Common TSN for Converging Networks

Henning Kaltheuner, d&b audiotechnik

Greg Schlechter, Intel

Günter Steindl, Siemens

Jordon Woods, Analog Devices

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AGENDA

- The TSN journey and convergence

- Why and what is convergence in Industrial Automation?

- Why and what is convergence in Professional AV?

- TSN's role in **composing converged, secure networks**

- Summary and call to action Q&A
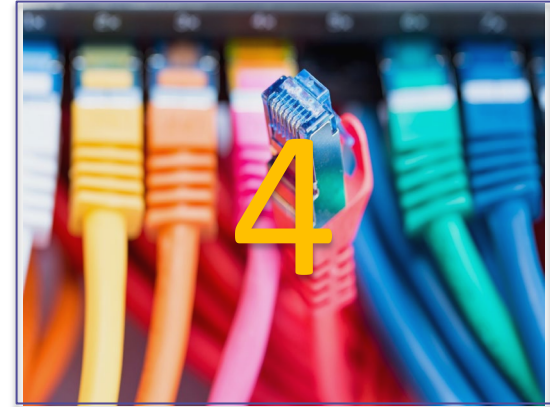
Industrial revolutions

Power

Electricity,
Communications
(Telegraph)
Railroads

Digital / Compute

Hyper connectivity
Information Technology

Common theme:

A convergence of technology and disciplines that previously were separate

"Convergence"

Convergence is a term that comes up often in the discussion of technology trends, including Industry 4.0

"The convergence of IT/OT"

"The merging of AV/IT"

But what is does convergence really mean for future networks ….and what role does TSN play?

What end goal should we keep in mind as we build an ecosystem

Convergence has always been the goal of TSN

"Many vendors and users desire a **single network infrastructure** to carry various multimedia applications such as digital video, high-fidelity digital audio, and gaming traffic, as well as non-time-sensitive traffic (e.g., data traffic)...."

https://grouper.ieee.org/groups/802/1/pages/802.1at.html

There is significant vendor and end-user interest and market opportunity **to consolidate layer 2 solution for both computer networking (e.g. internet access) and audio video services (e.g. home consumer electronics, professional A/V applications, etc) in mixed wired and wireless environments**. The use of such **consolidated network** will realize **operational and equipment cost benefits**.

https://www.ieee802.org/1/pages/802.1av.html

Network convergence in Industrial Automation

What's a converged network?
A converged network allows to connect applications / transport data with different quality of service requirements **and** it supports means to guarantee the requested quality of service.

Why is this a requirement?
Industrial automation, professional audio & video, … need communication, connectivity and plug & produce to fulfill the requirements of the customers.
Modular machines and applications are plugged into the network, communication and connectivity needs to be established providing the required quality of service.

Getting rid of separated networks (and the gateways between them)!
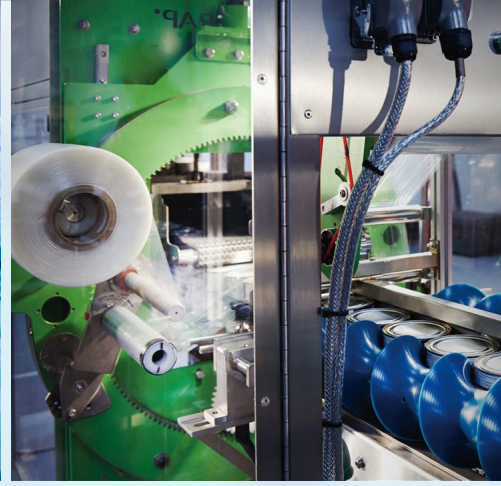
Different industries
All requiring a converged network
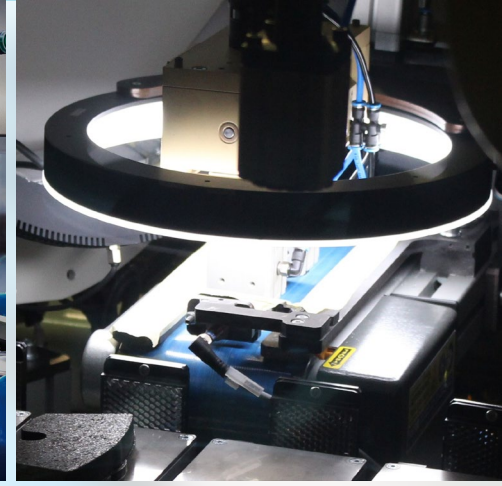

Factory Automation   Process Automation   Motion Control   Camera Integration   Worker Environment

One converged network needs to cover concurrently the requirements of the different industrial verticals

Converged Network Quantities

A vehicle manufacturing facility uses more than 50,000 Ethernet nodes in manufacturing.

