Accurate timing and guaranteed data delivery are critical in the automotive environment. IEEE 802.1AS™ provides timing accuracy in the sub-microsecond range, which will be required as Ethernet usage grows within the vehicle. In addition, other IEEE and TSN standards provide secure, ultra-reliable, and bounded low-latency communications throughout the vehicle at multiple data rates.

Because the in-vehicle wiring plant is a huge challenge with regards to weight and space coupled with higher throughput requirements for automotive sensors, various PHYs targeting automotive are available today, including 2-wire 10 Mb/s (IEEE 802.3cg™), 100 Mb/s (IEEE 802.3bw™), 1 Gb/s (IEEE 802.3bp™) and 2.5/5/10 Gb/s (IEEE 802.3ch™).

Previously known as the Audio Video Bridging (AVB) set of standards, which are successfully used in Automotive Infotainment systems today, AVB has evolved into Time-Sensitive Networking in order to reflect the expanded scope of work toward autonomous driving.

For more information on the IEEE 802.1 Working Group, visit ieee802.org/1
TSN IN VEHICLES

In vehicles, TSN works in synchrony with other IEEE technologies to deliver:

- **TIME SYNCHRONIZATION**: IEEE 802.1AS maintains synchronized time (+/- 500 nsec worst case) and supports scheduling-bounded low-latency traffic through the network where required while also allowing asynchronous traffic.

- **VERY LOW JITTER**: IEEE 802.1AS reduces jitter associated with Audio/Video, command, sensor, and control packet delivery to upper layers.

- **BOUNDED LOW LATENCY**: Time scheduled traffic, preemption, no need to compress video and other ADAS (Advanced Driver Assistance Systems) data (since speeds up to 10 Gbit/s allow multiple channels of high definition video) avoid the latency and processing power penalties associated with compressions and decompression.

- **ULTRA RELIABILITY**: TSN provides reliability in the network (frame replication and elimination), protection from errant devices (ingress policing), backup for network timing master (standby GM).

- **SECURITY**: Authentication of installed devices (secure device identity), segregation of traffic types and flows between authorized devices, message integrity, and authenticity are possible.

Other Enhancements

- **FAST STARTUP**: Preconfigured values for timing and bandwidth reservation allow quick startup followed by optional transition to negotiated values for dynamic adjustments.

- **FASTER UPDATES**: Firmware updates are quicker with Ethernet’s higher speed.

- **INFORMATION SHARING**: A homogeneous Ethernet network allows instant sharing of information between allowed devices without the delays and security risks associated with interconnecting different bus types through gateways.

STANDARDS

- IEEE 802.1AS™-2020 Standard for Local and Metropolitan Area Networks - Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks
- IEEE 802.1CB™-2017 Standard for Local and Metropolitan Area Networks - Frame Replication and Elimination for Reliability
- IEEE 802.1Q™-2018 Standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks; which incorporates the amendments:
  - IEEE 802.1Qbv™-2015 Enhancements for Scheduled Traffic
  - IEEE 802.1Qbu™-2016 Frame Preemption
  - IEEE 802.1Qci™-2017 Per-Stream Filtering and Policing
  - IEEE 802.1Qch™-2017 Cyclic Queuing and Forwarding
- IEEE 802.1Qcc™-2018 Standard for Local and Metropolitan Area Networks--Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks Amendment: Stream Reservation Protocol (SRP) Enhancements and Performance Improvements
- IEEE 802.1Qcr™-2020 Standard for Local and Metropolitan Area Networks--Media Access Control (MAC) Security Amendment: Asynchronous Traffic Shaping
- IEEE 802.1AE™-2018 Standard for Local and Metropolitan Area Networks - Media Access Control (MAC) Security
- IEEE 802.1AR™-2018 Standard for Local and Metropolitan Area Networks - Secure Device Identity

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PROJECTS CURRENTLY IN PROGRESS:

- IEEE P802.1DG™- Draft Standard for Local and Metropolitan Area Networks - Time-Sensitive Networking Profile for Automotive In-Vehicle Ethernet Communications
- IEEE P802.1ASdm™- Draft Standard for Local and Metropolitan Area Networks - Timing and Synchronization for Time-Sensitive Applications Amendment: Hot Standby
- IEEE P802.1CBdb™- Draft Standard for Local and Metropolitan Area Networks - Frame Replication and Elimination for Reliability Amendment: Extended Stream Identification Functions

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