ENABLING CONTINUOUS INNOVATIONS

AUTOSAR.ORG

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AUTOSAR

Limited Edition 20th Anniversary Publication

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DISCLAIMER

This 20th Anniversary Publication is a joint effort of the AUTOSAR community. The individual guest contributions and partner contributions in chapters 3-6 represent the opinions of the respective authors.
We would like to thank all authors for their contributions.

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Chapter 1
Editorial

"Nothing is more powerful than an idea whose time has come."

- Victor Hugo

Foreword

AUTOSAR – 20 YEARS OF CONTINUOUS GROWTH

by Günter Reichart

The famous quotation of Victor Hugo is also valid for the 20th anniversary of AUTOSAR. Founded in 2003 this international standardization effort of automotive software architectures is an incredible success story.

It was started as an internal company project and quickly turned into an industry wide standardization effort adopted not only by its founding members BMW, Bosch, Continental, Daimler Chrysler (today Mercedes-Benz), Ford, GM, PSA (today Stellantis), Siemens VDO (today Continental), Toyota and VW, but also by leading companies in the automotive and software industry, as well as many institutes in the academic field. Up to now the AUTOSAR consortium includes more than 350 partners worldwide and is still about to grow.

AUTOSAR was always understood as an open partnership for standardization, allowing the mutual granting of IP and exploitation rights based on a solid common legal framework. AUTOSAR has started to build a fruitful Automotive Development Ecosystem by establishing collaborations with many 3rd party organizations in the industry covering nearly all aspects of a future intelligent mobility.

This 20th Anniversary limited edition publication gives you a flavor of the spirit of AUTOSAR, especially the spirit of the Project Leader team and the many experts actively contributing to the success of it. Without their enthusiasm, devotion and engagement this success would have not been possible. This publication is therefore also an appreciation of their great contributions. This holds true for the many people in the AUTOSAR Support Functions.

Without the long-lasting support of our Executive Board and the engagement of the Steering Committee and their visions for the future of AUTOSAR this publication would be just a book about history. Instead, you will read exciting stories on the further developments of AUTOSAR and how it will pave the path to the future of mobility.

Victor Hugo
French poet, novelist, dramatist of the Romantic and politician (1802–1885).

Welcome Message

TO 20 YEARS OF ENDURANCE AND GLOBAL SUCCESS

by Thomas Rüping

20 years ago, AUTOSAR was founded by a few Core Partners with the intention to better master the increasing complexity in cars caused by the growing number of electronic control units (ECUs) in combination with a significantly growing amount of software. The approach aimed to enable software exchangeability and reuse through standardized interfaces and exchange formats.
It was 2008 when I had my first contact with AUTOSAR. At that time, the biggest challenge for AUTOSAR was still to replace the industry-established legacy basic software in ECUs with the standardized AUTOSAR (Classic) basic software. In the end, it took about 10 years since the launch to achieve significant market penetration.
Meanwhile AUTOSAR is a big success story and almost all microcontroller-based ECU´s in cars use this AUTOSAR standard. And the achievement is not only that AUTOSAR is included in the ECUs, but also that the players in the automotive industry have established a common language and a proven common IP pooling for meanwhile 350 partners.

Today we are facing the next leap in complexity with the integration of vehicles into cloud or backend systems. The involved industries are looking to address this in several initiatives with Software Defined Vehicle (SDV) activities, which are currently aligning their respective focuses.

Microcontroller-based ECU

Integration of vehicles into cloud or backend systems

Significant benefits are expected from open-source approaches adopted from other industries. With broad participation in open-source organizations, features should be implemented quickly under a "code first" approach, without specifications if possible.

In 20 years of joint effort, the AUTOSAR community has created a worldwide unique selling point with AUTOSAR, meeting requirements of the mass market in terms of high-level functional safety, real-time and reduced development effort. As a standardization organization, AUTOSAR would like to make this advantage available for the new approaches as well, even though specifications remain a core element in the area of safety-critical software.

Nevertheless, the implementation of specifications in code is becoming more and more important for AUTOSAR as well, in order to support the unambiguous interpretation of specifications by means of an exemplary implementation and to significantly increase the speed of development.

In addition, opening up parts of the AUTOSAR standards to non-partners will be important for acceptance and cooperation with other parties in the SDV context. Therefore, AUTOSAR plans to introduce open-source projects in the future, even though AUTOSAR as a whole may not be comparable to a classic open-source organization. The definition of requirements always involves a discussion of the possible solutions at a more abstract level than code. While this may take more time for conclusion, it will result in a compelling and globally accepted solution, viable for series development under the before mentioned conditions of safety and real-time.

I am sure that AUTOSAR as an organization with its extended standardization will take the key role within SDV development when it comes to on-board software with strict requirements for safety, security, homologation and certification for series production.

Our Mission

AUTOSAR is a global partnership of leading companies in the automotive and software industry to develop and establish the standardized software framework and open E/E system architecture for intelligent mobility.

AUTOSAR.ORG

Our Vision

AUTOSAR will be the global established standard for software and methodology enabling open E/E system architectures for future intelligent mobility supporting high levels of dependability, especially safety and security.

Chapter 2

Cover Stories

With a strong organization in the background, we pave the way for future success.

Spokesperson

Günter Reichart

A modern international standardization project must permanently present its frequent results and also the mission and vision with up-to-date communication in the industry-relevant regions in order to reach the relevant partners for continuous innovation.

—

Dr. Günter Reichart, AUTOSAR Spokesperson. In his professional career he was former vice president of driver assistance, body electronics and wiring harness at BMW and founder of AUTOSAR.

It was a great honor for me to be asked several years ago by Simon Fürst and Thomas Scharnhorst to serve as AUTOSAR Spokesperson. With the very good ramp-up by my predecessor Thomas Scharnhorst, I was soon able to give my first presentations. Questions from the audience and discussions during the conferences provided valuable input for improving presentations. It became clear that AUTOSAR's profile has to be actively expanded. This would require presentations to address the specific conference topics and audiences, as well as an increased presence on social media, in automotive-related print media, and with a dedicated booth at conferences.

SHAPING THE FUTURE OF COMMUNICATION

Thus, I wrote a communication concept, which was very well received by the AUTOSAR Steering Committee. In the AUTOSAR communication team we worked intensively to bring the ideas to reality. Meanwhile we have achieved a very good online presence, a regular newsletter, presence in social media, focused presentations in conferences and an international network with regional spokespersons.

The latter was a great asset for AUTOSAR especially in the times of the corona pandemic in which travelling was nearly impossible. With the so-called local hubs, led by the regional spokesperson, we could establish good communication channels and have intensive contacts with user groups, AUTOSAR partners and to official bodies in the regions.

For me personally it was not just an honor, it was a fulfilling experience. From the time when I was the founder of AUTOSAR as a vice president in the electronics division of BMW, the role of a spokesperson was and is an exciting experience in my retirement. It makes me proud and happy to see how this whole concept has developed and grown.

The Story of AUTOSAR

A PROVEN TRACK RECORD

by Günter Reichart

DESIGN THINKING TO MITIGATE COMPLEXITY AND HARDWARE DEPENDENCIES

About 20 years ago, there was a time in automotive industry in which the software development was company proprietary, hardware-dependent, lacking of standards, with varying interfaces and basic software modules adapted to the specific electronic control unit (ECU) under consideration. Obsolescence of microcontrollers shortly before a series production start was a common nightmare and required risky software adaptions under high time pressure. The integration of such heterogenous subsystems into a complex, interdependent vehicle network was error-prone and required huge testing efforts. Younger readers might not believe that this was the context in which the idea of AUTOSAR emerged. Those of us who have experienced the situation will still remember that a radical change was really needed. And so, in early 2002, the concept for an open system architecture emerged in BMW's electronics division.

The idea was to get rid of the late and risky adaptations of basic software for ECUs and to reduce the demand of internal and external resources involved in these software adaptations. It envisioned moving towards open system architectures by creating a hardware abstraction layer (HAL), a standardized basic software stack, and a middleware layer with standardized interfaces to the applications. The concept was influenced by former research projects like ITEA-EAST and the collaboration of several companies in the German Hersteller Intiative Software (HIS).

Implementing the idea was far not as easy as it may sound, and there was of lot of criticism on this concept at its early days. There was fear that it would make automotive software engineering even more complex and increase costs for the ECU's, which would lead to an enormous development effort and reduce the competitive advantage of the proprietary solutions. It was therefore extremely important that the supporters of this concept worked closely together. More and more, an internal network was formed which supported the development and took an important role in the spreading of the idea. Each top manager had to be addressed and convinced individually. There was a big internal workshop in which supporters and opponents exchanged and discussed their points of view. Professor Harald Heinecke and Dr. Jürgen Bielefeld played an essential role in developing, defending and disseminating of the concept. With all these efforts, a final success was achieved when November 2002 even the board was behind the idea to work towards a standardization.

We had created a lot of presentations with analogies to the "normal world" and to non-automotive IT that helped us a lot to communicate the idea even to those who are not familiar with the technical details.

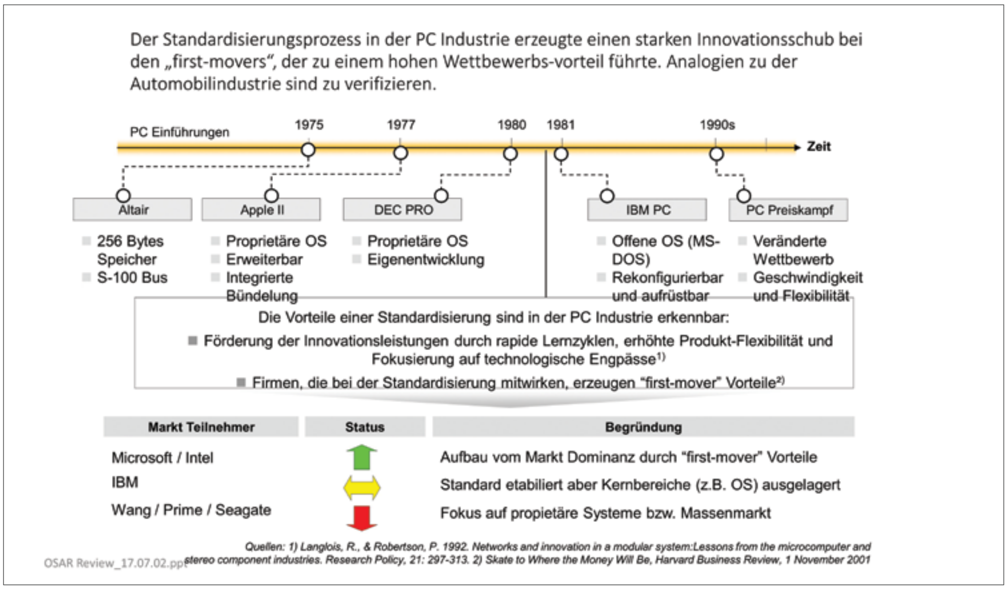


Figure 1
Analogies to IT Industry

Figure 2
Advantages of an open system architecture

FOUNDING THE AUTOSAR DEVELOPMENT PARTNERSHIP

Started as a company internal project supported by experts from IBM, it turned into a worldwide development partnership within the automotive industry from 2003 onward.

The first external contact was with the company BOSCH, where Mr. Reichart and Mr. Frischkorn from BMW presented the concept to Dr. Dais and his management. Mr. Reichart remembers: "I was in a tense mood during my presentation looking into many skeptical faces. After finishing my presentation, I awaited a huge debate from the so far silent audience. What a surprise when Mr. Dais raised his voice and said: "Gentlemen, we do it."

This was a milestone and we quickly found the other founding members of the consortium. From May 2003, the project milestones and the project plan have been defined and the consortium was formed by Bavarian Motor Works

(BMW), Robert Bosch GmbH, Continental AG, Daimler AG, Siemens VDO and Volkswagen. Ford Motor Company joined as a Core Partner in November 2003, and Groupe PSA (formerly PSA Peugeot Citroën) and Toyota Motor Corporation joined in December the same year. The following November, General Motors also became a Core Partner. Following Continental's acquisition of Siemens VDO in February 2008, the company is no longer an independent Core Partner.

Agreement on a technical approach was swift, and as early as July 2003, the architecture of the Classic Platform was drafted, which is still valid today.

The process of establishing the consortium and formulating the development agreement needed many meetings of the respective legal departments of all partners involved. Bringing them all together in a rather short time frame and getting them engaged in this complex legal construct required a great deal of creativity. Harald Heinicke was able to attract support for the joint meetings by organizing biker events, since many of the participants had motorcycles, as well as frequently organizing some other nice activities.

Bringing them all together in a rather short time frame and getting them engaged in this complex legal construct required a great deal of creativity.

As a result, it was possible to have the first AUTOSAR Development Agreement signed by the Core Partners and allowed the representatives of the consortium to present the AUTOSAR idea in September 2003:

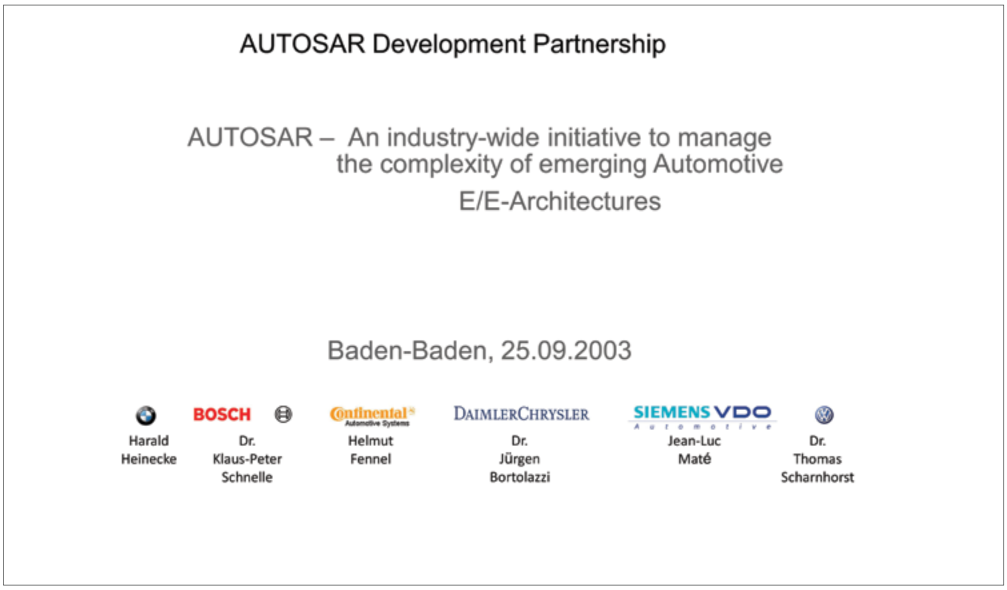


Figure 3
First presentation of AUTOSAR

Nothing attracts interest more than success.

The key factor for the fast start of the development community was probably that all parties involved in automotive software development had experienced the same problems and were looking for mitigation. The willingness to share one's own knowledge and patents in the common interest was a prerequisite for success. "Cooperate on standards, Compete on Implementations" has been our slogan from the beginning. Due to the strong effort of the founding Core Partners of the AUTOSAR consortium, we arrived early with convincing implementations and proved that many concerns, like cost increase or the high complexity of processes, were not valid. This early success attracted more and more partners to join and a mainstream had emerged; nothing attracts interest more than success.

We showed our project goals also at the VDI Conference Baden-Baden in September 2003 and they found great acceptance:

- Meeting of availability, safety and security objectives
- Redundancy activation
- Scalability and composability for vehicle product lines and fitting variants
- Implementation of basic SW-functions "Standard Core" largely as an industrial standard
- Transferability of functions
- Integration of functional SW-modules of different suppliers into common ECU's
- Assuring maintainability of the systems over the whole "Product Life Cycle"
- Intensified use of "Commercial off the shelf hardware"
- Feasibility of service-oriented software-updates and -upgrades with minimal efforts

ESTABLISHING THE AUTOSAR CLASSIC PLATFORM

The Classic Platform Release 1.0 was published in June 2005 as the first release of the classic platform specifications. In August 2005, AUTOSAR reached the next milestone by issuing a first standardization of some selected SW components whose AUTOSAR compatibility was approved. In addition, the first tools and generators to support the AUTOSAR methodology appeared.

A breakthrough has been achieved with the widespread use of the AUTOSAR Classic Platform in the automotive industry.

About a year later, the Classic Platform Release 2.0 was published, followed by release 2.1 at the end of 2006. Afterwards, a new release of the AUTOSAR Classic Platform followed nearly every year, proofing that AUTOSAR is a living standardization with continuous improvement processes, and even today we still see improvements and additions to the Classic Platform every year in the so-called release events. In parallel, the test and integration processes have been part of the AUTOSAR standardization, leading to the release of acceptance tests in 2014.

With the steadily growing membership of AUTOSAR and the worldwide spread of the standard, AUTOSAR has launched the so-called AUTOSAR open conferences (AOC). The first one took place in Detroit in 2008 and was subsequently held in annual sequences at other locations around the world to provide the community and other interested parties with a regular forum for personal exchange. Unfortunately, the regular AOC could not be held as usual during the Corona pandemic, so we are happy to start again with the AOC in the 20th anniversary year, as in the beginning again in the USA, this time in San Diego.

A breakthrough has been achieved with the widespread use of the AUTOSAR Classic Platform in the automotive industry. The originally planned time period for the standardization of the Classic Platform was also ended after several extensions and AUTOSAR was changed into a continuous development cooperation in 2013, which is intended to reflect the respective changes in the E/E architectures in the standardization.

AUTOSAR ADAPTIVE PLATFORM EXTENSION

This paved the way for the extension with the new AUTOSAR Adaptive Platform, which has been addressing the increased needs and challenges of the automotive industry since 2015. The challenges can be summarized by the terms connected, automated, shared and electrified driving (CASE), which have forced the automotive industry into new areas of technology.

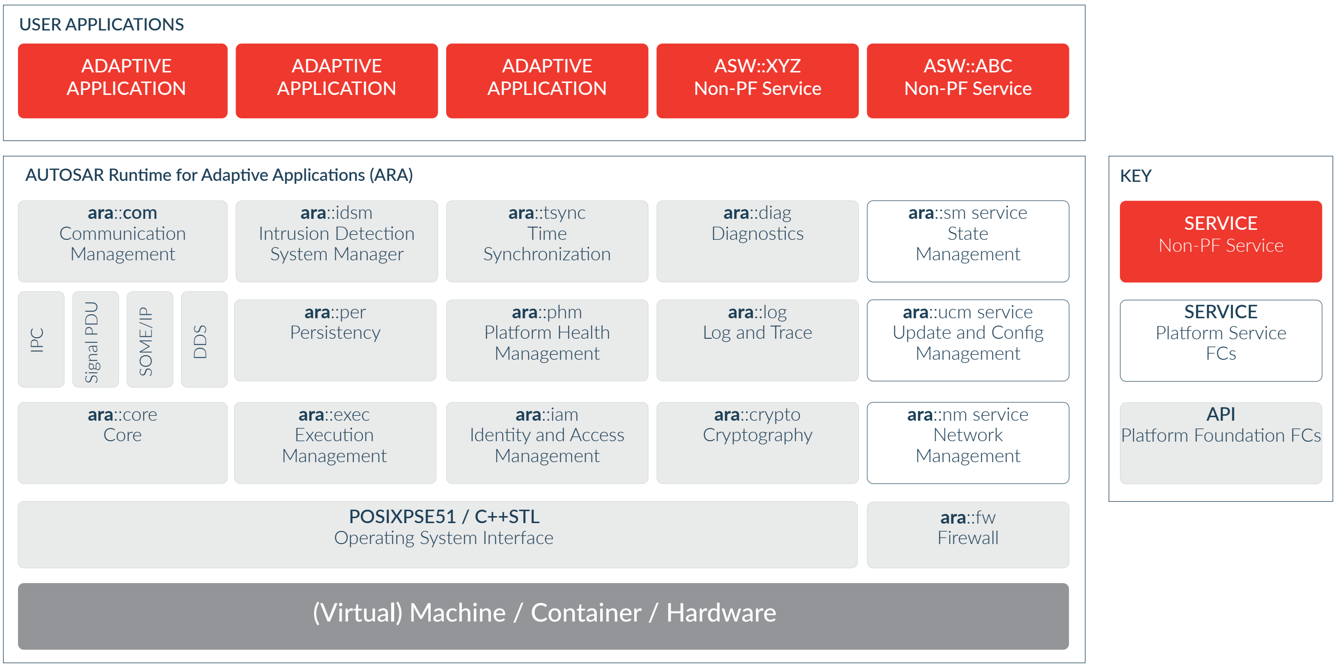
Vehicles are turning into real cyber physical systems – connecting to the internet and exchanging data with smartphones is state of the art. Future vehicles will be connected to almost everything: smart homes, roadside infrastructure and even vehicles around them – they become a part of the Internet of Things (IoT). Another trend besides increasing connectivity is the realization of the vision of autonomous driving, which is cutting its way through the further development of today's advanced driver assistance systems via highly automated driving and autonomous parking.

The realization of these new functions not only places new demands on the hardware and software infrastructure such as high-end manycore processors or hypervisor technology, communication with backend-systems for dynamic deployment or allocation of applications, as well as updates and upgrades over-the-air with the ability of self-configuration. On the way to autonomous vehicles, dependability will also play a key role, bringing the already existing focus on functional safety and cybersecurity even further into focus as part of the software architecture.

On the way to autonomous vehicles, dependability will also play a key role, bringing the already existing focus on functional safety and cybersecurity even further into focus as part of the software architecture.

Consequently, the new processor technologies, highly automated driving, IoT and cloud services along with functional safety and cybersecurity are major drivers for the further development of the AUTOSAR Standard and the AUTOSAR community has been developing completely new approaches to meet these challenging market trends in the automotive industry.

ADAPTIVE PLATFORM IS ORGANIZED IN FUNCTIONAL CLUSTERS



The result is an intelligent and flexible infrastructure software called AUTOSAR Adaptive Platform, which provides application developers with a stable programming interface. The platform utilizes POSIX based operating systems and supports parallel processing, allowing to be used for high-bandwidth communication as well as in numerous other data-intensive areas, and it enables customer applications during runtime.

The functional cluster architecture of the AUTOSAR Adaptive Platform is shown in the overview picture. With Release 17-03 in 2017, one of the main goals for the AUTOSAR Adaptive Platform was achieved and application developers were provided with a first stable programming interface, the so-called AUTOSAR Runtime for Adaptive Applications (ARA).

Functional Cluster Architecture of the AUTOSAR Adaptive Platform (using POSIX OS)

Executive Board

CORE PARTNER REPRESENTATIVES

by Dr. Günter Reichart, Bernd Mattner

This section is dedicated to the AUTOSAR Executive Board (EB) and provides an opportunity to introduce the Core Partner representatives that strengthen AUTOSAR as an organization on a corporate level. Each AUTOSAR Core Partner designates one representative of its executive management as a member of the AUTOSAR Executive Board, which is the ultimate decision-making body in AUTOSAR development cooperation.

The members of the AUTOSAR EB contribute their longstanding leadership skills and strong grasp of business fundamentals to ensure that AUTOSAR will always remain a trustworthy standard based on the strategic and technical concepts developed by the AUTOSAR Steering Committee and Project Leader Team, even under the changing conditions in the industry environment.

They guarantee compliance with the AUTOSAR culture of governance, which promotes the principles of open collaboration, transparency, credibility and accountability, with their final approval of strategic or contractual adaptation of AUTOSAR**.**

The AUTOSAR EB usually meets twice a year, but is regularly informed by the Steering Committee about upcoming strategic issues. In addition to, for example, appointing the chairperson and a deputy chairperson, the tasks also include the final approval of the financial planning.

The AUTOSAR EB also plays a key role in the decision-making process for extensive measures for optimizing the organization, such as most recently the addition of partnership types or the adaptation of standardization to the changes in the automotive development environment.

As with the introduction of the Adaptive Platform, the high-level commitment of the Core Partners ensures that the AUTOSAR development cooperation will continue to provide a future-proof support for its partners in the coming era of software-defined vehicles.

Our people

EXECUTIVE BOARD

Chris
Brandt
BMW

Mike
Colville
GENERAL MOTORS

Amen
Hamdan
VOLKSWAGEN

Matt
Jones
FORD

Martin
Schleicher
CONTINENTAL

Alexander
Springer
BOSCH

Steffen
Tacke
MERCEDES-BENZ

Satoru
Taniguchi
TOYOTA

Tara
Vatcher
STELLANTIS

Steering Committee

by Dr. Günter Reichart, Bernd Mattner

The Core Partners appoint members with management functions from their own companies to the AUTOSAR Steering Committee (SC).

At the AUTOSAR executive level, the AUTOSAR SC is responsible for converting the AUTOSAR strategy into reality. The Steering Committee meets every one to two months to coordinate operational steps and decide on necessary measures. For the day-to-day operations, two members of the SC are appointed each year as Chairperson and Deputy Chairperson.

In addition to regular business such as partner approvals, financial planning and controlling, the representatives in the SC develop the necessary measures to continue AUTOSAR's success story in the future.

For this purpose, they represent AUTOSAR at high-level professional automotive events and conferences worldwide and report openly on the development of the partnership as well as the strategic direction of the AUTOSAR standards.

As part of the AUTOSAR 3rd party collaboration initiative, the Steering Committee maintains a comprehensive overview of the automotive development ecosystem.

It is in active exchange with numerous other organizations to ensure a concerted effort to achieve effective standardization for major endeavors in the automotive industry, such as the software-defined vehicle.

In parallel, it has also expanded its presence in the regions of the world in recent years with the Regional Representation Hubs. This allows to further increase the awareness of AUTOSAR and to better integrate the partners in the regions into the AUTOSAR development partnership. In addition, specific needs from the regions can be more effectively reflected in the AUTOSAR standards in this way.

With this relentless commitment of their representatives in the Steering Committee, the Core Partners ensure that AUTOSAR is well positioned in the future for the benefit of all partners.

Our people

STEERING COMMITTEE

Andreas
Einmüller
VOLKSWAGEN

Dave
Gojarek
GENERAL MOTORS

Armando
Hernandez
STELLANTIS

Kenji
Hontani
TOYOTA

Michael Niklas
Höret
CONTINENTAL

Marco
Maniscalco
MERCEDES-BENZ

Peter
Redlich
FORD

Thomas
Rüping
BOSCH

Manfred
Zajicek
BMW

Project Leader Team

by Martin Lunt, Pinglei Wang

Since the beginning of AUTOSAR, the Project Leader (PL) team has been responsible to manage the development of AUTOSAR standards in all respects.

The PL Team supports the Steering Committee and the Executive Board in developing the strategic direction of standardization, thereby preparing the basis for the work in the Working Groups. For this purpose, current technical trends and requirements from series development are anticipated, but new technologies in general are also taken into account.

The strategic topics are usually translated first into concepts for the further development of the standards, but they can also lead to new standards, possibly even combined with adjustments in the partnership agreements.

The PL team is also involved in the daily businesses, like project planning, coordination of the development and publication of the AUTOSAR releases, financial planning and budgeting, as well as creating the rules of procedure as a prerequisite for an open and transparent standardization. It is driving the definition of processes to develop and maintain the standards, including quality criteria and their supervision.

The Project Leader team is deciding on setting up and maintaining tools and tool chains, subcontracting and management of contracted suppliers. It is responsible for the organization and staffing of work groups and it supports decision-making in case of different standardization approaches.

Finally, the PL team is supporting the external representation of the consortium, e.g. at the AUTOSAR Open Conference and at conferences or events of third parties. This task also includes the support of the presentation of our activities on the AUTSAR website, on Wikipedia and in form of articles in journals.

Our people

PROJECT LEADER TEAM

Sherif
Aly
GENERAL MOTORS

Adrian
Baruta
TOYOTA

Carmine
De Iesu
STELLANTIS

Bernd
Frielingsdorf
FORD

Martin
Lunt
BOSCH

Eduard
Metzker
VECTOR

Jennifer
Neumüller
DENSO

Christian
Nickl
CONTINENTAL

Steffen
Schneider
VOLKSWAGEN

Pinglei
Wang
MERCEDES-BENZ

Manfred
Zajicek
BMW

Zeng
Zhou
HUAWEI

Technical Support Functions

by Nadym Salem

As an international standardization organization that maintains nearly 35.000 pages of specification and more than 330.000 lines of code, we face manifold challenges when it comes to collaboration between hundreds of experts spread around the globe.

Nadym Salem, Technical Manager-AP / DevelopGroup

Technical Support Functions provide the core services for the development of the standard, i.e. processes, methods, and tools for an efficient standardization work. AUTOSAR, as an international standardization organization that maintains nearly 35.000 pages of specification and more than 330.000 lines of code, faces manifold challenges when it comes to collaboration between hundreds of experts spread around the globe. Technical Support Functions are the binding element in this standardization work. This complex task requires several entities, working on all the different aspects of the standardization work.

CHANGE MANAGEMENT (CM)

Change Management defines the change request management process in AUTOSAR and handles around 1500 change requests per release. The main goal is to enable the experts to focus on technical discussions and ensure specific quality measures within the process – to be sure, the resulting AUTOSAR standard will be released in the necessary quality, with the necessary content and on time.

QUALITY ASSURANCE (QA)

Quality Assurance handles the larger changes in the standard – the concepts – and can be considered the change request management for those changes. QA supports the concept owners during all the necessary development and review phases until the new feature is released in time and quality end of November. Additionally, QA coordinates the whole verification of the specifications to give the necessary confidence to the partners using the standard that AUTOSAR has taken appropriate measures to ensure the quality of the standard.

QUALITY MANAGEMENT (QM)

Quality Management defines all the quality related processes in the organization, especially for the development of the standard but also to ensure process quality throughout the whole organization.

RELEASE MANAGEMENT (RM)

Release Management ensures the final formal quality of all the released specifications and coordinates the yearly releases of Classic Platform, Adaptive Platform and Foundation.

TECHNICAL OFFICE (TO)

AUTOSAR generates specifications according to several development tools and processes that are well-known in software development. Model driven development and continuous integration are just some of the techniques being used to generate our specifications and to ensure consistency amongst them. Technical Office is the heart and soul of the IT and tool infrastructure that enables this development. All tools being used within the organization – Jira, SVN, UML modelling tools, just to name a few – are configured and maintained by TO.

This is accompanied by additional software development to transform this tool landscape into a coherent suite that supports the work of the experts. Again, Technical Support Functions are there to enable the experts to focus on the technical specification work.

SOFTWARE DEVELOPMENT

AUTOSAR does not only provide specifications for the Adaptive Platform but also an exemplary implementation – the AUTOSAR Adaptive Platform Demonstrator (APD). To coordinate these activities, there are two responsible roles, the Software Development Engineer (SDE) and the Software Development Integrator (SDI). Together with our different coding and integration Working Groups, they are responsible for the planning and coordination of the APD.

TECHNICAL MANAGEMENT (TM-AP AND TM-CP)

Technical Managers can be considered the project managers of Classic- and Adaptive Platform. Release planning, coordination of Technical Support Functions, reporting to the AUTOSAR management level are just a few tasks to name.

Additionally, it is the job of the Technical Managers to mediate between the partner interests in technical matters of standardization, both at the expert level and at the management level of AUTOSAR. All threads concerning the platform development converge at the Technical Management.

