

IEC/IEEE 60802

The Case for the Converged Network
in the Factory of the Future

April 6, 2023

**Jordon Woods, Product Line Director,
Analog Devices**

QUICK HOUSEKEEPING ITEMS

1. Upon entering the webinar, all attendee lines are automatically **MUTED**. Today's presentation is a one-way broadcast.
2. If you are experiencing technical issues (audio or visual), use the **CHAT** feature and message the host, for help troubleshooting.
3. To ask **QUESTIONS** throughout the webinar, use the Q&A feature.

The views expressed in this presentation are those of the speakers and do not necessarily reflect those of IEEE. To the extent any products or services are mentioned in the presentation, this is for informational and illustrative purposes only and should not be considered an endorsement of those products or services.

RECAP – TSN WEBINAR SERIES

[Watch the recordings](#)

IEEE SA
STANDARDS ASSOCIATION

FOUNDATIONAL TECHNOLOGIES

TSN Time Sensitive Networking

DRIVING DIGITAL TRANSFORMATION THROUGH IEEE 802.1 TSN TECHNOLOGY

IEEE TIME-SENSITIVE NETWORKING WEBINAR SERIES: AN INTRODUCTION TO IEEE 802.1

SPEAKER: GLENN PARSONS, PRINCIPAL STANDARDIZATION ADVISOR, 5G TRANSPORT, ERICSSON

MODERATED BY: SRI CHANDRASEKARAN, SR DIRECTOR & PRACTICE LEAD, FOUNDATIONAL TECHNOLOGIES, IEEE SA

16 Sept 2021

IEEE

IEEE SA
STANDARDS ASSOCIATION

FOUNDATIONAL TECHNOLOGIES

TSN Time Sensitive Networking

DRIVING DIGITAL TRANSFORMATION THROUGH IEEE 802.1 TSN

IEEE TIME-SENSITIVE NETWORKING WEBINAR SERIES: AN OVERVIEW OF TIME-SENSITIVE NETWORKING

SPEAKER: JÁNOS FARKAS, PRINCIPAL RESEARCHER, ERICSSON

MODERATED BY: SRI CHANDRASEKARAN, SR DIRECTOR & PRACTICE LEAD, FOUNDATIONAL TECHNOLOGIES, IEEE SA

2 December 2021

IEEE

IEEE SA
STANDARDS ASSOCIATION

FOUNDATIONAL TECHNOLOGIES

TSN Time Sensitive Networking

The Transport and Impact of Synchronization in Time-Sensitive Networking

An Introduction to IEEE 802.1AS

February 24, 2022

IEEE

IEEE SA
STANDARDS ASSOCIATION

FOUNDATIONAL TECHNOLOGIES

TSN Time Sensitive Networking

DRIVING DIGITAL TRANSFORMATION THROUGH IEEE 802.1 TSN TECHNOLOGY

IEEE TIME-SENSITIVE NETWORKING WEBINAR SERIES:

AN INTRODUCTION TO AVB (AUDIO / VIDEO BRIDGING), THE 1ST TSN PROFILE

SPEAKER: DON PANNELL, FELLOW, AUTOMOTIVE ETHERNET NETWORKING, NXP SEMICONDUCTORS

MODERATED BY: SRI CHANDRASEKARAN, SR DIRECTOR STANDARDS & TECHNOLOGY, IEEE SA

09 June 2022

IEEE

IEEE SA
STANDARDS ASSOCIATION

FOUNDATIONAL TECHNOLOGIES

TSN Time Sensitive Networking

DRIVING DIGITAL TRANSFORMATION THROUGH IEEE 802.1 TSN TECHNOLOGY

IEEE TIME-SENSITIVE NETWORKING WEBINAR SERIES:

TSN TO THE FORE OF THE TRANSITION TO 5G WITH IEEE STD 802.1CM™

SPEAKER: JESSY ROUYER, STANDARDIZATION SPECIALIST, NOKIA

MODERATED BY: SRI CHANDRASEKARAN, SR DIRECTOR STANDARDS & TECHNOLOGY, IEEE SA

8 September 2022

IEEE

Speaker – Jordon Woods

Product Line Director, Analog Devices

Jordon Woods is the product line director for Analog Devices line of industrial Ethernet products. Woods has 35 years of experience in the semiconductor industry. He is familiar with a variety of Ethernet-based Industrial protocols including Profinet, Ethernet/IP, as well as IEEE Std 802.1AS and other emerging TSN standards. He is also voting member of the IEEE 802 working group defining new Ethernet standards for Time Sensitive Networks and the editor of the IEC/IEEE 60802 Time-Sensitive Networking Profile for Industrial Automation.



