



# Common TSN: Converged Networks – A Way to Align IT and OT Networks

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Workshop on Common TSN for Converged Networks

## 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)!

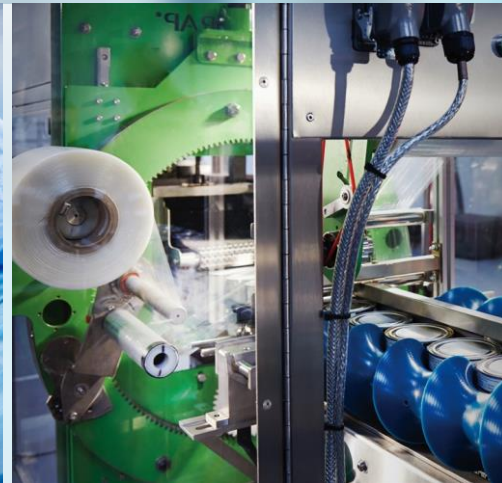
# Different industries All requiring a converged network



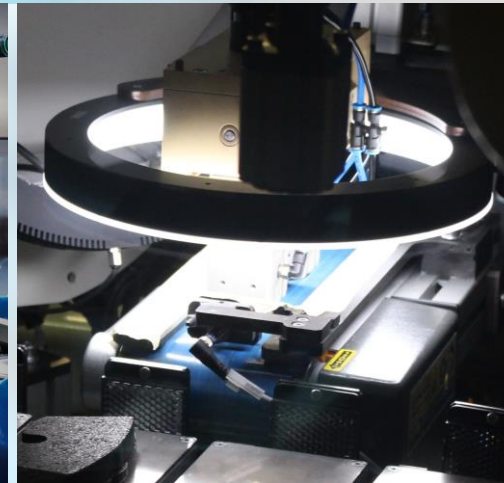
Factory Automation



Process Automation



Motion Control



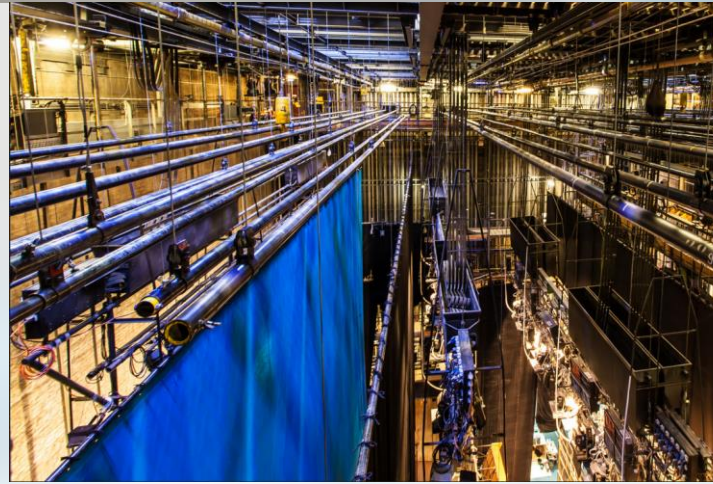
Camera Integration



Worker Environment

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

# Pro audio & video - different tasks All requiring a converged network



Stage Automation



Speaker Integration

Motion Control



Camera Integration

Microphone Integration

One converged network needs to cover concurrently the requirements of the different tasks

# Converged networks in ProAV

- ProAV bases on combinations of

- closed systems (events, halls, rooms)
- distributed systems (foyers, structure ..)