Our people

TECHNICAL SUPPORT FUNCTIONS

Yves Biener
TECHNICAL OFFICE

Markus Eberhardt
REQUIREMENTS MANAGEMENT

Manuel Funk
TECHNICAL OFFICE

Ilja Krüger
CHANGE REQUEST MANAGEMENT

Piotr Litwiniuk
SOFTWARE DEVELOPMENT ENGINEER

Víctor Morales
SOFTWARE DEVELOPEMENT INTEGRATION

Miriam Nees
QUALITY ASSURANCE/ TECHNICAL OFFICE

Niko Pollner
TECHNICAL MANAGER CP

Christine Roellig
QUALITY ASSURANCE/ RELEASE MANAGEMENT

Tony
Schmidt
REQUIREMENTS MANAGEMENT

Philip
Stolz
REQUIREMENTS MANAGEMENT

Lien
Tran
CHANGE REQUEST MANAGEMENT

Friedemann
Treblin
TECHNICAL OFFICE

Daniel
Wagner
CHANGE REQUEST MANAGEMENT

Havva
Yalcinkaya
CHANGE REQUEST MANAGEMENT

Achim
Zeeck
QUALITY MANAGEMENT

Business Administration

by Mareike Wulff

The backbone of AUTOSAR, the Partners, are supported by the Partner Management Team, responsible for administering and maintaining core data and partner contact information.

Mareike Wulff is Head of Business Administration
Chiara Polenske is Head of Communication

The AUTOSAR Business Administration supports the goals of the AUTOSAR standards in a trusted environment. Our various support functions are contracted as unbiased key players that enable compliant collaboration within the large AUTOSAR community.

PARTNER MANAGEMENT

The backbone of AUTOSAR, the Partners, are supported by the Partner Management Team, responsible for administering and maintaining core data and partner contact information.

This team is the first point of contact for partners when they require support.
They handle acquisition of new partners as well as everything related to partnership changes: partnership level, contributions, and others. Using effective user management, they provide AUTOSAR Partner experts with the appropriate access and accounts to AUTOSAR IT Tools.

Partner Management acts as the communication bridge between the AUTOSAR Partners, Core Partners, and the other Support Functions – Finance, Legal, Meeting Management, Communication, and Technical Management.

FINANCE

Within Business Administration, AUTOSAR has its own financial department. The Finance Team handles all financial details faced by the AUTOSAR organization. Interfacing closely with the other support functions and processes – primarily Legal Support and Partner Management, the team manages controlling, budget planning, the creditor as well as debtor proceedings.

LEGAL SUPPORT

The Legal Support Team coordinates all legal activities within the AUTOSAR Consortium. They are the point of contact for all partners regarding AUTOSAR legal topics. In addition, they coordinate the communication of internal and external legal questions. This team has a leading role in AUTOSAR Agreement changes, initiating and proposing drafts for Errata, Amendments, and new Agreements.

MEETING MANAGEMENT

The Meeting Management Team facilitates an environment for partners to share information and develop the AUTOSAR standard that ensures compliance with the specific legal requirements for an industry consortium, such as antitrust law. The team oversees the entire process of all board meetings.
A successful meeting starts with good preparation, including the scheduling of meetings throughout the year, anticipating required additional meetings, setting agendas due to the board's needs, and coordinating the invitation of internal and external parties. During meetings, the team keeps a collaborative atmosphere by moderating, time-keeping and processing required documentation. They follow-up on open actions and as one meeting closes, begin the preparation of the next based on previous outcomes, future goals and accurate scheduling.

COMMUNICATION

Communication Support supports the external promotion of the AUTOSAR Community's achievements, running both internal and external communication. In addition to running the website and various social media channels, the Communication Support Team keeps the public up to date with all things AUTOSAR through newsletters, Conference and Exhibition Participation, and AUTOSAR Events – AUTOSAR Open Conference (AOC), AUTOSAR Days, University Days, 20th Anniversary.

Turning challenges into opportunities, Communication Support demonstrated its adaptability during the Covid-19 Pandemic, seamlessly transitioning planned onsite events to hybrid or fully digital events. This gave way to the digital AUTOSAR Release Event, an annual presentation of updates of AUTOSAR's Classic and Adaptive Platforms, which is considered the highlight of the year.

The variety of communication strategies spreads the word of AUTOSAR globally. In 2022 Communication Support assisted in the formation of AUTOSAR Hubs in North America, Japan, and China, deepening the connection between AUTOSAR Administration and the regional partners.

Our people

BUSINESS ADMINISTRATION

Kristian
Andris

COMM SUPPORT

Maureen
Babiarz

FINANCE

Nattaya
Breier

PARTNER HANDLING

Ersin
Demirov

WEBSITE & LEGAL

Ramon
Fernandez

MEETING MANAGEMENT

Ramona
Hechtl

LEGAL AND PROCESS
MANAGEMENT

Maria
Jurin

EXTERNAL MEDIA
AND COMPLIANCE
MANAGEMENT

Monica
Montenegro

NORTH AMERICA
HUB SUPPORT

Tristan
Puntellini

COMM SUPPORT

Carlos
Purata

PARTNER HANDLING

Marina
Samoliuk

EXTERNAL MEDIA SUPPORT

Ricardo
Sanchez

CONFERENCE AND EXHIBITIONS

Ilija
Sholev

CONTROLLING

Elizabeth
Schwarz

FINANCE

Alina
Wächter

COMM SUPPORT

Anhui
Wang

PARTNER HANDLING

Echo
Wang

CHINA HUB SUPPORT

Andrea
Weber

COMM SUPPORT

Internal Affairs Officer

by Bernd Mattner

Standardization is an essential part of the complex system of technology development and knowledge transfer. It is closely linked to other factors in its contribution to worldwide open and non-discriminatory technological change.

Bernd Mattner is CEO & Founder of Fry Bern GmbH, Senator in the European senate of Economy and Technology, Chairperson of the EUTECH Mobility Alliance

THE CHALLENGES OF AN INDUSTRY

All industrial sectors are obliged to make their contribution to sustainability and climate action. The resulting transformation in the automotive industry also has an impact on an industrial standardization consortium such as AUTOSAR.

With the integration of vehicles into the future overarching mobility systems, the technical complexity and the associated challenges are increasing. Not only do additional interfaces between the vehicle and the cloud or backend systems arise, which must be addressed with technical standardization worldwide. This also changes the role and responsibility of a consortium like AUTOSAR. The motivation 20 years ago was to tackle the risks and effort of proprietary, hardware-dependent software development. Today, the focus is on enabling a sustainable and climate-friendly transformation of mobility by ensuring that vehicles can be integrated into mobility ecosystems.

RESPONSIBILITY IN THE AUTOMOTIVE DEVELOPMENT ECOSYSTEM

AUTOSAR decided at an early stage to take on its responsibility in the Automotive Development Ecosystem and to develop the globally harmonized and standardized frameworks for the technologies of future Smart Mobility in collaboration with other 3rd party organizations. In this context, besides other measures, the role of the Internal Affairs Officer (IAO) was created in 2020 to support the increased effort for the strategic organizational development. The IAO supports the AUTOSAR bodies in the development of strategic measures and their legal and organizational framework. He is a neutral contact person for the AUTOSAR partners and the Support Functions, and forms an interface for the collaboration with 3rd party organizations. He supports the Chairperson Team and Steering Committee in their regular tasks.

The Impact of Standardization

HUMAN-CENTERED MOBILITY BY DECISION AND TECHNOLOGICAL INNOVATION

by Bernd Mattner, Senator of the European Senate of Economy

NGOs and non-profit organizations can assist in building consensus between businesses and governments to collaborate on outcomes that move us forward on the path to a more just, safe and prosperous society.

Across human history, the way we span distances between people and regions, the means we choose to do so, and the motivations for mobility in general have been subject to social, economic, and technological change. The potential that digitalization is expected to provide is once again expected to fundamentally change the way people travel and products can be transported. Given the ongoing global population growth, urbanization and increasing environmental pollution and climate change, new concepts are essential in the field of mobility in order to globally sustain social and economic developments in a positive way.

This transformation to sustainable mobility is currently being driven by the following trends, and some of them are of a disruptive nature, building on numerous new technologies: Connectivity and Autonomous Driving, Vehicle Electrification, Shared Mobility and Mobility as a Service, and Intermodality.

A significant contribution to climate action could therefore depend on the industry providing solutions for electrification, connectivity and digital services as well as other high-technology. This approach ignores the question of how their global use is to be regulated and how the functioning of societies will depend on this in the future. In its Global Risk Report 2023, the World Economic Forum briefly summarizes: "Technology will exacerbate inequalities while risks from cybersecurity will remain a constant concern".

But this could mean that local optimization may be possible, but at the same time, the foundation cannot even be laid to secure digital business models or the functioning of society and the economy. In the end, we cannot even be sure that the measures introduced so far will support the change toward climate-neutral and sustainable mobility or possibly even hinder it. The Global Risk Report 2023 puts it this way: "Climate mitigation and adaptation efforts are set up for a risky trade-off, while nature collapses."

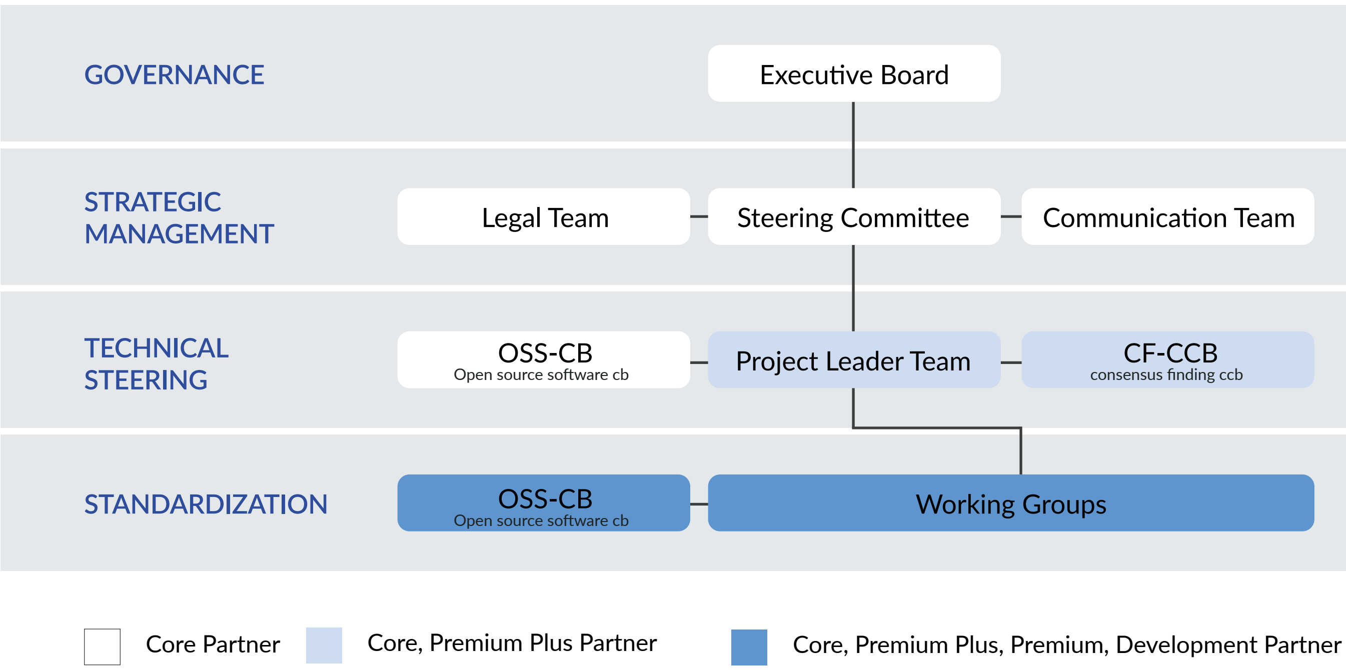
The mobility industry therefore needs a specific framework for action that describes the requirements and resolves the previously indicated trade-off as far as possible, but provides the necessary flexibility to create effective innovations. The United Nations System Staff College suggests that "the other stakeholders in mobility should also be involved in the elaboration process in order to balance economic interests with the needs of society and the environment." Due to the size and complexity of the mobility sector, the described framework for action can be created iteratively in order to make rapid progress. It can additionally be used to assess the measures introduced in terms of their contribution to target fulfillment and, if necessary, to take supplementary and optimizing measures.

The Edelman Trust Barometer 2023 concludes, "Business is now the only institution seen as competent and ethical; ... [It] is under pressure to step into the void left by government." Globally active, nondiscriminatory, and open NGOs and non-profits with broad industry participation, such as we have experienced for many years in AUTOSAR or comparable consortia in the automotive industry, are thus assigned a crucial position of trust in the area of mobility as well. They can provide the technologies for a human-centered mobility system and ensure compliance with the UN Sustainable Development Goals to achieve security and economic stability and reduce the negative impacts of mobility on health, the environment and the climate.

Excerpt of a speech held at
European Senate of Economy

AUTOSAR Organization

OFFICIAL ROLES



AUTOSAR Organization

SUPPORT FUNCTIONS

AUTOSAR SPOKESPERSON AND INTERNAL AFFAIRS OFFICER (IAO)

BUSINESS ADMINISTRATION

- Partner and User Management
- Finance
- Meeting Management

COMMUNICATION SUPPORT

- Marketing

TECHNICAL MANAGEMENT

- Standards
- Software Development Engineering

DELIVERABLE MANAGEMENT

- Change Management
- Quality Assurance
- Release Management

LEGAL SUPPORT

REQUIREMENTS MANAGEMENT

QUALITY AND PROCESS MANAGEMENT

TECHNICAL OFFICE AND IT INFRASTRUCTURE

Chapter 3
Automotive Development Ecosystem

"Coming together is a beginning, staying together is progress, and working together is success."

- Henry Ford

Collaborations for Future Mobility

THE AUTOMOTIVE DEVELOPMENT ECOSYSTEM

by Bernd Mattner, IAO

ON THE ROAD TO FUTURE MOBILITY

The automotive industry is continuously transforming into a part of the future human-centered and sustainable mobility - and the smart use of technology will be a key success factor of this evolution.
Historically, the production and use of vehicles has left an enormous carbon footprint, resulting in a global environmental impact that is no longer affordable. This puts external pressure on the industry towards a new normal with advanced and sustainable mobility, in addition to the disruption caused by the COVID-19 pandemic.

This means that in addition to the previous technological megatrends, other factors are accelerating the need for change in the automotive industry.
The main drivers in new technology fields have so far been generated by the challenges arising from the trends toward advanced networking of vehicles with each other and with the environment, advancing automation, car sharing or on-demand services, and the paradigm shift toward electric vehicles (CASE).

Government interventions are also having an increasing and accelerating influence on the momentum towards sustainable measures across the entire life cycle of vehicles worldwide. This is challenging the automotive industry to deliver sustainable solutions to achieve climate neutrality.

Government interventions are also having an increasing and accelerating influence on the momentum towards sustainable measures across the entire life cycle of vehicles worldwide. This is challenging the automotive industry to deliver sustainable solutions to achieve climate neutrality.

And last but not least, the shift in customer and employee expectations is impacting the industry in regionally varying ways. An adaptive user experience will have a significant impact on the successful transformation of the automotive industry, which will affect, among other things, the intuitive design of technology, safety and reliability, or the treatment of data privacy along with cybersecurity measures. With embedded technologies and software making up an increasing share of the overall vehicle, a new generation of tech-savvy, environmentally conscious employees join the automotive industry, challenging conventional methods.

Despite, or perhaps because of, the driving forces from outside and within the companies itself, the current transformation of the automotive industry will have a major positive impact. Many companies already have added measures for more sustainability to their agendas convinced that significant changes are needed for the future of the automotive industry.
This involves large and small companies in the automotive sector increasingly rethinking approaches across the entire product lifecycle of vehicles - from development to production, operation as well as maintenance, and end of life handling.

Some companies are already focusing on process redesign to achieve their sustainability goals - in the area of E/E architectures, for example, this includes initiatives with holistic approaches like the ones around the software defined vehicle (SDV).

JOINT EFFORTS TO COUNTER THE GROWING PRESSURE FOR CHANGE

The pressure to change is a global challenge for the entire value chain in the automotive industry. Numerous players in the automotive and IT sectors are committed to sustainable change and want to meet the challenges by promoting cross-sector collaboration and applying modern approaches from other industry sectors as well. Over the last few years, it has become more apparent that companies will not be able to manage the entire vehicle lifecycle and the increasing complexity in the technical and regulatory areas on their own, and that they need industry cooperation in order to develop the long-term successful solutions for the various regions of the world quickly enough.

Consequently, automotive manufacturers, suppliers and technology companies are also joining forces in new networks and consortia or expanding existing cooperations to address the industry's emerging challenges and diverse issues. As a result, an automotive development ecosystem is emerging in which numerous organizations worldwide cover the various aspects of automotive development. Ideally, the ecosystem provides gap-free, holistic support for all requirements or non-market differentiating solutions over the vehicle lifecycle.

AUTOSAR will actively participate in the orchestration of the automotive development ecosystem (ADE) in the spirit of the entire partnership.

Until then, companies in the automotive sector will have to overcome a number of obstacles on their way to future mobility in order to balance the pressure from the different directions. It is in the responsibility of the respective organizations and their member companies to pursue the exchange among each other with the necessary open-mind to ensure the necessary coordination of the respective activities in the sense of an orchestrated automotive development ecosystem. This seems essential in order to make the most effective use of the automotive industry's investment in global basic work and standardization and to comply with the corporate social responsibility (CSR) of the individual companies on the way to human-centered and sustainable mobility.

3RD PARTY COLLABORATION IN AUTOSAR

AUTOSAR will actively participate in the orchestration of the automotive development ecosystem (ADE) in the spirit of the entire partnership. Within its legal possibilities AUTOSAR intends to provide the assets from 20 years of standardization as well as future enhancements and additionally create an open framework also for future standardization together with other organizations.

The goal of AUTOSAR is to develop and establish a standardized software framework and an open E/E system architecture for intelligent mobility. Vehicles are integrating as a subsystem more and more into the higher-level intelligent mobility systems and address the vehicle user as the end customer. As a result, the system of interest in terms of vehicle application is also expanding from the vehicle only to the integrated vehicle systems and related systems. AUTOSAR is the only standards development organization that supports a high level of reliability, especially functional safety and cybersecurity for vehicle applications. In this area, AUTOSAR will continue to provide end-to-end value to its partners and to developers in the automotive industry, and will therefore adapt the scope of standardization to the expanding system of interest.

Figure 1
Extract of AUTOSAR 3rd party collaboration overview

AUTOSAR is actively seeking coordination with other organizations in the advanced mobility sector. For the coordination with other 3rd party organizations, AUTOSAR has created a lean process for establishing 3rd party collaborations based on the existing legal framework with the Attendee Agreement.

These 3rd Party Collaborations are publicly communicated and their added value is continuously presented, for example during the AUTOSAR Open Conferences (AOC). AUTOSAR has created a 3rd Party Day as part of the AOC to publicly present how AUTOSAR is shaping the joint work together with other organizations.

Collaboration with individual organizations will be used to align specific technical topics and then implement them with the specific standardization focus in the respective organizations. It will also help to better connect AUTOSAR to the regions and more effectively address regional requirements by leveraging third-party organizations that are established in regional automotive markets, such as JASPAR in Japan. A key effect for companies in the industry will be that end-to-end regulation and standardization across different organizations will not have to be done sequentially and will therefore become faster to implement.

A key effect for companies in the industry will be that end-to-end regulation and standardization across different organizations will not have to be done sequentially and will therefore become faster to implement.

In parallel, AUTOSAR is working with other 3rd party organizations on a model of the ADE that provides an overview of the thematic responsibilities, interrelationships and interfaces between the organizations. In the following articles, some organizations already in contact with AUTOSAR will briefly introduce themselves with their respective contributions to the automotive development ecosystem.

ASAM

Standardization at ASAM – a collaborative approach

ENABLING SEAMLESS INTERACTION IN THE AUTOMOTIVE ECOSYSTEM

by Dorothee Bassermann, Bernd Wenzel

ASAM e.V. (Association for Standardization of Automation and Measuring Systems) is a non-profit organization that promotes standardization of tool chains in automotive development and testing. Our more than 400 members are international car manufacturers, suppliers, tool vendors, engineering service providers, and research institutes. ASAM standards are developed by experts from our member companies and are based on their current and prospective use cases. ASAM provides the legal pre-competitive framework for these activities and is responsible for distributing and marketing the standards.

ASAM standards span a wide range of use cases in automotive development, test, and validation. They are targeted for the implementation level and define file formats, data models, protocols, and interfaces. The standards enable the seamless exchange of data and tools within and across tool chains and are applied worldwide.

The key roles of ASAM are to provide a platform for addressing technological challenges, to facilitate the networking of its members, to coordinate project groups, and to develop, release, and maintain standards for a long-lasting benefit of the users.

ONLY COOPERATION GETS US THERE…

Meeting today's mobility challenges technologically, while managing the significant costs associated with their development and deployment is only possible through the cooperation of all involved stakeholders. Standards therefore play an increasingly important role - from development, testing and validation to certification, approval and ultimately vehicle operation.
Various standardization organizations across the globe work to address today's mobility challenges. ASAM believes that it is important for these organizations to collaborate in order to avoid redundant standardization and diverging standards. For that reason, ASAM has entered strategic partnerships with other organizations, such as AUTOSAR, ISO, SAE, IAMTS, mipi alliance, prostep, and many more. We promote an active exchange among these organizations on both a management and working level. Partnering at conferences makes sure that the collaboration remains alive and is visible to the entire automotive community.

The partnership with AUTOSAR is one of the earliest and most lively engagements of ASAM with like-minded organizations. Each organization contributes with its competency to a well-functioning value chain.

The partnership with AUTOSAR is one of the earliest and most lively engagements of ASAM with a like-minded organization. Each organization contributes with its competency to a well-functioning value chain.

Currently, AUTOSAR and ASAM are working closely on alignment of their respective activities. This includes implementation of ASAM SOVD by AUTOSAR (first AUTOSAR components are already supporting ASAM SOVD since release R11-22. Others are following this year) as well as aligning ASAM OSI with AUTOSAR ADI and ISO23150. We are convinced that this way of cooperation offers an advantage for all – OEMs, tool vendors and standardization organizations – in solving the mobility challenges of the future.

WE WISH AUTOSAR ALL THE BEST FOR ITS 20TH ANNIVERSARY AND WE LOOK FORWARD TO A CONTINUING COLLABORATION IN THE YEARS TO COME.

CAN-based in-vehicle networking and CAN-based vehicle-external interfaces

by Holger Zeltwanger

The nonprofit CAN in Automation (CiA) international users' and manufacturers' group with about 740 members supports all three generations of CAN data link layer protocols: Classical CAN, CAN FD (Flexible Datarate), and CAN XL (eXtended Length) as well as CAN FD Light, a commander/responder communication approach.

Additionally, the 1992 established association, assists the development of CAN physical layer options: high-speed CAN, CAN SIC (signal improvement capability), and CAN SIC XL physical media attachment (PMA) sub-layer specifications (CiA 601-4 respectively CiA 620-3). Furthermore, CiA accompanies the standardization of CAN-based higher OSI (Open Systems Interconnection) layers for in-vehicle networks. This includes the SAE J1939 series for commercial heavy-duty road vehicles and ISO standards for road-vehicle diagnostics (e.g. ISO 15765 series, ISO 14299 series, ISO 26021 series, and ISO 16844 series).

Besides CAN-based in-vehicle networks, CiA supports also the development of CAN-based vehicle-external interfaces, such as ISO 11992 series (truck/trailer link), DIN 4630 (body-builder interface for commercial vehicles based on J1939 or CANopen), and CiA 447 (body-builder interface for passenger cars based on EN 50325-4).

The configuration of the OSI layers is also in the scope of CiA specification and standardization activities as well as OSI layer add-on functionalities (e.g. functional safety and cybersecurity). Especially for CAN XL, CiA develops a complete ecosystem. This includes the CANsec® data link layer cybersecurity protocol and the CAN XL frame fragmentation optional function. Time-stamping for CAN FD (CiA 603) and CAN XL is another add-on function.

For the optional disabling of the CAN XL data link layer error indication, CiA plans to specify a generic transport layer error management.

In order to make optimal use of the CAN communication features including standardized higher OSI layers, CiA supports AUTOSAR projects when creating and establishing an open and standardized software architecture for automotive electronic control units (ECUs). This includes the scalability to different vehicle and platform variants, transferability of communication software as well as the consideration of high availability (redundancy) and safety/security requirements.

The optimal use of CAN communication features also covers the management of OSI layers. For this purpose, CiA specifies the service access points (SAP) and related implementations. Layer management is possible by means of static configuration, special management protocols, or embedded layer configuration (e.g. SDT in CAN XL).

CiA is highly committed to support international standardization (such as in ISO and IEC) and to cooperate with other nonprofit associations (such as SAE).

The established partnership with AUTOSAR is intended for improving the usage of CAN communication for in-vehicle networking as well as external interfaces for diagnostics and other purposes.

CiA supports all three CAN data link layer generations: Classical CAN, CAN FD, and CAN XL as standardized in the next edition of the ISO 11898-1 series

COVESA

Orchestrating the Data Backbone of the Software Defined Vehicle

by Steve Crumb

The future of the software defined vehicle (SDV) is becoming clearer. Manufacturers and their suppliers have recognized the need to evolve historical methods of vehicle feature development and deployment. New architectures are forming, new vehicle services are being considered and software is defining how vehicles operate and how occupants experience their drive.

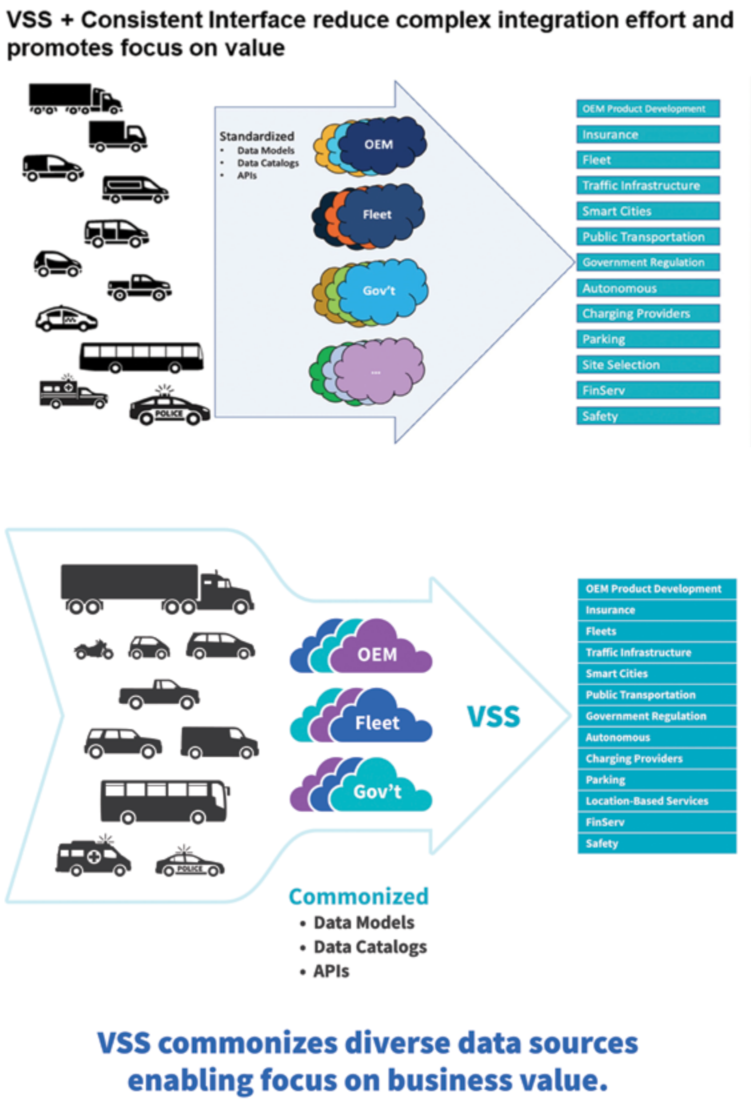
At the core of this evolution is the increasingly connected vehicle (both passenger and commercial).

Connectivity has revolutionized a vehicle's purpose, changing it from merely a way to move people and goods to becoming a mobile sensor, delivering a steady stream of information about the vehicle, its occupants and surroundings.

Electric vehicle drivers can easily find a charging station and a nearby coffee shop to better enjoy the time waiting for their charge to complete.

The combination of connectivity and software definition positions the passenger and commercial vehicle industries for an exciting future. The combination also positions industry standards bodies like AUTOSAR and COVESA to play a significant role in that future. But, a major barrier must be cleared to bring about the full promise of the connected SDV – an open and common method for describing and accessing vehicle data in the vehicle and in the cloud.

Modern connected vehicles can produce multiple terabytes of data daily from in-vehicle sensors (not to mention external sensors gathering data about the vehicle's surroundings). A major challenge, however, is that vehicle manufacturers describe data flowing from the vehicle in different ways. This limits the usefulness of sharing this data to identify insights that enable OEMs make better SDVs with new services and features that delight vehicle owners and occupants.



Figures 1 & 2
Vehicle Signal Specification (VSS)

As connectivity has become more robust, both commercial and passenger vehicle OEMs are recognizing the need for a more extensible, easy-to-use and machine readable method for describing vehicle data and accessing that data across brands. Fortunately, the Connected Vehicle Systems Alliance (COVESA) has developed and released the Vehicle Signal Specification (VSS) to serve exactly that purpose. And working together with AUTOSAR, the experts on open vehicle architectures that support the needs of future in-car applications, vehicle data can now be described in a common way that increases its usability in the vehicle and portability to the cloud.

COVESA's VSS is an easy to adopt, open and mature data model for describing vehicle data in and out of the vehicle. Not only are fleet data consolidators like Geotab and AWS Fleetwise heavily using VSS as a common way of ingesting vehicle data, but increasingly, passenger vehicle manufacturers are seeing the value of adopting VSS in their vehicle data description.

VSS is the best candidate to serve as the data backbone of the emerging SDV. It has growing visibility among regional projects in Europe and international standards bodies like ISO and has been adopted by both commercial and open licensed components proposed as essential elements to the SDV stack.

COVESA welcomes open contributions to improve VSS that increase the benefits of industry-wide adoption.

Eclipse Software Defined Vehicle

A CODE FIRST OPEN COLLABORATION

by Sara Gallian, Daniel Krippner and Michael Plagge

The Eclipse Software Defined Vehicle (SDV) aims at driving the development and adoption of an "open technology platform" able to accelerate the innovation of "automotive grade" in-vehicle software stacks. Moreover, by leveraging on a "code first" approach and "open standards", the Eclipse SDV WG fosters the creation and growth of a vivid "community".

The "Open technology platform" integrates open-sourced, modular software components and frameworks into a modern developer experience with a high degree of automation and virtualization.

"Automotive-grade" means from high performance computers as well as legacy ECUs, and from quality managed to safety-relevant functions across all vehicle domains. "Code first" means non-consent driven, agile code implementation adhering to the Eclipse open-source standard to increase efficiency and accelerate time to market.

"Open standards" includes adopting open standards wherever possible and shaping the future of industry standards through the power of open collaboration.

The "Community" builds value together and fosters a vendor-neutral environment, joins forces on non-differentiating SW stacks and shares best practices overcoming the talent competition.

Eclipse SDV was launched in Q4 2021, published its charter in Q1 2022, and as of November 2022, 12 projects have been contributed and more than 25 member organizations from various industry segments joined: OEMs, Tiers, IT integrators, hyperscalers and silicon vendors.

INTERFACES WITH AUTOSAR

With the diffusion of in-vehicle connectivity, the vehicle becomes an integral part of a network: it can access an impressive amount of data from other vehicles and for a connected infrastructure, and can receive over-the-air (OTA) SW updates during its life cycle. These possibilities unlock some of the potentials of the cloud-native approach which provides a set of tools and practices that support, automate, and speed up continuous integration and continuous delivery (CI/CD) and deployment of cloud-based applications.

A new way of working has therefore to be found, among the well-established requirements-driven approach and cloud enabled approaches. We believe that a discussion with the AUTOSAR community is most valuable.

