RealTimes

2019

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ESCRYPT
Security Special

DRIVING EMBEDDED EXCELLENCE

This is what the future looks like!

If you are a regular reader, you will no doubt have noticed that RealTimes has a new look. ETAS introduced a new corporate design in the beginning of 2018 to better represent our dynamic company. Do you like the new cover and layout? Turn the page, because there is much to discover – including a special feature on security. This 14-page section provides the most up-to-date research findings and solutions to critical security issues. Dr. Thomas Wollinger's report covers holistic security concepts for connected vehicles, and illustrates why smart factories need complete security solutions to ward off cyber attacks.

New look aside, as always, RealTimes provides an overview of innovative solutions as well as the latest industry news. This issue covers exciting customer projects and how our products are being used in a wide range of different market segments. In "One year in ETAS pictures," we look back at how interesting and productive 2018 has been for our customers and for us. Keep up with all the latest developments and share our delight in the top ratings we achieved in our ETAS Support survey. We sincerely thank you for your invaluable feedback. The encouraging results incite us to even greater improvements in the future.

That future starts now – and technological progress plays a central role. New solutions are needed to create tomorrow's business models and comply with increasingly strict environmental requirements. You will read how a super yacht or a gas extraction unit can be tested on an engine test bed. We explore the possibility of simulating the future and how ETAS is transforming so that we can continue to provide expert support for all your projects.

Can you keep a secret? The coming year will be no less exciting, because ETAS celebrates its 25th anniversary in June 2019! In addition to our continuous development we have some highlights in store for you, because without you – our customers and business partners – we would not be where we are today. We will keep you posted!

With this in mind, we hope you will enjoy reading this issue of RealTimes – from cover to cover and maybe even in one sitting. We look forward to receiving your feedback, and hearing your opinions and suggestions.

Have fun, and thank you!

Friedhelm Pickhard Bernd Hergert Christopher White

Left to right:
Christopher White
Executive Vice President Sales
Friedhelm Pickhard
President
Bernd Hergert
Executive Vice President Operations

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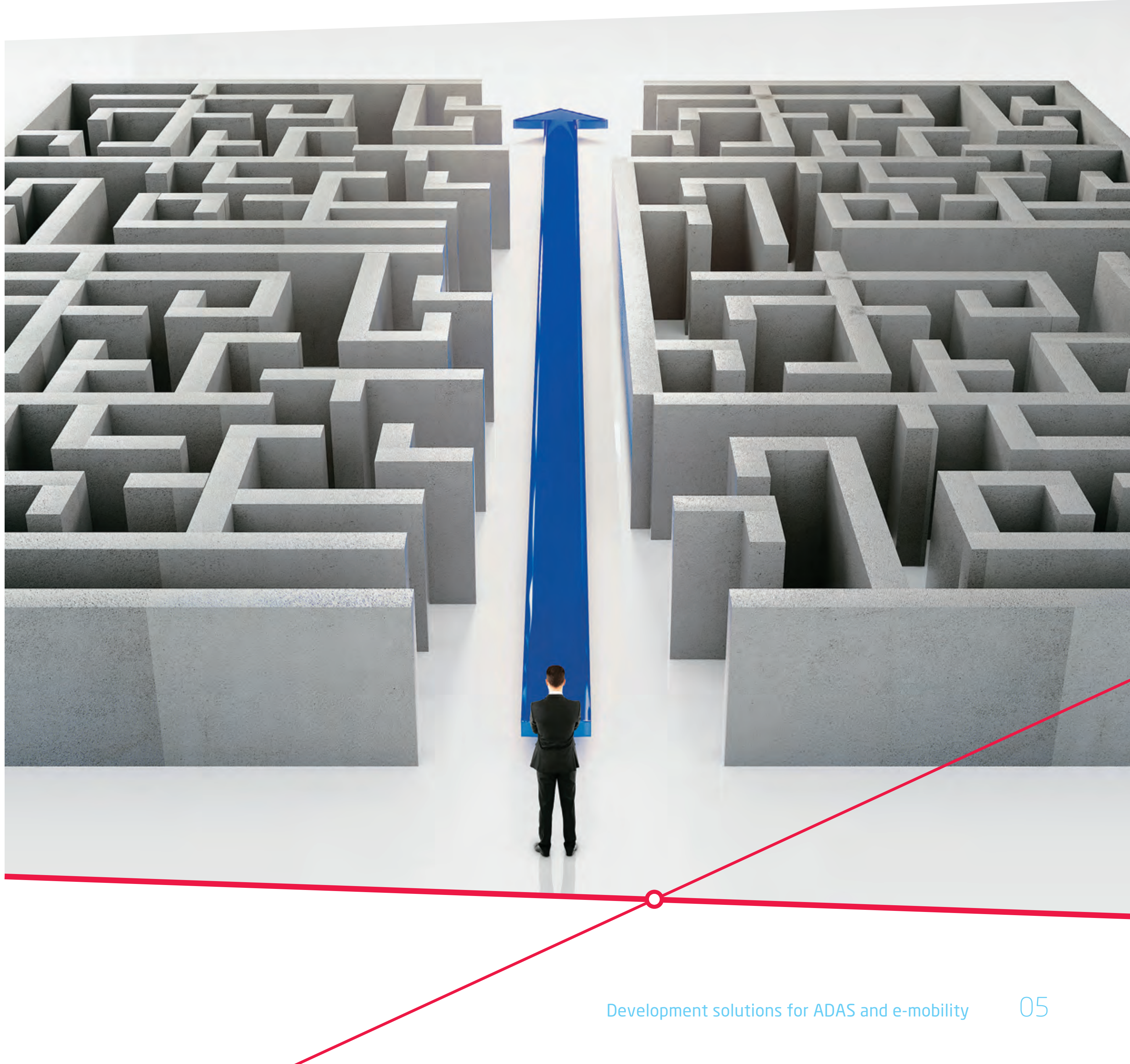
Ready for the future

XiL testing for autonomous driving

From advanced driver assistance systems (ADAS) to highly automated driving, electronic systems are designed to take some degree of control over a vehicle. But before they can be trusted to do that, they need to be rigorously tested. The goal is to verify that a vehicle's software and hardware systems will interact perfectly with the constantly changing environment. This can only be accomplished on time and within budget by using a combination of virtual testing methods, data reuse, and artificial intelligence.



Picture the scene: a heavy snowstorm, so fierce that it's difficult to see signs and pedestrians, or even make out the lane markings on the road. Can highly automated vehicles really cope with that kind of situation? How should they respond to a ball being kicked into the road or a policeman directing the traffic? In theory, self-driving vehicles must be able to deal with an endless array of different scenarios. To help them do that, ECUs, microprocessors (μPs), and graphic processors (GPUs) continuously analyze data from three to four dozen sensors under real-time conditions and translate it into driving commands for the vehicle actuators. All of that has to happen in whatever hardware and software architectures the vehicle manufacturer has chosen for each particular model. Additionally the complexity is compounded by frequent over-the-air (OTA) updates to vehicle software. Validating and verifying these highly complex systems is a mammoth undertaking that goes beyond anything this industry has seen before.

Virtualization makes complexity manageable

The time and investment this task requires could easily spiral out of control. That's why experts are looking for efficient methods, many of them virtual, that can help make this complexity manageable without neglecting safety considerations. Ideally, these methods would offer consistent workflows and data streams throughout the entire development cycle of a vehicle's software and hardware systems. The key is to get the data moving freely from one stage to the next, enabling developers to import a range of data formats into the virtual tests and allowing them to build on whatever verifications and validations they have already performed as they continue through the process.

For that to work, they need standardized interfaces for software and development tools and open system architectures that permit the use of development tools from different providers. Both these aspects are fully integrated in the X-in-the-Loop (XiL) solutions from ETAS. These encompass the Model-in-the-Loop (MiL) approach for the basic design of system functions and architecture in the early stages as well as Software-in-the-Loop (SiL) methods for subsequently validating and verifying software functions. ETAS XiL methodologies facilitate comprehensive testing, including the simulation of future Car-to-X communication, long before the ECUs, μPs, GPUs, and other hardware are available. Developers can run these kinds of tests on a computer with as many virtual ECUs as they like. That saves time because the tests can be run in parallel and in faster-than-real time, and can be reproduced as often as necessary. This produces verified and validated functions that can subsequently be tested and validated in Hardware-in-the-Loop (HiL) and Vehicle-in-the-Loop (ViL) settings using the production hardware. It also gives developers an entirely safe environment where they can run through safety-critical scenarios as often as they choose.

Making smart use of the existing toolchain

To validate highly automated vehicles, this XiL toolchain must be opened up to new data formats and prepared for simulation tasks with rapidly increasing amounts of data. Its scope must be widened to include not just in-vehicle systems, but also 3D data from environment sensors, traffic simulations, driver behavior, and the tasks involved in autonomous vehicle control. Depending on the architectures used in each case, developers need the option of connecting ECUs using either today's automotive buses or future Gigabit Ethernet cables. Equally important is a function that allows developers to input suitable stimuli into their simulation for each sensor and each ECU – from stereo video cameras to radar and lidar sensors.

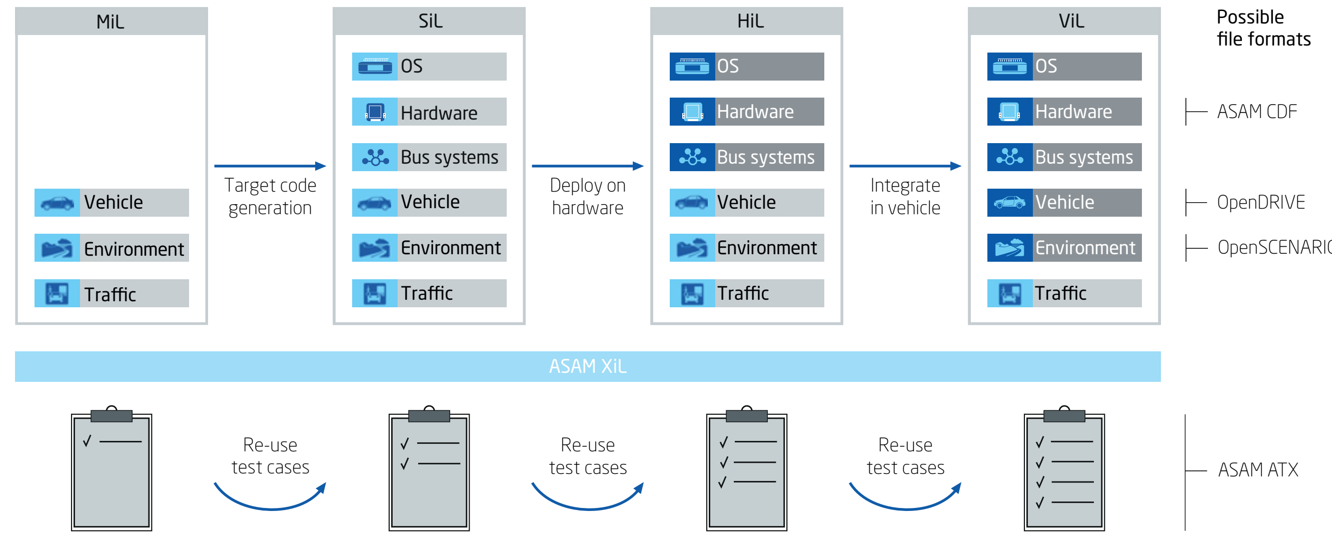
A further challenge is the sheer quantity of data captured by sensors and domain controllers. It is rare to find tools that can capture 500 Mbyte/s from an ECU, yet the ADAS environment – and especially the development of highly automated vehicles – requires data speeds of several gigabits a second. ETAS has now filled this gap in the market with its new high-performance GETK-Px series of interfaces. Combined with powerful data loggers that dock to interfaces using a 10 Gbits/s Ethernet switch, plus removable media with terabytes of capacity, these interfaces are the perfect choice for future-proof workflows.

Standardization is a must ...

Developers will only be willing to adopt new solutions if they can be seamlessly integrated in their standard workflows. That's why ETAS rigorously adheres to existing standards for interfaces and data formats and plays such a proactive role in numerous standardization bodies. It also supports well-established solutions for highly automated driving, such as the Automotive Data- and Time-Triggered Framework (ADTF). Its ultimate goal is to ensure that all the raw data measured in the vehicle can be imported into and replayed in XiL tests. This data replay is a key pillar of future verification and validation strategies: a clever combination of virtual and real data can be used to validate the various "layers of perception" of the ADAS ECUs used in the vehicle. Comparing the simulation with reality helps validate the simulation data used in the process. This opens up the full potential of virtual testing, allowing the results to be reused at later stages of development, too.

... and it paves the way for Artificial Intelligence

Previously unused data can be enriched through a combination of continuous, synchronous recording of measurements and intelligent analysis using big data algorithms. This enriched data provides training material that can teach neural networks to identify objects, calculate clearances, and make decisions. Providing developers with defined access to suitable sequences is key, so ETAS is actively involved in developing solutions such as Enterprise Automotive Data Management (EADM).



Schematic diagram of components at the various XiL levels

To keep pace with future developments and enable engineers to meet strict deadlines and budgets, the test methodology also needs to ensure that all suitable artefacts can be reused. Within an individual project, reuse steadily decreases the amount of testing required from one development step to the next, right the way through to calibration. From a broader perspective, reuse boosts the efficiency of virtual validation across all projects by increasing the quantity of available artifacts and measurement data. Ensuring this consistency in the simulation and testing process is one of the key future goals of the ETAS COSYM integration platform.

Ultimately, virtualization is the only way of minimizing risk in an environment that has an infinite number of parameter combinations. By conducting time lapse testing with virtual ECUs and running through a wide range of different parameters, it is possible to expose bugs and system weaknesses early on, minimizing the need for expensive test drives. This approach offers benefits at every stage of development, including HiL testing with solutions from the ETAS LABCAR. Outstanding flexibility is also a core feature of products such as ETAS EHOOKS, a tool that engineers can use to integrate bypass hooks into the ECU code without requiring detailed information about the software. That allows them to test functions directly in the ECU software with-out the assistance of the ECU manufacturer and to bypass unstable signals at the subsequent calibration stage.

Consistency at every stage of XiL testing

Efficient virtualization in the ADAS environment calls for well-designed holistic solutions spanning the entire XiL chain. Standardization is a pre-requisite for reproducing test cases throughout all the stages of the development process. Access to the relevant unit under test (UuT) and the models and data files used for testing is essential and must be safeguarded through established standards such as ASAM CDF, ASAM XiL, and ASAM ATX and new approaches such as OpenSCENARIO. This strategy paves the way for seamless verification and validation of software for self-driving vehicles – from troubleshooting in simplified models to testing with real hardware components. It facilitates the reuse of test descriptions, data sets and parameters, stimuli for sensors, and evaluation modules from one stage to the next.

Conclusion

Comprehensive virtualization has a key role to play in the efficient validation of highly automated driving. The sheer complexity and breadth of the testing process calls for well-designed, across-the-board solutions that include established test methods, high-performance data capture tools, and the option to reuse artifacts and measurement data. The aim is to gradually close the gap between test drives and simulation. ETAS offers a range of XiL testing solutions that are specifically designed to accommodate future developments. With its successful mix of established methodologies, XiL development, big data and AI, ETAS can help make self-driving vehicles a genuinely reliable option – even in a heavy snowstorm.

Authors

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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 micro-processor 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.

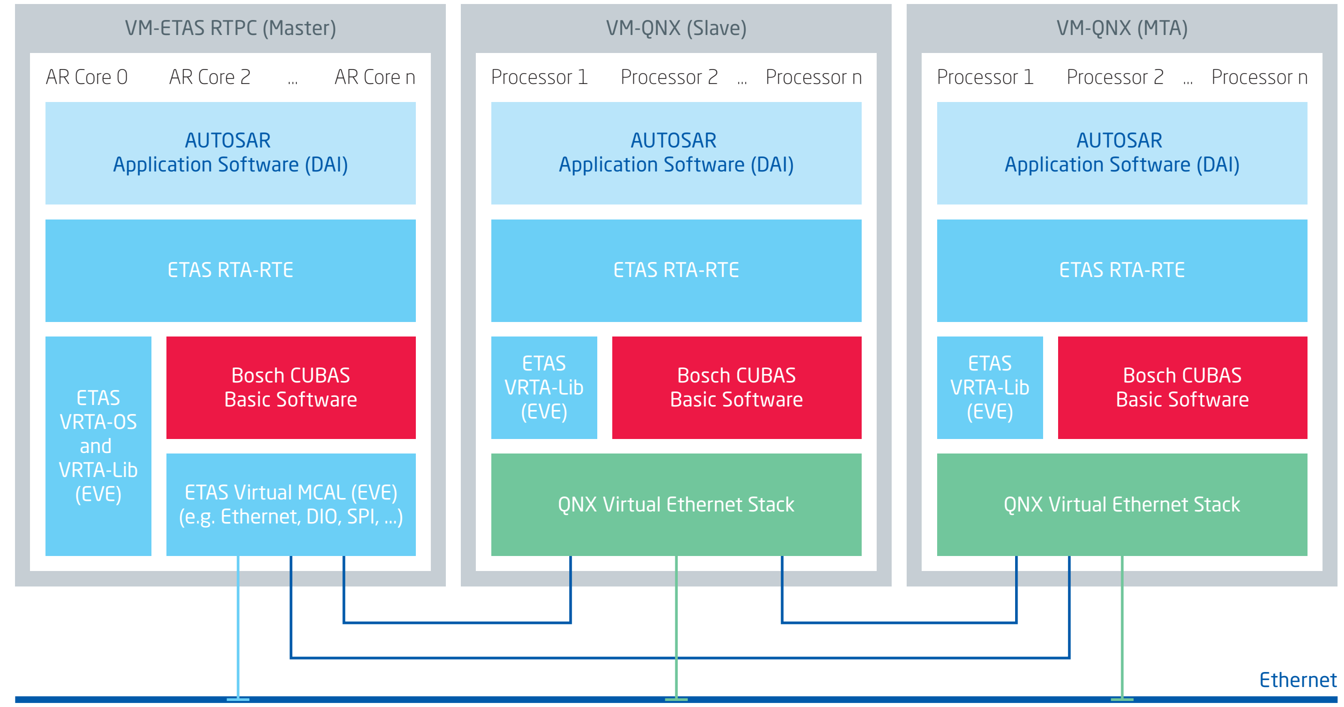
The development of the simulation framework took us into new territory in many respects. It was an encounter between the world of embedded ECUs and the world of IT. What counts in the former are real-time behavior and functional safety compliant with ISO 26262. As for IT, the key factors are data rates,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

Authors

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Everything safely in view

An efficient basis for fusing camera data and ultrasonic signals

Bosch is currently preparing the next generation of its near-range camera system for series production. The system combines ultrasonic sensors and at least four near-range cameras to monitor the vehicle's surroundings. Thanks to intelligent data processing on a single ECU with a multicore microprocessor, the system can detect both static and moving objects, providing a solid basis for safe and reliable automated parking. A hypervisor developed by ETAS partner Lynx Software Technologies acts as the enabler in the background.