- ‘Closed’ ProAV systems are comparable to industrial OT

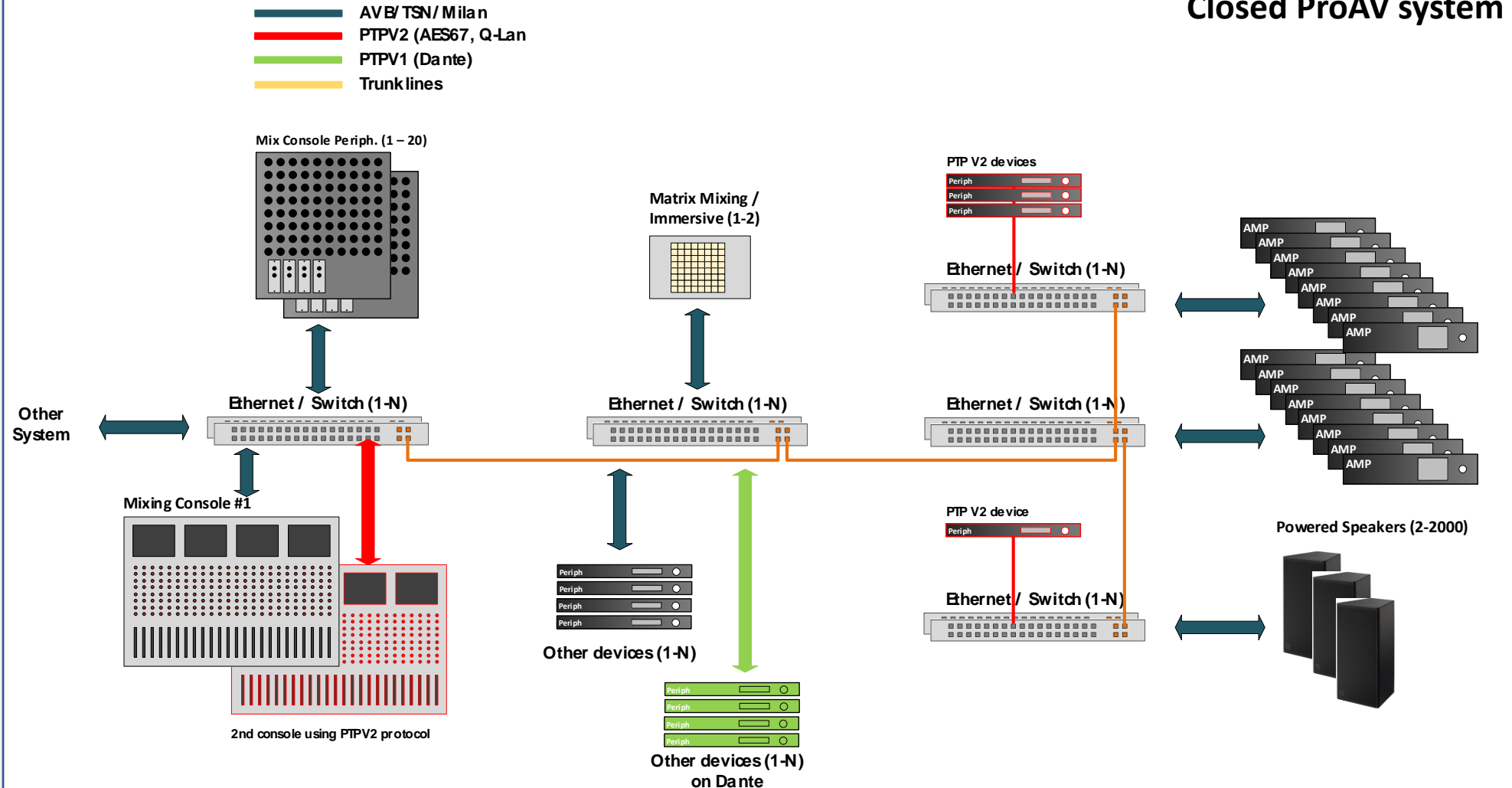
- Within one closed system different PTP and Q protocols have to coexist

- in one network
- on same ports (**trunk lines!**)

- These devices need to interact/talk to each other

This is very hard to achieve because .... :

