Common TSN for Converged Networks – Past perspectives, present realities

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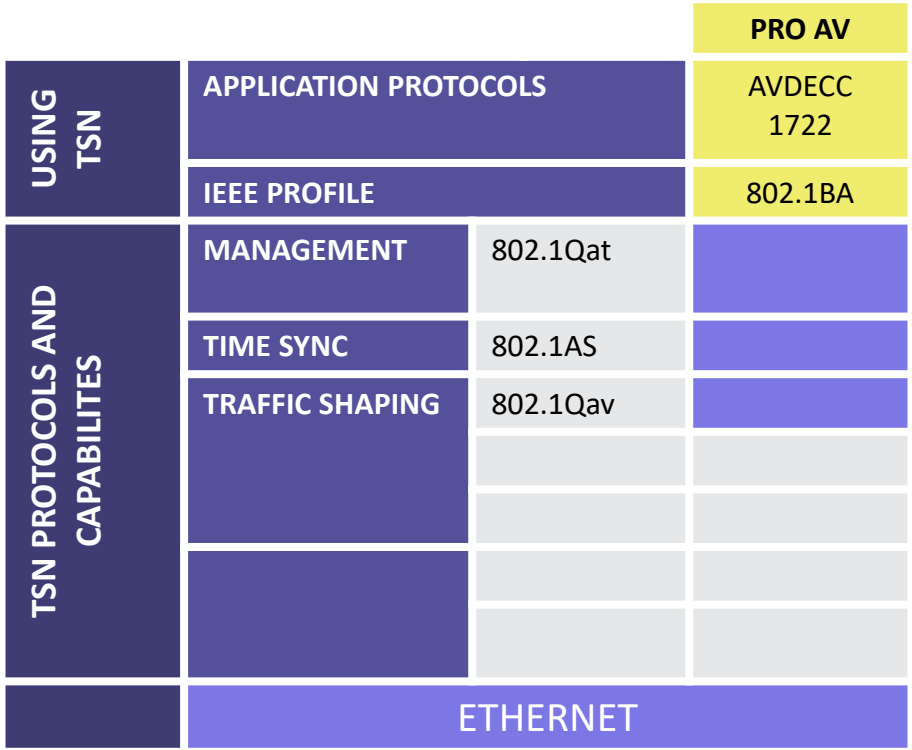
A brief history of Time (sensitive networking)



A brief history of Time

			PRO AV	AUTO
USING TSN	APPLICATION PROTOCOLS		AVDECC 1722	1722
	IEEE PROFILE		802.1BA	
TSN PROTOCOLS AND CAPABILITES	MANAGEMENT	802.1Qat		
	TIME SYNC	802.1AS		
	TRAFFIC SHAPING	802.1Qav		
		802.1Qbv		
		802.1Qbu		
	ROBUSTNESS			
	ETHERNET			

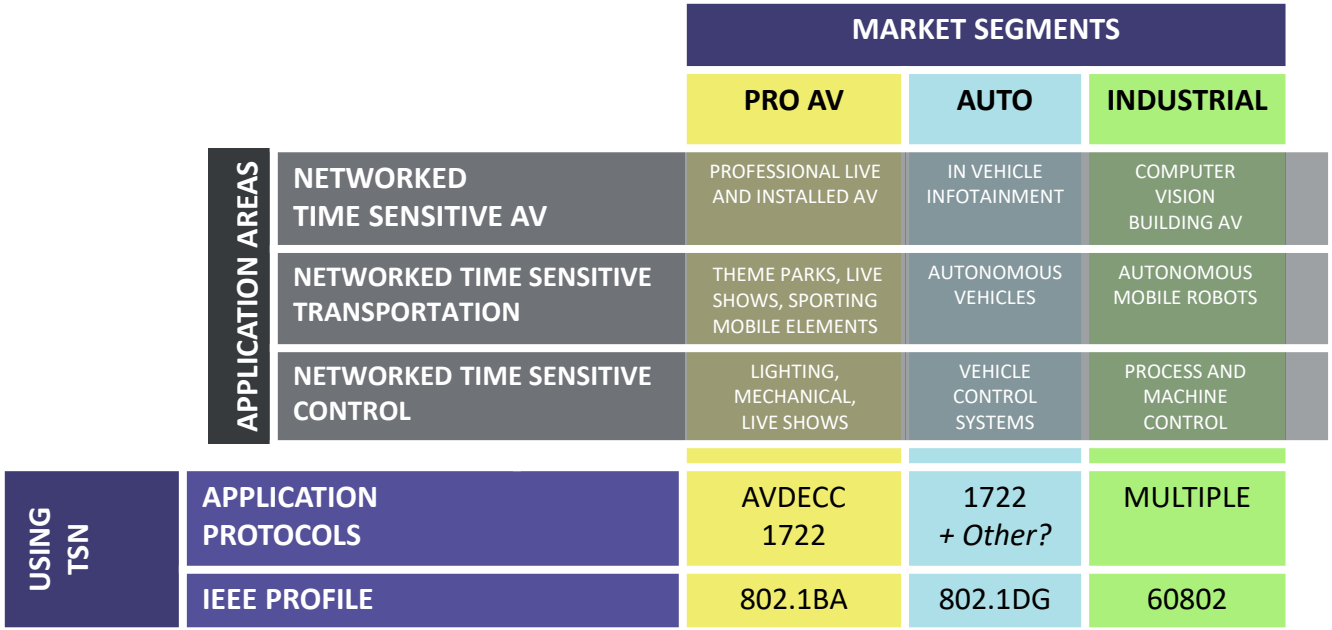
A brief history of Time

			PRO AV	AUTO	INDUSTRIAL
USING TSN	APPLICATION PROTOCOLS		AVDECC 1722	1722	MULTIPLE
	IEEE PROFILE		802.1BA	802.1DG	60802
TSN PROTOCOLS AND CAPABILITES	RESOURCE MANAGEMENT	802.1Qat 802.1Qcc 802.1Qdj			
	TIME SYNC	802.1AS			
	TRAFFIC SHAPING	802.1Qav			
		802.1Qbv			
		802.1Qbu			
	ROBUSTNESS	802.1Qci			
		802.1CB			
	ETHERNET				