Bigger production cells implement Layer 2 networks with up to 1000 nodes.

Automation devices requires up to 2000 streams or time-sensitive streams. This number doubles if seamless redundancy is demanded.

Multiple wireless connected AGVs or robots are entering and leaving the production cell concurrently.

Flexible production requires adding and removing of machines or machine-parts, AGVs, and robots or robot-tools without production disturbance.

Network convergence in ProAV

henning@kaltheuner.com

Network convergence in ProAV

Global mega-trend in all ProAV markets:

- Full digitalisation of venues and mobile systems:

    → **All parts of systems need to be networked**

- ‚Networked' means ‚accessible', ‚manageable', ‚configurable' **as one system by software**

    → **Enhanced functionality and versatility**

Problem: Most manufacturers have been thinking of ‚network' as something they could define on their own, isolated from others
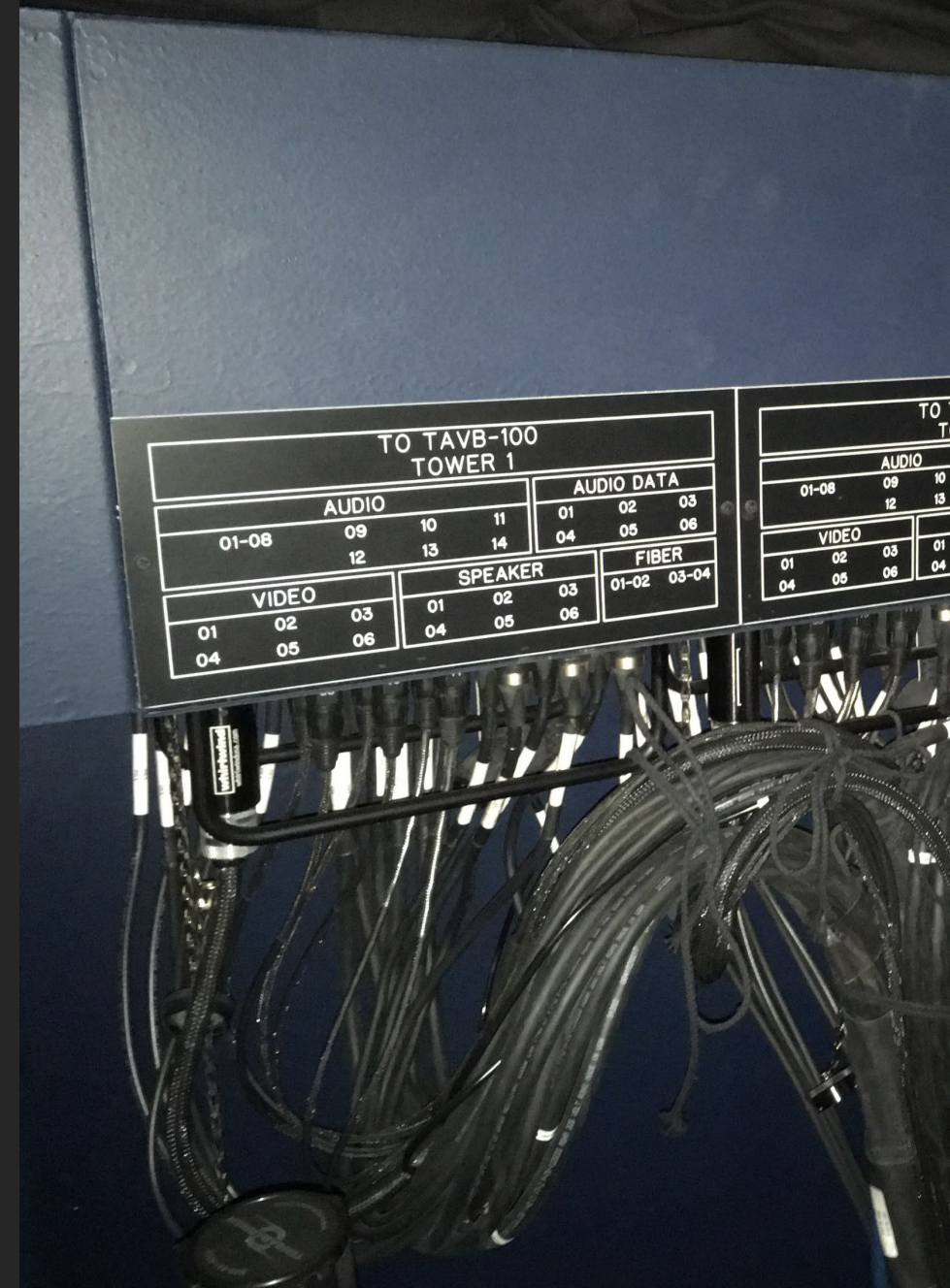
Network convergence in ProAV

