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dSPACE NEWS

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TargetLink 2.0 –
More than Just a Code Generator

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New Powerful Prototyping
Hardware at PSA Peugeot Citroën

Delphi Uses TargetLink for
EU Research Project

Feel the Speed:
Power Boost for Hardware

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dSPACE NEWS
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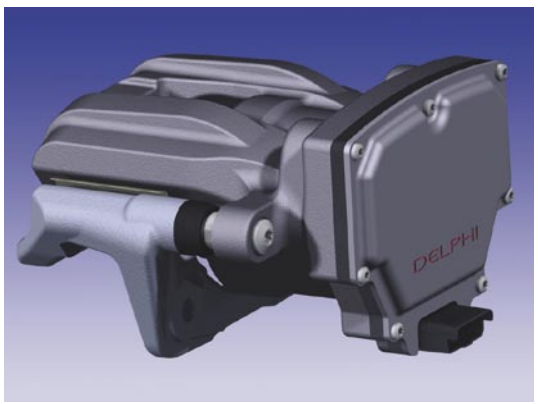


6 *Delphi is participating in the development of a prototype vehicle for a brake-by-wire system, making extensive use of TargetLink, the production code generator.*

8 *PSA Peugeot Citroën is developing highly sophisticated functions for its new engine management concept. dSPACE's powerful prototyping hardware is providing the best possible support.*

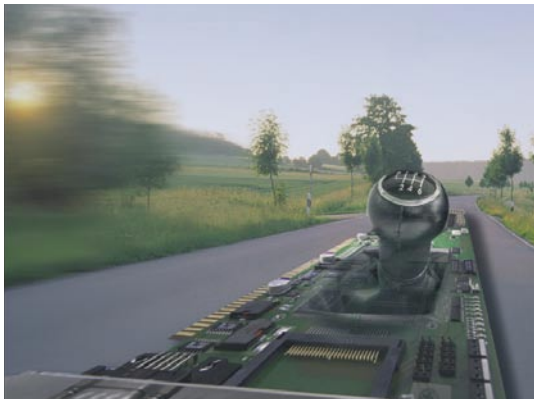
As a good look at the recently released TargetLink 2.0 reveals, our claim that it is "more than just a code generator" (see our Web site) is amply justified. We placed great importance on achieving even more extensive flexibility, and on the ability to integrate into development processes. TargetLink not only does the coding, it is also indispensable in defining and meeting memory and processing time budgets, designing software architecture, keeping track of large models, and assuring quality.

TargetLink 2.0 goes far beyond Version 1.3, as a few simple figures demonstrate: six times the number of source files, three times the number of code lines, almost 300 MB in distribution (previously 131 MB), 1600 pages of online help (previously 750). As could be expected, the testing needed for all this was enormous. Moreover, with numerous modeling options in Simulink®/TargetLink, and the enormous adaptability of code generation, the different possible combinations of code generation have multiplied – providing the flexibility that our customers so urgently need.
Now on the subject of the release date. Many of our customers were surprised that we could not release TargetLink 2.0 much earlier, as expected. They found it very untypical of dSPACE. It is indeed untypical, and we are determined not to repeat it. There were many reasons for this exception to the rule. TargetLink is in very widespread and active use in production projects, and lead customers repeatedly made requests for their ongoing requirements. We had also set ourselves ambitious goals. Our developers quickly realized that to be able to carry out foreseeable further developments, they needed to restructure the core of the Code Generator itself. Estimating the workload for all this, and scheduling the project, was tough. But we've learnt from the experience, and are confident that future versions will appear regularly and on time.

TargetLink 2.0 is taking us into a new phase – not only as regards its capabilities, but also as regards the situational constraints we are working under. Widespread, real-world use in product development imposes its own requirements: for example, on bug reporting and fixing, and on the stability and reliability of further development. We are ready to meet this challenge. Automatic production code generation has come of age. What better proof do you need than that whole departments are reshaping their processes, and going over to this method completely. Or that, as happened recently, entire production development departments at ECU manufacturers buy large batches of licenses at once, because they are convinced this is the way to go.

Dr. Herbert Hanselmann
President

11 *Version 2.0 of TargetLink, the production code generator, comes with a whole range of new features: model-independent data management, OSEK/VDX compliance, and intelligent model scaling.*



12 *Extra processing power for the dSPACE products DS1005, DS1103 and MicroAutoBox sets new standards in rapid control prototyping and hardware-in-the-loop simulation.*

The World´s Largest Industrial Robot

- Queensland University of Technology uses dSPACE Prototyper
- Development of dragline control
- dSPACE DS1104 R&D Controller Board for optimizing the digging cycle

Draglines costing up to $100 million each are used in Australian open cut coal mines. A dragline is like a huge crane which is used to clear and shift overburden, i.e., soil and rocks, with an excavation bucket suspended from its 100-meter boom. The bucket weighs 40 tons when empty and can reach 120 tons when fully loaded. Increasing the productivity of these machines by just a few percent could boost Australia's annual coal mining revenues by hundreds of millions of dollars. Current research by the Queensland University of Technology (QUT) uses dSPACE Prototyper to automate the machine's digging cycle.

The Digging Cycle

A typical dragline bucket scoops up about 100 tons of fragmented overburden in one go, swings it 90 degrees and unloads it to the spoil pile before returning to the dig face. This cycle is repeated once per minute, 24 hours a day, every day of the year. The digging cycle can be optimized by the following improvements:

- Maximizing the payload of the bucket by minimizing material spillage. Spillage is especially caused by the oscillations ("nodding") of the filled bucket when it is lifted off the slope.
- Improving the hoisting time. This can be achieved by controlling the bucket's motion, so that it moves along the ideal, minimum-time trajectory within its workspace.
- Reducing maintenance down time; achievable by reducing dynamic loads during the digging cycle.

Automation of the lift, swing, dump and return phases, which comprise 80% of the overall digging cycle time, will allow optimal bucket trajectories to be performed repeatedly and let the operators concentrate on the more challenging part of the cycle, which is filling the bucket. The result would be a significant productivity increase.

A typical dragline used in open cut coal mines. The experiments with dSPACE Prototyper aim to optimize the digging cycle to increase coal mining output.

