AUTOSAR for Intelligent Vehicles

The AUTOSAR Adaptive Platform

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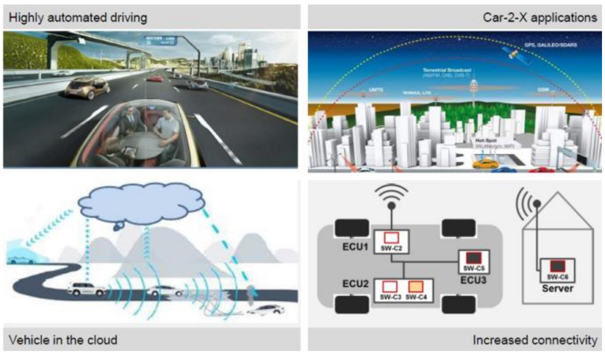
New applications like highly automated driving, Car-2-X, software updates over the air, or vehicles as part of the internet of things raise completely new requirements to a software platform for the next generation of ECUs. AUTOSAR as the worldwide leading standardization organization for in-vehicle software bears this challenge and paves the way making vehicles intelligent and adaptive. Based on a set of selected use-cases, identified by the AUTOSAR partners, the challenges and the approach to master requirements for next generation cars are described. The new platform aims to support dynamic deployment of customer applications, to provide an environment for applications that require high-end computing power and to connect deeply embedded and non-AUTOSAR systems in a smooth way while preserving typical features originated in deeply embedded systems like safety, determinism and real-time capabilities. Built around existing standards such as POSIX, the AUTOSAR Adaptive Platform will complement automotive specific functionalities enabling the platform to run in an automotive network.

AUTOSAR, Adaptive Platform, automotive software standard, dynamic architecture, software framework

I. INTRODUCTION

Cars continue to turn into real cyber physical systems – just connecting to the internet and exchanging data with smartphones is state of the art. Future cars will be connected to almost everything: Smart homes, roadside infrastructure and even vehicles around them – they become a part of the internet of things.

Fig 1. Use-cases driving the further development of the AUTOSAR Standard



Another trend beside the increasing connectivity is the vision of autonomous driving. Further enhancements of today's driver assistance systems like Adaptive Cruise Control pave the way towards highly automated driving and autonomous parking, see Figure1.

The realization of these new features also adds new requirements on the software infrastructure, hosting these functionalities. Besides the existing requirements such as functional safety and security the software architecture has to support e.g. hardware with high-end embedded computing power, updates-over-the-air, communication with backend-systems or dynamic deployment of applications, as well as dependability to realize autonomous vehicles. An evaluation by AUTOSAR showed that these new requirements cannot be realized by today's software architectures where almost all vehicle internal communication is done via a deeply embedded controller to meet OEM requirements like startup times or functional safety and where the communication can be described by AUTOSAR means. In general a software infrastructure is required that is much more flexible as today's. It has to be highly available and capable to adapt itself to specific application requirements at a given point in time. An extension of AUTOSAR's software architecture for deeply embedded systems turned out not to be feasible. Consequently today's architectures will be complemented by a new platform that comes along with operating systems designed for high-performance computing which needs to be enhanced by dependability features like e.g. safety, availability, security or real-time. Nevertheless the well-known characteristics of deeply embedded system will remain. The combination of these trends results in a revolution of today's E/E architectures.

II. Key aspects of the new E/E architecture

The following two key aspects characterize tomorrows E/E architectures:

A Integration of heterogeneous software platforms

Networking architectures of today's cars can be clustered into different domains for infotainment and connectivity, chassis, powertrain, etc. While infotainment ECUs are typically using Linux or commercial general purpose operating systems, the AUTOSAR Classic Platform is the standard for deeply embedded ECUs. With the new use cases and the increasing demand also from deeply embedded applications for computing power a third type of ECUs will arise with different characteristics that has to be interconnected with existing E/E architectures.

B Service oriented and signal based communication

The traditional automotive communication is still based on the idea of ECUs providing signals to other ECUs as broadcast. This paradigm fits very well for control data of limited size, which has to be communicated cyclically.