Disclaimer

This presentation should be considered as the personal views of the presenters not as a formal position, explanation, or interpretation of IEEE.

Per IEEE-SA Standards Board Bylaws, December 2017

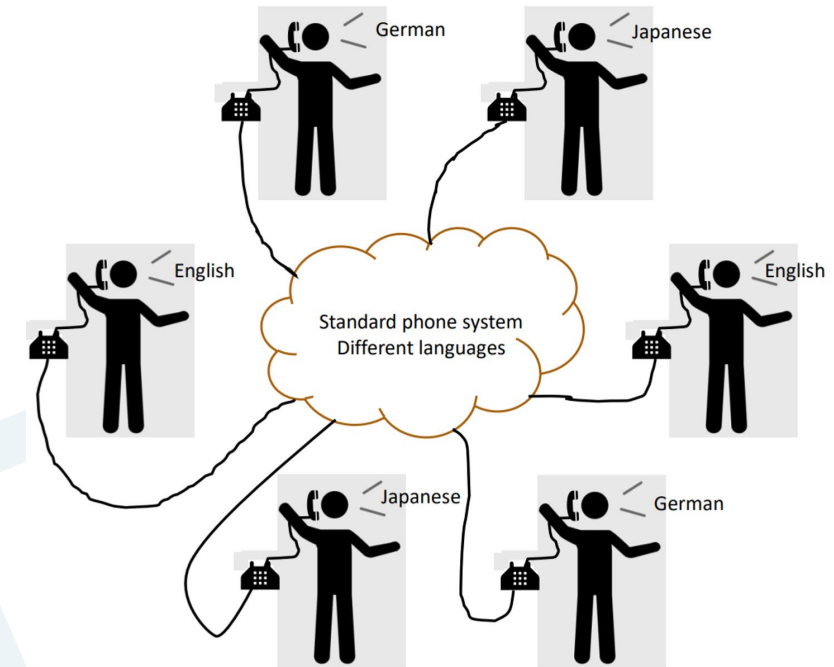
“At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.”

Introduction to the IEC/IEEE 60802 Profile for Industrial Automation

IEC/IEEE 60802 TSN Profile for Industrial Automation

- Time-Sensitive Networking* technology provides the features required for industrial networks:
 - Meeting low latency and latency variation requirements concerning data transmission.
 - Efficient exchange of data records on a frequent time period.
 - Reliable communications with calculable downtime.
 - High availability meeting application requirements
- The 60802 Profile selects “features, options, configurations, defaults, protocols, and procedures of bridges, end stations, and LANs to build industrial automation networks.”

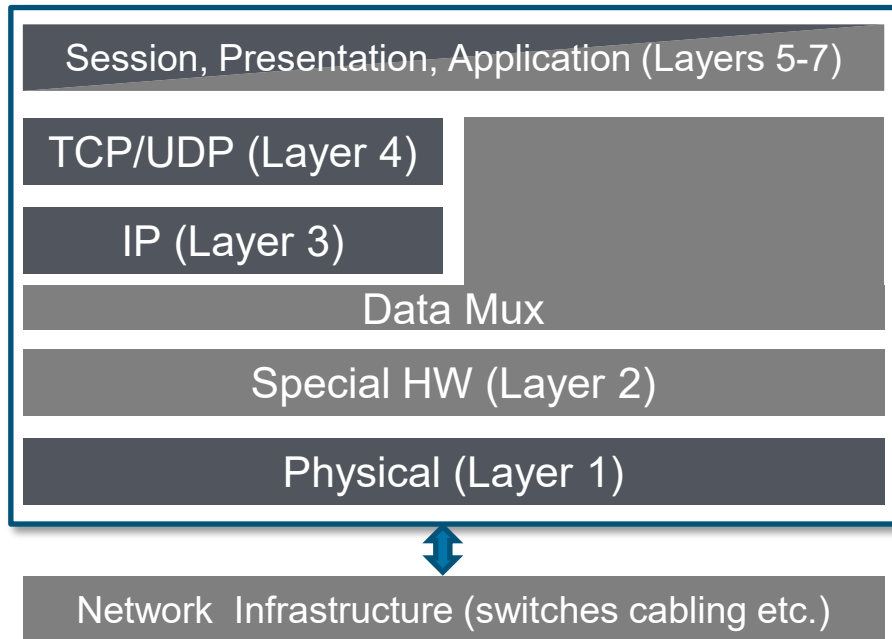
❖ Note: Time-Sensitive Networking is a set of standards developed or under development by the Time-Sensitive Networking task group of the IEEE 802.1 working group. These standards form the basis of the 60-802 TSN Profile.



