# 802.1 plenary meeting March 2022

# ProAV requirements

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RELIABLE SYNCHRONIZED NETWORKING

# Content

- ProAV system architectures
- Requirements in closed ProAV systems
- Network structures in ProAV contexts

- Status of TSN in ProAV and outlook

# ProAV system architectures

- **Two basic standard architectures:**
  - **Closed systems**
  - **Distributed systems**

- **Can be used as general models for +- all ProAV applications**
- **In large complexes such systems need to be combined to large nested systems**

**Closed systems:** vs. **Distributed systems:**

| Concert / Festival | Performance Stage | Foyer | Airport Hall |
|---|---|---|---|
|  |  |  |   |

# ProAV system architectures - Closed systems

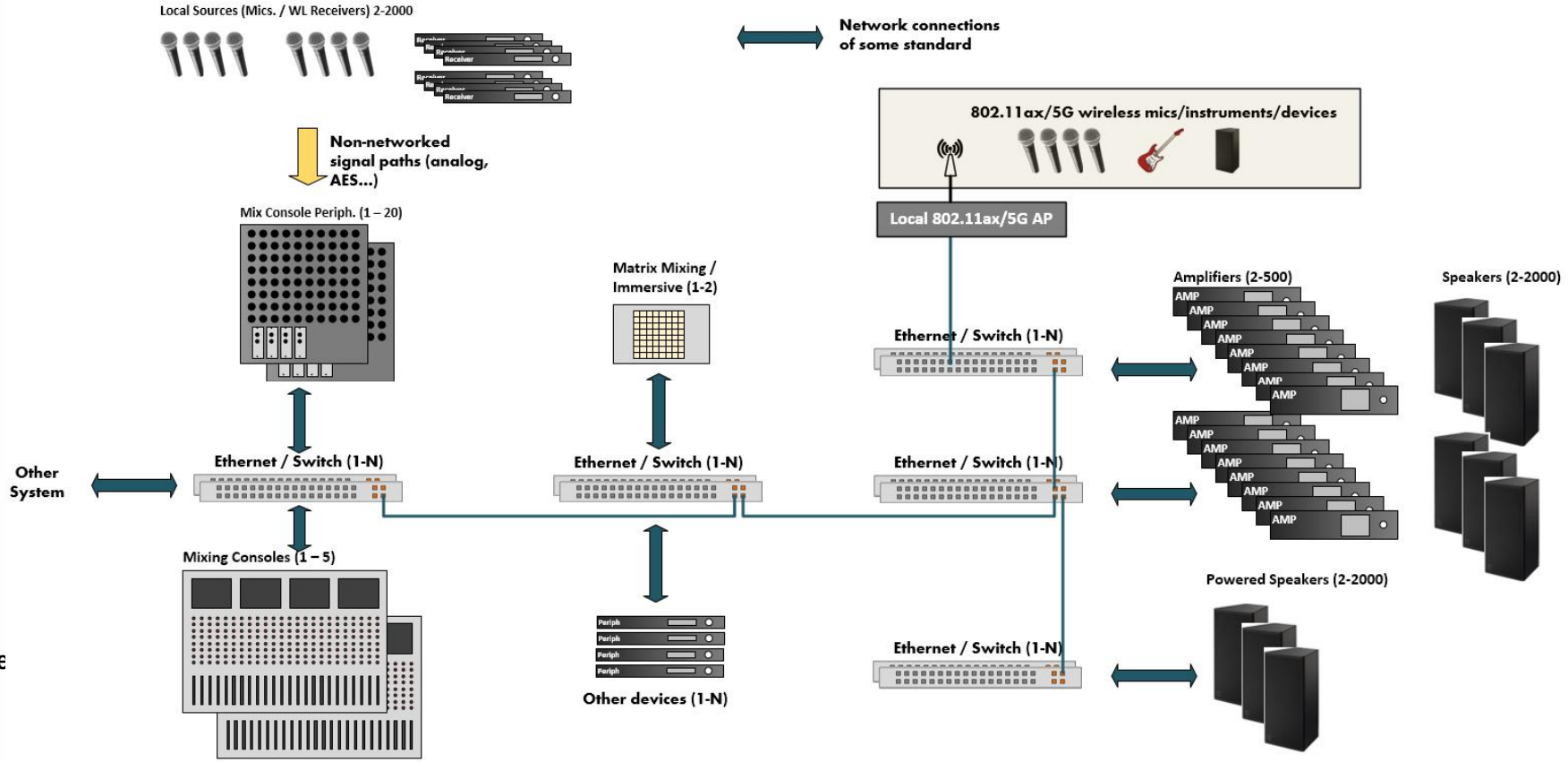
## Closed ProAV systems follow a certain use-case logic:

- **Serving one delimited space** (Stage, hall, theatre, festival ground …)
- **Self-contained processes and content:**
  - Completely managed by users/operators from within the system
  - No connection to systems outside the space needed for operation
  - Within a system there are different ‘disciplines’:
    (Audio, Video, Light, Pyro, Staging, Scenery, Musical Instruments …)
  - Each discipline is managed separately but often with some control interaction
  - Sharing one network is desired but yet unrealistic
- **Interaction with data and control from outside the system must be restricted / managed**
- **Closed systems are most often related to ‘events’.**
  - Events are subject to safety and very critical with regard to reliability
  - Event are usually very costly and financially highly critical
  - Quality expectations are usually high or even unrealistic

# ProAV system architectures - Closed systems

## For the audio part of closed ProAV systems a standardized system view is useful:

- This system scheme works for 99% of performance systems in clubs, theatres, festivals, large concerts etc.
- This picture assumes a +- fully networked system.
- Please note the scales from very small (e.g. a small club) to very large (e.g. large TV live concert show)



# ProAV system architectures - Closed systems

## Requirements for the network in closed Pro Audio systems :

| | now | min | future proof |
|---|---|---|---|
| Latency | <1ms | <1ms | 100us / 16 hops |
| Hops | 16 | 16 | 64 |
| Synchronicity[1] | max. 1us | max. 1us | max. 1us |
| Streams #[2] | 150 | 2.000 | 2.000 |
| Audio Channels # | 1200 | 10.000 | 10.000 |
| End Points #[3] | 1000 | 5.000 | 5.000 |
| Wireless networked[4] | TCP/IP for control | Audio & Control | Audio & Control |
| # Wireless end-points | WiFi control | 50 | 500 |

- This is what we currently get with AVB / 802.1BA-2021

**Key issue #1:**

- It is not sufficient for to cover even only the demand of one closed large audio system.
- Esp. number of streams is highly insufficient.

- Expectations for wireless TSN are huge.

