Elastic Ethernet based on Converged Switch

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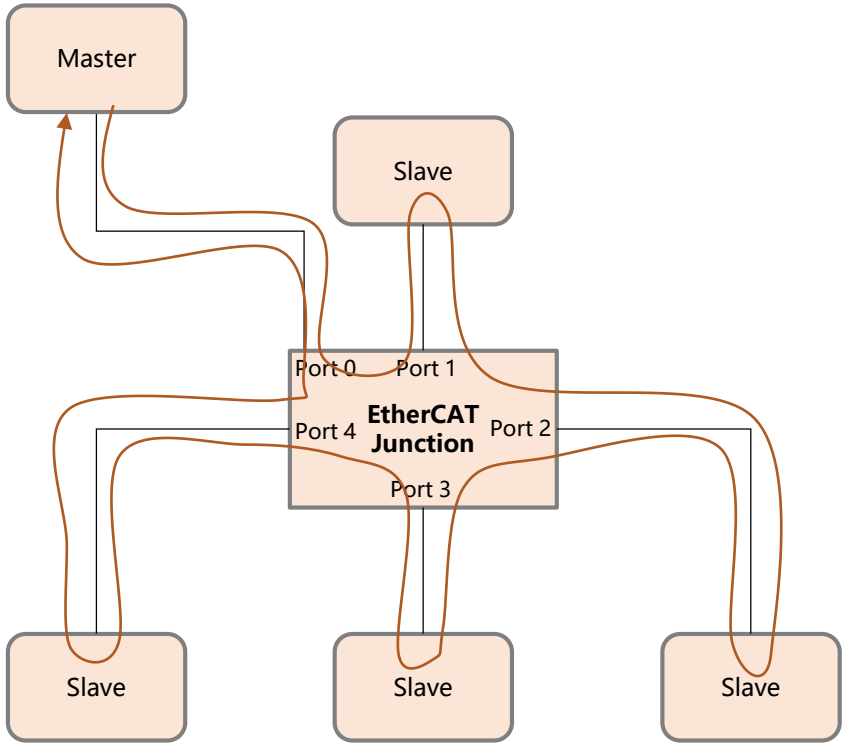
Background

