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Flexible platform for smart cars

Tomorrow's vehicles will be connected, environmentally friendly and ready to take over driving duties. To address this trend, electronic vehicle systems must learn to perceive their surroundings and react accordingly. This is a highly complex task – but ETAS has developed the new platform COSYM to help make it manageable.

It might seem that developing low-emission, electrified drive systems is complex enough, but the auto industry has set even more ambitious goals of making tomorrow's vehicles environmentally friendly, digitally connected and autonomous. The only way to achieve these goals is through a paradigm shift in vehicle development. Engineers need to work closer together – but that means they need new methods of simulating the complex behavior of distributed functions and validating the reliability and safety of these functions in the depth and scope required. The job of ensuring everything works properly can no longer be based solely on test drives and conventional hardware-in-the-loop (HiL) tests. In today's world, it requires high-performance environments that are capable of virtually replicating connected systems and testing them through simulations – not just in isolation, but also in combination with real components and with development artefacts from a wide range of different sources. These environments also need to be capable of virtually replicating the sensor systems, data communication, powertrain, steering and chassis of a vehicle as well as simulating aspects such as vehicle dynamics, test track routes, topography, weather and lighting conditions, other road users, and car-to-X communication.

This list is just a starting point – but it clearly illustrates the magnitude of the work involved. It also highlights the tremendous complexity of the tasks entrusted to vehicle software and its developers, especially since the logic of complex functions is frequently distributed across multiple connected ECUs. Replicating this kind of heterogeneous system environment requires open, scalable simulation platforms.

Less time, lower costs

Currently, model-, software- and hardware-in-the-loop (MiL, SiL and HiL) tests are generally performed sequentially, with different departments from the realms of development and quality assurance taking charge of the various different stages of the process. New vehicle functions are evaluated by modelling their behavior in MiL environments. The ECU functions validated in this way are then mapped to software components and tested in SiL environments, with virtual ECUs reducing the time and costs involved.

These virtual ECUs can be replicated without additional costs and their availability is not tied to hardware prototypes. As a result, they are increasingly being used in HiL tests, too. These include extensive tests of the overall system and extend right through to validation of the entire E/E architecture. Test engineers typically use different simulations on HiL test benches to those used by function and software developers in their MiL/SiL environments. But getting complex systems to market quickly and efficiently in the future will require test procedures that are more agile and more tightly interlinked. That includes restricting the test cases run on costly HiL test benches to those that are absolutely necessary, and running all the remaining tests as MiL/SiL tests on computers. This will require scalable system simulations that can be used for both MiL/SiL and HiL tests.

End-to-end system simulations

What is needed is a shift toward agile processes and fluid transitions between development and testing. The software components used in this context generally form part of a distributed