Challenges (1):

- Different **_technologies_** with different properties and requirements

  – Incompatibilities in protocols (e.g. PTP V1/V2, gPTP)
  – Very different requirements in bandwidth, criticality, latency, availability, security
  – ‚real-time' is somewhat different depending on context

- **Mixed criticality is standard in ProAV**

  – Meanwhile systems need to remain variable:
    Efforts for system design & maintenance are over-critical

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Challenges (2):

- Different ***disciplines*** coming together in one network

  - Video
  - Light
  - Audio
  - Staging and mechanics
  - Pyro
  - Signage
  - Communication
  - Remote services
  - General IT services

- Each of them with complex and ever changing requirements

Network convergence in ProAV

Challenges (3):

- Many different **_users_** of the same network:

  - Video systems engineer(s)
  - Audio systems engineer(s)
  - Lighting systems engineer(s)
  - Venue IT management
    ...

- Usually these users work independent and ‚asynchronous'

- How could a network support untuned and very independent workflows while offering determinism?

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Challenges (4):

- Components/devices from ***different industries*** on the same network:

  - Industrial components used for staging/lights
  - ProAV products in industrial/automotive contexts
  - Chipsets / IP with broad fields of application

- Convergence challenges the silo-thinking of isolated vertical markets

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Network convergence in ProAV

Technical aspects of network convergence

- **Coexistence**

- **Composability**

- **Interoperability**

These aspects have certain dependencies

Network convergence in ProAV

Coexistence

- Devices must be able to share the same network system / structure without technical conflicts

2 stages of coexistence

a) Sharing same physical network but in separate logical networks (Vlans)

b) True coexistence within one subnet/Vlan

Key problem in ProAV: Isolation in VLans is the standard method for ‚solving' incompatibilities.

- Once networks are split in isolated sub-systems it is very hard to achieve any meaningful interoperability.

- True coexistence is most often a precondition for any convergence

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Network convergence in ProAV

Composability

Components of a network system can be selected and assembled in many combinations with a deep flexibility

