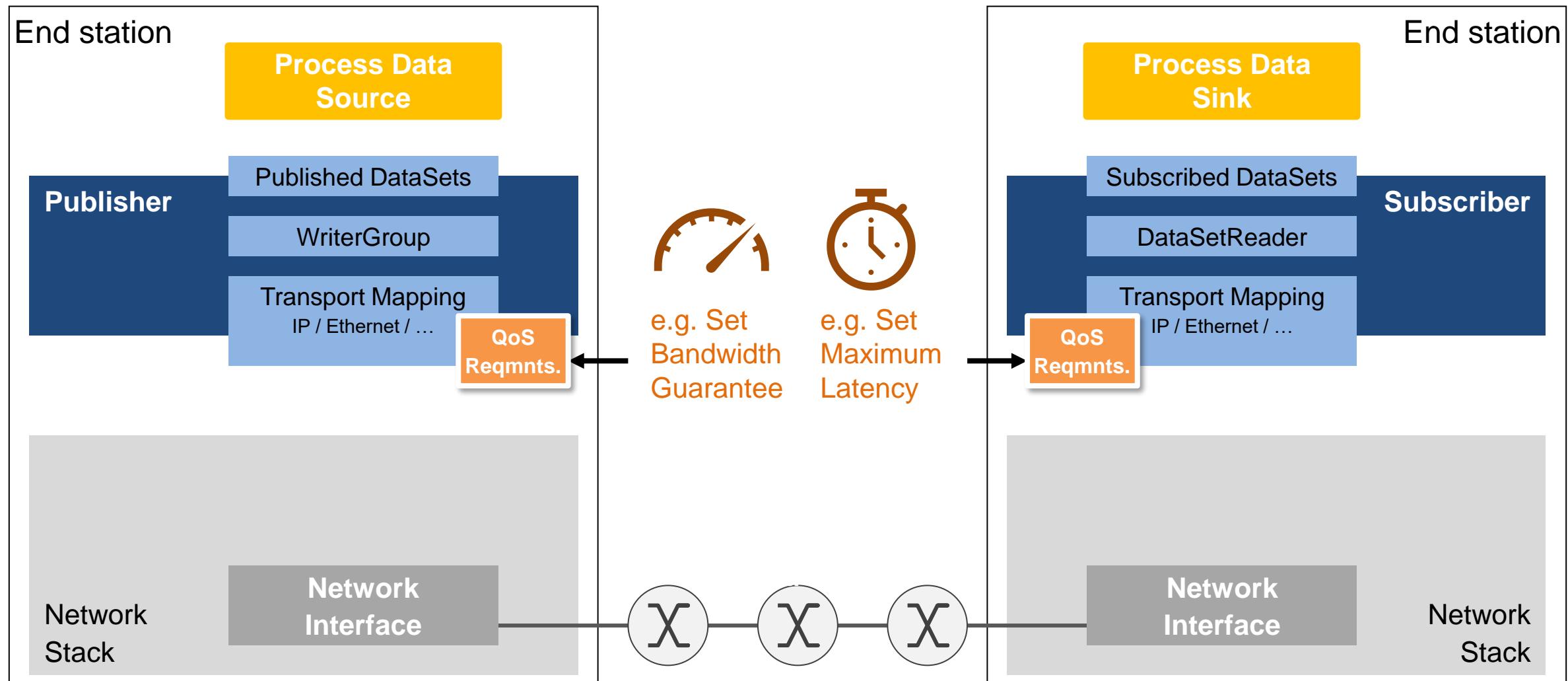
→ Prototyping in IIC Testbed (@Stuttgart / @Austin)

LRP: Link-local Registration Protocol (see IEEE 802.1CS)
RAP: Resource Allocation Protocol: (see IEEE 802.1Qdd)

CNC: Centralized Network Configuration (see IEEE 802.1Qcc / Qdj)
CUC: Centralized User Configuration (see IEEE 802.1Qcc / Qdj)

