

dSPACE NEWS

FACTS · PROJECTS · EVENTS

Business

Thinking in Architectures

Customer Applications

BMW:
Preparing for FlexRay

In Production:
Delphi Develops Rollover Detection with TargetLink

Jaguar:
Sporty Rear Wheel Drive



RapidPro: Mix and Match

Editorial

- 3** By Dr. Herbert Hanselmann
President

Customers

- 4** Nissan: RapidPro for Engine Control
7 Delphi: Surviving a Vehicle Rollover
10 BMW AG: Preparing for FlexRay
12 Jaguar: Rear Wheel Drive More Sporty
14 RailCabs: The Railway of the Future

Business

- 16** Thinking in Architectures
19 User Conference 2004:
Record Attendance
22 Hello From Korea
24 Conference in India

Products

- 25** MTest: Model-Based Test
Management Extended
25 New Catalog and Demo CD 2005
26 HIL is a Process Issue
28 MotionDesk: Instant Insights
30 Compact News
31 Info and Dates

dSPACE NEWS

dSPACE NEWS is published periodically by:

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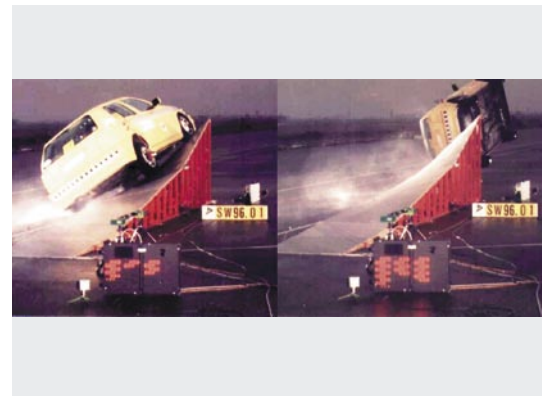
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- 4** Nissan Motor Corporation used the new dSPACE RapidPro hardware platform in a successful pilot project developing engine control functions.



- 7** Delphi's WinGAMR algorithm detects overroll situations and triggers safety actions. The algorithm was transferred to production code by means of TargetLink.



“A new optimism is spreading through the automotive industry, though as yet a little cautious” was the gist of many media comments as the new year began. So let’s think positively: Perhaps investments and consumer spending are starting

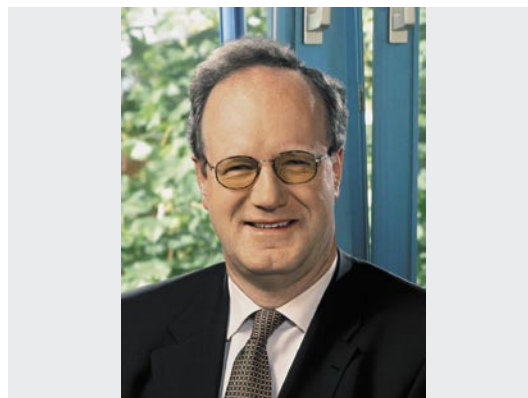
to move again. Financial insecurity and fears for the future made consumers wary, and they kept the lid on expenditure, preferring to save their money. Obviously, this also applied to cars. Especially since most cars nowadays have a very high life expectancy. So why buy a new one? Many households already have a second car in the garage – or even a third. I sometimes wonder where the demand for over 30 million cars a year in Western Europe and the US comes from, and is going to come from. Fortunately, manufacturers keep coming up with bright new innovations, such as comfort features and increased safety. Consumers too, with their heightened environmental awareness, are forcing governments to act on issues such as emission control, and this also keeps the automotive industry in motion. (My thanks to them).

In 2004, the car industry took its foot off the investment brake, and we felt the effect at dSPACE. New orders and sales rose significantly, and we’re definitely entering the new year with new momentum. Like the automobile manufacturers, we too have to keep the market supplied with new and attractive ideas, and 2005 will be no exception. At the same time, we are looking further ahead to a few years’ time, making investments and reinforcing our development team. We will also expand our hardware production and engineering sections. But to continue growing, we need more space. Our engineering teams are currently in temporary offices, but if you want to see how much they like it there, you’ll have to hurry up and visit us soon. The ground-breaking ceremony for dSPACE’s new production and engineering facility was held in January. We’ll keep you up-to-date on further developments.

*Dr. Herbert Hanselmann
President*



12 *Jaguar Land Rover used dSPACE’s MicroAutoBox to develop the control strategy for an electronic limited slip differential that improves vehicle behavior.*



16 *Hans-Georg Frischkorn, head of Future System Architecture and System Integration at the BMW Group, talks to dSPACE NEWS about his vision of electronics in the future.*

Nissan: RapidPro for Engine Control

- Pilot project with RapidPro hardware for engine control
- Successful in-vehicle tests on Nissan Maxima
- RapidPro to be used in further Nissan projects

The Nissan Motor Corporation, Japan, used the new signal conditioning and power stage hardware RapidPro in a pilot project, as part of a fullpass rapid control prototyping (RCP) application for control of Nissan's well-known VQ engine. The control functions were tested on a Nissan Maxima. The pilot project was completely based on the dSPACE hardware and software tool chain. Nissan continues to use the RapidPro units under real conditions in its projects.

Nissan's VQ Engine

To evaluate the RapidPro System with its signal conditioning and power stage features (presented in dSPACE NEWS 3/2004) under real conditions, Nissan chose the Maxima as the test vehicle in the pilot project. The Maxima was powered by the latest 3.5L VQ engine. The VQ engine series is Nissan's mainstream V6 engine lineup, which has been in Ward's "Ten Best Engines" for 11 years in a row. (Ward's Auto World magazine annually recognizes outstanding engine performance in this way). Following constant improvement, the engine is now in its 3rd generation and has a new engine management system (EMS). The EMS

supports numerous variable devices, such as continuously variable valve timing and a variable air induction system. System function redundancies are reduced by reading multiple information from one sensor (for example, the cam position sensor), so fewer sensors are needed. Another special feature of the EMS is that it efficiently controls emission reduction using an advanced air/fuel mixture control strategy and lambda probes.



◀ Nissan's VQ engine – powering the Nissan Maxima – was selected for the pilot project with RapidPro.

Nissan's RCP System for the VQ Engine

In a fullpass approach to controlling the VQ engine, Nissan employed dSPACE's MicroAutoBox prototyping system and two RapidPro SC Unit prototypes plus one RapidPro Power Unit prototype, equipped with the appropriate signal conditioning and power stage modules. The RapidPro units adapted the required sensor and actuator signals

to the MicroAutoBox (see pictures on next page). An engine controller model running on the MicroAutoBox was available from previous projects at Nissan. A proven software tool chain was used: MATLAB®/ Simulink®, dSPACE Real-

Time Interface (RTI) for basic I/O and Extended Engine Control, and the experiment software ControlDesk. Nissan's RapidPro hardware was configured with a terminal application, as the new ConfigurationDesk configuration software was not available at the time of the pilot project.

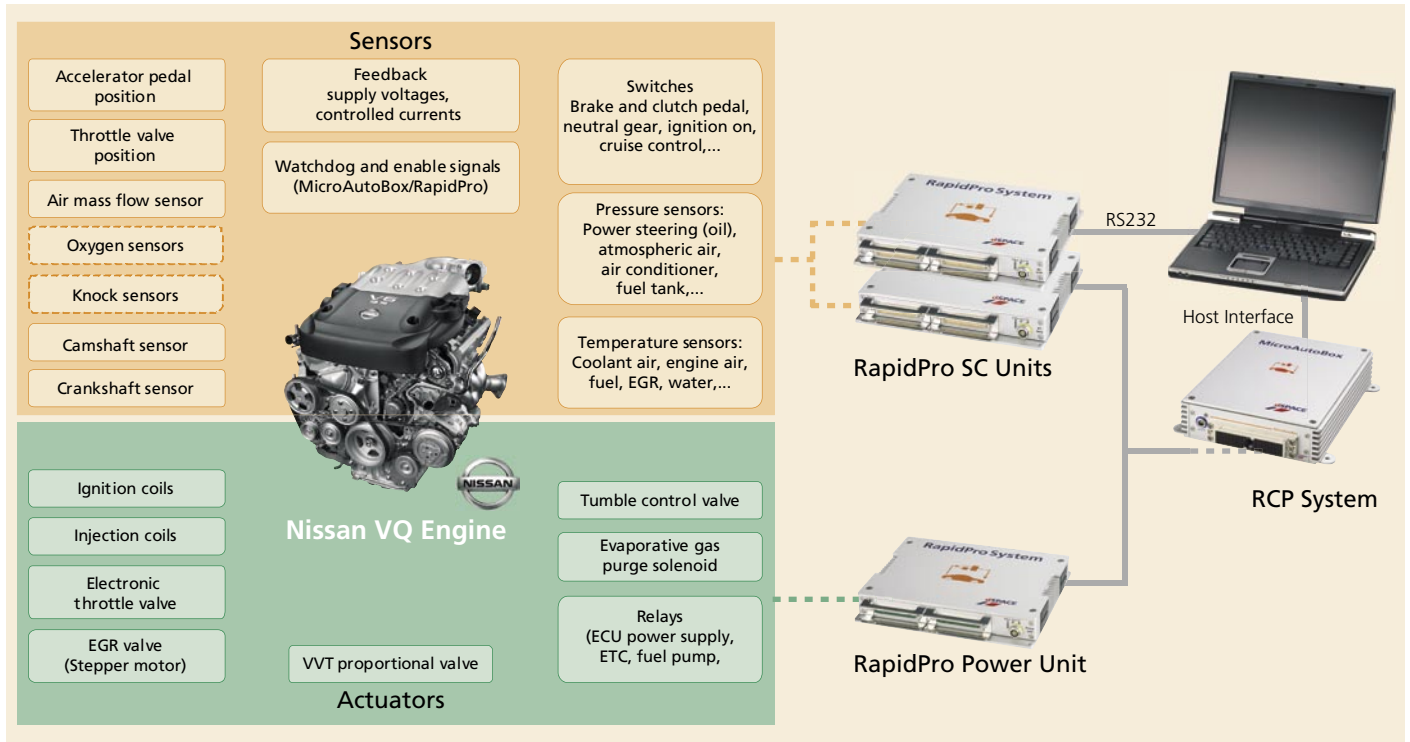
Phases of the Pilot Project

When the rough concept had been worked out, the pilot project was divided into four major phases:

1. Detailed specification and configuration
2. Commissioning and real load tests
3. Hardware-in-the-loop (HIL) tests on a test bench
4. In-vehicle tests

"We are very satisfied with the results. The system has worked reliably and was able to start our engine at once. Frankly speaking, I was very surprised to see that the RapidPro started the engine so easily and smoothly, because I predicted that this project would be very difficult."