ACTIVITIES AND LARGER AUTOMOTIVE SOFTWARE ECOSYSTEM

The automotive world is looking with growing interest and momentum towards the idea of a software defined vehicle. The notion of software development, deployment, and maintenance has already moved the automotive and IT ecosystems closer than ever before. Moreover, we observe a substantial increase of interest in open, collaborative software development models and the vision of a shared technology ecosystem.
The Eclipse SDV enters a landscape of long-established communities such as AUTOSAR, AGL and COVESA, together with other newcomers like SOAFEE. There already exist artefact-level relationships between Eclipse SDV, COVESA and SOAFEE, with further alignment and collaboration options being investigated multilaterally and continually.

As an open-source community, we believe in collaboration and the use of established open-source standards, while at the same time facing the challenge to recognize and connect with existing related initiatives.

As a new initiative we congratulate AUTOSAR on the 20th Anniversary and wish at least another 20 years of successful work. We are really looking forward to a future collaboration.

The Eclipse SDV enters a landscape of long-established communities such as AUTOSAR, AGL and COVESA, together with other newcomers like SOAFEE.

Supporting Trustworthiness in Automotive Cybersecurity

GLOBALPLATFORM STANDARD FOR MANAGING APPLICATIONS ON SECURE CHIP TECHNOLOGY

by Francesca Forestieri, Gil Bernabeau

GlobalPlatform, a not-for-profit member-driven standards organisation, with over 20 years of experience in delivering specifications and certifications for secure digital services and devices for the Banking, Financial, Government and Mobile industries. Our solutions have become THE global standard for managing applications on secure chip technology:

Over 60 Billion Secure Elements shipped worldwide are based upon GlobalPlatform specifications and over 15 billion GlobalPlatform compliant Trusted Execution Environments are in the market today.

Automotive solutions for hardware protected security environments, such as SHE++ and HSM, should evolve to answer acceleration of customer demand, cybersecurity regulations, higher security requirements including post-quantum cryptography migration, and over-the-air-secure updates for software and firmware across diverse product architecture and networks. This situation is compounded by fierce coopetition, an acceleration of evolution of the chip technology and automotive architecture from ECU to Domain Control Units and embedded Cloud Computing.

- Device Trust Architecture as a way for manufacturers to ensure that their devices are trustworthy through the use of Secure Components to provide Roots of Trust (RoT).
- Secure Elements as a tamper-resistant platform (typically a one chip secure microcontroller) capable of securely hosting applications and their confidential and cryptographic data (for example cryptographic keys) in accordance with the rules and security requirements set by well-identified trusted authorities.
- Trusted Execution Environments as a secure area of the main processor in any connected device to enable a minimal trusted computing base (TCB). It ensures that sensitive data is stored, processed and protected in an isolated, trusted environment. The TEE's ability to offer isolated

safe execution of authorized security software, known as 'trusted applications', enable it to provide end-to-end security by enforcing protected execution of authenticated code, confidentiality, authenticity, privacy, system integrity and data access rights. The TEE protects sensitive data in transit, while processed and when stored.

- Trusted Platform Services provides interoperable middleware for secure services that simplify the access to secure components. The attestation mechanism allows the users of the services to know exactly the security level of the provider. TPS supports open-source TPS APIs, which simplifies the integration into any kind of device.
- Security Evaluation Methodology for assessing the foundational security of connected products and parts for IoT scheme, providing a means to combine and reuse certificates to demonstrate compliance to regulations from different markets including UNECE 155.

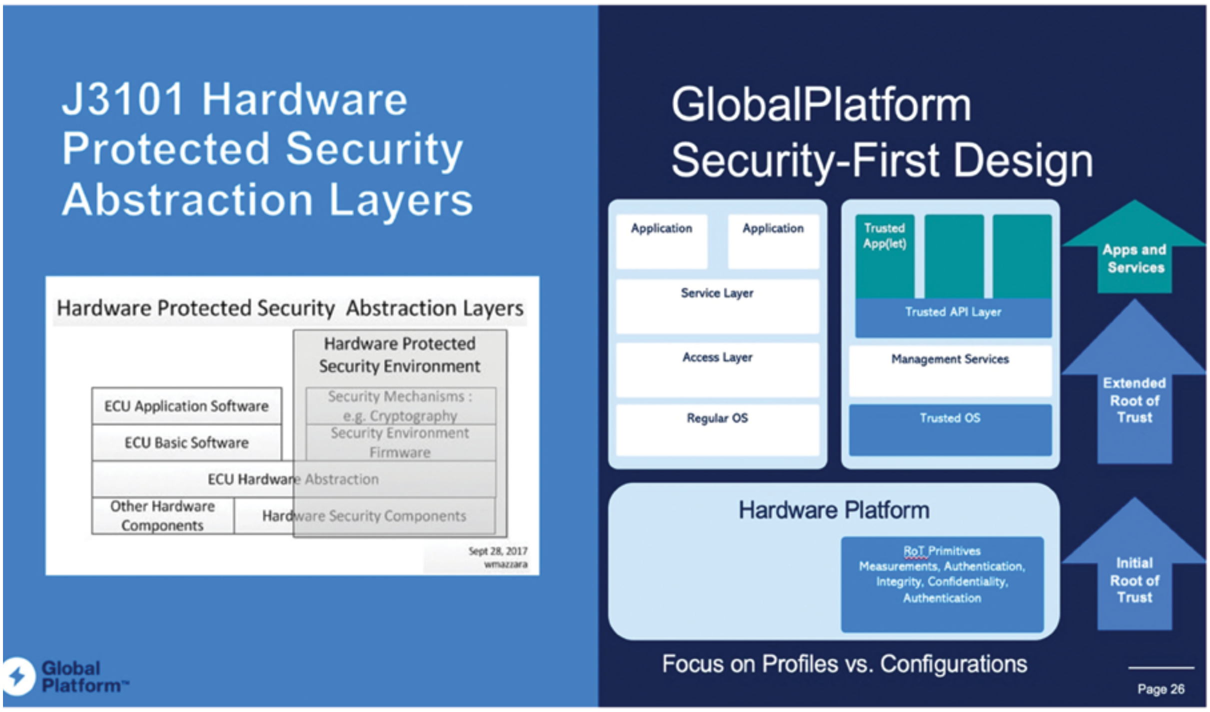


Figure 1
How GlobalPlatform Answers Security First Design in Alignment with SAE J3101 requirements

With the recently signed MoU with AUTOSAR, GlobalPlatform underlines the opportunity to cooperate on delivering implementation guidelines to simplify interfacing with AUTOSAR applications with Secure Components and Trusted Execution Environments.

Together we can help deliver foundational security solutions as the best means for trustworthiness within the vehicle and to the Cloud.

JasPar

Long journey together with AUTOSAR

HOW WE COLLABORATED WITH AUTOSAR

by Leader of the AUTOSAR standardization WG in JASPAR

JASPAR was established in 2004 to facilitate the adoption of new automotive related technologies throughout Japan and other countries. The organization helps improvement on both development efficiency and reliability through standardization and sharing of sophisticated automotive electronics, software and networks. It provides specifications and guidelines that will be commonly referenced by the country's members like automobile OEMs manufacturers and other players. Globally recognized auto manufacturers have listed their names, such as Toyota, Nissan, Honda, Mazda, Suzuki, Isuzu, SUBARU, Mitsubishi, Hino, and Daihatsu.

Experts from various car manufacturers, research institutes, academic societies, software developers, E/E suppliers, tool vendors and semiconductor vendors gather in its standardization activities. And JASPAR has also launched (regional) SDV-related discussions for the future.

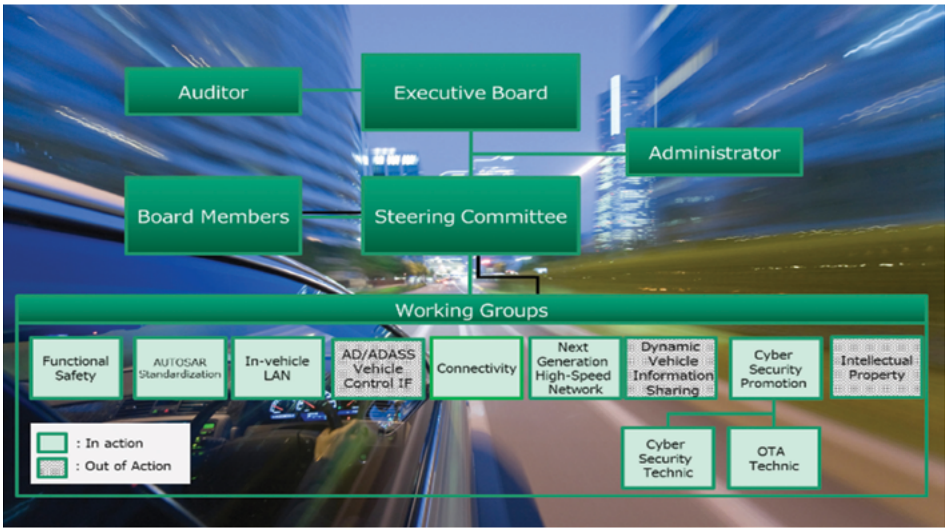


Figure 1
JASPAR Organization with AUTOSAR Standardization Working Group

In relation to AUTOSAR, JASPAR proposes changes and new concepts to the AUTOSAR standards, based on the knowledge and experiences on exploitation from 2007.
For example, JASPAR and AUTOSAR have held several Joint Meetings in the past to exchange opinions on common technical areas. The picture shows the joint meeting on security.

Figure 2
AUTOSAR and JASPAR joint meeting on security

Through these activities, the following AUTOSAR specifications have been developed based on proposals from JASPAR.

For example, SecOC Profile 3 had been developed and integrated into AUTOSAR specifications, based on the regional requirements (such as counter-based freshness values) which were gathered through discussions at JASPAR, and this specification are currently used in Japanese OEMs.

Another example is VMCI (Vehicle Motion Control Interface) which was drafted and proposed by JASPAR and refined through AUTOSAR WG discussions. The first vehicles based on the VMCI specifications will be launched in 2023.

In recent years, JASPAR has also developed a JASPAR specification for wired/wireless software updates established in UN regulation, and has also proposed the JASPAR specification to AUTOSAR to promote the standardization of OTA.

In April 2022, AUTOSAR and JASPAR announced the collaboration in strengthening standardization in the field of Automotive and Future Intelligent Mobility.

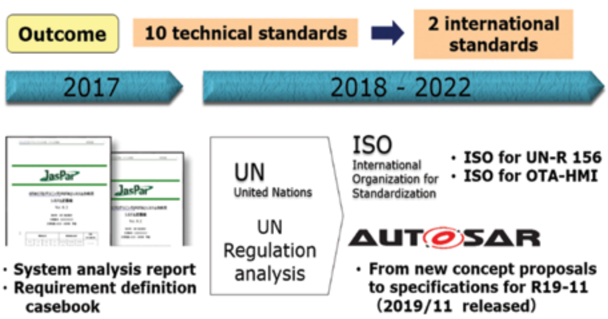


Figure 4
Standardization activities of JASPAR

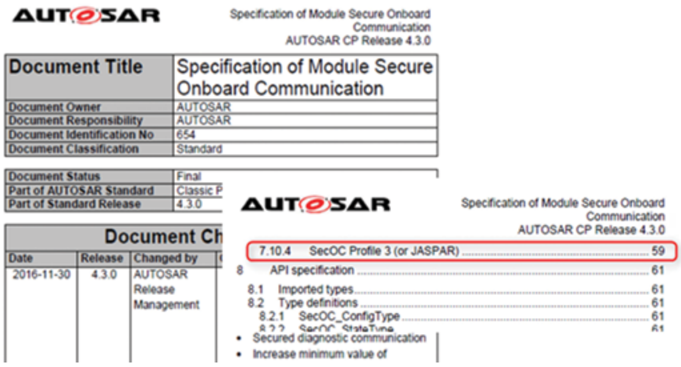


Figure 3

Since the agreement between JASPAR and AUTOSAR in 2022, JASPAR joined AUTOSAR as an Attendee Partner, and the representative experts have joined standardization activities in AUTOSAR WGs.

JASPAR will appoint delegates to participate in AUTOSAR Working Groups for future proposals from JASPAR. The planned AUTOSAR focus hub in Japan will enable a better alignment of activities with the local environment in Japan and make it easier for JASPAR representatives as well as those of AUTOSAR partners in Japan with their respective contributions to the globally relevant standardization in AUTOSAR.

The respective contributions made by representatives of JASPAR and those of AUTOSAR partners in Japan will allow us to better contribute regional requirements into international standardization.

Open Standard Acceleration APIs for Safety-Critical Graphics, Vision, and Compute

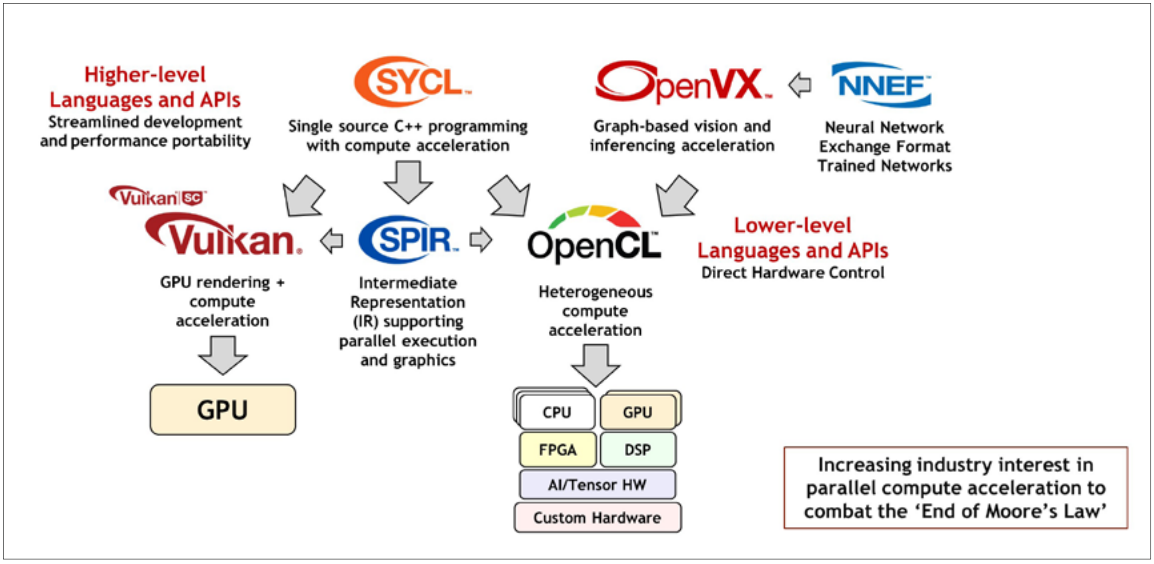
by Michael Wong, Chair of the SYCL Working Group

Acceleration open standards for the embedded market can enable cross-platform software reusability, decouple software and hardware development for easier deployment and integration of new components, provide cross-generation reusability, and facilitate field upgradability. Such standards reduce costs, shorten time to market, and lower the barriers to using advanced techniques such as inferencing and vision acceleration in compelling real-world products.

KHRONOS ACCELERATION STANDARDS

For over 20 years, Khronos has created open, royalty-free API standards that enable software applications libraries and engines to harness the power of silicon acceleration for demanding use cases such as 3D graphics, augmented and virtual reality, parallel computation, vision processing and inferencing.

Khronos open, royalty-free, interoperability standards



The Khronos family of compute acceleration standards

Khronos acceleration standards for parallel computation can be divided into two groups. High-level programming frameworks, such as SYCL and OpenVX, focus on streamlined development with effective performance portability across multiple hardware architectures. By contrast, low-level APIs such as OpenCL and Vulkan provide direct, explicit access to hardware resources for maximum flexibility and control, using the SPIR-V intermediate representation for kernel and shaders programs.

KHRONOS UPDATES FROM 2022

Khronos began work on a new API specification, Kamaros, for controlling camera system runtimes in embedded, mobile, industrial, XR, automotive, and scientific markets, providing applications, libraries, and frameworks explicit control over camera runtimes.

Khronos has a history of adapting mainstream acceleration APIs for safety-critical markets. Vulkan SC enables system implementers deploying GPU-accelerated graphics and compute to meet safety-critical obligations and provide certification evidence packages with reduced cost and effort. OpenVX has a safety-critical profile that enables the rapid deployment of trained neural network models. Finally, the SYCL Safety-Critical Exploratory Forum is investigating industry requirements for a general parallel programming API for accelerated compute using SYCL's standard C++ single source programming model in safety-critical markets.

KHRONOS AND AUTOSAR

In 2022, AUTOSAR™ and The Khronos® Group entered into a collaboration liaison to foster synergy between the two organizations to encourage standardization in the field of Automotive and Future Intelligent Mobility. This agreement encourages a productive flow of information while respecting the confidentiality and IP Framework of both organizations. It enables Khronos members to receive information and insights about AUTOSAR activities and vice versa. The end goal is for AUTOSAR use cases and requirements guide and influence the evolution of Khronos standards and to enable the AUTOSAR platform to effectively utilize those Khronos APIs. This collaboration has an in progress demonstrator using SYCL for automotive safety critical interface.

Khronos remains committed to playing a vital role by providing a safe space for companies to cooperate to create open standards that benefit their own business and the wider industry. If your own company would like a voice and vote in any of these standardization activities, or you wish to implement a Khronos standard on your silicon or use a Khronos standard in your system design, Khronos warmly welcomes any company that wishes to participate.

Navigation Data Standard

NDS, the Worldwide Standard for Map Data in Automotive Eco-Systems

AUTOSAR SOME/IP – A PERFECT MATCH WITH NDS.LIVE HD MAPS

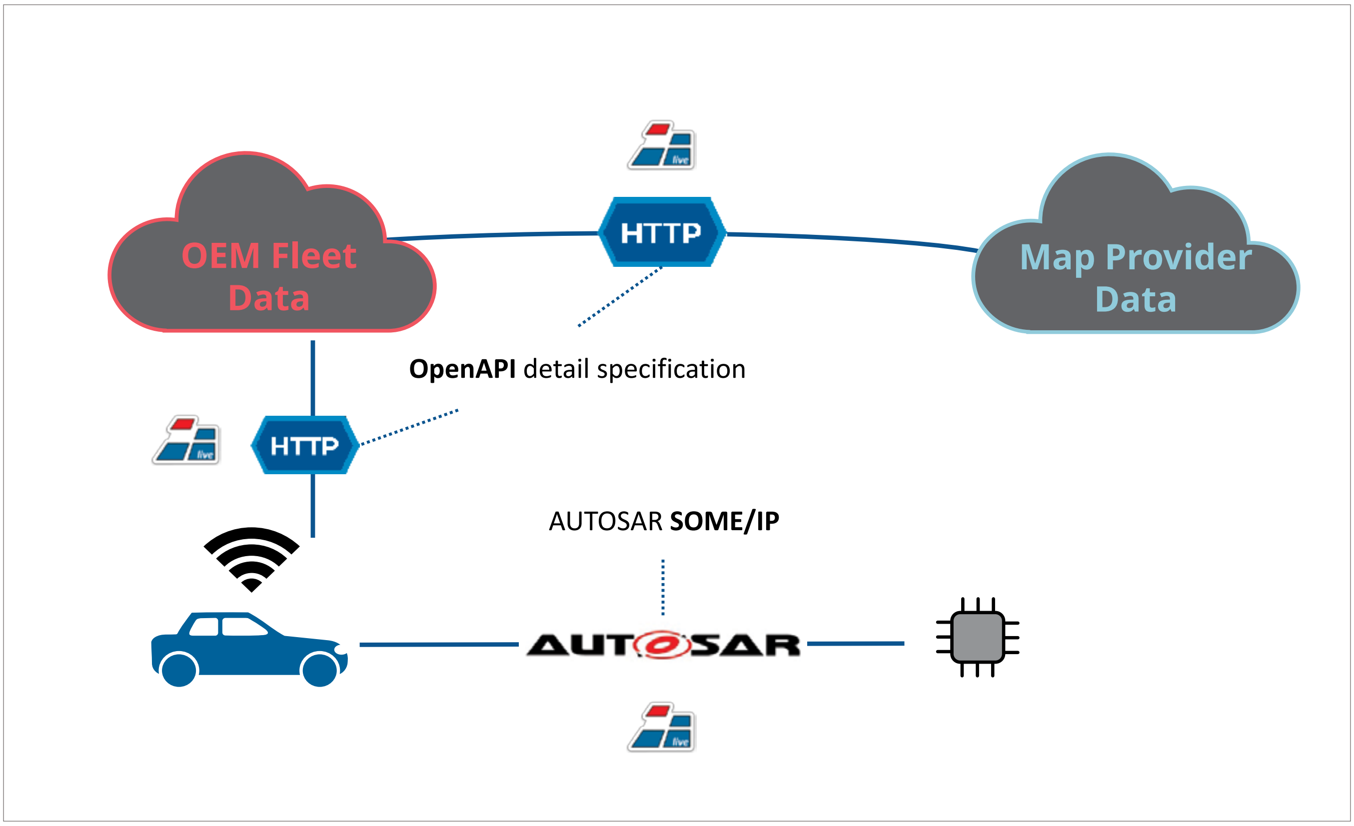
by Martin Schleicher, Chairman

The Navigation Data Standard (NDS) Association was founded in 2009 with the goal of creating a standardized map interface for automotive ecosystems. Members include automotive manufacturers, system vendors, map data providers and service providers.

The first generation of the NDS standard, now called NDS. Classic, was launched in 2012 and focuses on a physical data format for maps.

NDS.Classic can be used as an embedded database that can be incrementally updated and supports over-the-air (OTA) updates. NDS.Classic has been proven in millions of vehicles from over 40 different brands for navigation and ADAS applications. NDS.Classic HD maps for Level 3 automated driving systems have been on the road since summer 2022.

In 2019, the NDS Association began work on a new generation of the standard called NDS.Live. Unlike NDS.Classic, NDS.Live is not a database, but a distributed map data service. It aims to provide a standardized language for communication between the vehicle manufacturer's fleet data, the map provider's data, the local map storage in the vehicle, the live ECU data, and the accompanying applications. This includes both data services and application services such as route generation, EV range calculation, POI search or Horizon Assist functions. The interfaces of the services are



defined in NDS.Live, but not the transport layer. Users of NDS.Live have the freedom to decide where the NDS data or application service is deployed. This can be in the cloud, in the vehicle's head unit, in the vehicle's AD unit, or in another location, such as a companion mobile app.

Regardless of the transport layer, NDS.Live maintains interoperability at the interface level by serializing data in an interoperable, cross-platform, cross-language manner. For cloud-to-vehicle communication, HTTP/REST is a commonly used option. Within the vehicle, AUTOSAR's SOME/IP is the perfect complement.

NDS has partnered with AUTOSAR to use SOME/IP as a reference for in-vehicle communication.

To this end, NDS plans to provide a client application for the AUTOSAR Adaptive Platform Demonstrator.

Figure 1
NDS. Live
Distributed map data service

SOAFEE

An architecture to enable the development and deployment of the Software Defined Vehicle

BRINGING CLOUD-NATIVE METHODOLOGIES TO AUTOMOTIVE SOFTWARE DEVELOPMENT

by Robert Day

As the automotive world considers moving many of the functions in a vehicle to be software defined, it is promising change to both the computing architectures in the vehicle, and also the software development and deployment of the software functions that will run on these new architectures.

This software defined vehicle will allow automakers to develop, deploy and maintain features and functions across multiple vehicle platforms, and will allow a new relationship with the consumer of the vehicles.

The SOAFEE initiative was founded in 2021 by a group of companies that bring together both the automotive and software development worlds. The founding members comprised of Arm, AWS, Bosch, Continental, Cariad, Red Hat, Suse and Woven Planet and was realized as a Special Interest Group (SIG). The SOAFEE SIG sought to create an architecture based on existing open standards used in cloud-native software development that would enable a framework for development and deployment of vehicle software functions.

The vision of the SOAFEE architecture is shown in figure 1, where the SOAFEE architecture scope is shown in the blue parts in the cloud and vehicle side. This architecture will allow developers to start their development in the cloud using existing cloud-native methods and tooling, and by using cloud-based simulation, prototyping and digital twin technology, a large degree of software testing and validation can be done in the cloud. This is helped when the cloud and vehicle computing architecture are the same, and is often termed execution environmental parity, with examples being the Arm-based AWS Gravition and Ampere Altra based cloud instances, which have the same CPU architecture as many of the popular automotive SoCs.

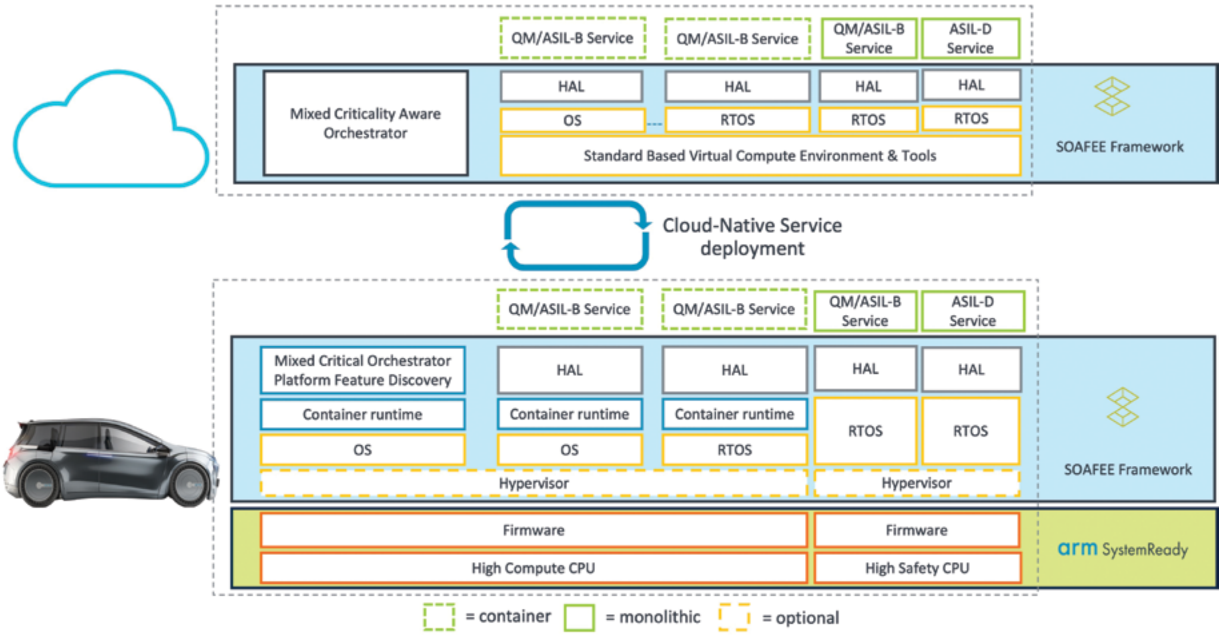


Figure 1
The SOAFEE architecture vision

Cloud technologies such as containers and orchestration then help move these software defined functions to the vehicle without modification, and a key vision of SOAFEE is to expand these technologies (through open standards) to meet the real-time and safety needs of the vehicle environment. This will involve the extension of the orchestration standards to encompass mixed-criticality functions in a heterogeneous computing architecture, and a deployable implementation of containers for a real-time application.

SOAFEE has both an architecture definition and also an open-source reference implementation so that the industry can both see and contribute to the SOAFEE vision, and use the reference implementation to get development started using a SOAFEE framework. SOAFEE membership is now at over 70 members (see https://soafee.io/about/members/ for details) from across both the automotive and software development worlds.

SOAFEE aims to provide example application workloads called blueprints, that will offer a starting point for using SOAFEE for specific vehicle functions. Examples using both AUTOSAR Adaptive and Classic Platforms are planned to showcase how the SOAFEE architecture can be used for real-world vehicle deployments. These blueprints will also be available across a range of different automotive hardware platforms and will demonstrate the ease of migration from cloud to vehicle, and then across multiple SoCs in the vehicle using the standards and technologies defined within the SOAFEE architecture.

Chapter 4

Connected, Automated, Shared and Electric

Every new challenge is a fantastic opportunity for innovation.

Reinventing the car

CASE MEGATRENDS ARE DISRUPTING THE AUTOMOTIVE INDUSTRY

by Pascal Nagel, Editor in Chief automotiveIT

The automotive industry can hardly boast of old virtues. The automobile as an exemplary expression of perfect craftsmanship is changing as never before in its 150-year history. It is becoming a vehicle for digital features, value-added services, and entirely new business models. This development can be summed up in four letters: Some call it CASE, others ACES. But they always describe a vehicle as a connected, electric, autonomous means of transport embedded in new mobility concepts and services.

Car manufacturers are leaving well-trodden paths and facing new competition. They are becoming digital players and mobility providers. They do not always take this development lightly. And yet, ultimately, these four pillars add up to a new overall picture of modern mobility.

CONNECTED CAR - A SMARTPHONE ON WHEELS?

> *The automotive industry is facing the biggest transformation in its history. The cornerstones of new vehicles and mobility solutions are the four buzzwords connectivity, autonomy, services and electrification.*

Tomorrow's vehicle will be a smartphone on wheels. The analogy to the most successful product of the consumer electronics sector in the past two decades has recently become an almost unquestioned target image in the automotive industry. Recent efforts from car manufacturers to develop a uniform, cross-hardware software operating system on which functional applications from the areas of automated driving, networking or infotainment are based, make it clear where the journey is heading: the connected car as a further end device in the Internet of Things.

But the comparison with the smartphone is lame. "Much of the metaphor is true, for example, with regard to the expectation of a smooth user experience in terms of operating infotainment via apps or the ability to update," says Elektrobit CEO Maria Anhalt. "But there are also significant differences: the complexity and computing power required for sophisticated ADAS functions, for example, are much higher, and ultimately the demands on the issue of safety are logically quite different - because at the end of the day, human lives are at stake here." Another difference to the smartphone is that the electronics architecture (E/E) that has been installed in vehicles to date consists of several hundred decentralized control units equipped with embedded software that is very much fused with hardware installed in the car and is, therefore, difficult to update and standardize. Thus, there is a lack of a uniform language between functions and services of the vehicle and the hardware.

Figure 1
IoT and Cloud Services

This is set to change in the Software-Defined Car.

According to McKinsey partner Johannes Deichmann, “the fact that nothing works without software in the vehicle has now been accepted by everyone in the industry, and the ambitions are also recognizable at most OEMs.”
On the other hand, the way of thinking and working required for the software-defined car “has not yet been precisely defined by all OEMs.” Ralf Blessmann, head of the automotive sector at Capgemini in Germany, describes the situation this way: “70 percent of OEMs have just started the journey, 15 percent are already further along.” The rest are somewhere in between. This is what transformation feels like. Visible results are expected soon, at least according to the timelines of many manufacturers. Mercedes-Benz and BMW are currently giving us a first taste of their operating systems.
So, while some are developing their own operating system or software stack, other OEMs are relying to a greater or lesser extent on technology companies - permanently, or at least until they can deliver a competitive software stack themselves.
“Whereby it is clear that in a market whose unit numbers are small compared with, for example, the smartphone market, there will be no room for ten or even fifteen different operating systems,” says Deichmann. BMW’s head of development, Frank Weber, takes the same line in an interview with automotiveIT. He says he is convinced that manufacturers must focus on what generates real added value in the vehicle for their customers. “Anyone who thinks they are generating differentiation for customers via basic functions in the operating system or via remote updates is wrong, in my opinion. I even fear that the architectures will drift apart,” predicts Weber.