The Bucket – A Complex Pendulum

Automation of the bucket movement requires the coordinated control of the individual motor drives for the hoist, drag and swing axes. Also, whilst the bucket is being carried, the aim is to avoid material spillage caused by bucket oscillations. Each phase of the digging cycle requires a different motor control strategy, and the automation system must provide seamless transitions between the control modes.
In this research we concentrated on the control of the bucket's motion in the plane of the boom. The bucket and the rigging behave as a complex pendulum with a variety of dynamic modes, which present a variety of troublesome features for the feedback control of

◀ *The bucket for scooping up overburden: Weight 40 tons when empty, 120 tons when full.*

the bucket carry angle. A frequency response analysis of the in-plane pendulum dynamics of the bucket and rigging shows a system with several sharply defined resonances. Other problems are the non-linear behavior of the bucket-rigging system and the changes in the dynamic characteristics as the bucket moves through its workspace.

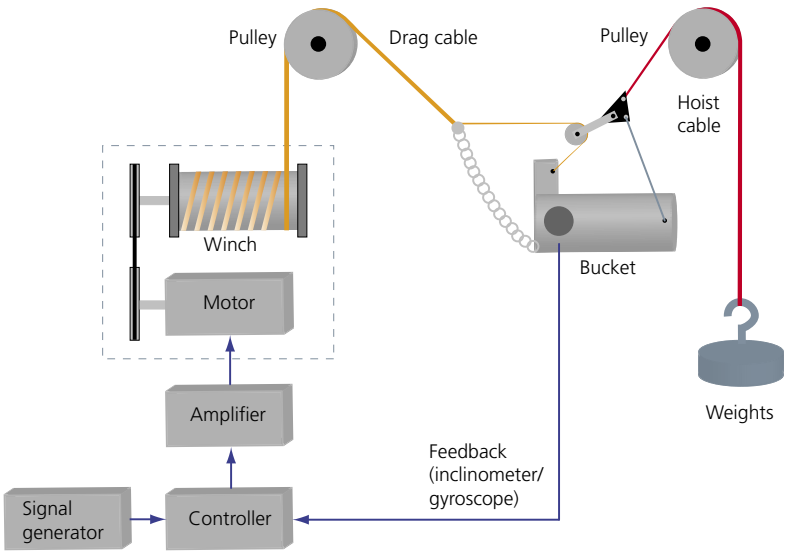
A Model of the Real World

Theoretical modeling, simulation and analysis produced a suitably stable and robust carry angle controller, which was implemented in the laboratory, on a reduced scale (1:20) planar model. A bucket-mounted sensor package has been developed to transmit carry angle data from the bucket to the controller. This package – containing a gyroscope and inclinometer – is a low power consumption, battery-powered unit, hardened for use in a hostile mechanical environment. It is capable of monitoring bucket carry angle, roll angle, and associated angular velocities at a 20 Hz sample rate. This unit interfaces with dSPACE Prototyper and with shaft encoders mounted on the DC motor drives. Postgraduate and undergraduate students were involved in the research work and therefore the control hardware needed to be user-friendly so that all students could participate. Using dSPACE Prototyper with the DS1104 R&D Controller Board along with MATLAB®/Simulink® provided an impressive combination of software and hardware. This allowed us to concentrate on solving the complex control issues without the frustrations associated with the need to create low-level code.

From Experiment to Real World

After the successful experiments with the 1:20 planar model, the next stage of the project is to transfer the control technology to a larger scale (1:7) experimental dragline, capable of full three-dimensional motion. We will switch to a dSPACE AutoBox in order to expand the number of inputs needed for automated digging trials of a fully functional machine.

We wish to acknowledge the assistance given to the research by the Australian Coal Association Research Program: Grant C11043.



Dr. Peter Ridley
Queensland University of Technology
Australia

◀ *The setup of the 1:20 planar model. The aim is to minimize material spillage by optimizing the bucket's motion control. A bucket-mounted gyroscope and inclinometer provide feedback control of the bucket motion.*

The European Research Project BRAKE

- Delphi used TargetLink for a new brake-by-wire system
- Four companies cooperating in the EU research project BRAKE
- Working brake-by-wire prototype car is the result

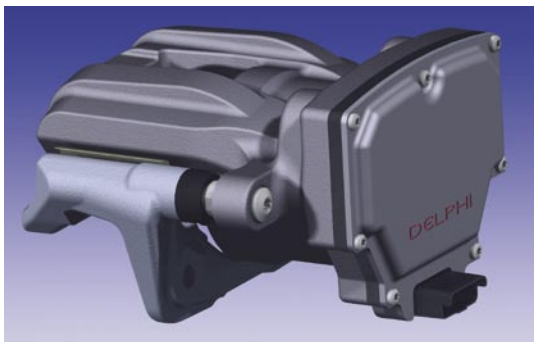
With the goal of developing a safe brake-by-wire system based on distributed control, four companies – the electronic systems manufacturer Delphi, and automobile, microprocessor, and operating system manufacturers – got together in the European Union research project BRAKE and produced a working prototype car which has already been presented in public. This car has a braking system whose hydraulics have been completely replaced by electromechanical components. Throughout the project, Delphi made extensive use of the TargetLink code generator.

The BRAKE Project

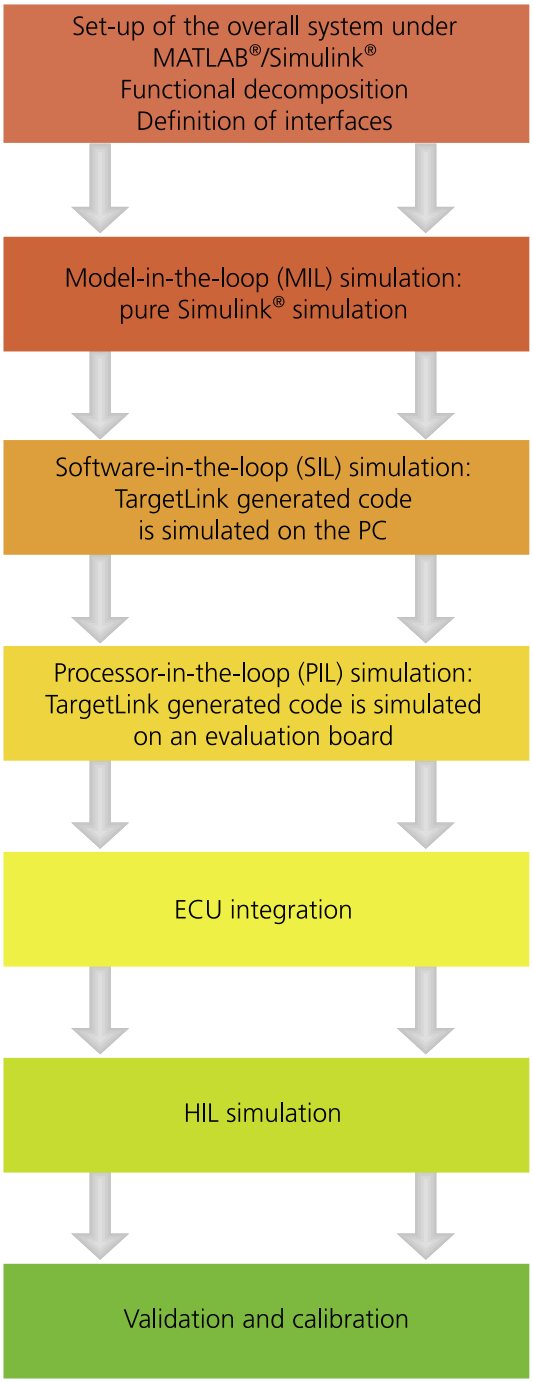
For a number of reasons, automotive companies are trying to replace in-vehicle mechanical subsystems by purely electronic control elements. This will not only reduce the weight of vehicles, but also has potential for a large number of new features which mechanical systems are unable to provide. A further advantage is that the electronic systems can communicate with each other and exchange information that is relevant to safety. The BRAKE project builds on this global control approach and aims at developing an advanced distributed brake-by-wire system in close cooperation between car manufacturers, electronic control unit (ECU) suppliers, electronic device vendors, and tool suppliers. The main objectives defined for the BRAKE project were to create a distributed fail-safe system using a time-triggered communication protocol, to expand an existing OSEK-based operating system to match time-triggered features, and to define an open interface between all subsystems.