- Switches do normally not support different PTP profiles simultaneously

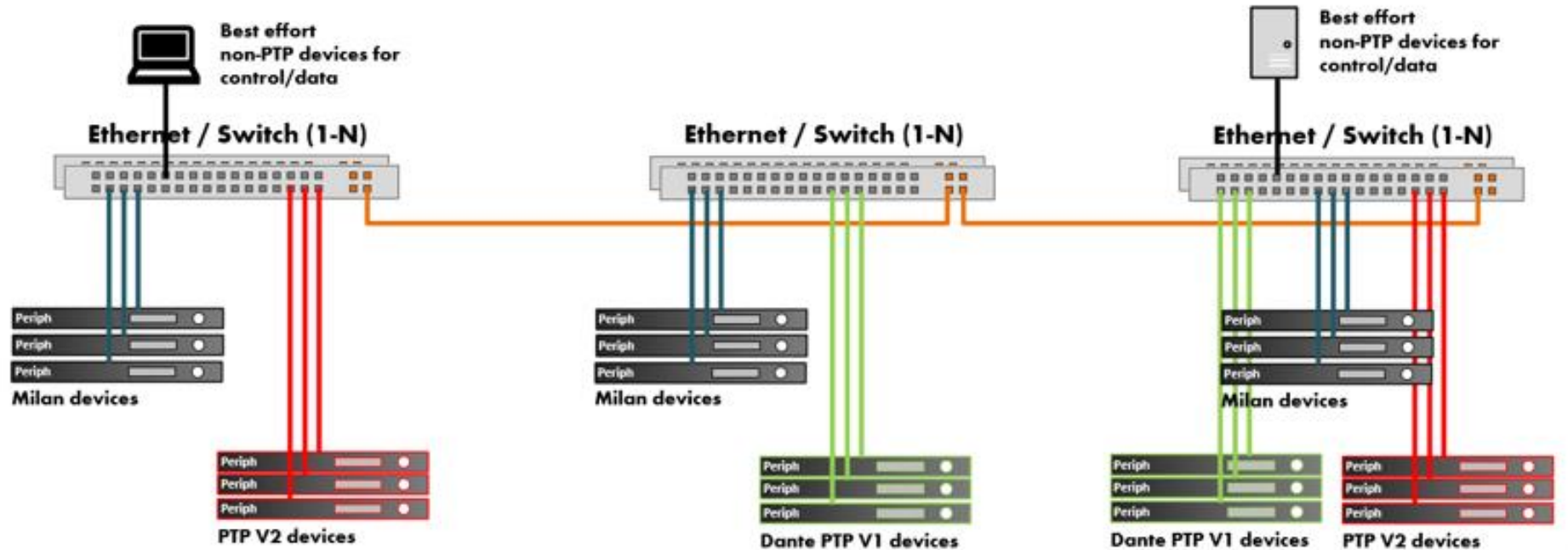


# Converged networks in ProAV

- In distributed systems (foyers, structure, hallways ..) IT and OT necessarily come together.
- Increasing AV content in buildings (Video, signage, huddle spaces, open event stages ....) questions traditional role of IT.

## IT has to accept and enable OT processes within their space:

- Real-time media to coexist with best effort data
- Daily changing setups, events, campaigns ....



## Distributed ProAV system (mixture of IT and ,OT')

# 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.



# Converged networks

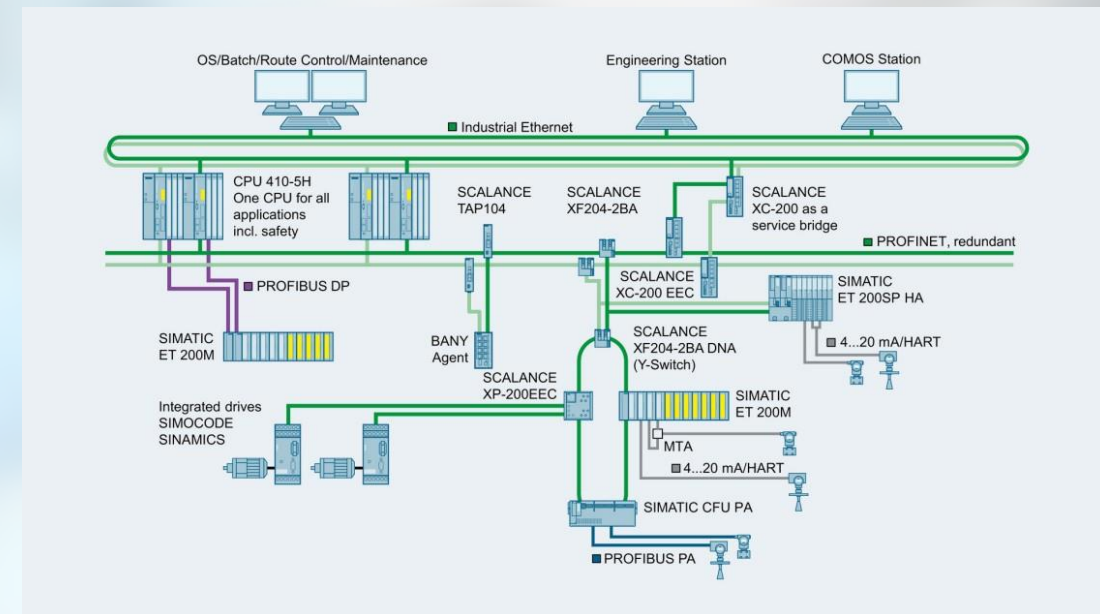
## Detailed requirements



# Converged Network

## Detailed requirements

- Applications in one network **sharing QoS**
- Applications can be **engineered, implemented and deployed independently** from the network
- Dynamic adaption: **plug and produce** (AGV, ...), topology changes, changed communication requirements for applications
- **Self-protecting** network e.g. against wrong connections, unexpected devices or network load
- **Network provides and guarantees** required **QoS** for the applications
- **Efficient bandwidth** utilization for communication with different QoS