The Challenge

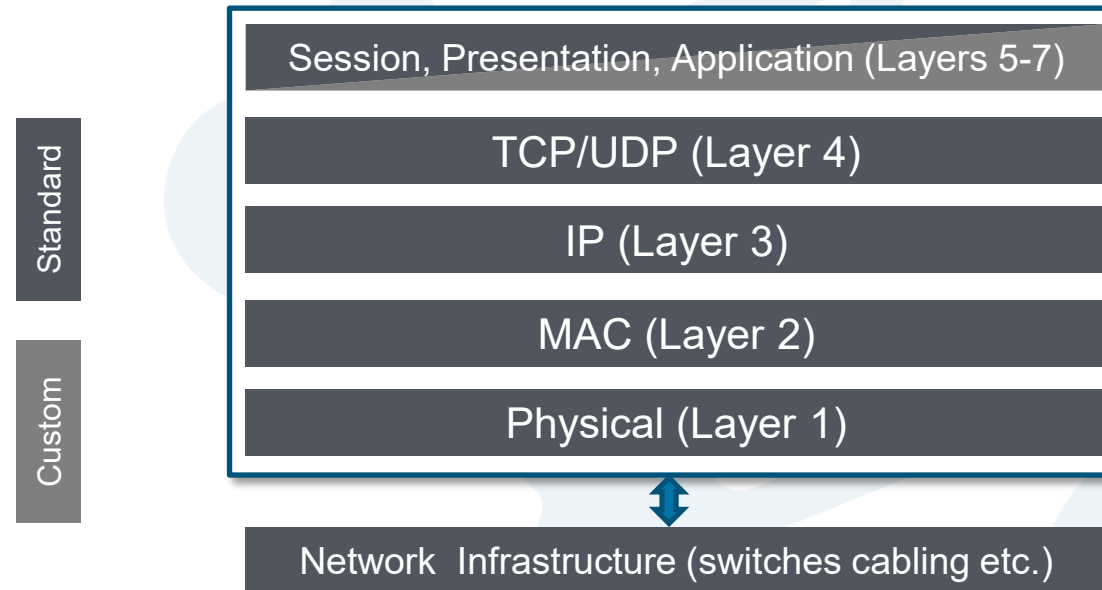
Traditional Industrial Networks:

- Tuned for latency and control
- Cannot “share the wire”
- Cannot scale (limited to 100 Mb/s)
- Proprietary HW/SW increases cost



Traditional (Best Effort) Ethernet:

- Openness and interoperability
- Does not bound latency
- Does not guarantee bandwidth



