Cut-Through Forwarding (CTF) in Bridges and Bridged Network – Need for Unified and Standardized Management

Johannes Specht
(Self; Analog Devices, Inc.; Mitsubishi Electric Corporation; Phoenix Contact GmbH & Co. KG; PROFIBUS Nutzerorganisation e.V.; Siemens AG; Texas Instruments, Inc.)

Dieter Proell
(Siemens AG)

DCN 1-22-0031 03 ICne

Introduction

- This slide set describes the need for unified bridge management for CTF standardized in IEEE 802.1.
  - To the author's understanding, it is not broadly understood by several IEEE 802.3 individuals why standardizing CTF is required at all.
  - The contents thereby follow the suggestions from the NEA/Nendica joint ad hoc meeting on CTF by the IEEE 802.3 chair for progressing.
- A unified bridge management for CTF is one of the motivations for standardizing CTF, but additional motivation is found in https://mentor.ieee.org/802.1/dcn/21/1-21-0037-00-ICne-ieee-802-tutorial-cut-through-forwarding-ctf-among-ethernet-networks.pdf

The Need for Unified and Standardized Management for CTF

IEEE 802.1 TSN background

- The need for unified and standardized management is nothing introduced by CTF:
  - It is needed in systems utilizing various IEEE 802.1 TSN tools like shapers and policers with the need for hard end-to-end QoS guarantees.
  - Such systems exist in various markets (e.g., Industrial Automation, professional Audio/Video, Automotive), not just a single market.
- Providing hard end-to-end QoS guarantees implies management on a per network/network segment resolution, not just a single port/port-pair.
- In many cases, systems using TSN tools rely on automatic configuration instead of human operators:
  - Computational intensive configuration tasks
  - Requiring hard QoS guarantees disqualifies 99% approaches
- In many cases, systems using TSN tools are composed by multi-vendor equipment and therefore require interoperable and unified management.

IEEE 802.1 appears to be the preferable Venue

- IEEE 802.1 is the “home” of the other TSN tools → fits into the existing management system
- Broad acceptance across vendors/markets questionable if outside of IEEE 802.1, in a reasonable timeframe and in general
- IEEE/IEC P60802 is an ongoing joint project of IEEE 802.1 and IEC for standardizing commonalities across different Ethernet derivates from IEC <<TBD: check>>

- <<TBD: Extend this list>>

Example: Simple TSN Management Flow and relationship to CTF

The simple management flow in this section is one of many possible management flows. See IEEE Std 802.1Qcc-2018, amendments to IEEE Std 802.1Q-2018 and ongoing amendments projects for further details.

One (out of many) TSN Configuration Flows (simplified)