# Converged Network

## Detailed requirements

- Link speeds from **10 Mbit/s up to 10 Gbit/s** and Link speed transitions
- **Topologies:** ring, line, tree, star and combinations
- **Media types:** fiber, copper and radio (e.g. wireless and 5G)
- **Bridges** with up to 255 ports
- **Scalable availability** for the network and the devices e.g. by media, network and device redundancy
- **Reliable and accurate** time synchronization for site, plant, line, cell and machine



# Converged networks Time Sensitive Networks

## Time Sensitive Networks

- IEEE 802 defined additional tools for stations to manage the communication quality of service.
- Stations – end stations and bridges – need to be configured to provide time-aware quality of service.
- Network management and configuration builds a Time Sensitive Network based on these stations.
- Time-awareness includes end station components and thus, is not limited to bridge components.

**=> Time Sensitive Networks are a  
network management and configuration challenge**

# Converged network Time Sensitive Networks

## Network management and configuration challenge

- Industrial (and professional audio & video) network often use linear topologies and thus, consists of bridge and end station components (bridged end stations).
- Stations are selected due to the application needs. Thus, networks often contain bridge components from more than 100 manufacturers. Interoperability needs to be ensured by certification.
- Manufacturer independent configuration e.g. based on NetConf/YANG. Interoperability needs to be ensured by certification.
- Modular machines requiring plug & produce (includes plugging of bridge components) needs to be covered
- Standard bridge components are mixed into the network where required.
- 24/7 working needs to be ensured – non-human network management and configuration required.

**=> Possible solution: Centralized network controllers**

# Converged Network

## Historic boundary between IT and OT networks

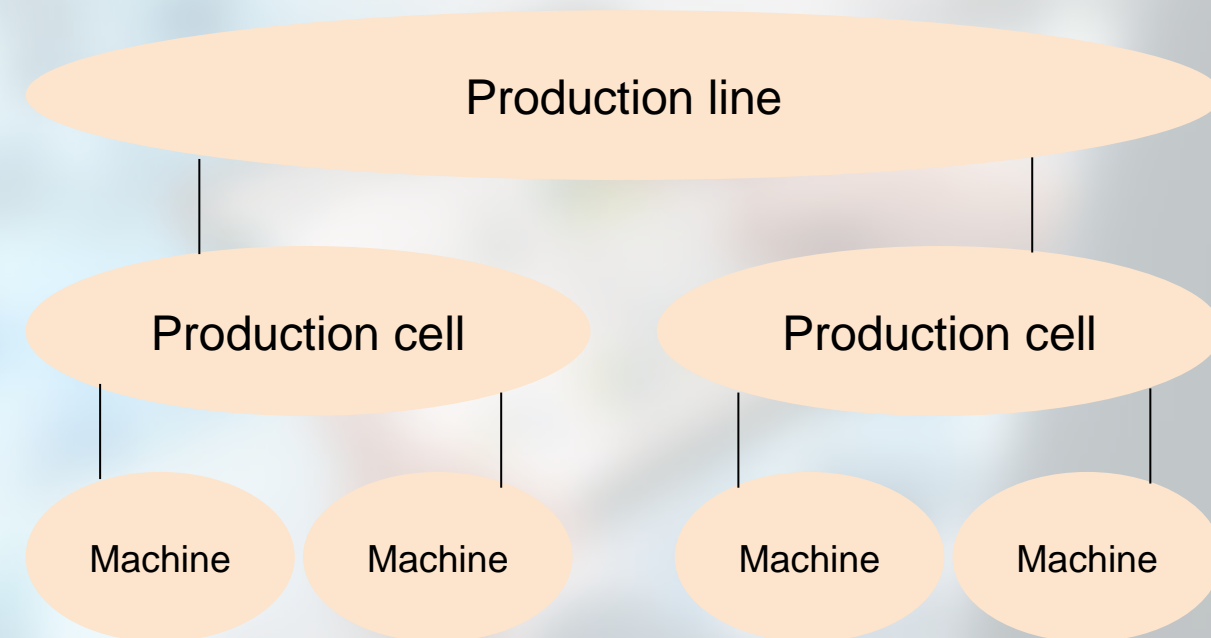
Converged networks are not limited to the Machine or Production cell.