A brief history of Time

			PRO AV	AUTO	INDUSTRIAL	AEROSPACE
USING TSN	APPLICATION PROTOCOLS		AVDECC 1722	MULTIPLE	MULTIPLE	
	IEEE PROFILE		802.1BA	802.1DG	60802	802.1DP
TSN PROTOCOLS AND CAPABILITES	MANAGEMENT	802.1Qat 802.1Qcc 802.1Qdj				
	TIME SYNC	802.1AS				
	TRAFFIC SHAPING	802.1Qav			Future?	
		802.1Qbv		?		
		802.1Qbu	Future?	?		
	ROBUSTNESS	802.1Qci				
		802.1CB	Future?			
	ETHERNET		WIFI		5G	

Applications span market segments



Base TSN from a Silicon Perspective

- Flexible selection of software and silicon
- New software
- New silicon
  - Superset vs. Purpose-built
  - Today's requirements vs. Tomorrow's use cases

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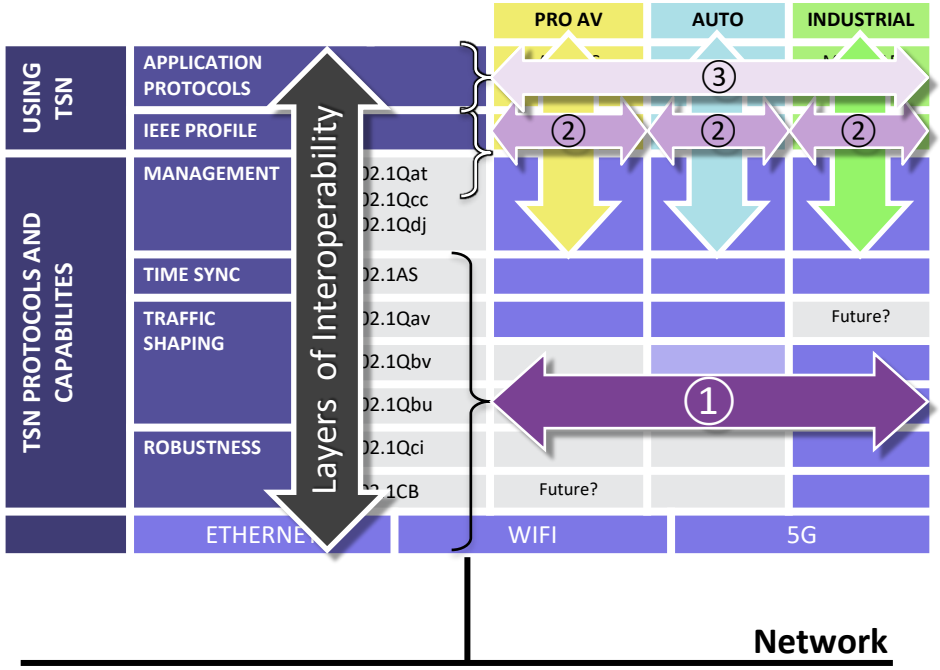
	ETHERNET			WIFI		5G

Base TSN from a Silicon Perspective

TSN does NOT mean
One Layer of Interoperability



① Silicon layer:
- Interoperability starts here
- ASSPs, ASICs, FPGAs must interoperate

② Profile layer:
- Devices interoperate within a profile
- Devices reconfigured for use across profiles

③ Application protocol layer:
- Devices with common application protocols interoperate
- Devices with different application protocols co-exist (share the wire)

STATE OF TSN AND NETWORK REQUIREMENTS IN PROAV AND INDUSTRIAL

ProAV application trends

ProAV applications are rapidly developing to:

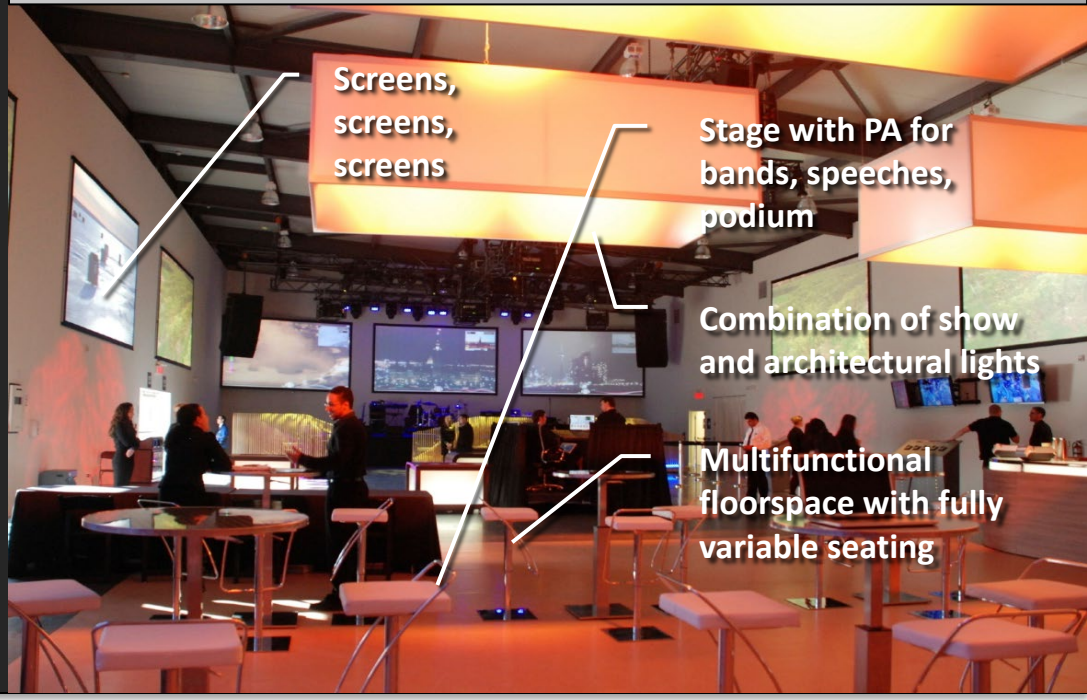
- Multifunctional systems, versatile use cases
- Visitor experience oriented

- Integration **of various media on different network protocols**

- Full control over all devices
- Remote management and support

Corporate ShowRoom:

- Meetings and small conferences
- Hybrid usage on-site and online
- Presentations, newsroom
- Space for sozialising, parties
- Concerts and other culture
- ….



