Automotive Ethernet
in the dSPACE tool chain

Not Your Average Bus

The Ethernet network standard has many advantages over classic bus systems and is increasingly being used in the automotive industry. The dSPACE tool chain already widely supports Ethernet, modified for use in automotive applications, with ever more possibilities.

Photo: Harald Czekalla, www.fotoharry.de

With each new vehicle model, manufacturers try to outbid each other in terms of assistance systems, connectivity, and features. This multiplies the volume of data transferred between the electronic control units (ECUs). By the time today's assistance systems are extended with complex functions for partially or fully autonomous driving, the bandwidth of "classic" automotive bus systems will no longer suffice. The Ethernet network standard is the answer to this problem. Having been adapted to the new environment, this technology can also be used in vehicles, where it is called "automotive Ethernet" (see info box). The current bandwidth of up to 1000 Mbit/s by far exceeds that of CAN/CAN FD (<10 Mbit/s), FlexRay (10 Mbit/s), and MOST (up to 150 Mbit/s). In addition, Ethernet supports a large number of protocols on different layers, some of which (such as SOME/IP) were designed and standardized specifically for in-vehicle use. This makes it possible to use it in different forms (optimized for bandwidth or real time) for a wide range of applications.

dSPACE Tool Chain – Ready to Go

The dSPACE tool chain already supports automotive Ethernet in many applications. The support is spearheaded by the versatile SCALEXIO systems for rapid control prototyping

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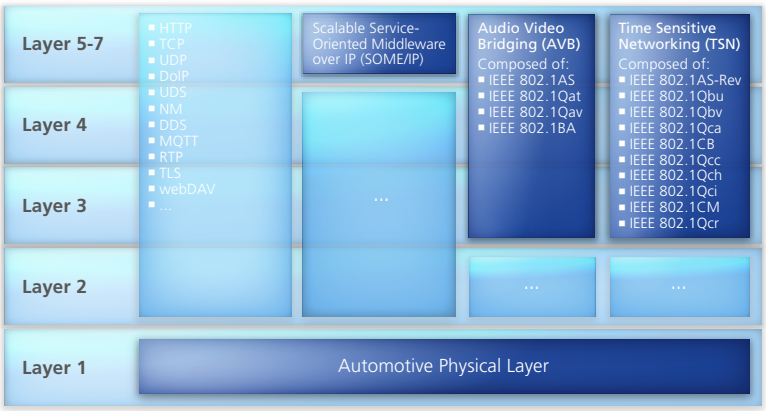
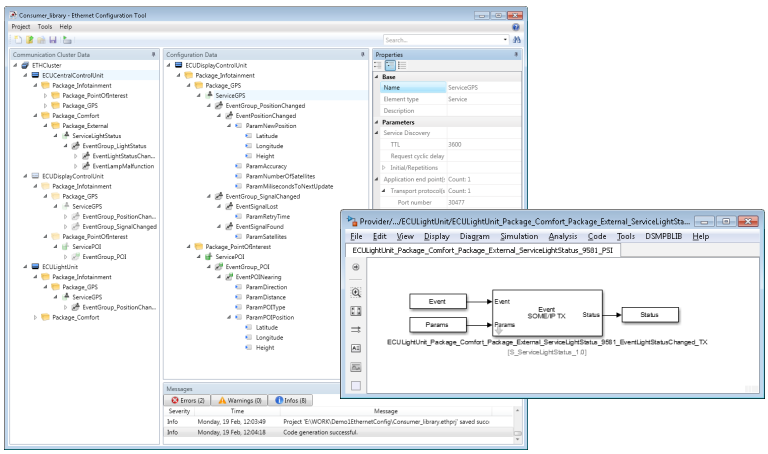
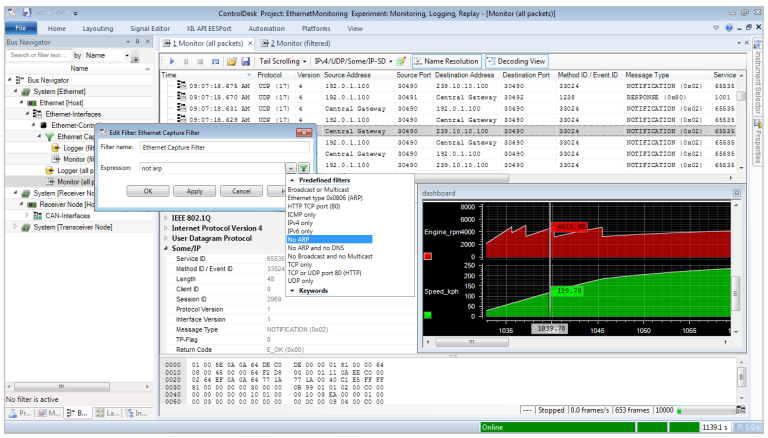


A wealth of possibilities: Automotive Ethernet provides multiple software layers above the physical layer. They can be used for an application-specific combination of protocols, such as SOME/IP, AVB, and TSN.



