

Industrial Network based on Convergent & Elastic Ethernet

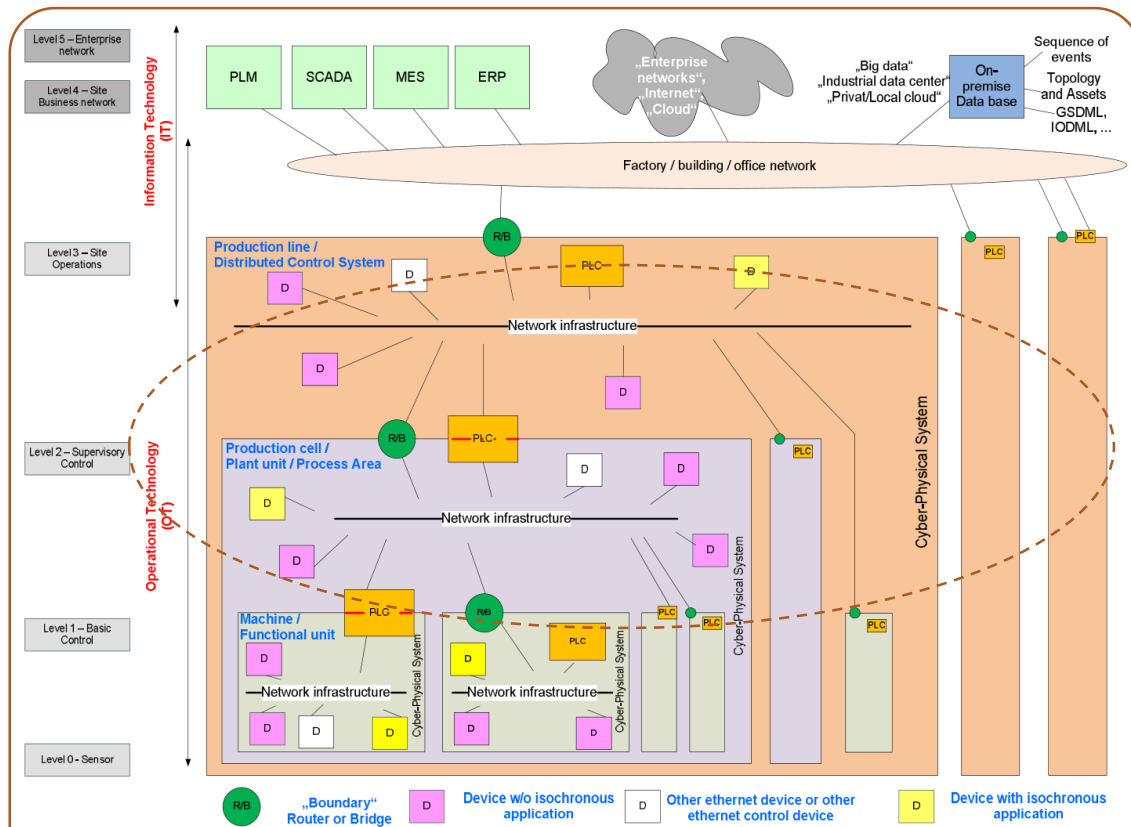
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Background

- This presentation is the follow-up discussion of [Convergent & Elastic Ethernet Networking for Industry](#).
- To present the following 3 points, and push the Elastic Ethernet network to support industrial scenarios better.

	1 No Need Scheduling	2 Centralized Control	3 Extreme Performance
Service Scope	<p>Service traffic QoS as:</p> <ul style="list-style-type: none">• $1\text{ms} \leq \text{application cycle} \leq 100\text{ms}$• jitter $\leq 15\%$	<p>Service traffic QoS as:</p> <ul style="list-style-type: none">• Application cycle down to hundreds of microseconds• jitter $\leq 1\%$	<p>Service traffic QoS as:</p> <ul style="list-style-type: none">• Application cycle down to dozens of microseconds• jitter $\leq 1\mu\text{s}$
Network Scope	<ul style="list-style-type: none">• The existing industrial Ethernet network based on TSN in production line / cell	<ul style="list-style-type: none">• The existing field network based on Ethernet (from edge PLC to OT devices) with different scheduling domain	<ul style="list-style-type: none">• The new field network based on standard Ethernet (from edge PLC to OT devices) in future
Proposed Direction	<ul style="list-style-type: none">• Assure QoS for Weak Deterministic Traffics without Scheduling base on existing TSN network	<ul style="list-style-type: none">• Ethernet Switch to connect existing OT devices from edge PL to OT device• Provide unified network scheduling within the whole network	<ul style="list-style-type: none">• Improve forwarding performance of standard Ethernet switch• Provide Ethernet-based field network to Ethernet-based field devices