Shigeaki Kakizaki, Nissan Motor Corporation, Japan



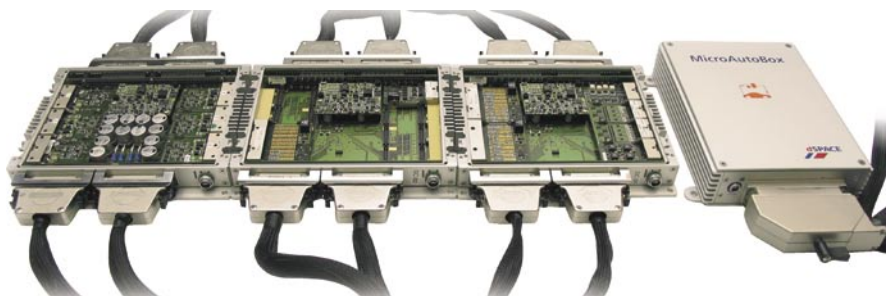
▲ Sensor and actuator signals of the VQ engine were adapted to the MicroAutoBox prototyping system via the RapidPro prototypes with signal conditioning and power stages.

**Phase 1:
Detailed Specification and Configuration**

To detail the concept design, Nissan provided the specifications for sensor inputs and actuator outputs, which were investigated and mapped against the RapidPro modules (see table on next page). dSPACE then configured the modules and assembled the two wiring harnesses between the sensors/actuators and RapidPro, and between RapidPro and the MicroAutoBox. The resulting system includes some spare signals, which can be used to connect additional sensors and actuators as the engine evolves in the future. The maximum configuration uses all the I/O channels of the MicroAutoBox.

**Phase 2:
Commissioning and Real Load Tests**

dSPACE ran initial tests with Nissan's real loads connected to RapidPro in the laboratory. Synchronization to crankshaft and camshaft, and correct ignition and injection, were tested by hardware-in-the-loop simulation (HIL). All these tests made use of a pure stimulus model running on the MicroAutoBox. During the commissioning of the system, especially the wiring harness, the need for a compact and easy-to-handle RapidPro break-out box (BOB) was obvious. In addition to typical features like closing/opening all the relevant signal connections, inserting stimulus signals, and signal measurement, the RapidPro-specific BOB has



◀ A powerful tool combination: RapidPro hardware and MicroAutoBox.

Quantity	Module Description	Example Application
1	SC-AI4/1 (4-channel differential analog input module)	Throttle position and pressure sensor signals which must be amplified
3	SC-AI10/1 (10-channel analog input module)	Accelerator pedal position, pressure sensors, temperature sensors, air mass flow sensor, sensor supply and battery voltage measurements
2	SC-DI8/1 (8-channel digital input module)	Crankshaft/camshaft sensors, switches (e.g., brake, neutral gear, etc.)
1	SC-DO8/1 (8-channel digital output module)	Relays, ignition coils
1	SC-SENS4/1 (4-channel sensor supply module)	Supply for sensors and ignition coils
1	PS-FBD2/1 (2-channel full-bridge driver module)	Throttle valve, tumble control valve
5	PS-LSD6/1 (6-channel low-side driver module)	Evaporative gas purge solenoid, VVT valve solenoids, EGR stepper motor, fuel injectors, heater, O ₂ sensor

▲ Project-related RapidPro signal conditioning (SC) and power stage (PS) modules.

the advantage of using RapidPro Sub-D connectors. If wiring errors are detected during commissioning, they can be temporarily corrected by rewiring directly on the BOB. At the end of the commissioning phase, the RapidPro BOB can be removed, and the corrected wiring harness can be connected directly to the RapidPro System.

Phase 3: HIL Tests on a Test Bench

Next the RapidPro System was shipped to Nissan, where it was connected to an existing dSPACE HIL simulator which matches the actuators and sensors of the real engine. The final configuration of the RapidPro System was done via software during the HIL tests. For example, engineers adjusted the upper and lower threshold values of some channels on the 8-channel digital input modules and the

cut-off frequencies of some channels on the 4-channel analog input module. The overall system passed the test without the hardware having to be changed. After this success, Nissan decided to start in-vehicle tests with the Maxima immediately.

Phase 4: In-Vehicle Tests

With the RapidPro System integrated into the vehicle, the signals were checked in two steps, without the engine running and with the engine running. Nissan tested all the sensors, actuators, and signals successfully for functionality, plausibility, and noise. The input signals were validated by measurements done with an oscilloscope and compared to the input signals of the model measured with ControlDesk. The engineers from Nissan were also trained in using and configuring the RapidPro System during phase 4.

Nissan's Experience with the RapidPro System

Nissan's objectives were to evaluate the RapidPro prototype and to develop new functions for engine control. RapidPro is still being used under real conditions and to great effect. The RapidPro prototype will be replaced with units of the upcoming release version. The fullpass approach to controlling the VQ engine will soon have to be expanded by adding lambda control and knock detection. dSPACE will provide the necessary modules for use in a successor project. Because MicroAutoBox's I/O resources were stretched to capacity in the pilot project, a Control Unit will be used to expand the I/O functionality. If the Control Unit performs the entire I/O, no customer specific wiring harness is needed between MicroAutoBox and the RapidPro System, and only the high-speed serial link is used for communication.

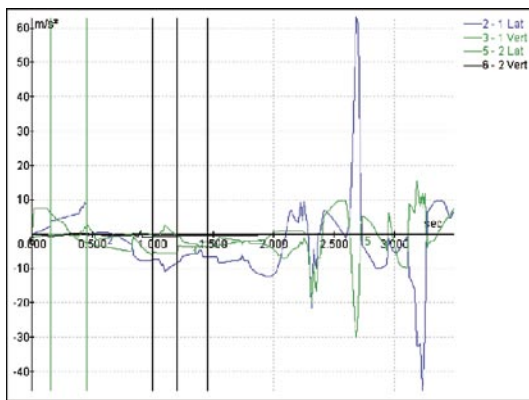
Shigeaki Kakizaki
Engine Management System Engineering
Nissan Motor Corporation
Japan

Frank Schütte
Application Department
dSPACE GmbH
Germany

Surviving a Vehicle Rollover

Vehicle rollovers are a serious concern in automobile safety and can be fatal. They account for approximately one quarter of all road accident deaths in the US each year. Delphi's patented WinGAMR rollover detection algorithm detects a rollover and triggers protection. Delphi used model-based design to implement WinGAMR. TargetLink from dSPACE was used for automatic production code generation. TargetLink's code profiling techniques helped to analyze the code and significantly improve the efficiency of the production code.

- Delphi's developments for passenger safety systems
- Rollover detection algorithm implemented and now in production
- Significant code improvements achieved using TargetLink's code profiling techniques



▲ Simulated sensor signals show the lateral and vertical accelerations to be analyzed by a rollover detection algorithm.

Background

Rollovers are complex events. They can have several causes, such as over correction by a drowsy or distracted driver. They can also occur when a vehicle loses positive traction, skids sideways, and encounters a low obstacle. Vehicle-to-vehicle collisions can also cause rollovers.

Protecting Vehicle Occupants

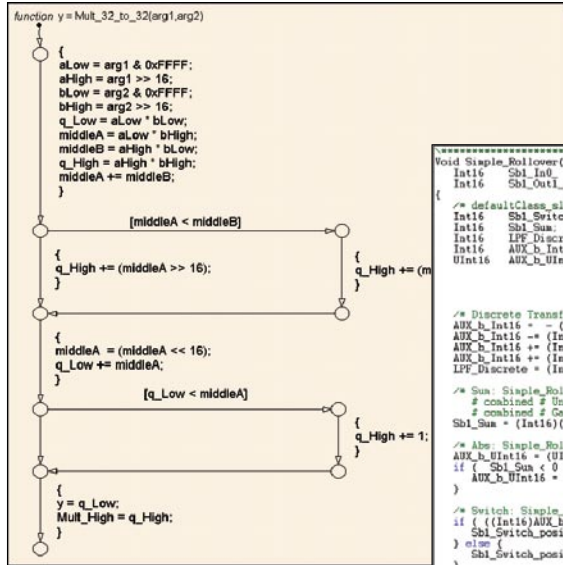
With front airbags now covering the driver and passenger, and with side airbags available on many vehicles, rollovers are the next big market for crash safety systems. There are three common ways of protecting vehicle occupants: removing seat belt slack (actively tensioning the seat belt) to reduce occupant ejection; deploying head-rest roll bars for convertibles; and side window curtain airbags to reduce head injury and prevent ejection. Post-rollover actions may also be required, such as cutting off the fuel flow and sending a distress call to the emergency services.

Rollover Detection

Knowing when to trigger such safety measures is the task of a rollover detection algorithm. Data from inertial sensors such as gyros and accelerometers is typically processed in a rollover-sensing module to make the trigger-or-not decision. The design of the rollover detection algorithm has to cover a very wide, dynamic range of events, from a gradual drift into a highway ditch to a rapid curb trip on a city



▲ In situations like these, the WinGAMR rollover detection algorithm triggers safety measures.



