Testing Audio Video Bridging (AVB) and Time Sensitive Networking (TSN)

Taming the Complexities of Ethernet-Based Audio-Video and Time-Critical Control Data

As technology moves forward, the landscape of audio and video (AV) interoperation and connections has continued to grow more complex. We expect higher and higher quality in more and more venues: at home, at concert halls, and even in our cars. AV connections were historically analog, one-way, single-purpose, and point-to-point. This model resulted in large confusing masses of cables, especially in professional and high-end consumer applications.

AV technology has widespread and far-reaching positive impact on different consumer segments. One of the more recent attempts to address AV technology issues, such as automated setup with time-bound quality of service, is audio video bridging (AVB). AVB uses Ethernet cabling and enhanced protocols as a means to address the various technical issues of best-effort Ethernet, synchronizing and simplifying AV connections and interaction.

The industrial segment is solving industry-specific challenges for timeliness and reliability of critical control data using proprietary busses or a modified version of Ethernet called TSN. The successor of AVB, TSN enhances Ethernet even more to allow for the minimum theoretical latency while allowing seamless redundancy and centralized configuration and control. This enables companies to use cost-effective Ethernet for converged IT/OT networks, sharing the same wire for critical time sensitive traffic and regular traffic.

Highlights:

- Verify conformance to the AVB standards (IEEE 802.1BA, 802.1Qav, 802.1Qat, 802.1AS and IEEE 1722 or IEEE 1733)

- Support AVnu certification testing, including for AVnu Automotive Profile 1.4 Spec

- Support TSN scheduled traffic (IEEE 802.1Qbv) and multiple domains (IEEE gPTP-rev)

- Verify time synchronization over gPTP for Grandmaster, Boundary, and even Slave clocks (using Ixia-introduced Reverse Sync measurement mechanism)

- Confirm bandwidth, QoS, priority remapping, and latency guarantees

- Check that device integration into larger networks works as predicted

- Support speeds ranging from native 100Mbps Automotive Ethernet to 40GbE

- Support testing for certification and in development labs of leading car manufacturers and device manufacturers

KEYSIGHT TECHNOLOGIES
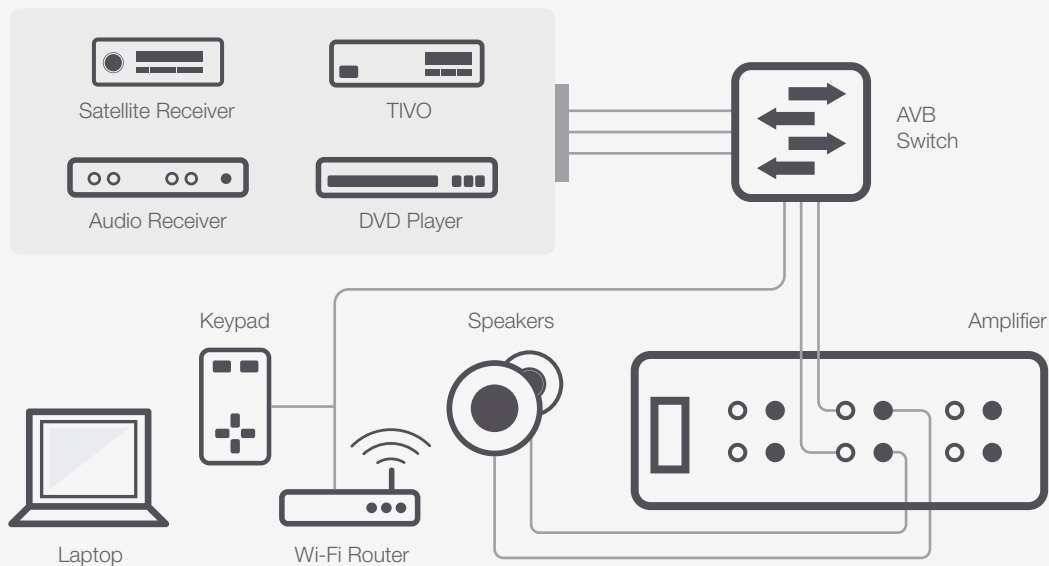
There are four main venues for AVB/TSN:

Automotive—Not long ago, it was sufficient that the automobile merely conveyed passengers safely and comfortably from Point A to Point B, but not now. While high-quality audio comparable with domestic systems has long been a default expectation, video and data services are increasingly in demand as manufacturers transform the car into a completely autonomous machine. AVB/TSN is the future of reliable, time bound, and prioritized traffic delivery over Ethernet and wireless. It enables advanced driver assistance system (ADAS), infotainment, Internet, and control traffic to be transmitted over the same, shard media, while meeting delivery and timeliness constraints of different domains.