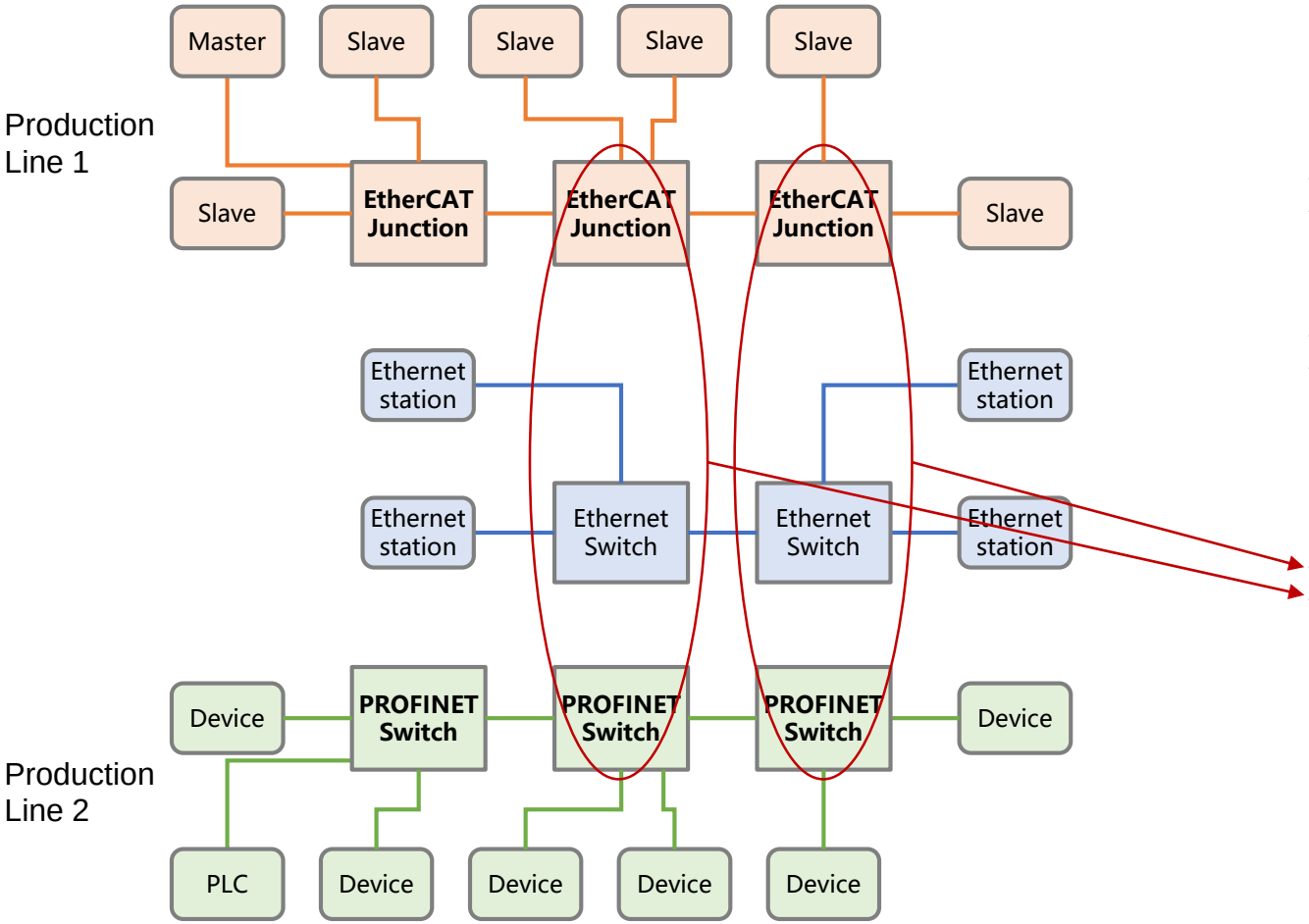
- Regarding Elastic Ethernet, several presentations were discussed:
  - 2021-05-26 Elastic Ethernet based on Converged Switch
    - ✓ Converged switch
  - 2021-05-16 Industrial Network based on Convergent & Elastic Ethernet (presented to 60802 Task Group)
    - ✓ Weak determinism
    - ✓ Centralized management
    - ✓ Extreme low latency / jitter
  - 2021-05-06 Convergent & Elastic Ethernet Networking for Industry (presented to 60802 Task Group)
    - ✓ Convergent industrial network based on Ethernet
  - 2021-04-07 Elastic Ethernet Networking for Industry
    - ✓ Elastic Ethernet framework
  - 2021-11-18 Low Latency Discussion for Ethernet Networking
    - ✓ Extreme low latency / jitter analysis
- This presentation further discusses the Converged Switch including a refined study item proposal.