TargetLink was used to generate efficient fixed-point C code from Simulink and Stateflow models.

```

Void Simple_Rollover{
  Int16 Sbl_In0; /* LSB: 2^-7 OFF: 0 MIN/MAX: -256 .. 255.9921875 */
  Int16 Sbl_Out1[3]; /* LSB: 2^-6 OFF: 0 MIN/MAX: -512 .. 511.984375 */
  /* defaultClass_allLocal: Default storage class for local variables */
  Int16 Sbl_Switch_positive; /* LSB: 2^-7 OFF: 0 MIN/MAX: -256 .. 255.9921875 */
  Int16 Sbl_Sum; /* LSB: 2^-7 OFF: 0 MIN/MAX: -256 .. 255.9921875 */
  Int16 LPF_Discrete; /* LSB: 2^-7 OFF: 0 MIN/MAX: -256 .. 255.9921875 */
  Int16 AUX_b_Int16;
  UInt16 AUX_b_Unit16;

  /* Discrete Transfer Function: Simple_Rollover/LPF_Discrete */
  AUX_b_Int16 = -((Int16)(((Int32)(X_Sbl_LPF_Discrete[0]) * 18193) >> 16));
  AUX_b_Int16 -= ((Int16)(((Int32)(X_Sbl_LPF_Discrete[1]) * 50279) >> 16));
  AUX_b_Int16 += ((Int16)(((Int32)(X_Sbl_LPF_Discrete[2]) * 16751) >> 15));
  AUX_b_Int16 += ((Int16)(((Int32)(X_Sbl_LPF_Discrete[3]) * 16751) >> 14));
  LPF_Discrete = (Int16)((UInt16)AUX_b_Int16 + ((UInt16)(Int16)(((Int32)Sbl_In0) * 16751) >> 15));

  /* Sum: Simple_Rollover/Sum
  # combined # Unit delay: Simple_Rollover/Unit Delay
  # combined # Gain: Simple_Rollover/Gain */
  Sbl_Sum = (Int16)((UInt16)(Int16)(((Int32)LPF_Discrete) * 20971) >> 21) + ((UInt16)X_Sbl_Unit_Delay);

  /* Abs: Simple_Rollover/Abs */
  AUX_b_Unit16 = (UInt16)Sbl_Sum;
  if ( Sbl_Sum < 0 ) {
    AUX_b_Unit16 = -((Int16)AUX_b_Unit16);
  }

  /* Switch: Simple_Rollover/Switch positive */
  if ( (Int16)AUX_b_Unit16 >= 640 /* 5. */ ) {
    Sbl_Switch_positive = 12800 /* 100. */;
  } else {
    Sbl_Switch_positive = 0;
  }

  /* TargetLink output: Simple_Rollover/Out1 */
  Sbl_Out1[0] = (Int16)(Sbl_Switch_positive >> 1);
  Sbl_Out1[1] = (Int16)(Sbl_In0 >> 1);
  Sbl_Out1[2] = (Int16)(Sbl_Sum >> 1);

  /* --- Update code of subsystem: Simple_Rollover --- */
  X_Sbl_LPF_Discrete[0] = X_Sbl_LPF_Discrete[1];
  X_Sbl_LPF_Discrete[1] = LPF_Discrete;
  X_Sbl_LPF_Discrete[2] = X_Sbl_LPF_Discrete[3];
  X_Sbl_LPF_Discrete[3] = Sbl_In0;

  /* Unit delay: Simple_Rollover/Unit Delay */
  X_Sbl_Unit_Delay = Sbl_Sum;
}
    
```

street. Given the complexity and variety of rollover events, distinguishing between trigger and no-trigger events can be a considerable challenge.

Design

Validating rollover detection algorithms and performing tolerance studies on their calibration to a specific vehicle platform are greatly facilitated by math-based design methods. Once an algorithm has been validated, it is ready to be autocoded for implementation on a fixed-point microprocessor. To ensure the reliability of the final system, it is essential to verify that the C code accurately represents the same performance as the math models.

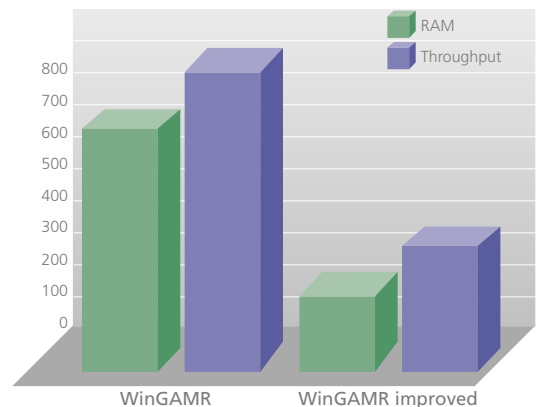
Project and Process

The patented WinGAMR algorithm, invented at Delphi Electronics & Safety, was first implemented using Simulink® and Stateflow® models. TargetLink was then used to develop the range and resolution for each variable, and to generate code. The fixed-point target C code was compared with the original model to clarify the tradeoffs involved in memory and throughput, and to optimize the system. Comparing target C code (PIL simulation) to the original validation file (MIL simulation) then verified the performance of the final product.

Profiling and Optimization

Using the execution time metric produced with TargetLink and a target processor evaluation board, a sub-optimal implementation of the algorithm was identified. Within minutes, the cause of the high

RAM and throughput was evident. By making a very modest change in the algorithm implementation, both RAM and throughput were reduced by 75%. This remarkable improvement may not have been noticed for weeks or months using the traditional approach. Bringing the consequences of algorithm implementations to the awareness of the algorithm designer enabled quick cycles of learning that led to rapid improvement in performance. Besides speeding up the time to market, the wasteful expenditure of a considerable amount of engineering effort was entirely avoided.



Insights into the algorithm gained from using TargetLink’s code analysis tools and an evaluation board led to huge improvements in RAM consumption and throughput (execution time).

Implementation

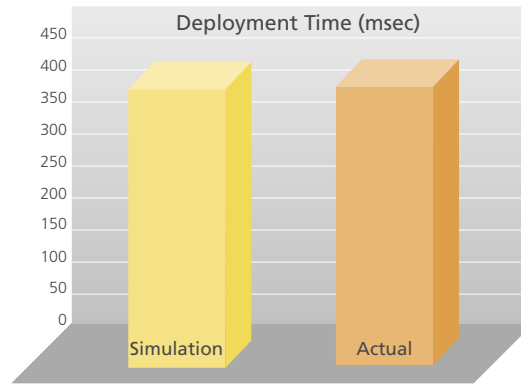
The auto-generated code was passed to the software integration engineer. Integration took less than 2 days. His comments were: *“The generated code was easy to understand. Every comment and variable name was a real help, and in my opinion it saved a lot of time. It is a good base for developing target C code. The main backbone of code was almost unchanged.”* The word “almost” is a reference to a digital high-pass filter that used 16-bit variables. The software integration engineer expanded these to 32-bit variables, which improved accuracy in the final results.

Handcode vs. Autocode

The autocode algorithm was a new development; so direct comparisons with handcode are not available. However, an earlier handcoded version of the rollover detection algorithm consumed more throughput, more RAM, and more ROM than the autocode algorithm. The autocode algorithm also improved field performance. This comparison involves other factors, but it can be stated that autocode did not cause any undesirable metrics in the newly-created rollover detection algorithm.

Live Testing

Live testing of the algorithm was performed to compare results to predictions. Three tests were run. The two near-rollover tests were successful, and did not trigger. The measured deployment time for the rollover test matched the simulation exactly (10 ms sampling rate). Moreover, a professional racing driver



▲ The deployment time measured for the autocode algorithm matched the simulation.

was unable to produce any undesirable behavior on a rigorous test course. The results were a success and this algorithm is now in production.

Future Outlook

Further development of rollover detection algorithms continues to use MATLAB/Simulink/Stateflow for development and calibration, and TargetLink for automatic production code generation. The re-use blocks from WinGAMR allow the next generation of rollover detection algorithms to be developed much more rapidly and efficiently.

*Peter J. Schubert, PhD
Technical Fellow
Systems Methodology Advocate
Delphi Electronics & Safety
USA*

Essence

Autocode Success Story

- Code-profiling led to handcode efficiency; RAM and throughput down by 75%
- Integrated in 1.5 days
- In production
- Statements from software engineers:
“The generated code was easy to understand. Every comment and variable name was a great help.”
“In my opinion it saved a lot of time. It is a good base for developing target C code. The main backbone of code was almost unchanged.”

Equipment and Methods

- TargetLink, Target Optimization Module and Motorola HC 12 Evaluation Board for code profiling
 - Throughput (execution time)
 - RAM (including stack)
 - ROM
- Back-to-back-tests (MIL, SIL and PIL simulations) at earliest stage

Autocode Reduces Risks

- No transcription errors
- No misinterpretation of specifications
- Match with model performance

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

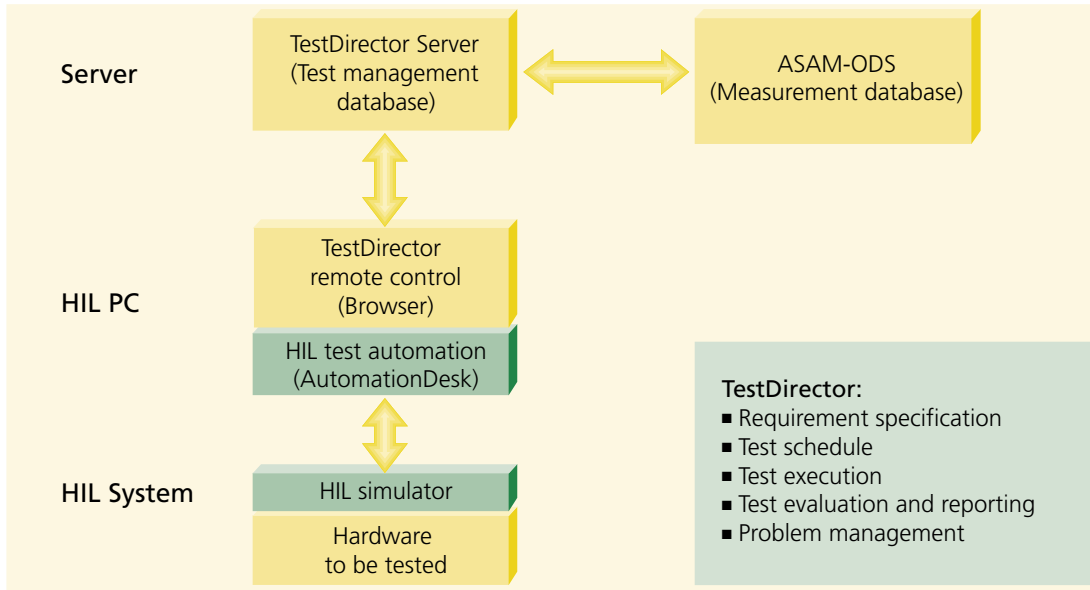
GS Embedded Software	IEC 61508
–	SIL 4
SIL 3	SIL 3
SIL 2*	SIL 2
SIL 2	
SIL 1	SIL 1
SIL 0	–

▲ 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*

Jaguar: Rear Wheel Drive More Sporty

✓ Jaguar Land Rover uses dSPACE Prototyper for powertrain control algorithms

✓ Vehicle tests with MicroAutoBox on a Jaguar S-Type

✓ More safety and driving fun for rear wheel driven cars

Jaguar Land Rover (JLR) in the United Kingdom is enjoying great success using dSPACE Prototyper to improve the handling and stability of the famous Jaguar S-Type with an electronically controlled limited slip differential (LSD). The approach is based on adjusting and optimizing torque transfer to the driven wheels by applying strategies which they tested in a vehicle using MicroAutoBox. The result is improved safety and a better driving experience. A key advantage was a development time of only nine months from project start to the first prototype vehicle.

