A virtual picture of tomorrow

A simulation framework for future mobility

In a not too distant future, our roads will be full of driverless vehicles conveying us safely and efficiently from A to B. Today, engineers are already busy working to turn this vision into a reality. One important part they need to realize this vision is the simulation in a virtual environment. The many complex questions involved can only be answered by testing and validating early prototypes. In the global simulation framework, developed by Bosch for Daimler, ISOLAR-EVE from ETAS plays a vital role.

Let's be frank, we can't predict the future. However, using our simulation framework, we can work toward realizing the future of fully automated driving. And "we" in this case refers to over 100 development engineers working for Daimler worldwide, the platform development team at Bosch, and the development team from ETAS. Using a comprehensive simulation framework, we are now developing ECU software to control the systems required for automated driving. But first things first ...

Given the complexity of the task – and the ambitious timeline imposed on the global development team – we are having to work on the production ECU software even before the corresponding hardware has been fully developed. We are continuously working on various functions and concepts so that they can be integrated in the virtual simulation framework. Instead of a relatively static hardware-in-the-loop (HiL) solution, we are using a software-in-the-loop (SiL) approach in which the system parameters are continuously changing.

But even the SiL approach requires us to think about the design of the future production ECU. It will be based on the Bosch DASy (Driver Assistance System) domain controller platform, which utilizes the AUTOSAR Standard. At present, the microcontroller utilizes the AUTOSAR Classic platform. In the future the microprocessor will be based on the AUTOSAR Adaptive platform.

The challenge

It takes countless driving maneuvers to demonstrate the functional reliability of the system, many of which would be highly difficult to reproduce, or even dangerous to carry out in real test drives. Virtual test drives play a key role in the development of highly automated driving. This is because they offer the only efficient means of achieving the test coverage required to ensure the functional safety of the software. For this reason, vehicle tests are used only for selected driving maneuvers – as a rule, to obtain necessary test data with which to repeatedly verify and validate the results of the simulations.

Our procedure

The simulation framework virtualizes the environment around the vehicle and simulates the ADAS electronic control unit as well as the sensors such as ultrasound, radar and camera. The system computes the decisions made by the system and the corresponding reaction of the actuators. The application software can then be simulated with the plant model – and vice versa. The simulation is controlled via the user interface, which was developed as an engineering service by ETAS.

This visualization provides each developer with a desktop validation environment. This is automatically based on the latest versions of all the software components and environment models, and it enables fast and simple functional validation, including debugging, code coverage analysis and the generation of log files.

> Our simulation framework for complex software for future vehicle systems provides developers worldwide with fast and secure access to large datasets and enables them to validate functions.

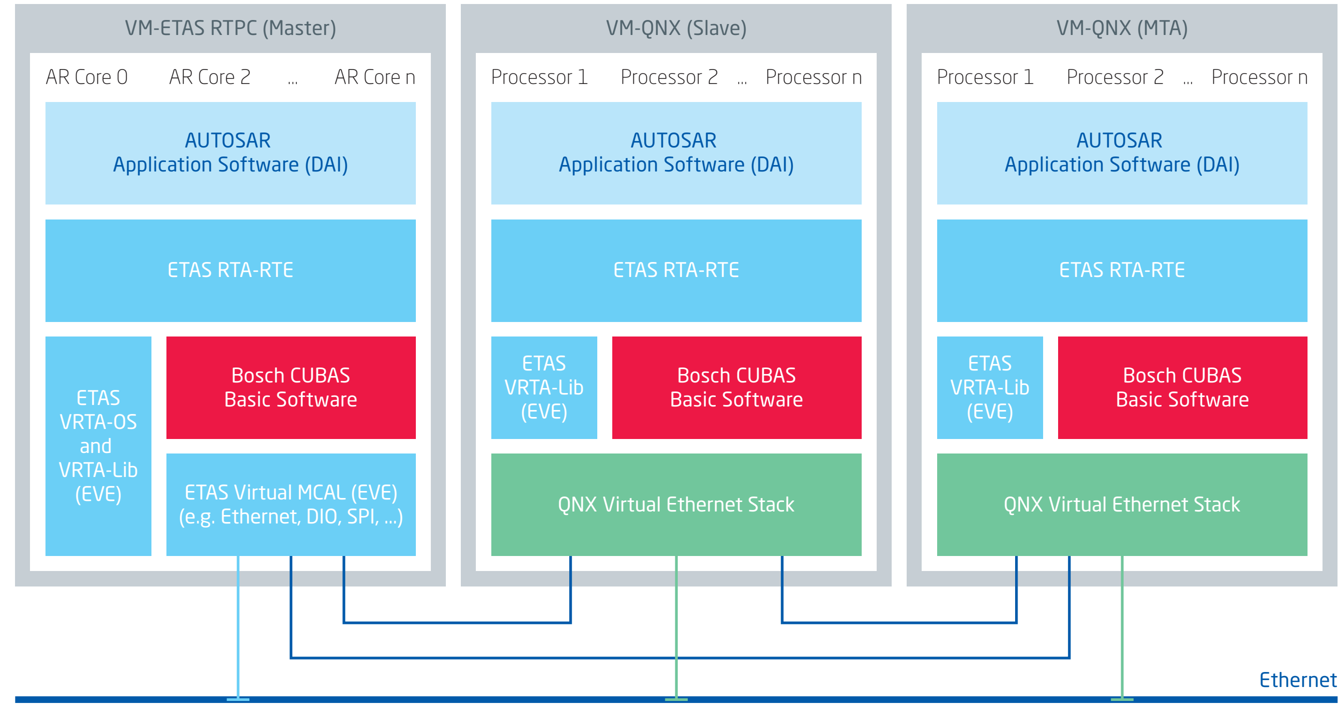
The development of the simulation framework took us into new territory in many respects. It was an encounter between the world of embedded ECUs and the world of IT. What counts in the former are real-time behavior and functional safety compliant with ISO 26262. As for IT, the key factors are data rates, connectivity and cyber security.