An Example of EtherCAT Network with Star Topology



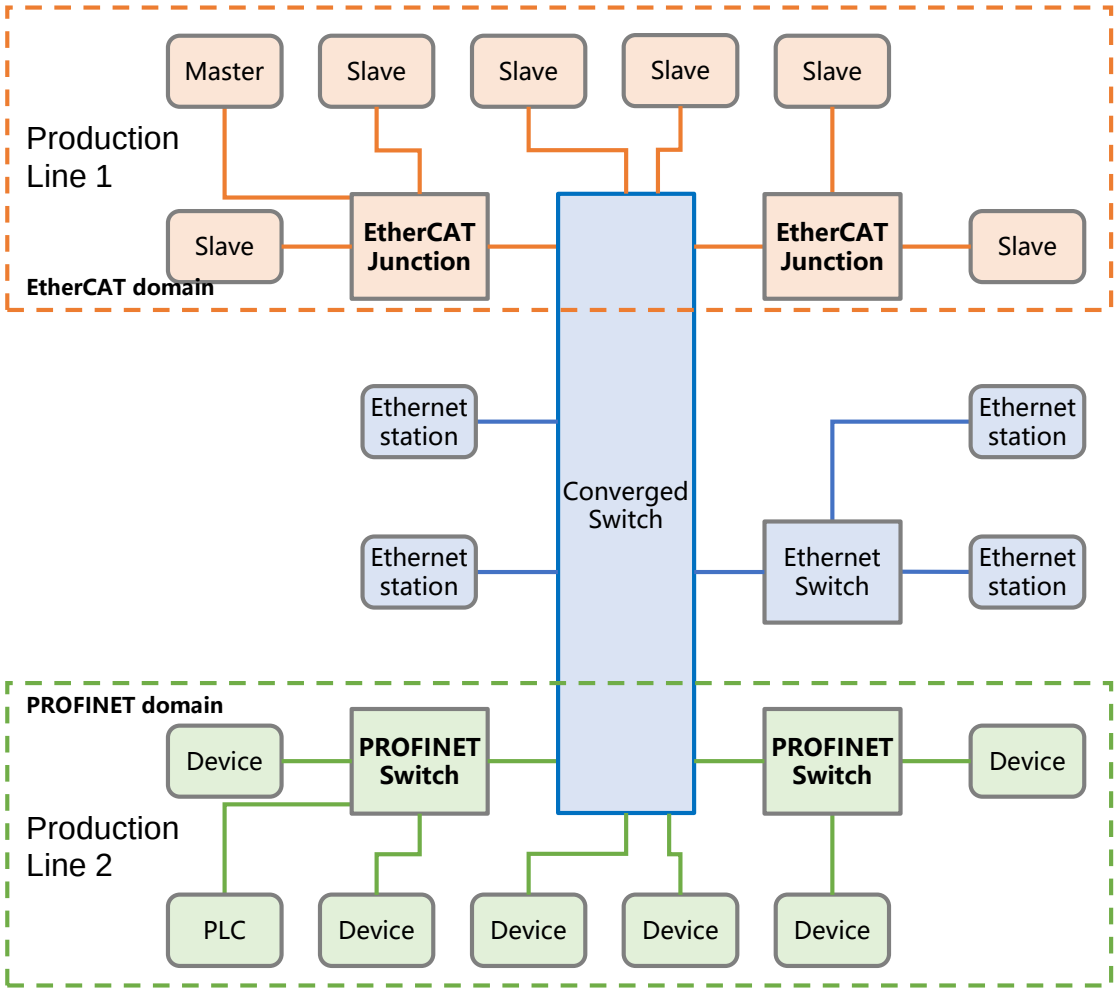
- EtherCAT uses a logical ring topology but can be deployed with a physical star topology.
- The basic principle is that internally the EtherCAT frames continue to be transported in a logical ring:
  - the EtherCAT master sends the frame on the port 0 of the EtherCAT junction
  - this frame passes each port & each slave once,
  - and is returned to the master through port 4 & port 0.
- But the EtherCAT junction **cannot be used as an Ethernet bridge**.
- *Is it possible to forward EtherCAT frames & standard Ethernet frames simultaneously in a converged forwarding device?*

Multiple Network Scenarios



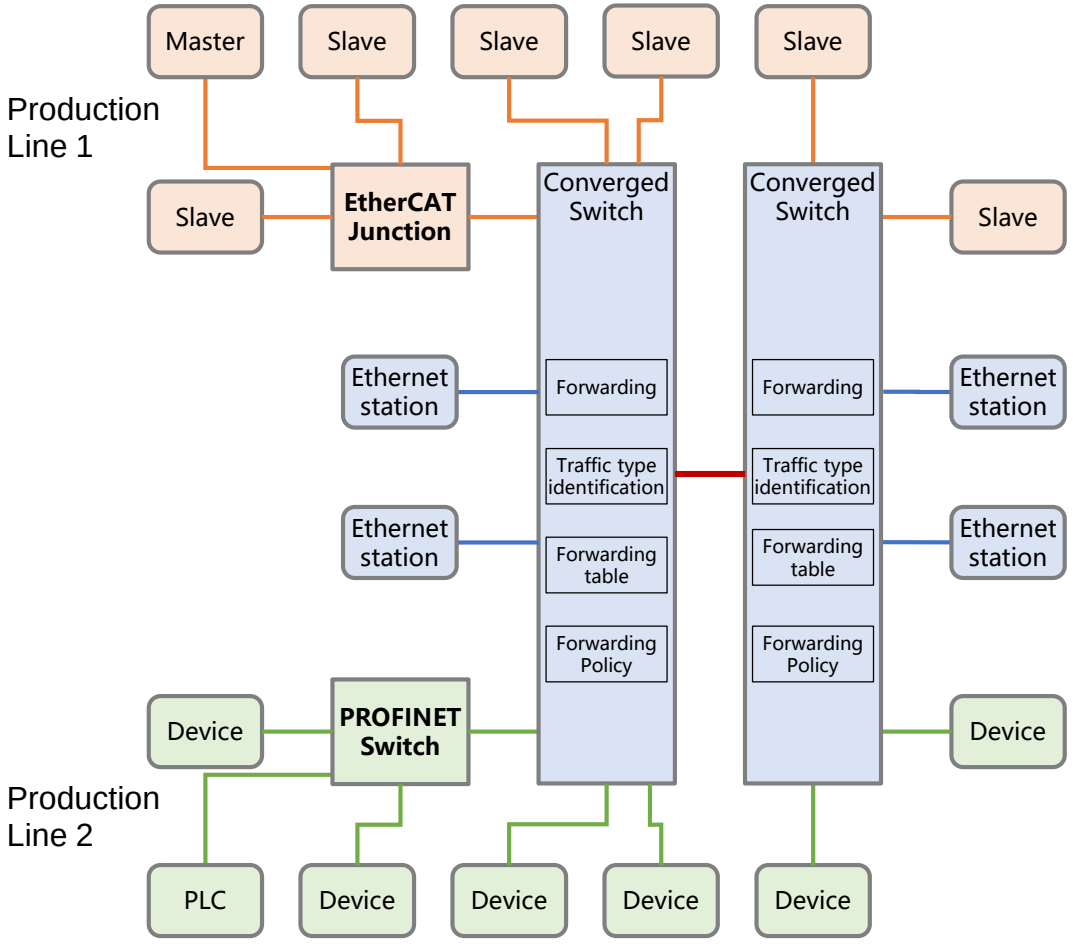
- Different production line use different industrial networks via different industrial frame forwarding devices.
- Each switch node connect the devices as star topology.
- Nearby some switch nodes, there are some Ethernet switches / stations or devices of other industrial network.
- *Is it possible to forward EtherCAT frames, PROFINET frames & standard Ethernet frames simultaneously in a converged forwarding device?*

