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Sensors Replace Senses – ADAS Data Acquisition for Functional Development

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To develop highly automated driving functions, system developers need comprehensive measurement data. New, modular measurement technology solutions from Etas now enable this data to be acquired and made available at every stage of development, from prototypes to pre-production vehicles.

The global automotive industry is investing in the evolution of today's driver assistance systems toward automated and semi-automated driving. Increasing numbers of radar, lidar, video, and ultrasonic sensors are being used to take vehicles from one level of assisted driving to the next higher level of automated driving on the five-level SAE scale. While one to two sensors are sufficient for SAE level 1, SAE level 4/5 requires up to 64 sensors to monitor the vehicle's surroundings.

As the complexity of sensor networks increases, so too does the performance of the Electronic Control Units (ECUs) that orchestrate and implement the automated functions. This is because they process large quantities of data rapidly and reliably. In order to achieve cost-efficient development of complicated control strategies for highly automated driving, it is necessary to shift a large proportion of function development work into the lab. This is only possible, however, if the development, testing, and release of the system functions is based on real environment data that ensures adequate validation of the underlying models. To achieve this, developers need a reliable and flexible development chain that supports efficient data acquisition via a cloud or backend and provides them with data access, **FIGURE 1**.

Such a development environment must support a range of development phases and aggregation levels. For example, OEMs are responsible for the overall system level, while Tier 1 suppliers coordinate the development of individual subsystems across company and departmental boundaries. In each case, this starts from the prototyping phase, progresses through the various development phases, and continues with function extensions and new platforms after Start of Production (SOP). Each phase requires the processing of comprehensive measurement data with varying configurations and data volumes ranging from just a few Megabytes (MB) to several Gigabytes (GB) a second. Etas addressed these requirements early on by developing a modular portfolio of scalable solutions for in-vehicle Data Acquisition (DAQ) that can be optimally tailored to requirements at every stage of the development process.

