AUTOSAR – Equipped for Everything?

In the early era of microcomputer-based automotive electronics, a separate ECU was developed for each functional unit such as engine management or transmission control. Coordination with the other ECUs was implemented via control lines, e.g., lines carrying pulse-width modulated signals. Growing functionality, however, was driving the number of control lines and their costs upwards. That is why, in 1983, Bosch began to develop a network protocol – the Controller Area Network, or CAN – which was implemented in a production vehicle for the first time in 1990. It enabled the exchange of large amounts of data between ECUs in real time. This, in turn, unleashed the creativity of development engineers in implementing many new convenience functions such as “Keyless Go” and enabled significant improvements in the areas of safety, fuel economy and exhaust emissions.

However, the approach was still “one ECU for each function” – and each ECU was developed and produced by one supplier company. Whenever multiple ECUs from different manufacturers were involved in implementing a function, this required additional coordination effort and very extensive integration tests. Problems also occurred when an alternate supplier or new supplier was added for an ECU (e.g., for a new vehicle generation). This incurred additional coordination and testing effort.

To improve this situation, automotive OEMs and suppliers founded the AUTOSAR consortium (AUTomotive Open System ARChitecture) in 2003. Its standardization would make it possible to integrate algorithms, in unmodified form, into the ECUs of different manufacturers, and this would support the distribution of functions to multiple ECUs much better.

More than basic software

Ten years later, AUTOSAR is still a hot topic, and with good reason. Over 100 companies have developed specifications in a number of working groups. Meanwhile, the fourth main version has been published. Vehicles with AUTOSAR are in production, many automotive OEMs are currently developing vehicles with AUTOSAR, and nearly all of the others are showing excited interest and will hop aboard the train sooner or later. As soon as it appeared, enthusiasm was
very high, and this led to some inflated expectations (Figure 1). Over time, the desire for a simple and cost-effective solution had to be tempered due to the growing volume of specifications (Figure 2).

AUTOSAR is often understood primarily as the basic software. Undoubtedly, this basic software is an important component. It contains an operating system, communication and management services, and it offers a uniform interface (Runtime Environment) for the actual application. Often automotive OEMs and suppliers begin their migration to AUTOSAR with the basic software – a reasonable step, because the specification of the basic software is well validated, and many producers offer implementations. In addition, this step lets ECU suppliers use a uniform software platform for multiple automotive OEM customers. Nonetheless, from the beginning AUTOSAR focused primarily on the overall development process. Therefore, the interfaces between participating partners were standardized and a methodology model was defined. The full benefits of AUTOSAR can only be achieved when all of its elements are implemented systematically.

New division of labor

While automotive OEMs previously created a text-based specification for each ECU and subcontracted its implementation to a supplier, AUTOSAR makes it possible to derive and share precise machine-readable specification requirements that come from a design of the total “vehicle electronics” system. Different suppliers can implement these requirements with assured processes and high efficiency. This enables a division of labor that does not require increased effort at the interfaces between the partners on the following levels:

- ECU hardware
- Basic software
- Application software
- Integration and comprehensive testing.

This division of labor has many advantages. Specialized companies can be contracted for specific sub-areas, and this leads to better solutions that are also more cost-effective. They range from ECU hardware suppliers to suppliers of basic software components, developers of individual driver assistance systems and suppliers of just certain parts of a complex assistance system. The automotive OEM can undertake tasks relevant to its competitive advantage to achieve complex innovations. This avoids having competitors quickly benefit from the development via suppliers who would
Development tools had to be created in parallel to development of the AUTOSAR specification itself. As a result, the first tools were not always very mature. The higher the level of performance that was required of the tools, the greater their development effort, and the later their availability and maturity. Since increasing stability has been achieved in AUTOSAR specifications in recent years, and it has benefited from experience from many production projects, very high-performance tools are now available for productive use. “PREEvision” might be cited as an example here. PREEvision is a development platform for the entire E/E-product development process according to AUTOSAR (Figure 3). It integrates the design, evaluation, optimization and documentation of E/E architectures in one tool. It exports and imports the interfaces definition in AUTOSAR format. To achieve comprehensive support of E/E development areas, other components are necessary; they range from requirements analysis to the provision of a collaboration platform and finally the management of variants (Figure 4).

Each standard, including AUTOSAR, harbors the risk that it could put the brakes on innovations. The current example of “Ethernet in the vehicle” shows that this can be avoided by pragmatic approaches. The standard is being developed in parallel with first implementations. This promotes quick definition of a practice-based standard, which enables quick market introduction. The downside is that first implementations are based on a temporary level of the standard, so they will need to be modified later with additional effort.

Tools

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Figure 3:
Universal process: software development with AUTOSAR

Figure 4:
One tool for everything: contents of the “PREEvision” platform
Not an end in itself

AUTOSAR is a consistent continuation and standardization of a development methodology that has evolved in automotive electronics over several decades. AUTOSAR relies on established and proven methods, and it utilizes the latest software technologies to enable the development of a new generation of vehicle functions. The progression towards more automated driving sets new requirements with regard to complexity and safety. Nonetheless, standardization must not be an end in itself. It is important to precisely observe the extent to which its advantages outweigh potential disadvantages and whether disruptive technologies might force out established players. There are signs of this already; just consider some new e-vehicle manufacturer or the autonomously driving car from Google.

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All figures
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