ProAV convergence

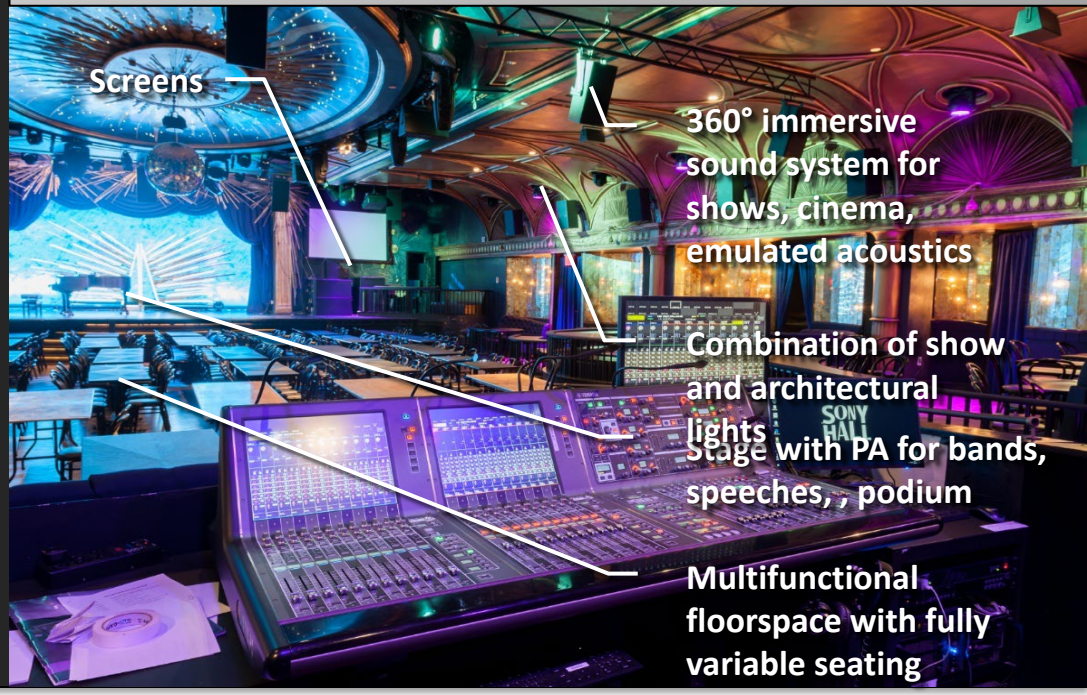
The technical requirements are tough:

- Vastly increased system complexity
- Deep requirement for variability
- Real time control

Today we have the requirement but the existing solutions are too complex, too slow, too unreliable, too expensive, not manageable.

Multifunctional Live Club:

- Mid-large size high-quality experience space
- Concerts of all kinds and other culture
- Hybrid usage on-site and online
- Venue can be booked for whatever type of event:
  - Presentations, corporate
  - Private, dinners, parties



ProAV convergence

Key paradigm for future ProAV:

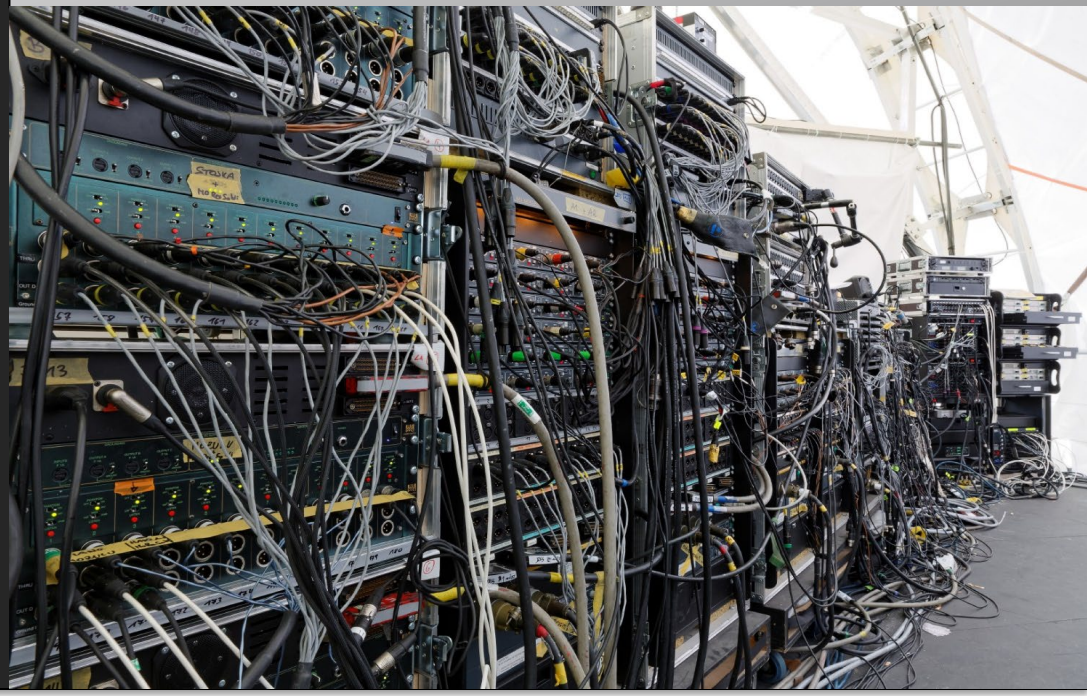
Make complex functionality simple and manageable

Key parameters:

- Everything will be networked
- **It must be one structure, one converged network**
- It must allow for transitions, coexistence of protocols and applications

Event signal distribution structures:

- **Digitisation itself has not simplified system structures**
- **With growing system complexity, signal distribution and connectivity becomes a core problem**