- **Ease of deployment: Plug-and-play / Plug- and-Produce**

- **Scale, size of network**

- **Resilience of system to errors**

- **Safety aspects**

How easily can the integrity of a network be maintained?
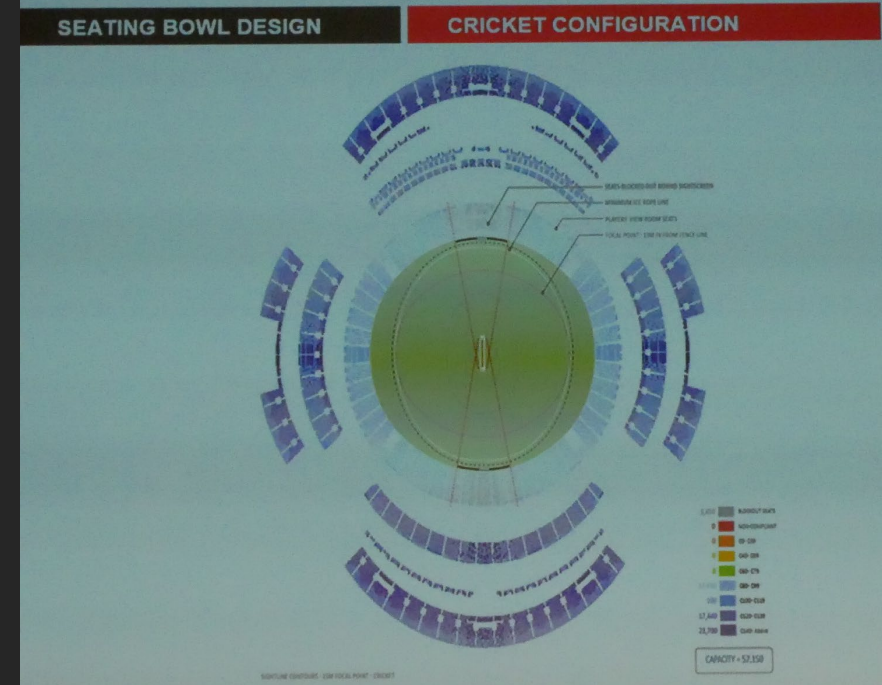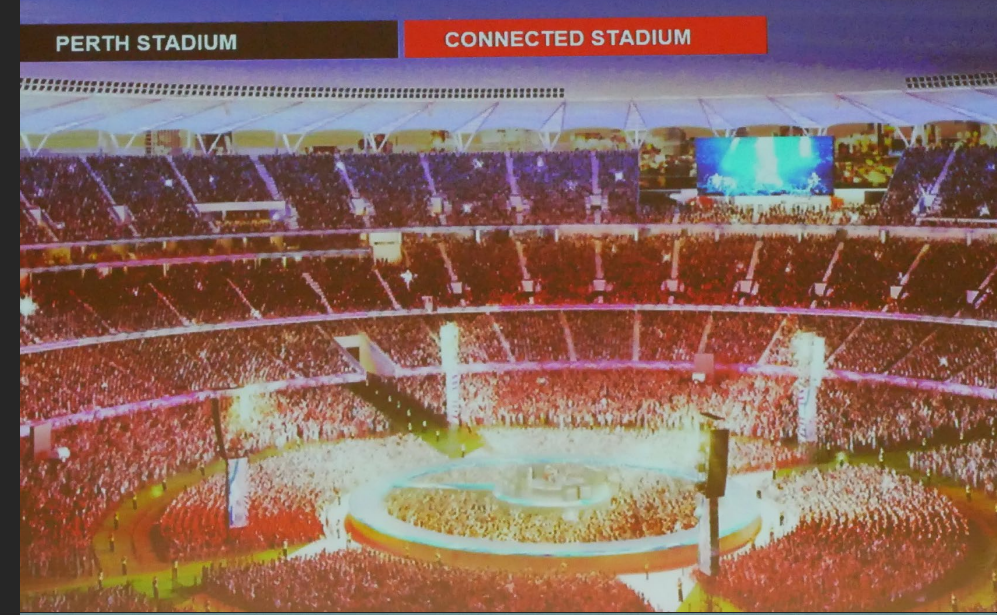
Network convergence in ProAV

Interoperability

- **Highest requirements are within disciplines** (Audio, Video, Light .....)

- **But: Digitalisation comes with a promise/need for total system control**

  - **Minimum: Read/modify operational status of each device**

    This is a function expected from *‚the network itself'*

  - **Ideally the network doesn't limit the degree of interoperability manufacturers can design into devices.**

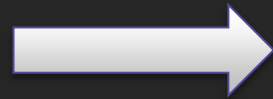**This was the promise when Ethernet became the choice .....**

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Network convergence in ProAV

Dependencies

Limited Coexistence
(in logical separation)

- **Separate NW / Vlan by discipline/user**
- **Exclusive choices for protocols in same physical network**

ProAV today

Low/no convergence possible

Network Convergence

Full Coexistence
(In same NW)

enables

- **Mixed criticality supported**
- **Legacy protocols supported**
- **NW serves applications to their requir.**
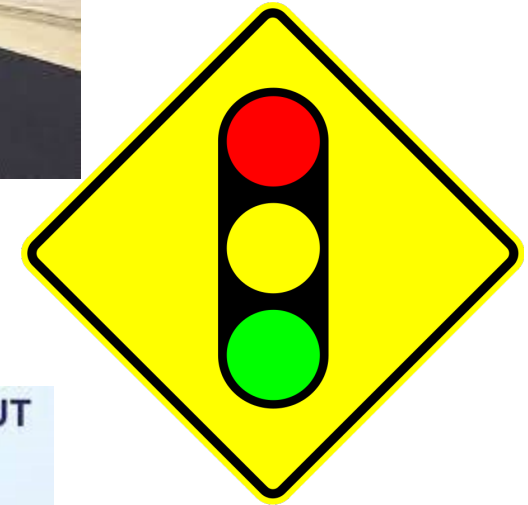- **Guaranteed bandwidth & bounded latency for critical traffic**

Unrestricted Interoperability

Composability

= Precondition for convergence

henning@kaltheuner.com

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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)

