Simulating Ethernet Networks in Real-Time Systems

New tool for restbus simulation of Ethernet

Translation of “Simulation von Ethernet-Netzwerken in Echtzeitsystemen
Neues Werkzeug zur Restbussimulation von Ethernet”

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Support for Service-Based Communication via Ethernet

The new Ethernet Configuration Package from dSPACE makes is possible to run service-based communication for ECU Ethernet networks in real-time systems.

Why Automotive Ethernet

Following FlexRay’s successful introduction into vehicles just a few years ago, Ethernet is now about to go into production use as an automotive communication bus. With its flexible layer model, high bandwidth and cost-effectiveness, independent implementations, Ethernet has numerous potential uses in vehicles. Ethernet networks will therefore play a decisive role in modern driver assistance systems, new comfort and entertainment functions, ECU flashing, and other functions.

Because Ethernet networks have often been optimized for automotive use, development is also focusing on many other aspects of the communication system. For example, the OPEN Alliance Special Interest Group (OPEN Alliance SIG), of which dSPACE is a member, is promoting the widespread introduction of Ethernet-based networks with unshielded twisted-pair cables. Activities in the areas of ASAM-MCD-2-NET (FIBEX) and AUTOSAR aim among other things to standardize communication descriptions and harmonize middleware layers. There is already a broad base of users and prospective users who are planning to introduce automotive Ethernet. dSPACE supports these customers with the new Ethernet Configuration Package.

dSPACE and Ethernet

dSPACE has been providing products and solutions for connecting Ethernet to real-time systems for many years. Two examples are the DS1006 Processor Board for hardware-in-the-loop simulation and the MicroAuto-Box® for rapid control prototyping with blocksets designed for MATLAB®/Simulink®. These products focus mainly on the User Datagram Protocol (UDP) and the Transmission Control Protocol / Internet Protocol (TCP/IP) via Ethernet.

The current Ethernet/IP discussion is addressing layers above UDP and TCP/IP, with service-based communication as the goal. The serialization protocol SOME/IP for service-based communication and the service discovery protocol SOME/IP-SD are playing a key role here. A version of the FIBEX standard called FIBEX 4, published by ASAM [www.asam.net] back in September 2011, meets the need to describe the additional elements required for service-based communication via Ethernet. The experience gathered from the initial application phase will lead to FIBEX 4.1, which is due to be released soon. FIBEX 4 is the first step towards a data exchange format for Ethernet-based, in-vehicle communication networks. More communication descriptions for service-based communication via Ethernet will follow, especially ones for AUTOSAR. The main idea behind this IP- and service-based communication is explained below with excerpts from the FIBEX 4 format.

Service-Based Communication with FIBEX 4

Ethernet is specified in IEEE 802.3 and covers the first two layers of the ISO/OSI model. Because the network nodes share the physical transmission medium, collisions can occur. These can be reduced by point-to-point connections with switches as coupling elements.

The fibex4services schema extends the FIBEX topology with the elements that are needed for describing Ethernet in the data link and physical layers. Network endpoints and application endpoints were integrated into the fibex4it schema and elements for the IP and transport addresses such as ports were added.

The FIBEX specification was extended by two basic concepts for communication via Ethernet. The first of these is typical signal-based communication like that used with CAN. This involves mapping protocol data units (PDUs) to Ethernet. The network and application endpoints for the PDUs are then modeled in FIBEX.

Ethernet provides more features than just transmitting simple signals via UDP, etc. The second basic concept allows the specification of complex service interfaces that contain methods and events for describing communication on higher layers. Generic data types can be used for the parameters of the methods to transmit information that is more structured than with simple signals. The fibex4services schema contains the elements for modeling service-based communication. Underneath the application endpoints are the service interfaces that are instantiated as either provided services or consumed services.

Tool Support

The dSPACE Ethernet Configuration Package supports the simulation of...
service- and event-based communication as described in FIBEX 4. The current version of the dSPACE Ethernet Configuration Package is available for systems with quad-core DS1006 Processor Boards.

Like the dSPACE FlexRay support, the dSPACE Ethernet Configuration Package consists of two parts: first, the dSPACE Ethernet Configuration Tool for configuring a dSPACE system as a simulation node in a service-based Ethernet network; and second, the RTI Ethernet Configuration Blockset for modeling service-based communication in MATLAB/Simulink (Figure 2).

The Ethernet Configuration Tool

The FIBEX 4 files can be imported and visualized with the dSPACE Ethernet Configuration Tool. FIBEX elements such as clusters, ECUs, services and events are represented in a clearly organized tree. Users can select whole ECUs and services or just single events for the simulation simply by drag & drop. A structured view displays the most important attributes of the FIBEX elements.

The selected services and events serve as inputs to automatic communication code generation. A transmission file is generated as a basis for service-based model frame generation in MATLAB/Simulink. The result is a Simulink interface model with preconfigured service and event blocks that build on the RTI Ethernet Configuration Blockset. The Simulink interface model provides subsystems for the simulated ECUs with the relevant service instance interfaces. With the help of the parameterized event blocks, users can design functions in the function model, for example, to try out the new communication via Ethernet/IP or to perform restbus simulation.

The new dSPACE Ethernet Configuration Package is the first tool for restbus simulation on real-time systems for service-based in-vehicle Ethernet communication. The latest version, Ethernet Configuration Package 1.3, will be released in September and also supports End-to-End protection mechanisms. Further versions will follow.

Figure 2: Architecture of the Ethernet Configuration Package

Dr. Ralf Stolpe has been with dSPACE GmbH since 2000 and was initially group leader for multiprocessor and distributed systems. Since 2007 he has been Project Leader for bus systems, responsible for the development of FlexRay and the new Ethernet Configuration Tool.

Björn Müller has been a member of Product Management at dSPACE GmbH since 2006. He is responsible for bus system products and bus technology.
Company Headquarters in Germany

dSPACE GmbH
Rathenaustraße 26
53102 Paderborn
Tel.: +49 5251 1638-0
Fax: +49 5251 16198-0
info@dspace.de

China

dSPACE Mechatronic Control Technology (Shanghai) Co., Ltd.
Unit 1101-1104, 11F/L
200001 Shanghai
Tel.: +86 21 6391 7666
Fax: +86 21 6391 7445
infochina@dspace.com

United Kingdom

dSPACE Ltd.
Unit 87· Beech House
Melbourn Science Park
Melbourn
Hertfordshire· SG8 6HB
Tel.: +44 1763 269 020
Fax: +44 1763 269 021
info@dspace.co.uk

France

dSPACE SARL
7 Parc Burospace
Route de Gisy
91573 Bièvres Cedex
Tel.: +33 169 355 060
Fax: +33 169 355 061
info@dspace.fr

Japan

dSPACE Japan K.K.
10F Gotenyama Trust Tower
4-7-35 Kitashinagawa
Shinagawa-ku
Tokyo 140-0001
Tel.: +81 3 5798 5460
Fax: +81 3 5798 5464
info@dspace.jp

USA and Canada

dSPACE Inc.
50131 Pontiac Trail
Wixom· MI 48393-2020
Tel.: +1 248 295 4700
Fax: +1 248 295 2950
info@dspaceinc.com

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