Industrie 4.0 – Future of industrial automation

Four basic principles to enable Plug & Produce for Industrie 4.0

Connectivity and Communication

- Easy access to data from sensors, devices, machines, productions cells, …

Information transparency

- Create information out of data by adding semantics

Technical Assistance

- Ability of assistance systems to support humans, e.g. by augmented reality

Decentralization of Decisions

- Ability to make decisions and perform tasks as autonomous as possible

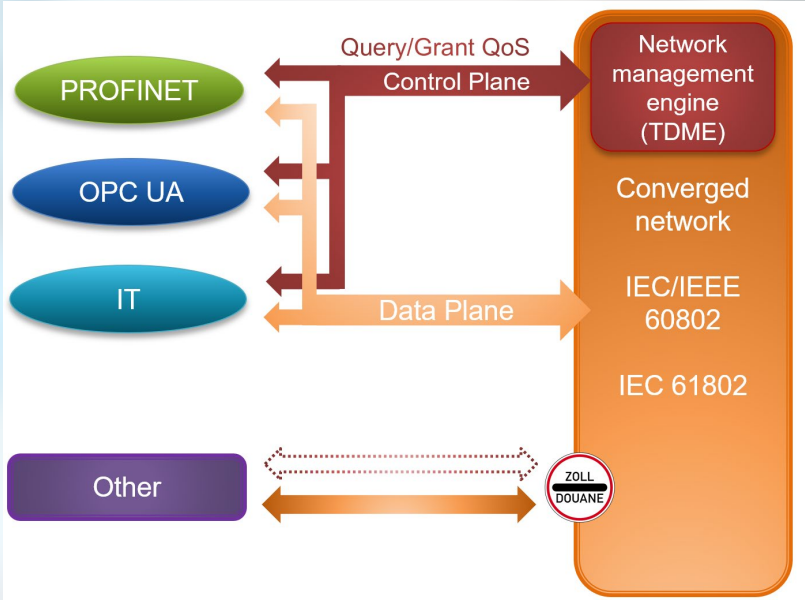
-> all together based on an IT/OT converged network

Requirements for Converged Network

- **IT, OT or other** devices in one network **sharing guaranteed QoS**
- Applications are **implemented, deployed and engineered independently** from the network
- **Self-protecting** network e.g. against wrong connections, unexpected devices or network load
- **Dynamic adaption**: plug and produce (AGV, …), topology changes, extensions for IT and OT devices

- **Scalable availability** for the network and the devices
- Reliable and accurate **time synchronization**

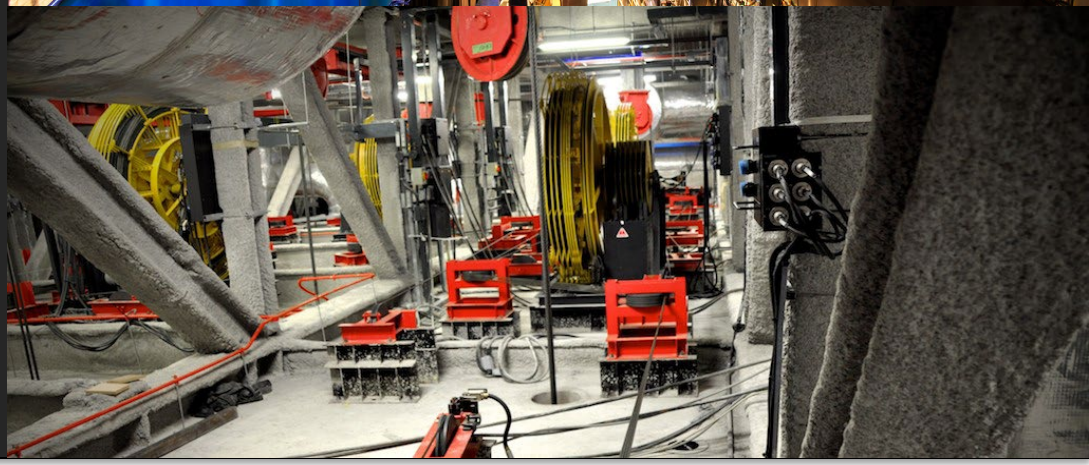
- Link speeds and transitions from **10 Mbit/s up to 10 Gbit/s**
- **Topologies**: ring, line, tree, star and combinations
- **Media types**: fiber, copper and radio (e.g. wireless and 5G)



ProAV & industrial components

Many ProAV productions incorporate various kinds of industrial components:

- Stage mechanics and kinetics



ProAV & industrial components

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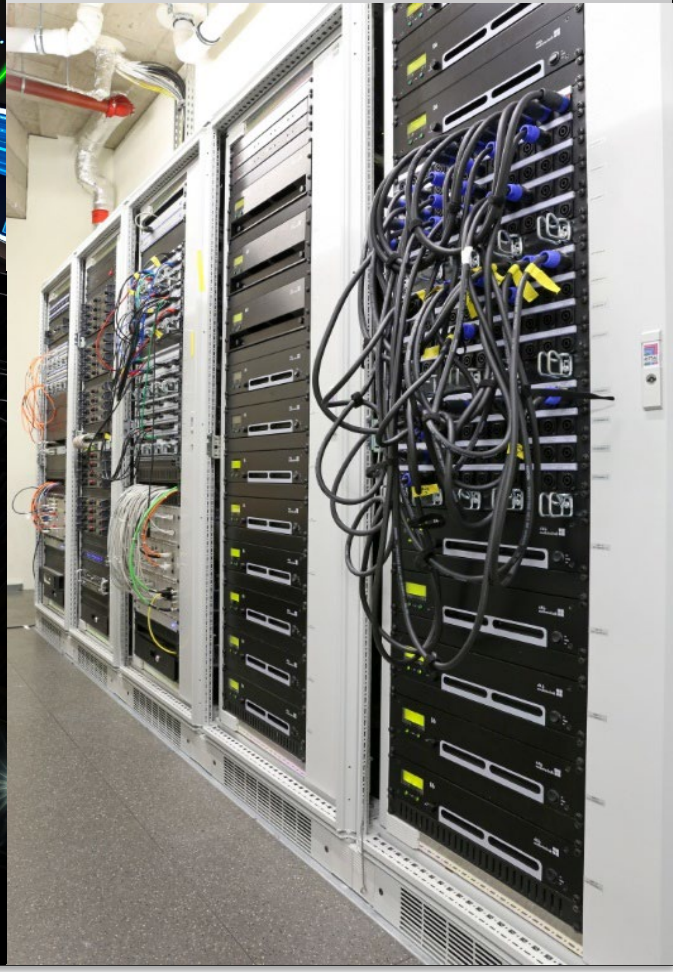
- Rigging for loudspeakers and video equipment
- Control systems