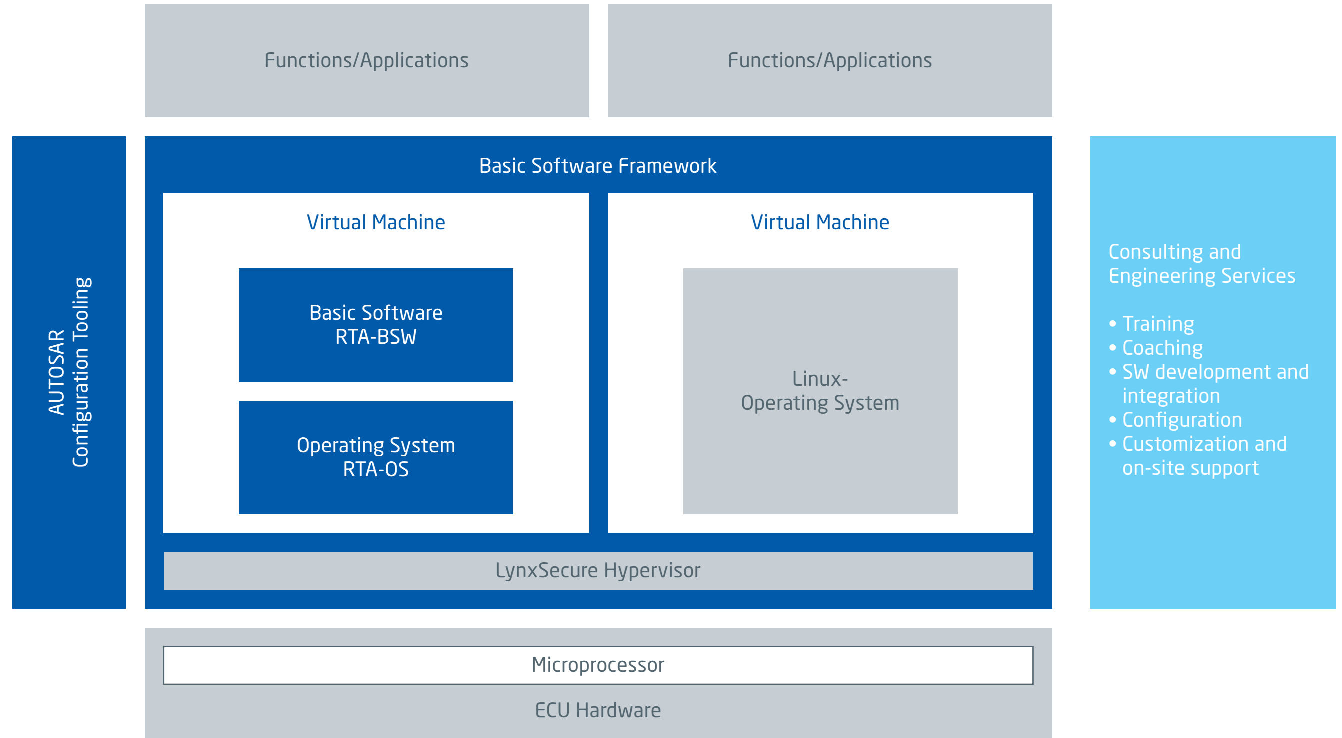
The children are having fun pretending to be drivers. Pedaling their tricycles, they escort their mother's car as it edges towards the garage at walking pace. It stops twice, and each time the kids know exactly what to do. First, they remove a scooter someone has left lying on the ground, and then they tug away their barking dog, Benny, so that the car can continue unimpeded on its automated journey.

Bosch plans to start production of the second generation of its near-range camera system in 2019. One of the features it offers a driverless parking system called Home Zone Park Assist. To ensure nothing goes wrong when children or animals get in the way, four cameras – each with a resolution of two megapixels – monitor the vehicle's entire surroundings. At the same time, ultrasonic sensors take readings of the area around the vehicle up to a distance of approximately five meters. They detect objects, measure how far they are from the car, and determine whether the objects identified in the video stream could be just shadows or opticalillusions. By fusing together this sensor data, the new system can detect both static and moving objects, providing reliable support for both driver assist and driverless technologies.

Combined evaluation of ultrasonic and camera data

The system combines the camera images into a high-resolution bird's-eye view of the vehicle, which it displays in the instrument cluster. That gives drivers full visual control over their parking maneuvers and provides warnings if they are on a collision course. Bosch is setting new benchmarks with both its park assist systems and its advanced display technology.

Obviously this kind of system needs to function flawlessly at all times. To meet high safety and security standards while staying within the budget of large-scale production, the developers opted for a completely new system architecture that involves processing video and ultrasonic sensor data in different cores of an ECU with a multicore microprocessor. The processor runs two different operating systems: an AUTOSAR OS (ETAS RTA-OS) for the assistance functions and Linux for the display function



Dividing the processor cores into separate virtual machines makes it possible to manage the complexity of the software

on one of the four cores. The developers chose the Low Voltage Differential Signaling (LVDS) interface to transfer the giant video files within the required timeframes.

More complex – but much more reliable thanks to the hypervisor

Processing data on the different cores of a multi-core ECU is cost-efficient and reduces hardware costs. However, it also increases complexity because developers must configure the system to ensure that running processes do not compete with each other for the limited hardware resources that are available. That means distributing hundreds of functions among the four cores in a way that allows the assistance system to handle safety-critical situations reliably in real time.

This is where the enabler of this new kind of architecture comes into play: the developers have used a hypervisor to partition the ECU into multiple virtual machines (VMs). This partitioning forms the basis for running the two operating systems separately, with complete freedom of interference between the processes of each OS. The hypervisor technology was developed by ETAS' US partner Lynx Software Technologies.

Thanks to ETAS, it is now available to the automotive industry. An architecture based on AUTOSAR 4.x already defines basic mechanisms for developing the different software modules on an ECU independently of each other and also provides basic elements for segregating them – even with different Automotive Safety Integrity Levels (ASILs).

But only partitioning guarantees the required safety level of the complex system while enabling cost-efficient implementation on just one ECU. In other words, the hypervisor provides solid foundations for automated parking, not just in financial terms, but also in regard to safety – even in situations where children are at play.

Authors

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AUTOSAR meets functional safety

ETAS helps Beijing New Energy Automobile Co. (BJEV) achieve its goals

AUTOSAR is continuing to expand in the automotive market as a reference standard for developing complete ECU software stacks. The benefits of higher efficiency, lower time to market, and full feature coverage are becoming increasingly evident in many areas as AUTOSAR becomes a more mature, all-around standard for supporting the development of embedded applications – including the fast growing electric vehicle (EV) domain. BJEV choses ETAS to introduce AUTOSAR for their ECUs.

Who is BJEV

Beijing New Energy Automobile Co., Ltd. (BJEV) – a subsidiary of Beijing Automotive Group Co., Ltd. – is China's biggest electric vehicle maker. The company produced over 100,000 electric vehicles in 2017, a figure that is set to rise to over 230,000 in the near future. As a new energy vehicle OEM, BJEV plays a key role in the Chinese government's strategic plans, including its "Made in China 2025" state-led industrial policy.

The challenge

The automotive industry has undergone some major changes in recent years driven by a number of factors. One key aspect has been the introduction of functional safety standards, such as ISO 26262 for passenger cars and ISO 25119 for agricultural machinery. These standards have had a significant impact on software development processes and practices.

The task facing BJEV was to develop ECUs such as the Motor Control Unit (MCU), Vehicle Control Unit (VCU) and Battery Management System (BMS) and to certify them as ASIL-C compliant in accordance with the ISO 26262 standard. This raised some challenging issues due to the simultaneous introduction of multiple elements of complexity at the same time – including AUTOSAR – and the implementation of various safety measures.

In regard to safety, the biggest challenge was the implementation of efficient mechanisms to support the "freedom of interference concept." This concept allows the coexistence of safety-related and non-safety-related software functions in the same execution context (e. g. one ECU). Typical strategies to implement freedom of interference include:

- Memory protection to isolate safety-related systems from non-safety-related systems
- Data corruption protection such as end-to-end signatures to detect if data contents are valid and received in the right sequence
- Sequential program execution using program flow monitoring functions to detect any unexpected sequence execution

Achieving these goals required clear actions and a meticulous, detailed project management approach in a range of areas. ETAS provided support in the form of consulting and engineering services, allowing BJEV to focus on their key innovation activities.

Project steps

This project comprised three steps. The first step was to build up AUTOSAR competence at BJEV with a focus on VCU development. During this phase, ETAS supported the customer in various ways, including training, engineering with the RTA Basic Software (RTA-BSW) Release Package, Microcontroller Abstraction Layer (MCAL/CDD) integration, fine tuning of Basic Software (BSW) configurations, on-site debugging, and Software Component (SWC) integration consulting. This step played a crucial role in helping BJEV to envision a tangible AUTOSAR-based future for ECUs that would improve the efficiency and quality of the final product.

In the second step BJEV migrated AUTOSAR architecture to BMS and MCU. This involved several tasks, including the porting of RTA-OS (operating system) to TI TMS570 and IFX TC234 microcontrollers.

The third step involved of a joint effort to obtain functional safety certification for all the ECU software stacks with TÜV, BJEV, and ETAS working together to achieve ASIL-C compliance. ETAS provided a holistic solution to BJEV to meet the requirements under ISO 26262, including functional safety qualification, safety manuals, safety cases, assessment reports, and safety reviews.

Conclusion

As automotive norms and regulations evolve and the market becomes more restrictive, complex and standards-driven, OEMs are faced with increasing challenges on the road to developing innovative and successful cars. The key to success includes an ability to keep costs to a reasonable level and, despite increased complexity, to reduce time to market. ETAS provided the right products and expertise to enable BJEV to achieve its goals, minimising the development work involved by deploying off-the-shelf ETAS AUTOSAR components and state-of-the-art techniques that ensured full ISO 26262 ASIL-C compliance.

"The ETAS AUTOSAR solution is a big step forward for us," says Yu Jun, Deputy Department Director of Strategy Development at BJEV. "It gives us a solid basis that allows us to focus on our innovation activities. The collaboration and expert support provided by the ETAS team was instrumental to the success of this project."

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High-level checkout

ETAS ES830 expands toolchain for Rapid Control Prototyping

Rapid Control Prototyping (RCP) makes life easier for function developers. It allows them to develop even the most complex systems quickly and securely by providing a simple means of testing and comparing new functions. To implement RCP, ETAS has developed a robust, high-performance real-time target that enables simultaneous execution of computationally intensive bypass applications on up to four ECUs. Seamlessly integrated in the ETAS toolchain, it offers developers a wealth of new opportunities.

Engineers need flexible and versatile tools to develop software functions, especially in the light of recent developments such as increasingly connected E/E architectures with multi-controller applications, complex hybrid drives, and sophisticated control tasks in autonomous driving. As the complexity of their tasks increases, developers are unlikely to see proportional gains in budgets and timeframes, so better tools are essential.

One solution is rapid control prototyping. RCP lets developers test specific new functions and compare them in the vehicle or on the test bench. However, current RCP hardware products soon reach their limits when it comes to new software architectures and functions that involve more than one ECU. Yet this enhanced level of complexity is exactly where real-world testing and validation become even more important.

New fields of application

ETAS prototyping solutions introduce a reliable way of meeting these new requirements while significantly expanding the areas in which bypass experiments can be performed. Firstly, though, what do bypasses actually do? Essentially, they replace existing functions in an ECU, or add new ones. That allows developers to validate these functions in real time – either directly in the vehicle itself or in the lab – without having to modify the ECU software beforehand or run through the time-consuming process of consulting the ECU manufacturer. The new ES830 high-performance Rapid Prototyping Module puts developers in the driving seat, allowing them to carry out bypass experiments with two – and soon even four – ECUs at the same time.

Not only does the ES830 let developers test and validate complex functions at an early stage of the process, it also allows them to replace real components with virtual hardware from simulation models. What's more, developers can choose to inject erroneous signals and readings whenever they like to test and validate how the system behaves when things go wrong.

Robust, reliable, and versatile

At the heart of the ETAS solution is the ES830 rapid prototyping target, which expands the successful ES800 series into a high-performance prototyping system. Up to five modules can be stacked on top of each other using a connector that provides both power and fast and secure module communication via Gigabit Ethernet and PCI Express. This robust stack configuration eliminates problems such as users plugging cables into the wrong ports or tests being aborted due to loose cables. The module stack is also protected against vibration and shock and is designed for use at temperatures between -40 °C and +70 °C. To ensure seamless integration in the automotive environment, the ES800 product family provides interfaces to all standard buses. The ES830 target itself comes with two Gigabit Ethernet ports, an I/O connector for querying status information in real-time operation, two USB 2.0 ports, and two USB 3.0 ports. Additionally ES800 interface modules are available to provide the required number of CAN (Controller Area Network), CAN FD, FlexRay, LIN, FETK/XETK, and Gigabit Ethernet interfaces. This modular set-up offers a level of flexibility that makes life considerably easier for researchers, pre-developers, and production developers. The ES800 range of products supports function prototyping at an early stage of the process as well as validation in the vehicle or on the test bench.

Embedded in the toolchain

As well as a flexible bus interface, this solution also offers seamless integration in established ETAS toolchains (see Figure). The ETAS INTECRIO integration and configuration platform can integrate function models from ETAS ASCET, MATLAB®/Simulink®, and C code, allowing engineers to validate and test open- and closed-loop control and diagnostic functions under extremely realistic conditions. The powerful ES830 module computes the bypass applications in real time and ensures a reliable exchange of data with the connected ECUs via either the FETK/XETK or XCP interface. ETAS also offers its ETAS EHOOKS tool to prepare ECUs and facilitate the integration of bypass hooks into ECU software. Finally, ETAS INCA can be used to validate the new open- and closed-loop control and diagnostic functions.

Conclusion

The robust, highly flexible, and high-performance RCP toolchain from ETAS provides exactly what developers need to verify and validate innovative ECU functions in future vehicle architectures. By opting for this solution, function developers will soon be able to integrate up to four bypasses in parallel. This will give them greater flexibility and more room for maneuver when it comes to developing complex electronic vehicle systems, including those designed for hybrids and autonomous driving.

Authors

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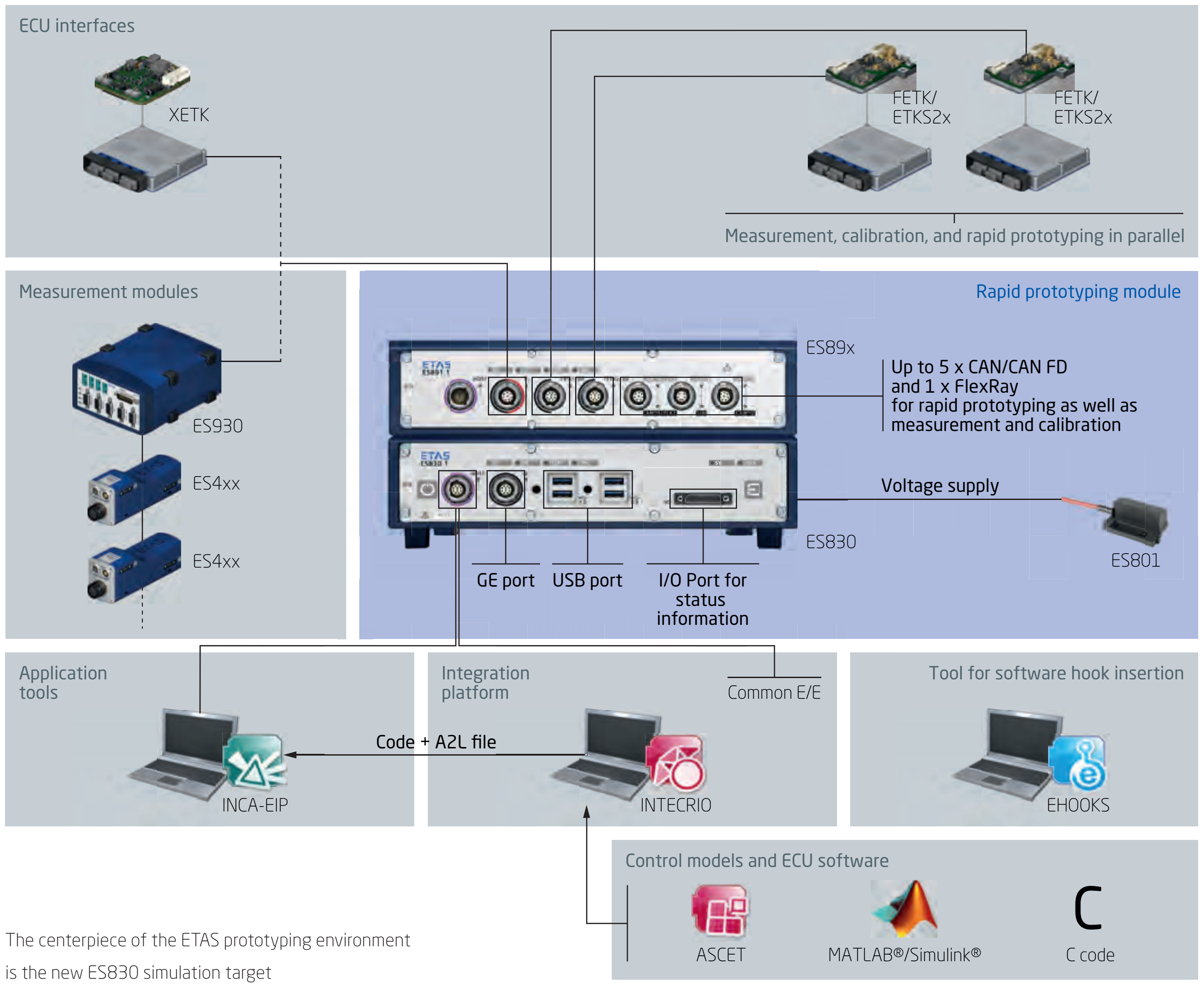


The centerpiece of the ETAS prototyping environment is the new ES830 simulation target

Renault Technologie Roumanie (RTR) – Test center in Titu, Romania

More than just tools

ETAS and Renault: a successful cooperation with ETAS Engineering Services

In a world of progressive globalization, increasing volatility, and continuous downward pressure on costs, efficient engineering is becoming an ever more important factor in a company's success. A solid and well-structured engineering set-up is therefore essential. ETAS' French subsidiary develops and maintains the "Byte to Intelligence" engineered solution based on close customer ties and an outstanding reputation for reliability and integrity. This modular software suite creates useful and robust interfaces between key tools in the real-time embedded systems validation market. Renault relies on ETAS not only to provide the right tools for the job, but also to provide superb levels of quality and maintainability in a responsive and professional format.