AUTONOMOUS DRIVING - FROM WISH TO REALITY

For decades, carmakers have been concerned with the question of how mobility can be simplified and made safer. As early as the 1970s and 1980s, OEMs were trying their hand at rudimentary variants of autonomous driving. In this sense, innovations such as the electronic stability program (ESP), the anti-lock braking system (ABS) and even the automatic gearshift were the first precursors of automated or at least assisted driving. Since then, the range of assistance systems has continued to expand. Premium manufacturers such as Mercedes-Benz, Audi and BMW have repeatedly integrated new technological aids into their vehicles. But until a few years ago, these were only incremental steps on the way to partially or highly automated driving. Tesla really got the competition going in 2015 when the electric car pioneer released the semi-autonomous autopilot system in its Model S via a software update. The system could auto-

Figure 2
Highly Automated Driving (HAD)

matically change lanes and keep its distance from other cars - a novelty. The advance triggered a veritable race in the auto industry and beyond to find the next stages of automated driving.
A preliminary assessment of automakers' innovative strength in driver assistance and safety systems was drawn up by the Center of Automotive Management (CAM) in its latest edition of the Connected Car Innovation Study. According to the study, the German manufacturers around the Volkswagen Group, Mercedes-Benz, and BMW dominated this technology field between 2012 and 2020. Tesla, which is particularly strong in Advanced Driver Assistance Systems (ADAS), already follows in fourth place. However, while many of the innovations so far have taken place in the lower range of the much-cited SAE scale - currently mostly at level 2+ - the manufacturers will attack autonomy levels 3 and 4 in the future. The truth is that the industry is nowhere near as far along as some announcements made a few years ago. BMW's head of development, Weber, knows why: "The approval process for highly or fully automated levels in which the driver is missing as a fallback level is extremely complex. The manufacturer must prove that the car acts at least as safely as the human." Despite computer simulation, this remains a tremendously costly undertaking.
Moreover, the infrastructure lags behind the requirements. After all, autonomous cars need to communicate in real time with each other and with appropriately digitized traffic infrastructure such as traffic lights, road works barriers or toll booths, to be smart and safe on the road. Although several individual car-to-x projects are underway, comprehensive networking is still a long way off. For that, cars and infrastructure must speak the same language. "The system architecture of the networking is crucial," says Franz Schober, Business Development Manager and Standardization for Connected Mobility at Yunex Traffic. "An intelligent hybrid approach of available solutions designed for automation gets us ahead here from an infrastructure perspective."

SERVICES - BRAVE NEW MOBILITY WORLD

In a perfect mobility world, only one app is needed. All means of transportation should be visible and directly bookable. Travel duration, travel costs and travel comfort could be perfected. The annual Mobility Services Report published by automotiveIT and CAM shows how far such a vision is from reality. Look at one's own smartphone. Most people have numerous applications helping them to be mobile. In recent years, the development of mobility services has been very volatile. The global crises have also played their part. It is difficult to predict today which forms of mobility will become established. Many people are still unfamiliar with smart mobility services. Just under one in ten

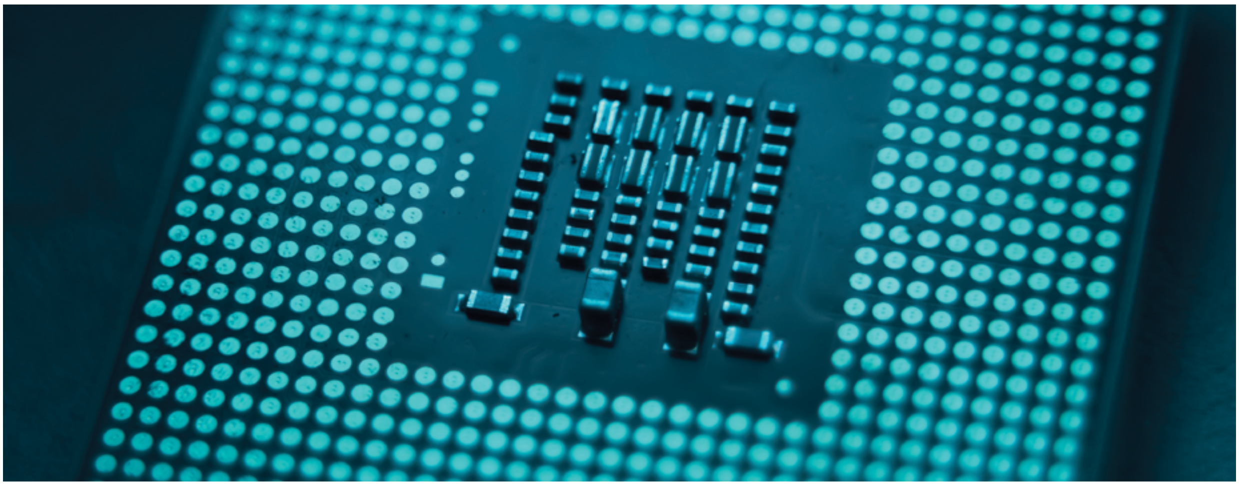


Figure 3
New Processor Technologies

Germans uses Uber, Free Now and the like. But one thing is clear: Mobility-as-a-Service (MaaS) is a playground for entirely new business models. Especially in combination with autonomous driving, new fields of activity are opening up for car manufacturers. They are increasingly supplementing the traditional source of revenue from car purchases. At the same time, the competitive environment is expanding due to digital players such as Apple, Google, Alibaba or Baidu, who want to expand their ecosystems to include mobility services. In addition, startups such as Uber, Lyft, and BlaBlaCar are entering the market with innovative digital mobility-on-demand services.
Probably the best-known type of service is car sharing. The largest providers include Share Now, Flinkster and Miles. While car sharing was often the domain of car manufacturers in its early days, more and more OEMs are withdrawing from the business. The most recent surprising change in the market was certainly the acquisition of the BMW and Mercedes-Benz ShareNow joint venture by the Stellantis subsidiary Free2Move. The acquisition created, by far the largest provider of free-floating carsharing and one of the largest carsharing services in the world. According to Stellantis, Free2move is set to become one of the leading mobility providers by 2030, with 15 million customers and €2.8 billion in revenue, while remaining highly profitable. A goal that Mercedes-Benz and BMW could not achieve together before.

ELECTROMOBILITY - NO-ALTERNATIVE TRANSFORMATION

The future of mobility is electric. No automotive executive doubts the battery-electric model range anymore. Alternative technologies such as hydrogen or synthetic fuels are likely to play a role in the transition phase at best. A look at the figures shows that e-mobility is not a topic for tomorrow, but for today: The share of newly registered electric cars in Germany in calendar year 2022 was almost 18 percent. Of the 2.65 million total cars registered, around 470,500 were battery electric - with more than 100,000 e-cars added in December alone. Compared to the previous year, a total of 32 percent more BEVs were registered. The magic mark of one million electric vehicles in Germany has been reached, albeit around two years later than hoped. The goal is clear, and the first market successes have been achieved. But numerous questions remain unanswered on the road to the electric future. “I would advise against looking at e-mobility purely from a product perspective. Simply putting a good electric car on the road will not solve problems. A complete BEV economy is needed,” says BMW manager Frank Weber. By this, he means the supply of green electricity, transparent supply chains of essential raw materials, the expansion of the charging infrastructure and a circular economy for valuable materials from the batteries and e-motors. “If even one of the aspects of the BEV economy addressed falls by the wayside during the transformation, electromobility as a whole will not fly,” Weber warns.
When it comes to e-mobility, the focus is increasingly shifting to the Far East: while Chinese OEMs are gradually embarking on global expansion and providing serious competition to traditional domestic carmakers in their home market, the Chinese market is and will remain the world’s most important for e-car sales. Almost two-thirds of electric sales in the global core markets are generated in China. Europe and the USA follow behind. The three markets have one thing in common: the sales curve for electric cars is rising steeply in all of them.

Chapter 5
Future Automotive Development

"The best way to predict the future is to create it."

- Peter Drucker & Abraham Lincoln

A Journey with Return Ticket

FROM COMPUTER SCIENCE TO EMBEDDED AUTOMOTIVE SOFTWARE

by Ulrich Freund
BOSCH

The automotive industry is a mechanical industry, a passenger car consists of a powertrain, a chassis and a bodywork, where the latter is often integration into the chassis – unitary body shell. The fabrication of passenger cars is optimized to series production, and all other elements must fit to this process. Over the years, the automotive industry evolved to an ecosystem with the stages development, production and after-market. Typically, the organization of the OEMs and tier1-suppliers reflect these stages. Until recently, this ecosystem defined rules to which also the design of distributed embedded systems must adhere.

One of these rules say that production cost per unit is of paramount importance and development cost is just a neglectable overhead. ECUs, networks and software are developed according to this paradigm. For electronics, the sourcing price of a silicon chip dictates the production cost, and the software must fit in this chip.

In computer science, the software engineering focus is reuse to limit the development effort.

Application Programming Interfaces (APIs) in high-level programming languages like C or C++ are a prerequisite for reuse of software and abstraction layers ensure to find the appropriate API at the intended level of abstraction.

Operating systems with a kernel and a user mode ensure the freedom from interference between user processes via Memory Protection Units (MPUs). For efficient execution of code in RAM, the Memory Management Units (MMUs) decouple virtual from physical memory addresses. This comes along with appropriate means for inter-process-communication and filesystems for non-volatile storage of data.

Cache hierarchies, multi-core processors as well as multi-threading were research topics in the early nineties but are common-sense today.
Control engineering, including system theory and identification, deals with finding an appropriate control algorithm with a set of parameters tuned to the system. Nonlinear systems where no analytical solution is available, require simulation-based and testbed/track approaches supported by efficient measurement and calibration solutions.

PRODUCTION COST DRIVEN ECOSYSTEM

A computer scientist entering the automotive industry as software developer 25 years ago would have been surprised by the employed software engineering methods back then. For example, subroutines were apparently the means of choice and information exchange between subroutines via global variables was the way to go, exactly what every software engineer learned at university NOT to do, but with a little fantasy, one could identify a structure in the code still valid today.

Depending on the task schedule, doubled global variables are necessary for inter-task data exchange and subroutines represent schedulable elements. However, one must keep in mind that the switch from pure assembly language to C was just mastered in the late nineties of the last century.

While this approach appeared manageable in the powertrain and chassis domain, it showed its first shortcomings in body electronics with a much higher degree of distribution and a necessity for reliable communication-drivers.

The CAN bus and the OSEK operating system[4] with its task scheme, a comprehensive approach to design distributed deeply embedded automotive systems was still missing. However, there where pre-development and research activities in the German and French automotive industry leading to the public funded research project EAST-EEA[2] in 2001. Mid 2002, first rumors appeared around yet another initiative which finally became AUTOSAR in 2003.

While TITUS[1] was a relatively closed approach, EAST-EEA had several research aspects, and OSEK-COM became not popular, AUTOSAR had the full commitment of the automotive industry. In the last 20 years, AUTOSAR Classic has gained acceptance by their achievements:

- A design language based on a meta-model, as described in research papers on architecture description languages at that time, to overcome shortcomings in the UML 1.x approach:
  - » Required services of a component have the same importance as the provided services. In AUTOSAR terms, there is an interface type which is instantiated as port prototype in the context of a software component.
  - » Hierarchic structuring of software components employing the concept of delegation.
- Embedded automotive additions were taken over form EAST-EEA and ERCOS[3]:
  - » Explicit distinction between data and method communication including a complementary definition of provided and required services.
  - » Describing the dynamic behaviour of a component by so-called runnable entities, thus taking over the idea of processes in ERCOS. Mapping these runnable entities to tasks during OS/RTE configuration closed a gap in the OSEK specification and linked the behaviour to the entities of architecture description languages.
- A transparent ECU-software architecture defining several abstraction layers and functional groups. Layers define µC and ECU independency relationships below the RTE. Functional groups split ECU software in vertical groups like communication, diagnostics, persistency or cryptography. Special function groups are system including the operating system and the I/O part. The latter represents together with dedicated sensor- and actuator SWCs (above the RTE) the inverse measuring chain to the system's physics.
- The major pillar in the layered ECU software architecture is the unified communication stack with its solutions for signal-based communication and, more recently, for service-based communication like SOME/IP. Several communication networks are supported, from LIN over CAN to FlexRay and Ethernet, the latter including TCP/UDP/IP.
- RTE generation is the focal point where computer science finally meets the production cost based automotive ecosystem. One might think that the most resource efficient implementation is a spaghetti-code, and AUTOSAR provides the appropriate ingredients to create a well-formed spaghetti. An appropriate system- and software component design provides C-APIs where the software components implementor can rely on. The mapping/deployment information in the system- and software component description is used to synthesize the C-APIs to a set of global variables for information exchange between the components in a thread safe manner. Consequently, this means that the source code of the software component implementation is just part of the "truth", the complementary part is the arxml design of the system – or meta-information, as it is called today. The drawback of this approach is that it requires a very detailed system model at an early stage of design, and one must know very well how the system works.
- A strict syntactic and semantic scheme for parameter-configuration of basic software modules. AUTOSAR takes a rather unique approach to configure basic software. Parameter definition files reflect the hierarchy and structure of the BSW module. Configuration values refer parameter definitions for correct interpretation during header-file generation.
- AUTOSAR enables a unique handling of UDS (ISO 14429) Diagnostics. This comprises a set of C-APIs, parameter definitions and exchange information (DEXT). There exists also a link between the UDS described part (DCM) and the application monitoring part (DEM). Diagnostic Routines are linked to application software components.

As a result, AUTOSAR classic became the lingua franca for the software design of deeply embedded networked automotive ECU living in a pure production cost driven automotive ecosystem.

It would have been possible without AUTOSAR to live computer science principles in a production cost driven automotive ecosystem, but with AUTOSAR everything is transparent and meanwhile common sense.

C.A.S.E DRIVEN ECOSYSTEM

Thirty years ago, there were debates about communication channel properties between telecom and data-communication people, both representing different ecosystems, as we say today. Though telecom network switches and mobile phone protocols already employed a lot of software, voice-over-IP and finally the invent of the smartphone connectivity marked a disruption in the telecom industry, sometimes named "digitalization".

The implicit backend connectivity of smartphone made the term ecosystem popular and gave the word "Operating-System" an extended meaning. The embedded functionality "voice communication" of a mobile phone became just another app on the smartphone.

For automotive, this kind of "digitalization" is ongoing, and the transformation of the production-cost driven ecosystem to a C.A.S.E-driven ecosystem[5] is obvious. Will the former embedded electronic functions for powertrain, chassis and body just become another app on POSIX based central ECUs? The AUTOSAR answer is: It depends.

From a computer scientist point of view the technical impact of C.A.S.E is:

- Connectivity: Connecting vehicles to the internet comes along with the possibility for attacks, thus security is necessary to protect system's integrity. Doing this requires measures resulting additional hard- and software.
- Automated: That is a goal the whole industry and IT/Tech-companies are working on. Video-perception algorithms require GPUs and hardware accelerators. Fusion and prediction algorithms require so much computing power that application processors and POSIX based OS becomes feasible. For neural network training a permanent connectivity of the vehicle (more precisely: the instance) to the perception provider backend is preferrable.
- Shared: Sharing of vehicles instead of owning them means connectivity of the user's smartphone to the sharing companies backend and the vehicle. This translates to connectivity and security in the shared vehicle.
- Electrified: Battery electric vehicles require software beyond pure powertrain management to enable traveling over medium and long distances. This includes route planning, battery conditioning, charging point reservation, billing and so on.

Additional hurdles of "free driving" like for example road-pricing, city-tax and parking management require software defined solutions for automatic access and billing.

Since 2003, computer science evolved and many back-than rather theoretic concepts, in particular multicore architectures and multi-threaded operating systems, but also reliable back-propagation neural networks, are meanwhile common-sense. Together with low-power SoCs, virtual-machines, containers and high-speed gigabit ethernet connections the difference between classical computer science and embedded automotive software diminishes.

On the one hand, AUTOSAR did account for advances in computer science by introducing an Adaptive Platform (AP) and renaming of the existing specifications to Classic Platform (CP). New hardware features are explored to enhance the platforms

appropriately. On the other hand, the C.A.S.E-driven ecosystem crosses the backend to vehicle border and meets other paradigms like RESTful communication with appropriate object models (like COVESA, SOVD) or containers seamlessly employed and orchestrated either on the target or in the cloud (like SOAFEE).
Furthermore, there are dedicated middleware solutions for automated driving like ROS using the AUTOSAR Adaptive Platform as µP foundation when running on SoC based targets.

CONCLUSION

In the last 20 years, AUTOSAR created with its classic platform a comprehensive approach to design deeply embedded software in the product-cost driven ecosystem. Adapted to advances in computer science, the AUTOSAR Classic Platform still plays a role in hard-real-time systems driving sensors and actuators as well as SoC supervision in C.A.S.E-driven ecosystems.

The AUTOSAR Adaptive Platform is the foundation for µP-based automotive systems and meanwhile established in SoC-based central ECUs.

As a result, automotive software changes from “just” optimizing mechanical automotive components to become the central component connecting the vehicle to the cloud. In fact, automobiles evolve to rolling IT-edge-devices. It appears, that combining AUTOSAR with COVESA, SOVD and SOAFEE has the chance to establish the foundation of an open software defined vehicle platform.

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Automotive collaboration in software development

by Detlef Zerfowski, Thomas Rüping, Martin Lunt, Jakob Kristoferitsch
BOSCH

RETROSPECTIVE

When AUTOSAR was launched 20 years ago, one of the biggest challenges was to replace the different proprietary base software (BSW) solutions in all vehicle ECUs. It took about 10 years of perseverance and continuous investment to achieve significantly increasing penetration and to benefit from the advantages of a standardized BSW.
Aiming to make application software independent from its underlying hardware communication channels, the associated standardization of specifications for communication paradigms and architecture description methods should also support the exchange and reuse of software. However, it has emerged that the implementations of this specification of the standard have resulted in solutions that are not fully compatible with each other. This continues to cause effort in the exchange or reuse of software both in the BSW and in the application functions. This was the time when we started the approach to implement and maintain the AUTOSAR Classic implementation in an open source like community – COMASSO.

But it turned out that this initiative came at the wrong time. On the one hand, it was too late, since other BSW implementation were already available, making it hard to catch up with current features. On the other hand, it was too early, because the benefit of a cross company collaboration within the automotive industry to implement software was not common view at that time.

An important key to the future success of the automotive industry is fast DevOps cycles based on cross-company collaboration and open-source software development in addition to existing development methods for safety-related software.

Then 2016 AUTOSAR started with the AUTOSAR Adaptive Standard. Due to complexity, high effort and to significantly increased development speed, the idea arose again not only to create specification but additionally realize a common implementation of the specifications in AUTOSAR. It was discussed if this could be used as basis for productive solutions, but finally the Automobile Industry was not yet ready for a common software implementation of the new standard suitable for use in series products. Therefore, it was decided to implement only an AUTOSAR Adaptive Demonstrator as an exemplary software implementation without claiming to be suitable for series production.

GAME CHANGER

Meanwhile new players entered the automotive industry introducing smartphone-like development methodologies from the IT world, enabling fast development iteration cycles and collaboration in open-source communities. With their approach, they seem to be able to deal much faster and more flexibly with the new complexity of automotive software resulting from the new requirements for connectivity with the world outside the vehicle and security. On the other hand, the automotive industry still needs to consider high standards for safety and real-time. This means that an important key to the future success of the automotive industry is fast DevOps cycles based on cross-company collaboration and open-source software development in addition to existing development methods for safety-related software.

The main drivers for the increased complexity in our systems are the following four, which today are also often summarized by the acronym CASE:

a. Connectivity: Connectivity between the ECUs of vehicles and especially with the world outside of the vehicle needs to be enabled by standardized, also non-automotive specific communication protocols. The increasing complexity comes with the requirements to improve transmission quality, security, and safety.

b. Autonomy: Automated, highly automated, or even autonomous driving requires high computing performance on todays and future µPs. This leads to new E/E architectures with high performance computers (HPC) inside vehicles which are the main drivers for centralized E/E-Architectures. All this sets new benchmarks for security-update frequencies and fosters the reuse of non-automotive IT-standards which are broadly available as open-source software solutions. In addition, Autonomy sets also new challenges for safety. Traditional open-source software approaches with "code only" will not be sufficient. Complementation by traceable requirement specifications and functional specifications is essential for all safety relevant features.

c. Sharing: The high amount of software in future automotive systems requires applications from multiple sources and reuse of non-differentiating commodity software. Therefore, a standardized Vehicle-Operating-Systems (Vehicle-OS) is a key to master the demand.

d. Electrification: With the introduction of electrical vehicles, less complex electrified powertrains are introduced. This eases the market entry for new players (OEMs) significantly. These new players are supporting reuse of commodity functions and drive open-source based solutions for Vehicle-OS. In addition, electrification requires new cross-domain features and services based on high bandwidth connectivity e.g., route planning with charging.

CONCLUSION

- Connectivity and Vehicle-OS need to be standardized to gain speed by reuse and usage of multiple source applications.
- Service oriented communication becomes a key enabler for flexible and adaptable software and services.
- New players are using open-source software-based development approaches and thus set new benchmarks for short and very fast development and update cycles - in particular during the lifetime of a vehicle.
- For AUTOSAR Adaptive this leads to the need for standardized implementations in addition to the AUTOSAR specification to enable the required development speed.
- Future standardization will only be possible by collaboration based on a common development of non-differentiating specifications, open source like implementations and standardized tool-environments.

VISION

We need consistent code, specifications, and requirements for the non-differentiation parts of the Vehicle-OS and communication protocol stacks including common tools to enable seamless development and integration from multiple sources.
Different standardization boards and open-source software communities are currently developing these solutions independently from each other. This missing overall coordination by the automotive industry leads to inconsistent building blocks, multiple and incompatible solutions for the same problem (double work).
Finally, this will lead to additional cost and insufficient speed without sustainable advantages with respect to differentiation. This might also cause disadvantages in the competition with new players.
Actually, the automotive industry needs a coordinated collaboration across different standardization and Open-Source Software organizations to continuously develop the common infrastructure.

PROPOSAL:

a. AUTOSAR could focus on the specification of the Vehicle-OS, the common services, and protocols. AUTOSAR has a well-proven IP pooling among its partners and now 20 years of experience with specifications and standardization across a huge community with more than 350 partners.

   Due to the organizational and legal setup especially when looking on liability, AUTOSAR is today not optimized for common software implementation for commercial usage.

b. Eclipse SDV could provide the platform with necessary tool environment to support common implementation of Vehicle-OS as well as applications based on the Vehicle-OS.

   Therefore, Eclipse needs to enable and support requirements-based software development fulfilling required traceability for certifiability in addition to the "code first" approach.

   As a pre-condition AUTOSAR needs to open its specifications to be implemented in open source software communities also for non-AUTOSAR partners – at least for non-commercial utilization – which here means no usage in services and products for sale.

c. SOAFEE could define the cloud infrastructure for the digital twins for autonomous vehicles, instantiating the Vehicle-OS defined by AUTOSAR and implemented by Eclipse SDV.

d. COVESA is using an ontology to specify the semantic and structure of the data provided by communication services that are specified by AUTOSAR.

e. ROS could provide the simulation environment for digital twins also running on SOAFEE's cloud infrastructure.

f. ASAM could provide the methodology for modelling, test automation, simulation, mass data management and analysis as well as the specification for service-oriented vehicle diagnostics (SOVD) to acquire diagnostic data, run SW updates, maintain the error memory etc.

This is of course not the complete view, because there are many more organizations, but it is important that the automotive industry starts to orchestrate the automotive driven activities across these organizations.

Based on such a development platform of multiple organizations the development of differentiating solutions for electrified, autonomous driving vehicles becomes realistic for competitive efforts and costs, considering also verification and validation. At the same time this approach enables a sustainable market and transparency to realize upcoming requirements, driven by legal authorities for autonomous vehicles.

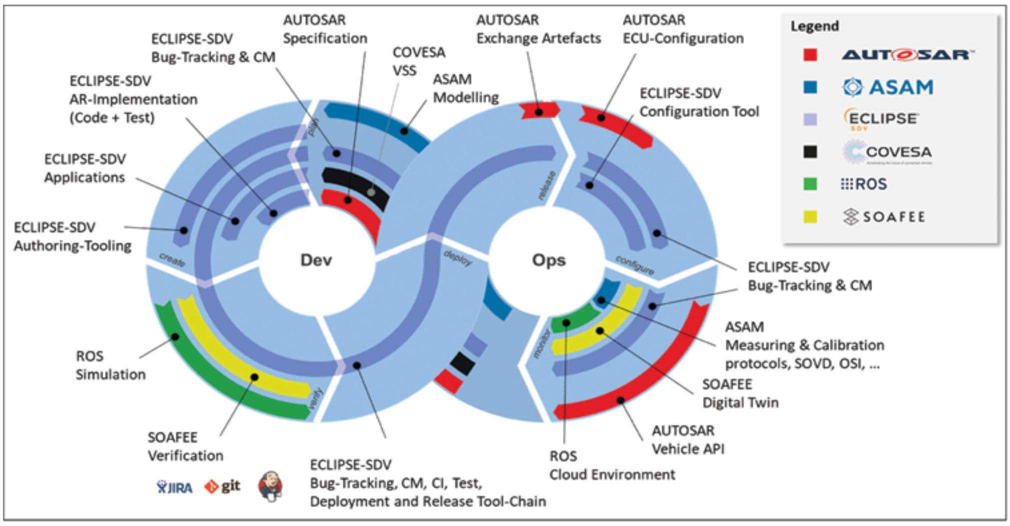

Figure 1
DevOps cycle and the most important players in the SDV environment

The figure shows the DevOps cycle and the most important players in the SDV environment. The DevOps cycle is overlaid with 5 tracks, which represent a potentially meaningful division of the contributions of these players in the overall cycle. The challenge is to design the tracks in a way that each track can have its own timing in the cycle. That means the interfaces between the tracks need to be lean and stable. In addition, the industry must define the interfaces between the segments within the track so that the various collaborating companies can seamlessly exchange their development artifacts. Some elements in the tracks can have multiple instances if e.g., multiple companies are involved in the development. Track 1 is on the inside of the development cycle and track 5 is on the outside. The other tracks are located between them in ascending order. In the operational cycle, this is logically reversed.

Track 1 represents the core system in the vehicle for hardware and network abstraction.

Track 2 represents the application layer. Because of the abstractions achieved in Track 1, applications can run both in the vehicle and in the cloud.

Track 3 contains the development infrastructure to manage all development artifacts, but also a continuous build, test and integration tool chain. Track 3 is therefore the connecting element in the whole process. It should seamlessly connect the different partners.

For development, validation, configuration and monitoring, **Track 4** provides user front ends that should be able to dock to Track 3.

Finally, **Track 5** provides the simulation environments and methods needed in the verification and monitoring segment of the DevOps cycle to host digital twins, for example.

AUTOSAR has been introduced 2003 by the top management of the founding partners.

Today, 20 years later, it would again be very helpful if the top management of the automotive industry would develop a common view to give directions to the different organizations and standardization bodies for their activities ensuring compatibility and allowing seamless integration of software from different sources.

We are convinced that regulation by the market will occur even without this intervention. However, we believe that a more consistent and faster discovery process will save a great deal of time, money, and most importantly, very scarce developer resources for the development of non-differentiating software.

The advance of technology is based on making it fit in so that you don't really even notice it, so it's part of everyday life.

\- BILL GATES

Secured Time Synchronization

by Pavithra Kumaraswamy, Andrei Rus
ELEKTROBIT

1. INTRODUCTION

The security of global time synchronization on automotive networks is vital to reduce the potential security risk in vehicles. Cybersecurity attacks on the global time synchronization result in below impacts as stated in IETF RFC 7384 (1):

- False time
- Accuracy degradation
- Denial of service (DoS)

These outcomes reduce the vehicle availability and robustness.

There are four classes of solutions to address the security risk in a vehicle from Global Time Synchronization (GTS) as stated in IEEE 1588 (2):

- Integrated security mechanism
- External security mechanism
- Architectural mechanism
- Monitoring and management

Integrated security mechanism on the automotive networks is standardized in AUTOSAR R22-11 as a draft version. It defines the architecture and detailed specification about Secure Global Time Synchronization (SGTS) on CAN, FlexRay, and Ethernet networks (3).

In the following sections we present the security mechanisms described above and the threat analysis on CAN and Ethernet networks in the context of an example vehicle E/E architecture.

2. INTEGRATED SECURITY MECHANISM

The integrated security mechanism is part of the GTS modules. It ensures the integrity and authenticity of the global time distributed across CAN, FlexRay, and Ethernet networks.

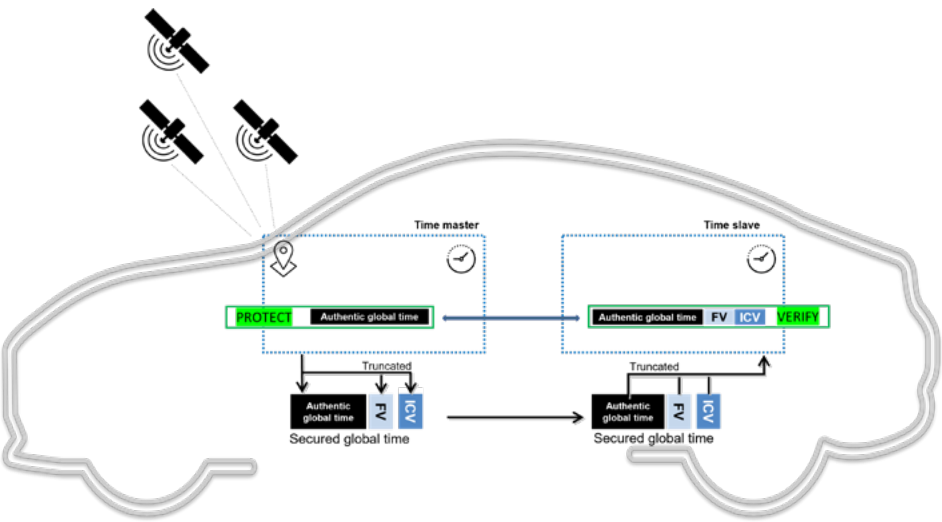

Figure 1
SGTS – Integrated security mechanism

2.1 INTEGRATED SECURITY MECHANISM ON ETHERNET

The integrated security mechanism on Ethernet network is specified in the EthTSyn module **(4)**.

Frame Payload (max. 1500 Bytes)											
PTP Header	Time Stamp	Follow_Up INFO TLV (IEEE)	Follow_Up INFO TLV (AR)	0 or more sub-TLVs	AR TLV: Sub-TLV Time Authenticated						
					T	L	Flags	Seq.Nr	FV.Len	FV	ICV

Figure 2
Follow_Up message format

AUTOSAR sub-tlv "Time Authenticated" is newly defined for Follow_Up message. The Integrity Check Value(ICV) which is calculated over the full Follow_Up message is included in the "Time Authenticated TLV". Optionally, a counter-based Freshness Value (FV) can be included in ICV calculation and verification to prevent replay attacks.

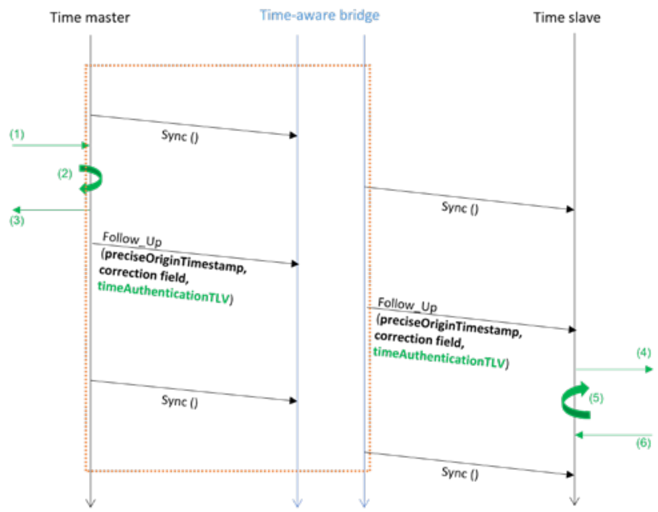

Figure 3
SGTS on Ethernet

Sync message does not contain any critical information, and does not need any protection. *Follow_Up* message needs to be protected and processed as below:

(1) After *Sync* is sent and the necessary timings are available (i.e., egress time), the master constructs *Follow_Up* except ICV field.
(2) ICV generation on *Follow_Up* starts by triggering a job in the Crypto Service Manager (CSM) module.
(3) After the job is completed, the result is notified to EthTSyn via the callback. It depends on the nature of the job, synchronous or asynchronous, if a timeout for ICV generation is necessary or not. If ICV is successfully generated, it is appended to *Follow_Up* and *Follow_Up* is sent.
(4) After *Follow_Up* is received, the slave extracts ICV from message.
(5) ICV verification on *Follow_Up* starts by triggering a job in CSM.
(6) After the job is completed, and ICV is correct, the global time is calculated and forwarded to the Synchronized Time Base Manager (StbM) module **(5)**.