ProAV & industrial components

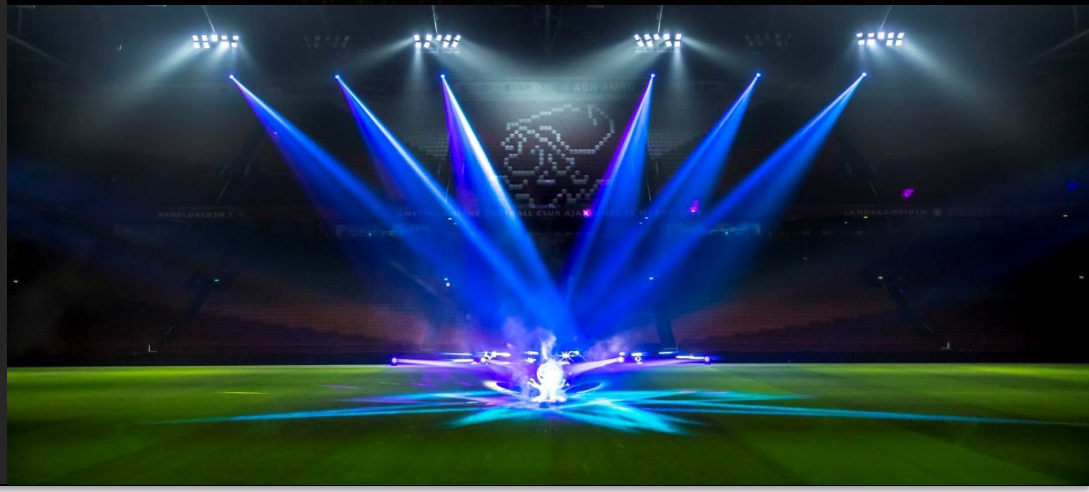
Many ProAV productions incorporate various kinds of industrial components:

- Stage mechanics and kinetics
- Rigging for loudspeakers and video equipment
- Control systems
- Moving lights and other moving elements

Industrial and ProAV have many overlaps

- Same components
- Low Latency
- Criticality (safety related)
- Requirements for control
- **Many business contexts**

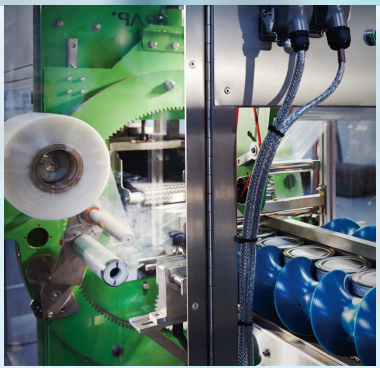
It makes sense to see them as closely related

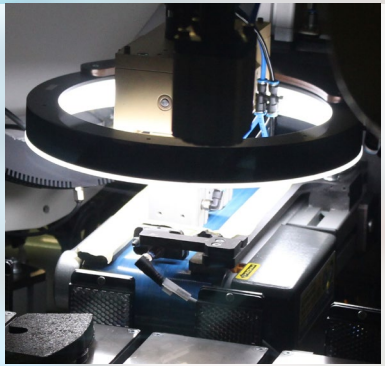


Factory and Process automation, Motion control, Camera-based quality control, all need converged networks


Factory Automation


Process Automation


Motion Control


Camera Integration

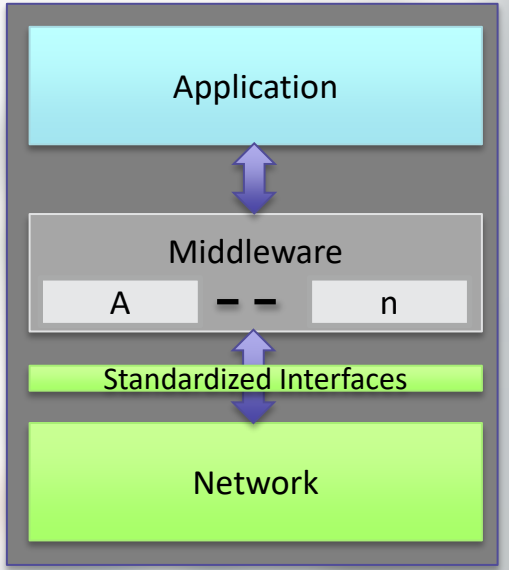

Worker Environment

- A converged network needs to cover concurrently the requirements of all industrial verticals
- While ProAV needs to bring Industrial to Rock'n'Roll…

  …Automation needs to bring Rock'n'Roll to Industrial

Digital Factory requirements

- Providing Working Clock and Global Time
- Guaranteed latency for time-aware streams
- Guaranteed reliability for time-aware streams
- Guaranteed zero congestion loss for streams and time-aware streams
- Decoupling between middleware and network enabled by well-defined resources and standard interfaces



Please be aware that TSN needs to be combined with a middleware.

e.g., PROFINET and/or OPC UA and/or others

Wait a minute – these are ProAV requirements!

- Providing Working Clock and Global Time
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- Guaranteed reliability for time-aware streams
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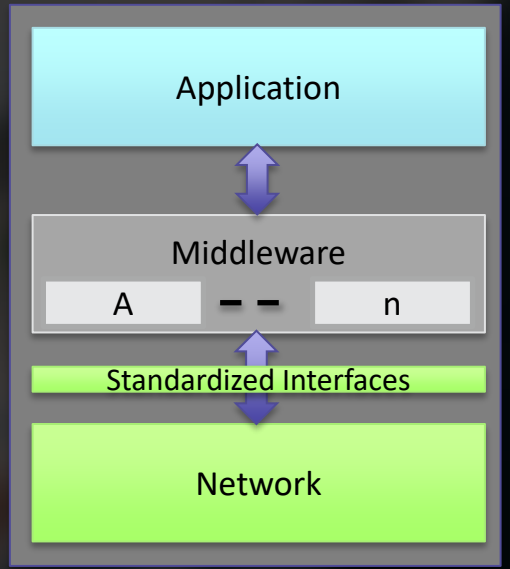
e.g., Milan and others

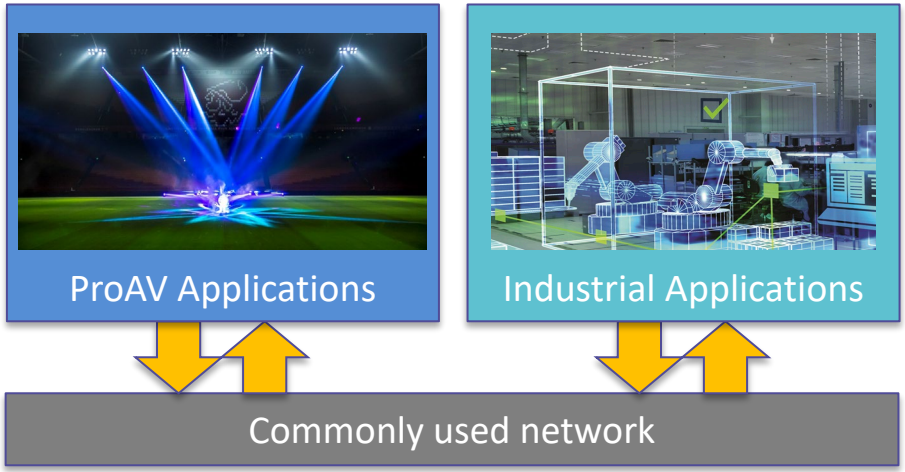


So…

ProAV and Industrial have very unique *application requirements*

Yet have *common requirements* OF THE NETWORK!