1. Gather **device capabilities**

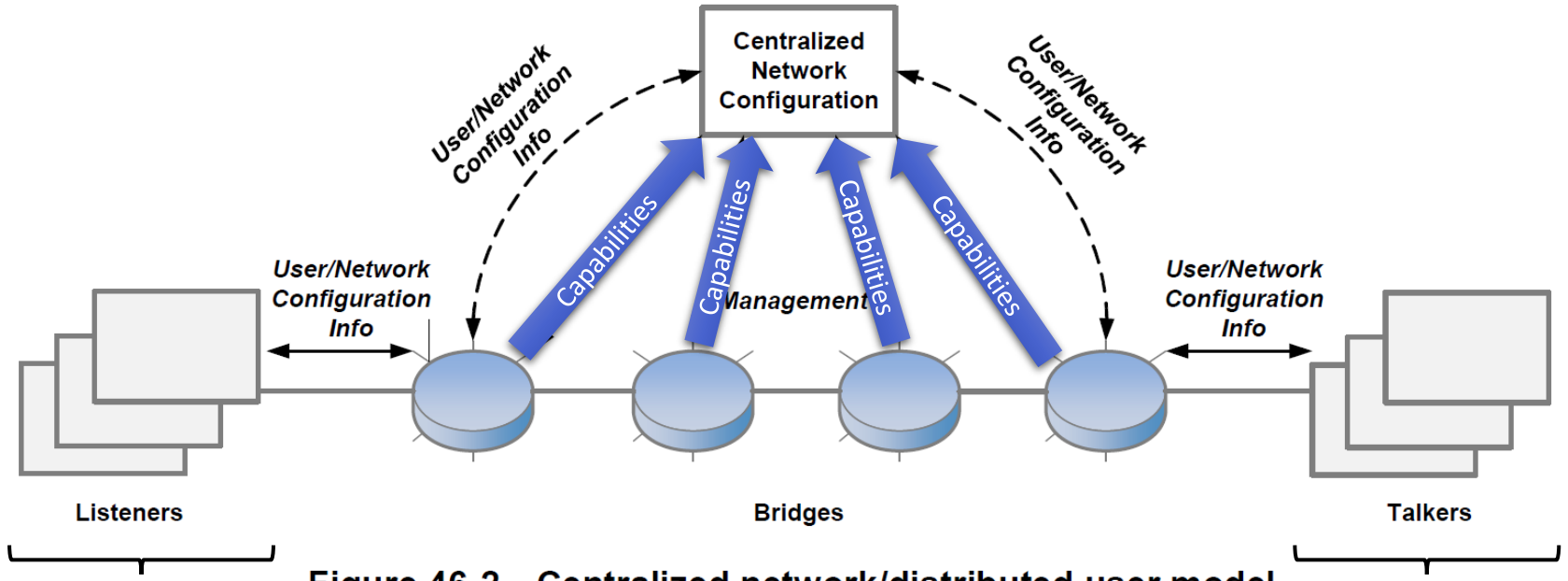


Figure 46-2—Centralized network/distributed user model

In End Station(s)

In End Station(s)

Based on Figure 46-2 of IEEE Std 802.1Qcc-2018

One (out of many) TSN Configuration Flows (simplified)

