VEOS
Platform for PC-based simulation of models and ECU network communication

Highlights
- Early validation of ECU software by means of PC-based simulation
- Precise simulation of ECU network communication for Automotive Ethernet, CAN, CAN FD, and LIN buses
- Off-the-shelf integration into RCP and HIL tool chains
- Support of the relevant standards such as AUTOSAR and Functional Mock-up Interface
- Support of multi-model scenarios

Application Areas
dSPACE VEOS is a PC-based simulation platform that promotes virtual validation for the development of electronic control units (ECUs). VEOS makes it possible to simulate a wide range of different models, such as function models, Functional Mock-up Units (FMUs), virtual ECUs (V-ECUs), and vehicle models, in the early development stages independent of any specific simulation hardware. For multi-model scenarios VEOS supports importing, connecting, and running any number of function and plant models based on Simulink or Functional Mock-up Interface (FMI), thereby extending the scope of the applications.

Key Benefits
VEOS runs on standard PCs, which gives function developers, software architects, and ECU testers a variety of new options for virtual validation during the early project phases.
- Software-software integration can be tested from component to system level.
- Sophisticated environment models can be integrated with virtual ECUs to validate complex controller strategies or simulate and test entire virtual vehicles.
- In preparation for hardware-in-the-loop simulation, models and tests can be created, set up, and run on a PC, independent of the hardware-in-the-loop (HIL) system.

Systematic Extension of the dSPACE Tool Chain
VEOS works hand in hand with other dSPACE products to provide an entire tool chain for the development and testing process. This means that tools and models that are commonly used in rapid control prototyping and hardware-in-the-loop simulation can also be used virtually. Similarly, layouts from HIL simulations can be reused in PC-based simulations with VEOS and vice versa. VEOS also provides open interfaces to connect and use existing tools.
- Simulink® and dSPACE Run-Time Target for generating C-code-based simulations
- TargetLink for generating AUTOSAR and non-AUTOSAR simulations based on production code

- SystemDesk for generating virtual ECUs
- Automotive Simulation Models for sophisticated environment models
- ModelDesk for graphically configuring and parameterizing environment models
- ControlDesk for experimenting and visualizing simulations and for monitoring bus communication with ControlDesk Bus Navigator
- MotionDesk for visualizing simulation scenarios
- AutomationDesk for creating tests and automating simulation runs
- SYNECT for managing test data and results
Functionality Overview

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Description</th>
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<tbody>
<tr>
<td>PC-based simulation</td>
<td>Simulation of heterogeneous models, from function models to virtual ECUs (V-ECUs), bus systems, and vehicle models. No additional hardware needed for simulation. NEW: Simulate sleep/wake mechanisms in V-ECUs for more realistic network simulation.</td>
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<tr>
<td>Simulink support</td>
<td>Simulation of Simulink implementation containers (SICs) generated from different projects.</td>
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<td>FMI support</td>
<td>Simulation of Functional Mock-up Units (FMUs) based on the Functional Mock-up Interface (FMI) for co-simulation. Support of FMI 2.0 functionalities and access/monitoring for all variables and parameters defined by an FMU.</td>
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<tr>
<td>TargetLink support</td>
<td>Simulation of TargetLink-generated code as V-ECUs, SICs or FMUs. Support for AUTOSAR as well as non-AUTOSAR TargetLink code.</td>
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<tr>
<td>Bus simulation</td>
<td>Simulation of ECU network communication on Automotive Ethernet, CAN, CAN FD, and LIN buses, including messages, scheduling, and arbitration. Optimized bus simulation for FlexRay. Simulate and validate distributed functions in complete LIN Networks on MCAL-Level without real hardware.</td>
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<td>XIL API support</td>
<td>Support of XIL API Model Access Port.</td>
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<td>XCP support</td>
<td>Access to Simulink and TargetLink models as well as V-ECUs via XCP on Ethernet.</td>
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<td>Debugging</td>
<td>C code debugging in a running simulation.</td>
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<td>Code coverage</td>
<td>Analyzing the extent to which code has been tested with CTC++ from Testwell.</td>
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<td>Tool chain integration</td>
<td>Off-the-shelf integration into the dSPACE rapid control prototyping (RCP) and hardware-in-the-loop (HIL) tool chain.</td>
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Order Information

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
<th>Order Number</th>
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<tbody>
<tr>
<td>Simulation of one or more Simulink models or FMUs</td>
<td>Simulation capability for executing Simulink and FMI models. dSPACE Model Interface Package for Simulink and The Mathworks Simulink Coder is required for generating Simulink Implementation Containers (SICs) from Simulink models.</td>
<td>VEOS_BASE</td>
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<tr>
<td>Simulation of one or more virtual ECUs</td>
<td>Add-on to VEOS_BASE. Simulation capability for executing ECU models including AUTOSAR Adaptive Platform</td>
<td>VEOS_ECU</td>
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<tr>
<td>Simulation of ECU network communication</td>
<td>Add-on to VEOS_BASE. Bus simulation capability. Supported bus systems: ETH, CAN, CAN FD, and LIN</td>
<td>VEOS_CAN</td>
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Relevant Software