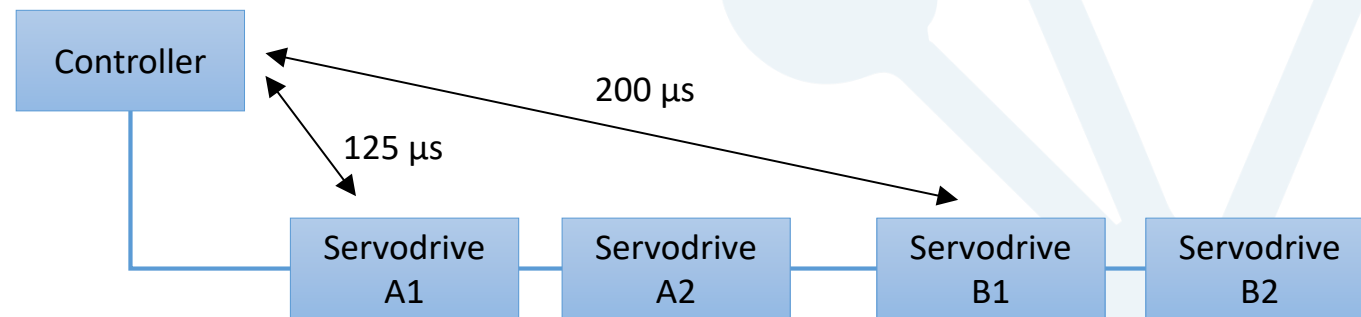
Industrial Automation Requirements



- Environmental
 - -40 to +85 C
 - Life cycle of 10+ years running 24/7
 - Frequency deviation due to
 - Production process tolerances and aging
 - Temperature and temperature change
 - Supply voltage and supply voltage quality
 - Shock and vibration
- Topologies
 - Physical constraints make cabling for star topologies impractical
 - The construction of the application naturally lends itself to point-to-point connectivity

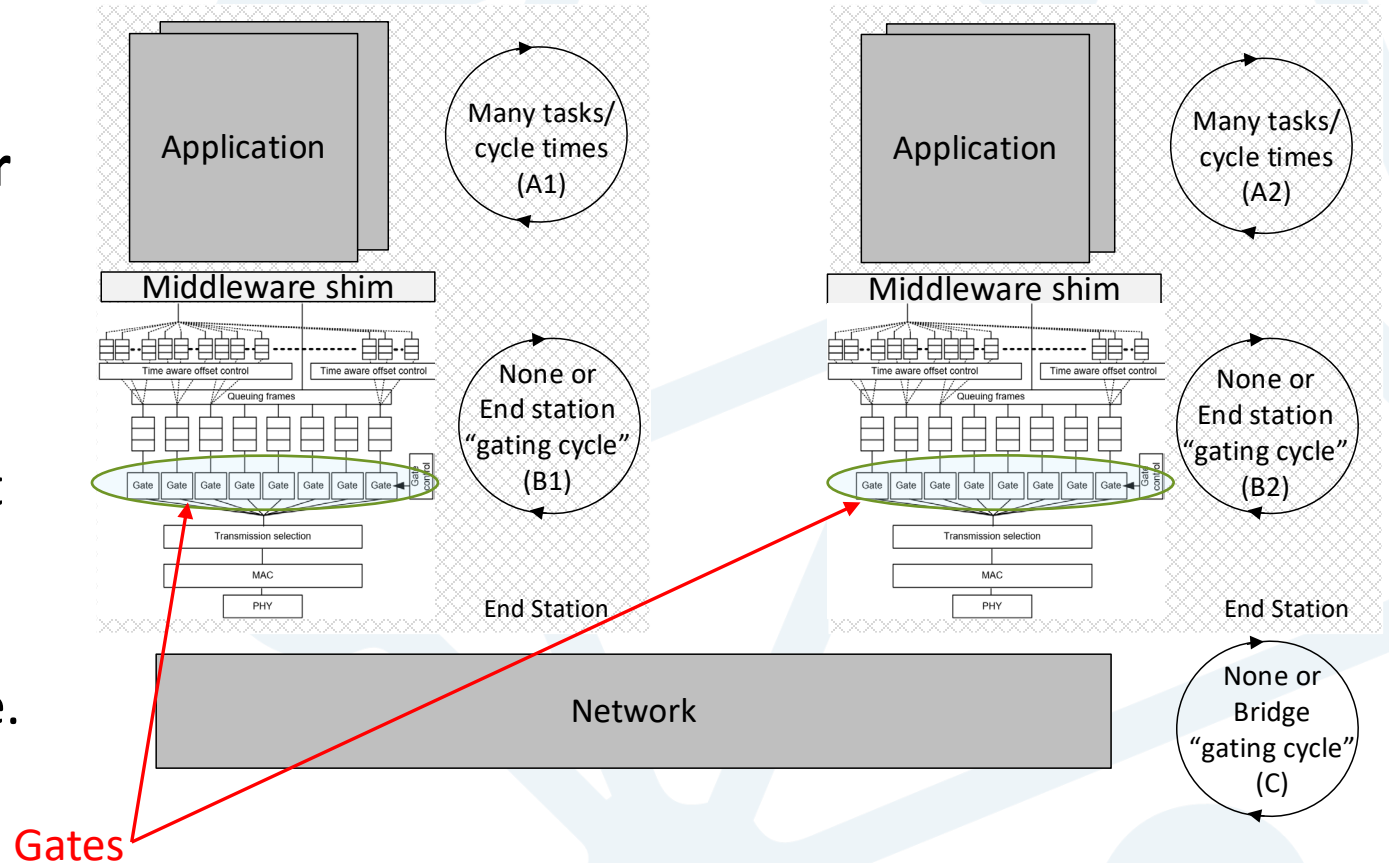
Control Applications and Line Topologies

