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IEEE P802.1DG: Evolving the In-Vehicle Network from AVB to TSN

Time-Sensitive Networking Profile for Automotive In-Vehicle Ethernet Communications

2023-10-26

Max Turner, Automotive Network Architect, Ethernovia

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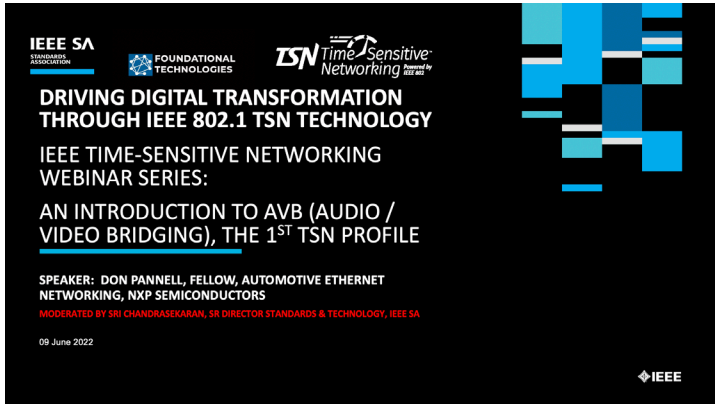

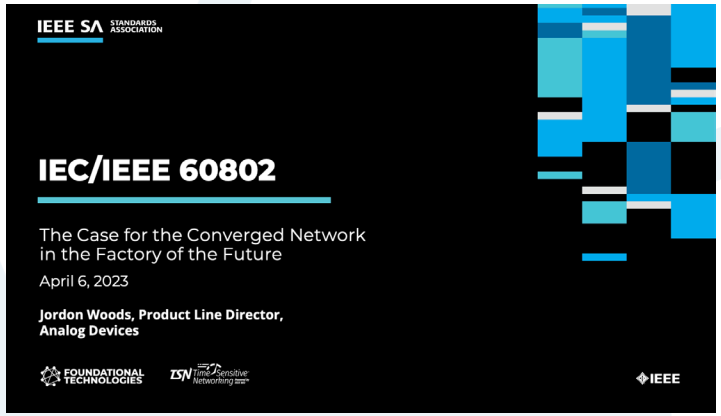

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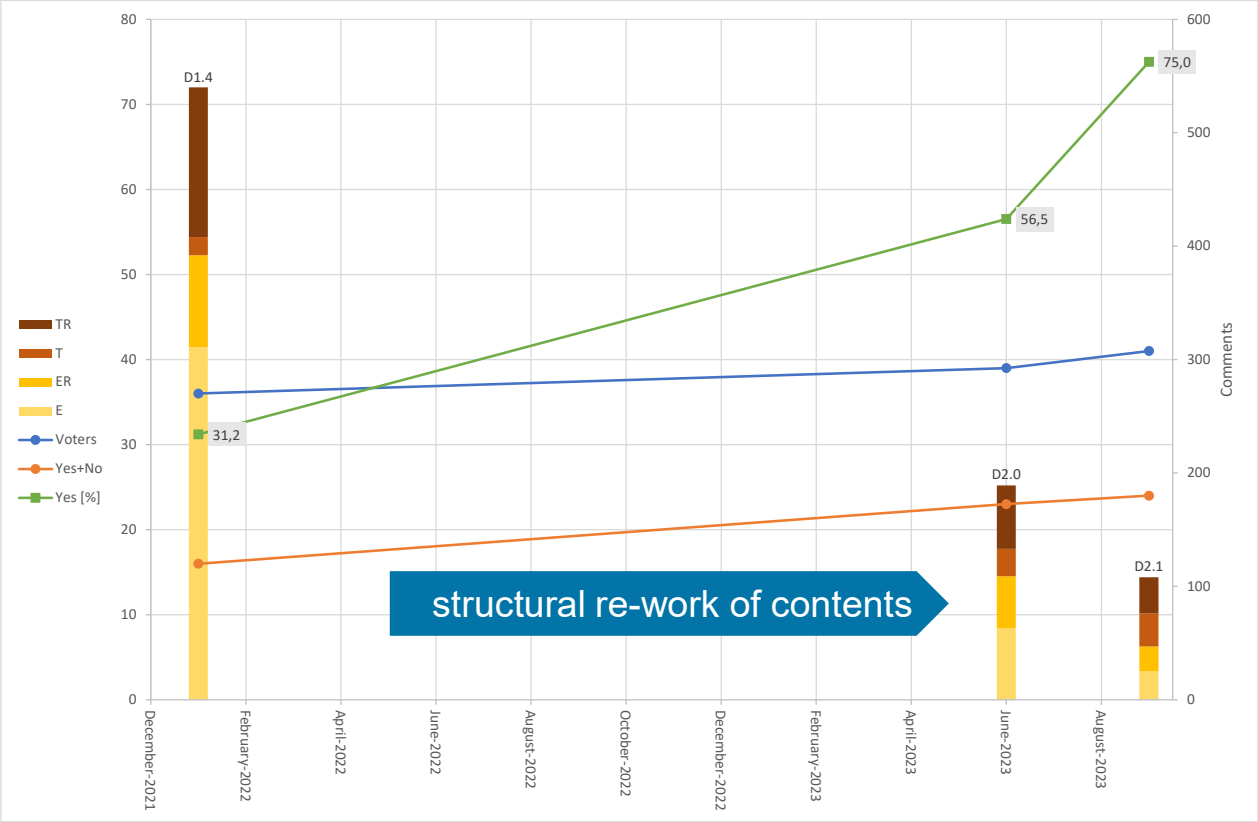
Speaker – Max Turner