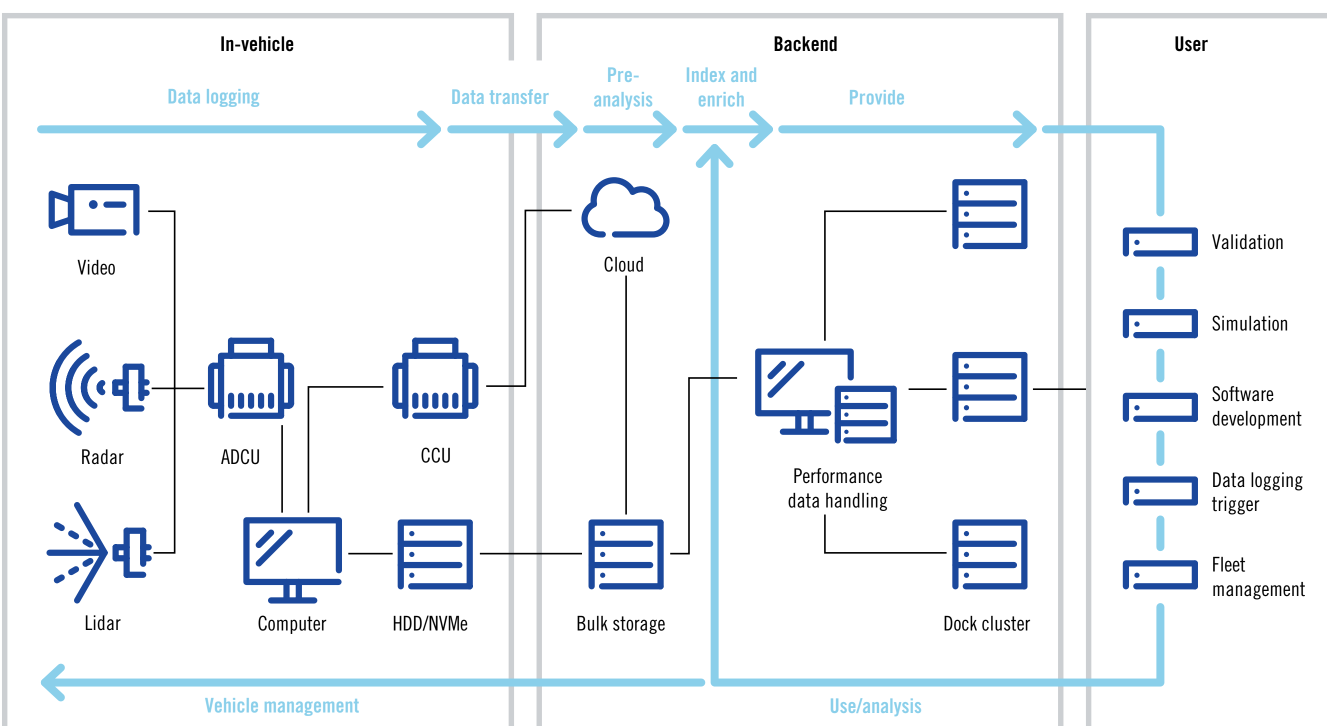
IN-VEHICLE DATA ACQUISITION FROM THE PROTOTYPING PHASE

In future development projects, in-vehicle DAQ will play an extremely important role in obtaining the real environment data required to develop autonomous driving functions. Typically, production-ready ECU and sensor hardware is not yet available in the prototyping phase. Instead, developers use industrial PCs to enable them to develop system and software functions in parallel with the hardware. This implies that the use of hardware-oriented Etas solutions such as the emulator test probe called ETK is not yet possible, since PC-based prototypes have different interfaces and characteristics to those of ECUs. To enable data measurements already in the prototyping phase, Etas has developed a virtual GETK (gigabit emulator test probe), the V-GETK, **FIGURE 2**.

By providing a solution for measurement data acquisition at an early stage of development, the Etas V-GETK helps to minimize costs and save time in the software function development process. The use of powerful multi-core computers is advisable in this context. The more cores and processing power are available, the more data can be recorded via this virtual GETK. The software integration in the customer environment may either be performed as service on the Autosar Adaptive interface ara::com or as a protocol driver in customer-specific middleware, **FIGURE 3**.

Since the V-GETK is integrated into the ECU prototypes as software, an Ethernet interface of the industrial PC can be used for data output. In this way, the measurement data reaches a data logger directly or via the Ethernet network. The Etas SW Framework is used to manage the V-GETK and visualize the data. It contains various modules, including the Ralo (rapid logging) Manager for control and configuration, the Ralo Graphical User Interface for display and control,

FIGURE 1 Development chain from real data acquisition to preprocessed data for system development (© Etas)



ADCU Automated Drive Controller Unit **CCU** Connectivity Controller Unit **ADAS** Advanced Driver Assistance Systems **HAD** Highly Automated Driving

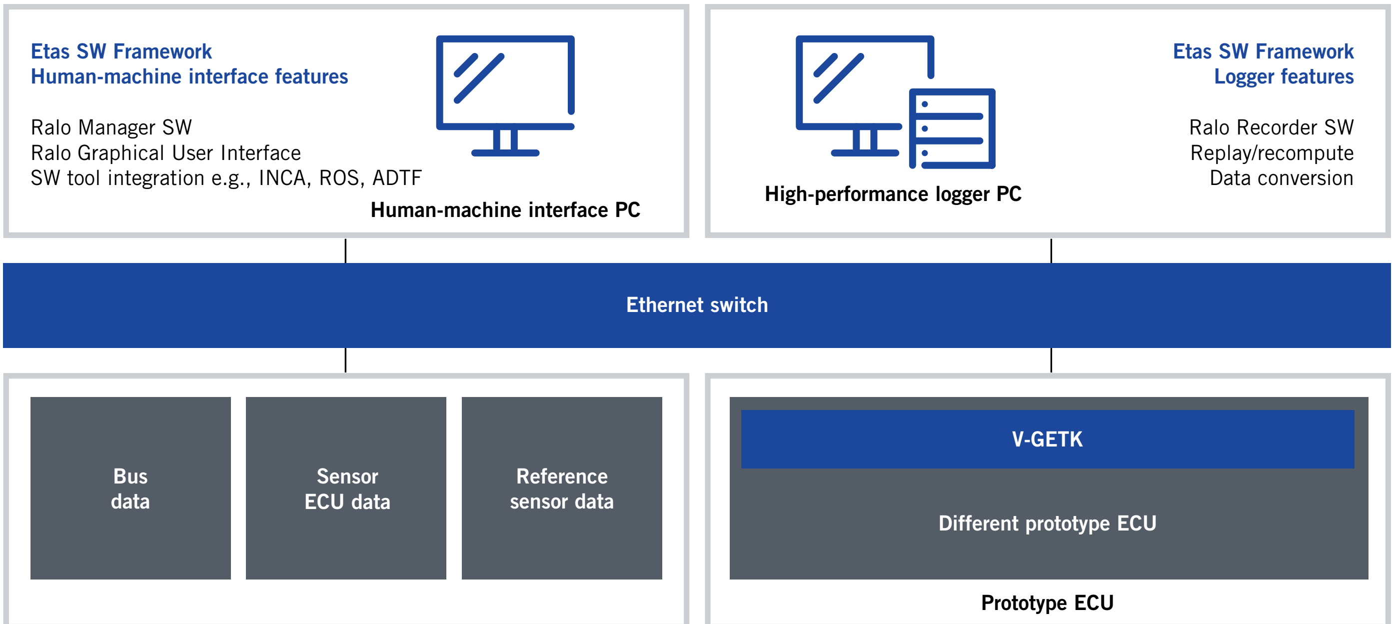


FIGURE 2 V-GETK integration in a prototype ECU (© Etas)

and the Ralo Recorder for data logging. Standard software tools and frameworks can also be connected, such as the Robot Operating System (ROS) and the Automotive Data and Time-triggered Framework (ADTF).