Task Distribution and Accomplishments

Each of the four companies in the BRAKE project had its own tasks, which interlinked with those of the other companies. The overall system – consisting of the vehicle model, brake actuators, sensors, communications, electronic control units, control strategy, I/O, and operating system – was put together in one single MATLAB®/Simulink® model. At first, Delphi was given the object code for the vehicle level control in Simulink by the car manufacturer. The embedded real-time systems capable processors on which the control algorithms were implemented, and the necessary time-triggered communication protocol, were supplied by the manufacturer of the microprocessor, while the operating systems manufacturer provided an



▶ Electromechanical brakes are part of the new brake-by-wire system developed in the European Union research project BRAKE. The result of this project, a working brake-by-wire prototype car, was already presented in public and test-driven on the car manufacturer's test circuit.



▲ *Steps of the model-based design process in the EU research project BRAKE.*

operating system in accordance with the OSEK standard and tuned to match the time-triggered implementation of the application software. Delphi developed the remaining parts of the software using TargetLink for automatic code generation. We also performed software integration and finally built the prototype ECUs. At Delphi and at the other three companies, we consider the experience gained with the model-based development process, which allowed us to work so efficiently in parallel, to be a major outcome of this project. And all four companies have benefited by extending our know-how on brake-by-wire systems and on development tools for distributed systems.

The Model-Based Development Process

The development process during the project can be characterized by the steps shown in the figure on the left. As the complete system was in a single Simulink model, the simulation of the overall brake-by-wire system was relatively simple to do. Both Delphi and the car manufacturer provided parts of the overall system model. Delphi contributed the actuator and sensor models, the basic braking algorithm, sensor processing, network communication, and the operating system. The various parts of the model were linked using the Simulink library concept.

Keys to a Successful Project

One advantage of the approach used was that the model-based process allowed exactly the same tests to be run in all the testing steps: model-in-the-loop simulation (MIL), software-in-the-loop (SIL), processor-in-the-loop (PIL), and hardware-in-the-loop (HIL). With TargetLink, the Simulink behavior could be translated into efficient code precisely, quickly and consistently in accordance with the Delphi software process for safety-critical systems. The TargetLink Optimization Module (TOM) for the processor in use was especially helpful, as it ensured optimal implementation. All in all, we at Delphi and the car manufacturer were able to implement 100 % of the control strategies with TargetLink. We believe that the keys to future success are an open architecture for vehicle control software with industry-wide interface standards, model-based development and automatic code generation.

Pascal Chaumette,
Paul Degoul
Delphi Automotive Systems
France

Advanced Prototyping

- dSPACE Prototyper for new engine control concept
- System for full-pass engine control
- Power and scalability for the future

For many years, PSA Peugeot Citroën used a self-developed rapid control prototyping tool, partly based on dSPACE hardware, to prototype new engine control functionalities. Then a new engine control concept with highly complex time processor unit functionalities called for a new prototyping tool offering even more performance. The dSPACE prototyping standard hardware provides the power to tackle the new tasks and at the same time offers scalability for future projects.

An engine controller is a very complex system, in which some calculations are time-based, and others are angular-based. Angular-based computation is very important since the injection and ignition pulses are defined to occur at certain angle positions of the engine. The engine's position and speed are calculated from the information coming from the crankshaft and camshaft sensors. The time processor unit's job is to calculate the position and the speed of the engine and then to correctly generate the injection and ignition signals at the right angle positions, at the right times, and taking into account the acceleration and deceleration of the engine.

When we decided to acquire a new prototyping tool that would handle the new engine control concept, the following requirements had to be met:

- Time processor unit (TPU) functionality (crankshaft/camshaft synchronization, multiple ignition and injection pulses) for up to 6 cylinders
- Knock signal acquisition and fast acquisition (up to 50 kHz) of relevant engine signals
- Compatibility with the working processes at PSA Peugeot Citroën, for example, full compatibility with MATLAB®/Simulink®
- Flexible hardware that will cope with whatever requirements the future may bring
- Signal conditioning for interfacing the real-time hardware and the engine

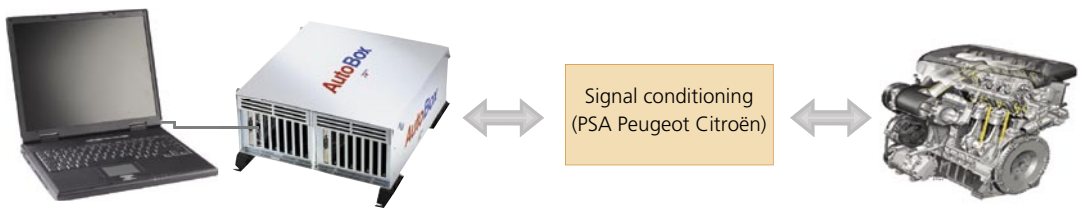
Our former prototyping tool was developed in-house, but we did not want to do that this time. Thus, we decided to consult 4 companies, specifying the above requirements. It is important to note that there was no specific requirement concerning the hardware solution. Solutions like VME-, CompactPCI, and dSPACE-based hardware were among the options, but none of them was specified as mandatory.