The aim of the project is also to create a framework that is as universal as possible and scalable for use from individual workstations all the way up to massive parallel testing on server clusters or in the cloud. By the same token, the framework must be suitable not only for testing individual new software functions but also for simulating a complex network of sensors and domain ECUs. The framework has therefore been designed from the very start on the basis of a flexible and scalable architecture. In addition to meeting stringent technical specifications, the simulation framework has also to be very robust, to avoid the risk of malfunctions. With over 100 development engineers working worldwide, even the slightest downtime cannot be tolerated.

Technical implementation

One important element in our quest to manage such a highly complex system was the adoption of a modular process in which each function can be treated as a separate unit. Not that we always knew right from the very beginning just which route we would take. We were prepared to learn from early prototypes and, if necessary, for them to fail early, so that we could then move in the right direction. As things now stand, we have attained a high level of maturity and entered the optimization phase.

The simulated environment is currently under development at Bosch. It is based on, for example, ETAS ISOLAR-EVE, which is used to generate virtual ECUs, and ETAS RTPC, which is based on Linux and therefore provides an efficient execution platform for the virtual ECUs. Here, it is crucial to have an in-depth understanding of the real ECUs. Without this, a realistic simulation is impossible.



Architecture of the simulated environment for microcontrollers and microprocessors

ISOLAR-EVE provides the operating system for the virtualization of the microcontroller (VRTA-OS for Windows and Linux), the microcontroller abstraction layer (MCAL) and elements of the build process. As such, it forms an important foundation for the virtual ECU. It also ensures a seamless integration of the AUTOSAR runtime environment (RTA-RTE). VRTA-OS is likewise used, together with VMware and QNX, for the virtualization of the microprocessors.

The advantages

Each developer has access to a powerful simulation platform on their desktop. Hardware availability is no longer a limiting factor. Testing requires fewer iterations, and the scope of testing is increased. In turn, this means that it takes less time for the software to reach a high quality standard and that subsequent HiL and in-vehicle tests are simplified. Similarly, critical driving situations can be observed at the desk, analyzed in detail, and reproduced at will.

And as if all that wasn't enough, tests based on virtual ECUs offer features not available on hardware-based validation platforms: artificial interfaces, playback of critical situations, fast motion and slow motion. All of these help engineers to detect individual errors or to comprehend the system as a whole.

Summary

Our simulation framework for the development of complex software for future vehicle systems with microcontrollers and microprocessors provides developers with fast and secure access to large datasets and enables them to validate functions. When working on projects of this scale, it is vital that all the people involved are able to collaborate closely, whether this be in the area of specifications, implementation or tool qualification. We have achieved this because of the highly diverse composition of our team. Yet we have by no means reached all our target. As our understanding of the complexities grows, so too does the scope of the project – which is also moving now in the direction of artificial intelligence. This only motivates us even more. Here, at our team, we are proud to be making a contribution to the development of safe and secure automated driving.

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