IN-VEHICLE DAQ IN THE DEVELOPMENT PHASE

As the development project progresses, function developers gain access to pre-production prototypes of ECUs and sensors that already contain measurement technology such as the Etas ETK or GETK. This enables the measurment of all the required data from the vehicle ECUs during test drives. The focus of data acquisition on sensor level is on raw and internal data. Measurement systems must be capable to handle data rates from 100 MB/s for radar sensors and up to 1 GB/s (for example for an eight-megapixel camera). It is also necessary to acquire data from different (traditional) domains of powertrain, chassis, infotainment, and connectivity. Depending on the measurement configuration, reference data from ground truth sensors or reference measurement systems, **FIGURE 4**, may also be required.

The next step in the development process is to further develop assistance functions towards automated systems. This involves new functions for environment data acquisition and data processing. These functions drastically increase the need for measurement data. Acquiring this data and ensuring a reliable transmission requires a dedicated in-vehicle network architecture for the measurement technology. Data rates of such systems (range 6 to 15 GB/s) can only be recorded cost-effectively using a scalable logger system that dynamically distributes the data streams to the available data sinks.

The Etas portfolio already includes a DAQ solution that is suitable for automated and semi-automated vehicle configurations. It consists of the Etas

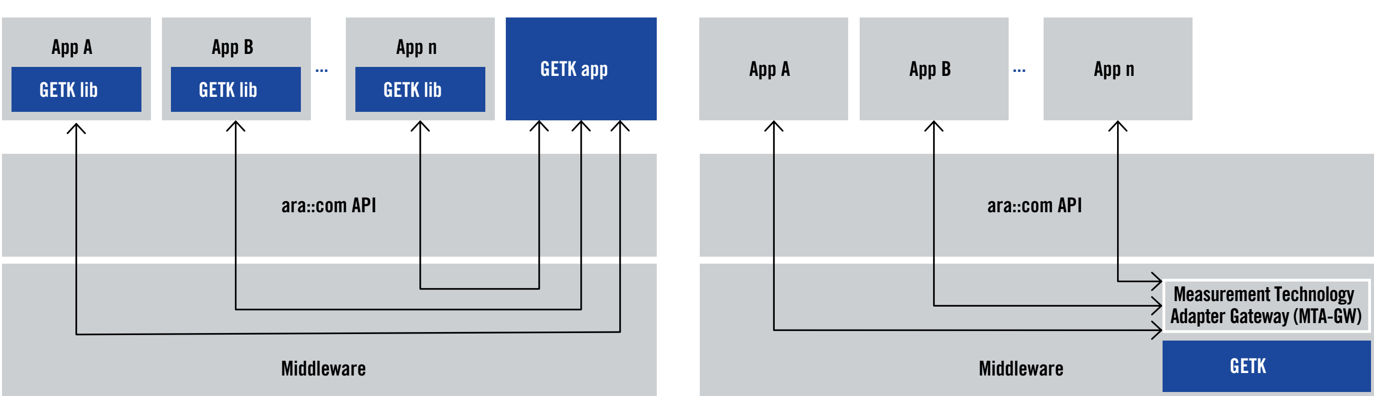


FIGURE 3 GETK integration in middleware as a service (left) and V-GETK integration within the middleware (right) (© Etas)