- Utilization of line topologies is prevalent in motion applications utilizing embedded switch technology
- There can be many hops along the line (64 hops or greater)
- Control loop times can be in the 10s of microseconds
- $\max|TER|$ of the synchronized time, relative to the Grandmaster Clock, is expected to be $1 \mu\text{s}$ across 64 network hops (goal: 100 hops)



Requirements for Scheduled Traffic

- **Scheduled Traffic (802.1Qbv)** introduces transmission gates for time-based control of queues:
 - A tick granularity of less than or equal to 10ns
 - A gating cycle of 250μs to 10ms at the 100Mbps data rate
 - A gating cycle of 31,25μs to 1ms for the 1Gbps data rate and above.
 - Timing points of less than or equal to 10ns



Industrial Automation Synchronization Requirements

- Industrial automation applications require:
 - synchronized time that is traceable to a known source (i.e. Global Time)
 - a source of time for use by the application (i.e. Working Clock).
 - A secondary domain for both Global Time and working clock may be optionally supported



IA-stations

In Industrial Automation, multiple end stations and bridge components may exist in a single chassis:

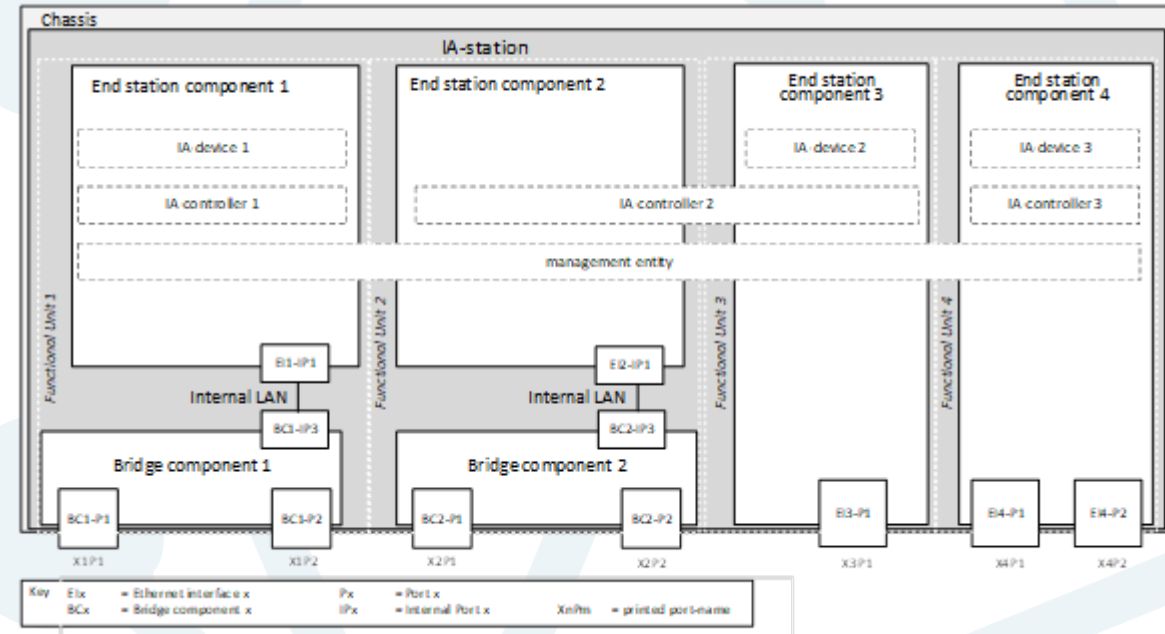
- End stations may be connected to bridge through interfaces that are not based upon IEEE802 standards
- These end stations and their interfaces must be manageable