Advanced applications like highly automated driving with higher payload demands e.g. to exchange dynamic length lists of objects detected by a set of sensors and Ethernet as a communication system require more sophisticated protocols. The concept of service oriented communication is based on applications that provide a service on the communication system and other applications subscribe to this service. The data will only be sent to the subscribers. The combination of service oriented communication with the existing signal based paradigm is the second key aspect of future E/E architectures and a demanding challenge from a methodological point of view.

AUTOSAR as the global standardization consortium for automotive software architectures aims to adopt to these trends and to provide a consistent standard for these aspects.

C New standard defined

For deeply embedded systems realizing typical power train and chassis functionalities the AUTOSAR Classic Platform will remain the first choice. Such applications are characterized by high-demands on safety, real-time and determinism while running on low cost hardware. Meanwhile AUTOSAR provides for these applications a well-proven and mature software platform including a widely used methodology, which supports all of today collaboration models.

To support dynamic deployment of customer applications, to support dependable applications and to provide an environment for applications that require high-end computing power AUTOSAR is currently standardizing a second software platform which is called AUTOSAR Adaptive Platform. Based on existing standards, the idea is to benefit as much as possible from developments in other areas (e.g. consumer electronics, automation industry), while still considering automotive-specific requirements such as functional safety.

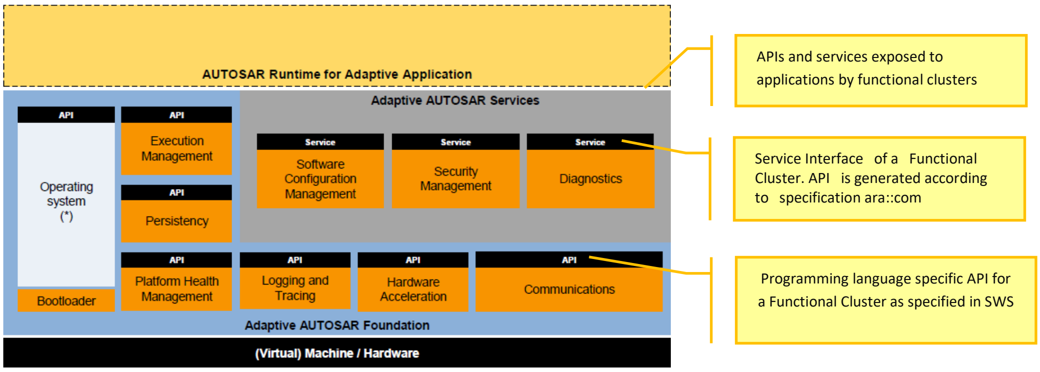
III. The AUTOSAR Adaptive Platform

Figure 2 depicts the overall architecture of this new platform. For Release 17-03 one of the main goals for the AUTOSAR Adaptive Platform was to provide application developers a stable programming interface the so called AUTOSAR Runtime for Adaptive Applications (ARA).

The interface consists of a standardized interface for accessing operating system functionalities and a communication middleware, which allows data exchange with local and remote applications as well as to the Adaptive AUTOSAR Services. The second goal is to support the basic functionality needed to smoothly integrate the platform into existing E/E architectures based on Ethernet.

To achieve this goal the following functional clusters are specified: The core of the AUTOSAR Adaptive Platform is the operating system based on POSIX. The OS can be used from the application via a subset of POSIX according to IEEE1003.13 [1], namely PSE51 and provides the application developer commonly used functionality such as signals, timers, semaphores, signals and thread handling. If an application restricts itself to the use of this subset it shall be portable to any AUTOSAR Adaptive Platform. From the functional point of view the operating system defines some of the essential differences of the AUTOSAR Adaptive Platform compared to the AUTOSAR Classic Platform. Applications are not bound any more to a very strict and static scheduling and memory management but are free (within well-defined boundary conditions) to create and destroy threads and to allocate memory depending on their current need.

Fig 2.Architecture of the AUTOSAR Adaptive Platform



(*) OS not standardized by AUTOSAR

The functional cluster Execution Management is responsible for startup and shutdown of the ECU and the applications by maintaining the application states. Together with the planned Platform Health Management (next release in 17-10) it has to take care that the necessary resources for the applications are available to trigger degradation or similar strategies so that the ECU can react in a critical situation according to a well-defined strategy.

The communication middleware realizes and abstracts the service oriented communication between local applications as well as to applications residing on other ECUs. This includes the interaction with the AUTOSAR Adaptive Services.

