



Semiconductor Maker Implements New Test for Automotive Ethernet

Enabling the future of in-vehicle networks

Organization

- semiconductor manufacturer

Challenges

- set up a new test for automotive Ethernet
- create real-world conditions in the lab

Solutions

- Infiniium MXR-Series real-time oscilloscopes
- AE6900T Automotive Ethernet Compliance solution
- IxNetwork L2–3 network infrastructure performance testing

Results

- quickly set up and test automotive Ethernet designs
- simulate realistic user applications and scenarios in the lab

Introduction

Advances in autonomous driving, connected vehicles, and advanced driver-assistance systems (ADAS) require more robust and reliable high-speed in-vehicle networks (IVNs). Automotive Ethernet addresses these needs with reduced cost, weight, and complexity. The advantages of automotive Ethernet over other IVN technologies (for example, LIN, CAN, FlexRay) include multipoint connections, higher bandwidth, and low latency. In addition, automotive Ethernet has room to grow, from 100 Mbps to 1 Gbps, and most recently with 2.5, 5, and 10 Gbps released as part of IEEE 802.3ch.

The customer, a global semiconductor company providing chipsets and modules that enable secure connections and infrastructure, needed to implement a new 1 Gbps automotive Ethernet test. It is well-versed in the technological trends of its target markets of automotive, industrial, and mobile. It also understands the importance of standards to ensure technological interoperability.

Challenge: Testing Real-Life Scenarios in the Lab

The business group that conducts network testing has used Keysight's Infiniium oscilloscope for hardware characterization and validation of microprocessor interfaces. A new project requires the customer to implement 1 Gbps automotive Ethernet testing, including a test called Time-Sensitive Networking (TSN).

TSN is a set of standards to enable time-critical applications on Ethernet-based communication networks. It is a higher-level protocol that sits on top of the physical layer (PHY); see Figure 1.

TSN supports real-time control and synchronization of high-output electronic control units (ECUs) over a single standard Ethernet network. Figure 2 shows a simple version of what might happen in a single port: ADAS, infotainment, and regular updates. In a real system, one port would see exchanges of 150 to 200 data streams. Each stream has its own priority, emergency level, and application data. TSN testing examines the entire narrative, with all the ports connected to the system, to see exactly how the network is behaving.

The results need to be precise. They must qualify the packet loss, latency, jitter, and delay to ensure no dropped packets.

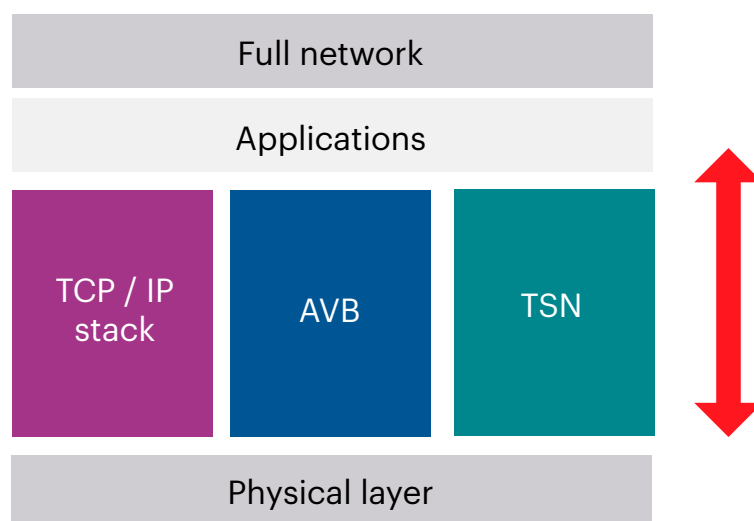


Figure 1. Simple view of the Open System Interconnection (OSI) model for automotive Ethernet

Automotive Ethernet differs from the standard Ethernet that has been around for decades. It is tailored to meet the needs of the automotive industry. It has a higher-bandwidth data transmission to handle the amount of data coming from vehicle sensors.

In the past two decades, the number of automobile electronics has risen exponentially, driving the demand for high-bandwidth data transmission. One benefit is that the lightweight, single unshielded twisted-pair automotive Ethernet cable weighs about 30% less than its shielded coaxial cousin. It can operate in the harsh automotive environment, ranging from -40°C to $+150^{\circ}\text{C}$, and meets the very stringent EMC and EMI requirements of a car.