…and increasingly will need to use, access, and coexist on the same converged, network



Are we aligned to this in our ecosystem approach?

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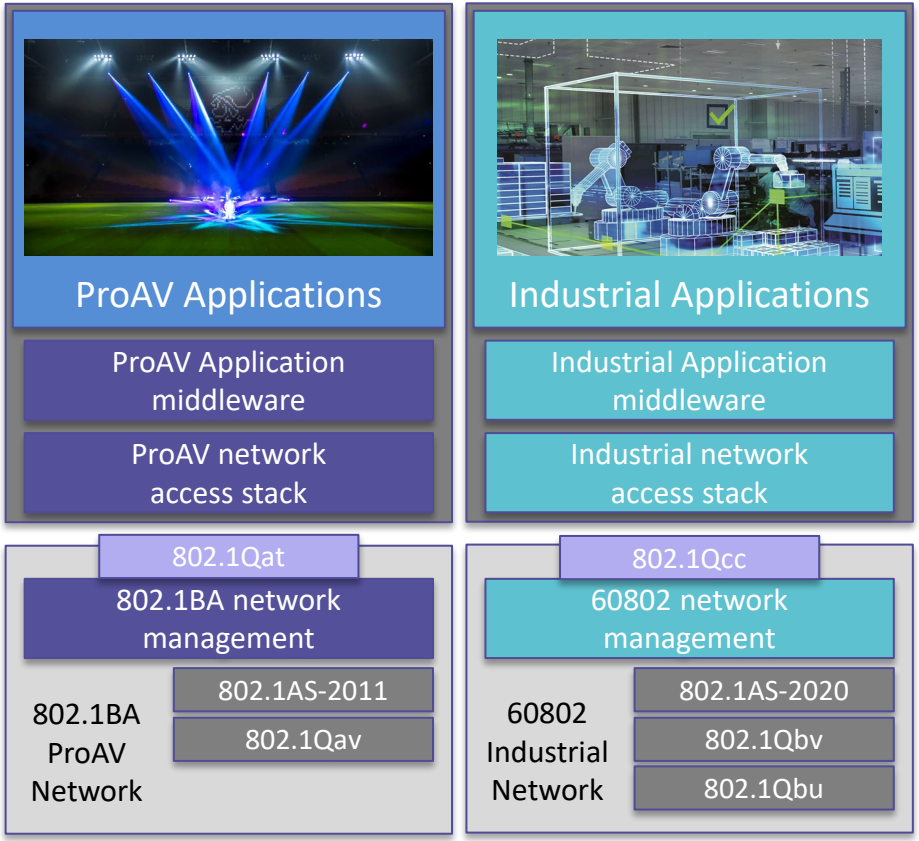

✓ *Unique application stacks*

✗ *Common methods to access and manage the network*

✗ *Common network that can be used by both types of devices*

Unfortunately, the answer is: No

Yet this is not a problem with TSN – simply how it is used

An alternate approach (same TSN standards):

ProAV and Industrial have very unique *application requirements*

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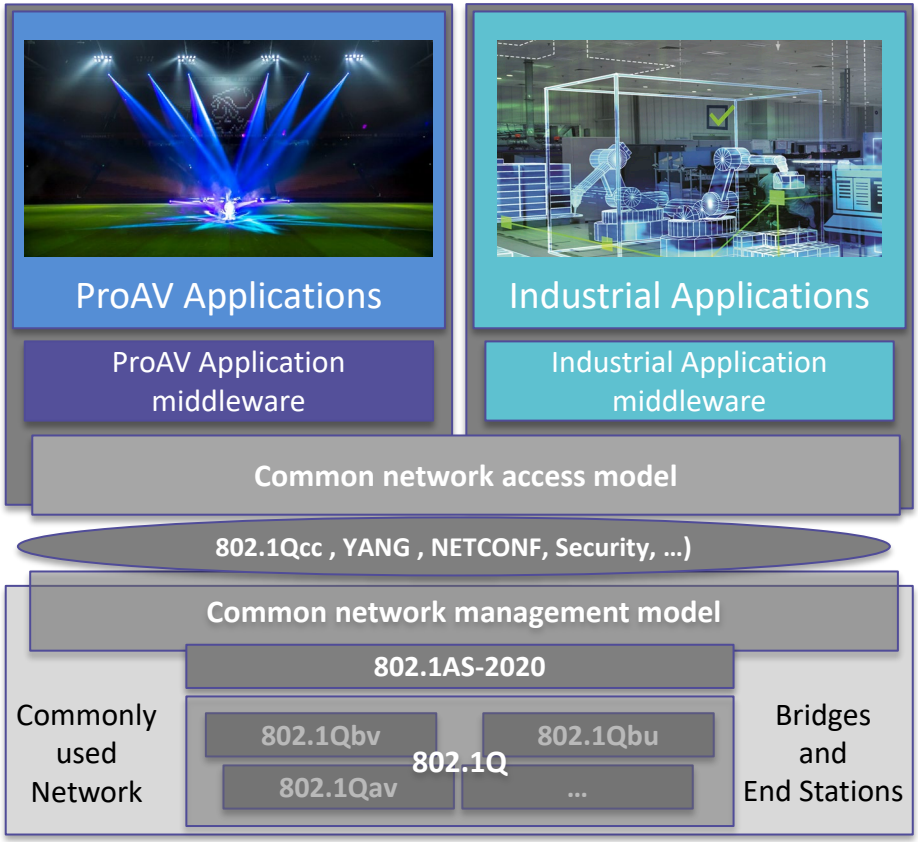

- *Unique application stacks*
- *Common methods to access and manage the network*
- *Common network that can be used by both types of devices*
- *Commonality at the network layer drives economy of scale*

