Industrial Network based on Convergent & Elastic Ethernet

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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.

### Service Scope

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<tr>
<th>No Need Scheduling</th>
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<td>Service traffic QoS as:</td>
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### Network Scope

- The existing industrial Ethernet network based on TSN in production line / cell

### Proposed Direction

- Assure QoS for Weak Deterministic Traffics without Scheduling base on existing TSN network

### Centralized Control

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- The existing field network based on Ethernet (from edge PLC to OT devices) with different scheduling domain

### Extreme Performance

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- The new field network based on standard Ethernet (from edge PLC to OT devices) in future

- Ethernet Switch to connect existing OT devices from edge PL to OT device
- Provide unified network scheduling within the whole network

- Improve forwarding performance of standard Ethernet switch
- Provide Ethernet-based field network to Ethernet-based field devices
Assure QoS for Weak Deterministic Traffics without Scheduling

**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

**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

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

- **Issue:** Above of field PLC and blow of field PLC, there are several management domains with different scheduling controlled by different entity (TSN or specific OT network). It’s complex and not good to improve overall management efficiency.

- **Service Scope:**
  - Application cycle down to hundreds of microseconds
  - Jitter ≤ 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.
Ethernet Network to Implement Extreme Low Latency / Jitter in Field Level

- **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 ≤ 1μs

- **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.

Refer to: Nendica contribution *Low Latency Discussion for Ethernet Networking*
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.