There can be up to five "Time Authenticated TLV", with a total of 1061 bytes available for the ICV field. This enables the usage of more sophisticated security algorithms.

The time slave has the capability to detect if the *Follow_Up* message is received too far apart from *Sync* (Follow_Up timeout), or earlier than expected (Rx Debounce time). These timeouts will make it very hard for the attacker to find an attack angle.

The propagation delay (Pdelay) is statically configured as the current automotive environment is a closed system. Hence, currently there is no protection for the Pdelay messages.

The forwarding delay in time-aware-bridge (Ethernet switch) is added to the correction field of *Follow_Up* message. When EthTSyn which is the Global Time Master (GTM) is managing a switch, it adds the forwarding delay to *Follow_Up* message, protects and sends it. When EthTSyn which is GTM and not managing a switch, then the forwarding delay is zero in protected *Follow_Up* message. In this case, the EthTSyn, which is slave and managing a switch, follows the below steps:

1. Verifies protected *Follow_Up* message from the master
2. Computes the forwarding delay and updates it in correction field of received *Follow_Up*
3. Generates the new ICV on the updated *Follow_Up*
4. Updates 'Time Authenticated TLV' with new ICV in updated *Follow_Up*
5. Sends this updated *Follow_Up* to respective slaves

The explained behavior also facilitates the usage of different security keys between different point-to-point time synchronization participants.

2.2 INTEGRATED SECURITY MECHANISM ON CAN

The integrated security mechanism on CAN network is specified in the CanTSyn module (6). It is supported only on extended CAN channels (CAN FD). The reasons for not supporting the same on classic CAN channels are:

- The integrated security mechanism is too complex to achieve on classic CAN channels due to payload limitation; therefore, any incorporated solution will leave security vulnerabilities (e.g., cryptographic attacks, DoS).
- ECUs part of today's vehicle E/E architecture, supports both classic CAN and CAN FD channels.

Frame Payload (max. 64 Bytes)											
B-0	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11 to B-63
0x78	UB2	D, SC	Flags	SyncTimeNSec				FVL	ICVL	FV	ICV

Figure 4
CAN FD Follow_Up message format

The time information on CAN FD is split between Sync (seconds part) and FUP (nanoseconds part). Even though ICV has been added only in FUP, the data for ICV calculation also includes payload of Sync message. This is feasible as the time information from both messages is used only as a whole in the slave. The ICV length can be up to 54 bytes.

As the synchronization mechanism also includes two step synchronization, like Ethernet, the security mechanism for CanTSyn is similar to EthTSyn one. It differs only in some network particularities/constraints.

The same approach is followed to protect the extended OFS message on a CAN FD channel.

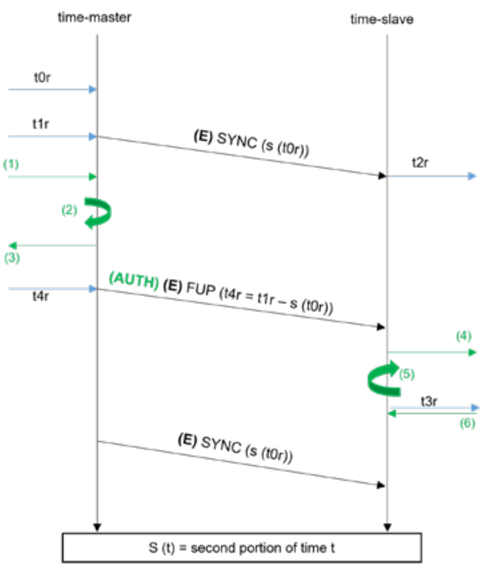

Figure 5
SGTS on CAN FD

2.3 INTEGRATED SECURITY MECHANISM ON FLEXRAY

The integrated security mechanism on FlexRay network is specified in the FrTSyn module **(7)**.

Frame Payload (max.254 Bytes)										
B-0	B-1	B-2	B-3	B-4	B-5	B-6 to B-15	B-16	B-17	B-18	B-19 to B-253
0x50	UB2	D, SC	Flags	UB1	UB0	SyncTimeSec, SyncTimeNSec	FVL	ICVL	FV	ICV

Figure 6
FlexRay SYNC
message format

The *Sync* message of the FrTSyn module is extended to include the ICV field and can be up to 236 bytes.

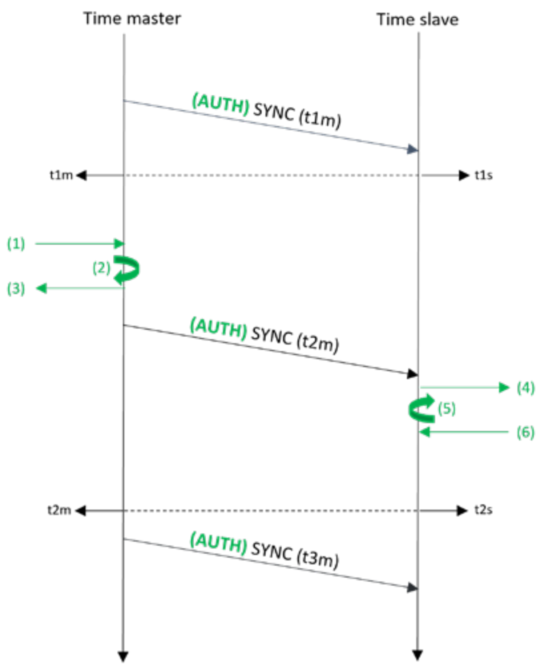

Figure 7
SGTS on FlexRay

The synchronization mechanism on the FlexRay network consists of one-step synchronization and requires only the Sync message. Hence the security mechanism will compute ICV before Sync is sent and it will protect the whole frame. The verification shall happen immediately after Sync is received, and only if the ICV is correct, the global time shall be computed.

The same approach is followed to protect the OFS message on a FlexRay channel.

2.4 SOFTWARE ARCHITECTURE

Among the various possible architectures, the below architecture was chosen considering its simplified methodology, reduced implementation overhead, and no run-time impact during operation.

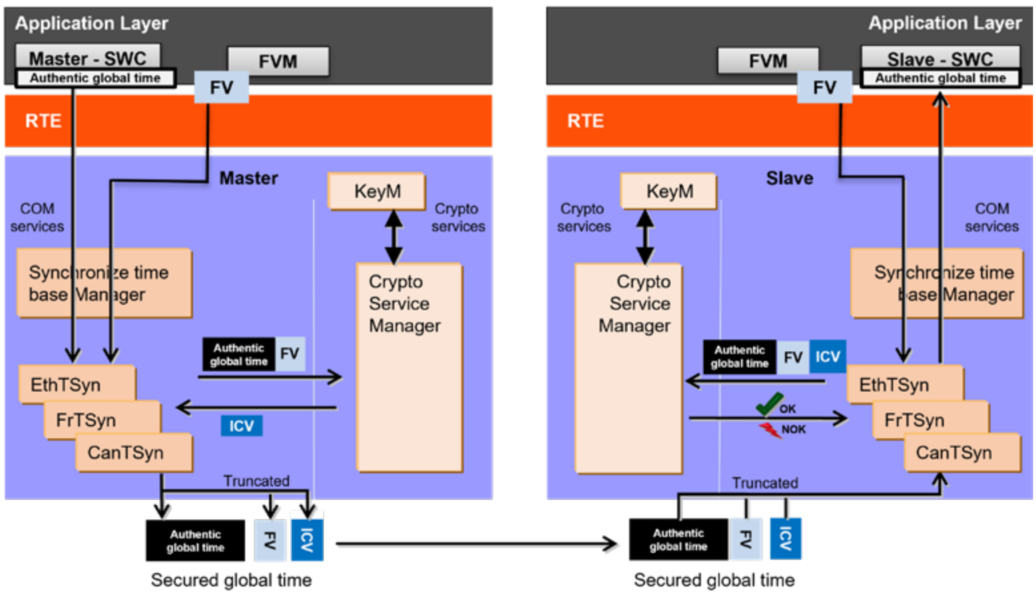

Figure 8
<BusTSyn>-based
software architecture

Time synchronization stack modules reside directly above the interface modules (i.e., EthIf, CanIf, and FrIf). This architecture allows keeping the current interactions, without changing the PDU handling (i.e., involving PduR).
Since StbM already has service interfaces to Rte, StbM is made to act as a proxy between the Freshness Value Manager (FVM), and <Bus>TSyn modules which do not interact directly with Rte.
<Bus>TSyn modules then communicate directly with CSM for the generation and verification of ICV. This makes for a simplified configuration and a runtime without any delay factors. It also stays consistent with the CRC implementation and keeps the overall backwards compatibility with previous versions (communication with ECUs that do not use the security mechanisms is still possible).

3. OTHER SECURITY MECHANISMS

3.1 EXTERNAL SECURITY MECHANISM

External security mechanisms in this context refer to mechanisms that are external to global time synchronization modules and that can, anyway, be used to address the security requirements for global time synchronization.
For Ethernet, MACsec (IEEE 802.1AE) provides point-to-point security at the Ethernet links. MACsec protocol is yet to be standardized in the automotive domain. Currently it is unclear whether it can seamlessly function with the time synchronization features.
For CAN, secure transceivers provide the detection and containment of security incidents (flooding, spoofing, and tampering) at the physical layer. When fingerprinting the transmitting ECU to authenticate the source, it is currently unclear whether it can guarantee the security in all scenarios.

3.2 ARCHITECTURAL SOLUTION

Several architectural solutions can be used to enhance the security. The most important one is to secure the source of global time by all possible means (e.g., redundancy, exposure). Other architectural solutions (e.g., plausibility checks) shall be applied in time-aware nodes in synergy with safety mechanisms.

3.3 MONITORING AND MANAGEMENT

Various aspects could be monitored to enhance security in global time synchronization system. The detection of several security events is incorporated in the <Bus>TSyn modules, giving the time synchronization stack modules the possibility to report any suspicious activities to the Intrusion detection System (IDS).

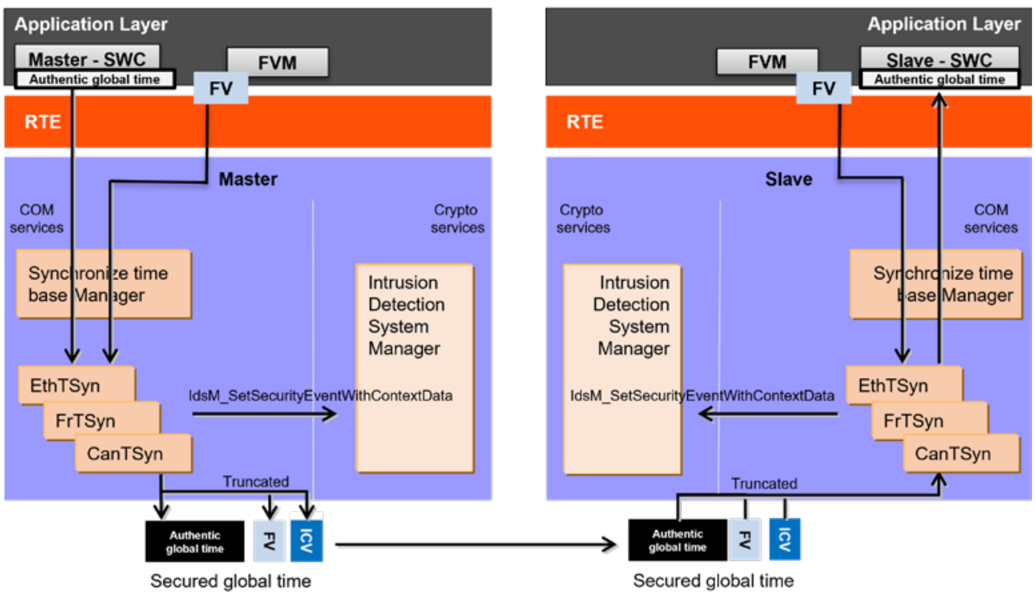

Figure 9
SGTS – Intrusion detection

4. THREAT ANALYSIS

All attacks specified in RFC 7384 (1) except the rogue master attack (as BMCA is not supported in AUTOSAR) are possible in the automotive domain. The security risk from Grandmaster Time Source Attack can be mitigated by an architectural solution and hence, it is not considered in the below threat analysis.

All attacker types mentioned in it except external MITM (as master and slave nodes are within in-vehicle network) are applicable in the automotive domain.
An example domain-based vehicle E/E architecture with the potential position of attacker types shown in the below figure is the basis for the following threat analysis.

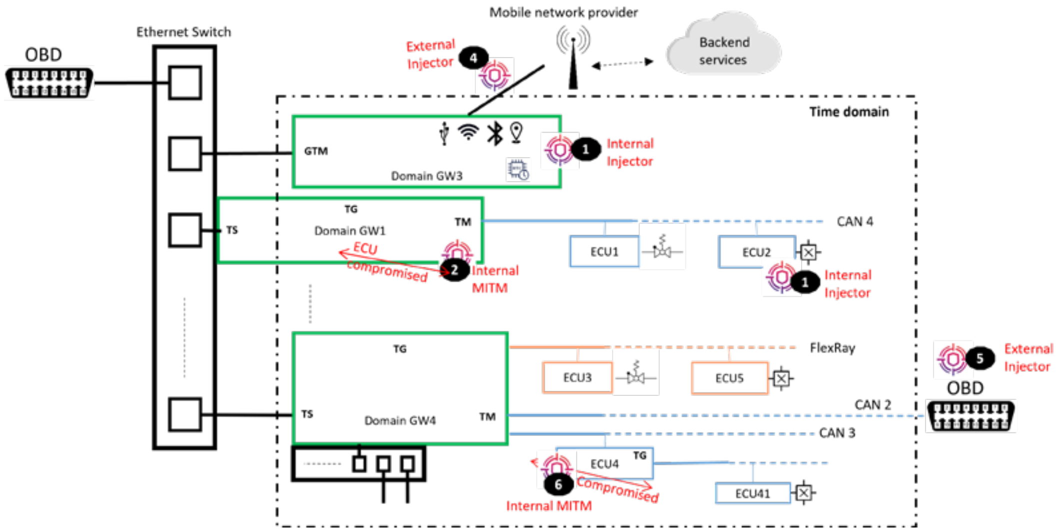

Figure 10
Example vehicle E/E architecture (domain-based) with potential position of the attackers

4.1 THREAT ANALYSIS ON ETHERNET

For each attack, the Table 1 of RFC 7384 (1) specifies its impact and its applicability to each of the attacker types. The table below specifies which security mechanism (SGTS, MACsec) is exposed to these attacks.

Attacks	Attacker type									
	Internal						External			
	MITM	Inj.	MITM		Injector		MITM	Inj.	Injector	
	Applicability		MACsec	SGTS	MACsec	SGTS	Applicability		MACsec	SGTS
Packet manipulation(1)(2)	+		✓	✓						
Spoofing(3)	+	+	✓	✓						
Replay attack	+	+	✓		✓					
Interception and removal(4)	+		✓	✓			+			
Packet delay manipulation(1)(2)	+		✓	✓			+			
L2 DoS attacks	+	+		✓			+	+		✓
Crypto-performance attacks	+	+	✓	✓	✓	✓	+	+	✓	✓
Time protocol DoS attacks	+	+	✓	✓	✓	✓				

Table 1
Threat analysis summary – Ethernet

(1) Attacks such as 'packet manipulation' and 'packet delay manipulation' are applicable when the time-aware-bridge is implemented as a transparent clock.
(2) In these attacks, SGTS is more secure than MACsec as it is exposed only when the attacker possesses the cryptographic keys.
(3) MACsec and SGTS are not exposed to spoofing to an internal injector when the master and slave have a unique pair-wise key.
(4) Attacks such as 'interception and removal' in case of the time-aware bridge are implemented as a boundary clock results in time slaves not synchronized to the global time master (but to the time-aware bridge).

4.2 THREAT ANALYSIS ON CAN FD

Attacks such as ‘packet manipulation’ and ‘packet delay manipulation’ are not applicable to the CAN network, as the time gateway does not forward the time synchronization messages across different networks or across CAN networks. Instead, time synchronization messages are consumed from one network by the time gateway and new time synchronization messages are generated by the time gateway on another network.

Attacks	Attacker type									
	Internal						External			
	MITM	Inj.	MITM		Injector		MITM	Inj.	Injector	
	Applicability		Secure Transceiver	SGTS	Secure Transceiver	SGTS	Applicability		Secure Transceiver	SGTS
Spoofing(1)	+	+	✓	✓						
Replay attack	+	+	✓		✓					
Interception and removal(2)	+		✓	✓			+			
L2 DoS attacks	+	+		✓			+	+		✓
Crypto-performance attacks	+	+	✓	✓	✓	✓	+	+	✓	✓
Time protocol DoS attacks	+	+	✓	✓	✓	✓				

(1) SGTS is not exposed to spoofing to an internal injector when the master and slave have a unique pair-wise key.

(2) Attacks such as ‘interception and removal’ results into time-slaves not synchronized to the global time master (but to the time-aware bridge).

Table 1
Threat analysis
summary – Ethernet

5. CONCLUSION

Securing GTS inside vehicles is vital due to its use cases in safety-critical, time-critical, and security-critical applications.
External security mechanisms are yet to be standardized in the automotive domain and to prove their stand against security vulnerabilities. They may cause latency and require expensive hardware.

A single mechanism is not robust enough against all attacks. A mixed solution of integrated and external security mechanisms along with architectural solutions and continuous monitoring can result in a cost-effective SGTS in the automotive domain.

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Unifying AP-CRYPTO backend accelerators

by Cao Jianlong, Fan Shiqing
HUAWEI

Security is a significant challenge in automotive operating system. "Remember to lock your car" is no longer a sufficient advice to protect your vehicle[1]. Attacks against automotive operating systems are a harsh reality and can cause great harm to the safety and property of customers and the production companies. There are many types of attacks against software application over operating system, such as arbitrary code execution, privilege escalation, or persistent manipulation of storage [2]. Therefore, when some vulnerable applications with exposed surfaces are exploited by attackers, they may obtain assets of users or control vehicles within a limited period of time until known vulnerabilities are fixed and OTAs are performed. For example, the Heartbleed vulnerability, one of the most significant consequences since the advent of the commercial Internet, allowed attackers to remotely read protected memory from an estimation of 24–55% among the popular HTTPS sites [3]. The vulnerable TBOX TLS application is linked to the OpenSSL library, where the key and vulnerable code are in the same address space. When the application is compromised, the key is also compromised. Even after the vulnerability is fixed, i.e. through OTA, the key and assets are leaked, and this might be disastrous for the OEMs reputation.

Attacks against automotive operating systems are a harsh reality and can cause great harm to the safety and property of customers and the production companies.

One mitigation method is that the cryptographic stack needs to be isolated from applications to prevent sensitive assets from being obtained after application vulnerabilities are exploited.

While AUTOSAR Adaptive Platform (AP) only defines the high-level CRYPTO Stack API exposed to applications, the AUTOSAR AP cryptographic stack is designed with automotive security in mind and provides mandatory requirements to isolating keys and requests [2]. The CRYPTO API can use Remote Procedure Call (RPC) to request services from cryptographic services manager (a process isolated with calling app) to consistently enforce platform-level tasks, such as access control and certificate storage, across applications [4]. In this paper we present a cryptographic framework for cryptographic services manager, based on the separation of processes and the access control mechanisms offered by the OS.

It is true that the absolute isolation cannot fully meet service-oriented requirements. Thus, from the level of system to function, a secure communication channel between the isolated components is also needed. In this framework, we provide a Secure RPC mechanism for CRYPTO API and cryptographic services manager. Moreover, as cryptography service manager needs to support TEE and other hardware accelerators, our framework needs to support all different hardware functions while hiding their complexity with as little overhead as possible. In our solution, the choice of encryption backend is transparent, and the low-level API abstracts specific methods for vendor drivers to integrate, so that existing driver ecosystems can be reused with a minimal overhead.

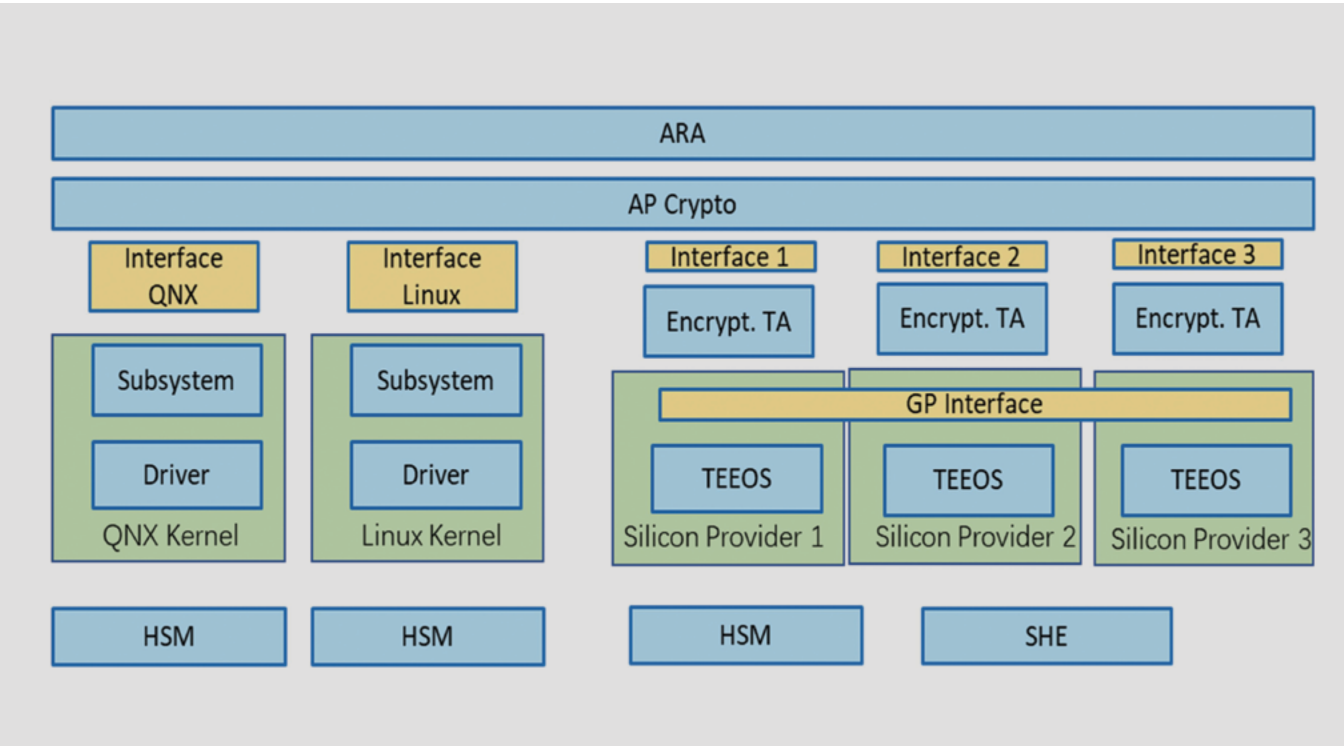
BACKGROUNDS AND RELATED WORKS

CRYPTO API AUTOSAR AP Cryptographic provides a set of standard object-oriented cryptographic interfaces for AUTOSAR applications. It does not provide cryptography implementation. Instead, it provides a set of abstract classes of CRYPTO providers. It integrates different cryptography hardware or software engines and allows applications to select different CRYPTO providers for cryptographic services as shown in Figure 1. Current CRYPTO API has 800+ functions and definitions is still in Draft state [5] with high complexity and learning curve. Meanwhile, it is not clear when the CRYPTO API will be stable and complete.

CRYPTOGRAPHIC SERVICE MANAGER This is a separated process managing CRYPTO backends and isolated with calling APP, which leverages the privileges levels of the operating system to implement the application isolation. The CRYPTO API can use RPC to request services from cryptographic service manager, invoking specific cryptography backend service through parameters or configurations. However, the AUTOSAR AP didn't define or recommend a secure RPC mechanism for communication between ARA and Cryptographic Service Manager, neither RPC communication protocol nor RPC API.

CRYPTOGRAPHIC BACKENDS Silicon Vendors provide various solutions to perform cryptographic services with different API standards as visualized in Figure 1. CRYPTO Service Manager shall not only support select accelerating hardware backends whenever they are available and fallback to software [6], but also adopt various vendor hardware driver. However, AUTOSAR AP does not standardize the interface provided by lower layers, e.g., HSMs. This leads to many of different and possibly proprietary interfaces provided by different silicon vendors [7]. The adaptation usually takes several months, including the development of the adaptation layer and joint commissioning of vendors. Increased development costs and reduced time to market.

Figure 1
AUTOSAR AP CRYPTO with different cryptography providers' interface



RELATED WORK

LINUX CRYPTO SUBSYSTEM: Mavro. N et al. have presented the implementation of a cryptographic framework for the Linux kernel [8]. It decouples cryptographic keys from the applications using them by confining the keys to kernel-space. Mueller S, Vasut M. have presented Linux CRYPTO API interface for consumers requesting cryptographic services and Cipher Algorithms abstraction for vendors to register driver into the framework [9]. Since Linux Kernel is quite popular in its community and ecosystem, many vendors have introduced cryptographic backend drivers that adapt to the framework. However, vendors do not have unified test cases that can be reused. In addition, calling APIs requires system calls, which require context switches (switch execution from user-space to kernel-space) which come at a considerable cost.

PSA CRYPTO API: PSA CRYPTO API is specified by the ARM Platform Security Architecture (PSA) frameworks [10]. It does not only provide high-level APIs, but also provides access to low-level primitives used in modern cryptography. Keys can be accessed using opaque key IDs. The framework provides a set of standardized resources and guidelines that provide a portable interface for cryptographic operations on a variety of hardware. The PSA CRYPTO API in the application processor consists of a thin layer of code that translates function calls to remote procedure calls in the CRYPTO processor between tasks in a multitasking operating system, between a userland task and the kernel, or between the non-secure world and the Secure world of a trusted execution environment.

REQUIREMENTS

A list of high-level requirements for the framework concerning key protection, application portability, hardware platform portability and usability, is provided as follows:

1. All cryptographic material such as keys must not be accessible from applications that use them, or from any other application, either directly or through a process memory dump.
2. Applications should be portable to other OSes without changing the CRYPTO related code.
3. Applications should be unaware of hardware backend APIs, and the framework abstracts libraries and back-end driver registration APIs for easy driver integration.
4. The API should have a simple, usable interface and parameter definitions, which shall be well documented and avoid accidental misuse.

ARCHITECTURE

SIMPLIFIED SERVICE-ORIENTED API INTERFACE

Our framework implements a CAPI interface in CRYPTO Service Manager, the CAPI reuses part of the interface prototype implementation of PSA CRYPTO API, and provides a library to translate CRYPTO API to CAPI through CM as the transport and service discovery layer. The CAPI interface is simple. Compared with the AP CRYPTO API, the CAPI interface has only about 30 interfaces. Therefore, serialization and deserialization are easy to implement and the possibility of misuse is reduced. In addition, CM is used as the RPC transport layer to provide service discovery capabilities and support service-oriented invoking between domains, heterogeneous cores, and even different trusted environments.

REUSE BACKEND DRIVER ECOSYSTEM

Since Linux Kernel is quite popular in its community and ecosystem, many vendors have introduced cryptographic backend drivers that adapt to the framework. Thus, in our framework, we reused the backend driver ecosystem provided in Linux CRYPTO subsystem. Accessing the Linux kernel CRYPTO API from user space in order to take advantage of hardware CRYPTO offload can be done in one of two ways: AF_ALG and Cryptodev. Both ways natively supported in OpenSSL. Therefore, our framework will provide a CAPI to OpenSSL translation which leverages OpenSSL to access Linux kernel Crypto subsystem, then reuse the existed hardware accelerator ecosystem.

SECURE KEY STORAGE

The Linux Crypto Subsystem does not support key management which means usually it takes plain key for encryption or decryption. In our framework CRYPTO service manager as a privileged process is isolated from the user application process. The user process uses the key ID to perform encryption and decryption operations, CRYPTO service manager will translate the key ID to actual key. When the TEE presents, this part of key management code may be placed in the TEE as a trusted application.

CONCLUSION

In this work we took inspiration from PSA Crypto API and Linux Crypto Subsystem to create a cryptographic framework.

The main goal of the framework is to decouple cryptographic keys from the application using them, by confining the keys in service manager.

This confinement requires inter process communication to initiate service requests across applications, so we created a CAPI to perform the service-oriented cryptographic service. The cryptographic service is achieved through different hardware backends or software libraries. To integrate diverse cryptographic hardware and software backends needs a uniform interface. The framework implemented the uniform interface by integrated OpenSSL to leverage the Linux kernel Crypto ecosystem. Compared with the traditional solution, this framework can help OEM save months to provide cryptographic on various platforms and help them bring their products to market.

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The software-defined vehicle as an outgrowth of megatrends

OPEN STANDARDS AND OPEN SOURCE AS KEY ELEMENTS OF SOFTWARE-DEFINED VEHICLE PLATFORMS

by Jochen Breidt, Christopher Schwager
ITK ENGINEERING

Digital features are figuring ever more prominently across all lines of business, and this trend shows no signs of slowing. Digital solutions, apps, and the like are already fixtures of consumers' day-to-day lives, and increasing numbers of drivers expect their vehicles to be fully integrated into this smart lifestyle. This requires new connectivity, automation, and personalization functions, more and more of which will be implemented with software. This has consequences for automakers.

While hardware and mechanical features had been the great differentiators for brands, now software is taking on a much more important role. In the future, software will have a tremendous impact on the customer experience and even on vehicles' hardware specifications.

This software-defined vehicle, or SWdV for short, is therefore an outgrowth of megatrends currently sweeping the globe – personalization, automated driving, connectivity, and electrification. It will give rise to new business models and digital services for customers. Above all, though, it is changing the way vehicles are engineered and how automakers are going to create value in the future.

A PARADIGM SHIFT IN AUTOMOTIVE ENGINEERING

Vehicles' increasingly seamless integration into the digital world will eventually require a constant exchange of data with the cloud. This will allow software to be continuously optimized and evolved to the full extent of the hardware's capabilities. Automakers will therefore have to speed up development cycles so they can differentiate their brands by updating and upgrading vehicle functions and the like throughout the lifecycle, even after the SOP.

This paradigm shift is primarily enabled by the separation of hardware and software, as well as by increasing connectivity.

Hardware and software abstraction is already commonplace on most IT platforms, but this practice is just beginning to gain traction in automotive engineering with advent of the software-defined vehicle. In the past, it had been possible to consider individual systems within the vehicle in isolation. Systems integration was already a challenge in and of itself. Engineers had to take dependencies into account and coordinate the individual systems. But emerging distributed software architectures are now pushing conventional E/E architectures and development methods to limits of their capabilities. Hardware/software abstraction and continuous integration and delivery (CI/CD) methods enable engineers to develop these new central E/E architectures and platform solutions. They can better integrate software functions and accelerate release and innovation cycles with these methods. This reduces system complexity, but it also raises the requirements bar and increases software complexity.