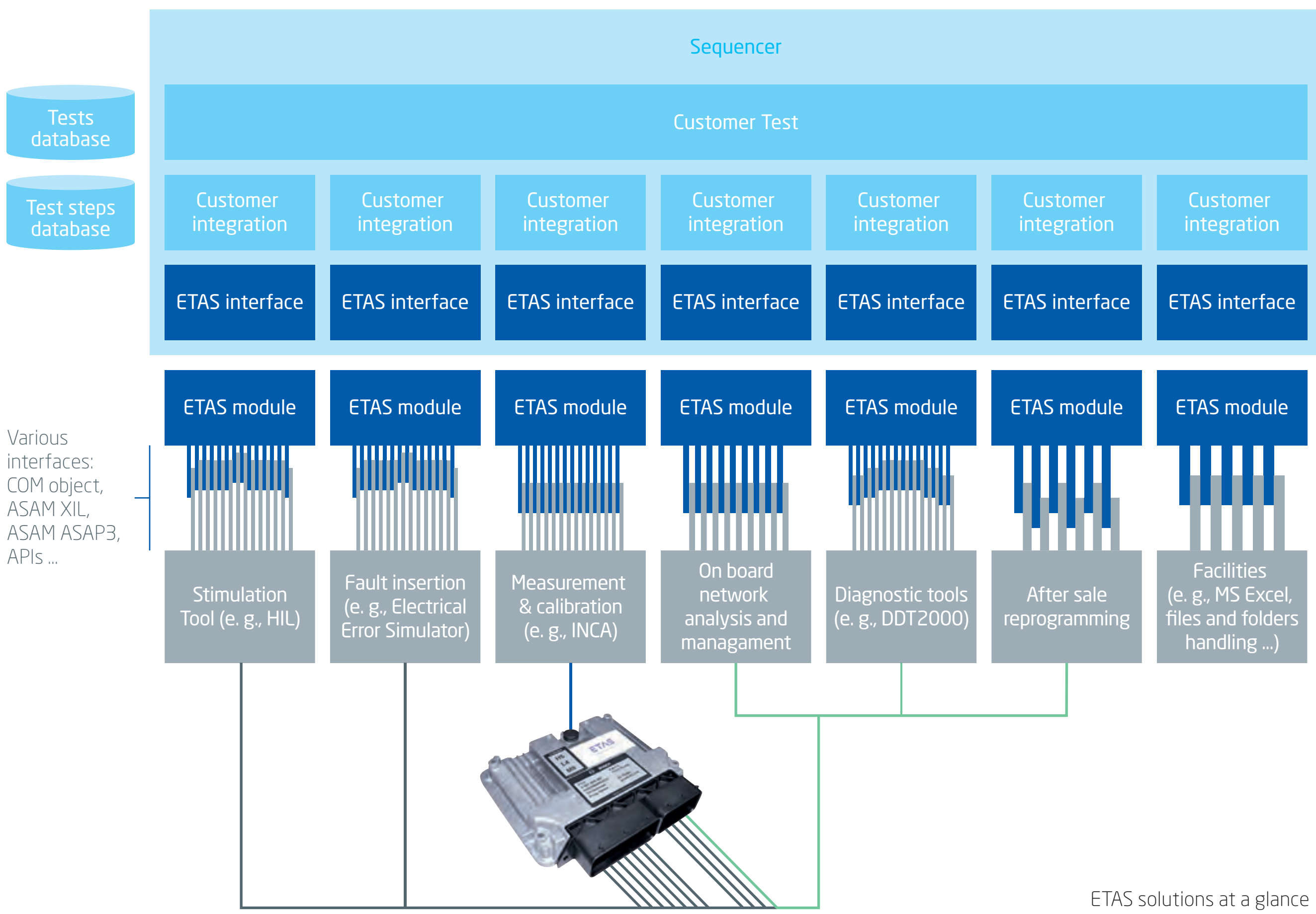
The Renault challenge

Renault validates its ECU software on cutting-edge HiL (Hardware-in-the-Loop) systems. These HiL benches provide full ECU interfacing capabilities and offer engineers extensive flexibility. Renault has also increased its validation capacity in ECU software development projects by using automatic testing at night, when no operators are present, to complement the validation work completed in the daytime.

The requirements for automatic night-time validation are both technically complex and highly demanding. For the automated test to run independently during the night, it must carry out the actions usually performed manually by a validation engineer. These include not just the various control tasks, but also monitoring, measuring, and recording the results.

When engineering makes sense

Complex tooling environments can sometimes force customers outside their core competencies. Task automation is a good example, requiring customers to get to grips with multiple implementations, handle multiple languages, and assemble numerous tool structures. That's where ETAS Engineering Services can help. With extensive expertise in tools and substantial experience in the field, ETAS understands how to deliver user-friendly, customer-focused solutions that rely on more than just tools to achieve success. Building on close customer ties and a professional approach, the French ETAS Engineering Services team offers technical services covering the entire spectrum from acquisition and support to development. With its open mindset, agile methods, and impressive adaptability, the team focuses on successful results every time, developing finely tuned solutions that generate genuine customer satisfaction.



ETAS solutions at a glance

The theoretical benefits of automation can sometimes fail to materialize due to start-up and clean-up delays, and the wide diversity of test equipment. Taken together, these issues often result in high failure rates in automated set-ups. Renault achieves better outcomes thanks to its an advanced tool chain, in which each piece of software performs robust, pre-programmed tasks. Underlying stability is assured by updating the software with the very latest technologies from the fast-evolving automotive market, and maintaining the harmonious interplay of all the components.

ETAS added value

Renault acchieved its goal by establishing a solid partnership between its in-house HiL teams and the ETAS development team, drawing on ETAS' reliability and expertise in this sector. The partnership has delivered multiple benefits in the field of automation, for example in the development of software modules used for the automated control of ETAS software such as INCA, Renault software such as DDT2000, and a range of other third-party software tools. These control modules are upgraded on a regular basis to keep pace with the new validation functionality requirements that emerge in the HiL process.
ETAS has also proved its worth in the realms of maintenance and support, showing a flexible and adaptable approach to handling new software features and major software migrations, including changes to operating systems and upgrades from 32-bit to 64-bit modules in mixed environments.

Overall, the collaboration between ETAS and the Renault HiL team has achieved flexible, robust, and efficient automation of night-time validation tests, a success story based on a combination of ETAS engineering expertise and Renault validation know-how and experience. This has increased Renault's validation capacity while maintaining the same number of test systems. From 2016 to 2017, the amount of automated HiL testing at Renault doubled, and this growth is set continue apace in the years ahead.

Authors

Emilia Buhaev is Project Leader for automated test methods, development, and maintenance at Renault Technologie Romania GROUPE RENAULT in Titu, Romania. **Stefan-Valentin Popescu** is Head of a globalized Hardware-in-the-Loop facility at Renault Technologie Romania GROUPE RENAULT in Titu, Romania. **Benoît Compagnon** is Field Application Engineer, and Project Leader at ETAS S.A.S. in Saint-Ouen, France.

> "I am very pleased with the results of our collaboration. The flexibility we witnessed in the technical challenges that came up was genuinely impressive. I feel confident that we will continue to head in the right direction.
>
> Stefan-Valentin Popescu, Renault

> "For anything that lies beyond the capabilities of our test benches we have to turn to simulation. It's simply not feasible for us to bring a super yacht or gas extraction pump into our yard for testing.
>
> Dr.-Ing. Sven Christian Fritz, MTU

Virtual test environment for large engine development

Virtual test bench at MTU Friedrichshafen

Developers at MTU Friedrichshafen GmbH in Germany have now solved a design dilemma they faced with large engines up to 10,000 kW that are used to power luxury yachts, mining trucks, and rail vehicles. The engines must comply with the respective exhaust emission standards applied in different parts of the world. Access to real test benches, however, is restricted, which limits the extent to which developers can create non-standard conditions. The solution? Virtualization.

In the American sports world, MVP stands for Most Valuable Player. In a similar spirit, the virtual test bench at MTU Friedrichshafen is referred as MVP, which stands for "MTU Virtueller Prüfstand" in German. This is certainly a fitting name for the highly efficient tool that plays such an important role in the company's development and validation of advanced diesel engines for large applications. The fully virtualized, automated test environment enables developers to engage in effective, interdisciplinary teamwork – and the advantages do not end there. Simulation also overcomes restrictions the developers faced with physical test benches due to the power range of the MTU generator sets.

Dr. Sven Fritz, Methodology Specialist at MTU, explains the dilemma they faced with the 4000 series generator sets. Weighing up to 15 metric tons and with a power range of 2,040 to 4,300 kW, they are used in applications such as luxury yachts, gigantic mining trucks, rail vehicles, and pump drives for oil and gas extraction. Such powerful engines burn up to a ton of fuel an hour which, for test purposes, required a system capable of supplying up to 25 tons of conditioned air to the test bench. Climate chambers used to condition air to a specific temperature and humidity, however, are not available for such large volumes of air. A further problem is that different regulations in place around the world mean the engines are subject to a dozen different exhaust emission standards – and these stipulate the exact environmental conditions for compliance with the respective limits.

Virtualization is the key

"For anything that lies beyond the capabilities of our test benches we have to turn to simulation," Dr. Fritz says. Virtual tests can plug the gaps left by physical test benches and help developers tackle tough assignments. Recently, for example, developers were called upon to reduce nitrogen oxide (NO_x) from 6.4 to 3.5 g and particle emissions from 0.2 to 0.1 g per kilowatt hour (kWh) for engines in the over 560 kW power range for the U.S. market (EPA Tier 4). Then, in a second stage, they had to reduce NO_x and particle emissions to 3.5 g/kW and 0.04 g/kWh, respectively, by the middle of this decade. Carbon monoxide and hydrocarbon emissions obviously had to be cut, too. No mean feat, given that the developers had no access to the drive trains in the overall system. "It's simply not feasible for us to bring a super yacht or gas extraction pump into our yard for testing," says the MTU expert, pointing out one of the major hurdles they faced.

To make sure the engines and their control systems comply with emissions standards, the developers therefore have to incorporate an extra degree of freedom, something that inevitably involves exponentially increasing levels of parametrization work. At the same time, they have ever shorter development times and shrinking budgets to contend with. This calls for highly efficient collaboration among the teams involved, which cover a range of different disciplines including thermodynamics, electronics development, and testing. The idea is to elaborate the operating strategies and optimize the parametrization data to the greatest extent possible in the simulation stage with a view to minimizing the number of Hardware-in-the-Loop tests in the real test environment. This is especially important given that the tests are a significant cost factor: depending on their series and power output, MTU engines burn anywhere between 200 and 2,000 kg of fuel an hour. To complicate things further, the number of test benches is limited and not every test bench can accommodate every engine. Taking all this into account, one thing became clear: "The test bench should only be used for fine-tuning the values parameters we assign in the simulations," Dr. Fritz says.

Combining expertise from all disciplines

The MVP developers faced the challenge of providing their colleagues from engine and ECU development, testing, and calibration with a virtual test environment that would enable them to execute test programs with minimal start-up times. Their solution also needed to be intuitive for calibration engineers to use. "First of all, we looked at the expertise and tools we had access to in our own ranks, and on that basis we set about pooling our knowledge and incorporating it into our virtual test environment," Dr. Fritz says. The idea was that engine, ECU, and ECU software developers and the calibration engineers could continue to use their tried-and-true tools without having to learn the ropes of new instrumentation and software routines. After all, engine parametrization is complex enough already when you consider the wide variety of charging and fuel-injection strategies involved, not to mention exhaust-gas recirculation and exhaust-gas treatment.

Since some sub-components were already available with MATLAB®/Simulink®, or could easily be transferred to the platform, it was clear from the outset that Simulink® should form the backbone of the virtual test environment. The central engine and ECU model is based on this platform, which caters to the integration of further load, cooling system, and exhaust-gas treatment models. The same applies to interfaces to ETAS INCA and AVL Puma Open.

Unlike those responsible for developing the methods, the calibration experts on the team were accustomed to working with INCA. This is where the ETAS strategy of relying on standardized interfaces came into its own. This proved to be the only way of ensuring that all developers could continue to use their established tools with updated toolchains – tools that may differ from team to team and from discipline to discipline. "We need solutions that can be easily tailored to our business requirements to avoid us having to constantly adapt the tools we use," Dr. Fritz explains.

In the case of the virtual test environment, the method developers connected INCA to the MATLAB® environment via INCA-SIP V7.2. It has been possible to link INCA to MATLAB®/Simulink® in the INCA Experimental Target Integration Package (INCA-EIP) in this way since the roll-out of INCA V7.2. Developers can also use the measurement and calibration functionality of INCA for the direct calibration of Simulink® ECU function models. This way, users at MTU do not need to familiarize themselves with the complex MATLAB® environment. Instead, they can continue working in their usual environment, where they can experiment with speed and load requirements, for example, or adjust the ECU or environmental parameters. "This is a key feature for us," Dr. Fritz says. "INCA gives our calibration experts a user-friendly, intuitive interface with which to navigate the complex simulation environment." Thanks to MTU's highly constructive collaboration with ETAS, implementation of the necessary system adjustments was a mostly smooth and seamless process. "Despite the complexity of the project, both partners were able to adapt relatively easily, not least thanks to the effective way we worked together to find solutions," Dr. Fritz says, praising efforts on both sides.

A bright future for the automated test bench

In addition to the setup described above, MTU Friedrichshafen has integrated an end-to-end automation system that converts the solution into a fully virtualized test bench. Offering simulated measurement technology and virtual driving programs under a wide range of load requirements, the virtual test bench works exactly the same way as a real test bench. Tests initially carried out in the virtual environment can be subsequently reproduced and verified on the real test bench at any time. The benefits extend way beyond cost reduction and a solution to the climate-chamber dilemma: "The simulated environment lets us experiment and gives us the freedom to try out unconventional approaches and operating strategies that time and cost restrictions would otherwise make impossible on the real test bench. We've already had a few of those light-bulb moments and greatly expanded our know-how in this area," Dr. Fritz says. And, unlike with the real test bench, time spent using the simulator no longer causes bottlenecks. Once fed with all the right data, the computer does everything on its own – and the running costs are barely more than the electricity it uses. The hourly operating costs of a real test bench, by comparison, lie in the four-figure range. Virtualization also reduces the CO_2 and emissions footprint.

Another major advantage, according to Dr. Fritz, is that – at the simulation stage – an approximation to reality is sufficient in two thirds of all cases. "It's not necessarily the accuracy but the quality of the tests that counts. Often, the second decimal place isn't even relevant," he says. "As long as the ECU and engine model are on the same time cycle, real-time processing takes a back seat." As things stand, the physical model for large engines is very CPU-intensive and still too slow to run the simulations in real time. But the developers are continuing to work on this aspect. Dr. Fritz is also considering another possibility: if they worked with the ETAS INTECRIO rapid prototyping tool, they could conceivably use the overall simulation for function prototyping. He also envisages using the virtual test environment for Hardware-in-the-Loop tests where appropriate – for instance as a means of testing, validating, and verifying real MTU ECUs and their software. One thing is clear: virtualization paves the way for truly effective collaboration on the large and efficient engines of the future.

Interviewee

Dr.-Ing. Sven Christian Fritz is Specialist DoE, method development, test bench automation, and virtual test benches at MTU GmbH in Friedrichshafen, Germany.

Sound check with INCA

BMW Group relies on ETAS INCA to calibrate audio systems

In-vehicle acoustics are a complex business. To ensure all occupants in a car enjoy the best possible audio experience, automakers individually calibrate audio systems in each of their models. Developers have so far relied on a variety of tools and programs to calibrate audio ECUs. The BMW Group, however, is taking a new approach by combining ETAS INCA with the XCP communication protocol to form the core of a standardized workflow.

Regardless of whether it's Bach, Pink Floyd, or an audio book, sound quality in today's premium car models is easily comparable to that of concert halls. Ultimately, the ideal listening experience relies on digital amplifiers, which are custom-fitted according to cabin features, as well as on the number, position, and performance of the speakers built into the coupé, SUV, or station wagon. Of course, safety always takes a front seat when the audio system is in use. When a driver turns up the volume, the clicking sound of the indicators and warning tones from the assistance systems remain audible without startling the vehicle's occupants. This is made possible by the ECUs, which automatically control the audio system's volume based on the urgency of the situation at hand.

As complex as the powertrain

Engineers have to choose from tens of thousands of parameters to calibrate infotainment ECUs to perfection. However, although audio and powertrain control units share comparable complexity, no standardized processes or tools previously existed for audio. Heterogenous toolchains with proprietary data formats and communication protocols were the order of the day. The lack of a formal data description also made administration and quick access to measurement and calibration data an arduous process. All these drawbacks made calibrating the sound system an unnecessarily complex, time-consuming task that required expertise in numerous tools.

To tackle this challenge, the BMW Group joined forces with ETAS to develop a new procedure. The goal of the project was to establish a lean, standardized solution to replace the various proprietary measurement and calibration tools from different audio systems and ECU manufacturers. The partners scored a win with an unconventional path; adapting ETAS' INCA solution for powertrains to the infotainment system. This approach had the added benefit of using a software solution that is well established among OEMs and key suppliers.

Standardization over unchecked growth

In order to cap further uncontrolled development, the project partners redesigned the audio workflow based on INCA. This approach required a powerful architecture because, unlike powertrains, the data flow in audio systems is large, and this most often calls for multi-core processors that use Linux operating systems and Ethernet connections. The answer lay in the Universal Measurement and Calibration Protocol, or XCP – a communication protocol standardized by the Association of Automation and Measuring Systems (ASAM). Thanks to separate command and transport layers, XCP is usable not just for CAN and FlexRay buses in powertrains, but also for USB or Ethernet data buses. The necessary XCP connection was achieved via Ethernet by integrating an XCP driver into the Linux operating system.