For the Release 17-03 the support of Ethernet based communication systems is achieved, based on SOME/IP as bus protocol, which also enables applications on the AUTOSAR Adaptive Platform to establish communication relationships with ECUs running the AUTOSAR Classic Platform.

The first release contains also Log and Trace features for debugging of an AUTOSAR Adaptive ECU as well as a first version for Persistency and the portation of the most important Diagnostics features to a POSIX based architecture.

The goal for the Release 17-03, to enable the first series projects to start developing ECUs and applications based on the AUTOSAR adaptive standard was mainly achieved. For the following releases of the Adaptive Platform a roadmap of major additional features is available. This includes e.g. the support for fail-operational systems, enhanced safety and security features and the integration of Car2X communication protocols. Due to the main use-cases of the Adaptive Platform special focus will be on the support for dependability.

IV. SUPPORT FOR THE INTEGRATION OF HETEROGENEOUS PLATFORMS

The methodology defined by AUTOSAR is the only standardized solution available today, which allows describing the software architecture together with the network topology in a unified machine readable format. Up to now this concept considered only the ECUs based on the AUTOSAR Classic Platform and the principle of signal based communication. For the future the most important challenge is to support a seamless integration process of different platforms. With the introduction of Ethernet and a service oriented communication paradigm based on SOME/IP in the Release 4.1.1 of the Classic Platform, AUTOSAR already made a big step to support this use case. In terms of SOME/IP, a service can be seen as the functional representation of an ECU on the bus independent of the underlying software platform. Therefore a formal description of a service has to be independent of a specific platform, be it the AUTOSAR Classic Platform, the AUTOSAR Adaptive Platform or a non-AUTOSAR platform. The key point is that each platform realizes the service in the same way w.r.t. to its behavior and the representation in the on-the-wire format. This means that AUTOSAR has to provide answers for the following aspects:

- Description of the relevant communication relationships on software level
- Provisioning of standardized communication protocols.

The main difference between platforms supported by AUTOSAR and other platforms is then the support of a methodology, which enables tool vendors to provide automated configuration of ECUs running a software stack, which complies with the standard.

V. AUTOSAR STANDARDS AND TIMELINE

Previously, AUTOSAR released all of its specifications as one bundle, however, it became increasingly difficult for users to track relevant changes to the standard, especially with the introduction of the Adaptive Platform. To keep the standard manageable, useable and to enable flexibility AUTOSAR decided to split up its results into several standards for different feature sets. An AUTOSAR standard is now defined as a consistent set of AUTOSAR deliverables, which are released at the same time. AUTOSAR deliverables can, but are not limited to be of the following kinds:

- textual explanations
- textual specifications
- test specification
- source code
- other formal or semi-formal textual formats (e.g. ARXML, UML models, XML Schema)

The approach of structuring AUTOSAR's deliverables into standards also opens up the new possibility to deal with future use cases and to establish the new AUTOSAR Adaptive Platform beside AUTOSAR Acceptance Test and the AUTOSAR Classic Platform. Common parts of these standards such as bus protocols and common aspects of the methodology are released as a separate standard called AUTOSAR Foundation.

Up to now the AUTOSAR partnership has agreed on the following timeline for their main standards. The next bugfix release for the AUTOSAR Classic Platform is planned for December 2017 followed by a next minor release in October 2018. The first Release R17-03 of AUTOSAR Adaptive was released on time on the 31st of March and will be followed by releases in approximately half year sequence with the next Release 17-10 in October 2017. The goal is that the major development activities are concluded in a joint Release of AUTOSAR Classic, Adaptive and Foundation in October 2018. This synchronized Release of the three AUTOSAR Standards shall enable the application of a new joint methodology to apply AUTOSAR as a whole properly in E/E architectures.

VI. CONCLUSION

For over more than 10 years AUTOSAR has demonstrated to be the best established and well-suited organization to coordinate and drive the standardization for software infrastructures and platforms meeting the requirements of automotive electronics.

Upcoming demands and new functionalities will pose further challenging requirements on future E/E architectures. With the restructuring of its portfolio and the introduction of the new AUTOSAR Adaptive Platform the organization has adopted this challenge and will provide also in the future a common platform for its users.

ACKNOWLEDGMENT

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