**Remarks:**

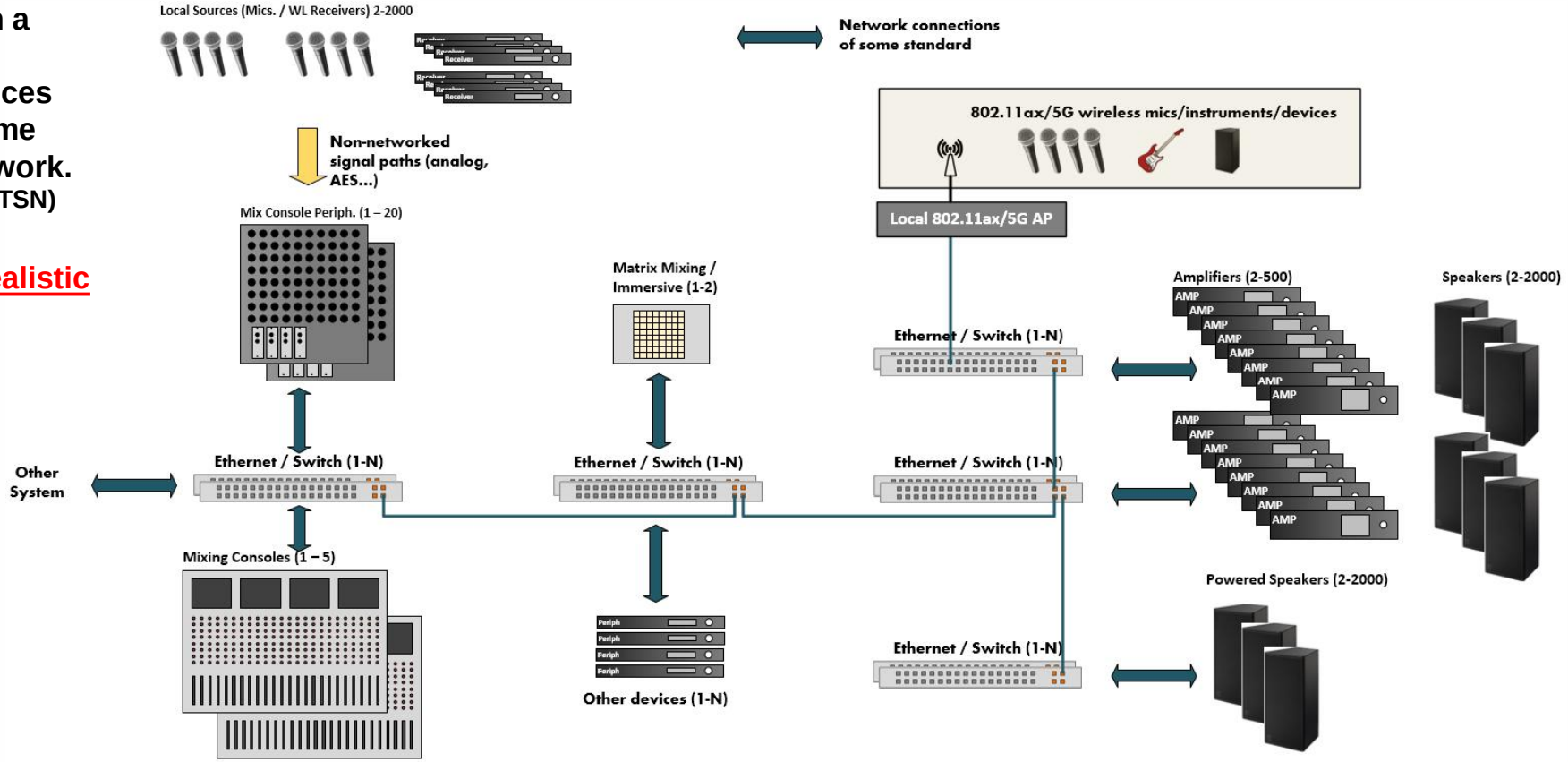
1: Max deviation in arrival time of packets
2: No. of streams limits number of active talkers
3: No. of End Points inidicates scale of one subnetwork
4: Audio over wireless TSN will have higher latency than 100us which is ok if < ~ 1ms

# ProAV system architectures - Closed systems

## However - this scheme contains a fundamental mistake !

- **It assumes that such a system would be composed from devices that all speak the same language on the network.**
  **(in our case Milan®/AVB/TSN)**

**This is completely unrealistic**



# ProAV system architectures - Closed systems

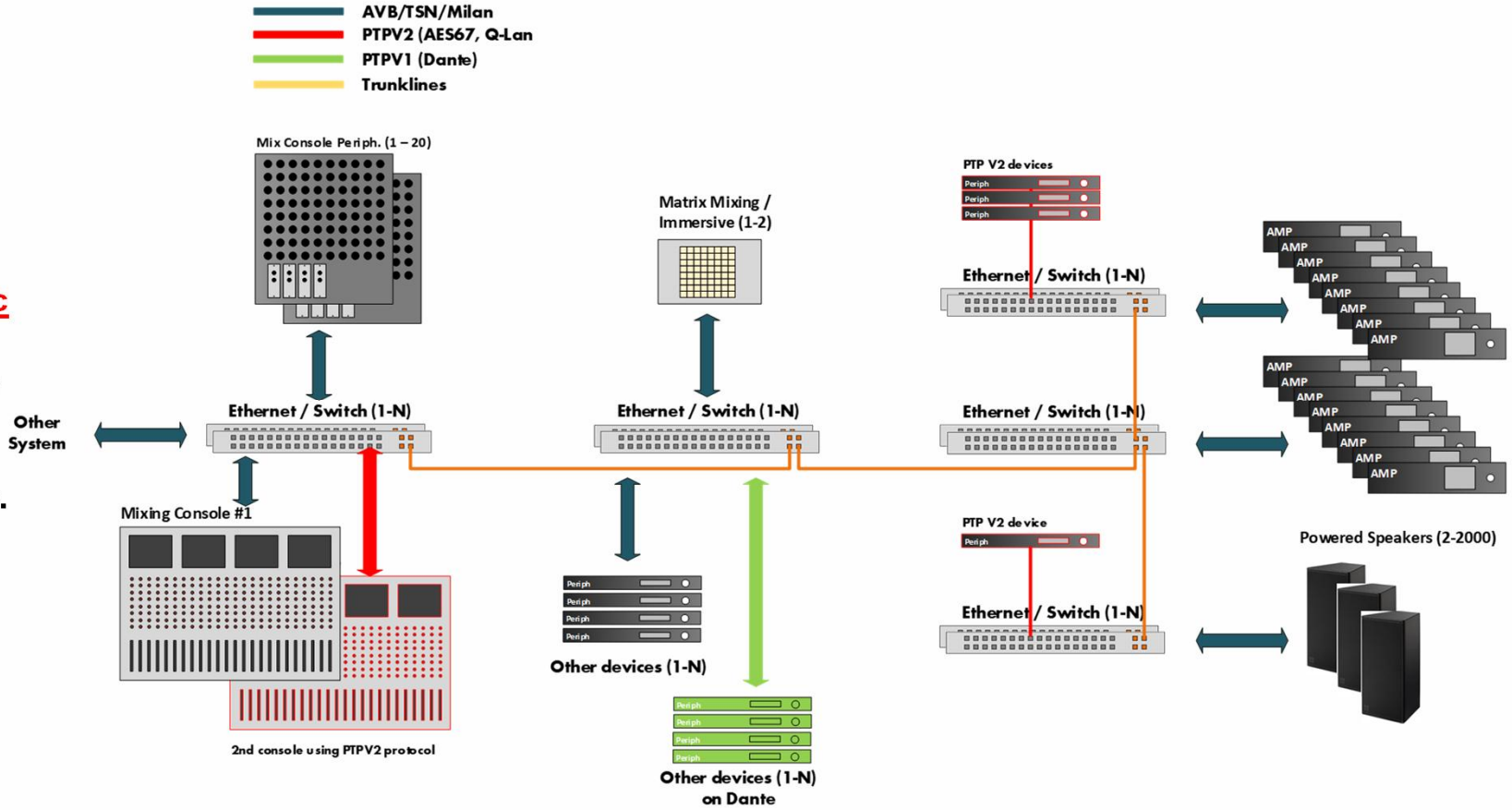
## However - this scheme contains a fundamental mistake