The IEC/IEEE 60802 Profile introduces the concept of an IA-station. All components within an IA-station share the following:

- A common LLDP chassis-id-subtype
- A common management entity

Therefore, the addresses requirements and options for:

- IA-stations
- Bridge components
- End station components



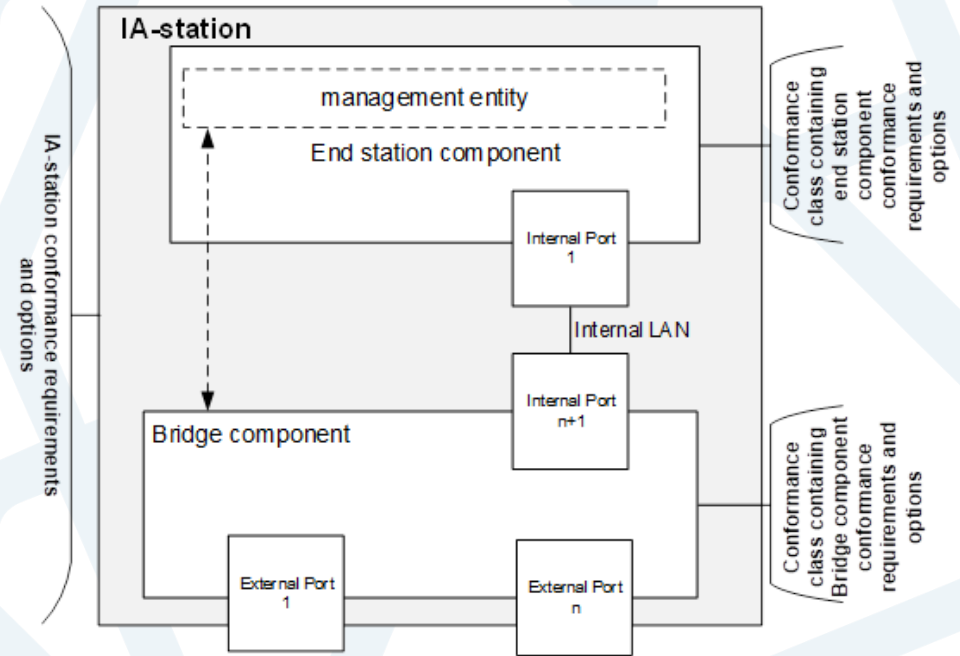
IA-stations (cont.)

IA-station requirements and options are functions common to the entire IA-station:

- E.g., time synchronization, management, discovery
- These end stations and their interfaces must be manageable

Bridge and end station component requirements and options have 2 conformance classes:

- Conformance class A (ccA) - feature rich, i.e., tailored to use cases requiring support of many TSN-IA Profile features.
- Conformance class B (ccB) - implementations that are more resource constrained.



Why TSN for Industrial Automation?

Why TSN?

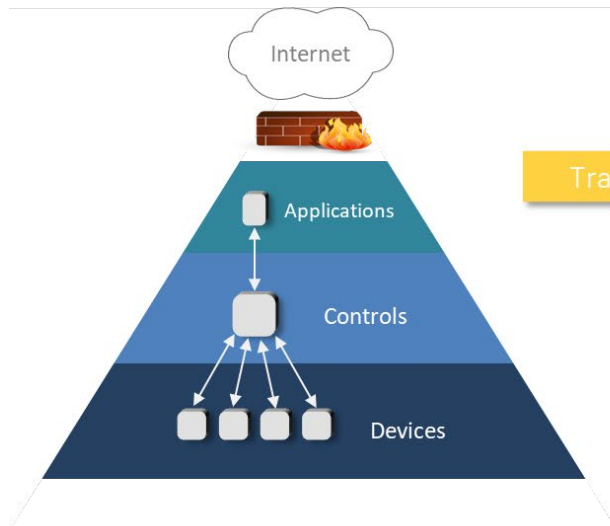
The true value of TSN lies in a common layer 2 which enables scalability and a common approach to resource management



