

Preparing for FlexRay

Development process according to SIL

HIL Simulator, QualityCenter® and AutomationDesk

Development for the FlexRay protocol

To pave the way for handling the complex and safety-relevant in-vehicle data communications of the future, the BMW Group is currently making preparations for using FlexRay. The quality of the development process is decisive. One way in which the group is tackling the quality issue is by introducing the BMW Group Standard Embedded Software (GS ESW). This defines the methods to be used for each safety level. dSPACE Simulator and AutomationDesk play a major part.

FlexRay-Oriented Development Process

Current in-vehicle data busses will soon be swamped by the volume of data, so in 2000, the BMW Group joined with other partners to found the FlexRay Consortium, dedicated to establishing FlexRay as the de facto international standard for advanced in-vehicle control applications. The quality of the verification and validation software on hardware-in-the-loop platforms will be brought up to the requisite level by the following means:

- Using precisely defined standard hardware and software platforms
- Standardizing hardware-in-the-loop test (HIL) processes (acquisition, construction, operation, ...)
- One HIL model database for all users
- Centrally organized HIL support
- Defining BMW Group Standard HIL
- Using test automation and test management for HIL environments

The GS ESW defines the method to be used for each specific safety integrity level (SIL). Hardware-in-the-loop simulation is recommended at all SIL levels, and mandatory from SIL 3 up. For control design based on MATLAB®/Simulink®, the FlexRay blockset and dSPACE's DS4501 Board with FlexRay interfaces are also used for testing function developments for the FlexRay protocol.

Safety Integrity Levels

Each safety integrity level (SIL) is a discrete level for specifying the integrity requirements for the safety functions assigned to an electronic control unit (ECU). SIL 4 is the highest level and SIL 1 the lowest according to IEC 61508. The GS ESW has an additional level, SIL 0, for quality requirements that do not cover safety integrity. It also has SIL 2*, an intermediate

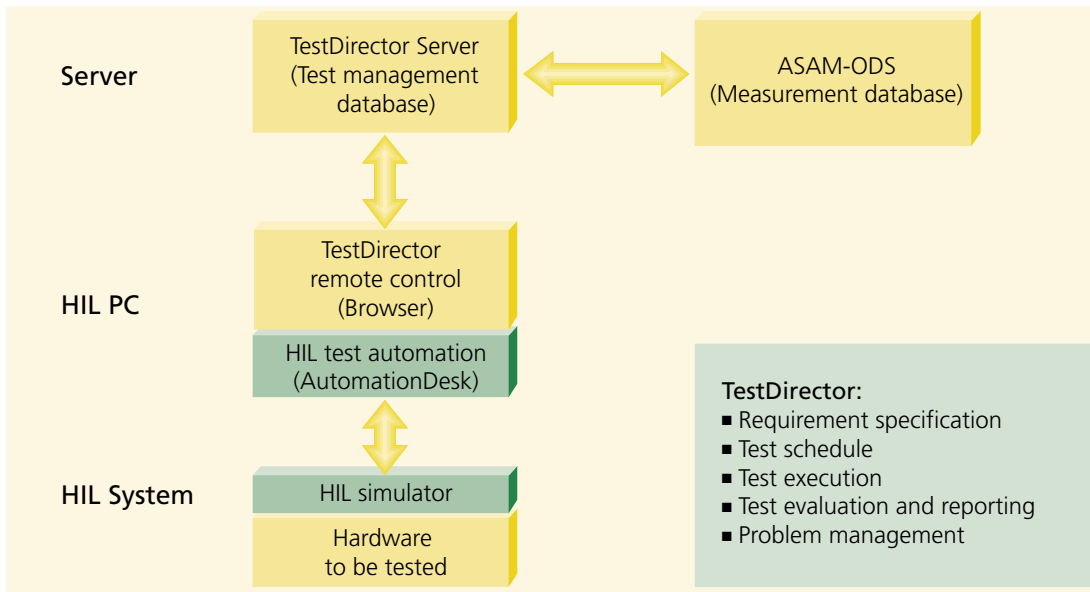
GS Embedded Software	IEC 61508
–	SIL 4
SIL 3	SIL 3
SIL 2*	SIL 2
SIL 2	
SIL 1	SIL 1
SIL 0	–

▲ Safety integrity levels (SIL) at BMW and according to IEC 61508. SIL 4 is the highest level for specifying requirements for safety integrity, SIL 0 the lowest.

level between SIL 2 and SIL 3, for better differentiation. SIL 4 is not relevant to automotive applications. The methods and actions suitable for each SIL have to be selected from the GS ESW during software development.

FlexRay – Fast and Safe

The time-controlled FlexRay protocol is fast (now 10 megabit/s, compared with max. 500 kilobit/s with CAN) and deterministic. These properties make FlexRay bus systems the ideal backbone for future in-vehicle ECU architectures. As a rule, current bus systems, such as CAN, are only event-controlled instead of time-controlled. A CAN bus can face a “traffic jam” if too many components all transmit simultaneously. In contrast, transmission via the FlexRay protocol is cyclic, and performed in precisely defined slots. Each message is assigned a slot, and only one specific subscriber can transmit in that slot. For further information, see www.flexray.com



▲ Test management with QualityCenter® and AutomationDesk. AutomationDesk is used for editing ECU software tests, and QualityCenter® from Mercury Interactive for global test management.

TestDirector and AutomationDesk

To edit ECU software tests, we use dSPACE's AutomationDesk and other software. Global test management is performed via QualityCenter® from Mercury Interactive. QualityCenter® is Internet-based and facilitates distributed work on IT projects. It can be connected to dSPACE's AutomationDesk via a COM/DCOM interface. Existing tests can then be selected in QualityCenter® and run in AutomationDesk. During test execution, AutomationDesk reports on the status and progress of execution to the other tools involved. Finally, the most important test results are sent to QualityCenter® along with other information (date, time, test operator, etc.) for output.

Outcomes and Outlook

We are handling more and more tests via QualityCenter®, and executing them automatically. This is happening at all test process levels, from components to subsystems right through to the entire electrical/electronic system, and in all development steps, from the A sample to production level. The test results, deviations from desired behavior, and the problem-solving process are also controlled and documented via

QualityCenter®. This makes the testing and problem-solving processes extremely efficient and transparent, enabling our engineers to meet the increased quality objectives. For example, a much larger proportion of errors is found in early test levels, and remedied immediately in the current version. This cuts the number of versions by up to 50%. The virtual verification of functions, for example, by software-in-the-loop tests, will play a more important role in the future, as it allows errors to be detected even earlier, making them less expensive to remedy. Model-supported specification and model-based development using MATLAB or Simulink models have to be intensified to achieve this. The present tool chain can continue in use with the new test processes. To further reduce the testing workload, each function could then be transferred straight to production code after testing, using production code generators like dSPACE's TargetLink. Use of these generators is currently being prepared.

*Dr. Peter RiBling,
Peter Riedesser
BMW AG
Germany*