- It assumes that such a system would be composed from devices that all speak the same language on the network. (Milan®/AVB/TSN)

**This is completely unrealistic**

- Markets need to transition slowly and systems are composed with devices from many manufacturers.

- This means that such a network will always also include other protocols such as
  - Dante (PTPV1, DiffServe)
  - AES67 (PTPV2, DiffServe)



# ProAV system architectures - Closed systems

## Thus - ProAV always has to deal with convergence:

- In principle all ProAV systems require a coexistence of different standards and protocols on one network.

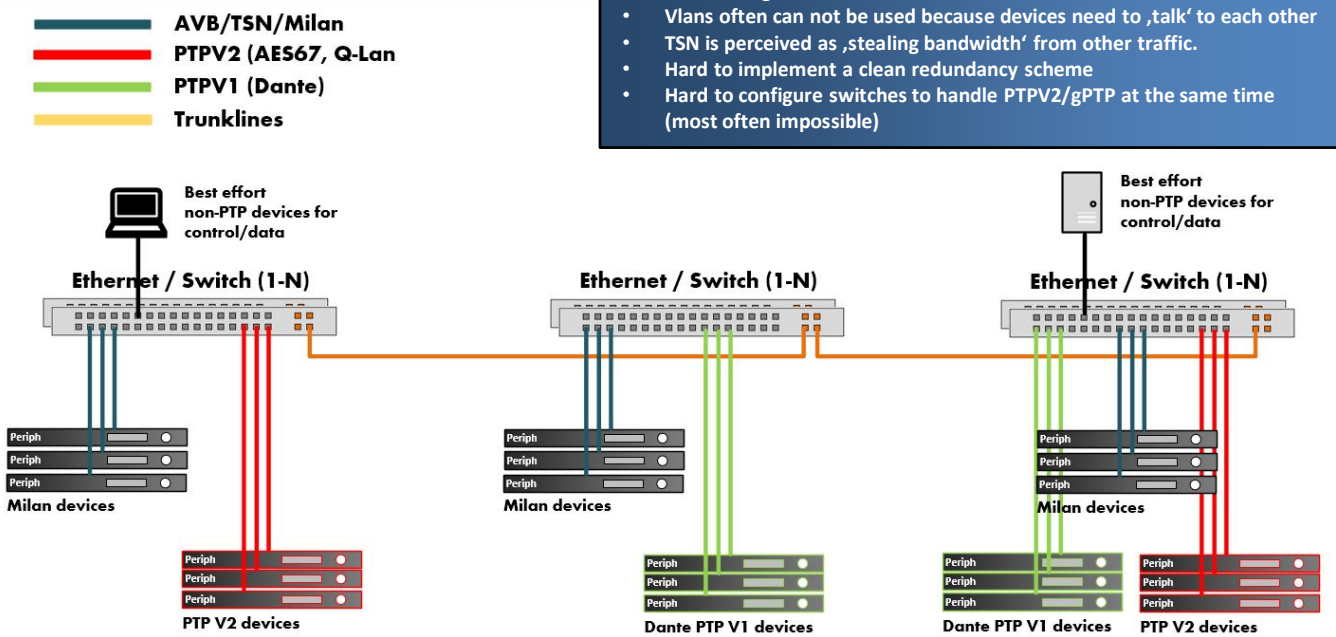
  <u>This cannot be avoided</u>

**<u>Key issue #2:</u>**

- Switches/Bridges that support such convergence of standards do not really exist
- Because it is not natively supported by IT products, such a scenario is perceived as 'unnecessary complicated' and is mostly refused by IT departments

<u>Problems arising in such a network:</u>

- Even if Vlans are configured for the different traffic classes Qos/scheduling is becoming an issue on the trunk lines.
- Vlans often can not be used because devices need to ‚talk' to each other
- TSN is perceived as ‚stealing bandwidth' from other traffic.
- Hard to implement a clean redundancy scheme
- Hard to configure switches to handle PTPV2/gPTP at the same time (most often impossible)




**This issue is a big problem even within 'closed systems'. But it also makes it very hard to bring AVB/TSN into the network systems for any kind of 'building'. TSN cannot be added to a structure and slowly become perceived as an attractive technology.**