Limited Slip Differential

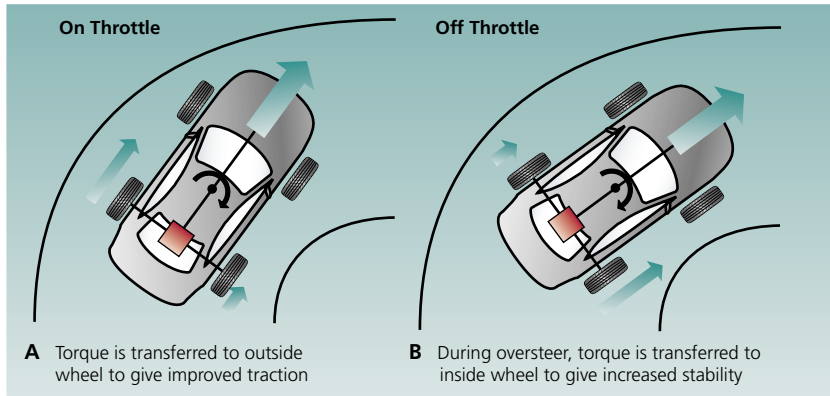
In a rear wheel drive car, engine torque is transferred to the rear axle through a crown wheel and pinion. If the axle is rigid, cornering becomes a problem as the outside wheel wants to rotate faster than the inside wheel, causing them to slip. The problem is overcome by fitting a differential, which allows the wheels to rotate at different speeds, while the same torque is transmitted to each. However, when the car is cornering, a strong centrifugal force transfers the vertical load from the inside wheel to the outside wheel, reducing the amount of torque which the inside wheel is able to transmit to the road. Eventually a point is reached where the inside wheel begins to spin, which sets the limit for the torque which can be transmitted by the outside wheel, as the differential

will only allow the same torque to be transmitted by each wheel. A similar situation occurs when one wheel is on ice and the other on a clear road surface, when the traction of both wheels is limited to that of the wheel on ice. By fitting a controlled limited slip differential, JLR engineers are able to direct torque from the slipping wheel to the nonslipping wheel and greatly improve the vehicle's traction, while maintaining control of vehicle stability, which would not be possible with a mechanical LSD.

Traction and Handling Control

The JLR traction control algorithm aims to optimize wheel speed difference. Developing a suitable controller for the LSD is critical to traction control, as the balance between improving traction and





◀ With the right control strategy, the controlled limited slip differential can both improve safety and enhance the driving experience.

maintaining stability has to be just right – too much power transferred to one wheel will destabilize the car. An LSD can also enhance handling. On cornering, the electromechanical lockers cause torque to be transferred to the inside, or slower, wheel. This in turn leads to understeer off-throttle, which JLR realized had the potential to significantly improve handling. The algorithms were developed with two aspects in mind:

- Improving safety
- Making driving a more pleasurable experience

The JLR approach is to develop control strategies in computer simulation, before implementing them on a vehicle. Once they were happy with the simulation results, the next stage was to take the algorithm to real time on a test vehicle. Early results were good, as the project team was able to start vehicle tests with dSPACE Prototyper on a Jaguar S-Type only nine months after starting the project. A MicroAutoBox mounted inside the Jaguar, in combination with the ControlDesk monitoring software on a notebook, made it possible to test, and optimize, the LSD control algorithms under realistic conditions, and to change parameters dynamically while driving on the test track. The effect of the LSD control is clear, and the theory was successfully validated by a further six months of development.

Speedy Development Process

The Advanced Chassis Technology department initiated the development project. This department investigates new chassis technologies for JLR cars by applying simulation and rapid control prototyping, and developing a technology to the point where it is suitable for production. JLR are very pleased with progress made in the project because the results have demonstrated that it is possible to apply hard-

ware formerly used only in sports utility vehicles to their road vehicles. The added value for the drivers of Jaguar and Land Rover cars – more safety, highly reduced driver intervention and a better driving experience – became apparent during vehicle tests with the Jaguar S-Type. dSPACE’s MicroAutoBox made it much easier for JLR to experiment with different control strategies and quickly adapt them. A fast turnaround time helps them compete with other vehicle manufacturers.



Matthew Hancock
Advanced Chassis
Technology
Jaguar Land Rover
United Kingdom

Matthew Hancock explained that MicroAutoBox was a natural choice for the application. “JLR have a number of dSPACE installations up and running successfully, and there is a lot of experience of using the tools in the company, so we knew that MicroAutoBox would be able to do what we needed.”



Bob Williams
Advanced Chassis
Technology
Jaguar Land Rover
United Kingdom

“The results have shown that we can use the limited slip differential control to stabilize the vehicle in difficult conditions, as well as improve the overall driving experience.”

RailCabs: The Railway of the Future

- **University of Paderborn uses dSPACE hardware**
- **Modular rail system for flexible passenger and freight transport**
- **ControlDesk used for RailCab control**

A completely new railway system using individual RailCabs is being developed at the University of Paderborn in Germany (see dSPACE NEWS 1/2002). The project was initiated by the research initiative Neue Bahntechnik (New Rail Technology) Paderborn, or NBP for short, some years ago. The control technology for the new rail system is supported by dSPACE hardware. The RailCabs are driven by a linear drive similar to that of the Transrapid. The aim is to utilize existing rail track to run automated, driverless cabs for both passenger and freight transportation.

An outdoor test track for the RailCabs was set up at the University of Paderborn in 2003 as part of the NBP research project. RailCabs are driverless, railbound vehicles that are driven and braked by a dual-feed linear drive. The test site includes a 530 m long track on which two RailCabs run at a speed of up to 36 km/h.

The drive is not in the cabs themselves, but on the track, and consists of two independently powered components with rotary field coils:

- The primary is installed along the track, between the rails.
- The secondary is mounted on the underside of the RailCab chassis.

This creates a magnetic field in the primary. The field moves along the rails and takes the RailCab with it.

Power Supply to the Linear Drive

The primary is divided into a total of 84 sections, each 6 m in length. A separate converter with a CANopen interface is assigned to each section. The converters are grouped at four locations along the test track and can be controlled via the CANopen network. No power rails or overhead lines are needed, as energy is transferred to the vehicle when the linear drive is run asynchronously in over-

CANopen

The CANopen protocol is a standard for industrial CAN-based system solutions. It allows both cyclic and event-driven communication between the devices on the CANopen network.

For further information, see www.can-cia.org

synchronous mode. To control the power flow via the drive, the frequency of the traveling wave needs to be regulated dynamically without impairing the slip ratio, which would put the drive out of step. This all makes tough demands on the control system with regard to the data transfer rate, real-time capability, and safety.

The Control and Instrumentation Technology

Each RailCab has an industrial PC (IPC), to which a dSPACE system with two DS1005 PPC Boards and several I/O boards are connected. This performs the entire control of a rail cab for the drive, the active suspension and tilt technology, and the track guidance of the vehicle. The IPC of each RailCab is connected to a host PC in the test site's control station via a WLAN. The IPC is remote-monitored from the control station by means of software called PC-Duo and remote-controlled using ControlDesk. The thrust of each RailCab is proportional to the strength of the magnetic field of the primary and secondary. The reference variables of the primary, consisting of the current and frequency, are therefore transmitted to the CANopen network master via a second radio channel with a serial interface. This distributes the values to the

The RailCab in Outdoor Test Runs	
Weight	1,200 kg
Length	3 m
Height	1.2 m
Width	1.2 m



▲ The RailCab test track with conventional ballasted ties at the University of Paderborn: testing in real-world conditions.

converters for the track sections which the RailCab is currently passing over. As the RailCab travels along, the control systems of the converters on the track are synchronized with one another. This prevents angular errors occurring when the traveling wave is switched from one section to the next, which would result in a gap in the traveling wave. The control system needs to know the current position of the electrical field in the primary, so that the electromagnetic field in the secondary can be set to provide optimum thrust. This prevents situations in which the RailCab suddenly accelerates in the opposite direction.

Synchronization of Real-Time Data

The communication paths via the field bus and radio are integrated into the vehicle control under real-time conditions. A synchronization mechanism was designed for the distributed control hardware on the

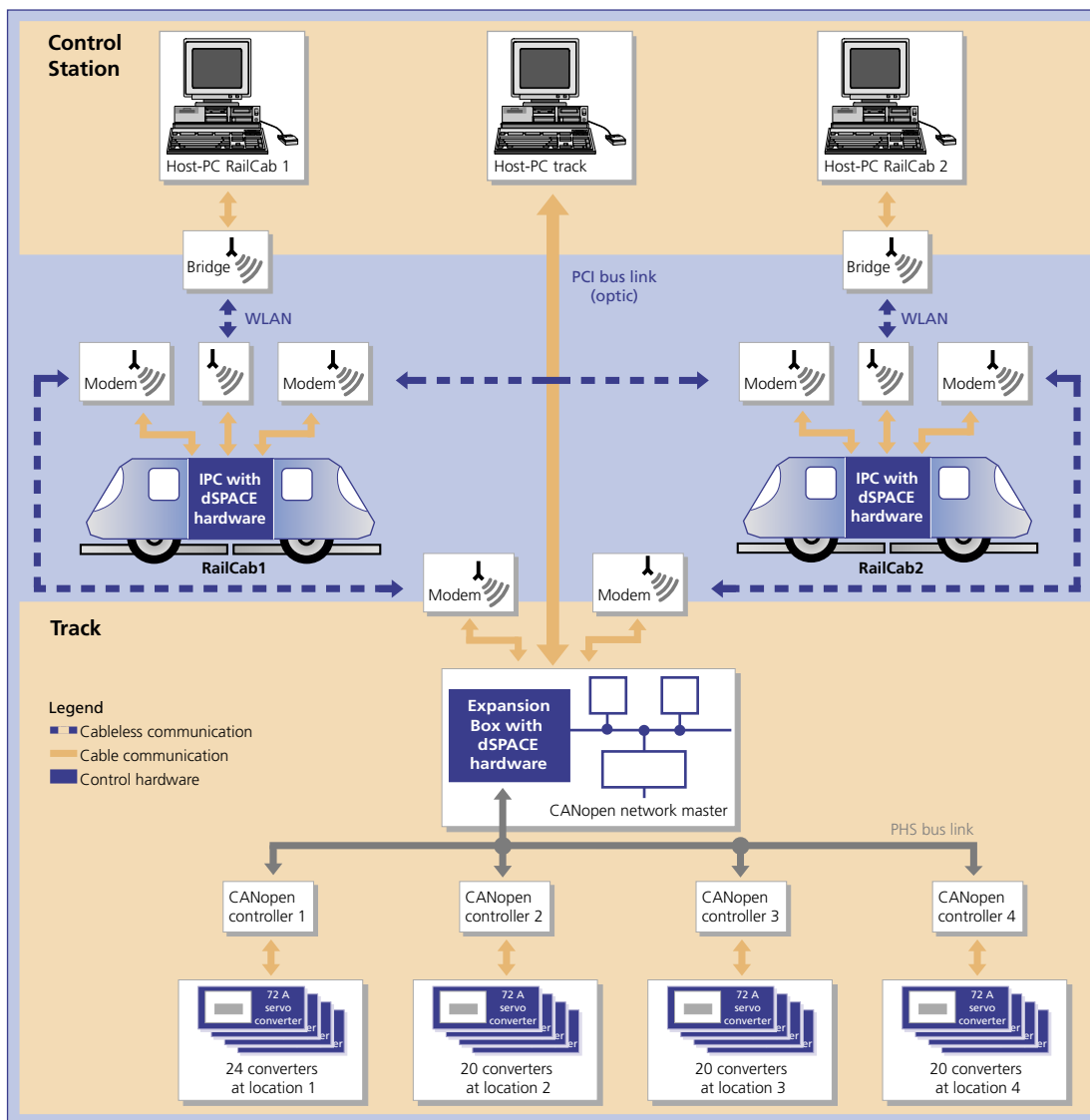
track and in the vehicle to ensure the reliability of the overall system. The synchronization mechanism guarantees that the system will work safely even if there are breaks in radio transmission or data transmission faults – as amply proven by more than two years of constant, successful test operation.