INCA replaces nearly a dozen tools

ETAS' consistent efforts to standardize its tools paved the way for the use of INCA in audio systems. Implementing XCP in INCA according to specifications was key to helping ensure a smooth flow of data traffic. However, capturing and visually processing the audio measurement data in INCA was somewhat more complex. Measuring instruments for powertrain systems from the

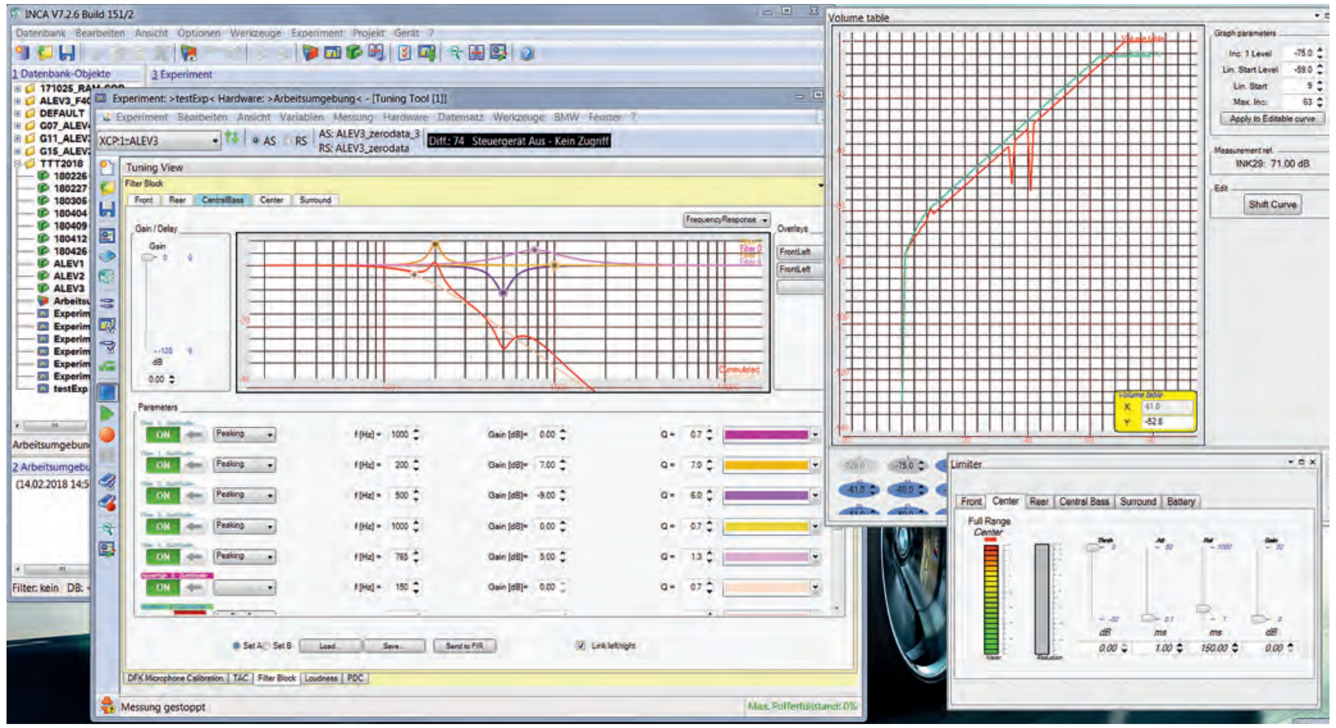


Figure 1: Plug-in for setting acoustic filter curves

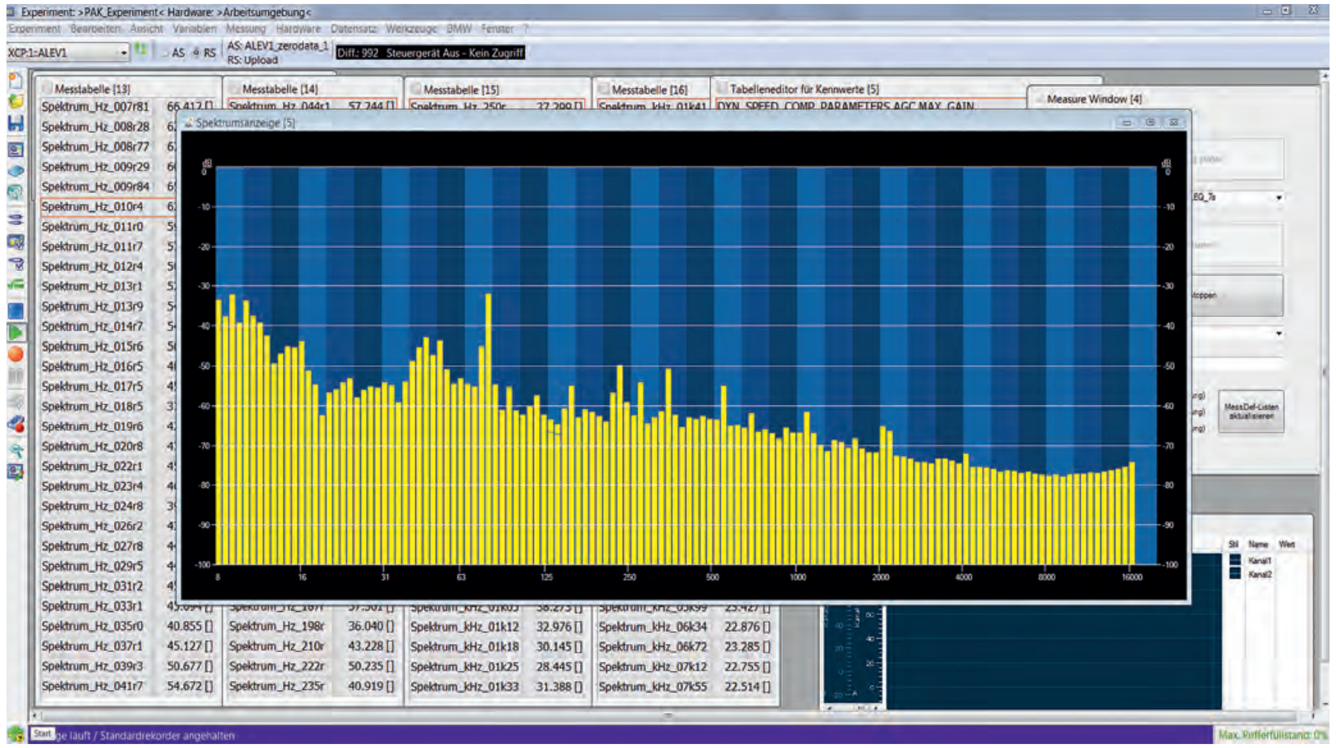


Figure 2: Display of the acoustic spectrum. The measurement data were recorded with a third-party acoustic measurement system

ETAS ES series and the oscilloscopes used for drive applications proved unsuitable for the task. Instead, measuring and visualization solutions for acoustic design were needed – for example, to set frequencies and to manipulate filters (see Figure 1). Both partners set to work to develop corresponding plug-ins for measurements and adjustments using ETAS' instrumentation kit for INCA. Measuring instruments from third-party vendors were then integrated through the development of INCA and XCP-compatible drivers. Calibration engineers can thus continue to display and process data directly in INCA using trusted third-party acoustic measuring technology (see Figure 2).

Once the prerequisites were established, a typical INCA workflow could be introduced. INCA-FLOW helps expedite the process of scripting recurring measurement and adjustment tasks. In addition, BMW is already experimenting with virtualization – for example, to bypass audio signals and quickly test new sound algorithms on the PC. It is precisely such virtualization that could raise development of sound systems to a new level of efficiency, making it an important tool for tackling increasing complexity in the years ahead.

Summary and outlook

Before making the switch to a standardized toolchain with INCA and XCP, the desktops of BMW's sound engineers were typically crowded with almost a dozen icons from different tool manufacturers. Developers needed to know how to handle numerous proprietary stand-alone solutions in order to calibrate infotainment ECUs. This situation has given way to a completely new, standardized workflow with INCA at its core. With only minor adjustments, this widely used platform in the automotive industry offers calibration engineers a development method to more quickly achieve optimum sound in every new vehicle model. Its use noticeably simplifies and expedites the development process in the infotainment sector. In order to exploit the toolchain's full potential, it is now being enhanced with additional functions. After all, it's only a matter of time before sound design for electric and hybrid vehicles will throw up a whole new set of challenges for audio specialists. This will require the creation of entirely new sound scenarios, and the INCA sound check is geared up to make a difference here, too.

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A measure of experience

Measurement and evaluation system for achieving desired levels of drivability

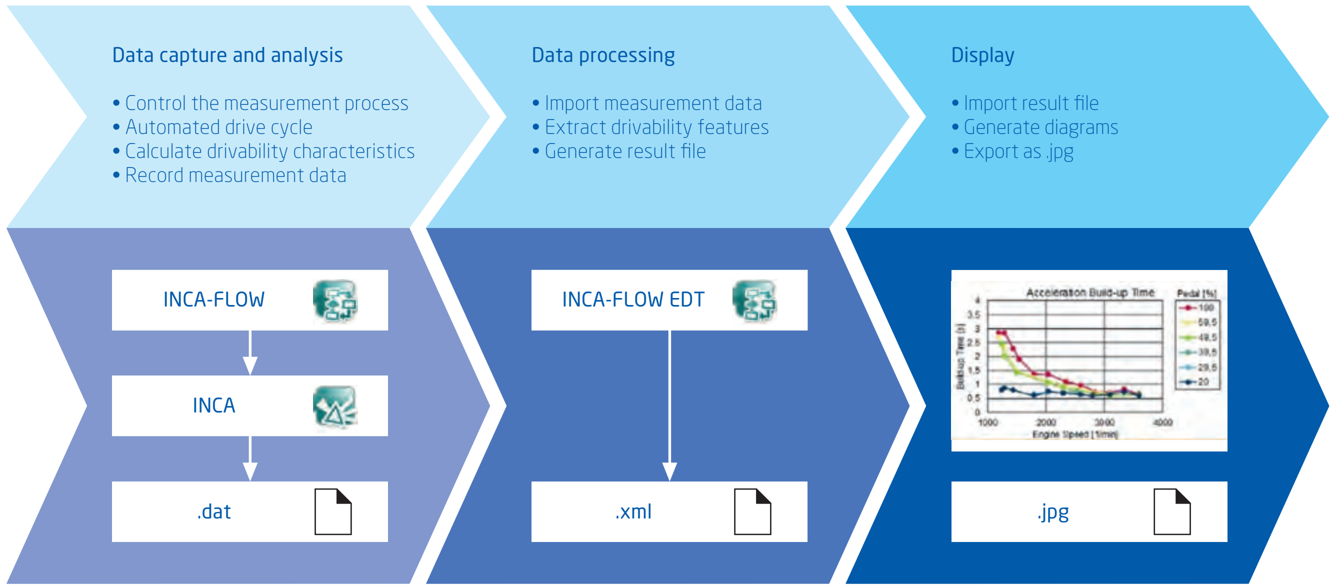
When people buy a car, they expect to get a carefully tuned driving experience that corresponds to their chosen brand. The problem is that test vehicles do not become available until late in the development process – and even then their numbers are strictly limited. As a result, calibration engineers often have to work under intense time pressure to tune the driving behavior of numerous different vehicle variants and models. Currently, they rely on their expertise and gut instincts to carry out this tuning process. But now ETAS, in collaboration with IAV, has developed a measurement and evaluation system based on INCA-FLOW that allows engineers to tune even large numbers of vehicles with remarkable efficiency.

It was certainly a daunting task: Carmakers were increasingly calling for a system that would simplify vehicle tuning in the calibration process while simultaneously enabling them to efficiently define the character of the vehicle itself. What's more, they wanted to create objective descriptions of calibration criteria that engineers had previously determined subjectively. But why were their calls for action steadily becoming more urgent?

Complexity is constantly increasing, and so too are the challenges it creates. The variety of vehicles car manufacturers offer is growing inexorably, with ever more nuanced differences between vehicle variants. As well as multiple different models, there is also a multitude of powertrain configurations to consider, with hybrid concepts that offer different operating modes and types of transmission. These include manual transmissions and torque converter automatic transmissions as well as automated manual transmissions, dual clutch transmissions, and continuously variable transmissions. The automotive industry is also facing ever stricter emissions standards in real-life driving conditions for combustion engines (RDE, real driving emissions) while simultaneously striving to reduce CO_2 emissions in the strict WLTP cycle (Worldwide harmonized Light vehicles Test Procedure). Yet none of these requirements can be allowed to have a negative impact on drivability.

On top of all these challenges, many end customers expect their chosen vehicle to offer a driving experience that meets their own individual needs, and they would ideally like to be able to fine-tune this experience as they see fit. For example, the driver of a luxury sedan may be looking for smooth and poised acceleration, while the driver of a sports car may prefer a more immediate response. There are also likely to be noticeable differences in the start-up and gear change characteristics. Each car model has its own character, and vehicle models may differ substantially from each other even within the same brand.

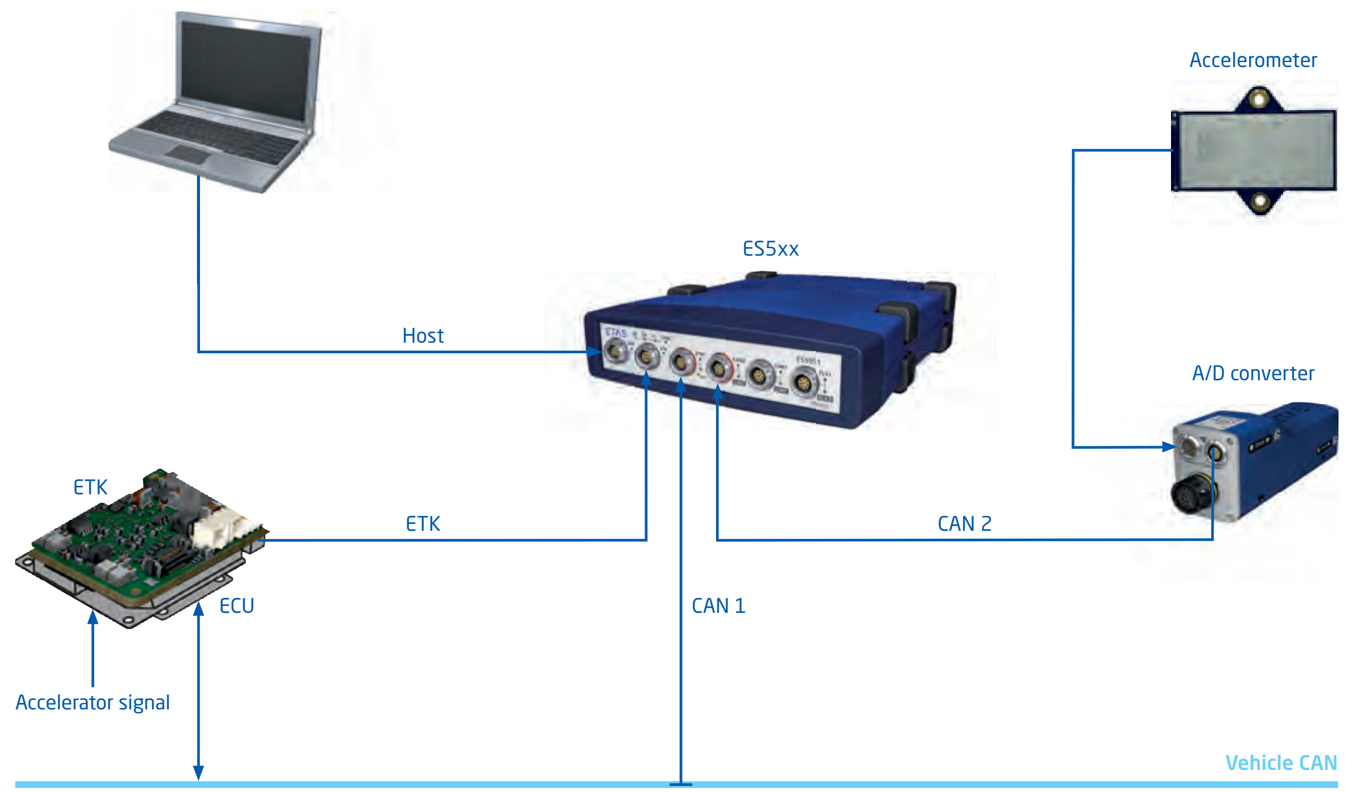
Calibration engineers are faced with the task of tuning each type of vehicle in line with the technical data specified for that model while simultaneously creating the desired level of drivability. Each vehicle's individual character largely stems from the driving behavior exhibited during forward motion, which is heavily dependent on the powertrain. Engineers have traditionally used a number of tools to tune the driving experience, but their subjective perception has also played a major role.



EDT toolchain – from the performance of driving maneuvers to the capture and analysis of measurement data and the presentation of results

Simplified calibration

In collaboration with IAV, ETAS has now developed an objective measurement and evaluation system that meets the auto industry's needs: the INCA-FLOW drivability toolboxes for the engine (EDT) and transmission (TDT). These toolboxes make calibration engineers' work considerably easier. The software tools are easy to use and fully integrated in the existing ETAS calibration toolchain. It takes just a few minutes for the toolboxes to gain access to the existing ETAS measurement hardware in the vehicle, for example, from the ES500 series. Instead of requiring their own sensors, the toolboxes simply read vehicle signals from existing bus systems such as CAN, FlexRay, and XCP. Engineers also have the option of using an external accelerometer that takes just a few moments to install on a seat rail.



Configuration of the measurement system

The process itself is simple: As the vehicle goes through its various driving maneuvers, the measurement and evaluation system records the physical parameters of the powertrain in real time. As a rule, the acceleration and speed signals are the best choice for providing reliable evaluation parameters for load changes, pedal modulation, gearshift sequences and start-up. The system evaluates this measurement data and displays the relevant drivability parameters as both numerical and graphical outputs, including comparisons with reference values. The system also provides the option of offline evaluation – for example with colleagues back in the office.

Rapid calibration chain

The relevant drivability parameters for forward motion can be changed even while a calibration test drive is in progress. The INCA-FLOW EDT and TDT toolboxes themselves determine the criteria (e. g., "jolting") based on objective rules and display them directly in the INCA experiment. That enables calibration engineers to shift the driving characteristics in the required direction quickly and efficiently.

The measurement and evaluation system really shows its strengths in situations where calibration targets are agreed with binding effect as acceptance criteria in the form of target parameters right at the start of the project. Engineers can then specifically measure these parameters during the calibration test drive and steadily optimize them to achieve the desired result.

In conclusion, the INCA-FLOW EDT and the Transmission Drivability Toolbox TDT are remarkably powerful tools for efficient vehicle tuning. One of their key benefits is the ability to replace calibration criteria that were previously determined on a subjective basis with objectively measured values. That makes the tuning process simpler and faster and makes it easier to draw comparisons. As a result, the system provides a successful method of delivering desired driving characteristics for numerous variants and models within short timeframes and with limited test vehicles.

Authors

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Storing entire test drives

Intelligent, systematic data acquisition

Electronics are the neural system of modern vehicles. Increasingly, electronic systems operate in connected environments and control safety-relevant functions – and that makes them even more complex to develop, calibrate, and validate. Developers need to come up with viable solutions that can keep pace with future developments. One promising approach is to systematically collect data from vehicle systems: Used intelligently, this data can render some test drives unnecessary, as well as facilitating collaboration between teams spread across different locations.

Improvisation is the name of the game in demonstrator vehicles. Piles of measurement hardware fill the trunk, connected by a tangled mass of cables that often leads to an off-the-shelf laptop on the passenger seat. This kind of setup is acceptable up to a point, but its flaws become evident once you start performing winter tests in arctic temperatures. Even in less extreme conditions, this improvised set of hardware poses a very real risk of cables coming loose or data recording being interrupted for some other reason during the test drive. With development cycles for new models running to ever tighter deadlines – and limited time available to spend on expensive hardware prototypes – these kinds of errors simply shouldn't be allowed to happen.

Given the growing number of ECUs and the increasing importance of electronically controlled vehicle functions, well-designed measuring equipment is crucial. As well as ensuring reliable measurements in any temperature range, it must stand up to vibrations and mechanical shocks and offer interfaces for all buses and networks commonly used in modern vehicles. It also needs to be compatible with existing measurement and diagnostic tools to enable calibration and test engineers to seamlessly integrate the new equipment into their standard processes.

Based on stable hardware designed for automotive use

For some time now, ETAS has been actively developing these kinds of reliable hardware solutions to provide a professional basis for testing in the lab, on the test bench, and in test vehicles. These solutions are specifically designed for automotive use, and they work at any temperature, from arctic cold (-40 °C) to tropical heat (+70 °C). A uniform, robust housing with a plug-in connection ensures clear, uncluttered integration. Stacking the modules one on top of the other ensures a reliable shared power supply and internal Ethernet data connection, minimizing wiring work and simultaneously solving issues such as synchronization, wake-up and shutdown. When cables do have to be plugged in, their connections are secured by robust LEMO connectors. The hardware modules also come with a PCI Express bus system.

The ETAS ES820 Drive Recorder is one of the latest additions to the strictly modular ES800 hardware family. Replacing an on-board laptop or INCA PC, it records all data and signals from ECUs, buses, networks, sensors, and measuring instruments for over 22 hours. Recording can begin when the engine starts; alternatively, it can be preprogrammed for certain measurement durations or trigger mechanisms, or initiated by the developers on a situational basis. Since the Drive Recorder – like all the hardware family modules – is compatible with ETAS INCA, developers and calibration engineers can design, test, and modify these mechanisms directly in whichever standard tool they prefer before putting them to use in the Drive Recorder. The advantage is that they can stick to familiar processes while gaining access to a whole host of additional functions for validating future development projects.