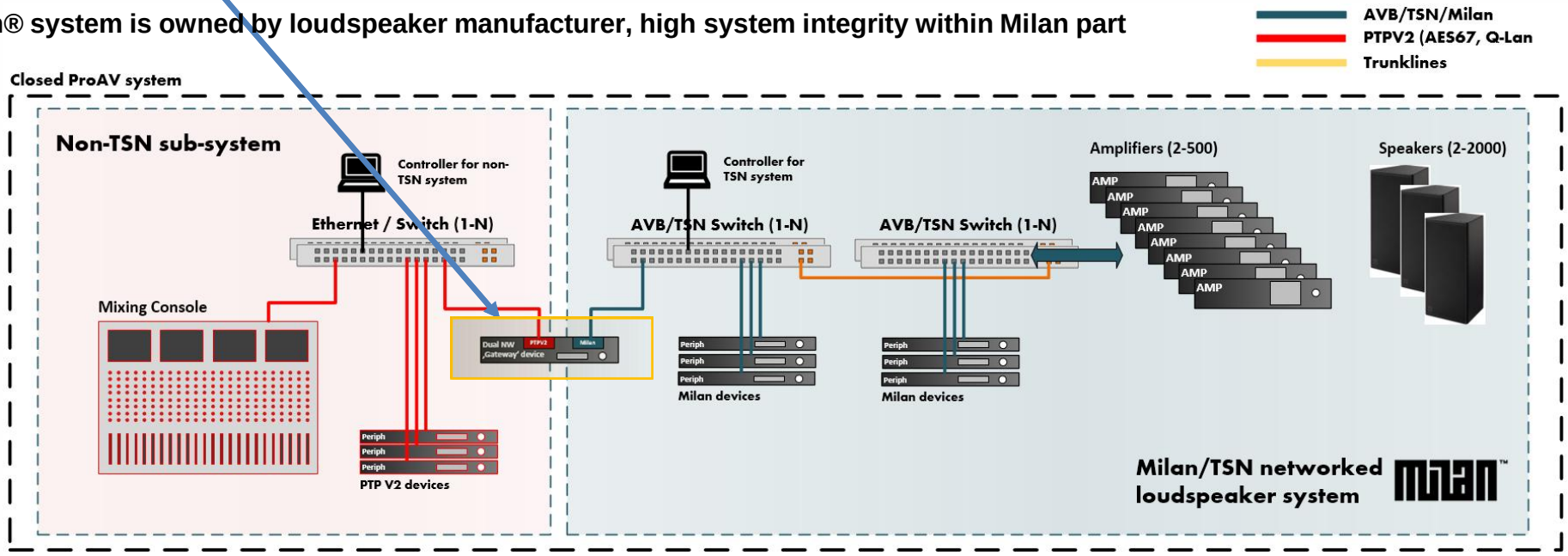
# ProAV system architectures - Closed systems

## So – how to deal with this ? <u>Split/isolate in separate sub-system</u>

- For the time being this is the only *practical* way to deploy Milan® (AVB/TSN) in ProAV applications: As an isolated separate subsystem
- It requires some device (Gateway), that can connect to two (3,4..) separate networks. Different architectures possible.

<u>This 'solution' (workaround) has issues and benefits:</u>

- Problems: No control interaction between the systems, low integration, management effort, cost
- Benefits: Milan® system is owned by loudspeaker manufacturer, high system integrity within Milan part



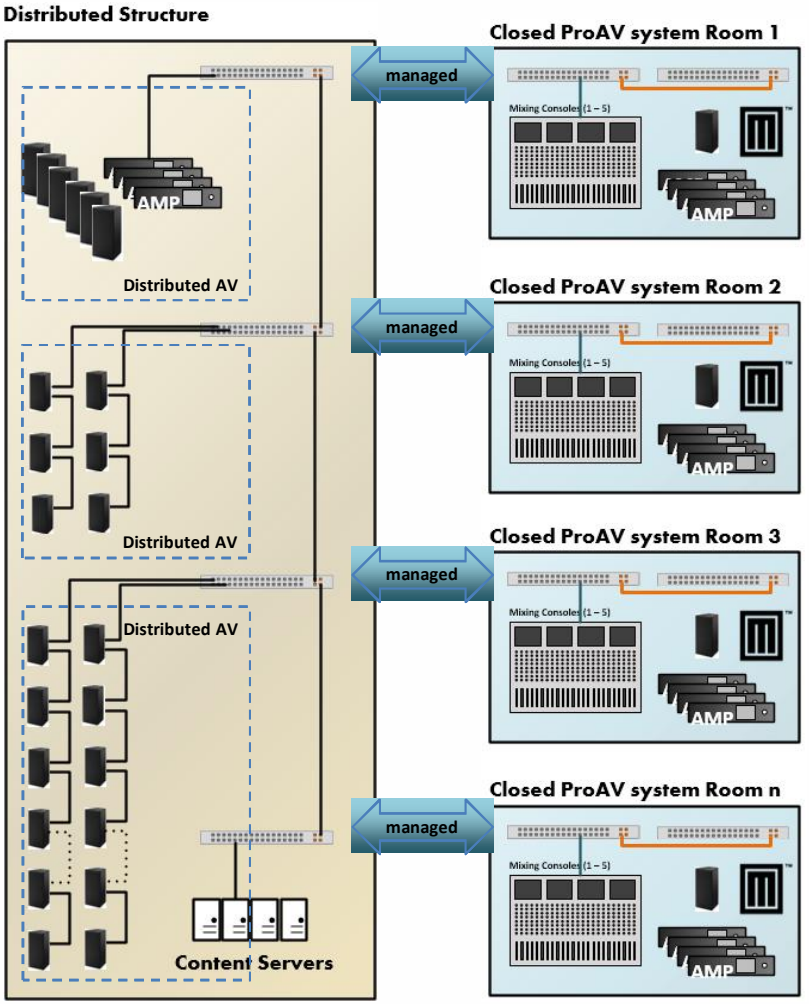
This was about closed systems

Let’s take a look at aspects of larger structures

# ProAV system architectures - System structures

## Most larger buildings have a nested structure of closed and distributed systems

- Rooms/halls each have a ‘closed’ AV system
  - Independent operation/Mngmnt.
  - Large # of streams/signals
  - Very low latency
  - Strict security requirements for privacy/NW integrity
- A distributed structure interconnects the different rooms for various purposes:
  - Exchanging signals between rooms
  - Enabling centralized system control/monitoring
  - Providing AV services across the building (Foyers, hallways, restrooms, lounges ….)
- Critical: The interconnections between rooms and building structure need to be manageable
  - Prevent unwanted action into rooms from outside = Filter signals and control
  - Still allow desired control and signal flows
  - Power/operational status of each sub-system can be very different