2. *Stream* requests

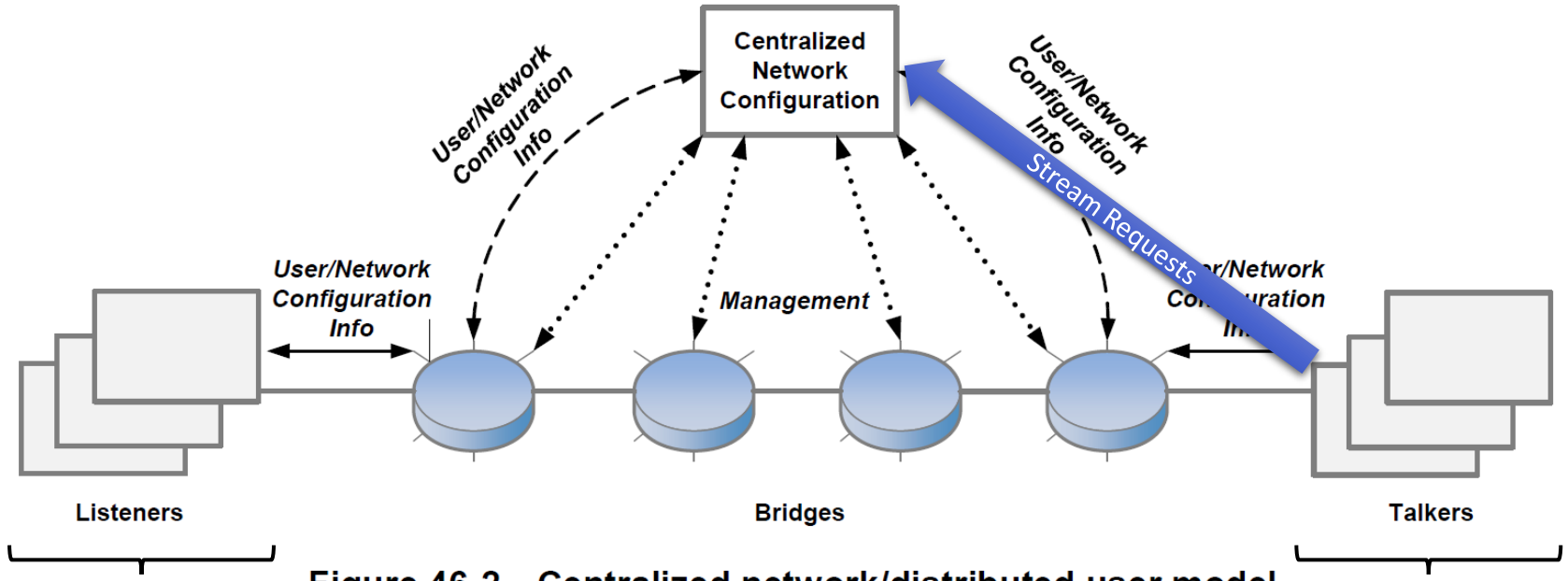


Figure 46-2—Centralized network/distributed user model

In End Station(s)

In End Station(s)

Based on Figure 46-2 of IEEE Std 802.1Qcc-2018

One (out of many) TSN Configuration Flows (simplified)

3. Compute and setup **device configuration**

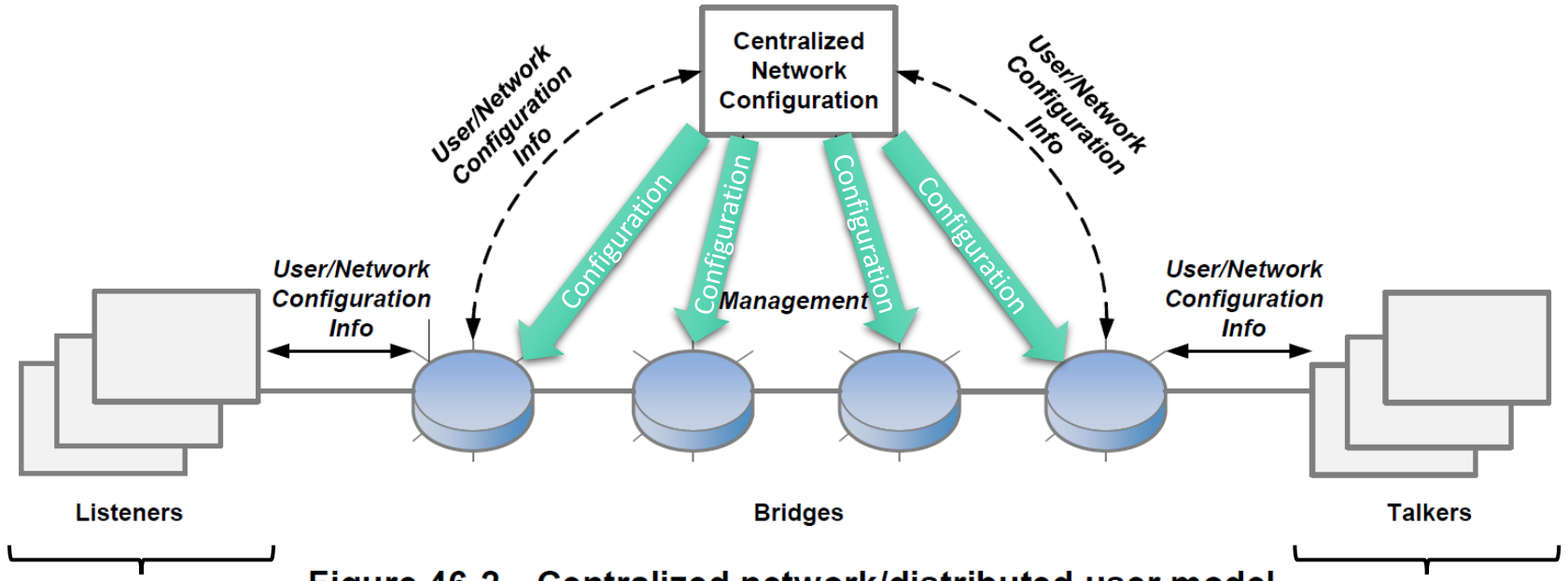


Figure 46-2—Centralized network/distributed user model

In End Station(s)