Converged Switch in Isolated Networks



- The converged switch simultaneously forwards standard Ethernet frames, connects all EtherCAT devices in EtherCAT domain, and connects PROFINET devices I PROFINET domain.
- The appropriate forwarding method is based only on the port, and the converged switch is configured based on the network attached there.

Converged Switch in Mixed Networks



- The converged switch may need to support mixed networks.
- Each access port (to a station) only carries a single frame type for a specific network according the station connected.
- The (red) inter-switch link between the converged switches carries a mix of frame types.
- The appropriate forwarding method is determined not only by the port; the frame type should be considered to select the forwarding rule.
- The inter-switch link is a shared resource, and the Converged Switch may need to allocate the resource to assure the QoS for each network.
- *Future end stations may need to support mixed networks; e.g. Ethernet control messaging to an EtherCAT slave.*

QoS of Traffic Through the Inter-Switch Link

As the network scales out, it’s important to manage the resources to assure the QoS.

- Centralized Management
  - Collect attributes and QoS request
  - Compute resource utilization, deadline, path routing etc. for each request
  - Allocate resources for each request
  - Distribute the result of allocation to each converged switch
  - Adjust quickly as the network scales out or is updated
- Improve the forwarding delay
  - Cut-through forwarding (required for EtherCAT)

The Pros & the Cons of Converged Switch

Category	Pros	Cons	Potential Solution
Forwarding	• One category of switch supports multiple scenarios	• Challenge to support forwarding modes different from standard Ethernet • Extra switching may increase latency in comparison to physical ring • Challenge to assure QoS, to avoid the shared resource conflict between different kinds of traffic	• To support different forwarding modes based on converged switch with new designed forwarding table • Unified to scheduling timeline and allocate bandwidth resources for different kinds of traffic
Management	• Centralized management based on converged switch leads to the overall effectiveness (e.g. proper traffic routing)	• Challenge to improve the management process and corresponding tool to mitigate complication of management	• To provide unified tool to implement the management & extension functionality
Extension	• To plan from the whole viewpoint, and to be good to get the optimal extension solution	• Challenge with network reconfiguration	
Future evolution	• To be ease to implement communication across different networks, e.g. Ethernet control message from IT application to PLC, or PLC to PLC of different industrial network for coordination across production line	• -	• -

Proposal for Nendica Study Item

- For Nendica to initiate a study item on **Converged Elastic Ethernet Network**

To be studied	• Industrial requirements for elastic topology / forwarding and converged switch. • Feasibility of assuring QoS for all devices connected by the converged switch. • Feasibility of scheduling. • Feasibility of centralized & effective management / scheduling. • Other related aspects (high available, security, etc.) requested by industrial scenarios.
Deliverable	An informal report documenting • Summary requirements of industrial scenarios unsatisfied by current industrial networks • Potential benefits from Converged Elastic Ethernet Network • Impact & optimization of evolving technologies • Possible standardization needs • Possible recommendation to initiate a work item
Leader	• Huajie Bao (Huawei), or other volunteers
Timeline	• Start in June 2022, finish in Nov 2022 • Draft version Aug 2022 • Call for comments Sept 2022 • Complete Study Item Report Nov 2022
Work schema	• Weekly meeting or on-demand meeting • Encourage all contributions

Thank you.