Common TSN for Converged Networks – Past perspectives, present realities

Presented by:

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Tom Weingartner, Analog Devices
Janos Farkas, Ericsson

Workshop on Common TSN for Converged Networks 2022-02-09
## A brief history of Time (sensitive networking)

### Using TSN

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<th>Application Protocols</th>
<th>PRO AV</th>
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### TSN Protocols and Capabilities

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**ETHernet**
## A brief history of Time

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Applications span market segments

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<td>THEME PARKS, LIVE SHOWS, SPORTING MOBILE</td>
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| IEEE PROFILE | 802.1BA | 802.1DG | 60802 |

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## Base TSN from a Silicon Perspective

### Flexible selection of software and silicon

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### New software

#### MANAGEMENT

- Time Synchronization (802.1AS)

### New silicon

- Superset vs. Purpose-built
- Today’s requirements vs. Tomorrow’s use cases

#### TSN PROTOCOLS AND CAPABILITIES

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### Future?

- 802.1Qav
- 802.1Qbv
- 802.1Qbu

### 5G

- Ethernet
- WiFi
- 5G

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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 socialising, 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

360° immersive sound system for shows, cinema, emulated acoustics
Combination of show and architectural lights
Stage with PA for bands, speeches, podium
Multifunctional floorspace with fully variable seating

Screens
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

Many ProAV productions incorporate various kinds of industrial components:

- Stage mechanics and kinetics
- 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

- 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
- 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., 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.
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

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
- Yet have common requirements OF THE NETWORK!
- ...and increasingly will need to use, access, and coexist on the same converged, network

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
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
Yet have common requirements OF THE NETWORK!

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

ProAV Application middleware

Industrial Application middleware

AGREEMENT ON THESE INTERFACE LAYERS ARE CRITICAL TO MAKING THIS POSSIBLE

Commonly used Network

802.1AS-2020

802.1Qav

802.1Qbv

802.1Q

... Commonality at the network layer drives economy of scale

Common network that can be used by both types of devices

Common methods to access and manage the network

Unique application stacks
Diffusing TSN to scale over time...

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Diffusing TSN to scale over time…
Diffusing TSN to scale over time…

ProAV APPLICATIONS

ProAV MIDDLEWARE

Industrial MIDDLEWARE

Industrial Applications

Future Applications

Future Application MIDDLEWARE

Decoupled Interfaces

R1
R2
R3
R4
R7
R8

MANAGEMENT & CONFIG

TIME SYNC

BANDWIDTH & LATENCY

802.1Qat
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802.1Qav
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+802.1Qdj

802.1Qdd

Future Application MIDDLEWARE

Future Applications

Future Applications

Future

Future

Future

802.1Qci

ETHETERNET

5G

WIFI

CAPABILITIES BUILD OVER TIME, ALIGNED TO BACKWARD COMPATIBLE RELEASES FOR CONSUMPTION BY MARKET

Concept only – open for discussion

IEEE

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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