Running 3 RailCabs Simultaneously

The plan is now to extend the existing controls and instrumentation to allow 3 RailCabs to run simultaneously. Communication between the vehicles will play a vital role in ensuring safety.

For further information, visit www.railcab.de.

*Andreas Pottharst
Institute of Power Electronics and Electrical Drives
University of Paderborn
Germany*



◀ Overview of the test site's control and communication technology for autonomous RailCab operation.

Thinking in Architectures

➤ An interview with Hans-Georg Frischkorn

➤ Challenges to the BMW Group and its partners

➤ The future of electrics and electronics

Hans-Georg Frischkorn, senior vice president System Architecture and System Integration at the BMW Group, gave the keynote speech at dSPACE's German User Conference 2004 in Stuttgart. He described his vision of the future of electrics and electronics in vehicles, and the challenges they pose to OEMs and suppliers. Hans-Georg Frischkorn spoke to us about the main issues in his paper.



◀ Hans-Georg Frischkorn, senior vice president Architecture and System Integration at the BMW Group, spoke with dSPACE NEWS.

Let's start with one of the main points of your paper at the dSPACE User Conference. As you see it, how can the industry cope with the increasing complexity and networking of automotive electronics?

H.-G. Frischkorn: Most innovations in vehicles come from the electronics. Many of them are based on intelligent networking of existing functions. To cope with the complexity, and still meet the high demands imposed on innovation and quality, we can leverage two factors. The first is the development processes. The suppliers, and we ourselves as manufacturers, have to get together and work hard on shaping up development processes. The second is open system architectures and standardization, which will allow more reuse of high-quality, tested "components".

"Suppliers and manufacturers have to get together and work hard on shaping up development processes."

What will this look like in practice?

H.-G. Frischkorn: For our joint development of robust and efficient processes, process maturity in software development must be improved fast and systematically, and verification and validation must be intensified in the early phases. Basic system functions and

interfaces need to be standardized to achieve this. We need to be able to integrate and replace functions. Software updates and upgrades must be improved. I'm very pleased to see that standardization initiatives like the FlexRay Consortium and the AUTOSAR development partnership have such wide support from manufacturers and suppliers in the automotive industry. Thinking in architectures is vital. My vision is of improved complexity management of highly integrated E/E architectures, with more reusability and exchangeability of software modules between OEMs and suppliers.

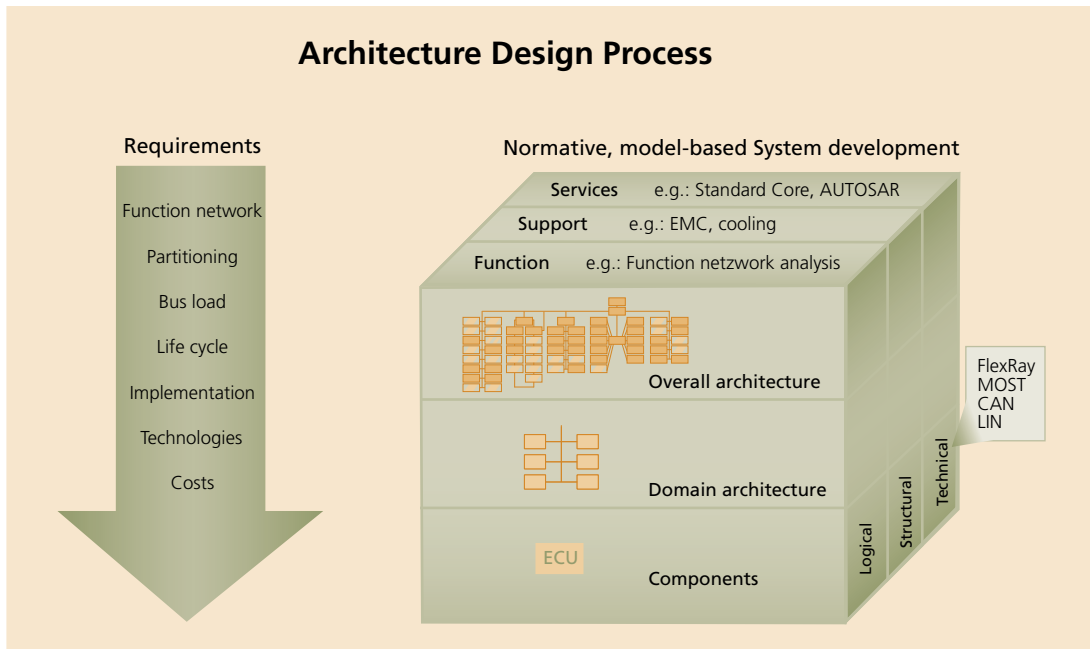
"Thinking in architectures is vital."

What architectures are you thinking of here?

H.-G. Frischkorn: At the BMW Group, we distinguish between the "logical architecture" and the "technical architecture". The logical architecture represents the function network as an implementation-independent description of vehicle functionality. The technical architecture comprises the hardware architecture and the software architecture, including the mapping of the software architecture to the hardware architecture. The logical architecture provides benefits such as reusing functional knowledge across a wide range of model series, and is the basis for evaluating alternatives. Most of all, though, it lets us design software components that are logically and functionally modularized, and thus reusable.

Could you explain your vision of system architecture and system integration?

H.-G. Frischkorn: The system architecture of the future will be hierarchically structured. Its starting point will be individual functions that are logically networked



▲ An integrated development process, and also measures such as providing software and hardware models for early verification of overall functionality are vital for the future architecture design process.

via middleware. Functions will be implemented on electronic control units (ECUs) which will communicate with each other via system busses. Functions with similar requirements and their ECUs will be assigned to domains – for example, powertrain, chassis, infotainment, and safety. Within the domains, the trend will be towards central domain ECUs that integrate several functions, and to actuators and sensors with their own intelligence. There will also be intelligent system services at a domain-independent central point, which will support the operation and administration of functions and ECUs within the domains. In planning system integration, it is important to create comprehensive system architectures in each individual development step at an early point in time. Using system services to create a global administrative view of the vehicle software system will enable manufacturers and suppliers to jointly standardize their development environment.

What are the main elements in the architecture design process?

H.-G. Frischkorn: It is important to see the development process from a system point of view, and not

from a component point of view. In the past, we had a bottom-up view of the architecture design process – the ECUs were there first. In the future, the system development process will be top-down. The focus will be on an integrated development process, and also on measures such as providing software and hardware models for early verification of overall functionality.

“It is important to see the development process from a system point of view, and not from a component point of view.”

What challenges will system integration present in the future?

H.-G. Frischkorn: Currently, 80% of system integration is on the right-hand side of the V-cycle. This is a reactive process. In the future, activities will shift more towards the left-hand side, and even early work on system design will be proactive and integrative. The aim will be to bring integration forward to earlier product development phases. The focus will be on early, validated simulation of the behavior of electric/electronic in-vehicle functions.

You say that systems engineering will be another challenge in the coming years. Could you say something more about that?

H.-G. Frischkorn: Thinking and working in systems – a strongly architecture-centered development workflow, not only for E/E – will be our greatest aid to coping with complexity.

“A strongly architecture-centered development workflow will be our greatest aid to coping with complexity.”

When manufacturers decide on systems, ECUs, and software, will they be looking more at the methods and process quality of the supplier?

H.-G. Frischkorn: Definitely yes – though of course functionality and cost will also have to be right. Suppliers are increasingly realizing that a high level of process maturity, using appropriate methods, is in their own interest if they want to make the grade – even according to conventional decision criteria.

With all these standardization plans, will there still be brand differentiation?

H.-G. Frischkorn: A modular, open software architecture, and standardization of the interfaces between the calibration software layer and the lower software layers, are actually the main prerequisites for differ-

entiated and innovative functionalities for future vehicle generations, and for handling the associated complexity. In addition, standardized interfaces, especially between hardware and software, provide the flexibility to create differentiating vehicle functions and features mainly by software implementation. OEM-independent standards can then be used for the nondifferentiating functions such as operating systems and other system functions.

How do you currently see dSPACE, and what would you like to see in the future?

H.-G. Frischkorn: We see dSPACE as a strong engineering partner, mainly as a system supplier of hardware-in-the-loop simulators and prototyping systems. We appreciate your company’s high level of automotive competence, as demonstrated by your involvement in initiatives like ASAM and FlexRay. For the future, we would like to see greater standardization in dSPACE products, for the reasons I have already stated. Inexpensive, compact solutions for HIL simulators, for mobile use in trials, would be very useful. To improve the tool chain, more use of standardization in areas such as production code generation and calibration, with standardized interfaces, is also desirable.

Thank you for talking to us.



Record Attendance

The conference room was packed to capacity for dSPACE's 4th German User Conference on October 21 and 22, 2004. Around 270 experts from Germany and elsewhere had gathered for firsthand reports on developing software for electronic control units (ECUs) with dSPACE systems – an attendance figure almost double that of the previous conference.

➤ **4th User Conference in Stuttgart**

➤ **dSPACE products a firm fixture**

➤ **Lively exchange of views**



▲ *Filled to capacity: Around 270 participants attended the User Conference.*

As the popularity of the conference clearly shows, there is a great need for events such as this, where experts in a field can meet to compare notes, learn from one another, and quite simply make contacts. One question was a recurrent theme in all the papers and discussions: How can development tools be integrated into the software development process? Numerous answers were presented, which we will sketch briefly below. The keynote speech from Hans-George Frischkorn, the BMW Group's head of System Architecture and Integration, described the challenges he feels process integration will pose for the BMW Group and its suppliers. He also speaks of this in detail in the interview he gave us on pages 16-18 of this issue.