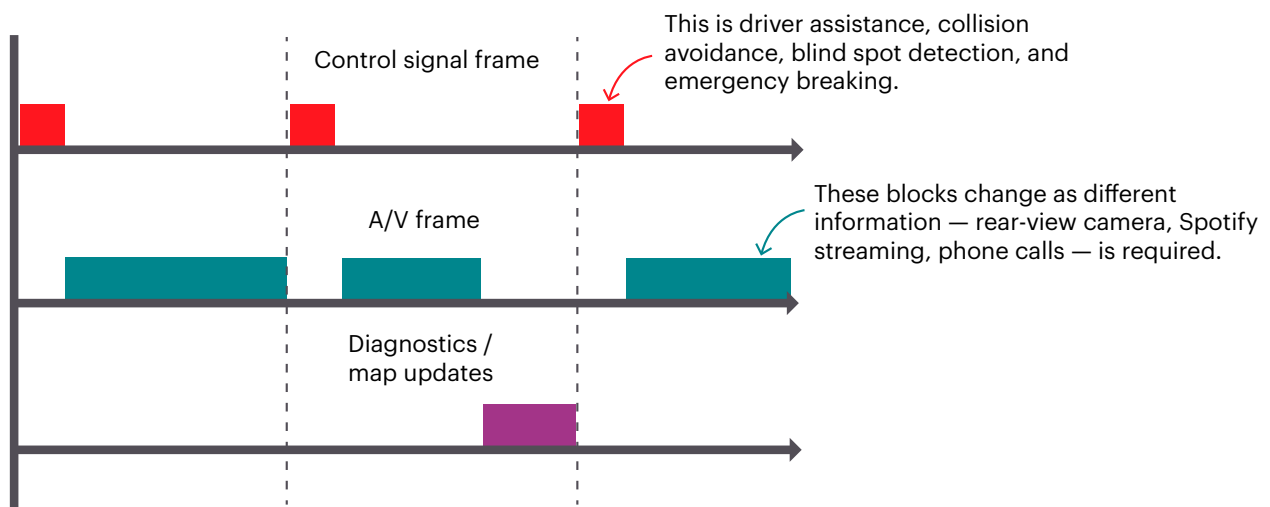


Figure 2. A simple example of how critical the timing and jitter can be on an automotive Ethernet port

Although the customer was not familiar with the terminologies of TSN in the test plan for automotive Ethernet, it knew that the oscilloscope alone would not be enough. Not only did the customer need to know which of the many standards to test, but it was also looking for a solution that covers both the PHY and networking layers of the automotive Ethernet.

The biggest challenges, however, are the fact that automotive Ethernet demands rigorous compliance verification and the need to create real-life workload simulations in the lab. The customer needs to ensure that these standards work under realistic conditions.

Solutions: Testing the Physical and Networking Layers

The physical layer test system is automated, tracks evolving standards, and validates automotive Ethernet designs. It covers all the data rates and standards governing the automotive Ethernet: BroadR-Reach, IEEE 10BASE-T1S, 100BASE-T1, 1000BASE-T1, and 2.5 / 5 / 10GBASE-T1.

By installing Keysight's AE6910T Automotive Ethernet Tx Compliance software on the MXR-Series Infiniium oscilloscope, set up as in Figure 3, the customer addresses the testing of the PHY layer. The solution automatically executes PHY electrical tests for transmission (Tx) compliance as specified by the Institute of Electrical and Electronics Engineers and the OPEN Alliance. The insight from the margin analysis in the measurement report shows how closely devices pass or fail each test. The software is available for purchase alone or as part of the complete suite, including software, hardware, cables, and accessories.

The networking layer test solution consists of Keysight's Ixia XGS2 chassis, Novus card, and IxNetwork software. IxNetwork generates traffic flows that mimic realistic user applications and scenarios. To emulate TSN-specific devices, Keysight equips each port with an independent processor and substantial memory in addition to specialized traffic stream generation and capture hardware. The IxNetwork TSN Conformance Package contains test cases for testing and benchmarking scenarios that span TSN standards and can track violated packet counts.

With this, the customer resolved its biggest challenges: rigorous and fast compliance testing and testing of real-life scenarios of workloads in the lab.

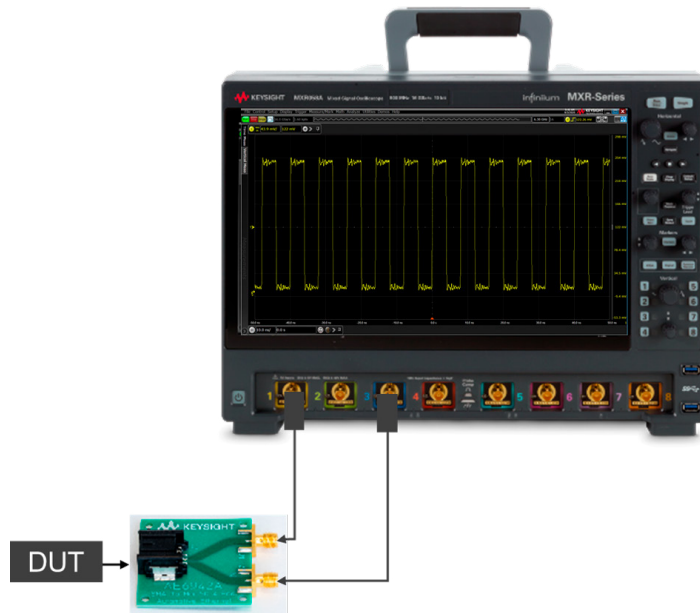


Figure 3. Infiniium MXR-Series oscilloscope 2 GHz or higher for 1000BASE-T1 Tx test

Results: Faster Development That Meets Compliance Requirements

The automated end-to-end solution from Keysight enabled the customer to implement a new test platform for automotive Ethernet quickly and easily. Full standards coverage ensures that the customer is testing the correct standard and complies with specifications. The software's automation and analysis allow it to speed up its development cycle, as well as show the pass / fail margins. Most importantly, the customer can create realistic scenarios and applications to ensure that the standards meet real-life workloads.

Conclusion

To meet the demands of next-generation mobility, automotive Ethernet standards evolve with incremental PHY speeds and enhancements. Keysight's automotive Ethernet solution automates testing and validation of automotive Ethernet designs, covering existing and emerging standards. The solution assures customers that their designs meet standard specifications and work in real-life applications for PHY and networking layers.

Resources

- [Infiniium MXR-Series Real-Time Oscilloscopes](#)
- [AE6900T Automotive Ethernet Tx Compliance Solution](#)
- [IxNetwork L2-3 network infrastructure performance testing](#)
- Virtual demo of [automotive Ethernet physical layer testing — transmit](#)