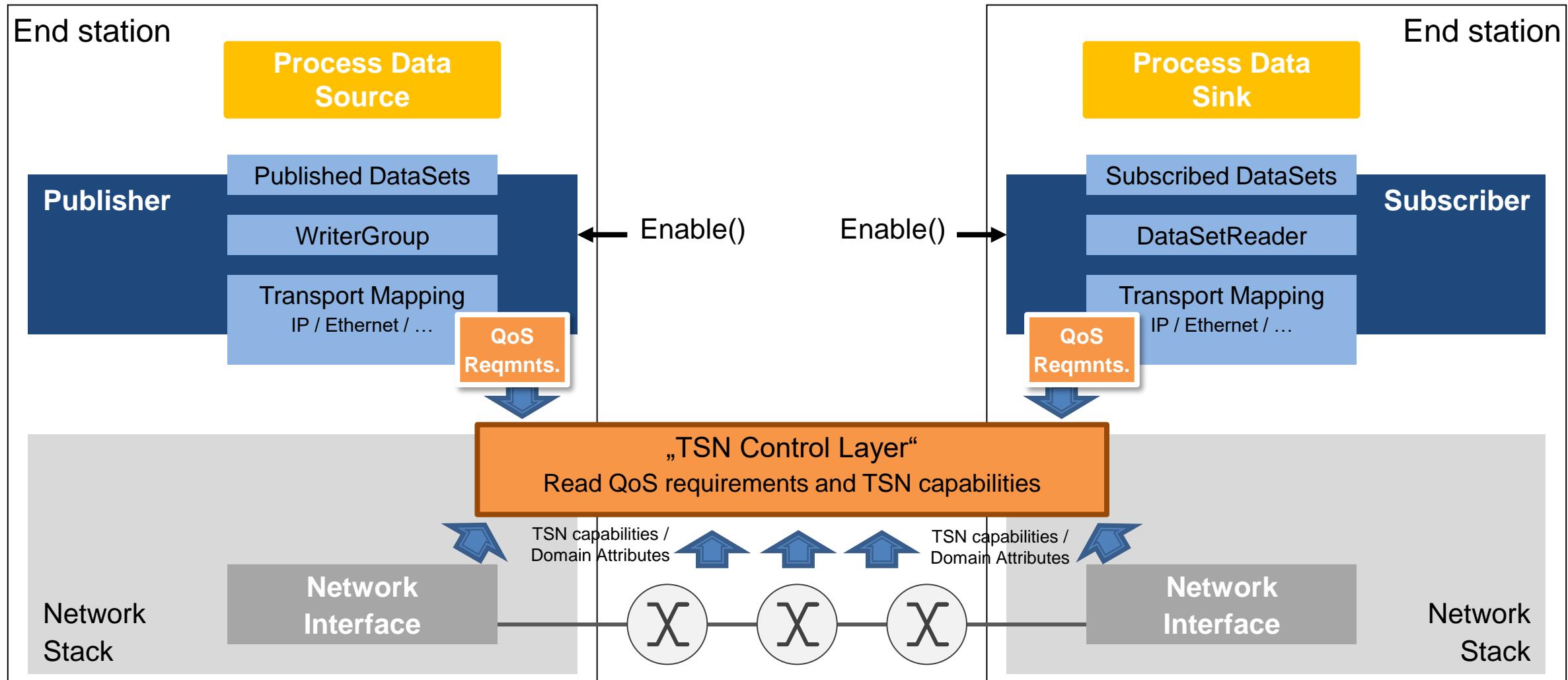
Example of QoS Configuration Workflow

1) Design Phase: Configuration of Application QoS Requirements using regular OPC Config Mechanisms