The Decision for a New Prototyping Tool

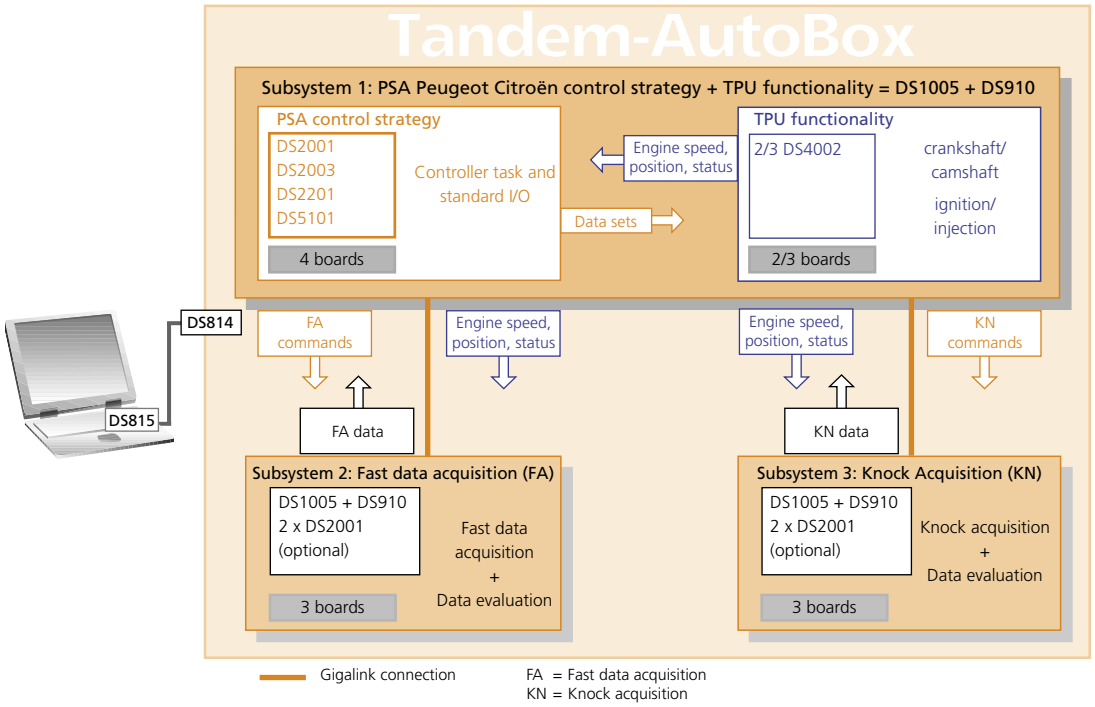
Finally, we decided on the dSPACE hardware because of its power and scalability, which we felt would be useful in future projects. And it met our requirements within budget.

The real-time hardware configuration is based on the dSPACE modular hardware in multiprocessing mode:

- One subsystem (mainly based on one DS1005 PPC Board and several DS4002 Timing and Digital I/O Boards) for the heart of the engine control: TPU functionality like ignition, injection, and cranking; and control strategy by PSA Peugeot Citroën
- One subsystem (based on one DS1005 PPC Board and several DS2001 High-Speed A/D Boards) for fast acquisition of relevant engine signals
- One subsystem (based on one DS1005 PPC Board and several DS2001 High-Speed A/D Boards) for knock signal acquisition



▶ *The rapid control prototyping system for full-pass engine control.*



▲ *The modular hardware system with multiprocessing configuration is the core of the advanced rapid control prototyping system.*

A multiprocessor system was chosen for the project because:

- With the fiber optic communication module DS910 running at 1.25 Gbit/s between the processor boards, we have high performance for exchanging data between the subsystems.
- The multiprocessor hardware provides very good modularity: adding or removing one of the subsystems is straightforward.
- While the main functions execute on the master processor with a sampling time of up to 100 µs, intelligent I/O subsystems perform the acquisition tasks with a sampling time of up to 16 µs.

The entire real-time hardware configuration is based on standard dSPACE products. No further hardware development was needed, which was important to limit the cost and the risks.The signal conditioning hardware was developed by PSA Peugeot Citroën.

Software Development Adjustments

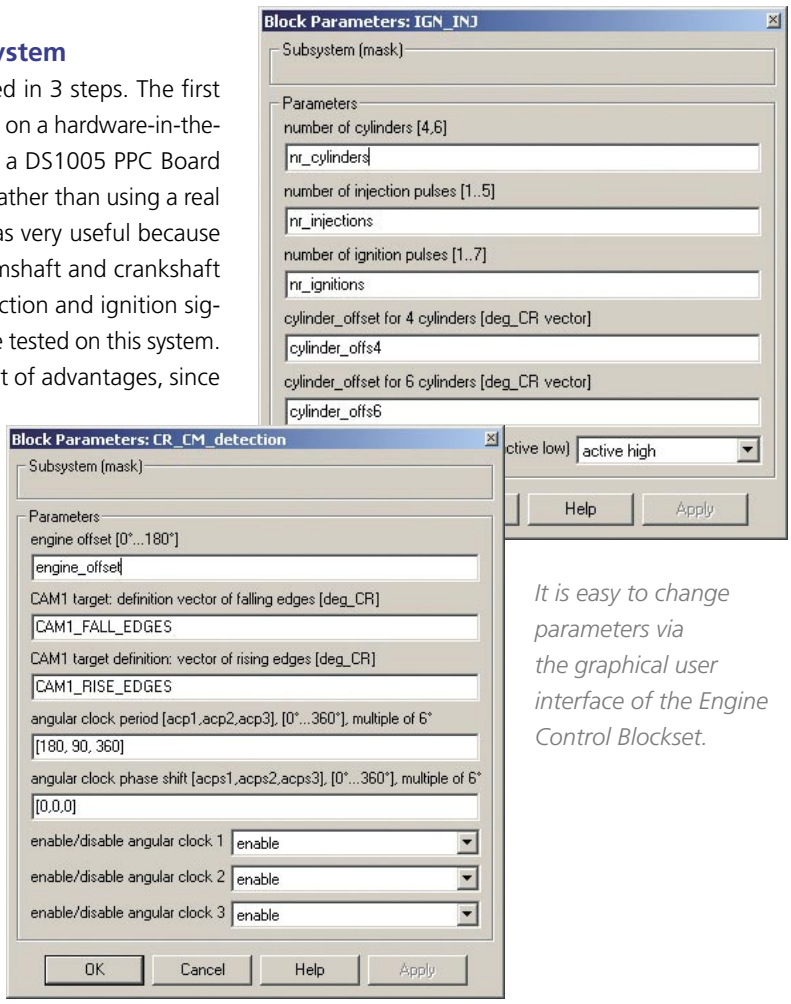
Only software development was necessary to integrate some specific requirements in the Simulink model, by means of S-functions written in C code. These included the TPU functionality on the DS4002 Timing and Digital I/O Boards and knock and fast signal acquisition on the DS2001 High-Speed A/D Boards. These engineering tasks were performed by dSPACE GmbH in Germany and by dSPACE Sarl in France. Although theoretically, we could do this ourselves at PSA Peugeot Citroën, we preferred to ask dSPACE because of their expert knowledge of I/O board programming.