# ProAV system architectures - System structures

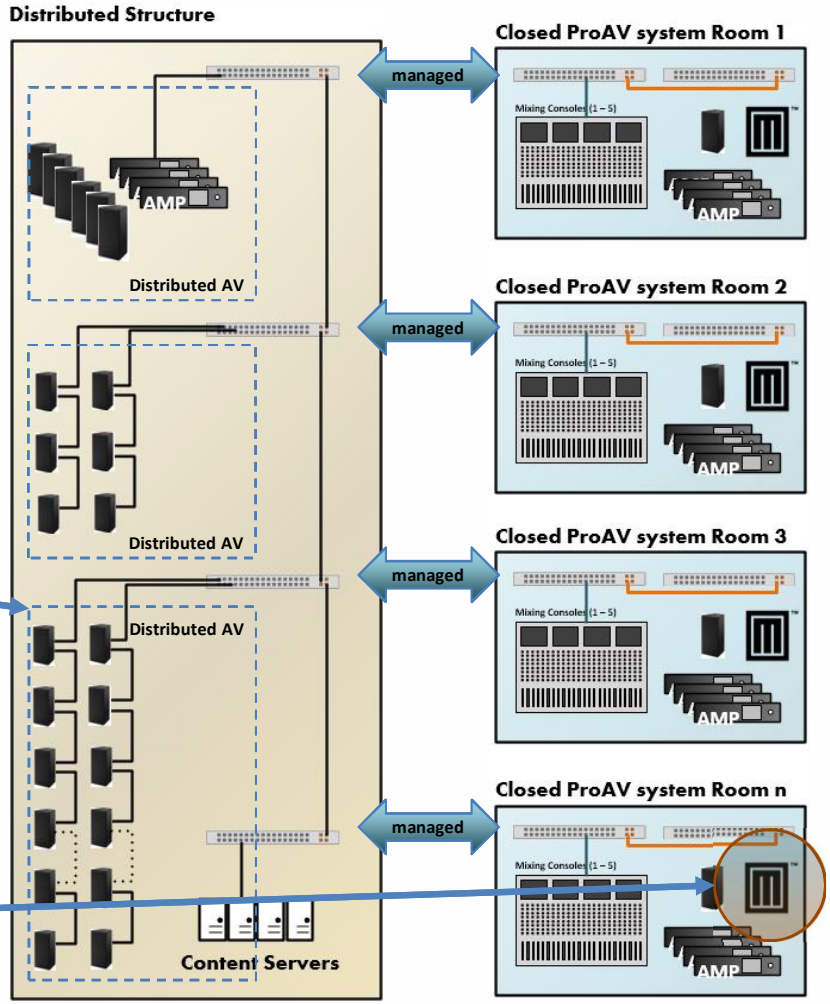
## Most larger buildings have a nested structure of closed and distributed systems

- **This structure model is valid for the vast majority of Conference, Government, Performing Art, Corporate, Theme Parc, Hotel, Casino (….) buildings.**
- **The ProAV market overlaps vastly with the enterprise network market**

- **The requirements in the distributed structure are a bit different from within closed systems:**
  - Daisy-chained structures are very important
  - Deep integration with building management systems
  - The heterogeneity of systems is extreme – everything lives in one structure

- **Requirements for convergence are even higher in the distributed structures**

- **For the reasons mentioned, currently Milan®/TSN can mainly only live in isolated areas within closed systems.**

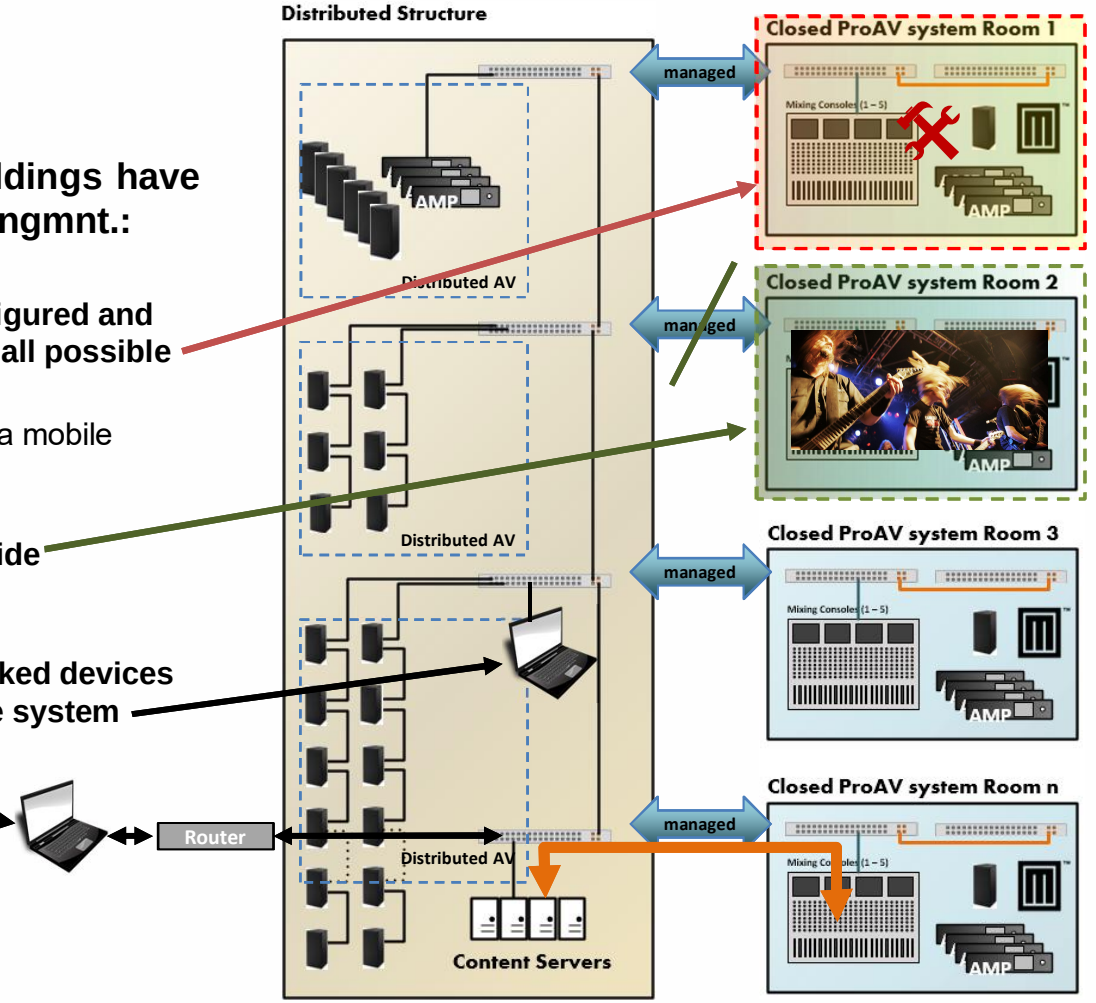


# ProAV system architectures - System structures

## Management of complex system structures

**Such very common structures of ProAV integration in buildings have certain requirements w. regards to system and network Mngmnt.:**

- **It is imperative, that a closed system in a room can be set up, configured and operated independent from the rest of the structure. This includes all possible changes in the network structure.**
  - Thus: Within a room the system must be manageable like a mobile system, that could change day-by-day. Plug-and-play
- **Once a system is running an event, it must be protected from outside influences, unwanted control etc.**
- **Still: It is desired that *in a manageable way* all systems and networked devices could be remotely surveyed or configured centrally from within the system or from the outside (as IoT devices)**
- **Some media traffic (audio, video) may be required between rooms and any other structure in the building.**