Editor IEEE P802.1DG, Ethernovia

Max Turner (geb. Kicherer) received his Dipl. Phys. from the University of Ulm, Germany in 1999. He joined BMW late in 2002 where he initially contributed to MOST and FlexRay. During a stay in the USA he worked on V2x wireless systems and the DSRC standardization (IEEE Std 802.11p). Returning to Munich in 2008 Max started the introduction of Ethernet into Autosar with the first Socket-Adaptor concept and became part of the group creating the ISO 13400 'Diagnostics over IP' standard based on BMW's predecessor. Around the same time Max stated working in IEEE on AVB and IEEE 1722, which lead to the introduction of these systems in BMW vehicles as well as the automotive profile in AVnu. He drove the re-use of PTP time-synchronization for multiple applications also on CAN and FlexRay. For the following 10 years Max was a member of the team introducing Ethernet as a system-bus (including SOME/IP, XCP, DLT, AVB and other protocols) into all BMW vehicle generations. In early 2018 he left BMW to join Jaguar Land Rover in in the UK for not quite two years, where he gathered experience in the overall E/E architecture for automated (L3/4) vehicles as the lead architect. Since Dec. 2019 Max serves as the automotive network architect for Ethernovia. He is and has been an active contributor to the AVB and/or TSN working groups of IEEE, Autosar, ASA, and OpenAlliance for most of his career and is now also the Editor of the IEEE P802.1DG automotive TSN profile.

IEEE P802.1DG - Balloting History



- A change in Editor and major structural re-work have unfortunately consumed more than a year.
- The new document structure (since D2.0) focusses on fewer topics and on requirements rather than informative text (similar to the structure of IEEE P802.1DC).
- With the re-work:
  - The number of voters has steadily increased.
  - The number and percentage of approve votes has steadily increased.
  - The number of comments has steadily decreased.

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New Document Structure and Content

Subject to change during the balloting process!

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New Document Structure

Introduced with D2.0

Main sections:

- Bridge requirements and options
- End Station requirements and options
- Conformance Module Basic Policing (CM-Pol)
- Conformance Module Basic Shapers (CM-BS)
- Conformance Module Time Aware Shaper (CM-TAS)
- Conformance Module Preemption (CM-Pre)
- Feature details

Subject to change during the balloting process!

Bridge Requirements

For Ingress, Forwarding, and Egress

Main requirements:

- Support C-VLANs ([Q]:5.5).
- Follow ingress and egress frame processing order.
- Support Ingress Selection (CM-IS).
- Support Policing (CM-Pol).
- Support Basic Shapers (CM-BS).
- Support the Learning Process ([Q]:8.7).
- Support Congestion Separation.
- Support Frame Filtering ([Q]:8.6.3).
- Support the Stream Filter ([Q]:8.6.5.3).
- By default, all Stream Gates ([Q]:8.6.5.4) shall always be in the OPEN state.

Subject to change during the balloting process!

Bridge Options

For Ingress, Forwarding, and Egress

Main options:

- Support the Time Aware Shaper (CM-TAS) on any number of ports.
- Support Preemption (CM-Pre) on any number of ports.
- Support Hop-by-Hop MACsec on any number of ports.
- Discard a frame after the frame's lifetime is reached.

Subject to change during the balloting process!

End Station Requirements

For Ingress

Main requirements:

- Follow ingress frame processing order.
- Perform Destination MAC address filtering.
- Support outfacing Ingress Stream Identification Function(s) ([CB]:9.1.1.5).
- Support Ingress filtering ([Q]:8.6.2).
- Support Stream Filter assignment ([Q]:8.6.5.3 b).
- Support Policing (CM-Pol).

Subject to change during the balloting process!