Full support for seamless processes

Validating the increasingly complex interaction between connected electronic vehicle systems is a major undertaking that requires drastic increases in the amount of testing and measurement work. Comprehensive documentation is essential, since many of the systems are relevant for the safety of vehicle occupants and for type approval. Fortunately, the ES820 Drive Recorder makes it easy to fulfill these requirements. Thanks to an exchangeable storage system with a capacity of up to one terabyte, the ES820 can capture all the data and measurement signals from an entire test drive and easily copy the results to the relevant in-house networks. The measurement data can be copied across at 200 megabytes per second using a suitable docking station. That means a full one terabyte hard disk can be ready for its next job in 30 minutes or less, and the specialists in the various departments involved can access the data immediately. This interchangeable system also enables seamless operation across multiple layers with different hard disks, paving the way for faster, more in-depth validation and eliminating delays between test drives and analysis.

To facilitate comprehensive datalogging on all channels, the ES800 system has connectors for ETK, FETK, and XETK interfaces, as well as all standard vehicle buses. That makes it easy to expand the system by connecting CAN, CAN FD, FlexRay bus, and Automotive Ethernet to the ES820 via its USB ports. All this is backed by a powerful Intel i5 processor and 4 gigabytes of working memory to ensure fast data processing. These specifications allow the Drive Recorder to be seamlessly integrated into existing toolchains and provide a good basis to meet future needs, particularly in view of new legal requirements – such as measuring real driving emissions (RDE) – which will see even sharper increases in the depth and complexity of measurement and validation processes.

Memory module and docking station

The ES820 Drive Recorder supports this option through the simultaneous multi-recording of multiple vehicle functions. To achieve this, an ensemble of measurement signals and various start and stop triggers can be assigned to each individual recorder. The recorders then run in parallel, storing the respective data in separate measurement data files at rates of up to 13 megabytes per second – a largely automated process that captures and records a comprehensive snapshot of in-vehicle processes. This is facilitated by four digital inputs and outputs on each device; the inputs can be used as triggers or markers, and the outputs for displaying system status and event messages.

Stacking the modules one on top of the other ensures a reliable shared power supply and internal Ethernet data connection

Broad basis for intelligent reuse of measured data

The broad range of data captured synchronously by the ES800 family of products facilitates precise, in-depth validation. Combined with deep learning and big data methods, it also paves the way for the intelligent reuse of measured data.

Recording this data end-to-end will create an increasingly comprehensive database as each project is completed. This will give users ever deeper insights into development and calibration, resulting in faster and more reliable validation. Systematically reusing data and executing measurement tasks in parallel reduces both overhead time and the need for expensive test vehicles.

ES800 stack
consisting of ES820 and ES891

INCA-TOUCH interface

INCA-TOUCH promises user-friendly operation and advanced connectivity

With its advanced functions, the ES820 Drive Recorder will replace the laptops and displays currently used in the field. That's good news, because operating laptops and similar devices during test drives can pose a serious safety risk. To ensure users can keep track of developments and interact with the measurement system even while on the move, ETAS is developing a solution that works in combination with INCA-TOUCH. This solution enables dedicated values measured by the Drive Recorder to be shown on a display.

As well as user-friendly operation, another key factor is connectivity. Just like so many other devices, measurement and diagnostic systems are part of an increasingly connected world. Modern vehicles, whether on the road or online, are also deeply embedded in the global flow of data. In the context of the new Drive Recorder, this connectivity will enable engineers to make adjustments while sitting at their desks – and even access data wirelessly where necessary. In this case, the data will be transmitted to a predetermined FTP/SFTP/FTPS data server. These kinds of remote functions were made available in the course of 2018 and will be gradually expanded in the future. With the ES820, developers are well equipped for the future flood of data.

Author

Thomas Schlotter is Product Manager responsible for the Drive Recorder ES820 at ETAS GmbH.

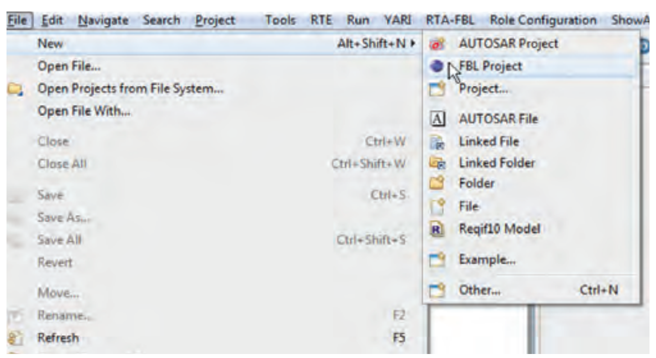
New ES830 Prototyping Module

Introducing the latest member of the ES800 family of products: The ES830 Rapid Prototyping Module is a powerful experimentation platform for the development and validation of ECUs and electronic vehicle systems – both in the laboratory and in the vehicle. It enables developers to run multi-ECU and multi-controller applications in combination with one or more simulation models. One of its most outstanding features is the ability to perform rapid prototyping of ECU functions plus measurement and calibration tasks on the ECU in parallel. Equipped with an Intel© Core™ i5 processor, the ES830 offers low latency and jitter. The stackable configuration provides a simple and secure way to expand the system, and the ES830's wide array of interfaces means it is fully prepared for the increasingly complex requirements of current and future vehicle generations.

Info Turn to page 16 to find out more about the ETAS prototyping solution.

RTA-FBL Flash Bootloader

Integrated in ISOLAR-B, the RTA-FBL Flash Bootloader further expands ETAS' AUTOSAR portfolio, enabling ECUs to be reprogrammed at every stage of the process – from the assembly line to updates at a repair shop. A generated instance of the RTA-FBL executes the start-up sequence, communicates with the tester to implement the reprogramming protocol and finally flashes the application software and the calibration data on the ECU. The flexible architecture of the AUTOSAR R4.x-compliant RTA-FBL supports multiple targets and is adaptable to various OEM-defined requirements. Customers who opt for the RTA-FBL can rely on the expertise of ETAS' engineers. That makes it much quicker for them to engineer their own solution while retaining the ability to configure relevant aspects of the bootloader software in accordance with OEM specifications.



The RTA-FBL can easily be launched from ISOLAR-B

Strategic cooperation

Forging links between research and industry is essential in an era of technological innovation. Daegu Gyeongbuk Institute of Science and Technology (DGIST) and ETAS Korea knew that a strategic collaboration was the right step to take.

Founded in 2004 as a research institute, DGIST is committed to developing talent in the realm of new technologies. The goal of its alliance with ETAS Korea is to share expertise, particularly in regard to AUTOSAR, a field in which ETAS offers solutions that cover the complete development cycle. ETAS will provide DGIST with tools and technical consulting for research and development projects, thus making a valuable contribution to the training of future specialists in the field of automotive IT. "I hope the cooperation will mean another leap forward not only for the growth of both DGIST and ETAS Korea, but also for the enhancement of Korea's automotive IT competence," says Jinhyung Kim, general manager of ETAS Korea.

DGIST
is a leading, fast growing science and engineering university that aims to facilitate national advancement by nurturing talented individuals through its innovative mix of education and research.

“Teaching virtualization is a great start!”

Master’s degree students learn model-based engine calibration at HAW Hamburg

Hamburg University of Applied Sciences (HAW) runs a Master’s degree program in automotive engineering that teaches model-based engine calibration from scratch. Over two periods of 16 weeks each, students get the chance to put their theoretical knowledge into practice. As Professor of Thermodynamics and combustion engines, Hanno Ihme-Schramm plays a key role in motivating his students to master the use of virtualization methods. This energy and enthusiasm is something that industry would do well to harness.

Professor Ihme-Schramm, what makes you so committed to the academic side of teaching prospective engine calibration engineers and function developers?

Function developers and engine calibration engineers are playing an increasingly important role in vehicle development, but there is a noticeable lack of rigorous academic training. Faced with the worldwide challenge of stricter emissions regulations and climate change mitigation targets, the automotive industry needs people who have expertise in established methods based on engine measuring technology as well as virtual methods, and who know which method is the most appropriate in each case. That’s why it is so important to familiarize the new generation of engineers with the opportunities offered by virtual engine development. Young people tend to be open to the idea of using new methods. They are not set in their ways to exploit the potential of virtual methods. If our graduates can offer the expertise these methods require, that will help the industry establish solutions that are fit for the future. And, of course, the potential offered by virtualization is not limited to powertrain systems.

How did you design the course to help students keep track of engine correlations and interactions in the complex process of model-based calibration?

Building on four engine-related lectures in the highly practical Bachelor’s program, we came up with two new lectures on “Engine management and engine calibration” and “Design of experiments and simulation” for the students on our Master’s program.

And are the new lectures proving to be popular?

Statistics and methodologies are not always instantly appealing! But I do my best to systematically link the topics to practical examples and build on a solid basic understanding of engine management. Our students learn the complex process flow of model-based engine calibration step by step, from design of experiments and measuring to modelling and evaluation. For most students, this is the first time they have been confronted with multi-dimensional parameter spaces, and it teaches them how to design experiments themselves. The model verification process gradually gives them a feeling for model accuracy, recalibration and map parameterization. They get an overview of the complete chain and can delve deep into the details in the comprehensive training exercises that we run in our engine calibration laboratory.

> “ETAS also gave us the go-ahead to install INCA on the computers, and our students can practice using it whenever they like using a self-study program.
>
> Prof. Dr.-Ing. Hanno Ihme-Schramm, HAW

What equipment do you have in the laboratory?

Twelve PC workstations that specifically support the application of virtual methods. That teaches students to think in abstract terms and enables them to work largely independently in the two 16-week periods of practical sessions. The computers run design of experiments (DoE) software from a range of providers, including ETAS ASCMO. ETAS also gave us the go-ahead to install INCA on the computers, and our students can practice using it whenever they like using a self-study program. The same applies to our own DoE-based engine simulator, because there is no need to worry about any expensive test bench systems getting damaged. The students are free to test their knowledge of engines down to the very last detail and practice deploying complex processes on the simulator. Essentially, it’s the simulator that is testing the students. Students leave our Master’s program with an excellent grasp of the relevant methods and a thorough understanding of model-based engine calibration. Half the students express an interest in using virtual methods in their final thesis, however skeptical they may have felt at the start.

How easy is it to transfer that enthusiasm into industry?

Numerous engineers specializing in engine development support the topic of model-based engine calibration in Hamburg, and I’m very grateful for that. But, over the course of my career, I have also noticed how companies are often skeptical about new methods. I have been working on the theory and practice of model-based engine calibration for more than 18 years, and I’m amazed how long it takes for method-oriented approaches to become accepted, despite all their advantages. Much of that comes down to people’s attitudes: a certain amount of trepidation and rejection is inevitable when you try to change well-established processes. But the way in which function developers and engine calibration engineers communicate and interface with each other can also be problematic, because they are basically two separate areas that think in different ways. That’s one of the reasons we teach both fields in a single module, because we want to make students aware of this interfacing issue. But we should probably do even more, for example by teaching engine students about the human factor and about change processes in day-to-day work. I have already made a start by incorporating relevant approaches from business psychology into my teaching. In order to cope with the impending switch to electrified powertrain technology and automated driving, the automotive industry not only needs new methods and trained specialists, but also people who have a deep technical and emotional appreciation of change processes and the ability to bring them to fruition. Teaching virtualization is a great start!

Interviewee

Prof. Dr.-Ing. Hanno Ihme-Schramm is Professor of Thermodynamics and Combustion Engines in the Department of Automotive and Aeronautical Engineering at Hamburg University of Applied Sciences (HAW) in Hamburg, Germany.

Formula Student with ETAS

Platform for technology development and talent acquisition

Formula Student has grown into an international event that puts new technology through its paces in the fields of high-performance motorsports, electromobility, and autonomous driving. One of the highlights of the season in this student engineering competition is the annual race held in Germany that boasts a line-up of 118 teams from universities around the world.

For the past six years, ETAS has been a key partner and sponsor of Formula Student Germany. This year it supported more than 30 international teams with hardware and software from its product portfolio as well as technical skills and assistance from its in-house experts. ETAS solutions give the sponsored teams a significant competitive edge in the race series. The company's products are especially popular in the development of drive systems and have earned an excellent reputation thanks to their ease of use, broad range of applications, and widespread industry support. For ETAS, the event is an opportunity to familiarize students with its products early on and to meet highly qualified and motivated young talents.

Formula Student Germany is divided into three independent categories: Combustion, Electric, and Driverless. In the Combustion category, teams battle it out with conventionally powered racing cars, while the Electric category sees electric cars compete for victory. The Driverless category, which was introduced last year, requires autonomous cars to recognize and complete a course unaided. A common thread through all three categories is that the cars competing are rated not just for their dynamic capabilities, but also for how well they fare in the economic and engineering disciplines of the competition. Their performance in these disciplines has a major impact on the final results.

The 13th edition of Formula Student Germany took place at the Hockenheimring from August 8 to 12, 2018. As the main sponsor, ETAS had its own booth at the event that proved to be a hot spot for technical questions, networking, meeting recruitment personnel, and enjoying some good coffee and chilled beverages. This year marked the Hockenheim debut the new „ETAS Blue Box". First unveiled at the 2018 embedded world trade fair, the Blue Box is a shipping container converted into a mobile ETAS exhibition booth. Equipped with a built-in counter and an ETAS LABCAR refrigerator, it was the perfect solution for the outdoor event at the Hockenheimring.

On the Monday, day one of the competition, the teams moved into their pits to ready themselves and their cars for the daunting challenges that lay ahead. But before they could demonstrate their technical expertise in the dynamic disciplines on the track, they first had to pass through the "scrutineering" stage – a series of tests designed to check the safety and race worthiness of the cars.

The static disciplines were held on Wednesday and Thursday, with the teams presenting their business plans, cost report, and engineering design. These disciplines are assessed by a jury of experts from a diverse range of companies in the automotive industry.

Friday was the chance for the teams to demonstrate their speed in the skid pad and acceleration tests. The skid pad test, which is held on a course in the shape of a figure of eight, aims to determine how much lateral acceleration the cars can generate. The acceleration test requires the race cars to accelerate as fast as possible over a distance of 75 meters. Saturday saw the teams go head-to-head in the autocross discipline, which also determined the starting order for Sunday's endurance round. Held on a circuit that is 22 kilometers long, the endurance round, which also includes an obligatory change of driver at the halfway mark, tests the race cars for their durability.

The teams gave their all, ensuring a sensational competition that had everyone on the edge of their seats right up until the award ceremony. In the end, it was the University of Stuttgart racing team that were victorious in the Combustion category, narrowly beating the Graz University of Technology team by just a few points. Coburg University of Applied Sciences took third place. In a double win, the AMZ Racing team from ETH Zurich took the top spot in the Electric and Driverless vehicle categories. ETAS has been supporting all the winning teams for a number of years, helping them develop race cars that incorporate ETAS hardware and software solutions. Congratulations!

Author

Klaus Fronius is University Liaison Manager at ETAS GmbH.

ETAS Support scores top results

Customer satisfaction continues to increase

The ETAS Support pursues the ambitious goal of providing consistently high levels of support to meet customer requirements. Top results in the latest customer survey confirm that the ETAS Support continues to meet this target.

First-ever global customer survey

The annual customer satisfaction survey has always formed a key part of ETAS' support activities over the years and 2017 was no exception. At the end of 2017, ETAS Support customers were once again invited to participate in an anonymous survey. Unlike in previous years, however, the 2017 survey was sent out to customers all over the world and provided in five different languages: German, English, French, Chinese, and Japanese. The next survey will be available in Korean, too.

Around 600 of the customers invited to take part seized the opportunity to share their feedback on their experiences with the ETAS Support. Key criteria such as "availability", "promptness of solution", "clarity", and "quality of responses" were evaluated using a points system, while comment fields gave customers the chance to provide more information on their general satisfaction, the strengths and weaknesses of the ETAS Support, and suggested improvements. In a third category, the survey asked customers how they rated the ETAS Support in comparison with other support providers.

The feedback from the survey gives the ETAS Support Team an in-depth understanding of how customers perceive the support services the company offers. Customer satisfaction levels remained high for the sixth consecutive year, and even surpassed previous years' results in certain categories including "quality of responses", as Figure 1 shows. This ongoing improvement is something the members of the ETAS Support Team can be proud of and is an incentive for them to keep up their good work.

Focus on personal contact

In intensive lessons learned sessions, the ETAS Support Team used the results of the survey as a basis to analyze customers' pain points, what customers value about the ETAS service in particular, and which additional services they would like ETAS to offer. The team then used their findings to develop and implement specific measures aimed at continuously improving the quality of support.

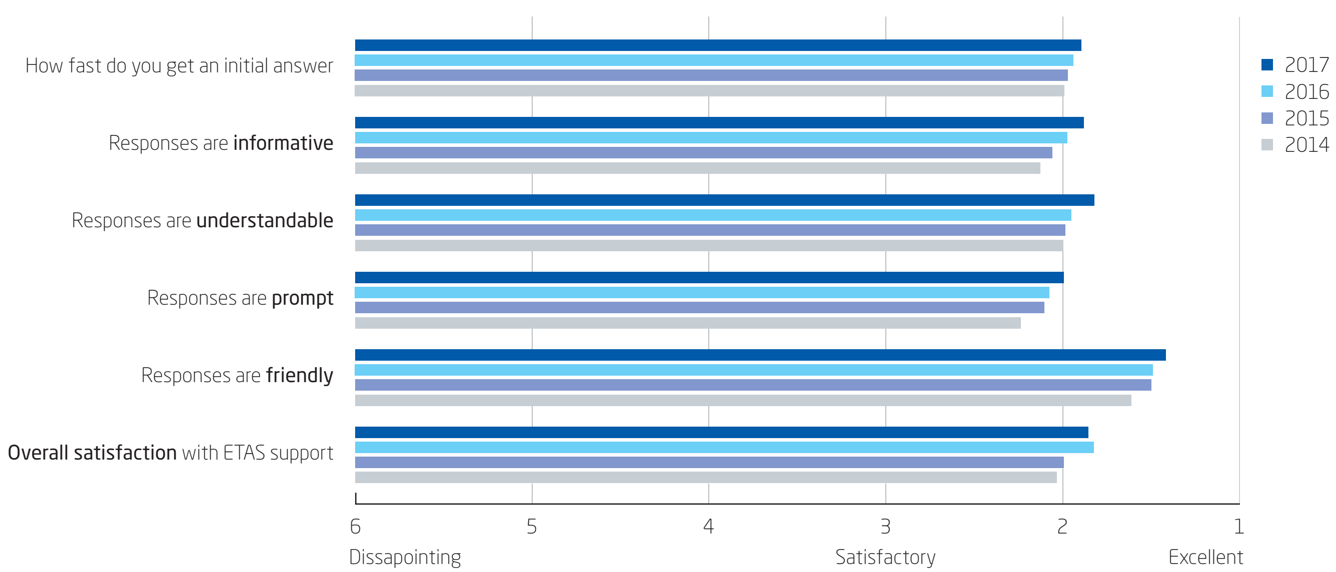


Figure 1: Quality of responses (2014 to 2017, average numbers)

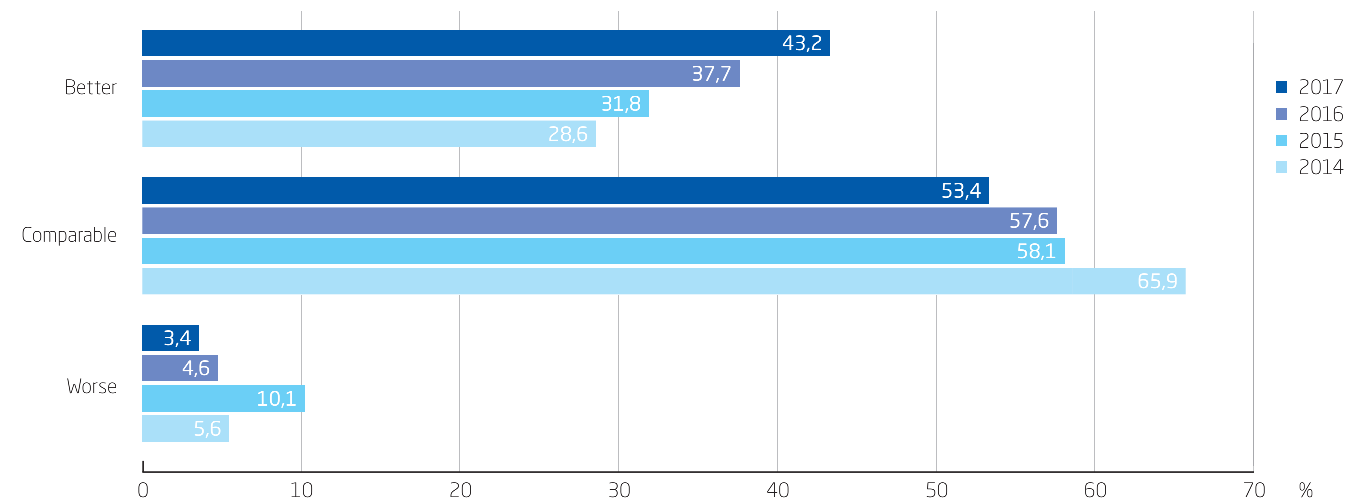


Figure 2: Availability compared to other service providers (2014 to 2017)

> "Almost perfect, friendly, competent, and easy-to-reach support service!