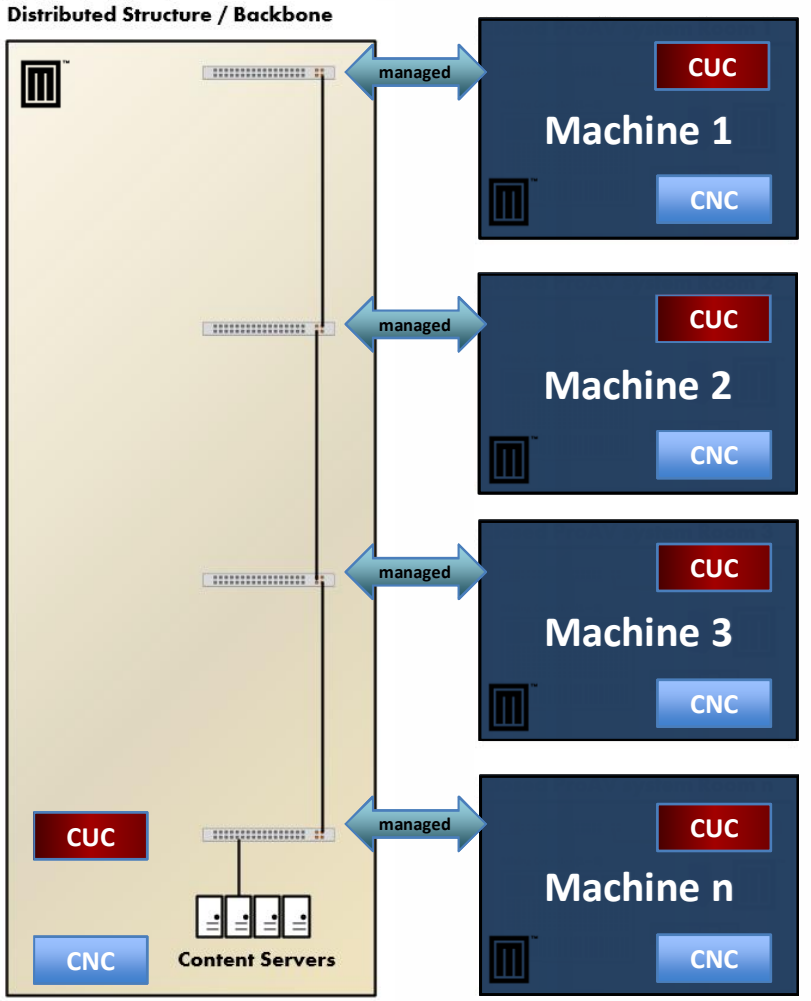


# ProAV system architectures - System structures

## Most larger buildings have a nested structure of closed and distributed systems

- We think that these requirements are to a large degree equivalent to industrial requirements as they are described in 60802
- Due to the required independency of the room systems the network management is most likely to be separate per room/sub-structure.
- However, it must be possible, that different instances in the overall system can execute a configurable amount of control for each system or across the entire structure
  This depends very much on the exact character of the venue and how it is operated
- Most important: Ultimately bounded latency and deterministic behavior are required in the entire structure.

  All parts of the system must be TSN capable while supporting the coexistence with other protocols

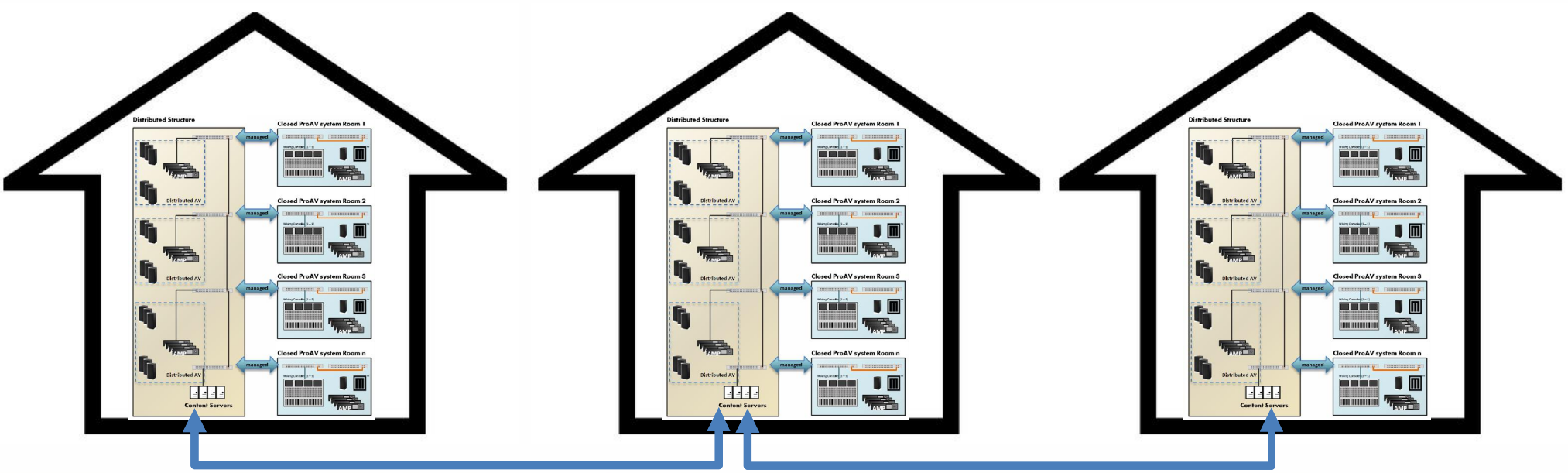


# ProAV system architectures - System structures

## Campus scale

- Larger complexes/venues require a campus scale of networking AV.
- Most often the latency requirements between buildings are less critical, required bandwidth is lower
- Bounded latency and guaranteed bandwidth are still desired

**Such structures are also applied within larger venues and sites (Cruise Ships, Casinos, Theme Parks, Universities)**



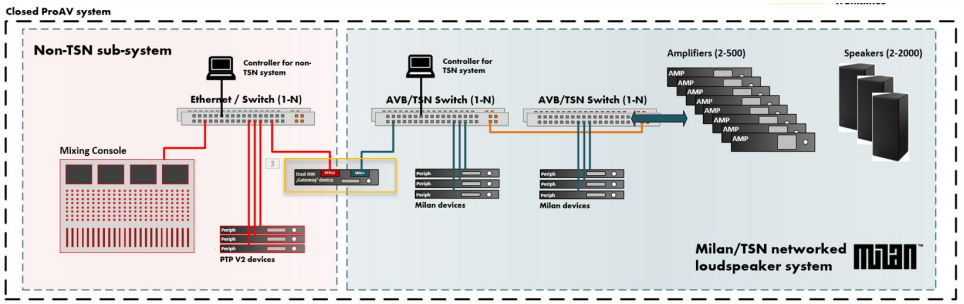
The perspectives:

What does all this mean for the future of TSN in ProAV ?