Insights into Development Work

André Strobel from DaimlerChrysler AG kicked off the first series of papers, describing rapid control prototyping (RCP) and hardware-in-the-loop (HIL) simulation for in-vehicle climate control. He also revealed some details of the pilot application with dSPACE's new

hardware platform, RapidPro. Ferdinando Ferrara and Giorgio Catalano from Elasis S.C.P.A. presented the rapid prototyping system for the Alfa Romeo 147 1.9 JTD 16V and discussed the considerable savings in cost and time achieved by means of bypassing and HIL. Speaking as an automotive supplier, Dr. Dirk Nissing from TRW Automotive GmbH argued that simulation methods such as RCP and HIL were indispensable, especially with regard to safety-critical

aspects. Martin Eckmann, Product Manager for Rapid Prototyping Systems, presented RapidPro, dSPACE's new modular hardware platform, and explained the associated software, ConfigurationDesk, which is used for hardware configuration. Georg Schneppe, DaimlerChrysler AG, outlined the history of ASAM, whose results include the MCD 3 interface for applications in which automation systems are coupled with calibration and measurement tools like CalDesk. André Rolfmeier, Product Manager for Calibration and Measurement Systems, briefly described the



▲ *The breaks provided plenty of opportunity for discussions and contacts.*

dSPACE Calibration System and the extended functionality of the current version. He described how it could be used in control design and gave a preview of the next version, CalDesk 1.2.

Time and Money Saved

Hervé Colin outlined the development process at Renault S.A.S., which is currently using 11 simulators to test different combinations of more than 20 powertrain ECUs. He particularly emphasized the generic hardware approach and the user-friendly interface. "HIL-Based Test Processes for Vehicle Electrical Systems with FlexRay Communication" was the topic of Dr. Peter Rißling and Peter Riedesser, BMW AG. dSPACE Simulator and AutomationDesk play a vital role in meeting the quality requirements laid down by BMW. For more details on this paper, see the article on pages 10-11. Dr. Eric Sax of Mercedes-Benz Technology GmbH argued that the processor-oriented use of HIL systems played a decisive role. "You cannot get quality into the ECU by testing late. Testing has to run parallel to the development process," was his view of electronics failures. He continued, "Around 90% of our tests are now being mapped in test drives on the HIL simulator." Mohammad Farid, Ford Motor Company Ltd., showed the successful use of dSPACE tools in carrying out system identification



▲ The exhibiting partner companies were also pleased with the interest shown.

tests. The entire VCT test project (VCT = variable cam timing) was developed and completed within 45 days. Matthias Sendzik from Volkswagen AG explained how the main task of the HIL simulator was currently to support the ESP developers in testing individual systems in the Touareg V8. In future, HIL simulation will be integrated directly into the process for production development. Susanne Köhl, Product Manager for Hardware-in-the-Loop Simulators, dSPACE GmbH, presented solutions to current issues, and discussed the latest trends in HIL simulation.

TargetLink 2.0 in Widespread Use

The use of the new TargetLink 2.0 OSEK module to model and implement event-driven system processes was described by Ulrich Nickel, Hella KGaA Hueck & Co. The paper given by Dr. Werner Bauer-Kugelmann and Ralf Belke described the TargetLink-based development tool chain for production-close embedded rapid prototyping at Audi Electronics Venture GmbH. "The code generated by TargetLink is then loaded to the ECU in the production project one-to-one – quite literally," said Ralf Belke. Tobias Schmid revealed how BMW is using TargetLink 2.0 in production projects for chassis control systems. He praised the resultant time saving and quality enhancement. Michael Beine, Product Manager for TargetLink, dSPACE GmbH, had a special anniversary to announce: TargetLink, the world's first production code generator based on MATLAB®/Simulink®/Stateflow®, celebrated five years of service in the fall of 2004. "When the first version was released in 1999, production code generation was a brand-new technology. It has since become



▲ dSPACE products and new developments on show in the conference exhibition.



◀ *Trying out the tools in the dSPACE DemoCar outside the conference center.*

standard. TargetLink is now used in production projects throughout the world," he continued. To conclude, he gave details of the highlights of TargetLink 2.0, emphasizing further important issues such as process integration and support of software verification and validation.

Conference Exhibition

The special conference exhibition included demos of dSPACE products and new developments. Also on show were exhibits from the following partner companies: OSC - Embedded Systems AG, Softing AG, The MathWorks GmbH, and TESIS. The RWTH University in Aachen, Germany, presented the Formula Student racing car designed and constructed by students. Guido Sandmann, Director of Sales at OSC - Embedded Systems in Oldenburg, Germany, summed up his impressions as follows: "The User Conference was the ideal opportunity to talk with development engineers about new technologies, like those provided by the EmbeddedValidator, and their introduction into the ECU development process."

dSPACE DemoCar Live

There was also a special outdoor attraction: the dSPACE DemoCar. The Audi A4 was constantly surrounded by engineers wanting to try out dSPACE's user-friendly tools in experiments themselves. One of these was CalDesk, the software of dSPACE's Measurement and Calibration System, which is ideal for in-vehicle use as it can be controlled completely via the keyboard of a notebook.

dSPACE Products in the Process

dSPACE products were now a fixed component in the development processes and tool chains of many companies, said Dr. Rainer Otterbach, dSPACE's head of Product Management, in his final summary. The process integration of all systems played a key role in successful development. It was also clear that systematic testing in the early phases would decide the success of automotive software development. As always, dSPACE would respond to these current and future challenges, and work together with customers to further develop the product portfolio.

We would like to thank all the speakers, the exhibitors, and the attendees. The papers are available on our Web site at www.dspace.de/goto?uc_stuttgart



▲ *The evening was the time for diversion – or for continued discussions. A live funk & soul band provided the atmosphere.*

안녕하세요

- **MDS Technology new distributor in Korea**
- **Intensive technical training for dSPACE team**
- **Customers looking forward to cooperation**

... means "Hello from Korea". MDS Technology went into action as dSPACE's sole distributor for Korea on November 1, 2004. The company was appointed with the aim of strengthening dSPACE's presence in Korea. The growing dSPACE team at MDS is committed to keeping Korean customers up-to-date on all that dSPACE has to offer throughout the entire V-cycle.

The company has allocated all the human resources and facilities needed to ensure competent technical advice, training, and support services. The dSPACE team at MDS is an extension of the sales and support forces in Germany, so Korean customers have full access to all the dSPACE engineering resources.

Who is MDS Technology Co., Ltd.?

MDS is a strong partner for dSPACE, and has already made a name for itself among high-tech companies in Korea. Founded in 1994 and now employing more than 130 people, the company is a market leader as a provider of solutions and services for embedded system development in the automotive and telecommunication industries. In addition to distributing complex products from European and American vendors, MDS has expertise in hardware design and has developed its own real-time operating system (VELOS). The company's know-how in real-time operating systems, compilers, and debuggers ideally complements

dSPACE's product portfolio of TargetLink production code generation and CalDesk calibration technologies, giving Korean customers added benefit.

Preparations

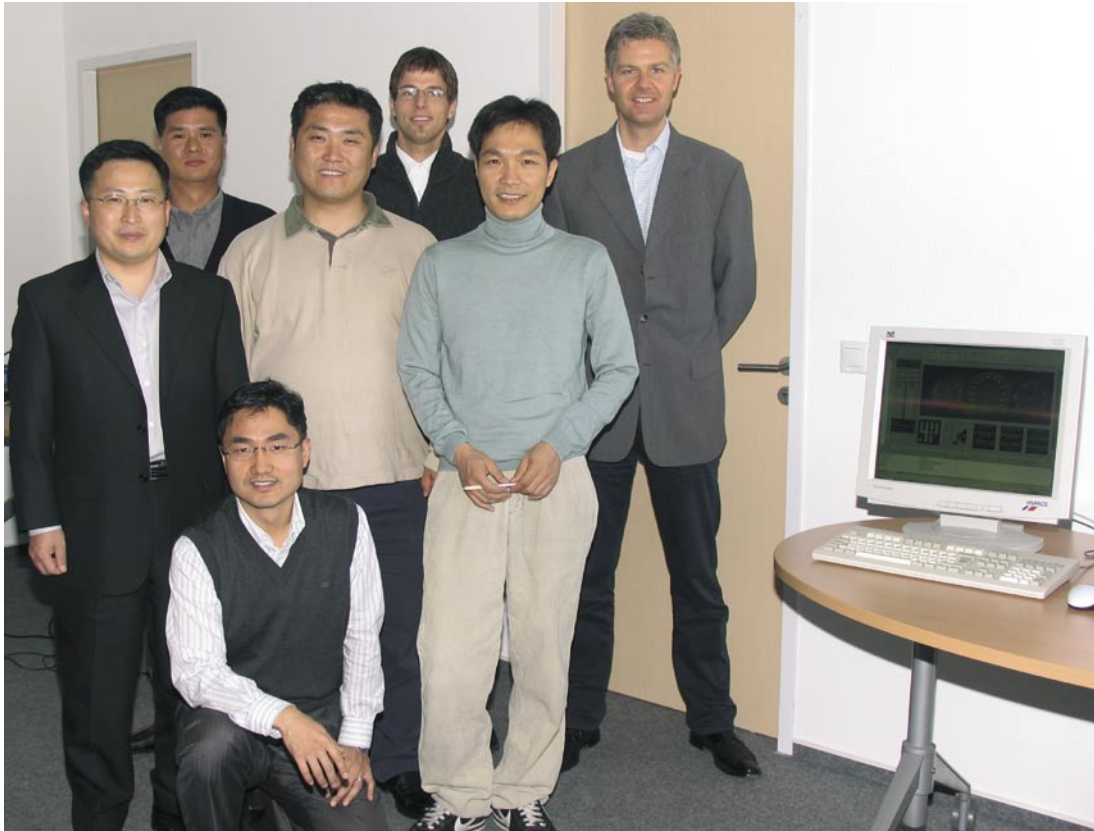
In the run-up to November 1, engineers from MDS technology underwent intensive technical training at dSPACE's headquarters in Paderborn. Cheolhee Kim, application engineer, describes his experiences: *"The introductory course gave us a good overview of the entire dSPACE tool chain and a variety of customer applications implemented with it. The following weeks were spent in in-depth courses, each of them dedicated to a particular topic such as the dSPACE HIL architecture or the dSPACE production code generation technology. What made the long training courses rewarding and dynamic was the large number of hands-on exercises, giving us plenty of opportunity to work with actual systems. We deeply appreciate that all the instructors from the various fields of technology were sincere and ready to share their knowledge."* Sales engineers from MDS also attended the 4th dSPACE User Conference in Stuttgart to learn how our products are being used by customers in Europe.