In End Station(s)

Based on Figure 46-2 of IEEE Std 802.1Qcc-2018

One (out of many) TSN Configuration Flows (simplified)

4. *Stream* activation

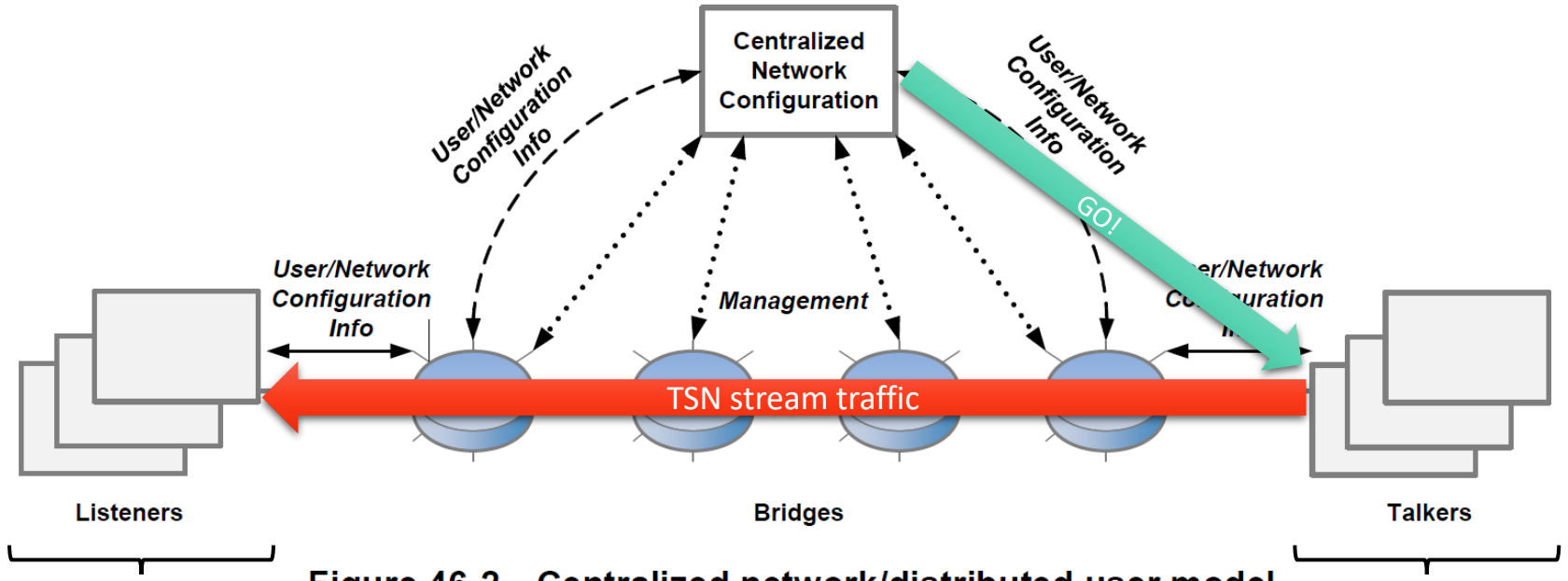


Figure 46-2—Centralized network/distributed user model

In End Station(s)

In End Station(s)