Therefore, the historic boundary between IT and OT networks is a burden which should be overcome.

Converged networks based on IEEE 802 / IETF defined features will solve the requirements of the former OT area.

IT networks are per definition already based on IEEE 802 / IETF defined features.

Therefore, what are the roadblocks which are still in place?



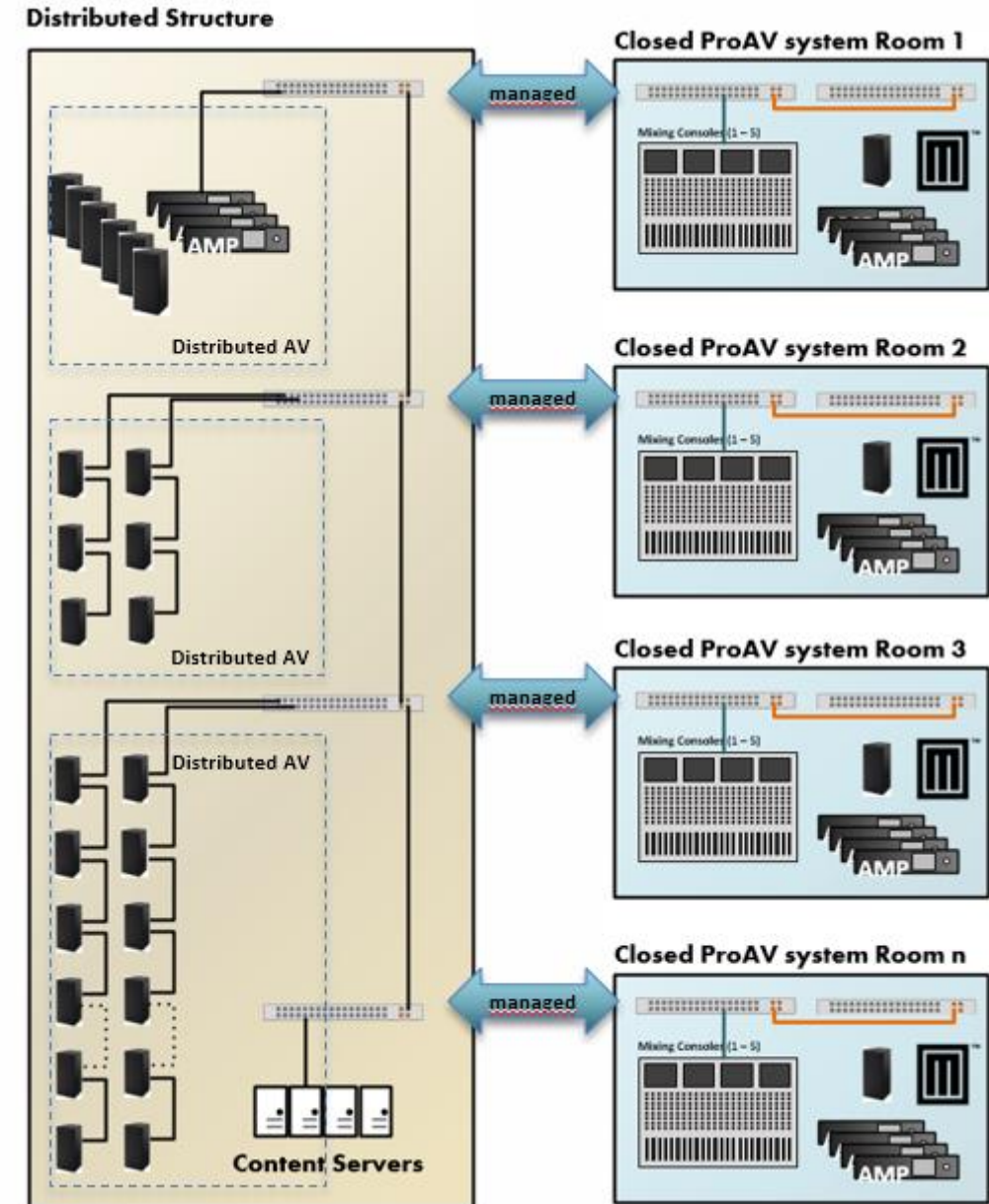
# Converged networks in ProAV

Combined ProAV system  
,closed'and distributed system interconnected/interoperating