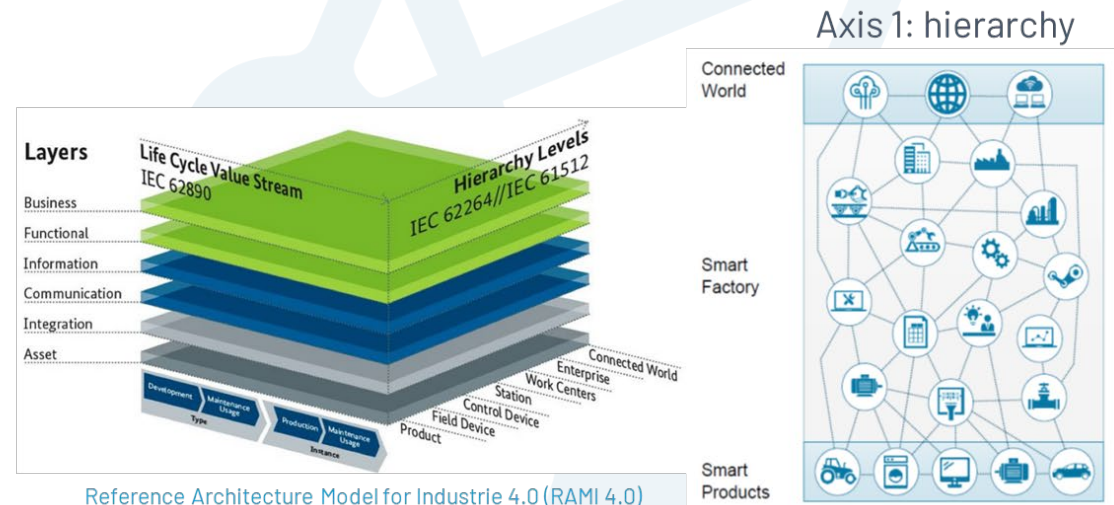
The scope of our ambition has expanded

- **Convergence:** IT, OT or other devices in one network **sharing guaranteed QoS (i.e., common layer 2)**
- **Self-protecting** network e.g., against wrong connections, unexpected devices or network load
- **Adaptability:** plug and produce (AGV, ...), topology changes, extensions for IT and OT devices
- **Scalability** for the network and the devices

Traditional Industrial System Design



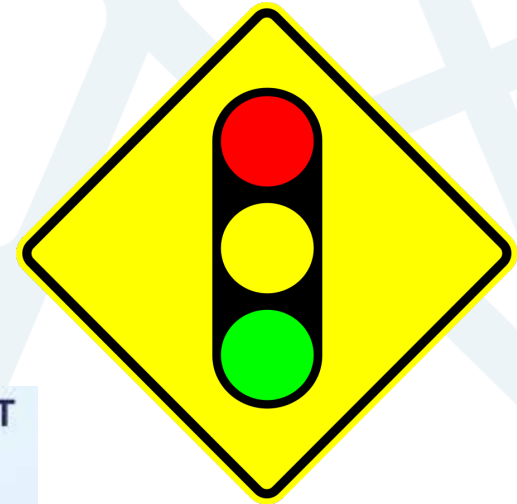
Converged Network Vision
Fully connected from device to cloud via converged IT and OT network



Reference Architecture Model for Industrie 4.0 (RAMI 4.0)

The role of TSN and Profiles in converged networks

- TSN IS Ethernet
 - These features are extensions to standard Ethernet
 - Includes IP and non-IP transactions
- A common layer 2 lays a foundation for all communication
- Profiles provide a common set of “rules of the road”
- These rules help avoid “mis-behaving traffic” from interfering with network operation
- A common layer 2 also enables a common approach to management
- Can span across mediums (wired and wireless)



Common Resource Management

A singular entity is aware of all traffic requirements (OT and IT) within its Configuration Domain