All the TPU functions specifically developed for us can be conveniently parameterized by means of a comprehensive Engine Control Blockset, which provides a graphical user interface to the C functions directly in the Simulink model. It is thus very easy to change parameters like the shape of the camshaft or the number of injection or ignition pulses per cylinder. It also allows us to optimize the hardware configuration: depending on the requirements for different engine control projects, it is possible to use 1, 2 or 3 subsystems, so the costs are scalable. It is even possible to scale the first subsystem (4 or 6 cylinders) by removing some boards and selecting the appropriate option in one of the Blockset dialogs.

Validation with a Hardware-in-the-Loop System

The development was validated in 3 steps. The first step was carried out by dSPACE on a hardware-in-the-loop (HIL) simulator (based on a DS1005 PPC Board and a DS2210 HIL I/O Board), rather than using a real engine. The DS2210 board was very useful because it allows the generation of camshaft and crankshaft signals and the capture of injection and ignition signals. All the functionalities were tested on this system. Using an HIL simulator has a lot of advantages, since it allows:

- Testing the TPU functionality implemented in the Engine Control Blockset in real time without risking damage to a real engine
- Configuring tests with a lot of flexibility, thanks to the DS2210's capabilities and to ControlDesk
- Performing systematic tests using ControlDesk TestAutomation (now replaced by AutomationDesk)



It is easy to change parameters via the graphical user interface of the Engine Control Blockset.

Finally, we performed the two last steps: Running the tests on our own test bench followed by successful tests on a real engine, to study the effects of its actual environment (noisy signals, for example).

Ready for Future Projects

The new rapid control prototyping system allows us to develop advanced engine functionalities – now and in future projects.

Natalia Lestrée, Laurent Genelot
PSA Peugeot Citroën
France

Highly complex TPU functionalities for gasoline direct injection are integrated in the new engine control concept at PSA Peugeot Citroën:

- Multiple injection (up to 5 pulses) and ignition (up to 7 pulses) for up to 6 cylinders
- 0.1° resolution
- Engine speed range: 40-10,000 RPM
- Pulse overlap management
- Knock and fast signal acquisition (~20 signals up to 16 µs sampling time)
- Full compatibility with MATLAB/Simulink

TargetLink 2.0 Released

Version 2.0 of dSPACE's production code generator TargetLink was released at the end of April. TargetLink 2.0's numerous innovations make automatic code generation even faster, easier, and more flexible.

More Than Just a Code Generator

It is not only TargetLink 2.0's increased number of options that make it stand out from its predecessor. Other innovations ensure that it is ready to meet the production code generation challenges of the future. Increasing the flexibility of production code generation and enhancing the ability to integrate into development processes were two of the key objectives in its development.

For example, TargetLink 2.0 provides a freely installable blockset that lets developers work with TargetLink models without a TargetLink license.

For more details on TargetLink 2.0 plus basic information on the subject of automatic production code generation, visit our Web site at *www.dspace.de*

The site also provides an online demo that will give you a good impression of automatic production code generation using TargetLink.

TargetLink 2.0

New in TargetLink 2.0

OSEK/VDX Compliance

Operating system objects are available at block diagram level. For example, you can set alarms and define tasks without leaving the block diagram you are in.

dSPACE Data Dictionary

The dSPACE Data Dictionary ensures consistent, model-independent data management and makes it easy to use the data and information in models.

Extended Autoscaling

The automatic scaling of models by the worst-case method drastically cuts the time needed for fixed-point scaling. Plant models and stimulus signals are no longer required.

Freely Installable TargetLink Blockset

The new, freely installable blockset lets developers exchange models with one another without needing a TargetLink license.

... And a Lot More

For detailed information, please refer to *www.dspace.de*.

Feel the Speed with dSPACE

- More processing power for a lot of PowerPC-based boards and systems
- New technology for hardware-in-the-loop simulation (HIL)

We have boosted the performance in the DS1005 and DS1103 boards, and MicroAutoBox. The PowerPC-based boards and systems have the fastest available processor in the PowerPC family. The new DS1006 Processor Board uses new technology: the AMD Opteron™ processor, also the fastest in its family. These innovations set new standards for boards and systems in rapid control prototyping and hardware-in-the-loop (HIL) simulation.

MicroAutoBox

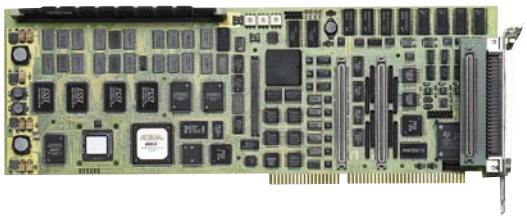
MicroAutoBox lets you test and analyze the functions of an electronic control unit (ECU) directly in the vehicle. You can connect a notebook to change parameters in real time while the test is running. Its compact design, robust construction, and tested quality make MicroAutoBox ideal for this purpose. The system successfully withstood up to 5 g sine-sweep vibrations between 5 and 200 Hz, and impacts of up to 100 g.

To make rapid control prototyping even faster, MicroAutoBox now has an 800-MHz PowerPC processor. This means it is ready to meet the function development challenges of the future, for example, in applications such as x-by-wire and engine management. The volume of data to be processed is also growing dramatically due to the greater bandwidths of new bus systems (for example, FlexRay with 10 Mbit/s), and the increasing number of sensors and actuators installed in vehicles.

MicroAutoBox	
Executing the F14 Simulink demo model	1.4 µs
Sampling rates for models, including digital I/O	Up to 330 kHz
Sampling rates for models, including analog I/O	Up to 110 kHz

DS1103 PPC Controller Board

Installed in a PC or an expansion box, the DS1103 PPC Controller Board is used to test control functions in the laboratory or in a vehicle. With its new

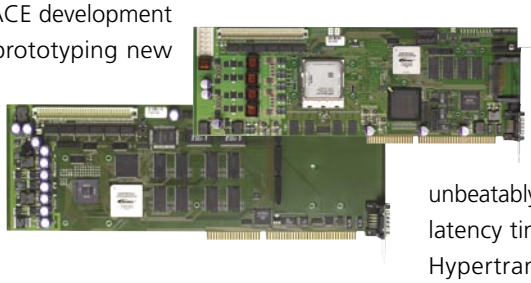


933-MHz PowerPC processor, the board is now up to 8 times as fast, depending on the application. The DS1103 is used in areas such as robotics and active reduction of actuator noise. Its digital signal processor makes it ideal for drives applications. It has also been used to control electromagnetic valve actuators.
The DS1103 offers a broad selection of I/O interfaces, with connection options for incremental encoders, outputs for three-phase PWM signals, and CAN and serial interfaces. The application memory has been increased to 32 MB, and can now handle larger applications. In addition, the new 16-bit A/D converter cuts conversion time from 4 µs to 1 µs. High processing power and fast I/O are vital to applications involving large numbers of actuators and sensors, and complex models (algorithms).