A SMART PLATFORM HELPS TAME COMPLEXITY

ITK Engineering believes that it will take a comprehensive SWdV technology platform with three components to create a cross-domain, centralized architecture and reduce complexity in software development and system integration:

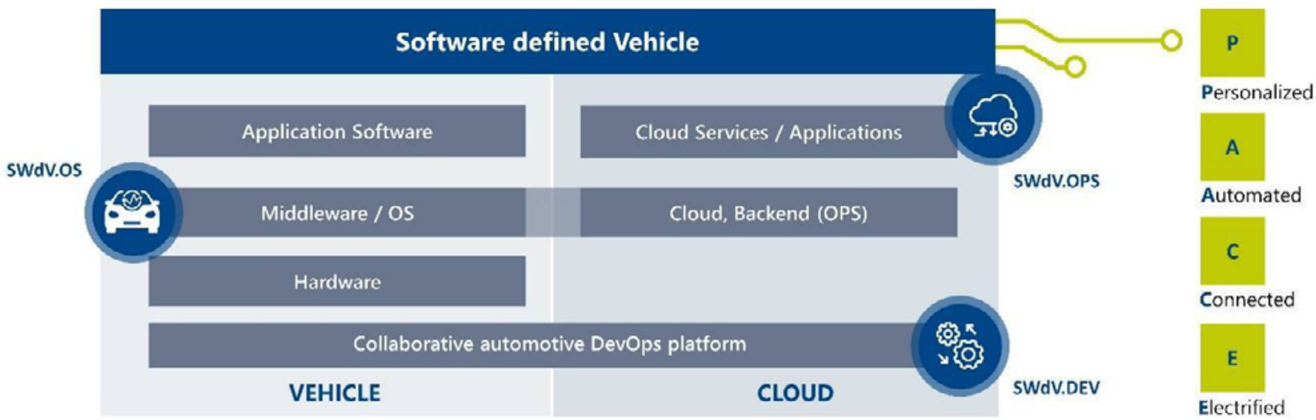

Figure 1

The SWdV technology platform

1. SWDV.OS: An operating system is required on the vehicle side to make it easier to integrate new vehicle functions. This software base layer serves several purposes, one being to enable the abstraction of software functions and, by extension, central data acquisition and software update management in the vehicle.

2. SWDV.OPS: This in-vehicle base layer and the platform in the cloud have to be coordinated. The two elements' functions complement each other to create an over-the-air connection with the vehicle and thereby support efficient and transparent communication among components of the application software. This also enables cloud-based operation of vehicle software and new services.

3. SWDV.DEV: This technology platform will have to include a scalable and collaborative development environment. This environment unifies the two sides, the vehicle and the cloud, to enable end-to-end development of innovative features based on new data-driven development methods and fast integration cycles. A scalable integration platform that accommodates and automatically tests vendors' software is an essential component for increasingly distributed and collaborative software development.

COMPLEX SOFTWARE INTEGRATION DEMANDS EFFICIENT COLLABORATION

The SWdV technology platform addresses general challenges faced by OEMs. Although not a differentiator from the customer's perspective, it is essential and also necessary for creating differentiating vehicle functions. ITK Engineering believes cooperation and partnerships are vital this end. A scalable platform based on open standards and open source could enable players to join forces and reach as many users as possible.

As OEMs adopt and evolve the SWdV technology platform, the collaboration will also have to be stepped up at the ECU level. The reason for this is that more and more software vendors are contributing to the functionality and demanding ever faster feedback on delivered software. This is compounding the complexity of software integration. Today's conventional approach of manually integrating and validating software is therefore no longer viable – it cannot cope with all the complexity. This will lead to a transformation of the software integration process. After all, state-of-the-art software integration is all about maximizing speed and flexibility while minimizing the validation effort.

This new software integration process will have to be efficient, which is why creating neutral ground between all stakeholders makes so much sense.

More open communication with a neutral partner mediating as a coordinator will inevitably promote collaboration. A detached and independent integration environment could serve to create this neutral ground. As it stands, manual software integration is a drawn-out procedure that takes place at long intervals. To meet the main requirements, it will have to be transformed – in all its details – into a collaborative and continuous software integration and validation process.

The result of a co-integration environment could look like this (Fig.2):

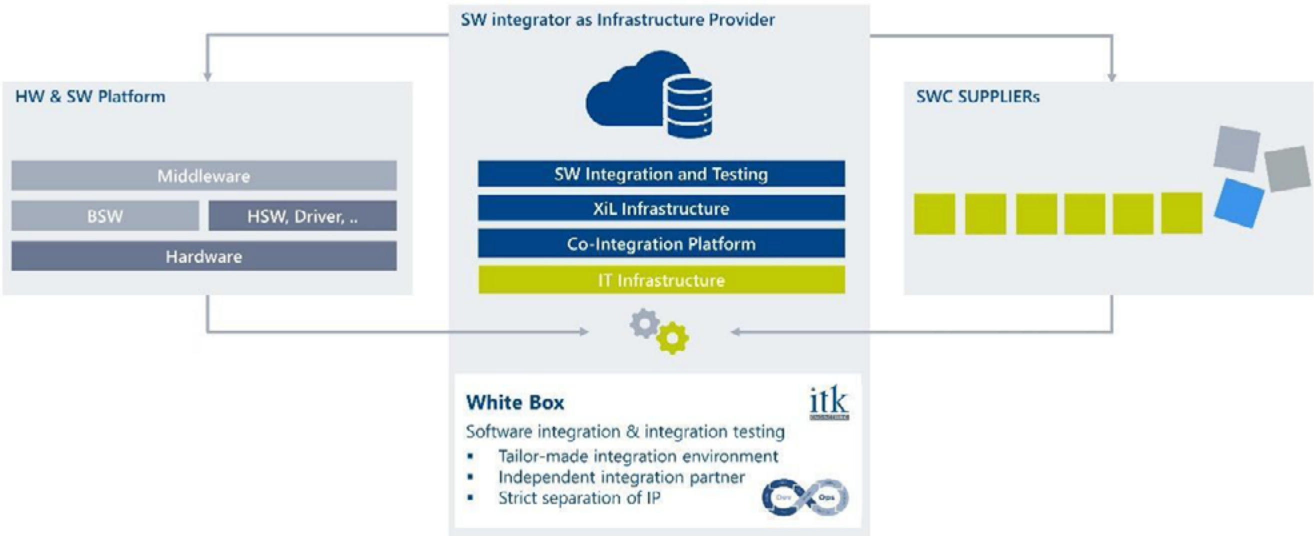

Figure 2

The co-integration environment

The SWdV technology platform is a key to the software-defined vehicle. It will take intensive collaboration within the framework of alliances and partnerships for this platform to succeed.

As an independent partner, ITK Engineering is rising to the emerging challenges of software-defined vehicle development and state-of-the-art software co-integration by offering tailored environments for collaborative software integration and validation. As an integration partner, the technology company can set up a collaborative co-integration environment to provide a neutral and independent basis and achieve the required scalability and high level of automation. This environment is the third pillar of the SWdV technology platform (SWdV.DEV) described in this article.

AUTOSAR AS A BUILDING BLOCK OF THE SOFTWARE-DEFINED VEHICLE

AUTOSAR has long appreciated the advantages of collaboration and for 20 years has been working on AUTOSAR standards, which have been adopted by many OEMs, suppliers, and tool vendors. The established standard focuses on specific requirements at the vehicular level. The SWdV technology platform is going to extend beyond the boundaries of the standard, but the consortium will remain an important component.

Combining established elements such as AUTOSAR with open source software can drive and accelerate innovations on the SWdV technology platform as well as reduce time to market.

Keeping pace with times, the AUTOSAR Alliance is pursuing its Opening Strategy and intends to declare part of the specifications as an open standard. Opening protocols at the network level is a crucial step to support efforts to develop compatible applications beyond AUTOSAR. This simplified access will further extend the reach. On top of that, the new Vehicle API standard is to create fresh opportunities for in-vehicle interaction with AUTOSAR for the world outside AUTOSAR.

This is a major stride towards connecting AUTOSAR with other elements of the software-defined vehicle. AUTOSAR is thus setting the stage for software-defined vehicle activities on a global scale. ITK Engineering believes this is the right thing to do and will therefore continue to support AUTOSAR as a Premium Partner.

SDV Goals and Journey Covered So Far!

SCALING THE VEHICLE.OS - SUCCESS FACTORS FOR REALIZATION OF SOFTWARE-DEFINED VEHICLES

by Meenal Awachat, AUTOSAR KPIT Team
KPIT TECHNOLOGIES

Enhanced user experience, achieving market differentiation and creating a sustained revenue stream through digital services post vehicle sales are the broad goals of software-defined vehicles.

Hardware-software decoupling is a key imperative and the development of Vehicle.OS is taking a priority at most OEMs. The majority of OEMs are choosing a combination of one or more of the following for development of a "Vehicle.OS" – MAKE in-house, BUY off-the-shelf solution, PARTNER across the value chain, and LEVERAGE Open-source consortiums such as SOAFEE, AUTOSAR, COVESA, and ECLIPSE to gain insights on latest developments in technologies.

OPTIONS AND KEY CONSIDERATIONS

Below is a list of key considerations and options that OEMs need to weigh in as the development of the Vehicle.OS happens in parallel.

1. Vertical Integration Vs Horizontal Integration (Partnerships): While OEMs desire speed and innovation within an independent ecosystem, vertical integration in the short term looks attractive. The magnitude of the problem, however, demands to look at allied partners to both develop and scale Vehicle.OS
2. Consortium Efforts Vs Individual OEM Priorities: While the underlying challenges in transitioning to SDVs such as building Service oriented architectures, building common APIs are common and need a collaborative solution, individual OEM-specific priorities such as legacy migration to HPC and customizations based on different vehicle programs are equally important. The success of AUTOSAR over the years will make OEMs, Tier-1s, and other players actively participate in consortiums and build standards and interfaces common to all. However, time-to-market and customizations demand OEM-specific standards development.
3. Hyperscalers Expertise Vs Business Models: Companies such as Amazon, Google, and Microsoft have entered the automotive space. Traditional automotive players have much to gain from the technical expertise that these companies bring in from cross industries but at the same time they need to develop the right business models that would create value for both themselves and the hyperscalers through digital revenue stream.
4. Restructuring Organizations (Domain Controllers vs. Central Compute Teams): Organizations need to move on from traditional team structures representing the distributed architectures to new divisions that represent a horizontal team across domains. The emphasis is not just on restructuring but changing the culture/mindset in which teams were operating.

5. Role of Orchestrators Vs Providers: OEMs are the undoubted orchestrators for the mega transition to SDVs. However, they need to have thought leaders as partners in either Tier 1 or Software Integrator segments who will help build the vision of new architectures together. The remaining participants (chip, cloud, OS) in the value chain could be the providers to the overall platform development.

SCALING THE VEHICLE.OS - SHORT TERM AND LONG TERM SUCCESS FACTORS

Category	Short Term (Next 3 years)	Long Term (Beyond 3 years)
Partnerships	• OEMs to establish strong partnerships with chip and cloud providers • Large Tier-1s to build cross-domain middlewares that go across OEMs • Define Central Compute E/E architecture with Tier 1s or Software Integrators	• Cross-OEM Licenses - Licensing the best available Vehicle.OS
Consortiums	• Support Consortiums such as SOAFEE, Adaptive AUTOSAR, COVESA	• Consortiums to harmonize standards, common tools and APIs across OEMs
Processes	• Implementing agile methodologies, virtualization and CI/CD infrastructure	
People	• Leverage software expertise from allied industries – semiconductor, smartphone, cloud, OS, etc	• Upskilling of Talent with Software Expertise (both Domain as well as Vehicle Level)

ABOUT KPIT

- KPIT Technologies is a global partner to the automotive and Mobility ecosystem for making software-defined vehicles a reality.
- Leading independent software development and integration partner helping mobility leapfrog towards a clean, smart, and safe future.
- 10000+ automobelievers across the globe specializing in embedded software, middleware, AI, and digital solutions,
- KPIT accelerates its clients' implementation of next-generation technologies for the future mobility roadmap.
- Working on 6 large SDV programs across OEMs and other clients within the automotive industry
- 75+ Platforms, tools and accelerators (IPs/Assets) across the CASE domains
- New investment in the areas of SOME I/P, High Speed Auto ethernet, Virtualization and Cloud-based services
- With engineering centers in Europe, the USA, Japan, China, Thailand, and India, KPIT works with leaders in automotive and mobility and is present where the ecosystem is transforming.

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The challenges of the automotive industry's paradigm shift

HOW AUTOSAR OFFERS A SOLUTION[1]

by Tobias Kühnel, Suat Kusefoglu, Christoph Hennig, Manish Singh Dhek, Owen Williams
LUXOFT

New customer expectations like electrification, connectivity, autonomy and shared mobility have led to a paradigm shift in development — software is no longer defined by the vehicle, but the vehicle is defined by the software.

Automakers are posed with numerous challenges in their necessary transformations for the future market and in ensuring proper and failure-free functionality. Those who are able to adapt fast will take the lead, while those who fail to do so will be left behind. In this paper, we'll look at the revolutionary approach that established automakers need to take, the role of Vehicle OS and vECU in the development of software-defined vehicles (SDVs), and how AUTOSAR offers a solution.

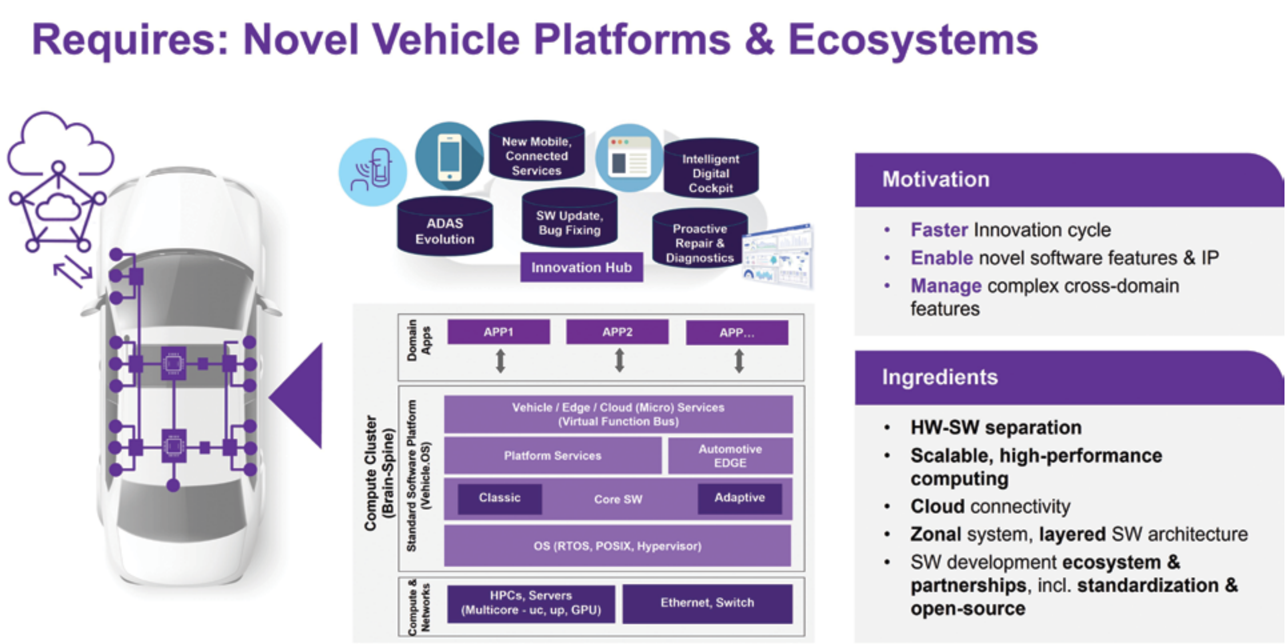


Figure 1
SDV Novel Vehicle Platforms and Ecosystems

A NEW WAY OF THINKING

Many established auto companies are not currently focused on software, but on features: Instead of pursuing an architecture and software centric approach, they try to squeeze features into suitable software components. However, as the world transitions to software-first, these established automakers need a fundamental shift in how they treat software: Software is no longer bound to specific ECUs, and in fact, often transcends the vehicle. With the seamless experience car users expect across platforms, automotive software now needs to live flexibly across in-vehicle high-performance computers (HPCs), the cloud and personal mobile devices. This novel paradigm is compounded by new regulations like UNECE R155 and R156 which enforce automotive companies to include software version tracking and updates after SOP — something which cannot be implemented and integrated without a properly designed software architecture.

Some automakers have approached this challenge by hiring thousands of software and data engineers, then trying to integrate them effectively into established automotive structures and processes, but this approach is showing its limitations (and it is practically impossible given the fact that the labor market is swept empty).

Instead, what many automakers need is a cultural shift, system thinking and a genuine willingness to collaborate.

To achieve this, the main challenge is to change the established way of thinking inside the automotive industry and use the advantages AUTOSAR provides to achieve the software capabilities which will soon be essential.

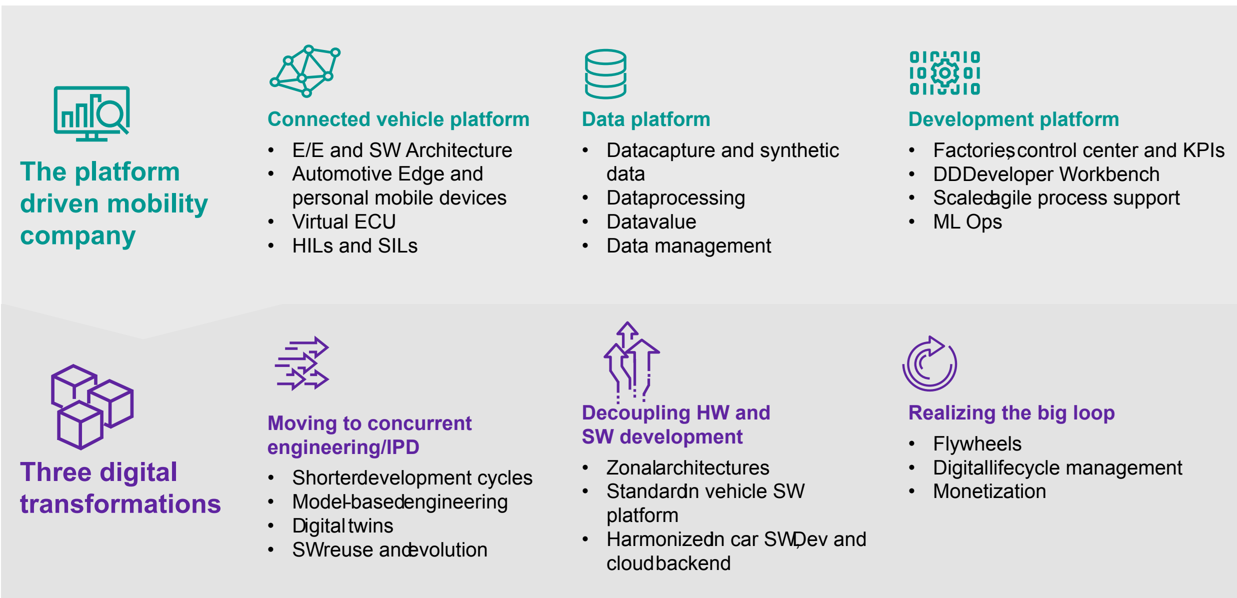


Figure 2
SDV trends

TRENDS IN THE DEVELOPMENT OF SOFTWARE-DEFINED VEHICLES

Platforms are key to enabling value and resilience from software. You need the actual connected vehicle platform — an in-vehicle platform that is connected to the outside world — then you need a data platform that runs in the background, and importantly, you need a development platform that enables you to develop software very quickly.

It's not just about structuring the business and building the platforms though; a big transformational change is also needed. Firstly, you have to be able to work in concurrent streams — with the increase in CI/CD pipelines and DevOps, plus elastic cloud architecture which enables fast scale-up and -down, there's a much bigger opportunity for automakers to work on software, models, digital-twins and hardware concurrently, push-left (virtual) testing and accelerate through many smaller, faster cycles.

Secondly, it's vital to realize and accept the importance of software to justify the decoupling of hardware and software development. Traditional — hardware-based — ideas of a set order that must be followed in development can disrupt the fast agile methodology that is a linchpin of software development. Ultimately, the development process should be looked at in loops that encompass not only the functions that design, build, manage and operate the car, but the huge data streams produced by the modern vehicle and its ecosystem partners.

ENABLING HARDWARE-SOFTWARE DECOUPLING THROUGH VEHICLE OS

With regard to a suitable in-vehicle platform, the time of AUTOSAR has come. AUTOSAR offers a standardized platform which enables the decoupling of hardware and software development and so sets the foundation for a concurrent and parallel development of application, base and hardware layer software.

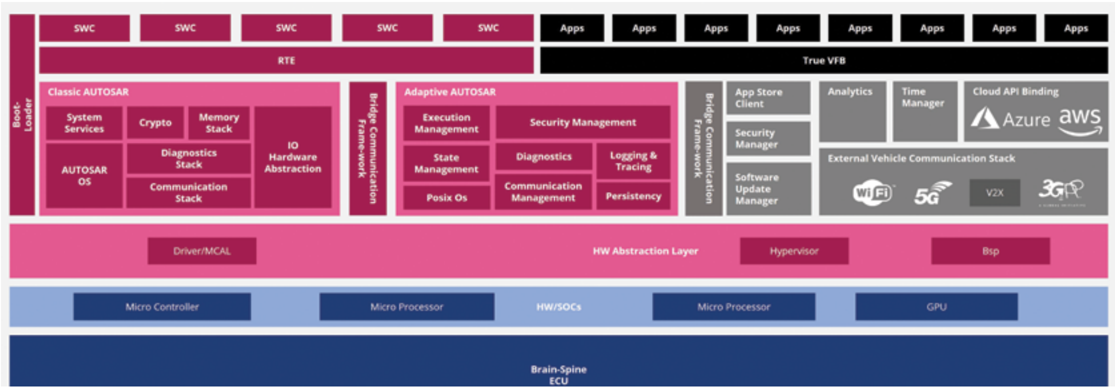


Figure 3
SDV VehicleOS
AUTOSAR

The in-vehicle platform (Vehicle OS) is the key enabler for a SDV which allows for seamless data exchange not only within the in-vehicle HPCs, but also between the vehicle and cloud. Both Classic and Adaptive AUTOSAR have their advantages here and could become the core component of this Vehicle OS platform (the classic platform ensures the execution of time and safety critical function, while the adaptive platform supports the execution of compute and data intensive complex functions).

A higher-level vehicle function abstraction layer enabled by the service-oriented paradigm-based AUTOSAR Adaptive Platform will create a 'True Virtual Function Bus'. The HW-SW decoupling realized via this vehicle services layer will allow the faster delivery of new customer features as software packages. It should be possible to develop, validate and deploy applications independently — similar to a containerized approach. The Vehicle OS platform will enable the integration of such applications without compromising other mission-critical functions. Here, an AUTOSAR-based platform is crucial to meet the predictable timing guarantees within the overall E/E architecture and to ensure system safety.

THE IMPORTANCE OF ECU VALIDATION

In the development of SDVs, it's essential to be able to efficiently validate software with a sufficient amount of testcases and test data. One of the best ways to achieve this goal is through virtual ECU (vECU) validation. With the increasing prominence of SDVs and the growing demand for driving assistance systems and digitalization in the car, the amount of software in a car has increased rapidly recently (a trend that isn't slowing down).

With all this data, proper validation is necessary (especially when it comes to Autonomous Driving due to the requirements for a huge amount of software, sensor fusion algorithms and motion planning, with a high level of safety criticality). Without proper validation, in a worst-case scenario, misfunction of such software could lead to the harm of people — something which needs to be prevented under all circumstances. Therefore, millions or even billions of test miles are required for validation. This would take years to validate using real hardware.

HOW AND WHEN TO VALIDATE

A suitable solution is to add an additional step to the validation process, located between pure software-in-the-loop tests and hardware integration tests, to validate driving algorithms on a virtual target, by feeding it with driving data from recordings or simulations.

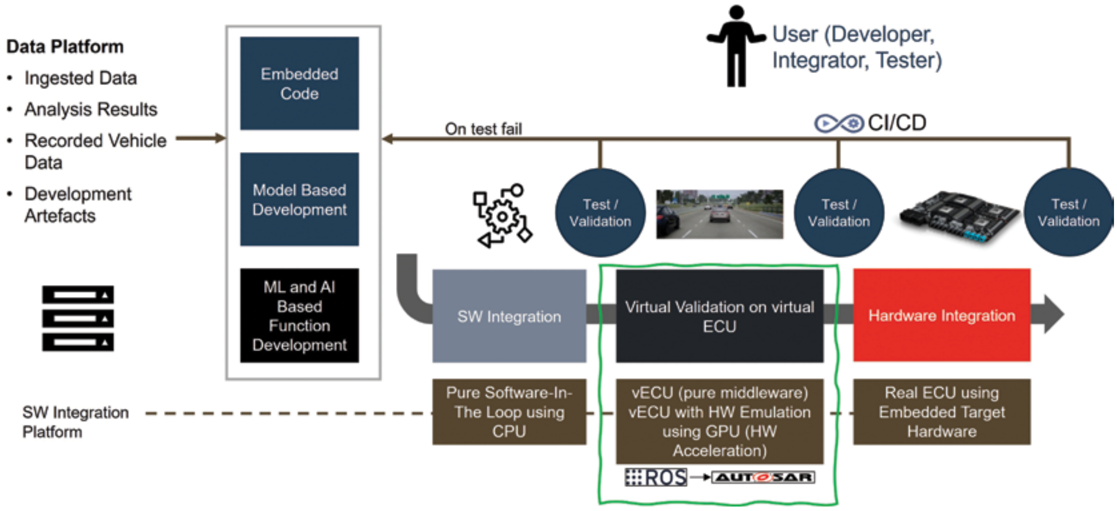


Figure 4
vECU Introducing virtual validation step

Early integration is the key to success here. The more software is needed, the more software needs to be integrated. First integration tests usually take place in late development phases, in which a failure detection would lead to costly time-intensive problem solving. Software and hardware are ideally developed in parallel, meaning that the hardware isn't usually available in early phases.

This problem can be approached by using virtual targets to shift the integration more to the beginning of the development. In other areas, like consumer electronics app development, this is already the DeFacto standard: Developers are using virtual machines or emulators to deploy their application, before using real hardware. Unfortunately, this method is still very rare in automotive development — something which needs to be changed.

INCORPORATING VECU VALIDATION

The following graphic shows a feasible way of approaching virtual validation in different virtualization levels.

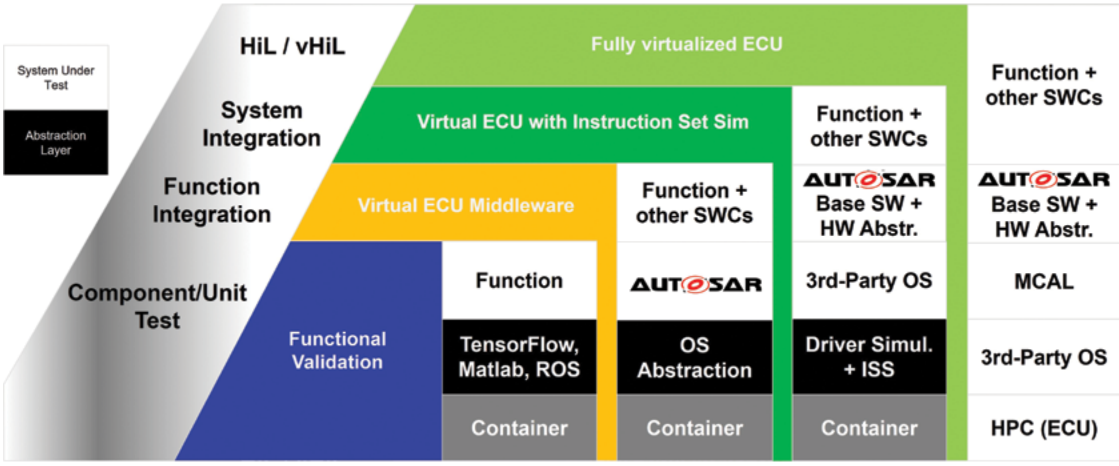


Figure 5
vECU Levels

It visualizes the right side of the classical V model where validation of software takes place. From the bottom to the top, the focus of each level is moving from a more software orientation, to a more hardware focus. By using these different virtual levels, the integration of the software and so the interaction with other components is moved more toward the bottom. This enables the tester to identify issues related to integration of the software much earlier.

THE BENEFITS OF AUTOSAR FOR VECU

As AUTOSAR decouples the application software from the hardware, it offers many advantages for vECU validation and the transformation to SDVs. AUTOSAR is a platform which provides fundamental functionality to the applications and so decouples the applications from the Operating System and from the hardware. This offers the possibility to deploy applications easily to different targets (e.g., a virtual target or real hardware). vECU is also possible with other platforms, but the advantages and functionalities which are offered by AUTOSAR fit perfectly for this virtual validation approach, so AUTOSAR will be an important player when it comes to SDV and vECU validation.

TRANSFORMING TOWARD SDVS

There are many challenges in the transformation to SDVs, but market demands and new regulations mean that those automakers who fail to transform will be left behind.

Luxoft is in a distinctive position to help automakers lead the SDV race as our experts bring a wealth of experience and deep knowledge to the industry. We've seen the challenges that many automakers are currently facing, and as we've shown, AUTOSAR often offers a proper solution.

Once a new technology rolls over you, if you're not part of the steamroller, you're part of the road.

- STEWART BRAND

Distributing IDE and Virtual ECU

A NEW APPROACH TO EFFECTIVE DEVELOPMENT OF THE AUTOSAR ADAPTIVE PLATFORM

by Seungyueb Chae
POPCORNSAR

Cloud based vehicle applications and the developments for SDV will require new development methods for AUTOSAR adaptive applications. In this contribution we show a new approach which solves the issues. The reason is as follows.

AUTOMOTIVE CYBER SECURITY (ISO 21434)

API containing new security vulnerabilities (e.g., CERT C/C++ and Common Weakness Enumeration (CWE)) can be discovered in POSIX-based OS and various open sources, and the API is prohibited from being used. The banned APIs can't be remembered by all developers and may be included in previously developed source codes. Furthermore, when security vulnerabilities are found in various open sources, the resolved libraries must be redistributed. All developers should develop using distributed libraries. Software should be redistributed by OTA.

DEVELOPMENT LANGUAGES

In addition to C, C++, various development languages like Python3 and RUST are included and developed. To apply AI to cars, AI models must be verified by using Python3 and in order to develop algorithms in autonomous driving, algorithm verification through ROS2 is required. Recently, it is also necessary to develop integrated RUST and C++ from the perspective of functional safety.

VIRTUAL ECU FOR FUNCTION VERIFICATION OF VARIOUS ECUS

In the case of smartphones, before a new smartphone is released, application developers can develop it in advance through virtual simulators. Likewise, automotive application developers should be provided an environment for developing applications as well before the new ECU is released. Especially in the case of developing only the application at 3rd parties, the actual ECU is not required.
Due to the lack of automotive semiconductors, it is often difficult to provide development boards to all developers. Additionally, the for development it is required to link several virtual ECUs, also hosting more than two different OSs that often run on one ECU like QNX, VxWorks, and Linux.

The aspect of automotive cyber security and challenges form development languages require a new Integrated Development Environment (IDE). This IDE supports history management, and requires support for various development languages, real-time API auto-completion capabilities, and Indication of the prohibited API. The IDE can be provided as Docker image using Remote Container on Visual Studio Code, and it can be automatically distributed according to the development ECU through Jenkins CI/CD linkage.