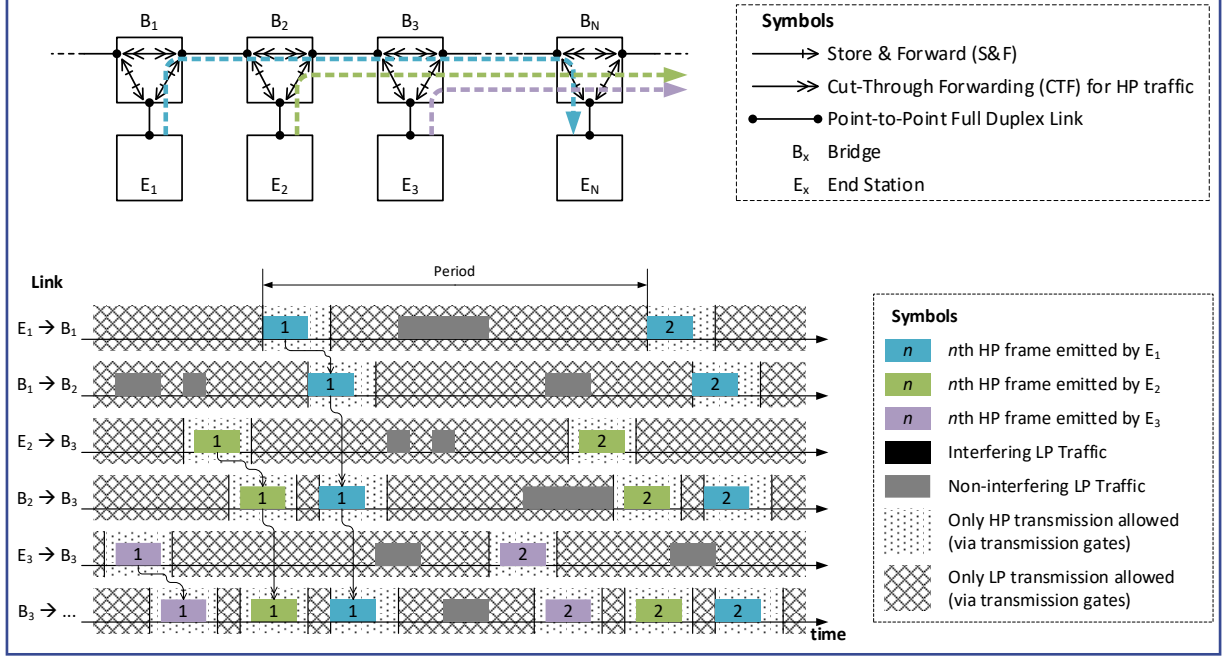
Based on Figure 46-2 of IEEE Std 802.1Qcc-2018

Simple CTF Example: Full TDM[1], Line Topology

CTF or S&F-only?
Can depend on the topological location
→ **Management** on the network level

Planning TDM Windows
Tight windows can be preferable for efficiency
→ **Per device capabilities** on RX-to-TX timing under CTF
→ **Management** on the network level required

Scenario: Full time division multiplexing



CTF or S&F?
Can depend on the traffic/ traffic class
→ Per port/traffic class **configuration** (CTF on/off)
→ Per port/traffic class/ **device capabilities** (CTF support yes/no)