DS1103 PPC Controller Board	
Executing the F14 Simulink demo model	1.2 µs
Sampling rate for a PID control loop, including I/O	300 kHz

DS1005 PPC Board

The DS1005 PPC Board is one of the cores for dSPACE's modular hardware. It is equipped with the fastest available processor from the 750GX PowerPC family from IBM, and has a 1-MB level 2 cache with additionally optimized access. The board is the heart of many dSPACE development systems for prototyping new ECUs and for hardware-in-the-loop simulation. The DS1005 PPC Board provides the computing power for modular real-time systems, and also functions as an interface to the I/O boards and the host PC. With a 933-MHz PowerPC, the board is now up to 3 times faster, depending on the size of the real-time model. Performance can be boosted even further by linking up to 20 DS1005 PPC Boards in a multiprocessor system. Old and new DS1005 boards can be combined in the same multiprocessor system. Programs and models compiled for the older version run on the new board without modifications.



DS1005 PPC Board	
Executing en-DYNA® (engine model from TESIS), including I/O and CAN restbus simulation	0.16 ms

DS1006 Processor Board

The DS1006 Processor Board is a new, alternative core for modular hardware, and the world's fastest solution for real-time development systems. The new processor hardware is based on the AMD Opteron™, which can handle any future challenges, such as extremely complex HIL simulations in ECU networks. The hardware is considerably faster than solutions based on conventional PCs, as it provides unmatched processor power, plus AMD Hypertransport™ technology for unbeatably fast access to I/O hardware with minimum latency times. Unlike standard PC interfaces, AMD Hypertransport™ allows direct access from the processor to the I/O and vice versa. This optimum combination of state-of-the-art components ensures extremely low execution times. Until now, large simulation models had to be distributed across several processors. Now they can often be executed at the desired sampling rate on one processor – an obvious cost saving. With its x86 technology and ability to create multiprocessor systems, the hardware is ready to face any conceivable future challenge.

DS1006 Processor Board	
Executing en-DYNA® (engine model from TESIS), including I/O and CAN restbus simulation	0.15 ms
Executing ve-DYNA® (vehicle dynamics model from TESIS), including I/O and CAN restbus simulation	approx. 0.15 ms

MicroAutoBox
DS1103 PPC Controller Board
DS1005 PPC Board
DS1006 Processor Board

Overview

MicroAutoBox

- Real-time system for fast rapid control prototyping
- Interfaces to CAN, LIN and FlexRay
- Compact, stand-alone system for in-vehicle use

DS1103

- Versatile controller board for rapid control prototyping
- Large selection of interfaces
- Increased I/O speed and precision

DS1005

- For applications with tough I/O requirements
- Minimum latencies, for example, for very low sampling times
- Can be networked to create multiprocessor systems

DS1006

- Extremely high performance, for example, for very processing-intensive real-time models
- Ideal for use in the laboratory, for example, automotive hardware-in-the-loop simulation
- Can be networked to create multiprocessor systems

Bypassing with Extras

- RTI Bypass Blockset for efficient function design
- Powerful XCP on CAN interface
- Bypassing gives automobile manufacturers the competitive edge

The Real-Time Interface (RTI) Bypass Blockset for MATLAB®/Simulink®/Stateflow® lets software developers concentrate on designing functions for electronic control units (ECUs). The blockset's user interface makes it easy to configure the bypass interface, and to select the ECU function to be bypassed and the variables to be transferred. dSPACE is the first to provide a complete and seamless solution for bypassing via XCP on CAN (the measurement and calibration protocol standardized by ASAM) with its own ECU service. Special synchronization options and safety mechanisms are also included.

Bypassing for Differentiation

To survive in the automobile market, manufacturers have to offer their customers new models with extra safety, comfort, and economy, that are also fun to drive. Differentiation is the name of the game. So manufacturers need to be able to adapt ECU software flexibly themselves, without depending on their ECU suppliers. The bypassing approach meets this need. Only selected parts of the ECU code are transferred to the prototyping system, which is far less work than developing a new ECU from scratch. Input and output signals can be changed quickly on the prototyping hardware, particularly with service-based bypassing, in which the C code services are compiled only once in the ECU code, and then linked. Moreover, the services have mechanisms for ensuring data consistency and safe handling when errors occur.

Powerful Bypass Interfaces

dSPACE supports several interfaces for service-based bypassing, for example, XCP on CAN and dual-port memory (DPMEM). There are special dSPACE services for both these interfaces. The services can be configured from the RTI Bypass Blockset. dSPACE also provides "conventional" address-based bypassing. In the near future, upcoming processor architectures and high-end applications will require completely new bypass concepts, especially if an external data or address bus is no longer exclusively available. dSPACE will make soon bypassing accessible to processors with on-chip debug ports via the Generic Serial Interface (GSI), and even support simultaneous bypassing and calibration. Such solutions can be based on established interfaces such as Nexus, NBD/AUD and JTAG/OCDS.

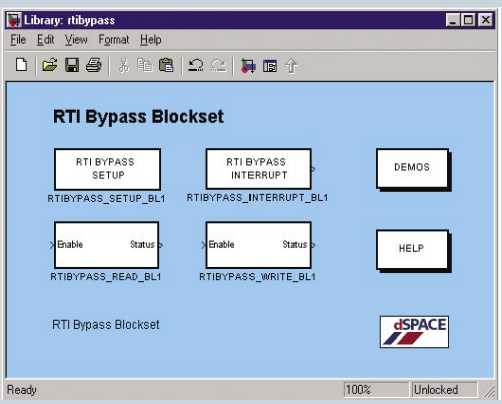
For more information:
www.dspace.de/goto?bypassing_extra

RTI Bypass Blockset

The RTI Bypass Blockset is an add-on for Real-Time Interface (RTI):

- Fast configuration of bypass interfaces and function preparation
- Service-based bypassing via dual-port memory (DPMEM) or XCP on CAN
- Easy importing of variable description files in the ASAM-MCD 2MC (ASAP2) format.
- Function-based view and filter options for handling large files

For more information, visit
www.dspace.de/goto?rtibypass



Formal Verification

OSC - Embedded Systems AG produces innovative testing products for the model-based design process. In cooperation with dSPACE, OSC - Embedded Systems has developed Embedded*Validator*, a powerful tool for the automatic validation of Simulink®/Stateflow® models, based on TargetLink-generated C code. The tool fully supports Stateflow charts and a wide selection of Simulink and TargetLink blocks for open-loop control engineering. Model validation enables engineers to detect errors early in the development process, which in turn cuts development time and costs, and enhances the quality of the models.

