Infotainment in an AUTOSAR environment

Since the 1990s, automobiles have been increasingly dominated by electronics and associated software. Now, automotive innovations without modern electronics are barely conceivable. The breakneck development of software-based systems in nearly all areas of life continues to drive this trend, presenting the automobile industry with a difficult dilemma. On the one hand, customers expect new, innovative and directly accessible functions as well as safe and environment-friendly vehicles. On the other hand, every additional component increases development, production and warranty costs. In this environment, the ability to implement innovations cheaply and quickly can represent a decisive competitive advantage.

Technical background

Introducing and networking electronic components presented the automobile industry with new challenges. System complexity increased with the number of devices. The development process became more complicated, installation space became increasingly restricted and the wiring harness grew into one of the heaviest and most difficult components. Not least, the entire system became increasingly difficult to manage and after-sales service had to deal with problems arising from the electronics and the software. Another problem during this phase arose from the way automobile manufacturers organised development and development processes, where every new function also meant a new control device that then had to be developed by one of the manufacturer's component suppliers. This process created a wide range of manufacturer-specific and vehicle-specific solutions and almost all the development expertise stayed in the component supply industry. The AUTOSAR (AUTomotive Open Software ARchitecture) development partnership was founded in order to change this situation. It has dealt with the standardisation of the automobile software platform and the associated processes and tools since 2002 and now specifies the standard for next-generation vehicles. Despite AUTOSAR's successes, a few important problems remain unresolved. The standards can be applied to typical vehicle functions, but in the areas of infotainment and connectivity they exclude precisely those areas which are most driven by the entertainment and telecommunications industries and in which customers experience innovations most directly and immediately. The data

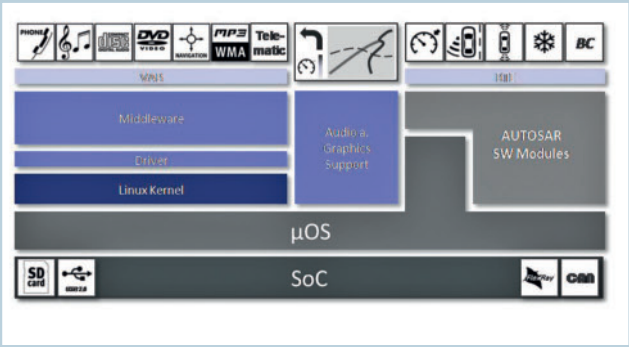

Figure 1:: The COQOS platform´s unique architecture:

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connectivity of these domains could also be extremely useful in many different ways when applied to vehicle functions, whether in after-sales service for diagnostics or software updates or in driver assistance systems that could function more effectively with data from the navigation system or even from the Internet.
OpenSynergy's vision is to bring these two worlds together safely and reliably.

The COQOS operating system

COQOS was designed as a universal automotive operating system with the following premises:

- 100% AUTOSAR compliance both in its architecture and in its processes
- Compliance with the relevant automotive standards
- Open system interfaces in the area of infotainment and connectivity
- A platform approach that drastically shortens the software development cycle, especially in the areas of infotainment and connectivity
- Reduction in the number of control devices, despite the growing number of functions
- Greatest possible openness and future-proofing
- Maximum reusability and scalability
- Flexibility due to modular approach

Implementation of this concept (i.e. joining these two worlds) required intensive expertise both in AUTOSAR and in telecommunications. The most important basis for COQOS is virtualisation - a technology that also developed into a trend last year in the world of home and office computing. The objective of virtualisation is to combine or distribute the different resources on a computer. The objective in COQOS is to distribute the resources on a control device based on a cost-efficient system-on-chip between infotainment and connectivity on the one hand, and AUTOSAR applications on the other hand. At the same time, it is important to ensure that there is no interference between the two software worlds in order to meet the automobile industry's specific requirements for safety, start-up behaviour etc. and the functioning of vehicles in all conditions. In addition to these self-defined requirements, COQOS must, of course, also meet familiar requirements such as on/off behaviour, diagnostic capability, etc. Another clear goal during development was to ensure that virtualisation would create the minimum possible additional strain on system resources.
To meet all these requirements, the AUTOSAR modules that are required for the individual case at hand are combined with a Micro Operating System that also provides a virtualisation layer. This Micro Operating System already provides basic mechanisms for the secure construction of the overall system (such as memory protection and timing protection), meeting aspects of functional safety and security from external attacks. While the automotive world is defined extensively with AUTOSAR, the infotainment world remains relatively undefined in the different systems to date. QNX is widespread in current systems, but there are also already approaches based on Embedded Linux or Windows Automotive. As a typical embedded operating system, QNX comes from the industrial milieu and the inclusion of functions from consumer electronics is a development intensive process. Windows and Linux both come from the area of entertainment electronics and therefore bring with them all the interfaces and technologies (such as WiFi or 3D graphics). Integrating them with the vehicle infrastructure, however, is development intensive and will provide every function developer in the automotive environment with problems. COQOS will combine infotainment operating systems with standard-compliant AUTOSAR basis software. Functional distribution of the components retains the advantages of the existing systems:

- The AUTOSAR modules meet specifications, and can therefore be used for all automotive applications and