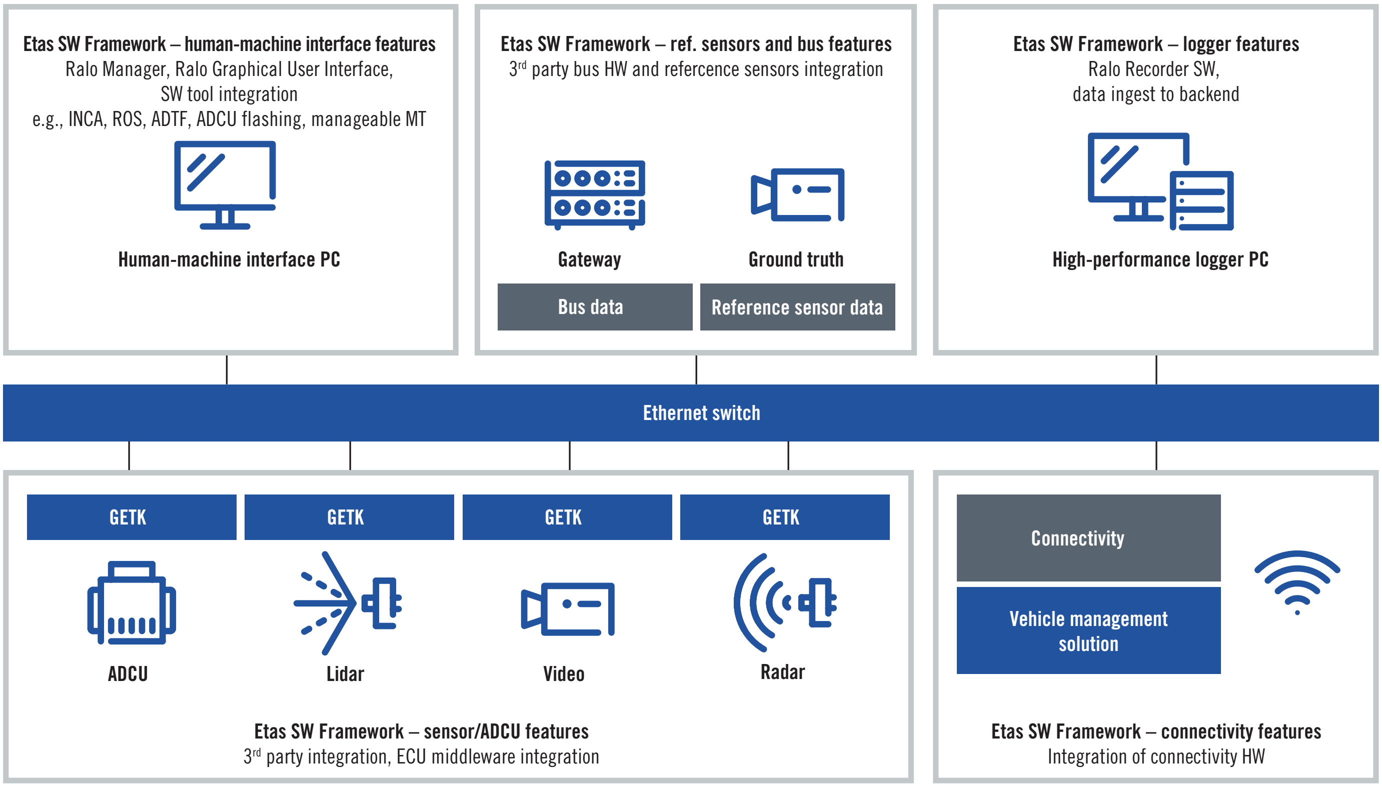


FIGURE 4 Schematic diagram of Etas measurement data acquisition (© Etas)

GETK family and the Etas SW Framework, as well as additional system components and supplementary measurement modules. The scalable solution enables a seamless transfer of development results from the prototyping phase. The GETK integrated in the ECU hardware is an excellent example for the consistent modular philosophy of Etas DAQ solutions.

The measurement network incorporates data sources from microcontrollers (µC) with rates of around 70 to 100 MB/s and from microprocessors (µP/SoC) with 2 to 8 GB/s per GETK. Data from the latter is read from the PCIe bus via Direct Memory Access (DMA). The new measurement technology standard thus provides the basis for measuring data of future systems. Key here is its scalability, which allows the flexible assignment of available PCIe lanes of a PCIe switch to multiple processors.

The Etas SW Framework guarantees a reliable and secure transfer of data from source to sink. The system efficiently distributes the data streams generated by the GETK to the available data loggers via 10/40/100-Gigabit Ethernet – at data rates of up to 8 GB/s per logger. Integration of standard SW Frameworks such as ROS and ADTF is also possible in this phase of development. Similar to the prototyping phase, centralized management is carried out by the Ralo Manager.

IN-VEHICLE DATA ACQUISITION IN THE POST-SOP PHASE

Measurement capability of data from sensors and ECUs is needed even after SOP – for example to ensure ongoing fleet validation. To validate current software functions, developers need access to measurement data from vehicles in the field and supplementary context data, as well as the ability to interact with vehicles via a cloud infrastructure. Reduced datasets are used for this purpose, allowing software developers to develop and test new software versions.

SUMMARY

The Etas DAQ solution provides suitable tools for recording measurement data in the vehicle at every stage of development. Its modular, scalable configuration enables the implementation of high-performance measurement technology solutions in the vehicle by integrating and upgrading existing measurement solutions from other vendors as well as in-house solutions. Thanks to this seamless integration from the prototype phase to the post-SOP phase, the Etas DAQ framework makes a significant contribution to time and cost savings. Moreover, the virtual GETK facilitates access to production ECUs. These new capabilities for comprehensive data acquisition from laboratory to production vehicle provide function developers with a highly effective solution that offers optimal worldwide support for the development of complex automated driving functions.