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<th>Software</th>
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<tr>
<td>Required</td>
<td>Operating system: <a href="http://www.dspace.com/goto?os_compatibility">www.dspace.com/goto?os_compatibility</a></td>
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<tr>
<td>Optional</td>
<td>Simulink</td>
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<tr>
<td></td>
<td>SystemDesk</td>
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<td></td>
<td>ModelDesk</td>
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<td>MotionDesk</td>
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<td></td>
<td>Bus Manager</td>
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Features and Benefits

**PC-Based Simulation of Heterogeneous Models**
With VEOS, you can simulate Simulink and TargetLink models, FMUs, AUTOSAR software components, virtual ECUs, and ECU networks in a single environment directly on your PC. This allows for a fast integration and validation process for your ECU software at the very early development stages. You can detect errors long before the first hardware prototype exists. Another advantage of a PC-based simulation platform is that parameters, models, and results can easily be exchanged between different kinds of user groups throughout the development process. If an error is found by software architects, integrators, or testers, it can be understood, investigated, and fixed much more easily by function developers if they can use the same simulation and testing environment.

**Convenient Model Exchange**
To simplify exchanging simulation models, dSPACE offers a Model Interface Package for Simulink® (MIPS) for generating Simulink implementation container (SIC) files. With the free-of-charge MIPS, modeling experts can generate the SIC file with Simulink Coder, without the need for a VEOS or ConfigurationDesk license. From the Simulink models and in combination with dSPACE Run-Time Target, they can generate code and create ZIP files that contain all the necessary code and artifacts for executing the models on different simulation platforms, such as VEOS and SCALExIO. Model integrators that use SIC files do not have to generate code again for building the simulation. Model integrators that use SIC files do not have to generate code again for building the simulation, which significantly reduces when using them in other projects.

**Comprehensive Bus Simulation**
By using VEOS, you can also simulate a network of virtual AUTOSAR ECUs. These include a realistic operating system and can be extended with basic software such as NVRAM or the ECU state manager, depending on the requirements of the simulation scenario. Automotive Ethernet, CAN and LIN buses and their bus-specific effects can be simulated on a PC using VEOS without any additional hardware. This gives you a precise simulation of distributed functions, including ECU network communication, very early in the development process.

**Openness Through Automotive Standards**
VEOS can easily be integrated into your existing tool chain, because it supports relevant automotive standards such as
- ASAM
- AUTOSAR
- FMI

When you add VEOS to your rapid control prototyping or HIL tool chain to perform PC-based simulation, you can keep your existing tools. By using VEOS, you gain high flexibility and protect your investments for new projects and challenges.
Use Cases

Simulating Virtual ECUs
VEOS enables open-loop and closed-loop tests for virtual ECUs (V-ECUs). You can simulate single V-ECUs or V-ECU networks and test the signal-based communication. In addition, VEOS supports a precise bus simulation for Automotive Ethernet, CAN, CAN FD, and LIN.

Typical application scenarios are:
- Integration tests
- Virtual bus simulation
- Tests during development

Integrating Plant and Environment Models
For more realistic V-ECU tests with VEOS, you can integrate plant and environment models, for example, dSPACE Automotive Simulation Models (ASM) and Simulink-based models. The FMI support allows you to use a wide range of additional third-party simulation models. VEOS also provides various coupling solutions to other simulation tools.

Typical application scenarios are:
- Virtual test drives
- Virtual test bench
- Virtual integration test
- Coupling specialized simulation software for sensor algorithms, for example, RTMaps from Intempora, is possible for customized projects.
**Generating Virtual ECUs**

The V-ECUs used with VEOS can be generated on the basis of code ranging from AUTOSAR software components (SWCs) and basic software (BSW) to complete V-ECUs including AUTOSAR Adaptive Platform ECU software. AUTOSAR V-ECUs, regardless of whether they are based on the Classic or Adaptive Platform, are generated by SystemDesk. You can use the dSPACE basic software or integrate your own modules based on the supported MCAL modules. For non-AUTOSAR-based workflows, legacy code is integrated into SystemDesk and the V-ECU is generated using the same powerful features that are available for AUTOSAR V-ECUs. V-ECUs also provide the option to include precompiled code to meet the demand for IP protection.

Typical application scenarios are:

- Integration tests
- Virtual ECU tests
- Easier cooperation between departments
**Experimenting and Testing**

VEOS provides interfaces such as XCP and XIL API that enables access for other test and experiment software. In addition, you can perform debugging or automate simulation runs with your own tool chain. VEOS supports the same interfaces as a HIL simulator, which means you can prepare and test HIL tests beforehand, maximizing the simulators use.

VEOS is a highly scalable software-based simulation platform. It lets you combine several instances to form a cluster. With this cluster, you can frontload function tests from your HIL system, freeing the HIL system for other tests.

Typical application scenarios are:
- Preparing hardware-in-the-loop (HIL) tests
- Frontloading HIL tests
- Cluster Simulation