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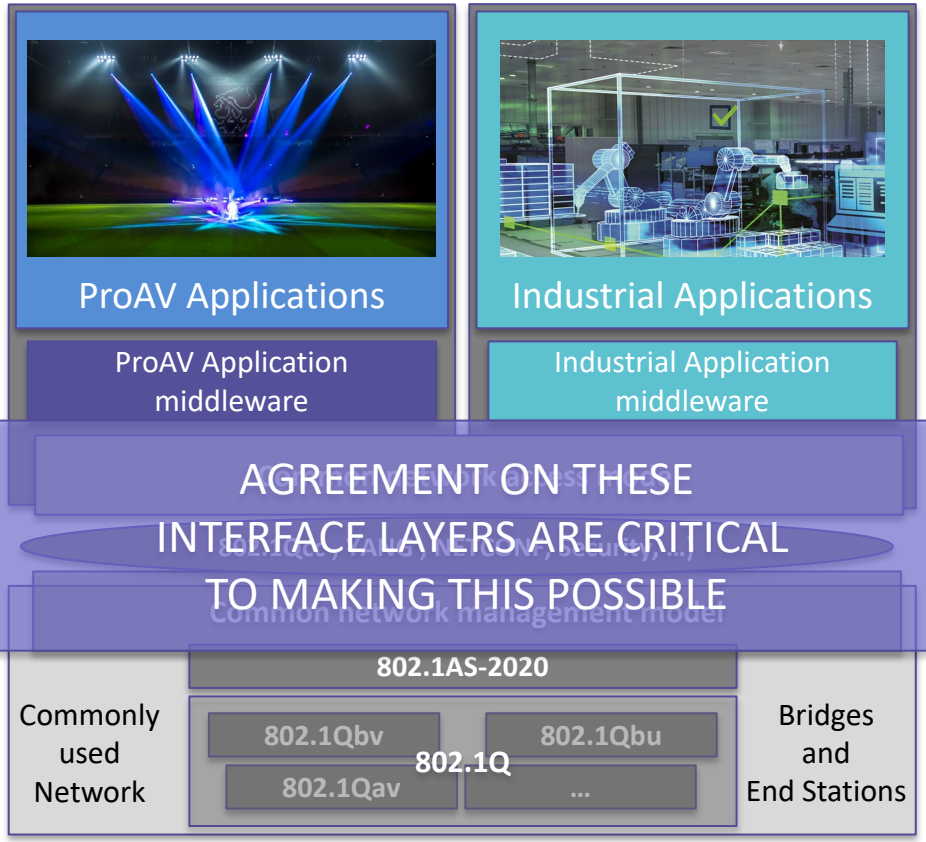


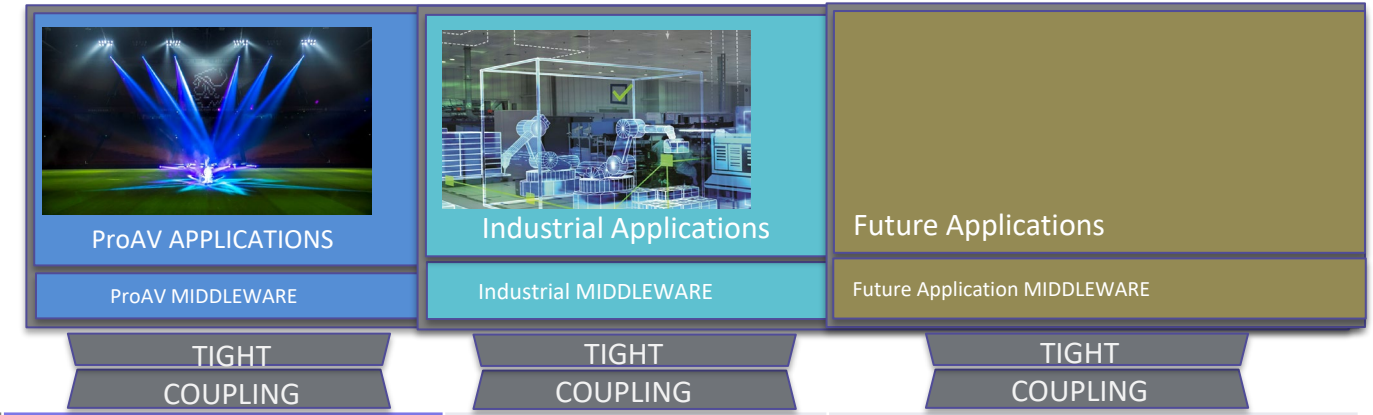
Unique application stacks

Common methods to access and manage the network

Common network that can be used by both types of devices

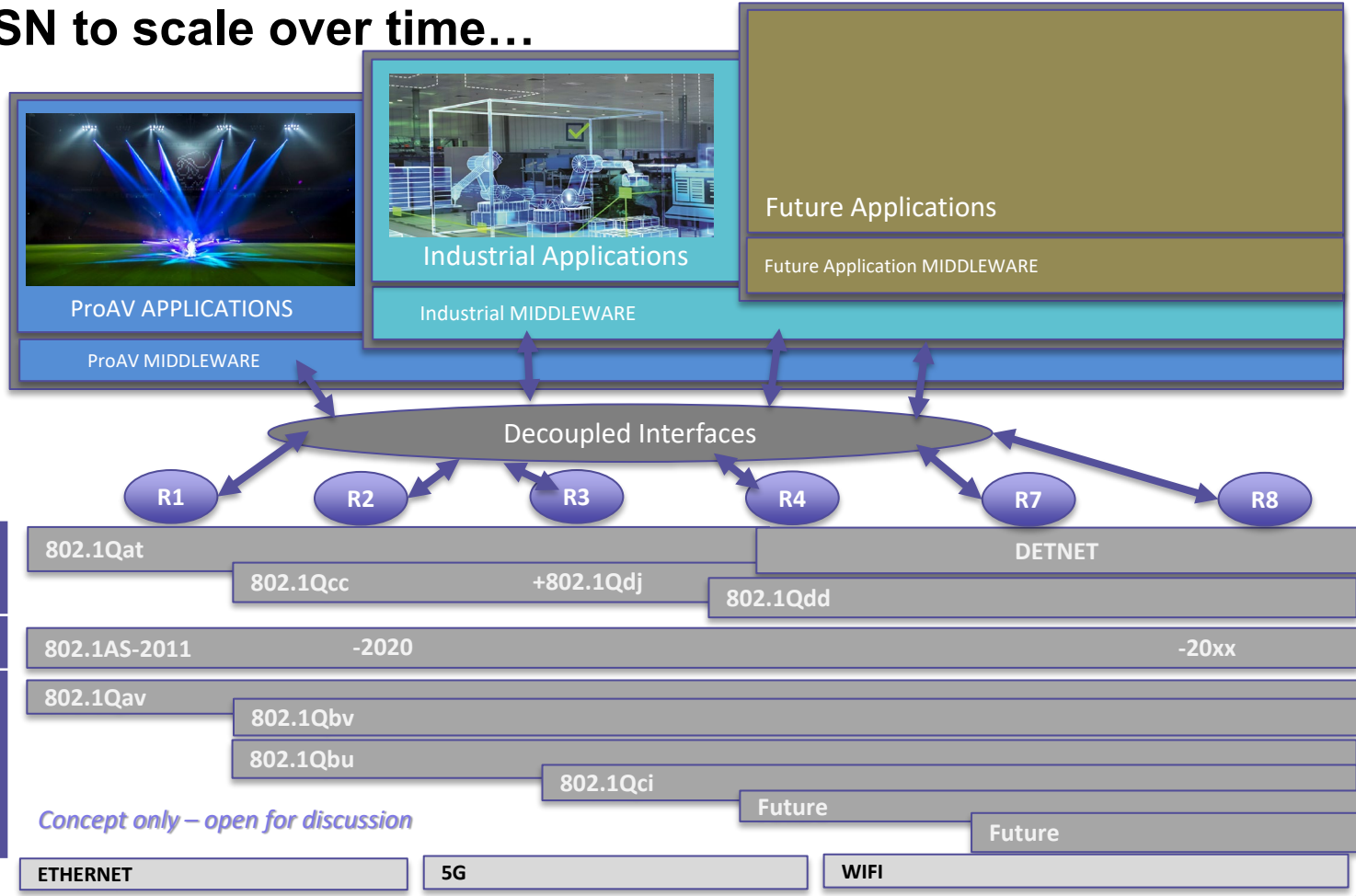
Commonality at the network layer drives economy of scale