Model Validation

"The customer started his car, which has the new automatic transmission. He put it into reverse, and the car suddenly shot backwards at speed."
As reports like this show, embedded control systems that do not work properly can have grave consequences in everyday life. Unexpected situations that crop up in the functional behavior of complex electronic control units (ECUs) urgently need testing. Frequently, however, they are not given the necessary attention because development times are too short. Such unexpected error situations can be found by means of model validation using formal verification methods. The tool developed by OSC - Embedded Systems checks models for specified functional properties. The methods are mathematically complete, so engineers have 100% feedback on whether a model fulfils its functional specifications under all conditions. If it does not, the executable specification violates the requirements. Or to put it another way: An error has been found in the ECU model.

Embedded*Validator*

Major automotive companies also cooperated on bringing Embedded*Validator* up to product level. DaimlerChrysler supported the proof of concept as part of a prototype project. Continental, Hella and Volkswagen also helped to ensure that the resulting tool meets industrial requirements right from the start. Easy-to-use patterns are employed to formulate the rules that a model must always comply with. The model is then analyzed completely automatically. Embedded*Validator* supports the formal validation of rules and also makes the following analyses:

- Are all variables used within their defined ranges?
- Can all the states of the system be reached?
- Can state configurations be reached?
- Does the model fulfil invariant properties?
- Does the model fulfil temporal logical properties?

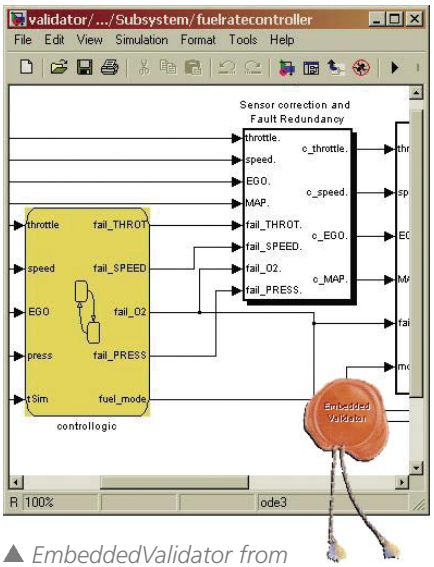
Embedded*Validator* uses C code generated by TargetLink to analyze and validate models that are based on Stateflow charts and on subsystems with a specific selection of blocks. The results of validation therefore apply to both models and C code. For information on the availability of Embedded*Validator*, visit *www.osc-es.de/products/en/embeddedvalidator.php*

Summary

Embedded*Validator* for TargetLink finds errors very early in the design process, and drastically reduces the cost of bug fixing. The maturity level of specification models is considerably enhanced. Downstream design phases, particularly automatic production code generation, also benefit.

Dr. Udo Brockmeyer,
Guido Sandmann
OSC - Embedded Systems AG
Germany

- **Automatic model validation from OSC - Embedded Systems**
- **Correctness of Simulink/Stateflow models**
- **Based on TargetLink-generated code**



▲ *EmbeddedValidator from OSC - Embedded Systems AG*

Embedded*Validator* (OSC - Embedded Systems AG)

Successful Implementation: ASAM-MCD 3

dSPACE has long been a member of ASAM e.V., a consortium for standardizing automation and measurement systems. Through its membership, dSPACE supports the definition of new standards such as the recently issued ASAM-MCD 3, an object-oriented API interface. Jobst Richert from dSPACE was spokesman for the working group during the development of the standard and project manager of the successful pilot implementation. We spoke to him about the new standard, and also to Michael Paulweber from AVL List GmbH and Georg Schneppe from DaimlerChrysler.

- **MCD 3: A new standard from ASAM**
- **Allows integrated measurement, calibration and diagnostic (MCD) solutions**
- **dSPACE closely involved in its development and implementation**

▲ *Jobst Richert, Section Manager Experiment Software at dSPACE.*

Why was the old, familiar ASAP3 interface no longer sufficient?

Jobst Richert: The ASAP3 interface had functional deficits. An RS232 interface linked conventional test bench automation systems with calibration systems, and its low data throughput was often inadequate. When the automation system was connected to a measurement and calibration (MC) system, double data storage was required, once for each system. There was a high risk of inconsistency. On top of that, ASAP3 did not allow synchronous data acquisition. This meant that values could not be mapped continuously.

What are the advantages of the new MCD 3 standard?

Michael Paulweber: The disadvantages of ASAP3 have been eliminated. MCD 3 allows synchronous data acquisition and central data storage, and as the "D" for diagnostics says, it supports diagnostics for electronic control units (ECUs). MC tools and D tools can now be connected in exactly the same way. This means a reduced implementation workload for tool manufacturers like AVL List GmbH and dSPACE.

Jobst Richert: The tools can be supplied to customers sooner and are less expensive to integrate. The COM/DCOM Reference Implementation enables developers to use either the complete tool, or just a core without its own user interface.

What are the application areas for MCD 3?

Michael Paulweber: MCD 3 is designed for applications in which automation systems and MC tools are combined, for example, for adjusting controller parameters in ECUs. ECU diagnostics are performed by a remote-controlled diagnostic connection. The integration of MCD 3 into the AVL PUMA Open automation system was compatible with the ASAP3 interface. The first reference implementation of the MCD 3 interface makes it available to all scripting applications, for example, from MATLAB® or Microsoft Excel.

◀ *Michael Paulweber, Head of Development Testbed Automation and Control Systems at AVL List GmbH, Austria.*

Who was involved in producing MCD 3?

Michael Paulweber: The main automobile manufacturers involved were BMW and DaimlerChrysler, who supported the project by formulating clear requirements and providing ECUs and databases. The MC tool suppliers involved were Vector Informatik, ETAS, dSPACE and AFT, and the D tool suppliers were Softing, DSA and T-Systems. IWQ acted as a specialist for specification and documentation, and was the central certification body. At AVL List, we were involved as test bench developers.

How mature is MCD 3?