▲ Customer training given by an application engineer at MDS.

Business Launch

To ensure the business launch ran smoothly, a dSPACE liaison engineer was on-site to provide support during the first weeks. Christian Bauer helped to reinforce links with the engineering and development departments in Paderborn, gave technical



▲ The MDS team: from left to right (back row), Sangheon Lee (Director, MDS Technology), Hyeonho Nam (Marketing Sales, MDS Technology), Jaehyung Choi (Marketing Sales, MDS Technology), Christian Bauer (Sales Engineer, dSPACE GmbH), Changyoul Lee (Application Engineer, MDS Technology), Mirco Breitwischer (Manager Distribution Channels, dSPACE GmbH). Front row: Cheolhee Kim (Application Engineer, MDS Technology).

advice on configuring systems for Korean customers, and accompanied MDS engineers to a number of meetings at Hyundai and Korean automotive suppliers. He attended many fruitful and lively discussions about upcoming projects in which dSPACE tools could be beneficial, and was overwhelmed by people's openness and the interest they showed in dSPACE's products.

Next Steps

MDS will continue to expand the team assigned to distributing and supporting dSPACE products. From February onwards, there will be seminars and workshops to give Korean customers a hands-on impression of the power and usability of dSPACE tools. Please check www.dSPACE.de/goto?mdstec for details.

Warm Welcome from Customers

Chunghi Lee, Senior Research Engineer at Hyundai Motor Co.: *"I feel happy to hear that MDS has taken over the distributorship for dSPACE business. I have enjoyed a good relationship with MDS's people. To support full tool chain solutions from control design to production in the controller development process, MDS and dSPACE will be helpful for our task."*

Wootaik Lee, Ph.D Professor, Changwon National University: *"Good to hear that. I'm sure MDS and dSPACE will make my work easier."*

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Conference in India

➤ **User Conference in Bangalore**

➤ **More than 150 attendees**

➤ **Lively discussion**

The Taj West End Hotel in Bangalore was the venue for dSPACE's Indian User Conference on September 8, 2004. More than 150 engineers from various industries and research fields, users and prospective users of dSPACE systems, accepted the invitation from dSPACE distributor Cranes Software International to learn more about the systems' versatile uses and compare notes with fellow engineers.

A Varied Agenda

Pradeep Kumar, Senior Vice-President of Cranes Software International, welcomed the guests. To start the day,



▲ Pradeep Kumar, Senior Vice-President of Cranes Software International, welcomed the guests at the User Conference in Bangalore.



▲ Intense interest and lively discussion on the part of the audience.

Success due to Speakers and Attendees

Following Dr. Achim Bothe's summary of the day's events, Rajashekhar Rao, Product Manager at Cranes Software International, thanked the speakers for their willingness to share details of their applications with the attendees. He also emphasized the contribution of the attendees, whose active participation had sparked lively discussion with the speakers.

Dr. Achim Bothe, Senior Sales Engineer at dSPACE GmbH, presented new developments in the dSPACE tool chain. In the main agenda, six Indian dSPACE users revealed details of their development work and the solutions they had evolved. To name some examples: Dr. Raja from the Centre for Mathematical Modelling and Computer Simulation reported on a digital active vibration control implementation. Amit Sanglikar, General Electric, described a control implementation for AC/DC power electronics converter, and M. Meenakshi from the Indian Institute of Science in Bangalore presented her hardware-in-the-loop simulator for testing the flight controller of an unmanned aerial vehicle (UAV).



▲ The Taj West End Hotel, venue for dSPACE's User Conference in Bangalore.

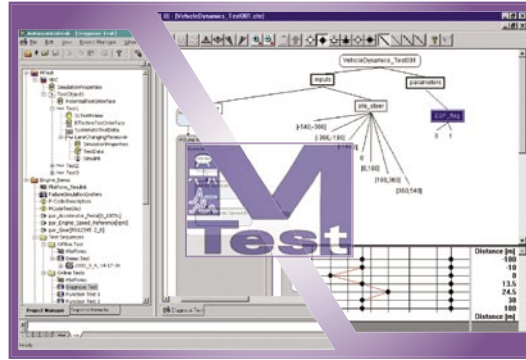
Model-Based Test Management Extended

Systematic, model-based testing during control design is now more convenient with the new version of MTest, which was released at the end of 2004. MTest 1.2 adds new features to test handling, the integration of Simulink® und TargetLink, and report generation.

The major innovations in MTest 1.2 include:

- Capturing internal TargetLink variables
- Capturing execution time and stack size from TargetLink
- Support of model verification blocks in Simulink models
- A new, graphical user interface called CTE Rule Manager for handling CTE rules
- Comparing output signals and reference data in a single plot
- Display of difference signal

MTest lets you execute and manage systematic, automated tests while development is ongoing,



even as early as model-based software or function development. MTest's graphical user interface and integrated Classification Tree Editor CTE/ES let you manage tests without programming knowledge. Different test modes (Simulink and MIL, SIL and PIL with TargetLink) are all supported seamlessly, so you can compare test objects directly in different process phases (back-to-back tests). Early, systematic verification of the function model on the target processor avoids the expense of later corrections and enhances the quality of the entire development process.

MTest

New: Catalog 2005 and Demo CD

Out now: Solutions for Control 2005, our latest product Catalog and Demo CD – with a new layout to make searching and comparing even easier. Around 380 pages bring you details of dSPACE's product range, plus numerous explanations and background information.

The Demo CD is packed full of audiovisual demos to give you a vivid impression of how easy our software is to use. To request the dSPACE Catalog or Demo CD, just tick the appropriate box on your response card, or visit our Web site at www.dspace.de/goto?dspace-news-info



HIL is a Process Issue

➤ **A key issue at dSPACE's German User Conference 2004**

➤ **Hardware-in-the-loop (HIL): Used in the overall development process**

➤ **Automated testing with AutomationDesk and MTest**

What were the key topics in hardware-in-the-loop simulation and testing at this year's 4th German dSPACE User Conference? Susanne Köhl, Product Manager for Hardware-in-the-Loop Simulation, and Dr. Klaus Lamberg, Product Manager for Test and Experiment Software, gave us the details.

Trends and developments in HIL were major topics at the User Conference. What emerged from the discussions?

Susanne Köhl: HIL is a process issue, as the current discussion in HIL shows. The focus is now far more on questions of "process integration" than on the actual technology. HIL is used for testing at all levels of electronic control unit (ECU) development. For example, a growing trend is for suppliers to test functions on ECU prototypes via HIL simulation. OEMs use HIL for testing distributed functions and communication networks. HIL simulation is often performed routinely throughout the vehicle development process. This goes right through to release decisions, where HIL tests are mandatory.

"HIL simulation is often performed routinely throughout the vehicle development process. This goes right through to release decisions, where HIL tests are mandatory."

The technical challenges are now no longer HIL technology in general – we all know that it works – but new in-vehicle technologies, and also the complexity of network test systems.

In the papers presented at the User Conference, both our customers and you yourselves repeatedly stated that manufacturers and suppliers have different responsibilities. What is the actual division of responsibility?

Susanne Köhl: The key question is, "Who tests what?" As Dr. Eric Sax (MB-technology GmbH) put it, it must never happen that network tests show up component failures that the supplier should have detected. This is why OEMs and suppliers have to cooperate ever closer on testing. For example, suppliers use the same test systems as the OEMs, so that they can compare and exchange tests and test results.

Process concepts avoid unnecessary redundancies and increase test case coverage by clearly apportioning responsibilities.

Even single ECUs require a large number of tests, and the figures run into the thousands for ECU networks. Where do the tests come from?

Dr. Klaus Lamberg: Test plans and test specifications are always based on the ECU, function, and system specifications. A large number of further tests come from the test developers' know-how. They just know

what still has to be tested. Some tests are always necessary, for every single ECU, and these are available to all applications. Diagnostic tests are an example. So reusing tests, for example

by means of test libraries, plays a key role.

How does all this affect testing procedures?

Susanne Köhl: There used to be an expert HIL team that did everything – from designing the simulator to creating and performing the tests. Now HIL tests are increasingly automated for greater productivity, and one group looks after test development and execution, while another group ensures that the test systems are available around the clock. The result is a clear division of roles, and the tools that are used also have to reflect this.

What does that mean for software tools, for example?

Dr. Klaus Lamberg: Users need different access routes for different tasks and different user knowledge. For example, AutomationDesk is a new graphical user



*Dr.-Ing. Dipl.-Math. Klaus Lamberg
Product Manager Test and Experiment Software
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interface that has been welcomed by customers who have no specific programming knowledge. On the other hand, there are many developers who still produce test scripts very efficiently using Python. We aim to respond to the needs of these users and give them real added-value support.

What other problems do people have?

Dr. Klaus Lamberg: One key issue is coupling test tools and process tools, for example, connecting AutomationDesk to TestDirector® from Mercury Interactive (see pages 10/11). There is also a growing demand for tests to be exchangeable and platform-independent. Standardization is the answer to this need. We are involved in this, for example, in the IMMOS project (Integrated Measurement, Modeling, and Simulation), alongside partners such as DaimlerChrysler, the University of Paderborn, and others.

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Is test automation restricted to HIL?

Dr. Klaus Lamberg: As Hans-Georg Frischkorn from BMW stressed in his paper: testing is of central importance. Testing must not be viewed in isolation, but as a component in the overall process. This naturally also includes testing in the early function design phase. We have MTest on the left-hand side and AutomationDesk on the right-hand side of the V-cycle, which puts us

in a good starting position, particularly since MTest is currently the only test tool for model-based testing. This means that seamless integration throughout the test process is already possible now.

What challenges will the future bring?

Susanne Köhl: HIL is now successfully established in all fields of application – powertrain, vehicle dynamics, chassis, and comfort. The potential for expansion is now mainly in using HIL simulation at either “end” of the development process: for early function testing and as network testers for system testing. Interaction between OEMs and suppliers regarding HIL is also growing in importance. And of course the process integration issues we have already mentioned.

Dr. Klaus Lamberg: And testing is highly topical at the moment. The pressing HIL issues are now efficient test creation and optimum system utilization, to be achieved by means of automation. In addition, “early testing”, for example, in function design, will soon be enormously important, as early error detection cuts development times and provides an enormous cost saving.