In the majority of cases, customers said they favored personal assistance from a member of the ETAS Support Team, despite the general trend toward self-service platforms and impersonal contact forms. This gives the members of the Support Team a sense of personal responsibility when it comes to solving customers' problems, and direct contact to specific customers also helps them tackle inquiries more efficiently and reduce the number of steps in the process. Personal contact also helps the team gain a greater understanding of each user's situation, which ultimately makes customer ties even stronger.

Sometimes numbers speak louder than words

Figure 2 highlights another notable achievement by the ETAS Support Team: respondents rated the ETAS Support Center's availability considerably better than other service providers in the market. The ongoing improvement in availability over the years is especially satisfying and the following comment from a customer sums up the result nicely: "Almost perfect, friendly, competent, and easy-to-reach support service!"

Open for criticism

This year's more than respectable survey results are certainly reason to be pleased, but the ETAS Support also responds to constructive criticism from customers. This kind of feedback offers valuable insights that can pave the way for targeted improvements.

Day in, day out, the whole Support Team works on maintaining the positive trend with the next survey in mind. Comments such as "Perfect support! We're extremely satisfied" certainly keep them motivated.

Author

Norbert Seidler is Expert Global Customer Support at ETAS GmbH.

One year in ETAS pictures

1 ETAS and ESCRYPT booth at the international trade fair **ConCarExpo** in Berlin, Germany. Key topics: ADAS and cyber security.

2 ETAS and ESCRYPT stood out at **embedded world** in Nuremberg, Germany with two attractive booths and a new booth concept. Inspiring talks on security solutions, open source software, and cloud development took place in the "ETAS open classroom".

3 As of April 2018, all ETAS associates are located under the same roof for the first time. Reason enough for the associates to affectionately call their new facility **ETAS Home**.

4 ETAS booth at the **Automotive Testing Expo 2018** in Stuttgart, Germany, with a focus on ADAS, ES800 modules, and cloud development.

5 **escar USA 2018**, hosted by ESCRYPT, took place in June. Over 300 attendees came together to discuss the latest approaches to cyber security in the automotive industry.

6 ETAS Brazil participated in the **International Symposium of Automotive Engineering** (SIMEA) in São Paulo. Key topics: measurement and calibration tasks for turbocharged engines.

7 The **JSAE** (Society of Automotive Engineers of Japan) **Annual Congress** held in Yokohama, Japan, was a resounding success for ETAS Japan. Key topics: ADAS, virtualization, electrification, and cyber security.

8 ETAS France presented its innovations at **Bosch TechDay** at the Renault Technocentre in Guyancourt, France. Key topics: SCODE-CONGRA, cyber security, the ES800 product family, and the ETAS Enterprise Automotive Data Management (EADM) environment.

9 ETAS UK participated in the **Cenex Low Carbon Vehicle Event** in Millbrook, United Kingdom. The ETAS Demo Car, equipped with SEMS (Simplified Emissions Measurement), was a highlight.

10 ETAS France participated in the **30th SIA Powertrain Conference** in Rouen, France. The ETAS Demo Car, equipped with SEMS (Simplified Emissions Measurement), took center stage once again.

Transformation at ETAS

Interview with Friedhelm Pickhard

ETAS will be celebrating its 25th anniversary in 2019, and you have been at the top of the company for the last eight years. How has the company evolved over that time? And what have been the biggest changes along the way?

The first thing I would point out is how much we have expanded the portfolio. For example, through the acquisitions of ESCRYPT GmbH and TrustPoint Innovations Technologies, Ltd., we were able to significantly expand our presence in the cyber security sector through the ESCRYPT brand. On top of this acquisitive growth, we have also built up our offerings for all stages of the V-model through organic growth – for example with new solutions such as ETAS ASCMO, the ES800 family of products, and our Real Time Applications Solutions for basic software, engineering services, and consulting services.

Broadening our portfolio has been accompanied by steady development of our expertise and methods. For example, we have already spent several years using SCRUM for agile software development, but now we are extending that process model to the entire portfolio management and development process, scaling it accordingly based on the SAFe method (Scaled Agile Framework). We also launched a working group to focus on the topic of Artificial Intelligence. In all these areas, we are determined to stay ahead of the curve and to help shape the changes that lie ahead, rather than being forced to simply follow the trends and market developments dictated by others.

The third key change has been the expansion of our international presence. By opening new locations close to our customers, we aim to provide them with even better support in their local area and establish the very best conditions for working with ETAS. That also means diligently and continuously assessing how our customers rate our current model of collaboration. As well as looking at the positive feedback, we are also determined to learn from the constructive criticism we get from our customers. We can leverage that as an opportunity and an impetus to keep evolving and improving what we do in the future.

How does that work in practice?

A lot of it comes from switching our mindset to one where we ask: How is the customer feeling about the whole interaction with us? And: What feedback are our customers actually giving us? The customer's use of the product is a key aspect here, of course, but it goes well beyond that. Other examples of questions we need to ask ourselves include: "How did the customer feel about the information phase?", "Did they get the offer they wanted quickly enough?", "How did delivery go?" and "Did we meet their expectations in regard to after-sales service?" We aim to inspire customers with our solutions and to transform every single touchpoint with us into an experience they see as positive. We have taken various steps to embed that mission throughout the company, including running a series of international workshops with all our associates. The workshops highlighted the various customer touchpoints and identified potential areas for improvement – areas that we are now specifically addressing.

How does all this affect the way you design and develop products?

First and foremost, it means that we "listen and understand" from the very beginning. The only way we can develop products and solutions our customers find useful is by genuinely listening to them – and that means fully appreciating and understanding our customers' problems, applications, requirements and challenges, and examining them from every angle. Every new development kicks off with user research. That marks a move away from opinion-based design – in other words developing and designing products and solutions based on individual, in-house opinions – and a clear shift towards needs-based design, which reflects what customers actually need.

Interviewee:
Silke Kronimus and Friedhelm Pickhard

This approach is often referred to as "design thinking". It transforms the entire product design and development process and puts a solid focus on continuous iteration in collaboration with our customers. Essentially, you follow up the first step of listening and understanding by reflecting on what you have learned, a step that also includes fleshing out the idea and concept. After that, we ask the customer for feedback – and we only continue with the development process if that feedback is positive. If we have failed to meet the customer's expectations, then we start the iteration afresh, and we keep doing that until we get the customer's official approval to move on to the next step.

That illustrates just how actively the customer is engaged in the design phase. Maintaining direct and regular dialog with the customer is the fundamental basis for offering them genuine added value.

How have customers reacted to this shift in mindset?

We have received some very positive feedback from our customers on this new approach, and they are increasingly starting to request this model of collaboration themselves. That is great news, because it confirms that we are on the right track. Plus it motivates us to delve even deeper into this whole area.

Are there concrete examples to illustrate this new approach?

ETAS EHANDBOOK – our product for interactive ECU software documentation – was developed on the basis of design thinking and needs-based design. We specifically drew on customer feedback in order to come up with concepts and solutions. A key aspect here is ensuring that each release implements a specific customer benefit instead of simply implementing features. It is essential that the customers experience concrete, tangible added value when they use the product or the overall solution. Our satisfied customers confirm that we are on the right track with this approach, as does the award of a recognized professional journal we received in the "Product of the Year" category.

Another example is the strategic analysis we carried out of all the touchpoints one particular large, global customer has with our company. We worked closely with the customer to analyze every part of the customer journey, meticulously identifying key areas for improvements at different points. We then continued that close collaboration with the customer when it came to defining targeted measures and putting them into practice.

What else must you do to keep pace with the constantly evolving environment ETAS works in?

Corporate culture is key. It provides a framework for in-house collaboration, and it also forms the basis for how we present ourselves to the outside world and how people perceive us. Through our initiative aimed at continuously improving our corporate culture, we strive to live our brand promise consciously within the company. These include, for example, organizing regular meet-ups of all the managers, open discussion rounds between management and departments, stepping up our internal communication, and getting associates at different levels more involved in the whole process, because listening to our associates and understanding how things are going on the inside is equally important!

That was the reason the ETAS associates in Germany were so heavily involved in the design and construction of our new headquarters in Stuttgart. The name chosen for the building, "ETAS Home", makes it clear just how strongly people identify with it – it is clearly much more than just an office!

At the same time, we endeavor to give our associates the space they need to develop their capabilities and skills. And everyone on our team needs to be constantly adapting to changes and working together to find the best solutions. Only by fostering enthusiasm for ETAS among our own employees can we succeed in creating concrete customer benefits with our solutions and the way in which we implement them. That, in turn, will generate the same kind of enthusiasm among our customers – both today and in the future.

Interviewee

Silke Kronimus is Director Marketing and Communications at ETAS GmbH. Friedhelm Pickhard is Chairman of the Board of Management of ETAS GmbH.

"Harmonious interplay"

Dr. Thomas Wollinger discusses holistic security for the networked vehicle

The automotive industry is in a state of flux, and automotive security is emerging as a key success factor. Dr. Thomas Wollinger, Managing Director of ESCRYPT GmbH, explains how mindsets and actions are changing direction – and why this calls for a conductor.

Dr. Wollinger, is the automotive industry starting to pay more attention to security issues?

Dr. Thomas Wollinger:
It's really exciting to see how things are taking shape. The industry is facing a fundamental shift, including completely new business models based less on selling cars and more on data-driven services. As digitalization and connectivity extend their reach, we are continuing to witness the death knell of traditional vehicle platforms with static control units and the advent of Ethernet-based platforms with distributed and connected ECUs. Individual embedded security functions just don't cut it anymore. We must think and act beyond the vehicle and take a holistic approach.

What do you mean by that?

Dr. Thomas Wollinger:
When we talk about the future, we're talking about connected and automated driving. And this is based on exchanging data in real time, which provides a bigger target for attacks and means that threats take on a whole new dimension. When vehicles become rolling computers in a network, IT security becomes a question of personal safety.

So the car as a system needs to be completely protected, as does the communication among vehicles and between vehicles and roadside equipment, as well as the traffic infrastructure itself. And we must do this throughout the entire life cycle. We need to protect vehicles that will be on the road for 15 years or more from cyber attack methods we haven't even experienced yet. Achieving that means having the right processes and organization in place right from the start. Holistic automotive security, as we at ESCRYPT understand it, requires effective protection for the entire system and its infrastructure. We need to apply that to the entire life cycle and provide the corresponding organizational support.

So that's the theory – but how does it translate into practice?

Dr. Thomas Wollinger:
A prime example is our intrusion detection and prevention solution: Security software in the vehicle monitors the central ECUs and gateways. Anomalies in the electrical system communications are detected, documented, and forwarded to a security operations center in the backend. There, tools analyze the aggregated data and, in the event of a cyber attack, security updates are carried out for the whole fleet in line with defined incident response procedures. The major advantage is that new attack patterns are detected as soon as one vehicle is targeted, so immediate steps can be taken to protect the entire fleet. What you get is a kind of immune system in which IT security mechanisms are sustainably maintained over the entire life cycle and supported by the organization.

In other words, the IT security of an automaker's fleet hinges less on the security measures themselves and much more on how these are coordinated and managed.

Dr. Thomas Wollinger:
Absolutely. For OEMs, protecting their vehicle fleets will be a constant, complex, and crucial task. They will require predictive concepts, concrete security structures, and sufficient resources. And they will need a central security management function that ensures the harmonious interplay of all the security measures, providing guidance to everyone involved at the OEM as well as to external service providers, suppliers, and workshop participants – similar to how a conductor leads and develops an orchestra.

Just as automakers already orchestrate the processes and requirements of their core business, in the future they will have to orchestrate automotive security. The only route to smart mobility is through effective IT security. ■

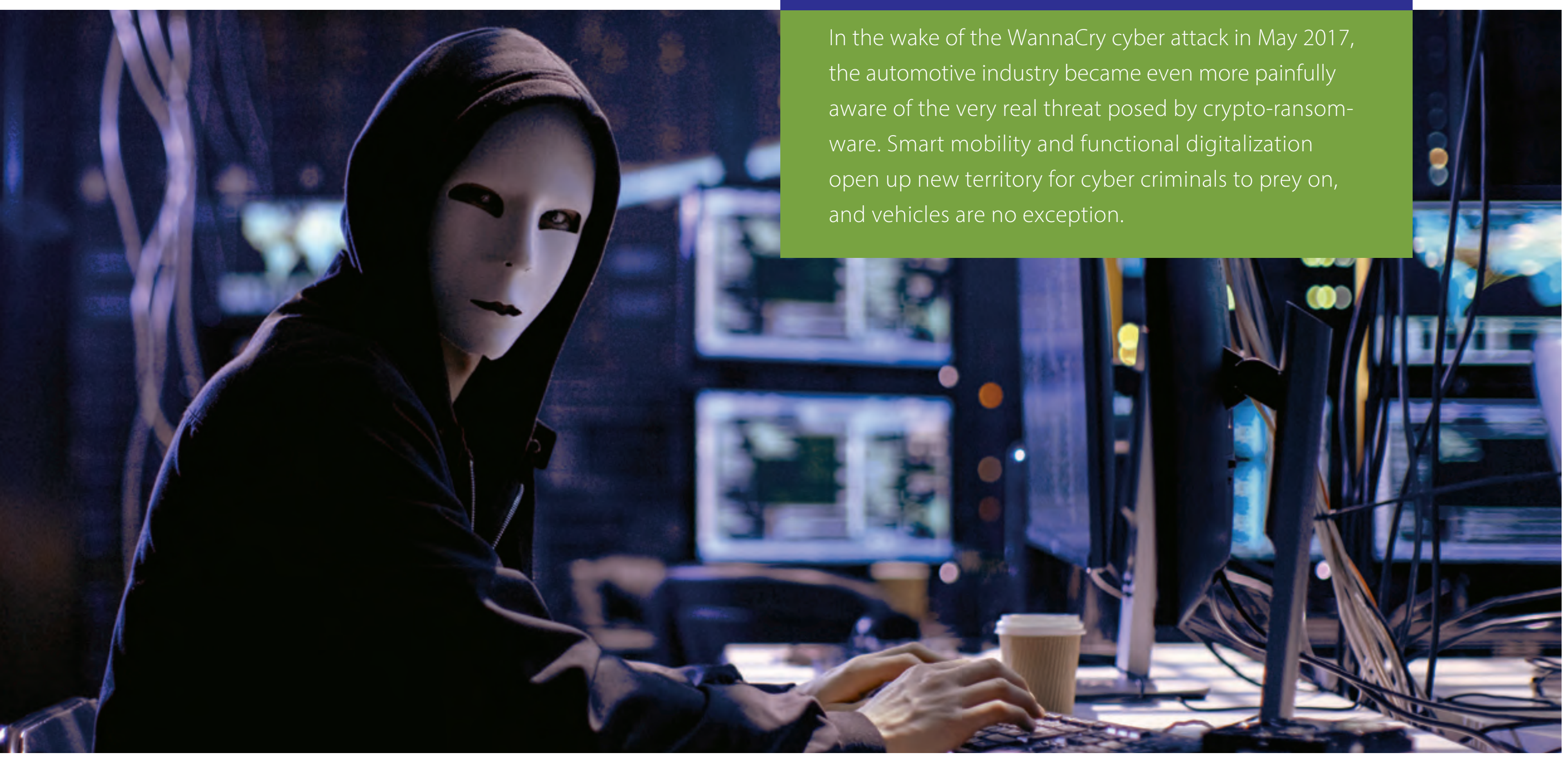
Dr. Thomas Wollinger – Managing Director of ESCRYPT GmbH

> "When vehicles become rolling computers in a network, IT security becomes a question of personal safety."

Dashboard demand for ransom payment

WannaDrive? Holistic IT security helps combat automotive ransomware

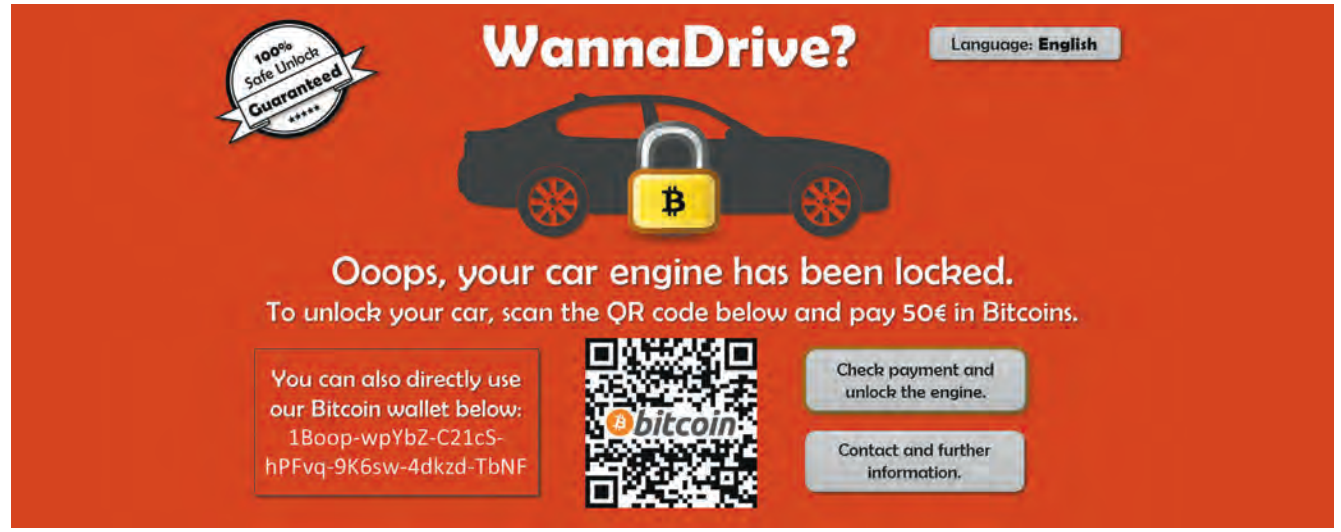
In the wake of the WannaCry cyber attack in May 2017, the automotive industry became even more painfully aware of the very real threat posed by crypto-ransomware. Smart mobility and functional digitalization open up new territory for cyber criminals to prey on, and vehicles are no exception.