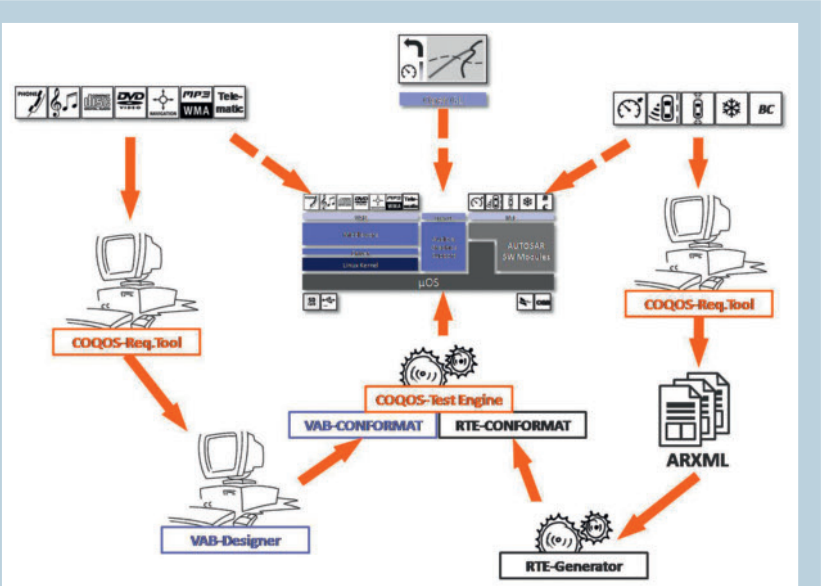

Figure 2: COQOS enables structured development processes

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provide a tool-based configurable RTE as a functional interface.

- In the infotainment area it is possible to use operating systems available on the market. There is no need for specific changes to the automobile environment. Functions can be implemented in the existing application interfaces.
- As an additional module, COQOS contains a Micro Operating System that provides the virtualisation layer for the infotainment system and enabling secure and independent parallel operation on a shared hardware platform.

The first COQOS implementation will be Linux-based in order to enable access to the widest possible spectrum of function providers from the areas of mobile communications and entertainment electronics. Linux also offers many benefits for development, such as open access to the source code, multiple-access development environments, etc. In later implementations, it will also be possible to apply other infotainment operating systems where required by customers.

Solution examples for current and future systems

COQOS was designed as a software construction kit and is based on multiple modules that can be used to design the relevant solution. The following list provides an idea of the wide range of different solutions:

1. AUTOSAR basic software

The construction kit can, of course, also be implemented without infotainment components. Unlike other systems, COQOS is AUTOSAR basic software and therefore includes the different listed safety mechanisms from AUTOSAR 3.1 onwards.

2. Connection of existing, complex, non-AUTOSAR-compliant functions with AUTOSAR

During the development of AUTOSAR, many automobile manufacturers developed functions that can be easily adapted to the standard. Other functions have already been developed according to the standard and can use an RTE as a system interface. If you want to combine both functions without starting new developments, you would have to install two control devices and connect them via an appropriate bus (usually CAN). COQOS allows their combination on shared hardware as non-AUTOSAR functions can be included on the virtualisation layer.

3. Infotainment with an AUTOSAR environment

This configuration provided the basic idea for COQOS and has already been described in detail. COQOS combines two software systems with different, non-functional requirements, separates them securely and enables targeted and managed communication. The performance of modern embedded processors can be fully employed, intelligent functional assignment makes it possible to save on control devices throughout the overall system.

These are probably the three most important COQOS-based solution approaches. Others are still being developed. The design of the development process, partitioning of the software architecture and high quality standards ensure that the system is strongly oriented towards reusability. Stable, standard-based application interfaces make it possible to continuously integrate new functions in ever shorter development times. COQOS ensures a stable system basis for very different vehicles, making it possible to concentrate on the important goals of developing new, exciting and affordable functions for next-generation vehicles.

The COQOS development tool

The development environment is an important, albeit often neglected, component of complex software systems. It plays an important role in managing complexity in the development process and also in providing targeted and accurate design for the latest vehicle software. The COQOS development environment had to meet similar requirements to COQOS itself. The tools needed to be modular, multi-purpose, expandable and they needed a basis that was already widely available on the market. As well as easy configurability, support for required development methods was also given high priority. Java and Eclipse were therefore used to

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reflect in the tool chain the methodology defined by AUTOSAR for developing the basic software. Because the COQOS development environment is used to develop both AUTOSAR software and an infotainment platform, theoretical AUTOSAR approaches were developed further in this area. Assignment to the different areas is performed in the development environment, as is assignment of the required sub-functions. As the first module of a customer-ready solution from the COQOS development environment, QONFORMAT is a tool that can be used to demonstrate AUTOSAR-compliance of basic software modules.

Benefits for consumers

The overriding objective when developing COQOS was to achieve a high level of benefit for consumers (i.e. buyers of modern automobiles). COQOS was designed to enable the integration of new, exciting functions without simultaneously increasing costs throughout the overall system. This can only be achieved if it is possible in the long term to reduce the hardware in the vehicle and drastically shorten the development cycle for software-based functions. Standardisation, reusability and separation of hardware and software are the keys to achieving our goal. COQOS enables these things. This will make it possible to implement new functions in mass production that were previously possible only in the luxury sector. Consistent compliance with the relevant software development standard will also make it possible to implement safety concepts and driver assistance functions in smaller vehicles, making them safer in traffic.

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