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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

1. Power
2. Electricity, Communications (Telegraph), Railroads
3. Digital / Compute
4. 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

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 require 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
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
Network convergence in ProAV

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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Network convergence in ProAV

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
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
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 …..
Network convergence in ProAV

Dependencies

- Limited Coexistence (in logical separation)
  - Separate NW / Vlan by discipline/user
  - Exclusive choices for protocols in same physical network

- Full Coexistence (in same NW)
  - 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

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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)
Common Resource Management

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

► A common management protocol and data model including security

This central intelligence enables automation for on-boarding new devices

Figure 46-3—Fully centralized model

A common layer 2 simplifies network modeling
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