Commercial vehicles and vehicle fleets are high on the list of targets for online extortionists. Potential victims include trucks transporting perishable goods on tight delivery schedules, bus companies, rental car fleets, car-sharing pools, expensive construction machinery, and special-purpose vehicles, to name just a few examples. If cyber attackers succeed in taking these vehicles as digital hostages using ransomware, their chances of coming away with the cash are pretty high.

Ransomware attacks take little effort to orchestrate

Although there are no known cases of ransomware attacks on vehicles to date, a look at real-world examples from other sectors make it easy to conceive a likely attack scenario. Cyber criminals usually rely on a ready-to-use ransomware kit or ransomware-as-a-service solutions, which include bot masters and bitcoin payment systems. Ransomware kits have thus far primarily targeted conventional desktop PCs and servers. But with the number of vehicles open to such attacks and fleet operators' vulnerability to extortion in the connected network increasing, ransomware variants for Automotive Linux or AUTOSAR will inevitably start to appear. There are already numerous potential access points for ransomware. Examples include infotainment systems that retrieve online content; in-vehicle reception of communications (such as emails, text messages, instant messenger services, digital radio); smartphones or navigation systems that are connected to a port in the vehicle; firmware updates over-the-air



If ransomware successfully hijacks the system, it proves extremely difficult to free the car, a digital hostage, from the hands of the cyber criminals

(FOTA); and cloud services or remote diagnostics from the vehicle manufacturer.

Security engineers from ESCRYPT were able to simulate a ransomware attack using a test model. They took a Raspberry Pi computer running Linux OS and a touchscreen as the automotive infotainment system. The next step was to connect these to a genuine speedometer control unit with OEM firmware using a gateway ECU and a proprietary bus network – as would be the case in a normal vehicle. They subsequently exploited a USB port to "infect" the Raspberry Pi, or host ECU, with Python-based ransomware. As intended, the ransomware client then locked the speedometer and set it to display the top speed at all times. At the same time, a demand for a ransom payment to an anonymous bitcoin account flashed up on the infotainment system's touchscreen (see Figure). The ESCRYPT experts concluded that ransomware attacks on vehicles are easy to execute and pose a real threat – if IT security is not continuously upgraded to address the increasing connectivity of motor vehicles.

Holistic security approach prevents attacks from the outset

Despite their numerous vulnerabilities to attacks, vehicles on the road today often fail to provide backup for important data and functionalities. Nor do they receive regular security updates. What's more, most of today's vehicles have only very basic (gateway) firewalls and rarely feature automatic intrusion detection and prevention systems (IDPS) that provide proper protection. Upgrading these vehicles is usually difficult and costly. The most effective way to protect vehicle IT systems against ransomware and other forms of cyber attack lies in automotive manufacturers integrating comprehensive and effective information security into the development of their vehicle platforms from the outset. An all-encompassing security approach should address the entire vehicle system from end to end – including its IT infrastructure and the entire life cycle of the vehicle until it is scrapped. It should also cover the complete spectrum of organizational aspects such as defined security processes and security governance.

The comprehensive protection of vehicles therefore necessitates a series of interconnected security measures. In vehicles themselves, embedded security components can help defend against hacker attacks and malware with known signatures. Moreover, an intrusion detection and prevention system (IDPS) can detect and shut down critical anomalies in onboard network communications – including ransomware attacks. This can be achieved within the vehicle itself. Alternatively, a connected cyber security operations center (SOC) in the backend can distribute security updates to an entire fleet of vehicles to counteract a newly detected hacking pattern. But what if a ransomware attack succeeds? In such a case, the victim needs to respond quickly and effectively. A pre-defined incident response procedure, for example, can be used to specify countermeasures, one of which might even be payment of the ransom demand as a last resort in an emergency.

One thing is for sure: the potential threat that ransomware poses to vehicles calls for effective, end-to-end security – and this should not be seen as a costly burden, but rather as a key factor for success. After all, this security gives fleet operators and vehicle manufacturers the protection they need to ward off online blackmailers, and prevent product recalls and claims for damages. ■

Author

Dr.-Ing. Marko Wolf is Head of Consulting & Engineering at **ESCRYPT**.

Protection for smart factories

End-to-end protection against cyber attacks – a must in connected manufacturing

These days, everyone is talking about the advantages of fully connected, automated, and self-regulating processes in Industry 4.0. When production facilities become accessible via industrial Ethernet and internet protocol (IP), however, they become vulnerable to new risks and targets – but these have proved to be a less popular topic of conversation. To prevent intrusion and extortion by cyber attackers, holistic IT security solutions are required.

Time is of the essence. Picture a facility in which production processes run at full capacity 24 hours a day. Suddenly, the touchscreens on several machines fail. When the personnel check to see what is wrong, they realize that access to the central process data is blocked. It is not long before they receive a blackmail threat by email.

This is not a made-up scenario. Since 2016, Germany has been hit by six major waves of cyber attacks. According to the Federal Office for Information Security (BSI), some of the companies affected saw their operations grind to a standstill for several weeks and re-ported losses amounting to millions of euros. The BSI reports that attacks on plant control systems and industrial computers are on the rise. This upward trend is attributable to increasing numbers of connected processes which create new targets for cyber criminals. BSI president Arne Schönbohm is understandably worried: "We're seeing an ongoing surge in IT security incidents; they are occurring with increasing frequency and reaching new levels of sophisti-cation." At the dawn of Industry 4.0, this is clearly an unsettling message.*

Industrial Ethernet offers better performance but poses new risks

Industry 4.0 promises to bring enhanced efficiency, transparency, and flexibility to production processes – but also comes with a greater number of risks. Connected environments see the field-buses used in the past replaced by Industrial Ethernet, while production systems can be accessed via internet protocol (IP). Opening the systems to the outside world in this way increases the risk of unauthorized access to the control software and to sensitive data. The recent spate of attacks – many of them successful – shows that even global corporations with highly advanced IT infrastructure underestimate the risks.

Small and medium enterprises do not always make the necessary investments in cyber security, either. Many falsely assume that hackers would have no interest in their production facility. They run their production IT systems non-stop and often miss updates as a result, which is precisely what makes these companies so vulnerable to both manual and automated attacks. Even machines not connected to the smart factory are at risk from attack during maintenance, for example, or via unauthorized USB interfaces. Blackmailers can moreover target production operations as part of wider supply chains. And if that is not reason enough to take precautions against cyber criminality, new regulations such as Germany's IT Security Act stipulate that companies must implement industrial IT security measures by law.

A job for the experts

The only way to reliably protect connected production facilities from the dangers of cyber criminality is to put holistic security solutions in place. It takes a deep understanding of heterogeneous IT systems in the production environment to perform the detailed status quo analyses required to systematically identify and evaluate risks, and to define security objectives. Security concepts must allow for maintenance and updates in facilities where machines run around the clock, and account for multiple operators accessing individual systems – which makes password protection a highly impractical solution. In-house IT departments – perhaps more accustomed to dealing with office IT – are rarely in a position to develop holistic security solutions for their production systems alone. This is where the experts come in.

After all, security needs to be addressed at all levels and appropriate governance developed in order to firmly embed IT security in organizational structures, in processes, and in people's minds. Verification of the solution's effectiveness using the PDCA cycle (plan, do, check, act) is equally as important as having an information security management system in place (ISMS). Cornerstones of holistic protection include prevention of risks, identification of critical incidents, and initiation of quick responses to defend against such incidents. End-to-end security solutions must also enable conclusions to be drawn about future threats. Only in this way can companies ensure the integrity, availability, and authenticity of all IT components and systems in their connected production facilities, and protect the confidentiality of the associated data.

Concrete security measures

Given the heterogeneous nature of IT systems, existing production lines are difficult to protect. For this reason, it is advisable to transfer protection measures for individual machines or security zones to upstream systems. That, first of all, shields process communication from the outside world and filters out any suspicious network traffic. It moreover enables antivirus software, defense functions, application recognition, and user identification to be updated without stopping production activities. Zone models also provide protection whereby firewalls monitor communication between individual production zones. Based on source and target information, they filter out unauthorized network traffic. Setting up these zones calls for IT experts to work closely with production experts. And, if a secure environment is divided up in this way, it is important to ensure that tasks such as implementing updates or changes, or legally compliant reporting, remain easy to manage.

Best practice: end-to-end security by design

The situation is different in new smart factories, however, because industrial cyber security can be integrated directly into the software and hardware control systems for the production lines in the planning stage. Security organization, continuous IT security management, and protection of components and systems can be harmonized from the outset and designed to cover the entire lifecycle of the plant and machines. This end-to-end security by design approach means that production facilities become connected IT systems in themselves, which puts security at the very heart of Industry 4.0. ■

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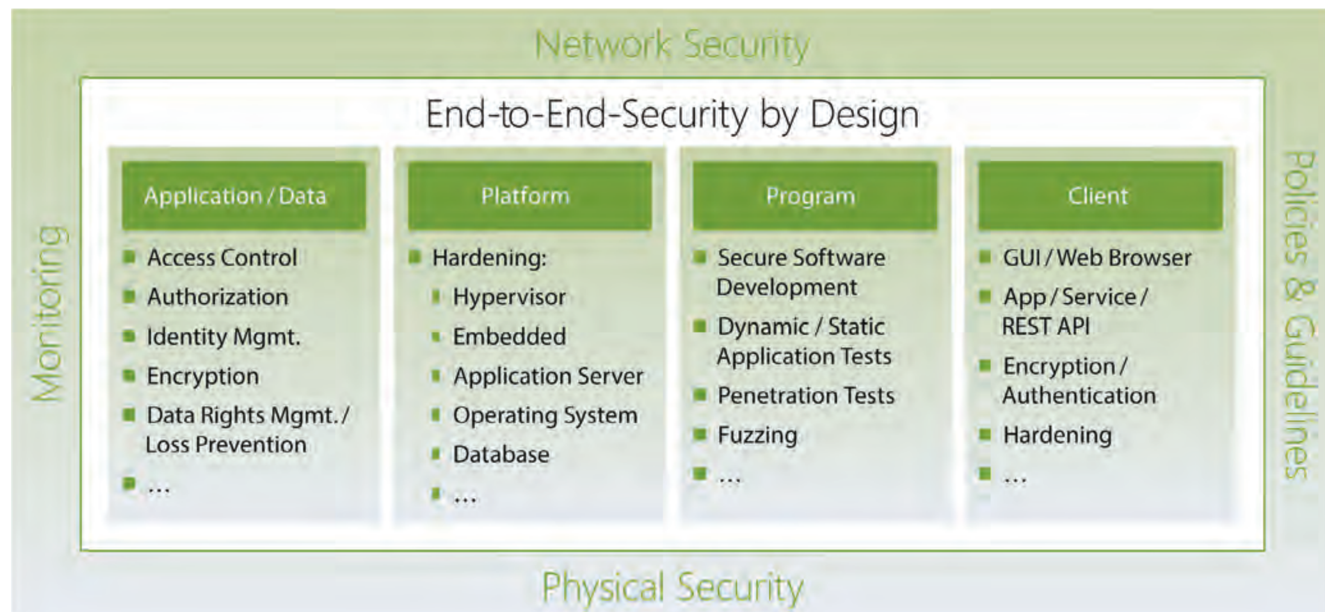


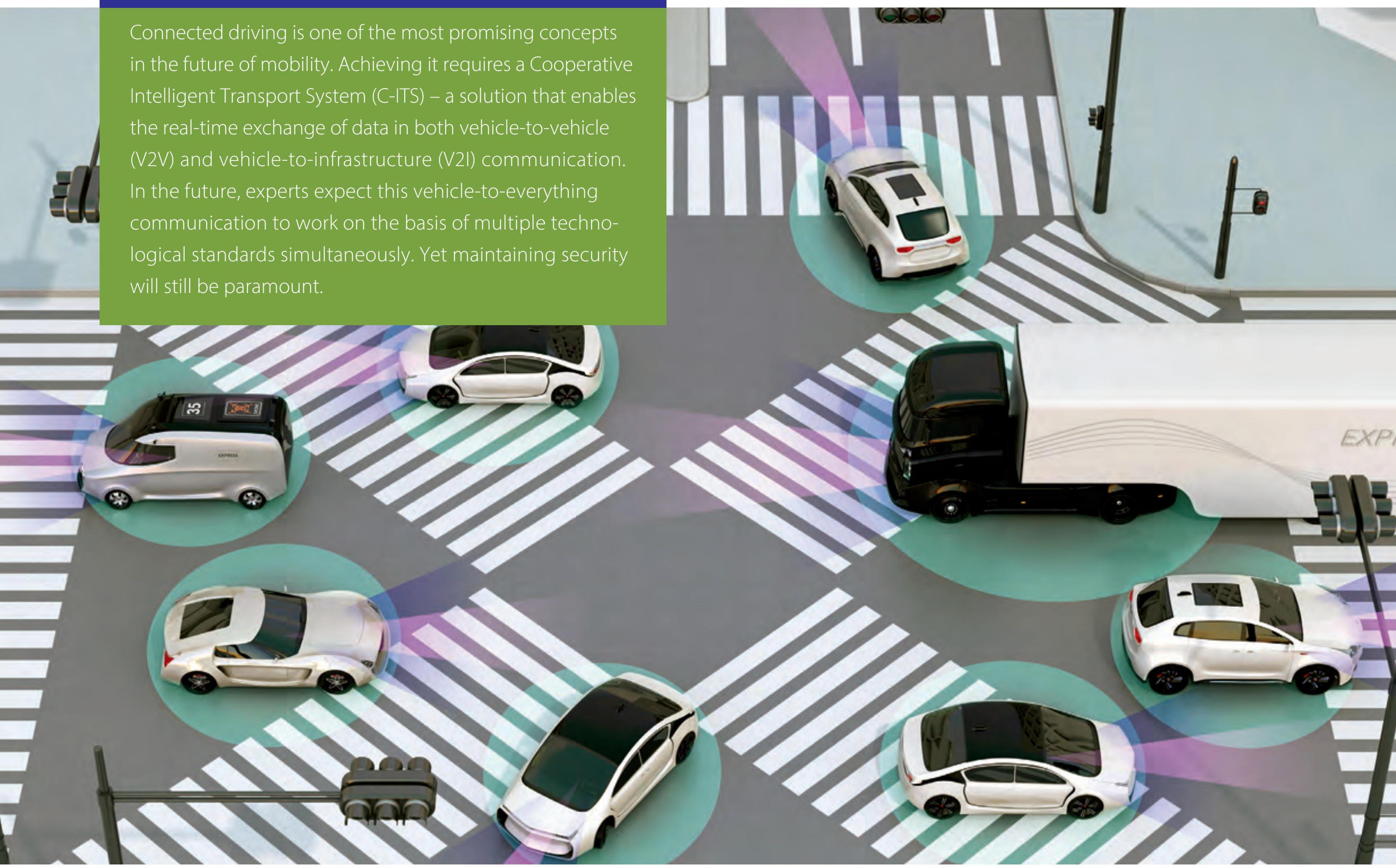
Best Practice – End-to-End-Security by Design

*) Source: BSI-Magazin 2018/1

Homogenous security for hybrid V2X communication

Standard solution enables versatile data transfer during connected driving

Connected driving is one of the most promising concepts in the future of mobility. Achieving it requires a Cooperative Intelligent Transport System (C-ITS) – a solution that enables the real-time exchange of data in both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. In the future, experts expect this vehicle-to-everything communication to work on the basis of multiple technological standards simultaneously. Yet maintaining security will still be paramount.



Up to now, direct V2X communication has been based primarily on ITS-G5, a dedicated short-range communication (DSRC) standard. That means the vehicles and roadside equipment essentially exchange data through direct wireless LAN communication. But this situation is set to change. Efforts are already underway to implement parallel use of another standard for V2X data exchange, namely the LTE-V standard for high-speed wireless communication (currently 4G, soon to be 5G). With new kinds of wireless chips installed in devices, that will make it possible to include other road users (e. g., pedestrians or cyclists) in the communication process in the form of direct, ad hoc data exchange between devices (C-V2X autonomous). A number of other standardized concepts will also be added to the mix, including mobile edge computing (MEC), which distributes messages via a cellular network at close range (e. g., for tailback warnings), and traditional wireless communication via cell towers for communication with cloud and backend services (see Figure 1).

Protocol stacks with a consistent, intelligent structure

The likelihood is that we will see various types of V2X communication designed to serve different channels and standards depending on the particular use case and entity. That raises the question of how to secure this kind of hybrid V2X communication in the most efficient manner. It would be entirely wrong to think that each of the different transmission channels should have its own security solution. Instead, what is called for is a security concept that is effective across the full spectrum of V2X communication with all its different use cases.

> That raises the question of how to secure this kind of hybrid V2X communication in the most efficient manner.

The solution lies in ensuring the protocol stacks used for V2X communication between all V2X devices and entities have a consistent, intelligent structure (see Figure 2). V2X messages are generated on the application or device level and relayed to the transport and transmission level. This is where the security header is added to each V2X message via the security components interface. The header includes the message signature and the associated certificate; if necessary, the message can be symmetrically encrypted in a second step. Information relating to the symmetric key is included in the header to enable recipients to decrypt the V2X message. To ensure data protection for the entities communicating via the V2X network, each V2X message receives a signature before it is encrypted. Even within a hybrid communication network, this method fulfills all the security requirements for V2X data exchange: data integrity, sender authenticity, sender authorization, replay detection, confidentiality, privacy protection, reliability, and revocation of trust.