1 Assure QoS for Weak Deterministic Traffics without Scheduling



➤ **Issue:** There are quite a few constraints related to the machine internal networks. Each machine may run a different schedule and even the intervals may be different. **It may be very complex or even impossible to find an optimal communication schedule** down from the sensors and actuators to the cell control. Source: [60802 industrial use cases V1.3](#)

➤ Service Scope:

- ❑ 1ms < application cycle < 100ms
- ❑ Jitter < 15%

➤ Network Target:

- ❑ To assure QoS for these traffics
- ❑ Only need bridge internal scheduling
- ❑ To avoid scheduling with device cooperation

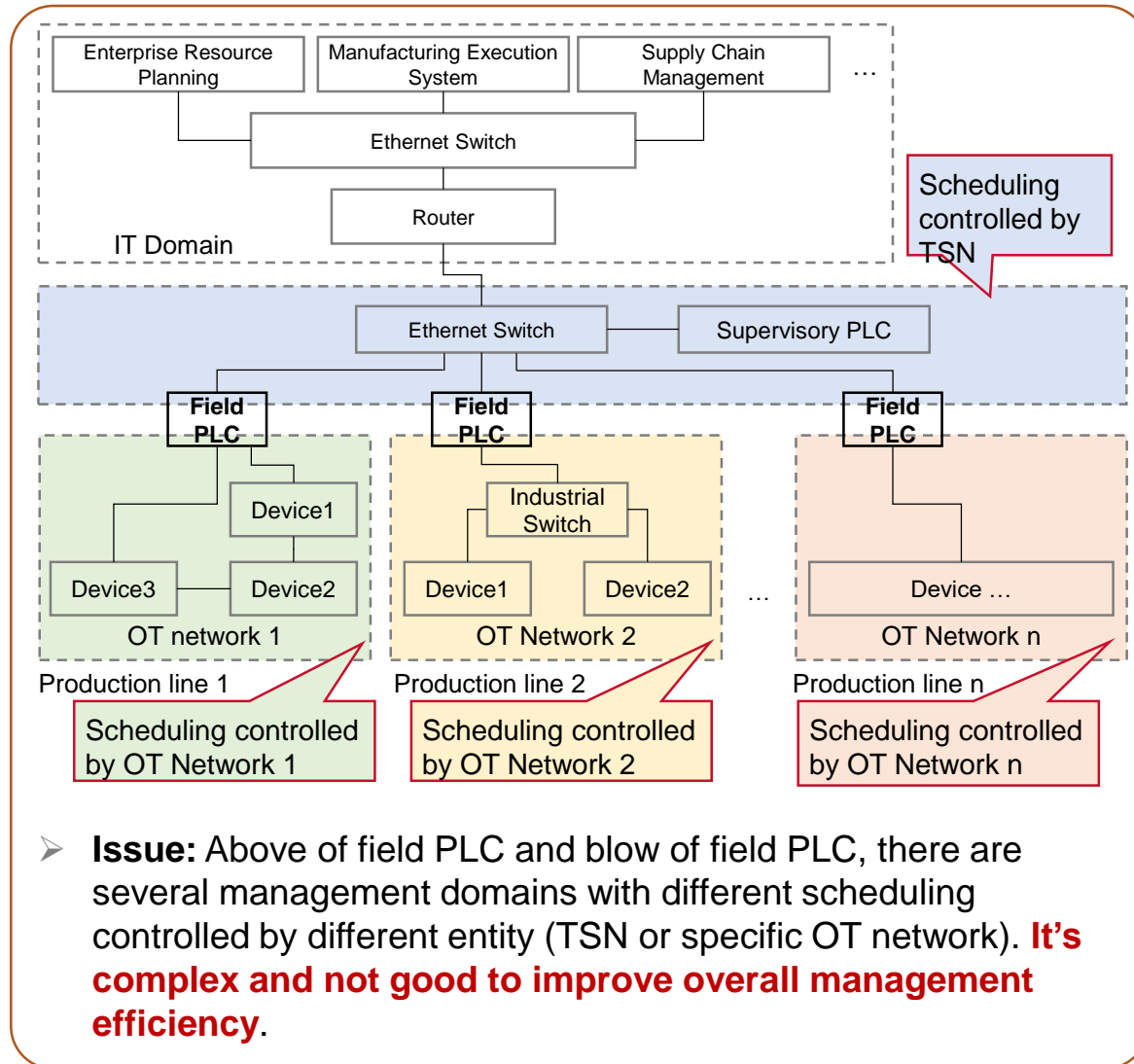
➤ Potential Solution:

- ❑ To implement soft clock
- ❑ To improve bridge internal scheduling mechanism with multi-factors according to traffic attributes

➤ Different from 60802:

- ❑ In 60802, it may be very complex or even impossible to find an optimal communication schedule.
- ❑ We hope to find a weak determinism capability without scheduling for these traffics.

② Centralized Scheduling Control for Multi-domains including TSN domains and OT Network Domains

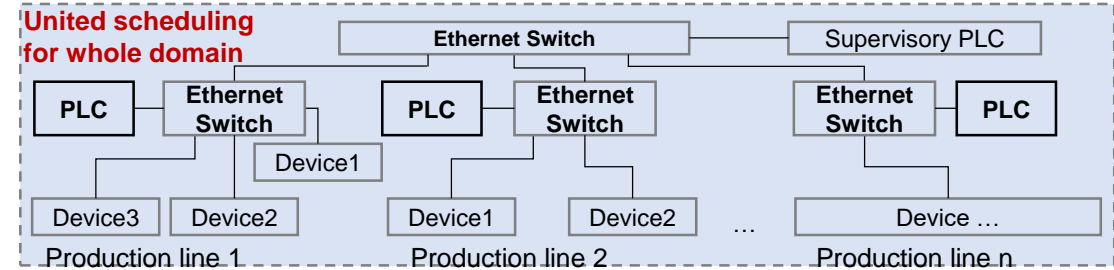


➤ Service Scope:

- ❑ Application cycle down to hundreds of microseconds
- ❑ Jitter $\leq 1\%$

➤ Network Target:

- ❑ United scheduling / centralized management & control with Ethernet switch covering field level



➤ Potential Solution:

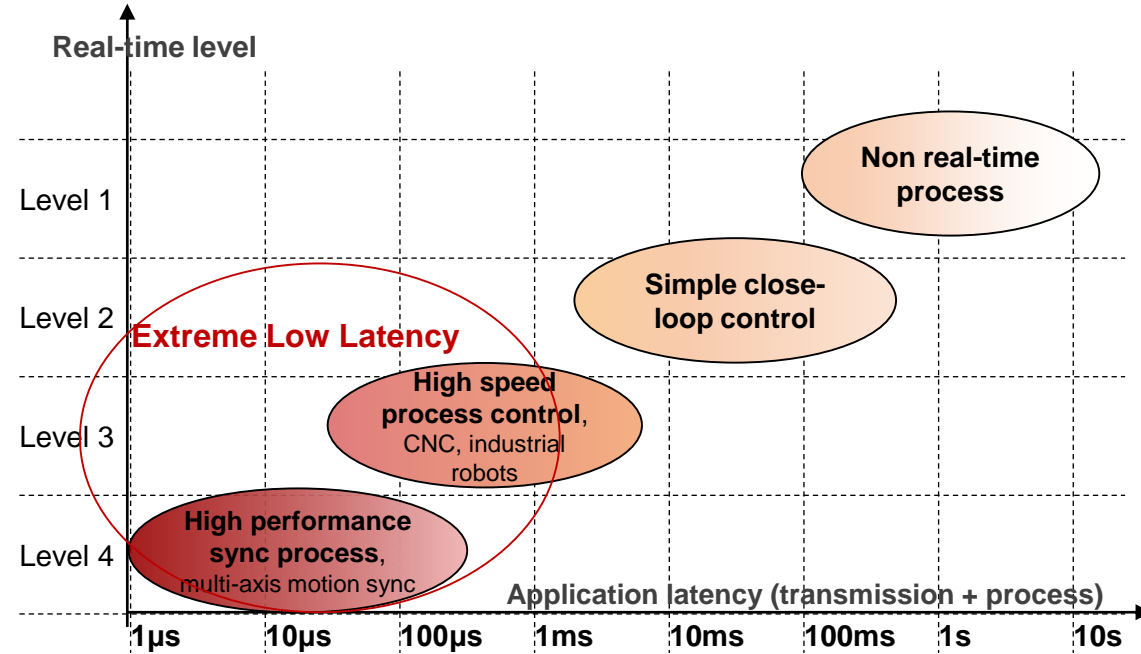
- ❑ Ethernet switch connects existing PLC / device of OT and simulates the OT network mechanism
- ❑ To implement united scheduling under TSN for whole domain

➤ Difference from 60802:

- ❑ In 60802, different domain with different scheduling under TSN or specific OT network
- ❑ We hope to get a united & centralized scheduling control under TSN, and improve scheduling efficiency and overall adjustment.

③ Ethernet Network to Implement Extreme Low Latency / Jitter in Field Level

As increasing of control complexity and precision of the control system, the real-time performance is also increasing.



Refer to: Nendica contribution [Low Latency Discussion for Ethernet Networking](#)

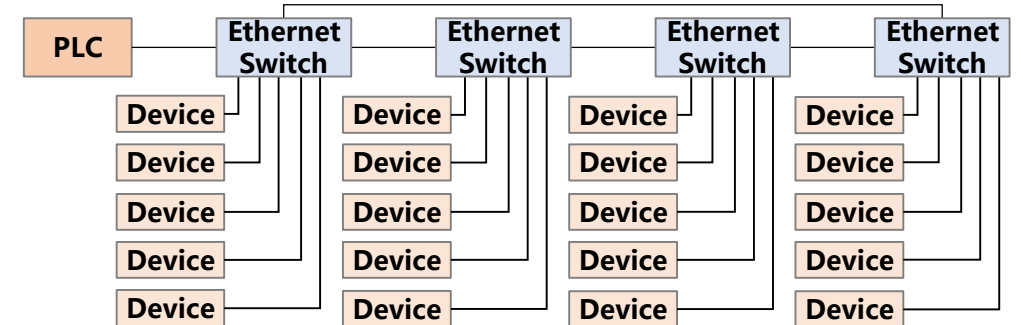
- **Issue:** The main purpose of TSN is to guarantee the bounded latency. Compared with existing industrial Ethernet connections, **standard Ethernet network has the gap to address the absolute low latency for industrial scenarios.**

➤ Service Scope:

- ❑ Application cycle down to dozens of microseconds
- ❑ Jitter $\leq 1\mu\text{s}$

➤ Network Target:

- ❑ Extreme low latency / jitter based on standard Ethernet for industrial scenarios



➤ Potential Solution:

- ❑ During forwarding progress, Ethernet switches implement extreme low latency / jitter via payload optimization or other aspects
- ❑ The PLC and devices support standard Ethernet.

➤ Difference from 60802:

- ❑ To pursue the absolute low latency for industrial scenarios based on standard Ethernet, it's not covered by 60802.

Next Steps

- To explore the technology:
 1. Weak deterministic without scheduling
 2. United scheduling and centralized management
 3. Extreme low latency & jitter based on standard Ethernet for industrial scenarios
- Consider to initiate a new study item in Nendica.

Thank you.