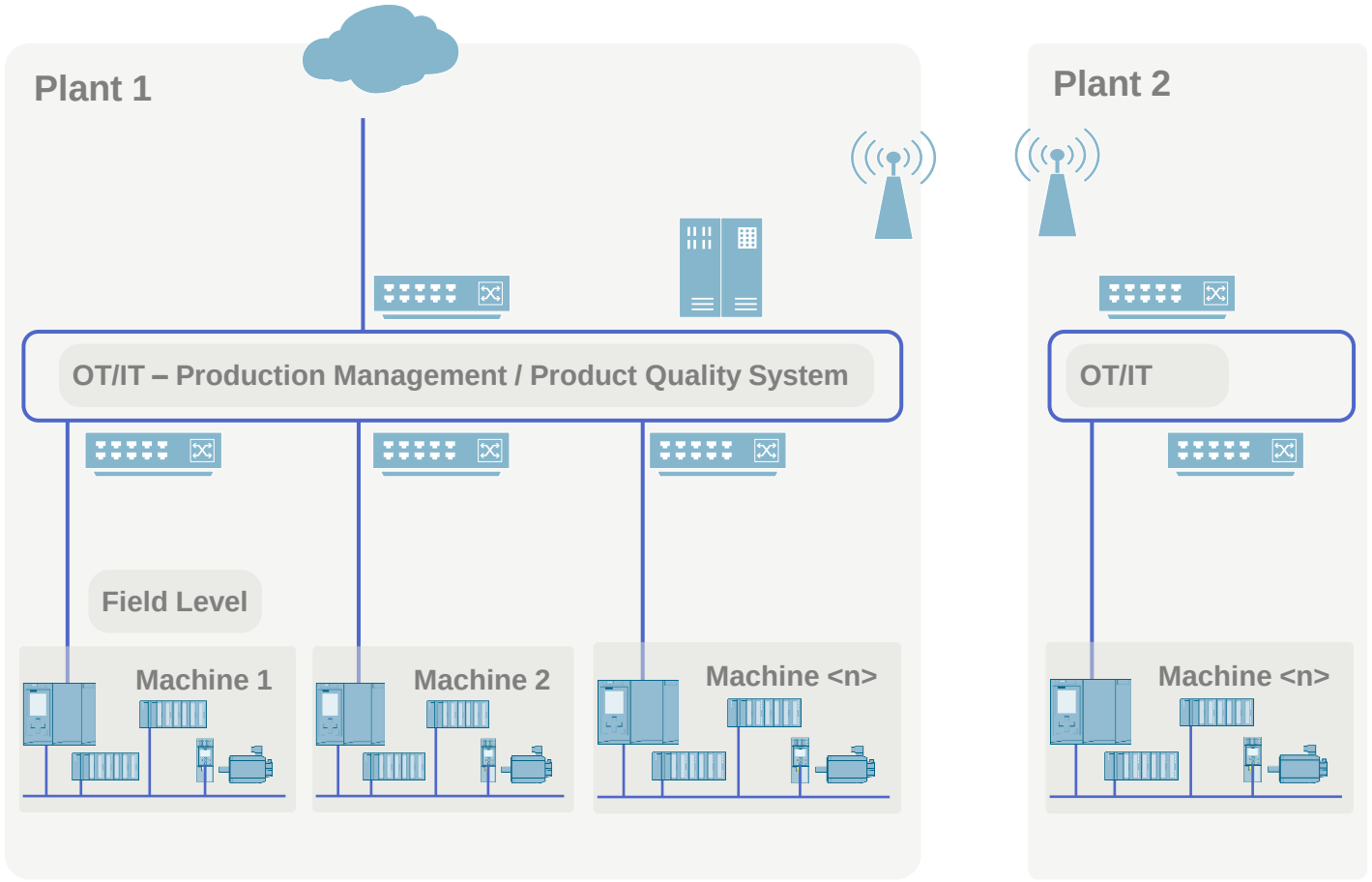
Notes
1: This is just one example out of many configurations CTF can be used. See section "Introduction" of https://mentor.ieee.org/802.1/dcn/21/1-21-0037-00-ICne-ieee-802-tutorial-cut-through-forwarding-ctf-among-ethernet-networks.pdf for further details and more simple examples.

Example: Management in Industrial Automation and relationship to CTF

Industrial Automation is one of many relevant markets. See https://mentor.ieee.org/802.1/dcn/21/1-21-0037-00-ICne-ieee-802-tutorial-cut-through-forwarding-ctf-among-ethernet-networks.pdf for slides on other markets.

Converged Network – simplified Industry Automation example

Please note, to see more details and more examples from Audio/Video and DataCenter, we recommend the Tutorial from July 2021 Plenary.
Link https://1.ieee802.org/2021-07-plenary-tsn-agenda/#IEEE_802_Tutorial with Video Recording



- Plant operators expects a design following industry 4.0 and request bounded low latency and quality of service to all components and levels.
- Data exchange is requested by the plant operator from / to:
  - Machine to Machine
  - Machine to OT/IT
  - Machine to Cloud
  - OT/IT to Cloud
  - Plant to Plant
- Industry 4.0 features are requested on wired and wireless network (Wifi, 5G)
- Different companies built the machines and OT/IT network.
- Companies use different products from different vendors, based on there experience or request from plant operator.

→ Converged network is answer and enabler of industry 4.0
See IEEE SA TSN Industrial 2020 Flyer

Requirements

➢ Standardization of relevant communication and management features

➢ This includes the feature Cut-Through

Thank You for Your Attention!

Questions,
Comments,
Opinions,
Ideas?