In case of virtual ECU for function verification of various ECUs, QNX and VxWorks can be operated in QEMU method, and Linux can be operated in Docker Container. In particular, the virtual ECU provides the same CPU architecture as the actual ECU, and when the functional verification is completed in the Virtual ECU, the Virtual ECU can copy the Adaptive Application to the actual ECU without compilation. In addition, Virtual ECU can be automatically distributed to the corresponding development ECU through Jenkins CI/CD linkage. When developing AUTOSAR Adaptive Applications on SDV, it can be divided into OEMs position (use case1) and Tier 1 or 3rd Party Application Suppliers (use case2).

USE CASE 1: IDE AND VIRTUAL ECU FOR MULTIPLE TIER 1 DELIVERIES TO ONE OEM

One automotive company must define E/E architecture for SDV and, according to all variants, OEM must distribute Integrated Development Environment and virtual ECU to Tier 1. The Integrated Development Environment and virtual ECU are used by each Tier 1 development team.

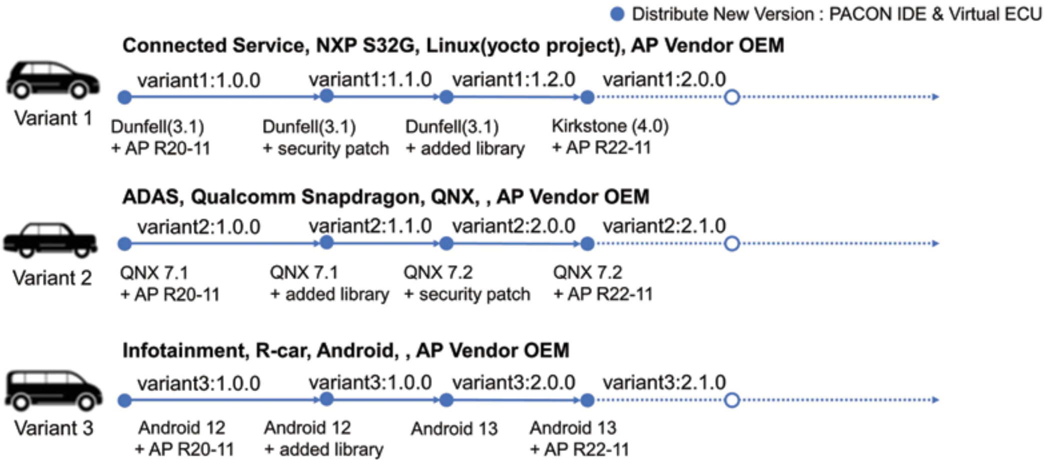


Figure1
Multiple Tier1 deliveries to one OEM

USE CASE 2: IDE AND VIRTUAL ECU FOR MULTIPLE OEMS WITH ONE TIER 1 OR ONE 3RD PARTY APPLICATION SUPPLIER FOR THE SAME SERVICE ECU

In order for the same developer to provide the same application to multiple OEMs, one developer must be able to select and develop Integrated Development Environment and virtual ECU for multiple OEMs.

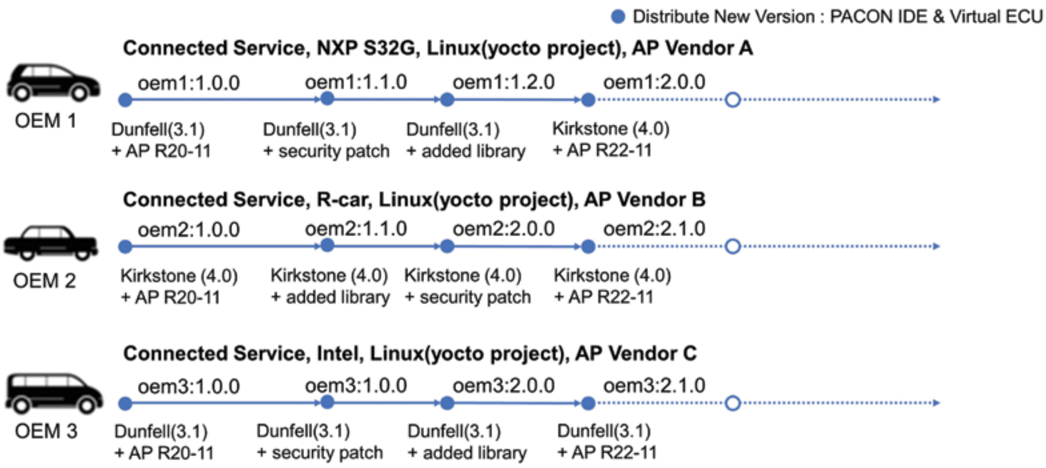


Figure2
One Tier1 or 3rd party application supplier supports multiple OEMs

Integrated Development Environment (PACON IDE) and virtual ECU should be automatically created and distributed. To do so, Jenkins and dockerhub built with DevOps are needed.

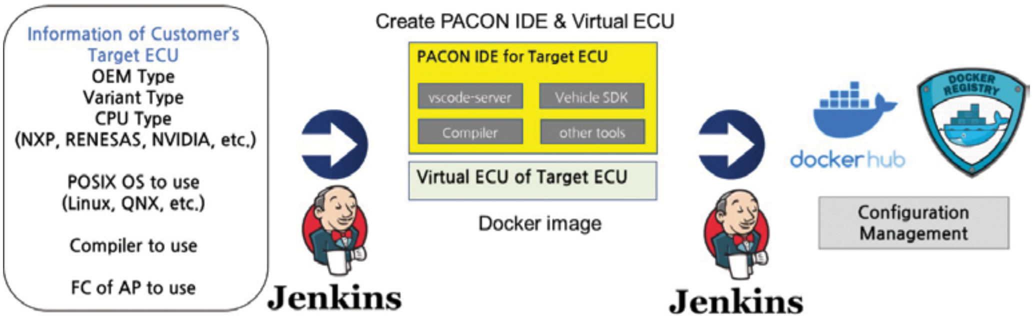


Figure 3
DevOps for Distributing Integrated Development Environment and Virtual ECU

By automatically distributing Integrated Development Environment (PACON IDE) and virtual ECU, AUTOSAR Adaptive application developer can use Visual Studio Code to select the desired development environment. It can be used locally on a user's PC or remotely connected to a development server to select and use integrated development IDE and a virtual ECU. This method is a method in which infrastructure as code (IaC) is applied, and Integrated Development Environment and virtual ECU are used.

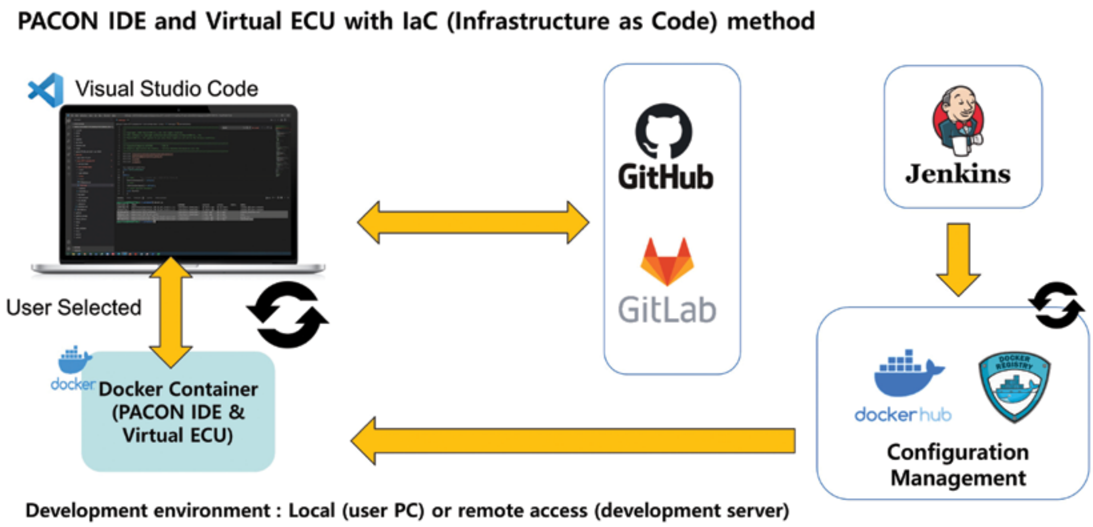


Figure 4
Integrated Development Environment (PACON IDE) and Virtual ECU with IaC (Infrastructure as Code) method

The evolution and future of communication protocols and middleware

by Emilio Guijarro
RTI

COMPUTERS AND COMMUNICATION

The challenge of effective communication between computer software components is almost as old as the computer systems themselves. Whether two pieces of computer code run and operate from different memory regions within a single computer, or thousands of miles away, the challenge to make them "talk" to each other has kept computer scientists and engineers busy since the early days of computing.

The reason for this fundamental requirement arises from many perspectives:

- To begin with, single compute units have always been (and will presumably always be) limited in their capabilities, both in instruction execution and storage capacity. Software components running on these units can leverage cross-communication to distribute and execute workloads more efficiently.
- Even though computational capability has been growing in many directions for decades, no single human mind can manage the complexity of the software systems that today's computers can run. Therefore, software needs to "fit" in the computer(s) at hand as well as be structured and modularized into cohesive units that single organizations, teams, and ultimately engineers can realistically develop and maintain. Unquestionably, these cohesive units need to communicate among themselves.
- Furthermore, software traits such as safety and security heavily depend on the notions of execution environment isolation. Just like no man is an island, no single piece of code can act in total isolation from its environment, thus making cross-environment communication necessary.

The challenge of effective communication between computer software components is almost as old as the computer systems themselves.

The concept of remote communication is so embedded in computer design, that generations of processor instruction sets have featured "call" instructions. Of course, in this context, calling means transmitting the flow of execution to a different location, while preserving the current estate until the call is completed. In a way, these call instructions were the predecessor to communication mechanisms that allowed data elements to be moved across different portions of a single computer program while running (possibly concurrently) as different processes or tasks.
This is where the term Inter-Process Communication (IPC) is derived. Initially, before computers started talking to each other, IPC mechanisms were devised to share data across processes or tasks running on the same computer, where a set of memory resources and/or interconnects were accessible by multiple software components. But then computer networks changed the game, allowing software elements in different computers to use IPC-like mechanisms to share information.

One crucial point that is being overlooked is that despite their far-reaching capabilities, IPC mechanisms are relatively low-level and primitive forms of communication infrastructure. They bear no semantics about the data they transport, and in many cases provide little or no guarantees on safety, integrity, authenticity, timing, or privacy. As U.S. Senator Ted Stevens once famously described the internet, "It's a series of tubes".

Communication protocols bring both rhythm and meaning to the data as it flows through those tubes. Depending on the level at which they operate, they prioritize voice calls over multiplayer gaming communications, differentiate a video streaming session from an earthquake alert, or secure banking operations. Communication protocols are an essential part of any computer system, regardless of size.

Communication protocols bring both rhythm and meaning to the data as it flows through those tubes.

It's a useful reminder that even the smallest microcontroller has internal bus protocols governing memory and peripheral access, and cannot serve its purpose until it is connected to another element of the system and communicates using, yes, a protocol.
As expected, eventually protocols became too complex and large to be effectively managed directly by software components and their designers. [Just like everything else in computing], they became abstracted away into layers, first informally and then more formally according to the Open Systems Interconnect (OSI) model: physical, data link, network, transport, session, presentation, and application protocols.

As one moves in the OSI model from left to right, these layers are less implemented by I/O hardware and more by software infrastructure. The communication middleware components stand at the top of the OSI stack, just between the hardware/software communications infrastructure and the application, mission-specific, logic.

FROM PROTOCOLS TO MIDDLEWARE

As described above, communications infrastructure has been structured into layers and protocols within those layers, with hardware and software components abstracting away one challenge on top of the other. However, software engineers still face a scenario where their specific inter software component semantics and requirements are far from the "dumb" series of "tubes" abstracted away by even the highest layers of the OSI model.

That's where middleware technologies provide a solid software foundation, not only in leveraging the strengths of protocols in each OSI layer, but also serving the upper application layer with a cohesive set of abstract communication patterns, type systems and Application Programming Interfaces (APIs) to realize them. These patterns include:

- Request-Response communication, where one end transmits data conveying a request of some kind, and the other, in turn, provides a reply (e.g. a reception/execution acknowledgement)
- Send-Receive communication, where one end sends discrete data units, and one or more recipients receive and process them
- Publish-Subscribe communication, similar to Send-Receive but with an added concept of dynamically "expressed interest" by the receivers, so recipients not interested in certain kinds of information are not subscribed to receive that data, and will not be included in the distribution transmission(s)
- Trigger communication, similar to Send-Receive and Publish-Subscribe patterns, but with semantics restricted to the mere occurrence of a given event, with no extra data about the event itself being conveyed

In summary, middleware combines communication protocols and software infrastructure to bridge the conceptual gap between domain-specific logic and inter-process communication infrastructure, whether local or networked.

AUTOSAR PLATFORMS AND COMMUNICATION MIDDLEWARE

The key proposition of AUTOSAR as a software architecture, is to abstract and unify a vast range of technologies and standards (e.g. microcontroller architectures, hardware interfaces or on- and off-board communication protocols) so that automotive software engineers can focus on actual feature development.

In the automotive industry, AUTOSAR is one of the most, if not the most, representative examples of middleware. None of the AUTOSAR platforms will tell you what microcontroller or microprocessor architectures to leverage in your design, what vendor to buy it from, what networking technologies to deploy interconnecting your systems, or what underlying protocols to use.

What AUTOSAR will determine (among many other things) is what communication patterns your software components will use to communicate with each other. In the Classic Platform, the Run-Time Environment (RTE) supports Request-Response, Send-Receive and Trigger communication, among others.

In the Adaptive Platform, the Communication Management Functional Cluster (CM or ara::com) Request-Response, Send-Receive and Trigger communication patterns are grouped under a single Service-Oriented Architecture (SOA) concept.

These middleware solutions not only enforce communication patterns, but also provide a unified type system to define the structure and nature of the data as it flows between for example requesters and repliers, senders and receivers, publishers, and subscribers. Of course, no AUTOSAR platform implements these communication patterns in a single layer, functional cluster, or software module, but instead leverages a complete stack of system services, hardware abstractions and drivers.

COMBINING MIDDLEWARE STANDARDS

As we have traveled in time through this article, it seems that communication middleware solutions are destined to build on top of each other, just like networking protocols have over the decades, providing further layers of abstraction upon which more functional systems can be designed.

Re-platforming application-facing middleware components on top of other mature middleware standards opens the door to not just network-level interoperability (e.g. a firewall can filter Network Layer frames knowing nothing about the data they carry), but to application-level interoperability. In the latter, applications built upon different middleware solutions such as AUTOSAR Classic, AUTOSAR Adaptive, DDS and ROS are interoperable since internally, they share common middleware layers configured to operate in complete harmony.

AUTOSAR's unique flexibility is key to enabling the introduction of these new middleware technologies:

- In the Classic Platform, the PDU (Packetized Data Unit) router seamlessly integrates several upper-layer communication patterns and serialization technologies with lower-layer transport mechanisms such as low-bandwidth buses and IP-based protocols
- In the Adaptive Platform, ara::com's Network Binding concept allows several underlying network technologies to realize Service Orientation

In both Classic and Adaptive Platforms, the OMG® DDS middleware is standardized not just as a protocol, but as an underlying middleware implementing and improving, respectively, RTE and ara::com beyond the current prevalence of SOME/IP and PDU-based protocols. A similar approach could be followed, for example, by the different ROS derivatives.

As AUTOSAR platforms continue to improve and grow to cover more functional areas, they will also experience vertical expansions with new and more industry-aligned middleware integrations.

This alignment will bring not only extended interoperability within and beyond the AUTOSAR ecosystem, but also add important new capabilities including (but not limited to) advanced QoS policies, more flexible choice of underlying transports and run-time observability. This continued progress towards interoperability will help automotive engineers in the evolutionary journey of designing the vehicles of the future.

AUTOSAR is an important element of the Software Defined Vehicle

by Armin Lichtblau
SIEMENS

Siemens is embracing the changes towards Software Defined Vehicle (SDV) in the automotive industry, and similar changes in other sectors.

As a long-term Premium partner of AUTOSAR, Siemens brings broad experience from a wide range of successful projects, not just deploying basic software, but including full vehicle system and ECU software design and development.

SOFTWARE DEFINED VEHICLE

The automotive industry is going through several dramatic changes, initially visible to the customer is electrification, with its effects on the industries value chain, how consumers interact with their vehicles with increasing use of connected Apps to manage charging, precondition cabins and in some cases pay for services. Indeed, the trailblazers in this area have set an expectation that battery electric vehicles are performant and connected with smart phone like user interface and features.

Software, both on the surface and deeper within the modern vehicle, is rapidly becoming more sophisticated, supporting an increasing range of highly integrated customer features, increasing levels of automation (not just driver assistance, but also of comfort and convenience features) and expanded user interactions.

Software Defined Vehicle captures the transformation, where software increasingly dominates the characterization of each vehicle, enabling options, updating for security and new functions over life, and the as-built physical differences between vehicles of a given type reducing to trim, color, and a reduced set of major hardware variations.

AUTOSAR is an essential building block of this new world, along with an increasing range of middleware, and automotive ethernet unlocking the ability to share much more data across networks, combined with virtualization enabling the centralization of the computing, and a zonal architectural layout.

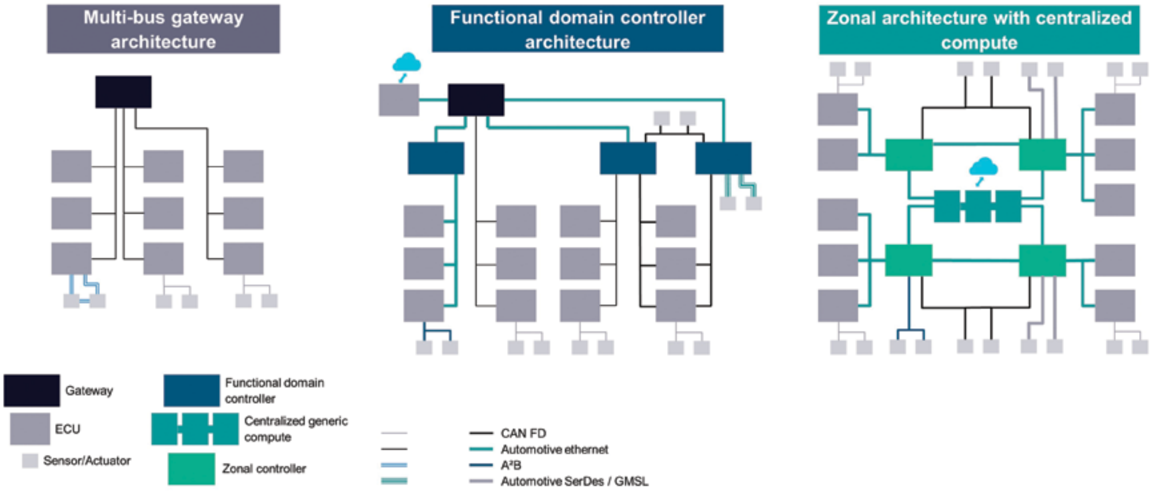


Figure 1
Evolution of Automotive E/E Architecture

SOFTWARE FACTORIES

Increasingly Automotive OEM's are adjusting their development process, separating the software development from the vehicle hardware. Software is in some cases becoming more vertically integrated in its development, with the establishment of software factories, often somewhat separated organizationally and in physical location from the OEMs.

Separation enables the software factory to adopt software methods and processes designed to deploy versions of the software platform not just to individual vehicle launches, but over the life of multiple vehicles. Traditional waterfall development processes can rapidly become cumbersome taking too much time and resource when dealing with multiple target vehicle programs at different stages of development or service life.

Software specific development processes can be deployed in a dedicated organization, allowing appropriate processes for each area of development and deployment. Functional and software digital twins further support the rapid development of planned customer features across complex platforms with assured integration when deployed to physical vehicles.

CLOUD CONNECTIVITY

The increasing software defined functions on vehicles often rely on connected data, both data logging and processing off-board the vehicle, updates, configurations and services provided to the vehicle. Managing these data flows needs to be done in a timely and secure manner.

Connectivity affects almost the entire vehicle, remote updates mean that a robust process has to be defined with the vehicle able to manage or relearn any characterizations and confirm that the update has completed correctly without the intervention of a physically present service technician.

App like functionality, which can be added to vehicles over their life, pushed as an update, or requested by the user with potentially a single payment or subscription, leads to new business models with the potential for a service-like continuous revenue stream for the OEMs, and software partners.

AUTOSAR ADAPTIVE PLATFORM

The original AUTOSAR standard has been expanded into an Adaptive and Classic platform supported by a Foundation standard. Between these a comprehensive set of automotive use cases are supported, from hard real time functionally safe functions through to high compute functions needed to process larger data sizes that are increasingly common.

HETEROGENEOUS SOFTWARE

Increasing availability of automotive qualified sophisticated System on a Chip (SOC) silicon featuring a heterogeneous set of processing cores is best utilized by a heterogenous software mix, of which AUTOSAR provides two foundational elements. An expanding set of collaborations with multiple other software standards from ASAM and Kronos through to COVESA, SOAFEE, Eclipse SDV, and more, ensures ongoing compatibility.

Automotive OEMs are moving towards defining their own OS's, describing the software platform across their Electrical/Electronic architectures, made up of a defined mix of software in each ECU type.

FUNCTIONAL SAFETY

AUTOSAR plays a vital role in these OEMs software platforms fulfilling the trusted middleware role where functional safety is concerned. Commercially available ASIL D AUTOSAR solutions provide a reliable base to deliver critical systems in increasingly automated systems. Optimizations allowing partitioning and allocating of functions across the cores of multi-core silicon enable performant safe software.

CYBER SECURITY

Software Defined Vehicles, and their OTA software updates and re-configurations add to the existing challenge of securing the vehicle from malicious hackers, indeed the OTA ability is critical to maintaining the cyber security. Layers of technological solutions are applied, well established principles and solutions can be adapted from other industries and have been included in the AUTOSAR standards and made available by AUTOSAR solutions vendors such as Siemens.

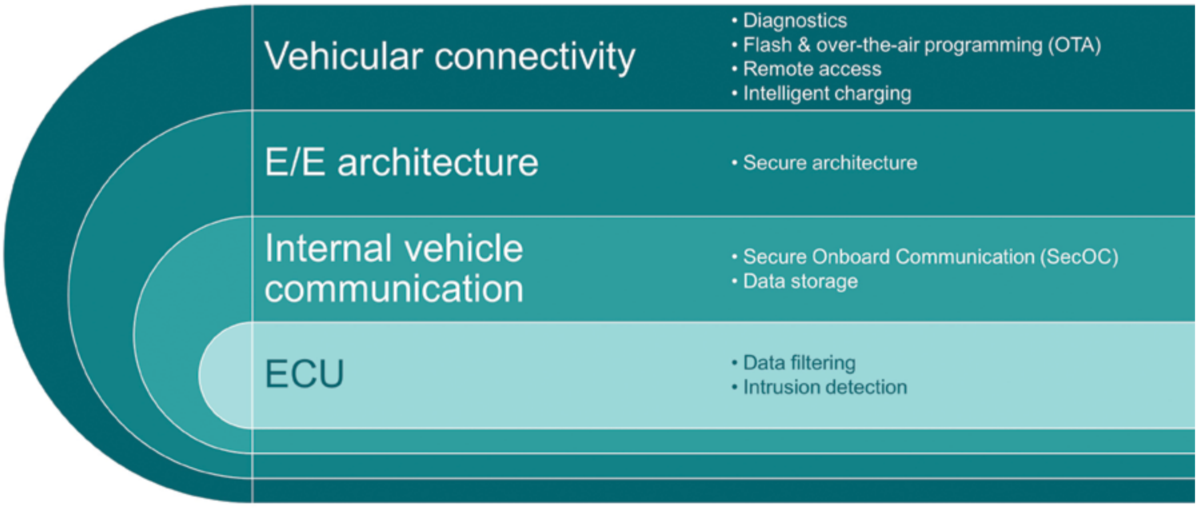


Figure 2
Layers of Cyber security

Support for Hardware Security Modules (HSM), inclusion of Firewalls, and a wide selection of secure protocols, methods and algorithms ensure that the required layers are supported by AUTOSAR. Securing the storage and communication of data, on and offboard the vehicle, booting and flashing of software, over the life of the vehicle.

METHODOLOGY

The AUTOSAR methodology, and the solutions available supporting it, increasingly enable Continuous Integration/Continuous Deployment (CI/CD) processes with connections to Application Life Management (ALM) to manage and trace requirements, and increasingly available virtual validation methods accelerating automated validation of software revisions and releases. OEMs and Tier 1 software factories are in many cases also using agile processes, supporting controllable changes in release content allowing timing of software releases to be better managed. The ability to perform OTA software updates without time consuming dealer visits, enables features to be added subsequent release seamlessly for the end customer.

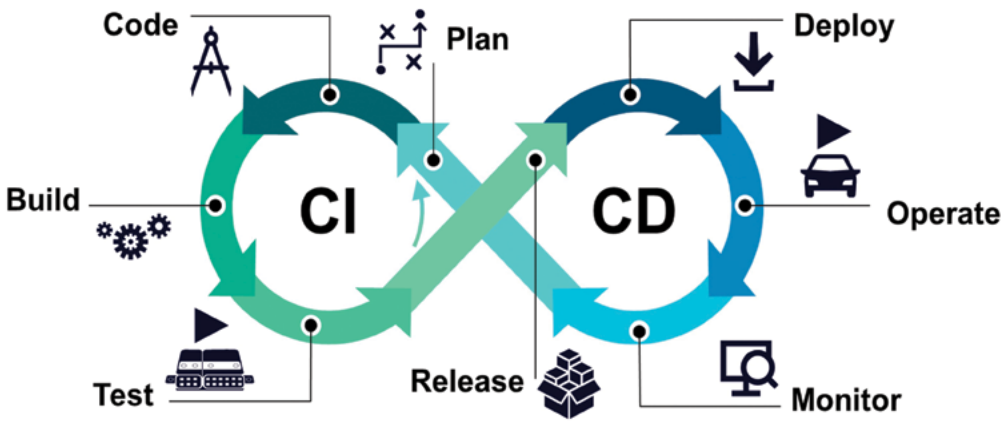


Figure 3
Continuous Integration / Continuous Deployment

RIGHT FIRST TIME DEVELOPMENT

Issues identified late in programs can then drive single vehicle solutions compromising the compatibility with other programs, and risking the launch quality, of the whole vehicle, or software update. Accelerated software configuration using generative automation, reducing manual efforts and erroneous inputs. Early correction of issues at design time through developer first guided user interfaces, design consistency checks through to virtual validation all shift left the correction of potential error states.

XCELERATOR

Siemens is helping companies transform how they work. Our integrated portfolio of software, services and an application development platform helps companies blur the boundaries between traditional stand-alone engineering domains such as electrical, mechanical, and software.

There are three business imperatives to turn today's complexity into tomorrow's competitive advantage:

First, a comprehensive digital twin of the entire product and production lifecycle, and it must include a closed-loop to ensure actual performance data is fed back into models that are continuously refined.

Second, companies must take a personalized approach. Companies need to be able to work at their own pace, and must consider how to meet the needs of individual users throughout their organization.

Finally an open ecosystem, no organization exists in isolation and collaboration between organizations is necessary to create value. This approach extends to the user level as well, where turning complexity into competitive advantage requires systems that work extremely well together.

Closed systems that don't allow deep levels of interoperability create unnecessary barriers.

AUTOSAR's role in context of a Vehicle OS

BRIDGING THE GAP TO OTHER ECOSYSTEMS LIKE ROS2

by Dr. Marc Weber, Florian Breitkopf
VECTOR INFORMATIK

***Software-Defined Vehicles require a Vehicle OS to cope with the increasing software challenges*.**

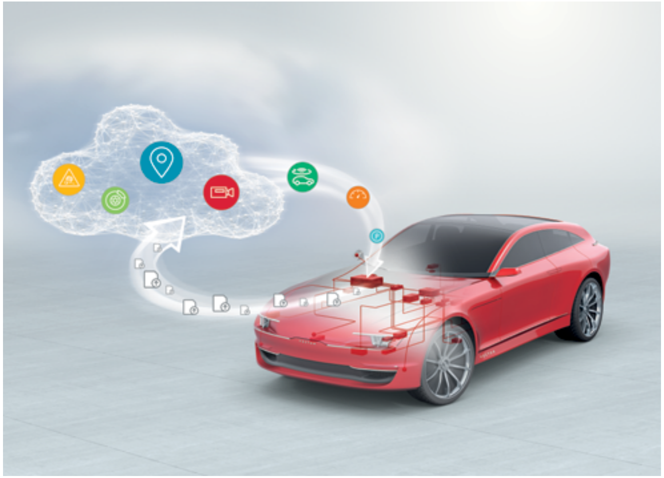
One of those challenges is the co-existence of different ecosystems to fulfill the needs of specific vehicle domains. In this context, the AUTOSAR Adaptive and Classic Platforms play a significant role. They are mature software platforms on their own, but they can also be used to bridge the gap to other ecosystems that were initially not designed for automotive use cases.

SOFTWARE-DEFINED VEHICLE

Many automotive OEMs are on a journey towards the Software-Defined Vehicle. They share and follow the vision that vehicle functions will be primarily defined by software rather than mechanical or mechatronic components. Consequently, static mechanics and mechatronics should no longer prevent OEMs from upgrading vehicles with new functions after production, opening new business opportunities.

To realize the Software-Defined Vehicle and to leverage its full potential, three pre-requisites need to be fulfilled:

1. The Electrical/Electronic (E/E) architecture needs to support the decoupling of mechatronic components, computing hardware and software. Therefore, most next generation E/E architectures are based on the centralized/zonal principle featuring three classes of Electronic Control Units (ECU): High-Performance Computers (HPC), zonal ECUs, and sensor/actuator ECUs (Figure 1).
2. HPCs and zonal ECUs require high-performance microprocessors and microcontrollers, offering the necessary computing resources. Such chips are available, and their performance is increasing with every generation.
3. A powerful software platform and ecosystem – called "Vehicle OS" – is necessary to cope with the increasing challenges associated with ECU software. This is especially true for HPCs and zonal ECUs which are based on a heterogeneous hardware/software architecture and integrate dozens to hundreds of applications.



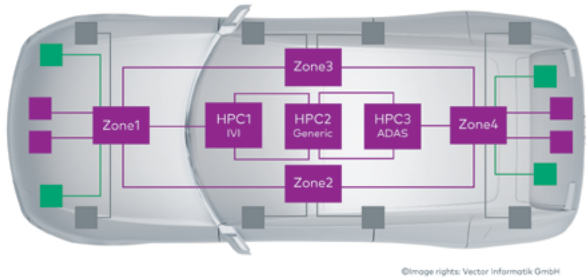


Figure 1
Centralized/Zonal E/E
Architecture

VEHICLE OS

Since the term Vehicle OS is currently used and interpreted in diverse ways across the industry, the following definition is proposed:

A Vehicle OS is a development and operations platform for services and applications of all vehicle domains. It consists of a Base Layer and a Software Factory and supports collaboration between companies.

1. The Vehicle OS runtime software is called Base Layer and its instantiation may differ from target to target (e.g., microcontroller, microprocessor, and backend).
2. As Vehicle OS infrastructure, the Software Factory supports and automates the developer's journey to develop, integrate and deploy Base Layer and applications.
3. Close and agile collaboration between OEMs and suppliers via a supporting platform is the key for success.

A Vehicle OS addresses ECUs with high software complexity, mainly HPCs and zonal ECUs, as well as the associated backend and is assumed to be under the control of an OEM.