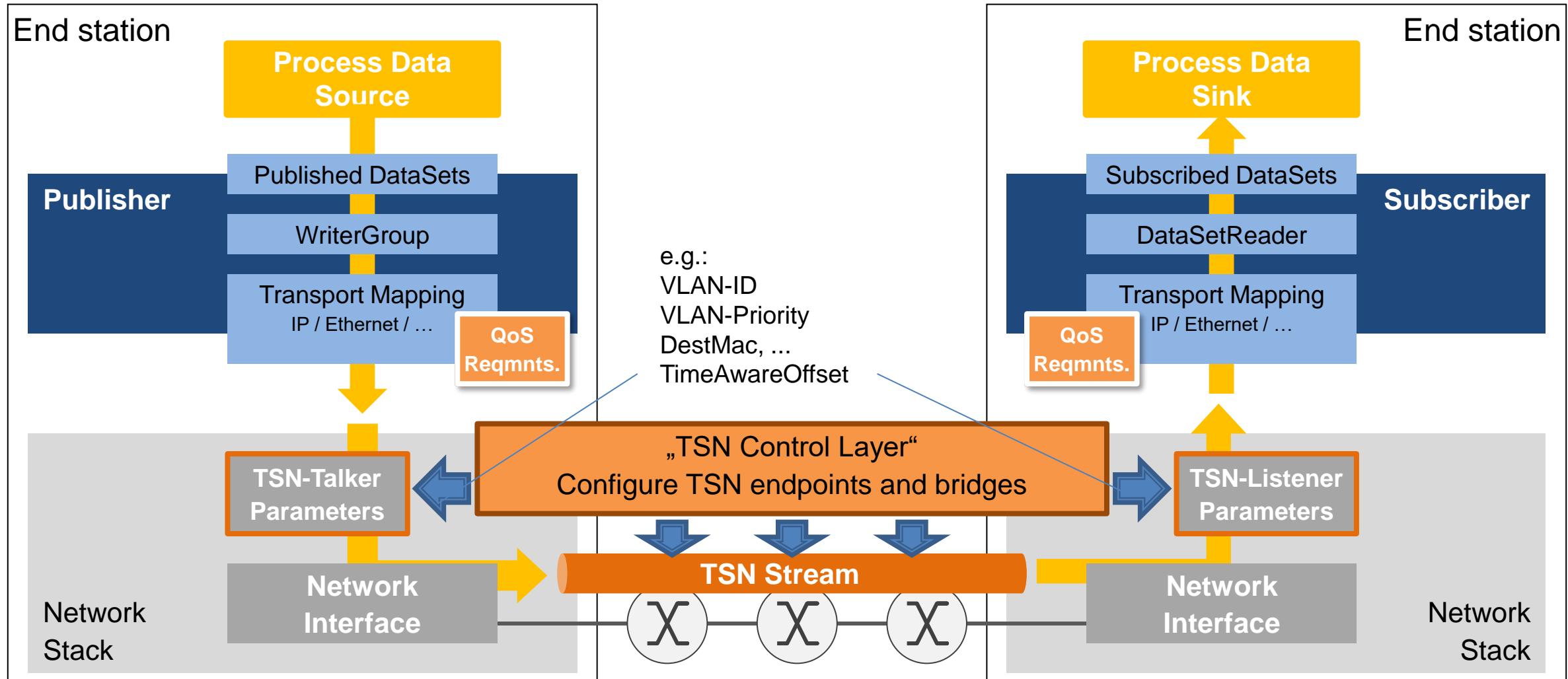
Example of QoS Configuration Workflow

2) Operational Phase: TSN Control Layer reads QoS Requirements and Network IF Capabilities