- **Closed systems** (venues, stages, halls, concerts) and distributed systems (halls, foyers, ....) are always interconnected.
- Although the closed systems (OT) need to operate +- self-contained and self-managed a decent amount of interoperability is required:
  - System monitoring, system management
  - Exchange of audio visual content
  - Integration in building automation

## This means:

- 'Convergence' is not achieved by separating different traffic into V-Lans. (!!)
- Areas that need to be managed by 'production' and are equivalent to industrial OT still need to be manageable by overarching management systems.
- Many different PTP and Q protocols have to coexist. At a minimum they have to coexist on the trunk lines between switches, else these systems wont work.
- Astonishingly this situation is hardly achievable with current switching products.



# Converged networks Conclusions



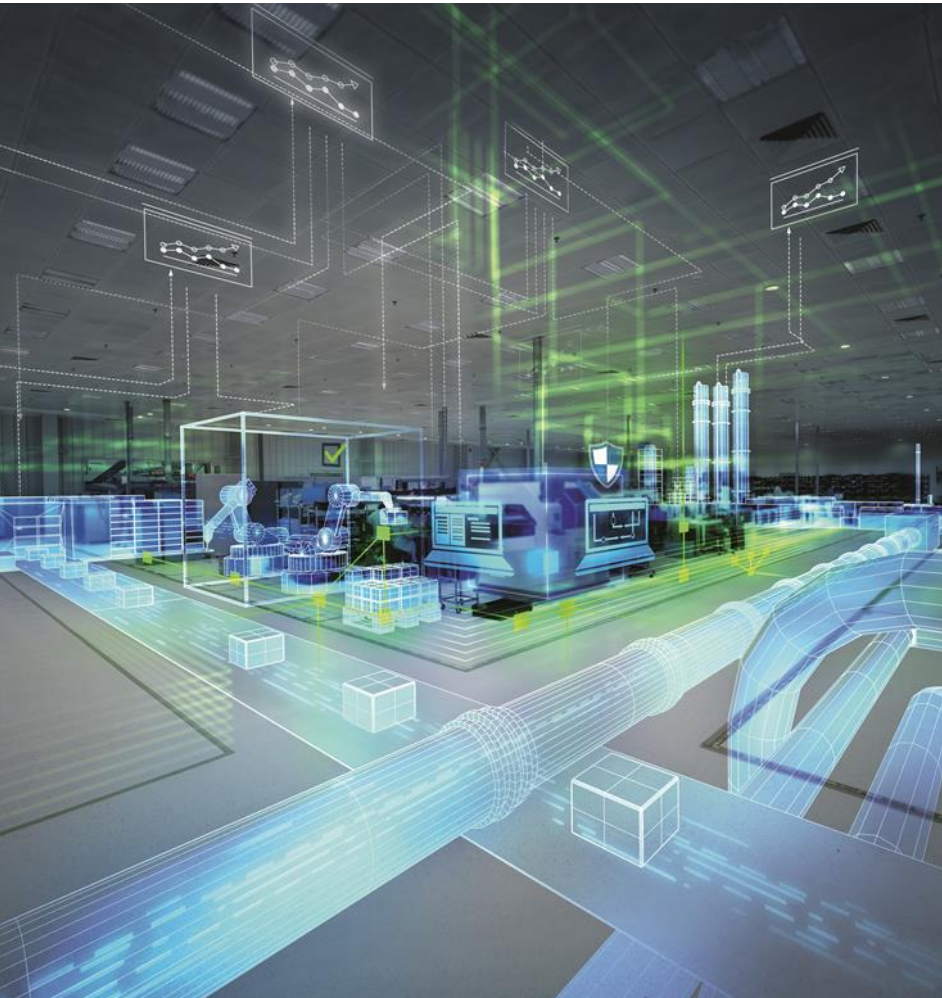
## Conclusion

### A common understanding between IT and OT?

- Stations based on the same IEEE 802 / IETF specifications allow a common understanding of the available features to build a converged network
  - Network management and configuration is an important topic to build a converged network
    - Customer VLAN networks are extended into the end station components for TSN
    - Manufacturer independent NetConf/YANG based configuration
  - More than 100 manufacturers of network components require means to ensure interoperability both, in time-aware behavior and network configuration
    - Certification is a way to solve this topic
  - Standardization of secure converged networks for automation is done at IEC/IEEE 60802
- => It now time to work on roadblocks which are still in place

# Questions

# Contact page



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