# ProAV status and perspectives

## The current ProAV status

- Milan® has started in 2016 as a profile that guarantees interoperability of AVB audio devices in the market [Interoperability = marketability]
- Milan® in its current state (802.1BA-2011) can only be applied in a limited way to small systems or isolated 'TSN areas' within closed ProAV systems
- This has a good *but very limited value* as 'System Network' for manufacturers **but we have shown that it by far does not fulfil requirements for deploying TSN into larger relevant applications and markets.**



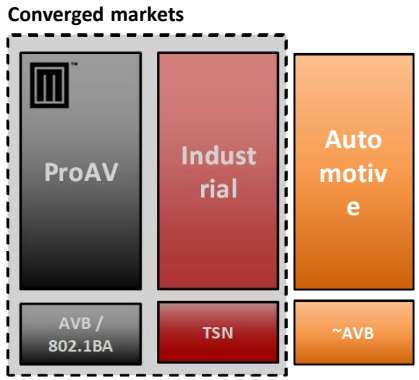

| | | |
|---|---|---|
| **Key issues:** | **1. Current 'AVB' standards do not support** | - the required system scale (no. of streams, hops)<br>- the desired system performance (latency)<br>- the required system architectures |
| | **2. Required convergence with other protocols is not supported:** | - coexistence with non-TSN traffic is a must for the practical market implementation.<br>- TSN has not been positioned as a feature of 'network', it is seen as an exclusive ambition for 'the better network'. **This can not be positioned on our markets.** |

**Milan based on 802.1BA-2011/2021 (802.1as-2011, Qav, 1722.1, MSRP…)**

| 2016 | 2018 | 2020 | 2022 | 2024 |
|---|---|---|---|---|
| Milan founded | Milan launched | First certified products | Advanced cert. program | Well established as System Network |

# ProAV status and perspectives

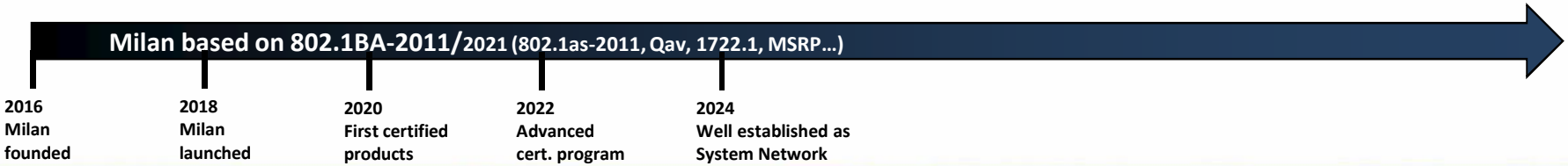
## The ProAV perspectives




### Another issue: Splintering of TSN

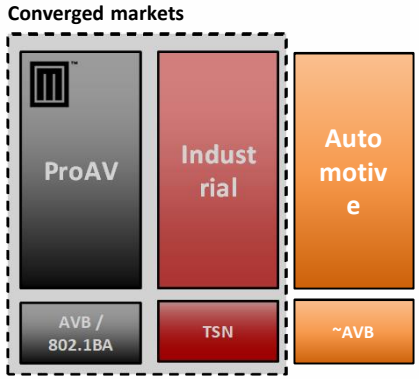
- ProAV bases on ‘AVB’. AVB is seen as ‘old’ and ‘ProAV specific’. This makes AVB a tiny niche market that is not well supported by infrastructure and silicon manufacturers
- Industrial (60802) bases on ‘TSN’, which is ‘newer’, more advanced, more future-proof, bigger market. - **In reality, these two verticals are converging *markets* !**

- **This presentation has focused on audio – the requirement for ProAV is that all disciplines that belong to ‘Event System’ and ‘Building System’ [Audio, Video, Light, Pyro, Staging, Scenery, Signage …] coexist on one network and can interoperate wherever desired.**
- **Video has slightly different requirements from audio but the key problem statements made here remain the same.**
- **A future ProAV system incorporates a variety of different media and control traffic in the same way and with equivalent structures as it is required for industrial applications. In principle it makes no sense to treat the verticals as different w. regards to requirements.**



# ProAV status and perspectives

## The ProAV perspectives

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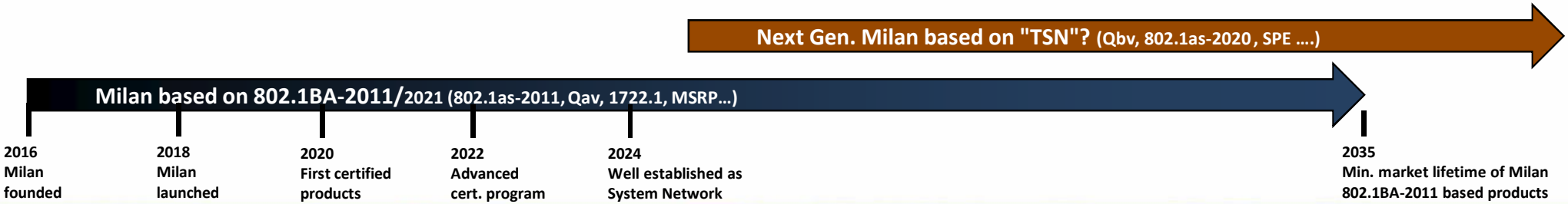
- Industrial (60802) bases on ‘TSN’, which is ‘newer’, more advanced, more future-proof, bigger market. - **In reality, these two verticals are converging markets !**

- **Key question: Could (from a technical viewpoint) ProAV solve its technical issues by adopting industrial TSN in future?**
  - This would probably give us most of the technical features/capabilities we need
- **We might however get into a deep problem with backwards compatibility to current products:**
  - For current Milan® we have to estimate a market lifetime of 15y from now.
  - Hardware that is now used for Milan® will often not be able to run Qbv - **can 802.1BA-2011 and "TSN" coexist on the same port?**