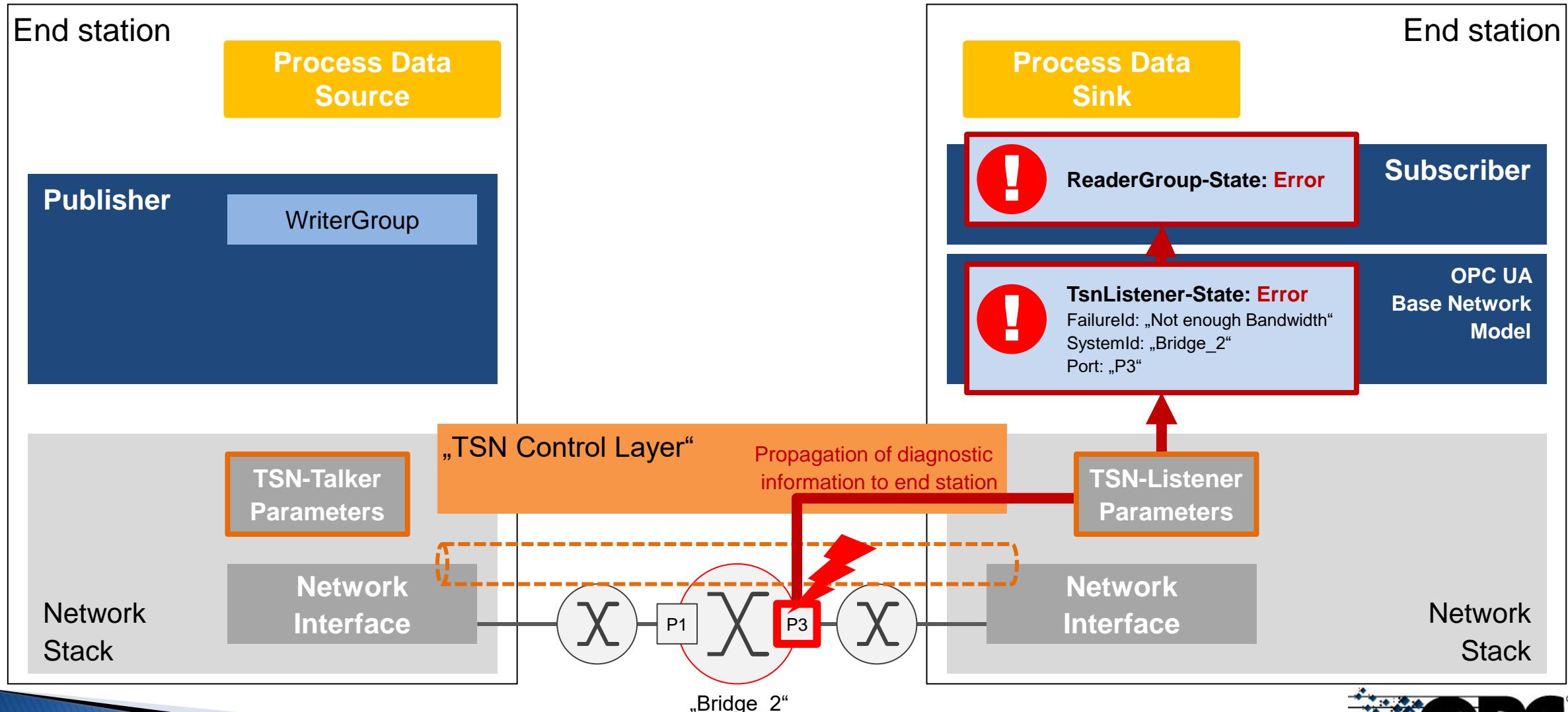
Example of QoS Configuration Workflow

3) Operational Phase: TSN Control Layer establishing streams and deploying Talker / Listener parameters