End Station Requirements

For Egress

Main requirements:

- Follow egress frame processing order.
- Support one or more shaping mechanisms to generate traffic conformant as input to the shapers deployed in the network.
- Support max. SDU Size Filtering ([Q]:8.6.5.3.1).
- Support Queuing frames ([Q]:8.6.6).
- Support Transmission selection ([Q]:8.6.8).

Subject to change during the balloting process!

End Station Options

For Ingress and Egress

Main options:

- Support Time Synchronization.
- Support Time Aware Shaper (CM-TAS).
- Support Preemption (CM-Pre).
- Support Hop-by-Hop MACsec.
- Support End-to-End MACsec.
- Support Stream Gating on ingress ([Q]:8.6.5.4).
- Support Flow metering on ingress ([Q]:8.6.5.5).

Subject to change during the balloting process!

Conformance Module Ingress Selection (CM-IS)

Main requirements:

- Support the Port-based VLAN Classification ([Q]:6.9 d)).
- Support the Priority Code Point Decoding ([Q]:6.9.3).
- Support the Priority Regeneration ([Q]:6.9.4).
- Support the outfacing Ingress Stream Identification Function(s) ([CB]:6.2).
- Support the Active topology enforcement ([Q]:8.6.1).
- Support Ingress Filtering ([Q]:8.6.2).
- Support Egress Filtering ([Q]:8.6.4).
- Support Queuing Frames ([Q]:8.6.6).
- Support the Egress VID Translation ([Q]:6.9 g)).

Subject to change during the balloting process!

Conformance Module Basic Policing (CM-Pol)

Main requirements:

- Support the Frame Type Acceptance Filter ([Q]:6.9 c)).
- Support the Maximum SDU Size Filters:
  - Per Stream Maximum SDU Size Filter ([Q]:8.6.5.3.1)
  - Per Traffic Class Maximum SDU Size Filter ([Q]:8.6.8.4)
- Support Flow Metering ([Q]:8.6.5.5).

Subject to change during the balloting process!

Conformance Module Basic Shapers (CM-BS)

Main requirements:

- Provide the capabilities for the Credit Based Shaper ([Q]:8.6.8.2).
- Provide the capabilities for the Asynchronous Traffic Shaper ([Q]:8.6.11).
- By default, disable the Time Aware Shaper (TAS) if CBS or ATS are active on a Port.

Subject to change during the balloting process!

Conformance Module Time Aware Shaper (CM-TAS)

Main requirements:

- Support Time Synchronization (next slide)
- Provide the capabilities for the Time Aware Shaper ([Q]:8.6.8.4)
- By default, disable the Credit Based Shaper ([Q]:8.6.8.2) on any port, when the Time Aware Shaper is active.
- By default, disable the Asynchronous Traffic Shaper ([Q]:8.6.11) on a port, when the Time Aware Shaper is active.
- Enable the closing of the Stream Gates ([Q]:8.6.5.4) using a separate schedule from the transmission gates (for policing).

Conformance Module Preemption (CM-Pre)

Main requirements:

- Support the preemptable MAC as per [Q]:6.7.1 a).
- Support the express MAC as per [Q]:6.7.1 b).
- By default, disable the Time Aware Shaper (TAS) on any egress port where Preemption is configured.
- Use a single TC for queuing frames to the express MAC.
- Have no shapers configured for the TC queuing frames to the express MAC.
- Configure the TC queuing frames to the express MAC as the numerically highest.

Time Synchronization

Is no longer a Conformance Module (from D2.2)

No specific Time Synchronization requirements are mandated.
Possible choices include:

- IEEE Std 802.1AS-2011
- IEEE Std 802.1AS-2020
- IEEE Std 802.1AS-2020 + IEEE P802.1ASdm (release in 2024)
- AUTOSAR (R22-11) Time Synchronization Protocol Specification
- AUTOSAR (R23-11) Time Synchronization Protocol Specification (release in Dec. 2023)
- AVnu Automotive Profile (Rev. 1.6 of 7 Nov. 2019)

Shared media are excluded (IEEE P802.1ASds is approved).

(https://sagroups.ieee.org/1588/ptp-profiles/)

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Further Project Schedule

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IEEE P802.1DG - Future Project Planning

- A 2 year PAR extension was requested at the July 2023 Plenary session in Berlin and has been approved by the IEEE SA Standards Board on 2023-09-21.
- Comment resolution on Draft D2.1 was concluded in the call on Tue. 2023-10-24.
- The next Draft (D2.2) is expected to be issued tomorrow (2023-10-27).
- A proposal to move to Working Group Ballot is expected for the March 2024 Plenary session in Denver.

THANK YOU

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UPCOMING WEBINARS

- Aerospace Ethernet – IEEE P802.1DP / SAE AS6675