Simulating Ethernet Networks in Real-Time Systems

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Leinfelden-Echterdingen · 26.09.2013
A problem has been detected and Windows has been shut down to prevent damage to your computer.

**DRIVER_IRQL_NOT_LESS_OR_EQUAL**

If this is the first time you've seen this Stop error screen, restart your computer. If this screen appears again, follow these steps:

Check to make sure any new hardware or software is properly installed. If this is a new installation, ask your hardware or software manufacturer for any Windows updates you might need.

If problems continue, disable or remove any newly installed hardware or software. Disable BIOS memory options such as caching or shadowing. If you need to use Safe Mode to remove or disable components, restart your computer, press F8 to select Advanced Startup Options, and then select Safe Mode.

*** ABCD.SYS - Address F73120AE base at C0000000, DateStamp 36B072A3

Kernel Debugger Using: COM2 (Port 0x2F8, Baud Rate 19200)

Beginning dump of physical memory

Physical memory dump complete. Contact your system administrator or technical support group.
Ethernet & IP in Automotive Systems

- Ethernet in use for decades, but in different applications

**Difference**

- Not possible to close and restart tasks in automotive systems
- Errors in safety relevant ECUs not acceptable

**Solution**

- Combined development and testing of application together with communication
- Method of choice is hardware-in-the-loop (HIL) with
  - Real-time Simulation and
  - Dynamic Restbus Simulation
Validation of Electronic Control Units

Hardware-in-the-Loop Simulation

- Approved method for ECU validation
- Scalable tests
  - Function, component, networked system tests
- Provides the control unit’s environment
  - Inputs/outputs
  - Communication
- Simulation in real-time

Benefits

- Easy modification of test parameters
- Automated testing
Bus Support for Hardware-in-the-Loop Simulation

- Tailored tools for bus systems
- Support of >20 bus systems and protocols
  - Automotive (e.g. CAN, LIN, FlexRay)
  - Aerospace (e.g. ARINC 429 & 717, AFDX)
  - Industry (e.g. Ethercat, PROFIBUS)
- Even more...
- Blocksets for MATLAB/Simulink®
- Based on a database (DBC, LDF, FIBEX, AUTOSAR)
- Real-time restbus simulation with dynamic values
- Various manipulation options during run-time
NEW! Automotive Ethernet & IP Simulation

- New requirements, e.g.
  - Database support
  - Middleware support
  - Physical layer support

“Classic” Ethernet Simulation

- Used for e.g. data exchange or 3rd party coupling
- MATLAB/Simulink® Blockset
- Blocksets for UDP and TCP/IP
- Raw data access
Real-time Restbus Simulation for HIL Testing

Requirements

- Missing nodes (ECUs) implemented virtually on the simulator
- Provides all features of a communication system
- "Positive Testing"
  - Tests good behavior with correctly emulated communication
- "Negative Testing"
  - Emulates the communication with failure interspersion
- Restbus simulation with dynamic values calculated by real-time model
dSPACE Ethernet Configuration Package

- HIL tool chain for SOME/IP on Ethernet
- Ethernet restbus simulation
- Ethernet Configuration Tool
- RTI Ethernet Configuration Blockset

Special features

- Support of automotive specific functions, e.g.
  - Database import
  - Automotive middleware support
  - Manipulation options
Requirement/Challenge

- New middleware
  - SOME/IP
  - SOME/IP-SD (Service Discovery)

Solution

- Mapping of typical signal-based communication to service-based communication
  - Network and application endpoints
  - Provided/consumed services
  - Service interfaces and parameters
  - Dynamic Service Discovery support
Requirement/Challenge

- Import of FIBEX 4 (Extended Draft) database
- Frequent changes

Solution

- Adapted requirement process
- Contribution in ASAM and AUTOSAR
- Flexible development process
Requirement/Challenge

- Test and real-time requirements
  - Dynamic restbus simulation
- Support of experiment and test tools
- Support of end-to-end protection profiles

Solution

- Adapted blockset in matter of
  - Structure, Naming, …
- Support of variable description files
- Automatic configuration for end-to-end protection
Ethernet Configuration Package – Workflow

dSPACE Ethernet Configuration Tool

Configuration of services and events for simulation

Ethernet Configuration Blockset

Ethernet blockset for modeling with MATLAB/Simulink

Simulation on dSPACE hardware

FIBEX 4.0

*.m

*.c

*26.09.2013 Ethernet & IP @ Automotive Tech Day - © 2013, dSPACE GmbH. All right reserved. Changes without notice.*
Ethernet Configuration Tool

- Start code generation
- Selected nodes, services and events for restbus simulation
- View of important element attributes
- Visualisation of FIBEX elements, i.e., the cluster, node, services and events
- Log view
Simulink Interface, ECU Subsystem

- RBS_DisplayControlUnit
  - Generated by: dSPACE Ethernet Configuration Tool V1.0
  - Config. M file: rbs_displaycontrolunit_data.m,
    14.09.2012 12:00:20
  - XML file: ETHCT-Demo_00_2012.xml,
    05.09.2012 19:02:29
  - HW platform: DS1000

- RBS_DisplayControlUnit/RTIETHINETCONFIG ECU Services/ECUDisplayControlUnit
  - Ready: 100%

- Provided Service Instance
  - ECU_DisplayControlUnit_Package_Infoatainment_Package_PointOfInterest_ServicePOI_9899_PSI

- Consumed Service Instance
  - ECU_DisplayControlUnit_Package_Infoatainment_Package_GPS_ServiceGPS_9001_CSR

- Ready: 100%
Simulink Interface, Event Block
Ethernet Configuration Package (ETHCP)

**Version 1.0**
- Graphically restbus configuration
- Preconfigured Ethernet blockset for MATLAB/Simulink
- Support of FIBEX 4
- Support of SOME/IP
- Support of VLANs

Nov. 2012

**Version 1.1**
- Dynamic Service Discovery support

May 2013

**Version 1.2**
- Improved support of experiment and test automation tools with TRC file generation

July 2013

**Version 1.3**
- Support of end-to-end protection profiles according to FIBEX/AUTOSAR

Oct. 2013
Conclusion

- Application and communication has to be tested together
- HIL is an approved method for validation
- Automotive Ethernet simulation needs adapted tools
  - Support for VLAN, multi MAC simulation,..
  - Middleware
  - Databases
  - Encode/decode
- Tools for Ethernet restbus simulation in real-time are available