Diffusing TSN to scale over time…



MANAGEMENT & CONFIG	802.1Qat	■		
	802.1Qcc		■	■
TIME SYNC	802.1AS-2011	■		
	802.1AS-2020		■	■
BANDWIDTH & LATENCY	802.1Qav	■		
	802.1Qbv		■	■
	802.1Qbu		■	
	FUTURE			■
	FUTURE			■

Diffusing TSN to scale over time…



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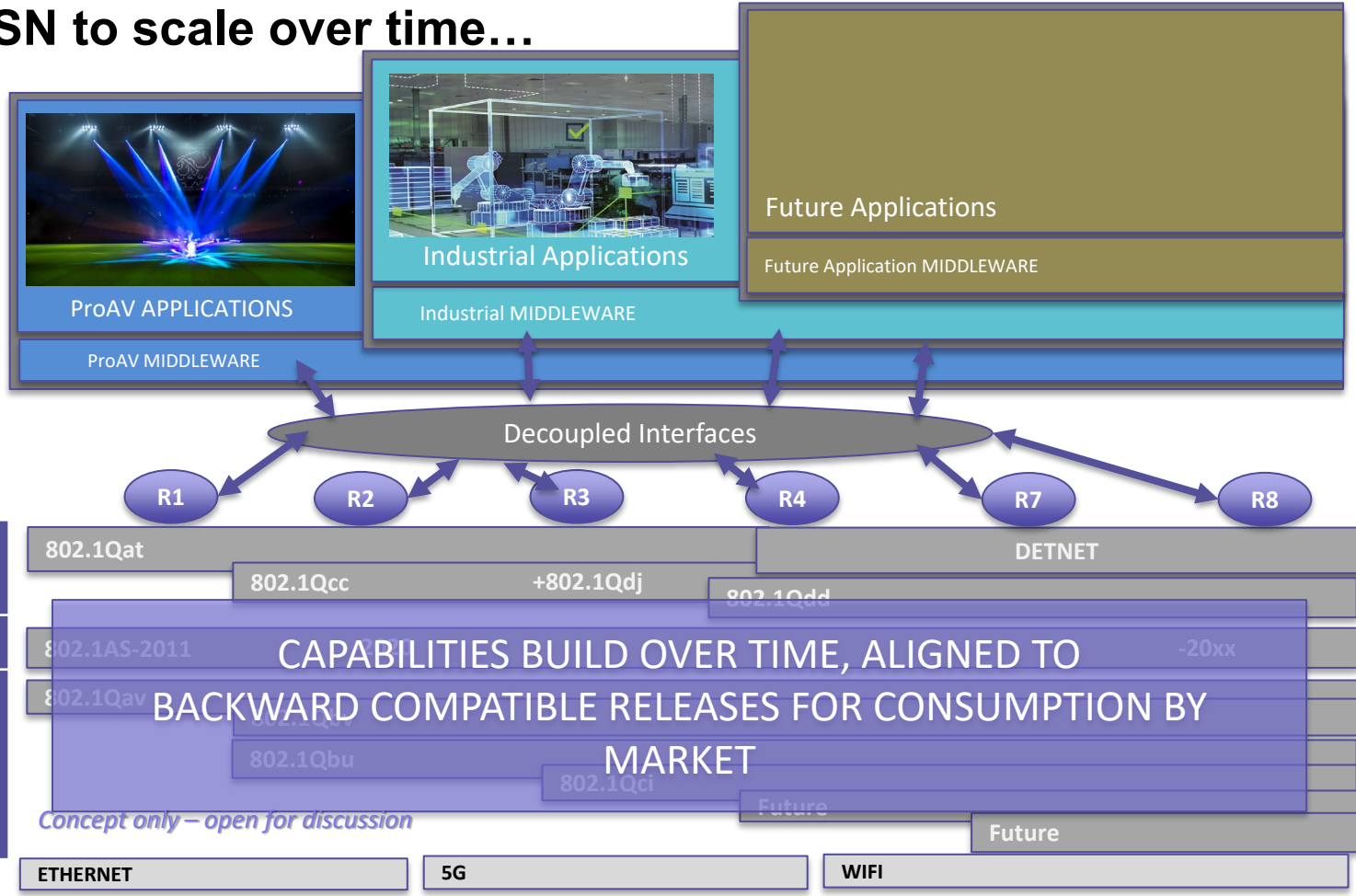

Questions + Discussion

- What is a converged network?
  - Converged network setup?
  - Converged network engineering
  - Converged silicon
  - Common interfaces for the middleware
  - Common understanding of security and access control
- Are profiles (inadvertently) causing a perception of splintering of networks, not convergence of networks?
- What is the role of a profile in converged networks?
  - Selecting network capability and facilitating configuration
  - BUT a profile must also cover basic network capability for an application functionality