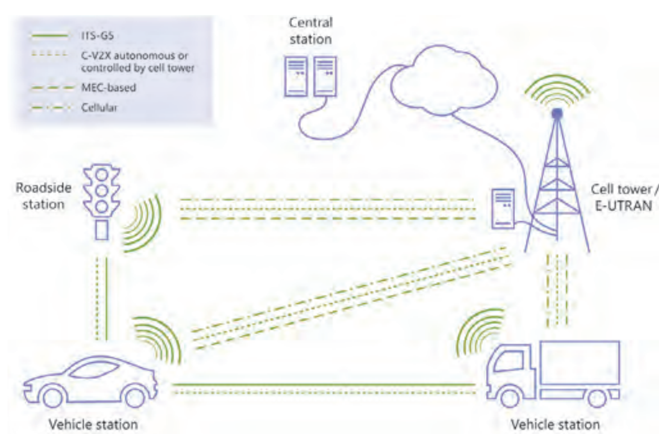


Figure 1: Hybrid V2X communication architecture

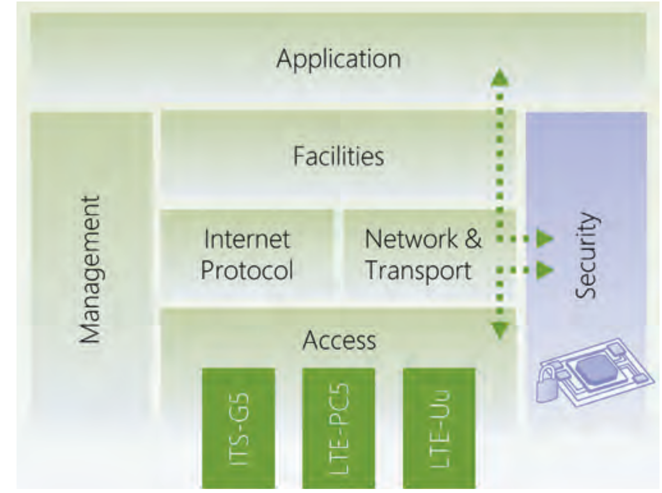


Figure 2: Software stack for consistent V2X security in hybrid communication

Road testing with the CONCORDA project

Hybrid communication for vehicles is a sensible and useful development for connected driving. It paves the way for integrating more systems, road users, and services into V2X data exchange. At the same time, IT security is and will remain a necessary and fundamental condition for V2X. Establishing an intelligent concept means providing consistent, homogeneous, and efficient IT security across the various V2X communication channels and standards.

A trial run is currently underway on test routes in the Netherlands, Belgium, Germany, France, and Spain in the shape of the CONCORDA (Connected Corridor for Driving Automation) project, which is funded in part by the European Union and carried out in collaboration with companies including ESCRYPT, Deutsche Telekom, Nokia, Bosch, and Volkswagen. By mid-2020, CONCORDA will have shown how a hybrid V2X communication system with ITS-G5, LTE connectivity, and a consistent IT security architecture performs in practice. ■

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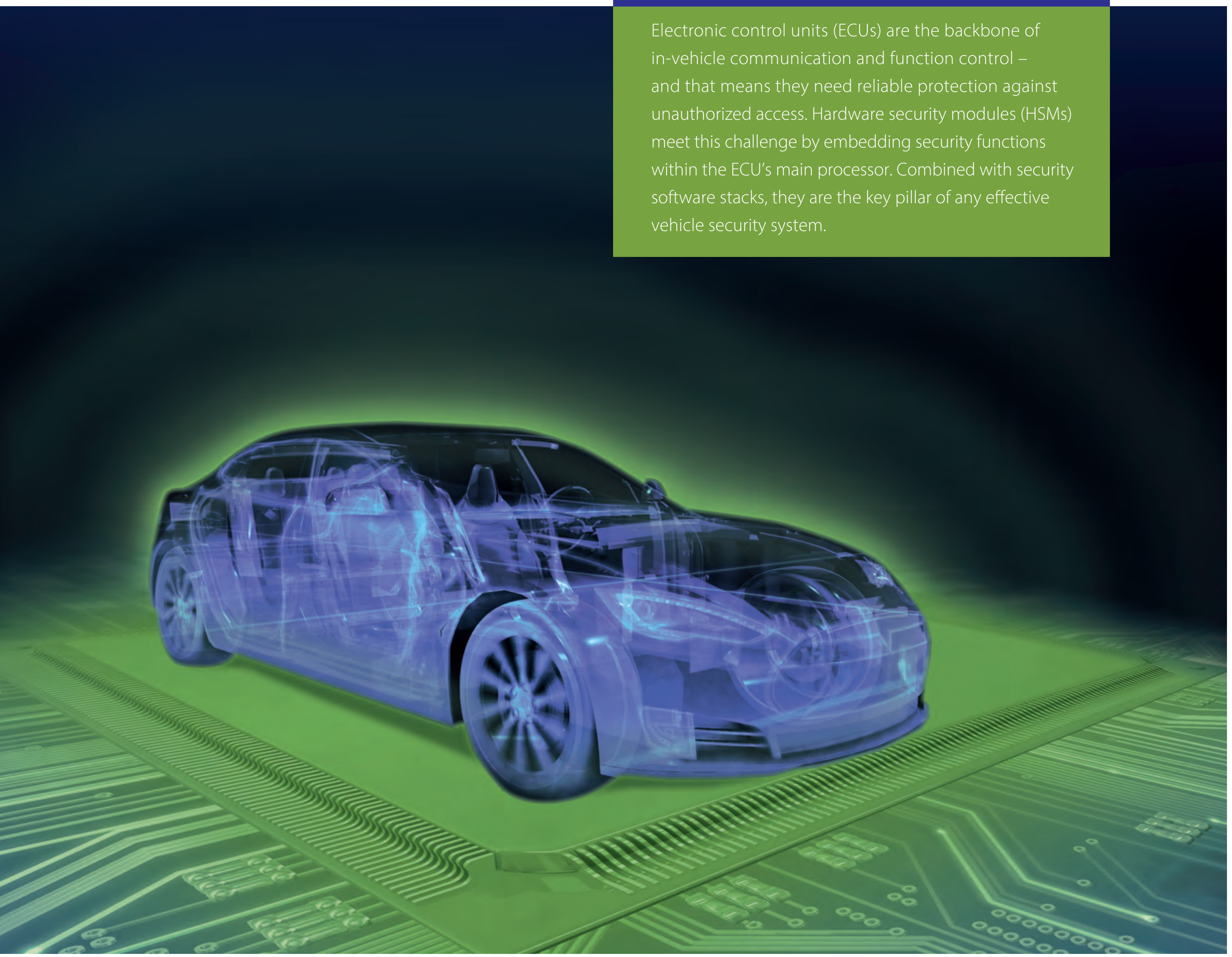
Automotive security from the inside out

Hardware security module (HSM) offers protection inside ECU's main processor

Electronic control units (ECUs) are the backbone of in-vehicle communication and function control – and that means they need reliable protection against unauthorized access. Hardware security modules (HSMs) meet this challenge by embedding security functions within the ECU's main processor. Combined with security software stacks, they are the key pillar of any effective vehicle security system.



When chip tuners access powertrain ECUs to modify system parameters, noise and emissions restrictions are the last thing on their mind. Yet perhaps even more unsettling is the very idea that they can access electronically controlled vehicle systems in the first place.

The problems that a malicious hacker could cause in a powertrain or chassis ECU simply do not bear thinking about. Every ECU in a vehicle's electrical system is a potential target, especially when it comes to connected vehicles. To prevent unauthorized software manipulation and access to critical key material, modern vehicles need robust IT security mechanisms to shield them from the outside world. That's exactly what hardware security modules (HSMs) do by implanting security functions right at the heart of ECUs.

Automotive-specific HSMs

HSMs are a form of hardware that physically encapsulates security functions. Specifically designed for IT security applications, these integrated chips typically have their own processor core, various types of memory (e. g., RAM, ROM, flash), and hardware crypto accelerators. HSMs must also meet specific standards for use in vehicles, and highly efficient integration is essential to keep costs down. Key requirements include secure interfaces between the ECU application and the HSM as well as debugging and testing interfaces for analyzing malfunctions. HSMs must be able to process cryptographic information with minimal latency and exhibit adequate resistance to the typical temperatures found in automotive environments.

Several leading chip manufacturers already offer hardware security modules with automotive-grade architecture, including Infineon, ST Microelectronics, Renesas, and NXP. Essentially, the HSM uses its own processor core to provide all the IT security functions required for automotive use cases. These include a 128-bit AES hardware accelerator, a true random number generator (TRNG) to generate key material, hardware-protected storage of cryptographic keys, flash and debugging functions, and the HSM's own RAM that is separate from system memory (see Figure 1).

Tailored security software and real-time communication

An automotive HSM only really comes into its own in combination with a secure software stack. If the HSM is the nucleus of vehicle IT security, then HSM security software is its genetic code. ESCRYPT provides this in the form of its CycurHSM security firmware, which is specifically tailored to automotive HSMs from a range of manufacturers. CycurHSM links the existing hardware security peripherals to the relevant HSM and host controller applications. The firmware also implements a comprehensive cryptographic library on the HSM including symmetric and asymmetric encryption mechanisms and additional HSM-based security functions. CycurHSM also includes the AUTOSAR-compliant and non-AUTOSAR-compliant interfaces required to integrate HSMs in standard vehicle ECUs.

The core element of the software architecture is a real-time operating system. This ISO 26262-certified system is specifically

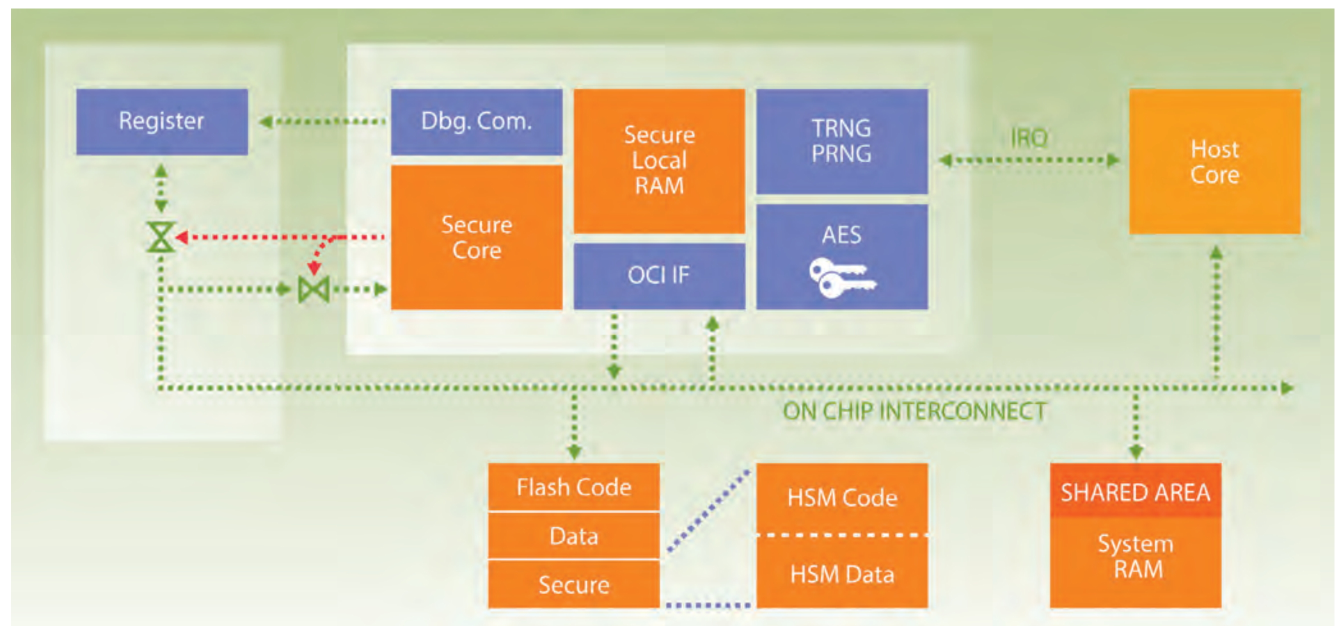


Figure 1: Hardware architecture of the hardware security module (HSM)

tailored to automotive ECUs and supports real-time HSM functions such as secure in-vehicle real-time communication. The operating system works with minimal runtime overhead and is MISRA-C-compliant. CycurHSM includes a session manager that implements priority-based task scheduling. For example, the validation of new messages on the vehicle bus takes priority over non-time-critical operations. It also incorporates a keystore manager that governs both access to and generation, storage, and deletion of key material in the HSM and supports symmetric and asymmetric keys of different lengths. The cryptographic library (CycurLIB) provides the cryptographic primitives (ECC, RSA) using the HSM's crypto accelerator. Where required, a SHE emulation can also be run on the HSM while accessing the cryptographic library in order to meet enhanced automotive-specific requirements (SHE+). In addition, dedicated HSM drivers secure communication between the HSM and host processor: an AUTOSAR-compliant crypto service manager (CSM) at the interface to the HSM ensures that AUTOSAR applications can access the module at any time (see Figure 2).

- Enables simple customer integration through standardized interfaces to HSM
- Fully programmable – can be configured to meet specific needs thanks to its modular structure
- Multicore support

This feature set enables the HSM software stack to support a broad array of security use cases. It provides a standardized interface that can be used to implement a variety of IT security functions either on the HSM itself or in concert with the host processor, in all cases based on strong cryptography. These functions start with secure boot – in other words checking the code stored in the flash memory each time the ECU is activated – and also include runtime manipulation detection and secure flashing as well as authentication of software download providers and a secure log function for reliably documenting security-critical events. The core principle in all these cases is mutual authentication of the requesting instance and the HSM. This also applies to secure debugging,

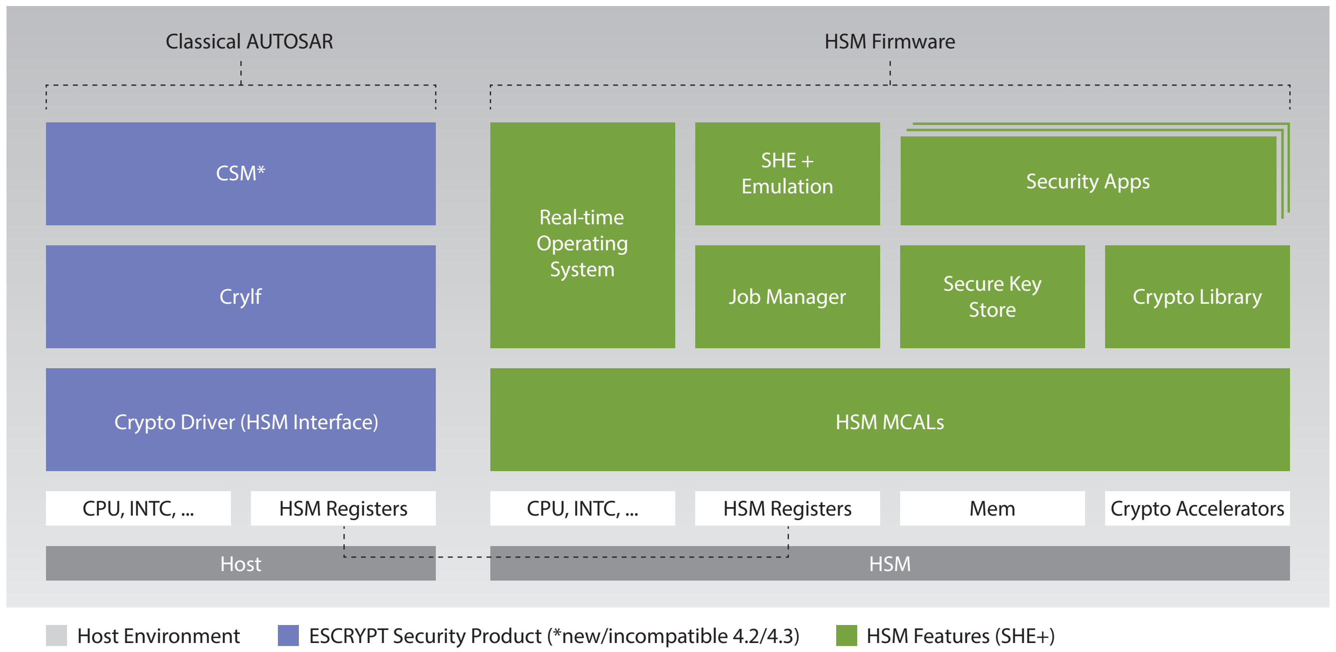


Figure 2: Software architecture of the hardware security module (HSM).

Multifunctional and easy to implement

Hardware security modules offer far more powerful features than purely software-based solutions. Since the HSM security functions are physically encapsulated, the ECU host controller can focus entirely on its own tasks. Combined with the HSM security software, this approach yields a turnkey solution with numerous advantages:

- Offers a powerful hardware/software co-design platform for customer-specific applications with high-performance encryption requirements

which protects the ECU against unauthorized access to the debug port while simultaneously allowing authorized access for software debugging purposes. In this case, too, the HSM exercises control over communication and authentication.

New HSM firmware generation

The development of HSM hardware and software is progressing rapidly, and an increasing number of microcontrollers for ECUs now come with an automotive-specific hardware security module as standard. ESCRYPT is keeping pace with these developments by steadily improving its HSM software stack, CycurHSM. The latest generation of CycurHSM offers even more user-friendly and differentiated options for implementing customized IT security functions in ECUs. The new HSM firmware enables easy configuration via the applet manager plus activation of individual security features using the variant management system. The ASPICE-compliant software also comes with a flexible keystore architecture.

End-to-end protection is the name of the game when it comes to securing connected vehicles and their increasingly automated driving technologies in the future. Developers need to secure all the critical points in the connected environment by integrating technology such as intrusion detection systems, automotive firewalls, secure over-the-air software updates and secure V2X. End-to-end protection means embedding IT security functions right down at the most fundamental component levels of digital vehicle functions – in other words within the microprocessors of individual ECUs. That's exactly what hardware security modules can offer. They lie at the heart of today's developments in automotive security – and their future looks equally bright (see Figure 3). ■

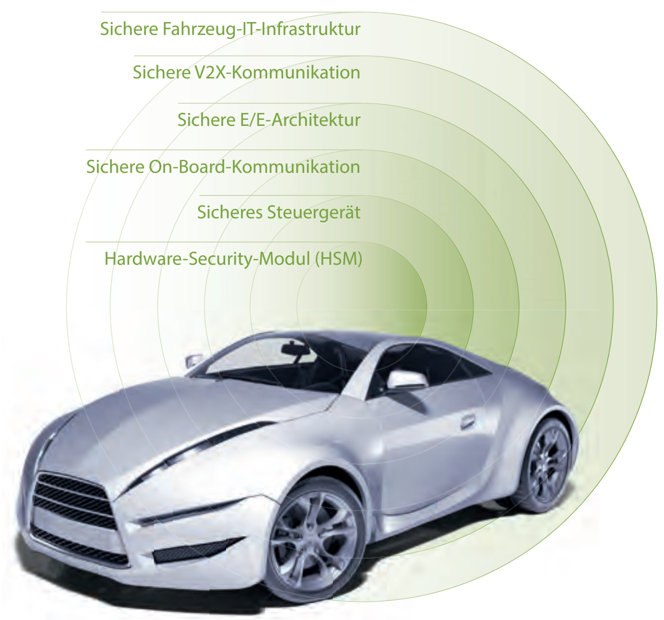


Figure 3: Hardware security modules (HSMs) lie at the heart of automotive security

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ESCRYPT honored as "Innovator 2018"

Renowned German business publishing house **brand eins** recently released its annual ranking of the most innovative German companies – and ESCRYPT was one of the top performers. The company took a leading position among SMEs in the Technology and Telecommunication category, earning the accolade **"Innovator of the year 2018".**

Guided by specific selection criteria, more than 25,000 experts were asked to name innovation leaders from a pool of over 3,400 companies. ESCRYPT received an above-average number of recommendations in all three predefined innovation areas: products and services, process innovations, and corporate culture. **"We are delighted to have received this award,"** says Division Head Uwe Müller. **"More than ever, it's an incentive to ensure innovation continues to be the driving force at our company."** ■

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