This central intelligence enables automation for on-boarding new devices

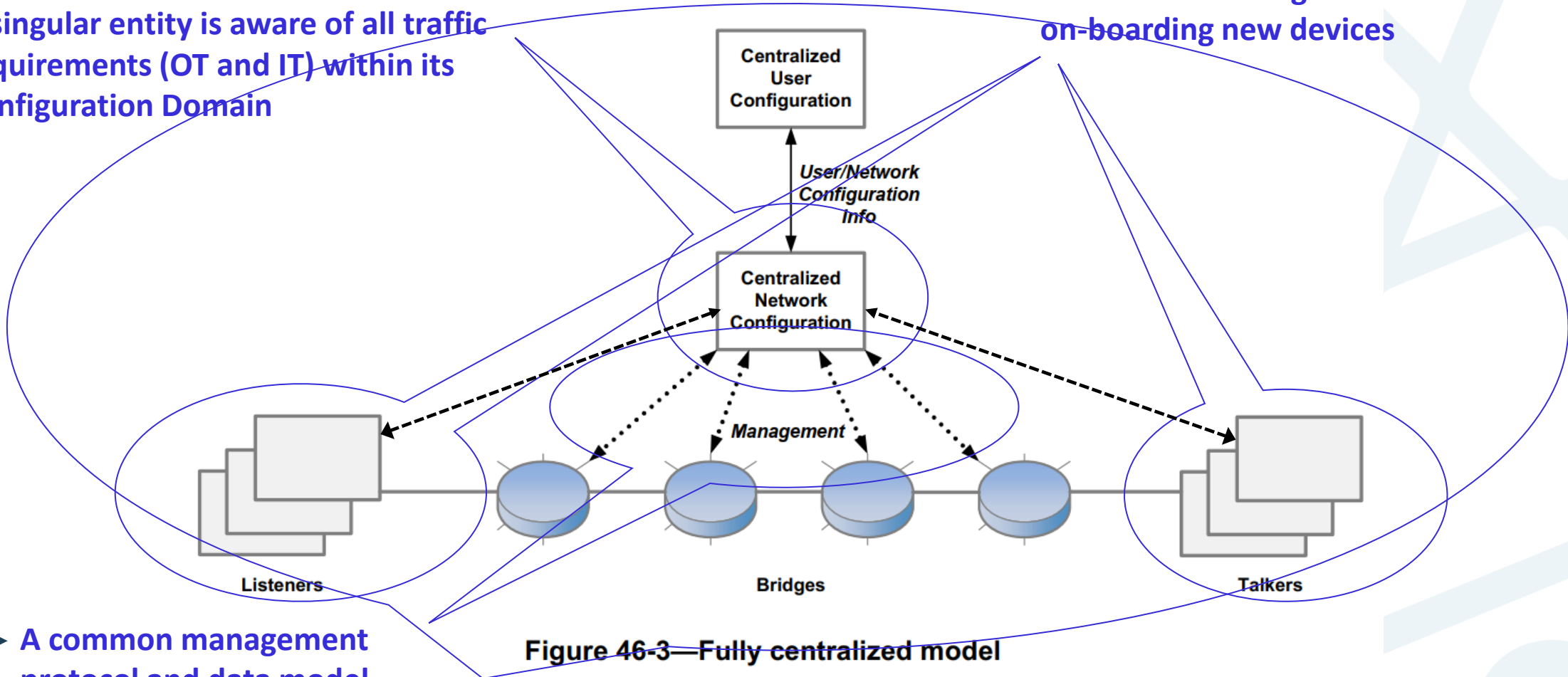


Figure 46-3—Fully centralized model

A common layer 2 simplifies network modeling

- ▶ A common management protocol and data model including security

Building the traffic infrastructure for convergence



- A Common Layer 2 Enables:
 - A Common Approach to Resource Management
 - Remote Management
 - Security (Identity)
 - Boundary Port Protection
 - Simplifies Network Modeling
 - Simplifies automation for on-boarding new devices
 - Elimination (minimization) of Data Silos
 - Economies of Scale

Please Participate

- Those interested in further progressing this important work are encouraged to join the standardization process.
 - To become an IEEE 802.1 participant, you simply subscribe to the mailing list.
 - Please see page 4 in:
<https://www.ieee802.org/1/files/public/docs2022/admin-rouyer-WG-logistics-orientation-0322-v01.pdf> , which contains further useful information.

UPCOMING WEBINARS

- Automotive Ethernet – IEEE P802.1DG
- Aerospace Ethernet – IEEE P802.1DP / SAE AS6675

THANK YOU

Jordon Woods

Director, Industrial Ethernet Solutions

Analog Devices

jordon.woods@analog.com

www.analog.com

www.linkedin.com/in/jordon-woods-4a877a14