Georg Schneppe: From the very beginning, in the prototyping phase, the ASAM-MCD 3 working group examined a large number of application cases, and performed intensive testing. DaimlerChrysler carried out several cross tests between AVL PUMA Open, CalDesk, and INCA and CANape. A large cross-test workshop in early May completed the project. DaimlerChrysler provided ECUs and ECU description files for the workshop.

▲ *Georg Schneppe, TCU – Basic Functions/Methods & Tools at DaimlerChrysler.*

When will the first MCD 3 products be available?

Jobst Richert: dSPACE is integrating the connection to COM/DCOM based on MCD 3, in Version 1.1 of the CalDesk calibration software. Integration into AutomationDesk will be available shortly after that, with slightly extended connection options for Softing's Diagnostic Tool Set.

Michael Paulweber: Our AVL PUMA Open will support MCD 3 from the summer onward. AVL CAMEO and AVL IndiCom will follow in the fall. Other tools also support the new standard, for example, the Diagnostic Tool Set from Softing.

What did you learn during the project?

Michael Paulweber: We realized very early on that we needed to run a pilot project before releasing the standard. dSPACE managed the pilot project and developed a prototype jointly with Vector Informatik and ETAS. This did a lot to ensure that the standard works in practice. The results of the pilot project were passed on to all interested companies free of charge.

Georg Schneppe: DaimlerChrysler already started using the new standard, in the DC-MH3 project we are carrying out jointly with AVL List GmbH. We ran cross tests with the tools from dSPACE, ETAS, Vector, Softing and AVL List, and found and fixed the last few flaws in the specification. So we have proven that the standard functions properly. It was immediately implemented in products, so these will be available to users very quickly.

What difference will MCD 3 make?

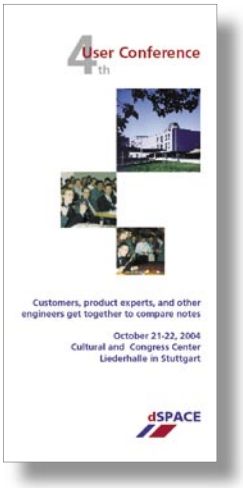
Georg Schneppe: With MCD 3, we can now bring together measurement, calibration and diagnostics issues, and it is also a standard interface for meeting our increasing diagnostic requirements. With synchronous data transfer, we can analyze dynamic processes automatically. The interface makes it very easy to handle communication, and we can react to varying requirements very fast. We are using it in hardware-in-the-loop simulation and testing, and also in the vehicle.

Thank you for talking to us.

CalDesk in ASAM-MCD 3 Cross-Test

The ASAM-MCD 3 cross-test mentioned in the article convincingly demonstrated the thoroughness with which dSPACE implemented the new standard. dSPACE was the only participant to run both a server solution (CalDesk) and extensive client solutions for M, C, and D (in M, Python, VB and C++). The CalDesk solution also gave the most complete support to the MCD 3 standard (Multi-Collector, Multi-Device, measuring scalar variables and COMPU-VTAB measuring variables), and was the only server that was multiclient-capable and enabled automation without prior interactive configuration.

dSPACE User Conference



The Liederhalle Cultural and Congress Center in Stuttgart opens its doors to the fourth dSPACE German User Conference on October 21-22, 2004. This year's program of papers includes contributions from several European countries. Our aim is to bring together experts from throughout Europe, so they can compare notes on using dSPACE systems for developing electronic control units in a pleasant, relaxed atmosphere.

We offer you an attractive program, with sessions covering the fields of rapid control prototyping, automatic production code generation, hardware-in-the-loop simulation, and calibration. The speakers will present innovative solutions, followed by expert discussions based on first-hand experience. Papers will be held in English and German. The conference language is German, with simultaneous interpretation into English.
We are sure there will be plenty to interest you, and look forward to welcoming you in Stuttgart. Ask for our brochure and conditions of participation, or visit our Web site for the latest information.

You can also register online at
www.dspace.de/goto?uc_stuttgart

A Good Start in Life

Whenever we replace a PC at dSPACE, we sell the old PC in a non-stop, in-house auction. Anyone working at dSPACE can bid for the computers and monitors on offer in the auction. When a reasonable amount of money has been collected, it is donated to a charity.

We have just made our fourth donation to the Westphalian Children's Village in Valayanchirangara in India. Founded in 1985, the village is home to 64 children and youngsters, who live in families with their foster parents. There is a kindergarten for the youngest ones. The older children go to school and later learn a vocation at the Training Center, along with other teenagers. The Center offers technical training in offset printing, painting and decorating, metalwork, smithery and book-binding.

Our donation enabled the village community to make some urgently needed purchases: a car and sewing-machines. The car will be a great help to the villagers. They can now do things like driving to the hospital several kilometers away and going to markets in the neighborhood to sell the products made in the village. The sewing-machines mean that the Training Center can now offer tailoring courses.

The aim of the Children's Village is to give the children the emotional and financial support they need for a good start in life. We plan to continue donating the proceeds from our auction to charity in future.

▶ *The Westphalian Children's Village in Valayanchirangara in India bought a car with the proceeds of dSPACE's in-house auction.*

Papers

Dr. P. Wältermann, Dr. H. Schütte, K. Diekstall
"Hardware-in-the-Loop Testing Of Distributed Electronic Systems "

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

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Are you an engineer who is just graduating? Or are you looking for new professional challenges? Then come and join our team in Paderborn, Munich or Stuttgart, Germany; Paris, France; Cambridgeshire, United Kingdom or Novi, MI, USA!
Due to our continuous growth, dSPACE is looking for engineers in

- Software development
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- Applications
- Technical sales
- Product management
- Technical writing

Training

Please check the corresponding field on your response card.

- dSPACE Real-Time Systems
- ControlDesk
- AutomationDesk
- HIL Simulation
- TargetLink
- CalDesk

Events

EUROPE

MeasComp
September 28-30, Wiesbaden, Germany
Rhein-Main-Hallen, Hall 1
Booth #33/34
www.meascomp.com

dSPACE User Conference
October 21-22, Stuttgart, Germany
Cultural and Congress Center Liederhalle
www.dspace.de/goto?uc_stuttgart

USA

dSPACE User Conference
June 21-23, Plymouth, MI
St. John's Conference Center
www.dspace.de/goto?uc_detroit

American Control Conference (ACC)
June 30 - July 2, Boston, MA
Boston Sheraton Hotel
www.mie.uiuc.edu/acc2004

AIAA Guidance, Navigation, and Control Conference and Exhibit (GNC)
August 16-19, Providence, Rhode Island
Rhode Island Convention Center
www.aiaa.org

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