Professional Audio/Video—Over the last decade, Ethernet and Wi-Fi have become the most dominant networking technologies. Many people have plugged their computers into an Ethernet network via the RJ45 jack. Over time, these technologies have continuously pushed the boundaries of speed—with the current state-of-the-art Ethernet moving to 100Gbps. Given the enormous cost savings in cabling and other infrastructure over analog cable, it is natural that networked A/V would be widespread in the professional world. AVB is a breakthrough technology for professional AV, enabling higher bandwidth (10/40/100GbE) for broadcasting media and sports events, enabling multiple channels over single and all-pervasive Ethernet media.

Consumer Ethernet—Consumers today own more devices than ever and have shifted their consumption from physical to digital content, while home networks have become nearly ubiquitous. The convergence of these trends has created a desire for many consumers to not only use their networks to connect to the Internet and exchange data,

but also to distribute digital content among their devices, many of which are connected over wireless networks. With emergence of Internet of Things (IoT), AVB allows IP address-enabled devices to connect and interact simply and with high quality over a single network.

Industrial Automation and Control—due to the specific latency and reliability requirements, the industrial domain has resorted either to specialized bus systems or modified version of Ethernet. This approach solves the problem, but restricts the usage of the networks for non-critical tasks and also generally brings higher costs because of the need to use specialized equipment. There is a need in the market for a converged information technology/operational technology (IT/OT) network that can provide deterministic or even minimum latency and seamless redundancy at reasonable cost, and this is just the match of TSN.

Market Issues and Status

In the past, audio and video systems employed custom networks designed to provide a good end-user experience. These networks coexisted with LAN networks and required special skills and maintenance. To make things worse, these custom networks did not use standard technologies, and users had to pay for the costly upgrades when they moved to higher speeds or when more elements were added.

One of the fundamental issue is synchronization of AV traffic. Without the synchronization, the audio and video aspects of traffic are not lip-synced. Synchronizing Ethernet to ensure proper audio and video transmission is a difficult task. Ethernet is inherently an asynchronous protocol, and operates without timing. Ethernet networks were built for best-effort delivery traffic, and lacked support to deliver time-sensitive traffic.

AVB provides a way for these custom networks to migrate to Ethernet networks. The IEEE standard 802.1AS provides a method for Ethernet systems to synchronize time with each other. The IEEE 802.1Qat and IEEE 802.1Qav standards provide a mechanism for ensuring quality of service (QoS) and bounded latency for AVB traffic.

The time-synchronization quality of an AVB system must be verified before devices are released to market. What's more, both AVB and non-AVB traffic can coexist on existing Ethernet networks today, so both kinds of traffic must be properly forwarded through the network to provide the desired QoS.

The AVnu Alliance is an industry forum dedicated to the advancement of professional-quality AV by promoting the adoption of the IEEE 802.1 Audio Video Bridging (AVB) and related standards, over various networking link-layers. The organization creates extensive test procedures and processes that ensure interoperability of networked AVB devices, helping to provide the highest quality streaming AV experience.
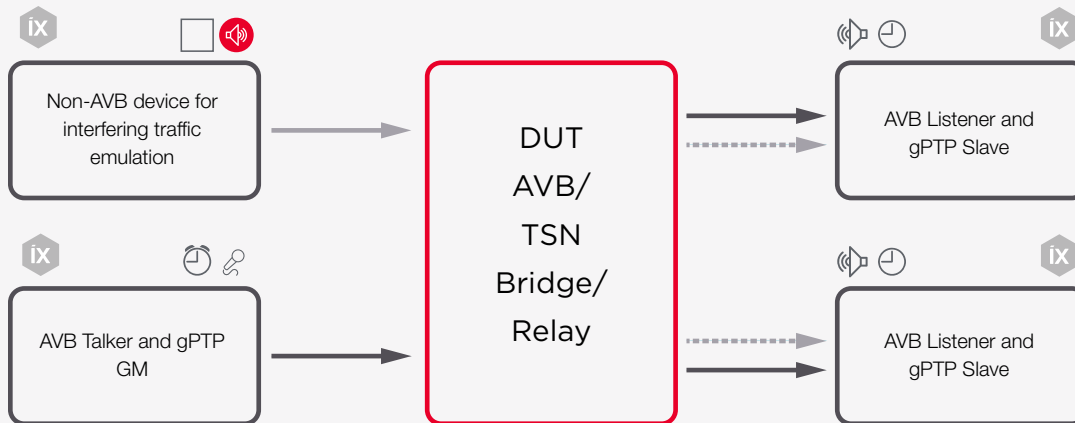
Test AVB for time synchronization quality, bandwidth, and latency guarantees

Ixia's AV Conformance, Performance, and Timing Test Solution

Ixia's AVB/TSN test solution is used by leading network equipment manufacturers and car and ECU makers to develop and integrate standards-compliant AVB equipment. Ixia's AVB solution in IxNetwork not only helps prepare for AVnu certification by running the conformance tests in-house, but it can be used to speed development time of devices—allowing configurable and customizable tests depending on the functionality tested, giving the user insightful debug information.