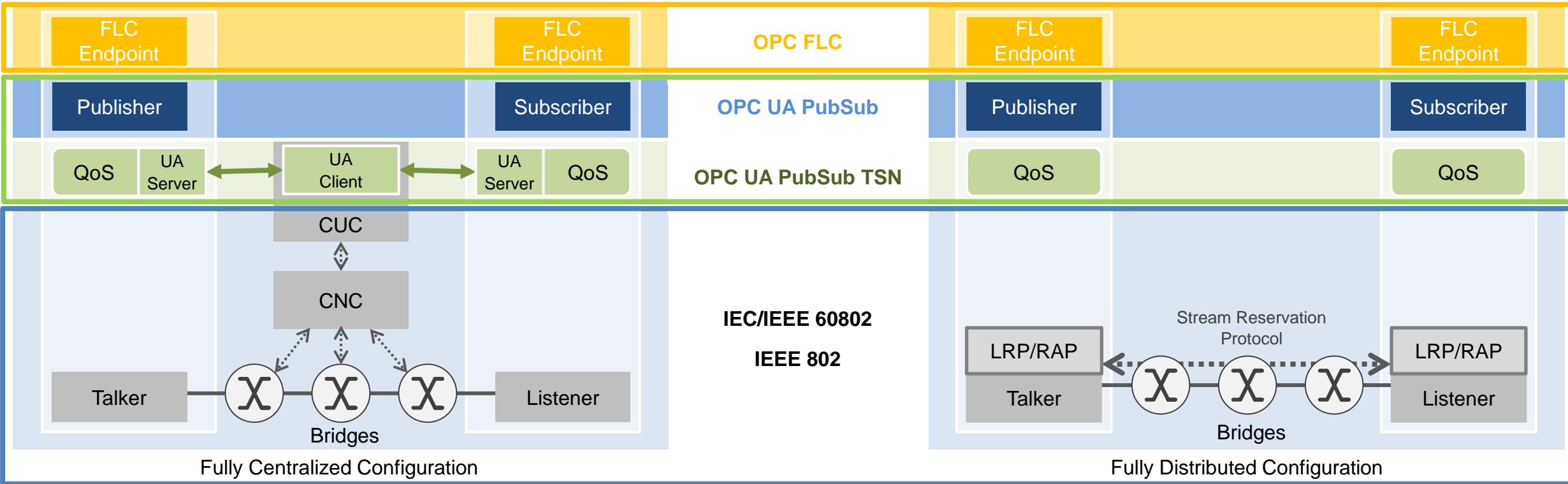


Failure Scenario Example during Stream Establishment

TSN Control Layer delivers Diagnostic info to OPC UA Information Space (Base Network Model)

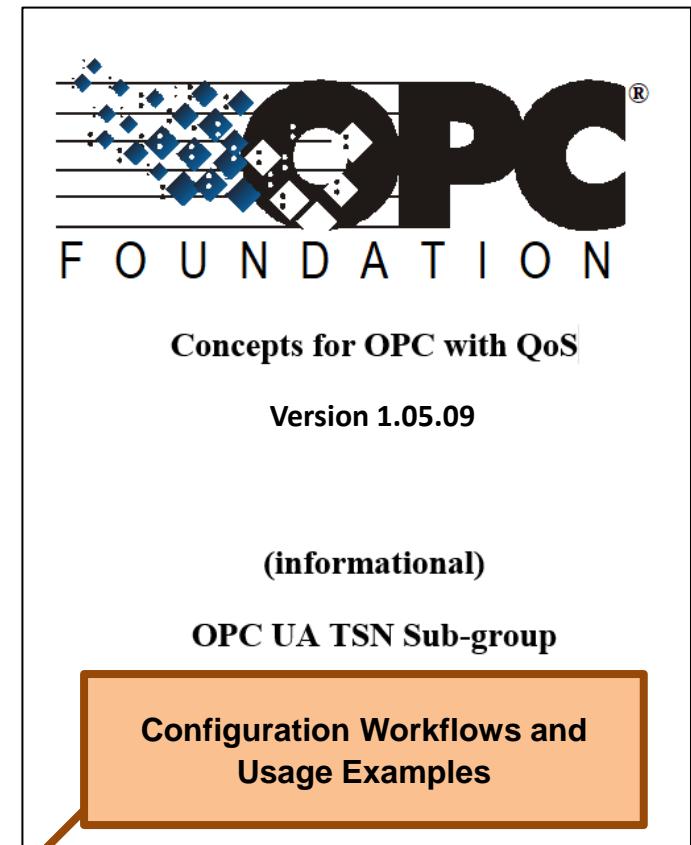
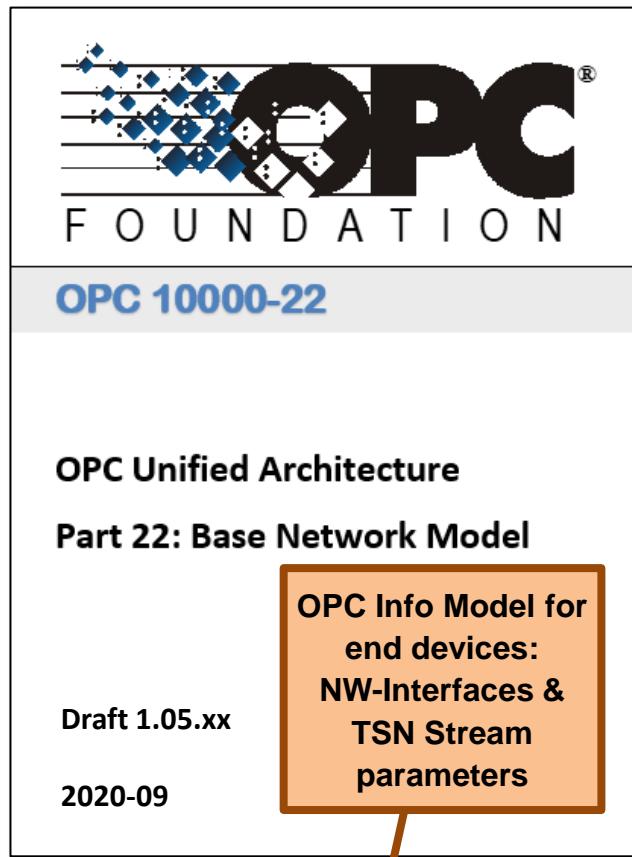
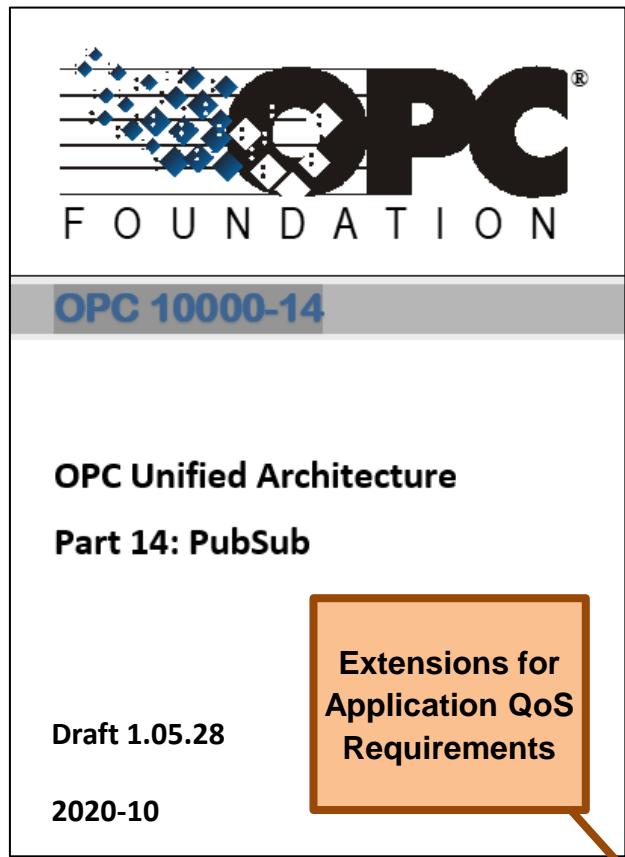


