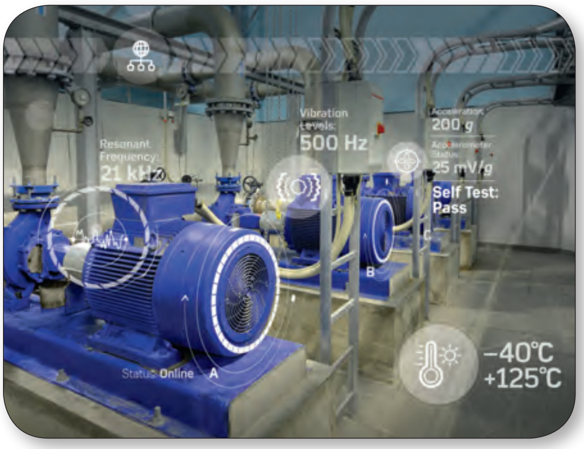
Five challenges faced by Time Sensitive Networking in supporting the IIoT

Based on information from Analog Devices

This article highlights the contribution Time Sensitive Networking makes towards providing deterministic performance over Ethernet.



■ The ongoing development of Time Sensitive Networking (TSN) has resulted in significant updates to both the IEEE 802.1 and 802.3 standards. Essentially a set of deterministic Ethernet extensions, TSN is also the successor to Audio Video Bridging (AVB), the IEEE project initially designed to support real-time media streaming within professional audio and video environments (such as live DJ sets). Once AVB caught the attention of automakers, though, the seeds for TSN were sown. The cars of tomorrow have long been envisioned as sophisticated vehicles, equipped with high-speed IP network connectivity, intelligent and automated driver assistance/braking systems, infotainment portals, simplified internal wiring harnesses and lighter overall weights. The drive toward these features has yielded many auxiliary benefits to the industrial automation industry, too.

Creating a converged IEEE 802 specification, using Ethernet, was the most obvious solution to the problems standing in the way of such a vision. More specifically, the automotive sector could use deterministic Ethernet to overcome limited in-vehicle bandwidth and eliminate the need to resort to a gaggle of legacy networking protocols – e.g. FlexRay, LIN and MOST – to link various car systems together. Remove the in-vehicle part of that sentence, along with the references to the automotive-specific protocols, and you get a close approximation of the five challenges that the automation industry has faced as the Industrial Internet of Things (or Industry 4.0) continues to come into focus.

Supporting mixed traffic. Ethernet has been put forward as a one-size-fits-all automotive network that can streamline the different domain architectures inside cars. Via TSN, it can fulfill a similar role in industrial networks by handling mixed traffic in automation and control systems, power utilities, wind turbines and printing (see reference 1 below). TSN should excel at transporting time-stamped, latency-sensitive data regardless of any best-effort traffic that may be present on the same network. This is essential with Ethernet, which is much "noisier" than previous automation networks that carried only real-time data and not a diverse mix of protocols. TSN is designed to handle multiple traffic types.

Providing interoperability. In the IIoT in particular, the use of standard components manufactured in large volume is essential. This is due to central issues of scale and cost that weigh down many current approaches to networking. Relying on special ASIC-based industrial Ethernet implementations and/or legacy fieldbuses (including but not limited to the ones used in cars, such as CAN) is less scalable or cost-effective than simply leaning on commercial silicon that can still support regular HTTP interfaces, Web services and diagnostics (reference 2). TSN helps keep costs down and a path open for future expansion.

Ensuring tight synchronization. AVB evolved into TSN in order to handle particularly demanding applications such as the Advanced Driver Assistance System (reference 3). ADAS requires multiple systems to work seamlessly in concert to account for braking distances and human reaction times. TSN includes several mechanisms for ensuring such determinism across similar settings such as the IIoT, namely: improvements to the Precision Time Protocol, redundant path availability for any data stream, convergence of Quality of Service onto the TSN over an Ethernet network at reduced bandwidth (without compromising real-time guarantees, though), and bandwidth reservation – a central feature carried over from AVB for ensuring deterministic performance.

Supplying sufficient bandwidth. One of the decisive advantages of Ethernet over legacy serial fieldbuses – i.e. everything from PROFIBUS to Modbus – is that it can provide much more bandwidth to applications of all types. In automobiles in particular, the limited data rates and capacity of CAN made it insufficient for the next generation of in-vehicle applications, which opened the doors for Ethernet (in the form of AVB). Applications like machine vision and 3D scanning require a lot of bandwidth. The same can be said for many of the fieldbuses still in use in control systems. Increasingly important applications such as machine vision and 3D scanning require a lot of bandwidth; TSN over Ethernet can provide it.

Making network infrastructure simpler. TSN is meant to be a consolidated and easy-to-use approach to deterministic Ethernet networking. Rather than having to rely on multiple infrastructures to handle different types of traffic, everything can be carried over Ethernet. A 2015 podcast hosted by David Greenfield of Automation World, while it did not bring up TSN specifically, did a good job of outlining general advantages of Ethernet over fieldbuses (reference 4). Guest Sari Germanos of the Ethernet POWERLINK Standardization Group talked about how complex applications (like the ones mentioned) strain the limits of legacy network architectures. Ethernet, in the form of TSN, is already addressing this problem in cars. A recent EE Times article provided a look at how the domain architectures in a vehicle could be rearranged if legacy technologies did not have to be supported. Ethernet would serve as a backbone bus to connect the various application domains, making better use of bandwidth. It can do the same for the IIoT (reference 5). "As [industrial] IoT adoption continues, increased amounts of data and widely distributed networks will require new standards for sharing and transferring critical information," explained Todd Walter of National Instruments, AVnu Alliance Industrial Segment Chair, in a Design World article (reference 6). "Just as an ambulance or fire engine receives priority among other traffic during an emergency, the TSN standard ensures that critical, time-sensitive data are delivered on time over standard network infrastructure." TSN moves beyond being just an idealistic project and instead becomes a widely used standard that is certified by industry groups. The points outlined already show it already has a strong technical base. The next thing to watch is how its testing and deployment play out. In late February 2016, Bosch Rexroth, Schneider Electric, National Instruments and Kuka announced their joint work on the first TSN testbed in the world (reference 7). This testbed is designed to combine various traffic flows over a TSN over Ethernet network. It will test the multi-vendor interoperability of TSN, as well as its security features, performance, latency and integration with cloud-based control systems.

National Instruments is hosting the testbed. One of its executives, Eric Starkloff, commented that TSN is "necessary for the future of the IIoT," highlighting how far a converged deterministic form of Ethernet has come from its roots in pro A/V technology. The scope of the IIoT could prove to be enormous, but many enterprises still have a way to go in terms of understanding and harnessing its benefits. A mature and widely adopted TSN will help them get there. ■