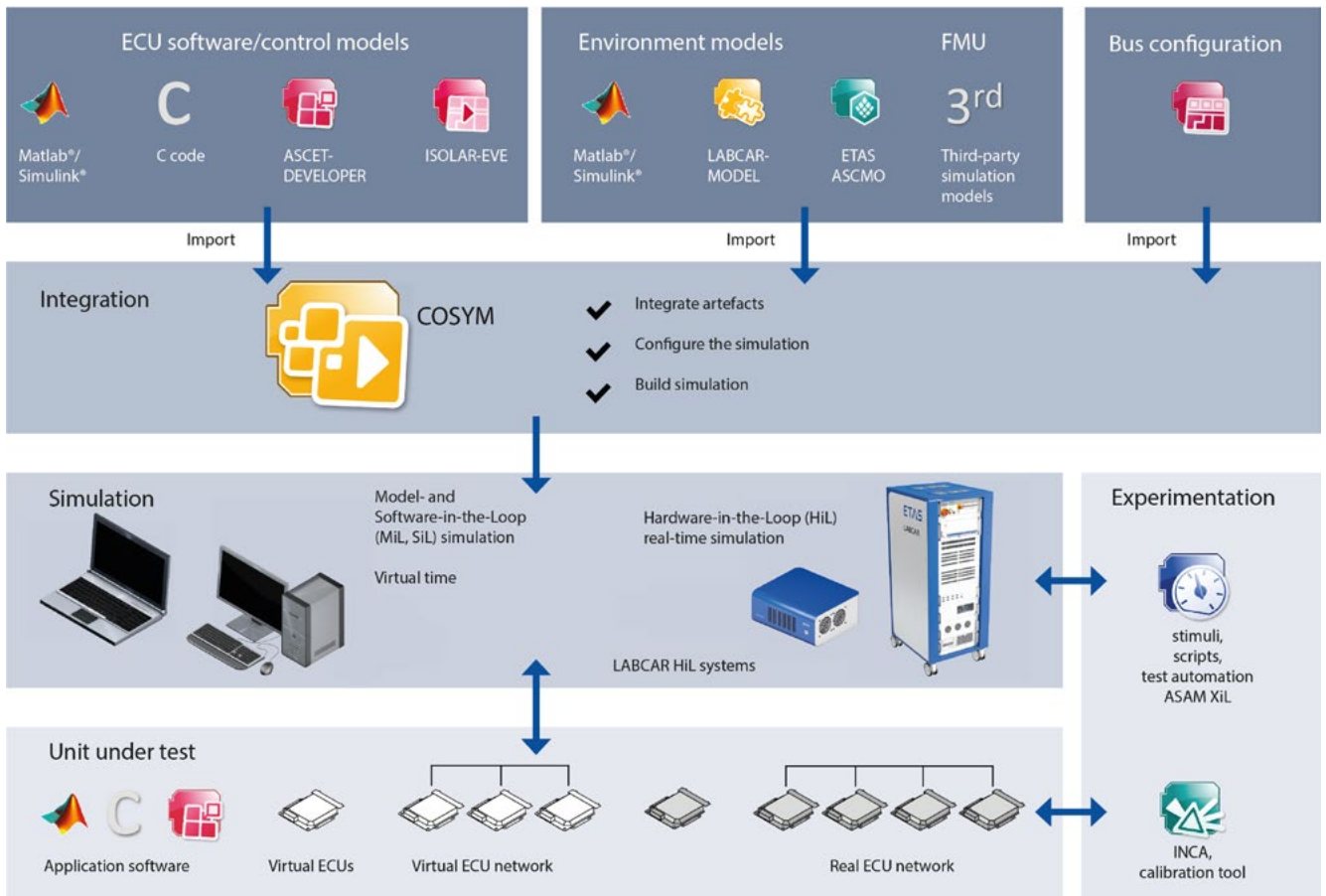


Fig. 1: Many components need to be linked together to develop complex systems. COSYM plays a key role in achieving that.

function jointly developed by teams from different companies. Testing these kinds of functions requires highly transparent solutions that facilitate fluid integration and validation. The key to success in this kind of environment is ensuring compatibility not just between new and existing tools, but also between simulation models and configurations. What's more, developers need the option of leveraging and reusing artefacts from previous development stages and projects. These kinds of integrated, interconnected procedures rely on powerful environments to generate virtual ECUs. They necessitate practical tools capable of integrating and configuring modular system models and scalable platforms for the flexible execution of simulations. Crucially, developers must maintain the ability to use established modelling environments from different providers as well as existing vehicle and environment models. They must be able to run simulations of individual system components as well as entire connected systems. Sometimes this will be possible on a standard Windows laptop, while in other cases it will require the multi real-time computing structure of a fully-fledged network HiL system. In short, the only genuinely future-proof solution is a platform that offers maximum flexibility.

Yet achieving this degree of flexibility can be challenging due to the differences in time response behavior of MiL/SiL and HiL tests and their heterogeneous interfaces. A solid basis can, however, be achieved with standards such as FMI, ACOSAR, and AUTOSAR as well as standardized protocols for LIN, CAN, and FlexRay buses and Automotive Ethernet networks. These can be used to link plant and functional models as well as ECU networks. Equally important are the relevant interfaces and protocols for integrating domain-specific plant models and ECU functions. Ideally, developers should also be provided with suitable test automation interfaces for automating test procedures, such as the ASAM-standardized XiL API.

These standards form the basis of the open simulation platform ETAS COSYM. At its core, COSYM facilitates integrated MiL/SiL/HiL (XiL) system testing, with a particular focus on ECU networks. The platform offers a wide range of efficient tools, enabling users to create system models by importing plant, function, and restbus models and their signal connection, and to create virtual networks that link up virtual and physical ECUs. The advantage is that the generated system model does not merely couple model signals, but can also factor in network communication. In COSYM,

virtual ECUs from ETAS ISOLAR-EVE are integrated on the micro-controller abstraction level instead of the application software level.

A platform that facilitates end-to-end testing

These features make COSYM simulations far more precise. COSYM also offers a configuration tool for MiL, SiL, and HiL environments that caters to the execution platform and time response behavior in each case (real-time or synchronous with the simulation timescale). What's more, it is compatible with the tried-and-tested ETAS experiment environment. The platform also paves the way for automation via the XiL API or a native REST interface, allowing for state-of-the-art software implementation of continuous integration environments.

COSYM is based on cutting-edge software technology and offers consistent separation between services and user guidance. The well documented REST services interface facilitates easy integration into each developer's own user guides. COSYM also comes with a web-based user interface as standard. Thanks to its consistent, service-oriented architecture, the platform can be smoothly incorporated into integrated development environments such as Eclipse.

COSYM is a powerful, open platform that facilitates testing and validation of distributed functions and connected, embedded systems in vehicles. It is being launched in three stages. The platform has been available for ETAS LABCAR HiL systems since the end of 2017, making it possible to frontload HiL tests to virtual environments. This can be done using plant simulations of the LABCAR model family, for instance. By replacing the physical ECUs with virtual ECUs or appropriate functional models, it is possible to make the entire system virtual.

Market launch scenario and outlook

The second stage, which is currently underway, is to integrate virtual networks for standard vehicle buses. Virtual timescales will also be supported as an alternative to real-time simulation for the MiL and SiL use cases. This will enable tests to be performed with more precise – though generally not real-time-capable – simulation models while also facilitating faster calculation as a real-time system when using models from the HiL environment, for example.

Finally, in the third stage, ETAS will lay the foundations for calibrating complex systems in virtual environments, with a particular focus on real driving emissions. It will also be possible to adapt and train ADAS and driving automation functions in the virtual environment.

In the medium term, ETAS intends to expand the COSYM platform to enable implementation in high-performance server infrastructures within a company (on-premises) or in the cloud. In order to better support data-intensive development in the realm of automated driving, ETAS will also focus on integrating big data solutions that will allow developers to quickly filter out relevant measurement and simulation data from large data sets. All these features make COSYM the perfect choice to ensure comprehensive and efficient validation of modern vehicle systems throughout the entire development cycle, paving the way for the automotive industry to enjoy a robust and successful future.

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