Implementation: The Ethernet Configuration Tool lets developers efficiently and conveniently set up and configure automotive Ethernet applications. The latest AUTOSAR standards can also be considered.



Monitoring: The Bus Navigator in dSPACE ControlDesk can be used for easy monitoring and recording of Ethernet traffic. The built-in Ethernet filter makes it possible to limit data capturing to individual Ethernet package types. The Time Cursor in ControlDesk lets you easily compare recorded Ethernet communication with other buses and measurement data.

(RCP) and hardware-in-the-loop (HIL) applications, for which a range of Ethernet boards with up to 5 ports will be available. For in-vehicle prototyping, the newest members of the MicroAutoBox product line, the Embedded PC with an Intel® Core™ i7-6822EQ processor and the upcoming Embedded SPU, can be equipped with up to 6 automotive Ethernet ports. In addition, numerous dSPACE hardware products feature conventional Ethernet ports, which can be used for different automotive Ethernet speeds by means of a media converter. The ports of the upcoming SCALEXIO Ethernet boards (DS6333-PE/CS) even have a modular design, so they can be configured for both conventional Ethernet and native supported automotive Ethernet with different speeds (100 Mbit/s and 1000 Mbit/s).

Implementation

A service-based network simulation for the Ethernet SOME/IP protocol can be set up on the basis of FIBEX or AUTOSAR communication descriptions with the Ethernet Configuration Tool. It is part of the dSPACE Ethernet Configuration Package, as is the Ethernet Configuration Blockset, which provides the Simulink blocks required for implementation on the supported hardware. By providing AUTOSAR-oriented support, relevant safety and security mechanisms are easily implemented. This includes end-to-end protection, secure onboard communication, and global time synchronization, which is particularly important for driver assistance systems.

Recording and Visualization

To round off the support for automotive Ethernet in the dSPACE tool chain, it is possible to flexibly monitor the different Ethernet protocols. The central tool for this is the optional Bus Navigator Module for ControlDesk. When combined with automotive-

Automotive Ethernet

Automotive Ethernet is a modification of the established Ethernet network standard, designed specifically for in-vehicle applications. A new physical layer was added to meet the requirement of cost-effective wiring via an unshielded twisted pair (USTP) cable without violating existing requirements, such as electromagnetic compatibility. Two bandwidths are currently standardized for automotive Ethernet: 100BASE-T1 (also known as BroadR-Reach) and 1000BASE-T1 (Gigabit Ethernet, i.e., 1000 Mbit/s). Other bandwidths ranging from 10 Mbit/s to 10 Gbit/s are currently being developed. If there is no native automotive Ethernet support, conventional Ethernet interfaces can be converted to 100BASE-T1 and 1000BASE-T by means of media converters.

As the software layers of Ethernet can easily be separated, an application-specific mix of different protocols can be used. This includes scalable service-oriented middleware over IP (SOME/IP), audio-video bridging (AVB), and time-sensitive networking (TSN). The SOME/IP protocol was specifically designed for in-vehicle use and is part of the AUTOSAR specification. With a service-based communication concept and dynamic service discovery, it provides maximum flexibility with limited protocol overhead. SOME/IP is already being used by a number of OEMs and has been established as the standard for transferring control information between ECUs. The AVB protocol combines several IEEE-802.1 standards. It covers various requirements for time synchronization, delay, and jitter for data streaming. This is also a point of reference for the TSN protocol, which contains even more standards of the IEEE-802.1 group and is used especially for time- and bandwidth-critical applications. In contrast to AVB, however, not all IEEE specifications in TSN have been officially adopted as standards yet.

With the dSPACE product range, automobile manufacturers are already well-equipped for automotive Ethernet.

Ethernet-capable hardware, such as SCALEXIO, with the soon-to-be-available Ethernet simulation on the PC-based simulation platform VEOS, or with the PC Bus interfaces, the Bus Navigator Module provides convenient handling of all Ethernet packets in the network. Even today, automotive Ethernet traffic can effortlessly be monitored and recorded in ControlDesk. In the future, dSPACE will also provide a dedicated Ethernet Bus Instrument. This will enable users to create tailor-made layouts with just a few clicks. The Time Cursor in ControlDesk can be used to quickly compare the recorded Ethernet data traffic with other measurement data or protocols, such as CAN, LIN, and FlexRay. The built-in Ethernet Capture Filter makes it possible to limit data capturing to individual Ethernet packets. For dSPACE Release 2018-A, a tree view for the decoding of Ethernet communication and a function for improved name mapping of individual Ethernet packets were implemented.

Conclusion

The growing demands on bandwidth and the high number of supported protocols will strengthen the position of the Ethernet standard in automotive engineering. It is good news for automotive engineers that the dSPACE tool chain already contains a number of hardware and software products that support the new standard in many use cases. In the future, dSPACE will continue to expand its support for automotive Ethernet. ■