# ProAV status and perspectives

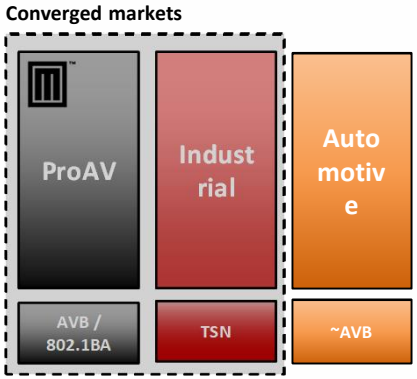
## The ProAV perspectives

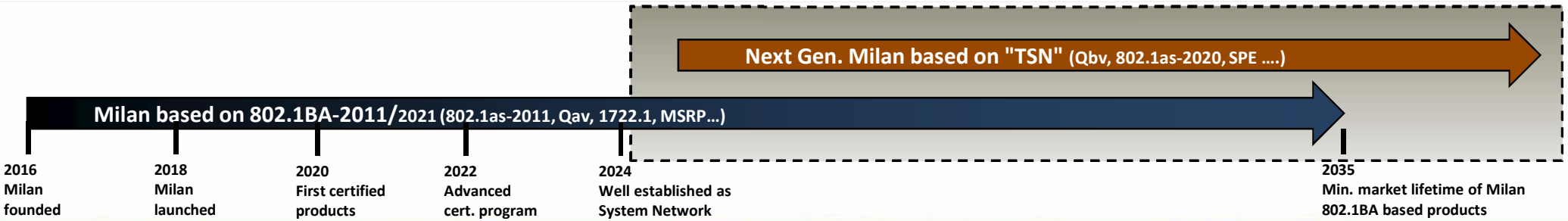
**We strongly believe, that if Milan as a ‚next Gen.' goes for new TSN standards we will for a quite long time**

- …. still need to support "AVB" in networks (Qav, 1722.1, MSRP…)
- …. still need to support the coexistence with non-TSN protocols (PTPV2, QoS)
- …. coexistence means on the same Network Port in parallel

**We in fact see a future for different scales/*flavours* of TSN in different ProAV markets.**

- It will never be a straight ‚one or the other' game
- We assume that this experience about horizontal and vertical backwards compatibility will become highly relevant for other verticals as well.



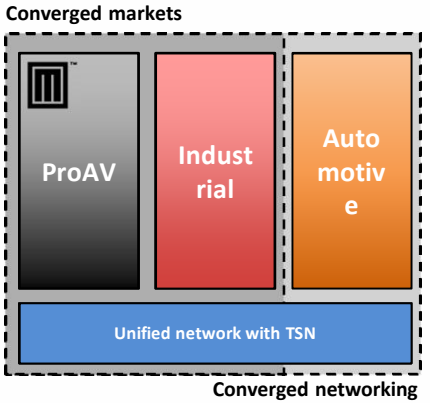



The perspectives:

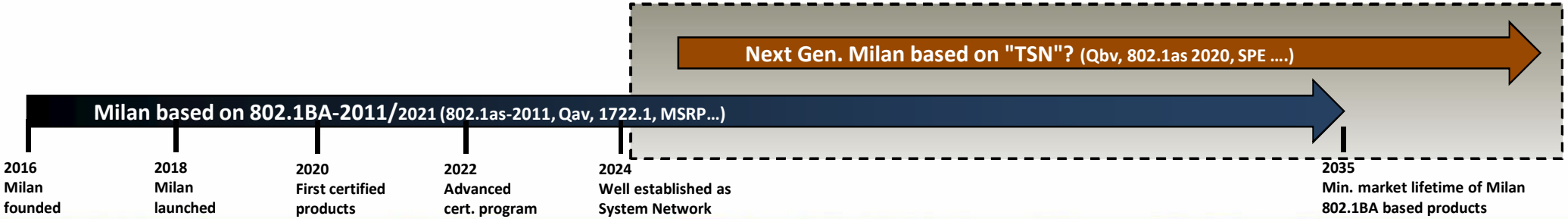
What are the concrete next steps in ProAV ?

# ProAV status and perspectives

## Next steps in ProAV



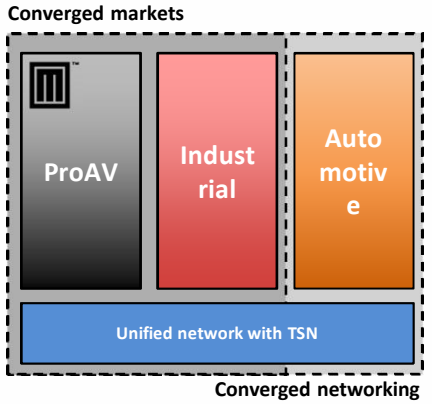

- **The ProAV / Milan® grp. in Avnu has decided for the staged strategy shown below:**
  - We will further have to drive Milan® based on 802.1BA-2021 in order to achieve max. market penetration
  - It is imperative for Milan® to become successful, it is the most important opportunity for TSN in ProAV.
  - However: **This will not enable Milan® to cover large and deeply converged applications and these applications are already today requested in our market**
- **In some future we will have to introduce NextGen Milan based on improved TSN standards in order to achieve a wide market coverage for Milan**
  - We think that this step must be a step based on a converged network architecture at least in alignment with Industrial (60802), ideally also with Automotive – if we can not achieve this, TSN will most likely have no future in ProAV
  - Finally, only such convergence across verticals will create the required economies of scale and enable wide availability of IT products, modules, silicon and components

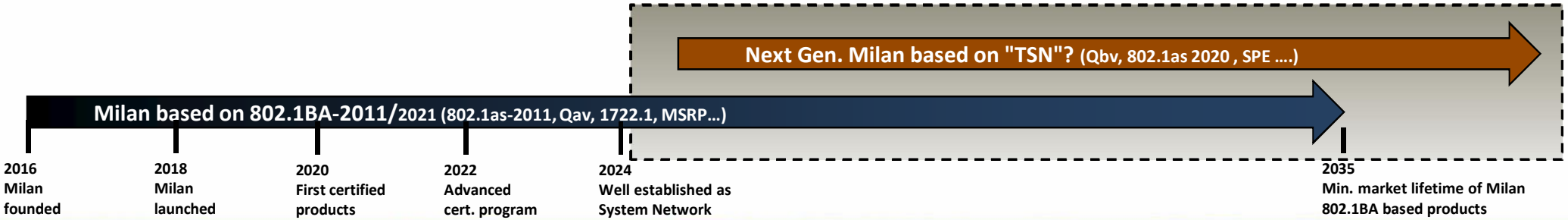


# ProAV status and perspectives

## Next steps in ProAV

- However - it is imperative, that we can achieve an integration of different AVB/TSN standards and non-TSN protocols within such a unified network architecture
- It is the only way we see for TSN to become adoptable in markets



# ProAV status and perspectives

**Thanks for listening!**

**Q&A**