FLC over TSN – Layered Architecture



- ▶ IEEE 802 defines base standards & IEC/IEEE 60802 selects from these for TSN-IA profile
- ▶ OPC UA PubSub TSN enhances OPC UA PubSub with framework for QoS/TSN configuration
- ▶ OPC FLC defines system-level integration of TSN based on OPC UA PubSub TSN

UA TSN Subgroup: Related Drafts and Concept Papers



Contributions from OPC UA TSN Subgroup

Drafting and Prototyping Activities around OPC TSN

OPC FLC (Field Level Communication)

- ▶ OPC FLC WG:
 - First Release Candidates expected in Q4 2020 for C2C
- ▶ OPC FLC Prototyping :
 - Starting with Prototyping for C2C
- ▶ OPC FLC TSN Expert Assessment Group
 - Focus on TSN data plane mechanisms used for OPC FLC
 - → Contributing to IEC/IEEE 60802

OPC UA

- ▶ OPC UA TSN Subgroup + OPC UA Prototyping Subgroup
 - Focus on TSN configuration mechanisms
 - Support of Distributed Model (using LRP / RAP) and Centralized Model (OPC-CUC + CNC)
- ▶ OPC Base Network Model Group
 - Information Model for Network Interfaces and Streams.
Used for UA TSN / FLC and other Companion Specs

Summary

- ▶ FLC defines the concepts for combining OPC UA with real-time, safety and motion for controllers and field devices in factory automation and process industry.
- ▶ OPC UA framework provides the flexibility to map QoS to multiple communication standards.
- ▶ Upcoming technologies which are considered:
 - 5G and WiFi-6/7 for mobile industrial applications
 - DetNet as an “Umbrella Layer” for E2E QoS over various network technologies (e.g. TSN, 5G, Wi-Fi)
- ▶ TSN and IEC/IEEE60802 are key elements for a converged industrial network.
- ▶ A general / standardized “QoS-Service-Interface” is needed to simplify integration of OPC on end device stacks.

Thank you!



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