For further information on the papers at dSPACE’s 4th German User Conference 2004, see www.dspace.de/goto?uc_stuttgart

Instant Insights

- **New features of MotionDesk 2.0**
- **Synchronous animation of several simulations**
- **Animation speed can be varied**

Version 2.0 of dSPACE's successful 3-D animation software, MotionDesk, includes major innovations and extra features. The new multitrack mode visualizes several simulations at once, so that developers can watch and compare. The speed of the animation can also be varied. MotionDesk's makers reveal interesting details on using some of its key functions in practice.

MotionDesk at a Glance

MotionDesk visualizes simulations of moving mechanical systems in real time. The motion data is either supplied online straight from dSPACE Simulator or fed in from a Simulink simulation. Simulation data can also be saved and replayed later. Tools are also provided to build the 3-D scenery needed for each simulation. The software's classic application fields are vehicle dynamics, robotics, and flight simulation.

Multitrack Mode

Multitrack mode allows several simulations to be combined in one single animation. The movable objects in an animation are cloned, and each clone is assigned to a track along with a source of simulation data. The method is ideal for reference comparisons

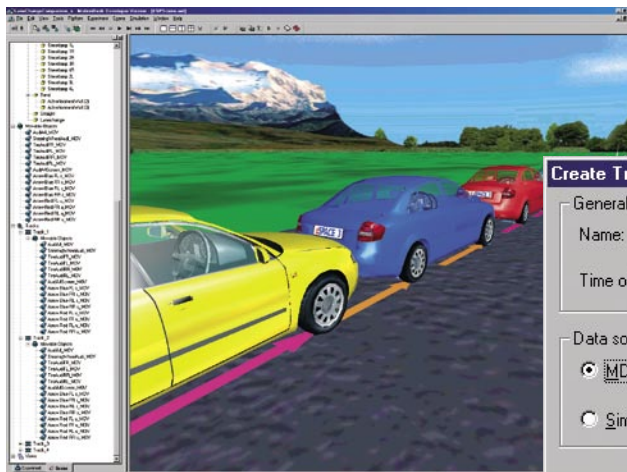
and visual assessment of driving maneuvers. Different vehicle dynamics strategies can be compared with one another in the specification phase, for example, and later on, actual results can be tested against a reference run. The animations are also an ideal way to document results visually, in the form of video files (such as AVI and MPEG4).

Speed Control

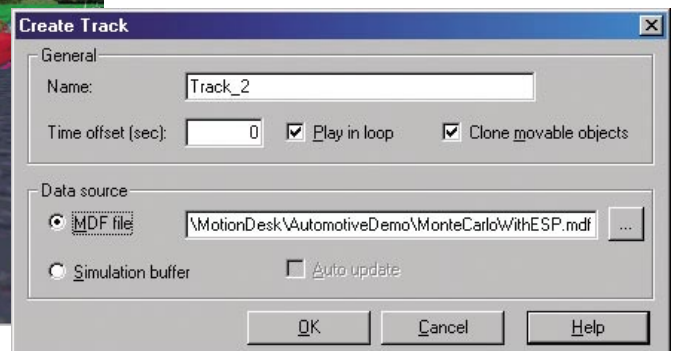
The Motion Player in MotionDesk controls how animations are replayed. The speed can be varied while the animation is playing, so developers can assess important and eventful sequences in slow motion, or fast-forward through less interesting sections.

Technology

Time stamps are now included in the simulation data to support the new functions. Developers have two ways of calling the new function – via the user interface or via the blockset.



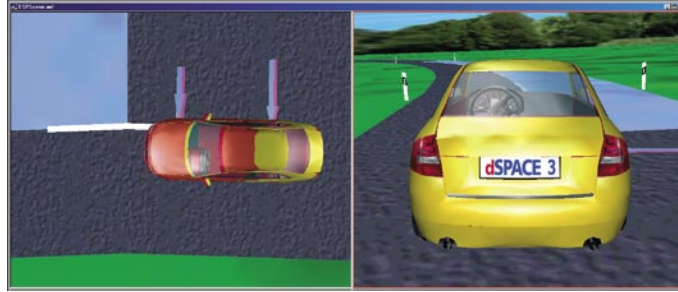
▲ The yellow vehicle was cloned four times by adding four tracks in the Scene Navigator. Each clone was given its own color. The static background was the same in each case.



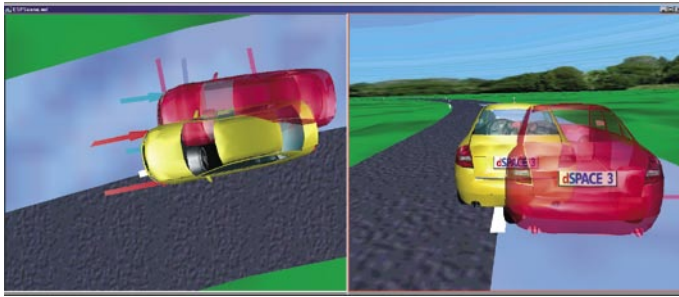
▲ This is the dialog for adding new tracks. The cloned objects are linked either to a stored simulation (MDF file) or to data from the simulation buffer.

Demonstration

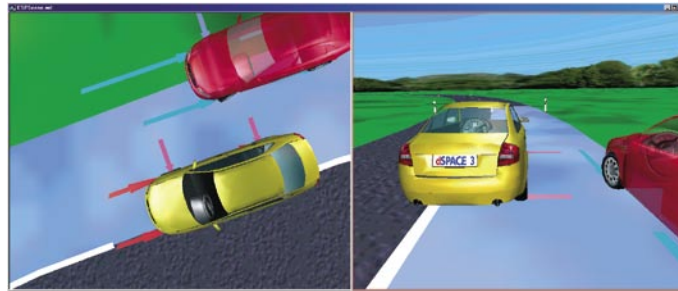
A simulated braking maneuver, performed by two vehicles on a road with a μ split zone, is a convincing demonstration of the kind of instant insight that MotionDesk affords.



▲ MotionDesk can show animation objects from different perspectives. At this stage, the red and yellow vehicles are in the same position.



▲ Both vehicles brake on a road with a varying surface (μ split). The ESP system installed in the yellow vehicle controls the braking force.



▲ In the final stage, the simulation shows that the yellow vehicle's ESP system functioned reliably. The red vehicle, which has no ESP, went off the road.

Statements from Experts

Two members of the MotionDesk 2.0 development team point out some of the software's special features and practical applications: André Klawa, Dipl.-Inf. (FH), who implemented the multitrack mode, and Irina Zacharias, Dipl.-Math., who developed the blockset.

Irina Zacharias: "The blockset implements the moving vehicle. The transformation blocks convert the scalar motion data from the Simulink signals into transformation matrices for 3-D animation. This means you can visualize models in a 3-D world without having to program them."

André Klawa: "The multitrack mode opens up a very interesting application for drive simulators: comparing human driver and machine. Driving maneuvers can be performed manually alongside a recorded simulation, in a similar way to computer games. In practice, this provides on-the-spot evaluations of vehicle dynamics strategies.

"The animation can be triggered by specific events in the simulation. If developers need the simulation results after the vehicle exceeds a specific speed or has driven a specific distance, they can define conditions for recording to start exactly when required."

"With MotionDesk 2.0, real time is guaranteed. We introduced time stamps to ensure that animations really run in real time."

Training Cooperation with IAV GmbH

IAV (Ingenieurgesellschaft Auto und Verkehr) began holding training sessions on dSPACE's calibration software CalDesk in September 2004. With its years of successful activities in the field of calibration, IAV can guarantee real-world training by experienced calibration engineers.



IAV also supported dSPACE in specifying and developing CalDesk to ensure that all practical calibration requirements were covered. The two companies have joined forces to offer training that is precisely tailored to the needs of calibration engineers.

For the dates of training in the first half of 2005, visit www.iav.de/schulungen/caldesk

Ground Breaking

The ground-breaking ceremony for dSPACE's new facility in Paderborn was held on January 18, 2005. Our photo shows the Mayor of Paderborn, the building contractor, and the architects alongside dSPACE's project team, all with spade in hand at the start of construction work. The first building of 5,400 m² will be completed in early 2006.



New Version of CalDesk

The upcoming new version 1.2 of the CalDesk calibration software will be enhanced by a lot of features, for example:



- Variable Editor for creating and modifying ECU description files
- Module for creating virtual or calculated variables based on any kind of formula
- Automatic insertion of bookmarks based on trigger rules
- Polling measurement based on PC timer
- Improved handling of large measurement files
- Improved instrumentation

For information about the release date of Caldesk 1.2, see www.dspace.de/goto?releases

dSPACE Release 4.2

The new dSPACE Release 4.2 will bring you several innovations for your development environment, including the following functions:

- The new RTI RapidPro Control Unit Blockset supports the new RapidPro hardware as an intelligent I/O subsystem (see the article on RapidPro in this issue).
- ControlDesk 2.6 now also takes input from joysticks and steering wheels.
- MotionDesk 2.0 has a new multitrack mode to animate several vehicles simultaneously, showing different simulation runs (for example, to compare a braking maneuver with and without ESP).
- The new RTI BypassBlockset 2.0 enables you to configure bypass interfaces.
- RTI CAN MultiMessage Blockset 1.1 provides new functions for editing messages.
- AutomationDesk 1.2 includes: Report Library, Automation of DTS7, Automation of CalDesk 1.1

For further details on dSPACE Release 4.2, see www.dspace.de/goto?releases

Papers



O. Grajetzky, Dr. F. Schütte, C. Grascher
**"Using TargetLink 2.0 in a Multiuser
 Development Environment"**

Paper download, SAE World Congress 2004:
www.dspace.de/goto?SAE_Papers

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dspace-news@dspace.de – thank you!

Events



EUROPE

6th Stuttgart International Symposium

February 22-24, Stuttgart, Germany

University Campus Vaihingen

Stand #4

<http://www.fkfs.de/veranstaltungen/symposium2005/>

ASIM 2005

March 1-2, Berlin, Germany

TU Berlin, Main Building

<http://swt.cs.tu-berlin.de/asim-sts-05/>

RTS Embedded Systems

April 5-7, Paris, France

Parc des Expositions

Porte-de-Versailles

<http://lrts05.loria.fr/>

Automotive Testing Expo

Mai 31 – June 2, Stuttgart, Germany

Messe Stuttgart, Hall 4

Booth #4420

<http://www.testing-expo.com/europe/>

USA

SAE 2005 World Congress

April 11-14, Detroit, MI

Cobo Center

Booth #1701

<http://www.sae.org/congress/>

Training



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- dSPACE Real-Time Systems
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