IxNetwork works with Ixia's test platforms to exchange control-plane and data-plane traffic with the device under test. Ixia's chassis are populated with load modules that implement a wide variety of interface types, including Automotive Ethernet connectors.
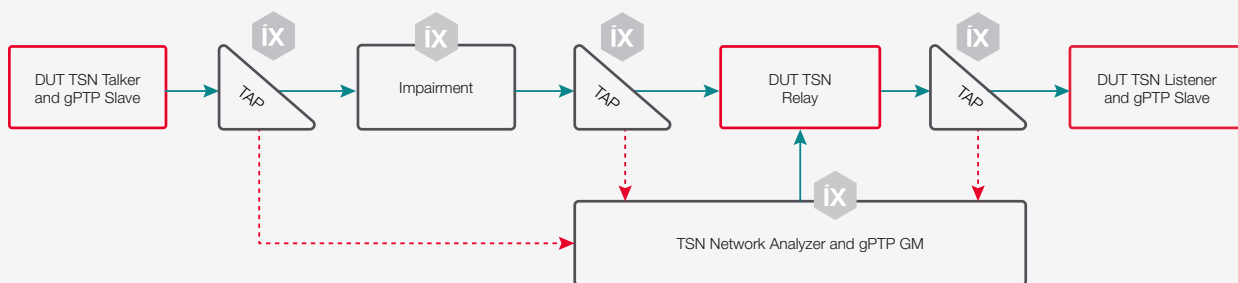
Ixia solutions used to validate TSN performance

To emulate AVB-specific devices, such as a Talker, a Listener, a Grandmaster or a Slave device, or even a whole topology of devices, each test port is equipped with an independent processor and substantial memory in addition to specialized traffic stream generation and capture hardware. These functions provide the speed and intelligence needed for large-scale protocol emulation.

Ixia's AVB solution can also be used for sizing production networks, testing load handling, and time synchronization capabilities; and for qualifying and deploying actual network components.
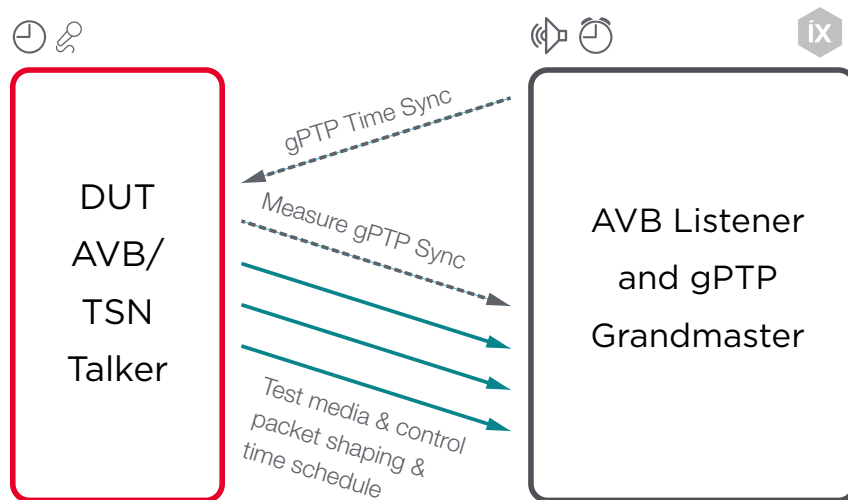
Test AVB/TSN Talker time synchronization quality and media and control packet shaping and time schedule

Functionality:

- Emulate gPTP Master and Slave—provide the ability to test compliance and quality of gPTP Boundary, Master, and Slave Clocks (using Ixia-introduced Reverse Sync mechanism), including support for negative testing and true time error measurement relative to GM

- High scaling for number of Talkers and Listeners on the same port, using the user-friendly Next-Generation Framework

- Debug issues down to each MSRP/MVRP state machine, messages, and stream reservation

- Easy-to-use traffic wizard for AVB 1722 encapsulation, AVB Raw and Non-AVB traffic all on the same port

- Measure the traffic latency, jitter, inter-arrival time, and throughput and data integrity for each reserved stream

- Automotive ready—support for AVnu Automotive Profile static configuration and Automotive Ethernet connectivity

- Generate and analyze TSN IEEE 802.1Qbv scheduled traffic, relative to gPTP time

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