HOW TO DRIVE A ROUNDABOUT

Do not look back
Do not turn

Fasten your seatbelt   Speed up   Pray

STAY
IN
YOUR OWN
LANE

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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
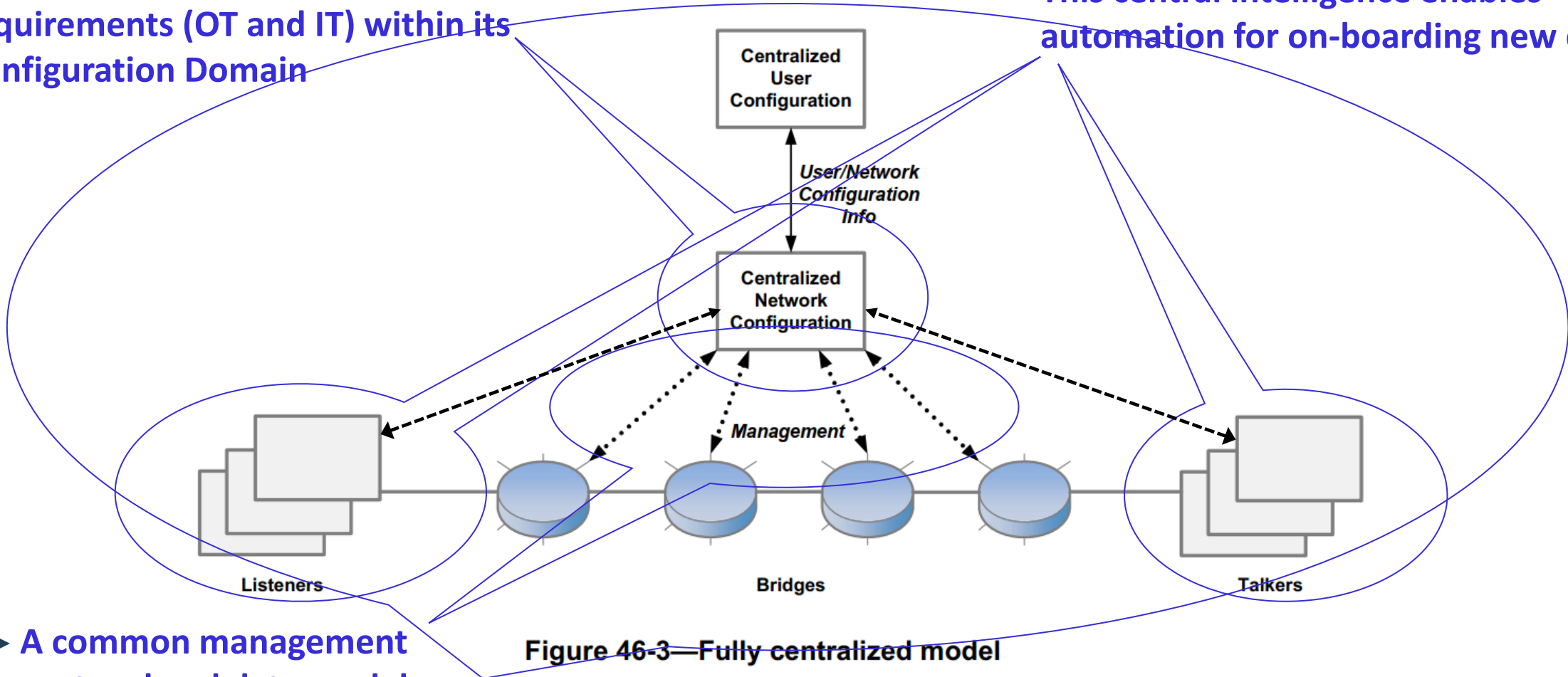

Centralized User Configuration

User/Network Configuration Info

Centralized Network Configuration

Management

Listeners

Bridges

Talkers

Figure 46-3—Fully centralized model

► A common management protocol and data model including security

A common layer 2 simplifies network modeling

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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

Summary and call to action

- Converged networks have always been part of the vision for TSN. Market and user needs now require it

- Both AV and Industrial (and likely others) markets require convergence for common needs

- TSN enables a common layer 2 to support coexistence of mixed criticality traffic and the interfaces to compose networks that respond to dynamic requirements

- This common layer must be deployed as such in the ecosystem: with mechanisms to support all traffic and diffused into standard network tools and ecosystem. There is no "TSN traffic"

Questions and discussion