AUTOSAR'S ROLE WITHIN THE IN-VEHICLE BASE LAYER

The In-Vehicle Base Layer consists of low-level infrastructure software, operating systems, middleware implementations and system functions that are shared by ECUs in scope of the Vehicle OS (Figure 2). By selecting relevant building blocks, the instantiation of the Base Layer is tailored to the needs of a specific ECU.

The AUTOSAR Classic Platform is the established automotive standard for microcontroller software. While the Base Layer is therefore quite homogeneous for ECUs based on microcontrollers, the situation for microprocessors is different. On microprocessors, usually one or multiple POSIX-based operating systems are executed, each of them running dozens of applications based on one or multiple middleware implementations. One reason for this heterogeneous software architecture lies in the different requirements and workflows being applicable for different domains like In-Vehicle Infotainment (IVI), Advanced Driver Assistance Systems/Automated Driving (ADAS/AD) and vehicle control.

The AUTOSAR Adaptive Platform specifies a middleware on top of a POSIX-based operating system supporting typical automotive use-cases and protocols. It is designed for safe and secure applications, while also enabling high-performance solutions, e.g., based on a zero-copy Application Programming Interface (API). However, in contrast to the AUTOSAR Classic Platform, it does not specify a complete software solution for microprocessors.

This means that the AUTOSAR Adaptive Platform needs to interoperate or integrate with other ecosystems, especially in the ADAS/AD and IVI domains. In most cases, an integration or co-existence is valuable, since the AUTOSAR Adaptive Platform is the only microprocessor middleware that is natively designed for automotive use cases, supporting required features like diagnostics, network management and automotive communication protocols.

AUTOSAR'S ROLE WITHIN THE SOFTWARE FACTORY

During ECU software development, one important task is the integration of applications and Base Layer, while applications are probably developed asynchronously across the globe, likely by multiple suppliers. If done manually, software integration causes a substantial portion of the overall development efforts.

This is true for even medium-sized ECU projects, and efforts grow exponentially with the number of applications to integrate. Therefore, a high degree of automation is required in this process step, especially for HPCs. This challenge is addressed by the Software Factory. It takes applications and Base Layer and performs an automated integration based on system design and integration constraints (Figure 3). This way, application developers get fast feedback on integration level, which is required for an agile, feature-based development approach in line with the DevOps principle. Having said this, the Software Factory uses standard DevOps workflows and tools like GitHub/GitLab and adds automotive specific extensions, e.g., tailored integration pipelines.

Besides defining major In-Vehicle Base Layer building blocks as part of the embedded runtime software, AUTOSAR defines a development methodology, including data exchange formats like the AUTOSAR System Template. Although these definitions might not be sufficient, e.g., to specify all constraints necessary for an automated integration or in terms of data model handling, they build a good starting point to realize a Software Factory. In this context, one property of high value is the potential to split an ECU Extract of System Description into different parts, some of them being relevant for the Base Layer, others being relevant for the application development only. Like the Base Layer, also the Software Factory must be able to interoperate or integrate with non-AUTOSAR ecosystems, e.g., the Robot Operating System 2 (ROS2).

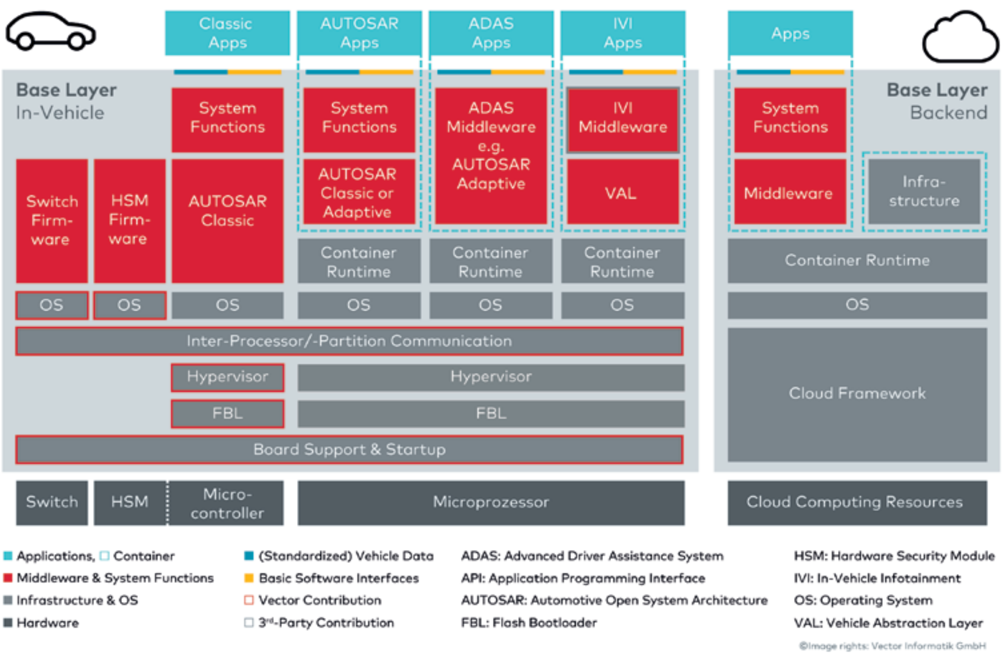


Figure 2
Base Layer Architecture and Building Blocks

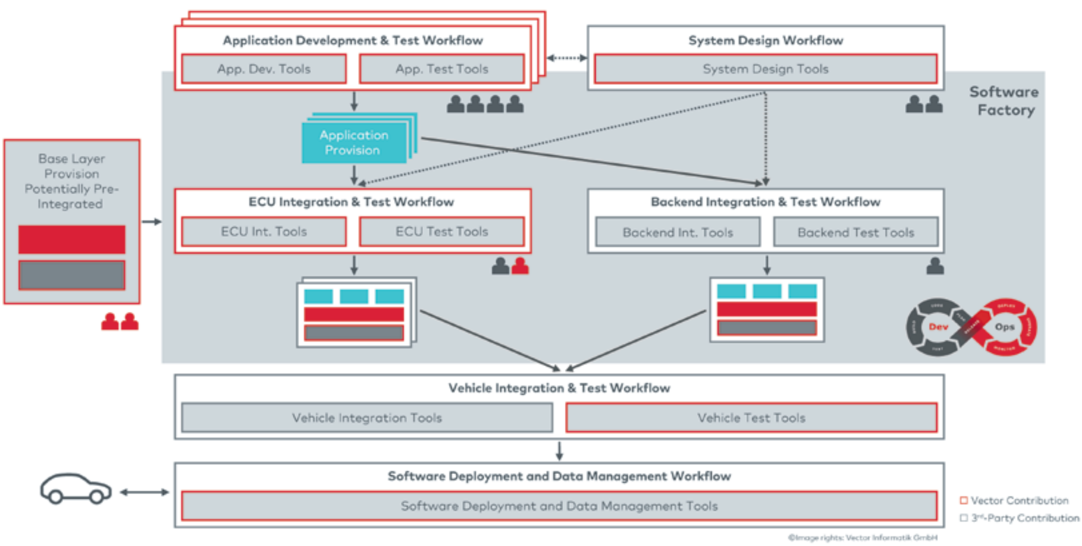


Figure 3
Software Factory – Workflow and Tools

ROS2 AT A GLANCE

ROS2 is a set of software libraries and tools that help to build robot applications [1].

Its middleware layer consists of the ROS2 Client Library (RCL), which is the language specific implementation of the ROS2 functionalities, and the ROS2 Middleware Interface (RMW), (Figure 4). The data exchange between applications (ROS2 Nodes) is realized via 3rd party Data Distribution Service (DDS) and Inter Process Communication (IPC) implementations. ROS2 is open source, can be used free of charge and runs on Linux, Windows, and MacOS.

The entry hurdle is low as it provides good documentation, tutorials, comes with a build environment, and can be quickly installed by using, e.g., the Ubuntu package manager. Additionally, many sensor and actuator manufacturers provide ROS2 Nodes converting proprietary interfaces into ROS2 Messages. This allows for easy integration and use of the sensors and actuators.

Due to these advantages, ROS2 is especially popular in academia and used, e.g., as prototyping platform in the ADAS/AD domain. However, it lacks features and protocols required in the automotive industry. Currently, there are neither specific safety nor security considerations. Signal-based communication with other ECUs, diagnostics via Unified Diagnostic Services (UDS), State Management and Platform Health Management are also not covered by ROS2 at the present time.

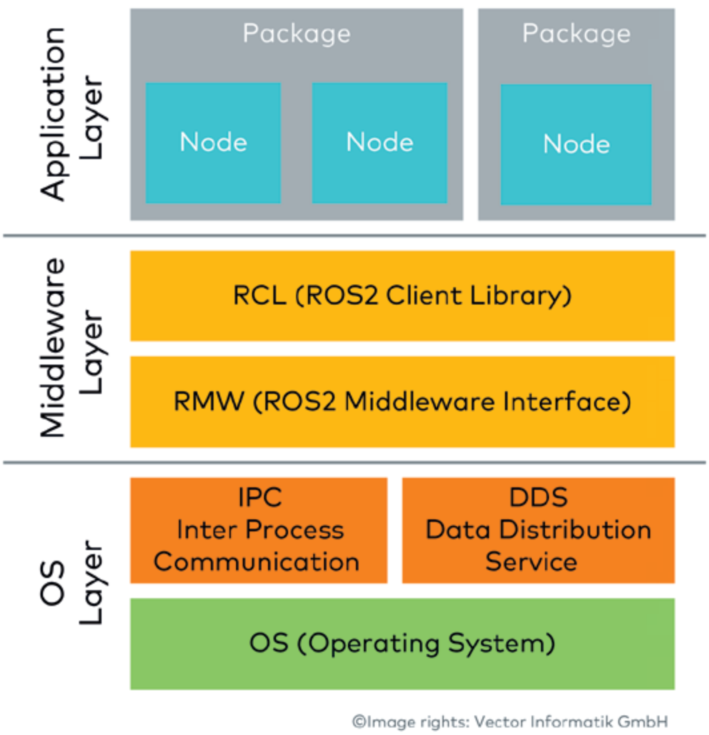


Figure 4
Integrated Development Environment (PACON IDE) and Virtual ECU with IaC (Infrastructure as Code) method

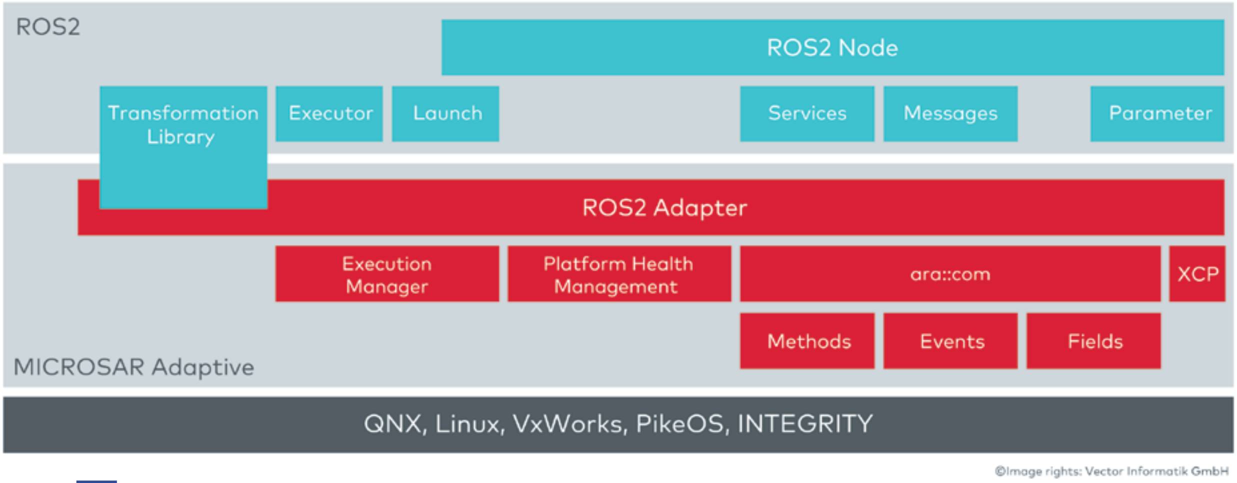


Figure 5
Using a ROS2 Node on Top of MICROSAR Adaptive

HOW TO COMBINE THE BENEFITS OF AUTOSAR ADAPTIVE AND ROS2?

The benefits of both ecosystems can be combined by using a ROS2 Adapter that takes the role of the RCL when ROS2 Nodes are integrated into the AUTOSAR Adaptive Platform (Figure 5). With this approach, it is possible to develop and test ROS2 Nodes in the familiar ROS2 environment using the corresponding build system and tools like rosbag and Rviz. In the final ECU software, the ROS2 Adapter maps the ROS2 APIs to the AUTOSAR Adaptive Platform APIs. The Adapter itself can be fully generated from the information provided in the AUTOSAR model. But how to get to the AUTOSAR model? There are two approaches: Top-down, based on an already existing software design and bottom-up, where the software design is generated based on existing ROS2 Nodes.

If there is an existing software design, all artifacts required for a ROS2 Node can be derived from the AUTOSAR model. These artifacts are the ROS2 Workspace, the .msg files for messages (events in AUTOSAR), the .srv files for services (methods in AUTOSAR) and a package specific integration manual. They can be used to integrate an existing or develop a new ROS2 Node. Depending on how accurate a ROS2 Node is represented in the AUTOSAR software design, messages, services and topics need to be adapted accordingly.

For the bottom-up approach, the AUTOSAR software design will be generated from an existing ROS2 Node. However, AUTOSAR requires more information in its model than ROS2 provides in a formal way, e.g., deployment specific information. Therefore, these parts need to be added manually to the corresponding software design.

SUMMARY

One enabler to realize the Software-Defined Vehicle is the Vehicle OS, providing a powerful software platform and ecosystem, both in-vehicle and for the backend. AUTOSAR plays a significant role in context of the embedded runtime software (In-Vehicle Base Layer) and the necessary infrastructure (Software Factory). Nevertheless, AUTOSAR needs to interoperate or integrate with other technologies and solutions, especially on microprocessors. One example is ROS2, which is popular for fast prototyping in the ADAS/AD domain.

Vector has extended its Base Layer and Software Factory offerings by specific building blocks and tools to support the integration of ROS2 Nodes on top of its safe AUTOSAR Adaptive Platform implementation MICROSAR Adaptive.

[1] https://ros.org/

Movement is everything, direction is what matters.

- MANFRED HINRICH

How different timing groups finally came together

THE AUTOSAR METHODOLOGY TO BOOSTING EFFICIENCY

by Rudolf Dienstbeck, Lauterbach GmbH
AUTOSAR WG-RES

HOW IT ALL STARTED, "TIMING EXTENSIONS" AND "TIMING ANALYSIS AND DESIGN" ...

Some members of OEMs, Tier-1s and tool vendors, experts and users had been facing problems with timing aspects for a long time. All stakeholders agreed the best approach was to discuss the everyday difficulties and solutions in a common Automotive forum: AUTOSAR. The group started its activities as a separate methodology group WP-M1 in 2012. The claim: "to write the most attractive timing document ever" was realized in a technical report and firstly released in 2014.

This claim was related to the wish in the development process: "start timing analysis early", because the awareness for timing arises mostly if problems occur. In order to not invent the wheels twice older concepts like TIMMO2Use were integrated. The technical report, called "Timing Analysis and Design", addresses specifically the users, that is why it is based on "every-day" use-cases to demonstrate how timing analysis should be realized. The application of methods and tools including a common methodology over all levels of the automotive development stands in focus of the specification.

The next natural step was to bring the specified timing extension (TIMEX) more into life and therefore its alignment with the "Timing Analysis and Design" document was started in 2016. And a new challenge arose at the horizon: adaptive platform. Of course, we wanted to address the timing aspects of this new platform in the same enthusiastic manner as we did this for the classic platform years before.

... AND "ARTI"

Twenty years ago, right at the time when AUTOSAR came into life, "ORTI" was released. ORTI ("OSEK Run Time Interface") is a standard for debugging and tracing, released within the OSEK ecosystem. This specification became very successful when it came to debugging, tracing and profiling ECUs with hardware-based development tools. ORTI didn't change since then, which means it is hopelessly outdated. But due to the lack of alternatives, it is still in broad use, with non-standard extensions. Eventually a small group of enthusiasts decided to officially bring ORTI functionality into AUTOSAR; that was 6 years ago, when ARTI was born („AUTOSAR Run-Time Interface", pun intended). As ORTI couldn't be reused due to formal requirements, a completely new interface for debugging and especially tracing classic platform ECUs was established. ARTI didn't fit into the former „work package" structure, and operated somewhat outside, missing a „home".

...AND FINALLY, ALL TOGETHER

When AUTOSAR was restructured to work groups in 2019, the idea came up to put ARTI into a new „Working Group Resources" (WG-RES), together with „Timing Analysis and Design", „TIMEX" and „Log and Trace". After the first getting to touch, it quickly came out that those groups form a natural fit. Without having this goal in mind, ARTI suddenly served as a base for Timing Analysis and as an implementation for TIMEX constructs. Discovering this fit, the workgroup established a universal methodology to design, define, trace, measure and analyze timing, with ARTI taking care of the tracing part. While the workflow is now there and specified, the work is not over.

ARTI mainly consists of light-weight instrumentation hooks which are especially designed for being generated by tools. The link to TIMEX thus allows an automated, tool-based integration to analyze and verify the software timing on a real target.

In order to check the fit between specification and reality a new timing "baby" was born, the long- time expected Timing Reference Platform, which is a demonstrator to integrate all timing aspects like use case, tracing, logging and analyzing for classic and adaptive platforms. And of course, the adaptive part is based on the adaptive platform demonstrator.

A further step was to transfer the "Timing Analysis and Design" document to the foundation in 2020 emphasizing the platform agnostic character of timing.

The last big issue for all resource groups was to finalize the joint "Unified Timing and Tracing Approach" in 2022 not only covering the Timing Reference Platform, but also new aspects like timing on functional level.

WHAT IS NEXT?

WG-RES is continuously working to reach this goal of a comprehensive approach to deal with timing. Twenty years ago, mathematical computations were enough to ensure the correct timing behavior of software. Nowadays with much more complex software and hardware, and further software consolidation, a validation on real systems is indispensable. For AUTOSAR systems, L&T, ARTI, TIMEX and TAD give the foundation to accomplish this.

Software deployment in modern vehicle architectures is already targeting scalable deployments of both, classic and adaptive platform in a single vehicle and interactions with off-car systems, e.g. Cloud, V2X. Thus, Timing Analysis and Design needs to scale in accordance with the architecture.

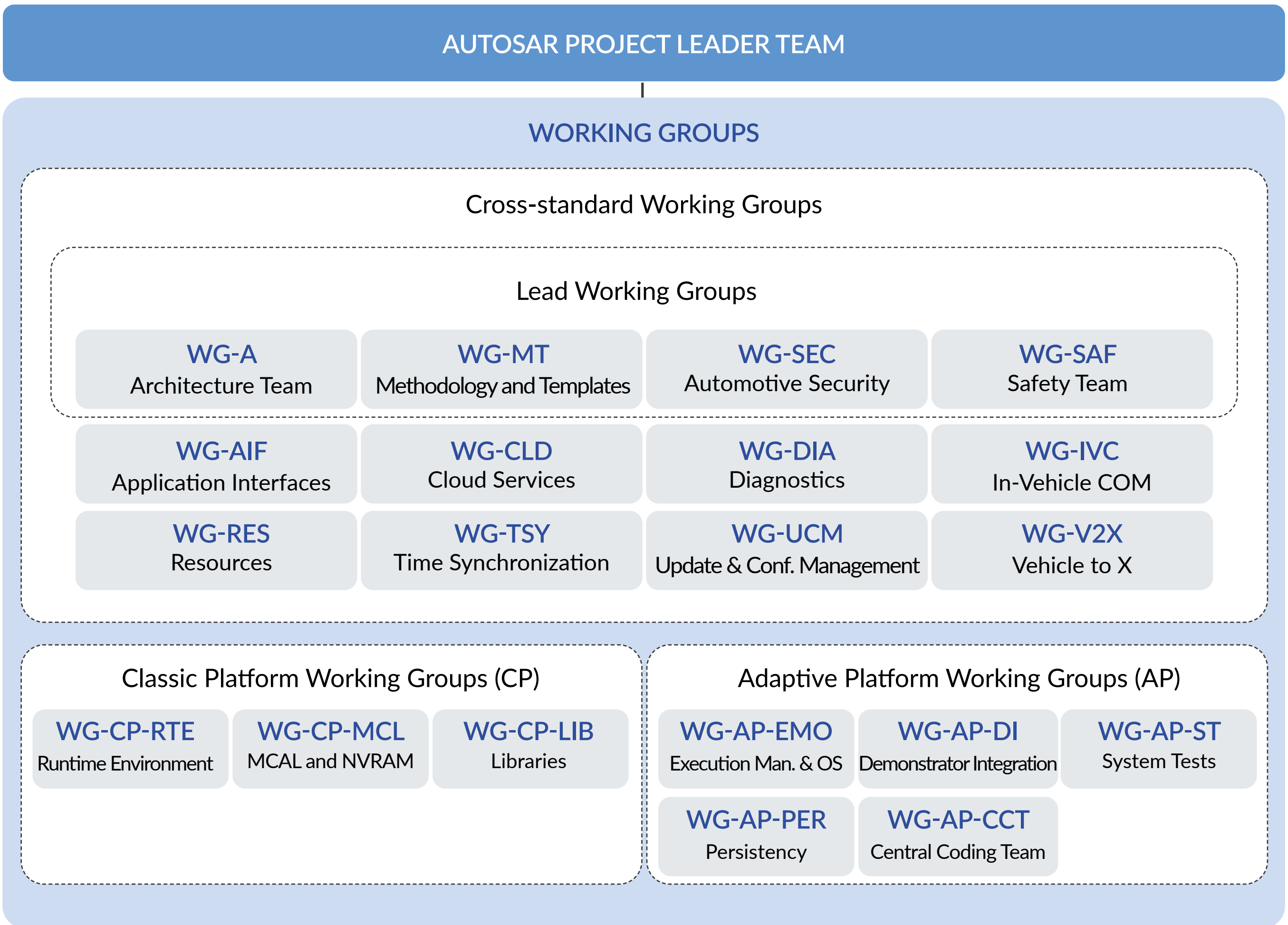
"It is never too early and always too late to start with timing analysis."

It is a matter of timing

AUTOSAR Organization

OVERVIEW OF WORKING GROUPS

The working groups are the core of the AUTOSAR organization. This is where technical issues relevant to AUTOSAR are introduced into the standard, discussed, clarified, and then implemented into the specifications according to predefined processes. Because the representatives in the working groups are also users of the standard, the circle from specification to application is closed. The result is a living, practical standard that is widely used.

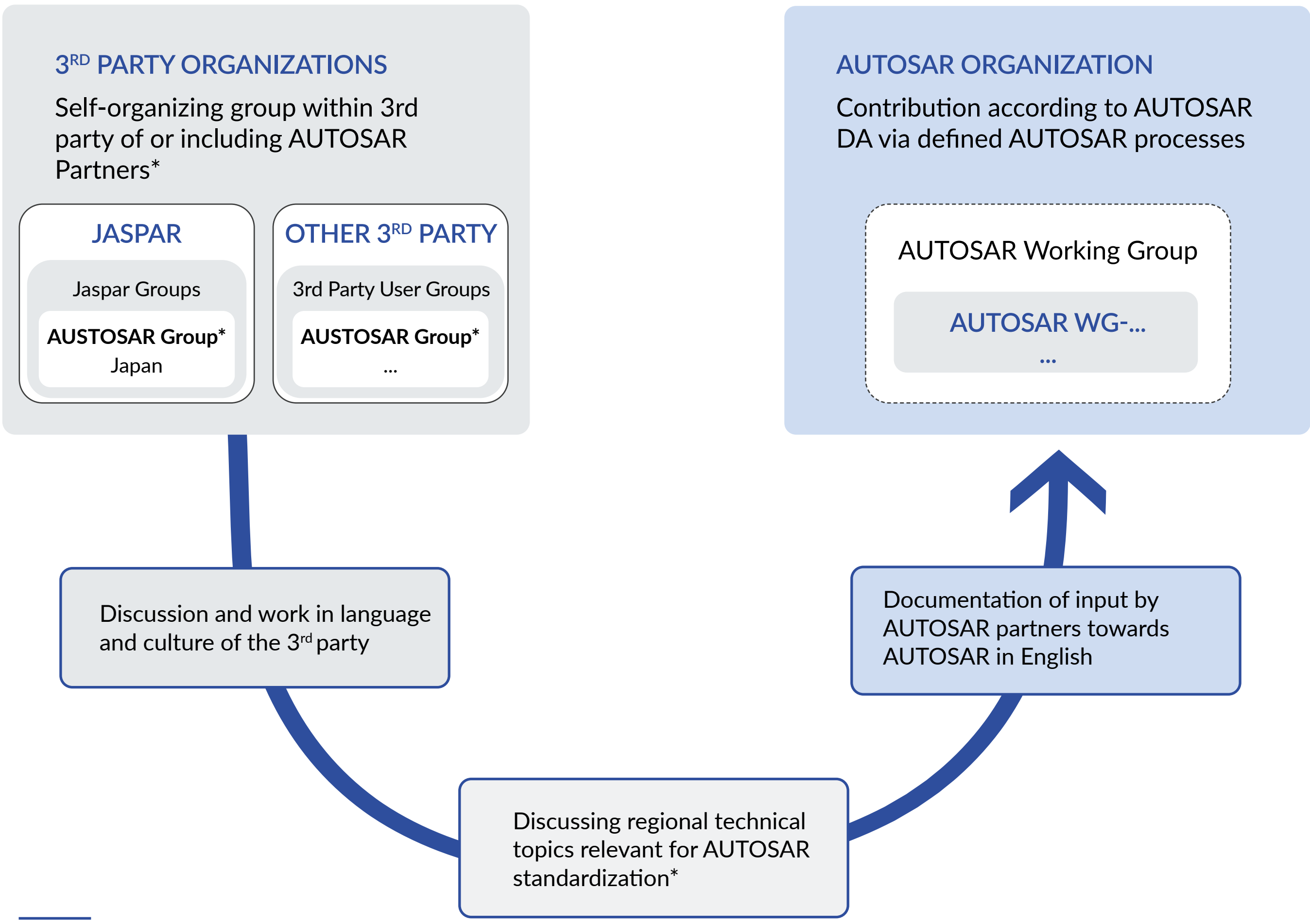


AUTOSAR Organization

USER GROUP – CONTRIBUTION OF REGIONAL TECHNICAL INTERESTS

Regional technical interests are elaborated in regional 3rd party organizations
Interested 3rd party organizations establish internal groups to interface to AUTOSAR.

EXAMPLE COLLABORATION MODEL:



*Discussion of AUTOSAR work in development only between AUTOSAR partners with development license

Chapter 6

Partnership

"Businesses need to go beyond the interests of their company to the communities they serve."

- Ratan Tata

AUTOSAR Partnership

COLLABORATION MODEL WITH PROVEN TRACK RECORD

by Dr. Günter Reichart, Bernd Mattner

"Coming together is a beginning, staying together is progress and working together is success."

This quote from Henry Ford describes very well how the AUTOSAR partnership has developed over time. It also describes the unique strength and openness of AUTOSAR, which again and again allows interested companies to come together under the AUTOSAR umbrella when faced with new challenges and to start with the necessary standardization.

This has been proven by the AUTOSAR partners working together to successfully implement the AUTOSAR Classic Platform for overcoming the risks and uncertainties of hardware dependency. Since the introduction of the Adaptive Platform, the partnership is again standing together and making continuous progress in standardization for high-performance computing in modern E/E system architectures.

And currently, the AUTOSAR community is once again coming together and beginning to make its contribution to software development with a focus on functional safety and cybersecurity as part of the Software-Defined-Vehicle initiatives. As a globally active, non-discriminatory and open non-profit organization with broad industry participation, AUTOSAR will once again demonstrate its position of trust and, together with all interested parties, will provide the technological standards for the mobility systems of the future.

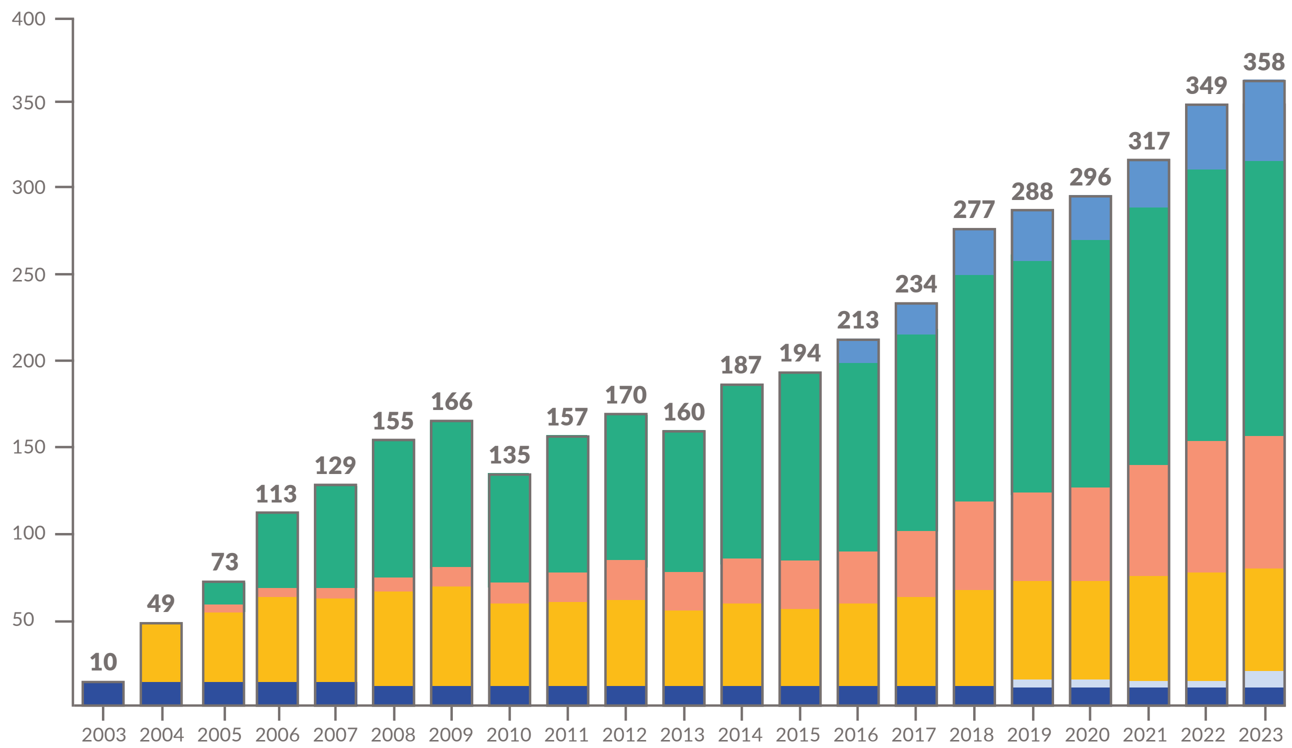
THE AUTOSAR PARTNERSHIP

Starting from a rather European, local beginning, the AUTOSAR partnership has grown continuously over the last 20 years to more than 350 partner companies (see figure 1) and has developed into a global partnership within the worldwide automotive industry. This growth path still continues, because in some regions of the world, e.g., in the Asian region, the exploitation of AUTOSAR is increasing due to rapidly developing markets.

Henry Ford
American industrialist and business magnate, founder of Ford Motor Company, and chief developer of the assembly line technique of automobile mass production (1863 –1947).

AUTOSAR Partnership

PARTNER DEVELOPMENT SINCE 2003*



TOTAL FOR 2023*

358	9	3	64	77	165	40
	Core	Premium Plus	Premium	Development	Associate	Attendee

*Amounts considered at the end of each year

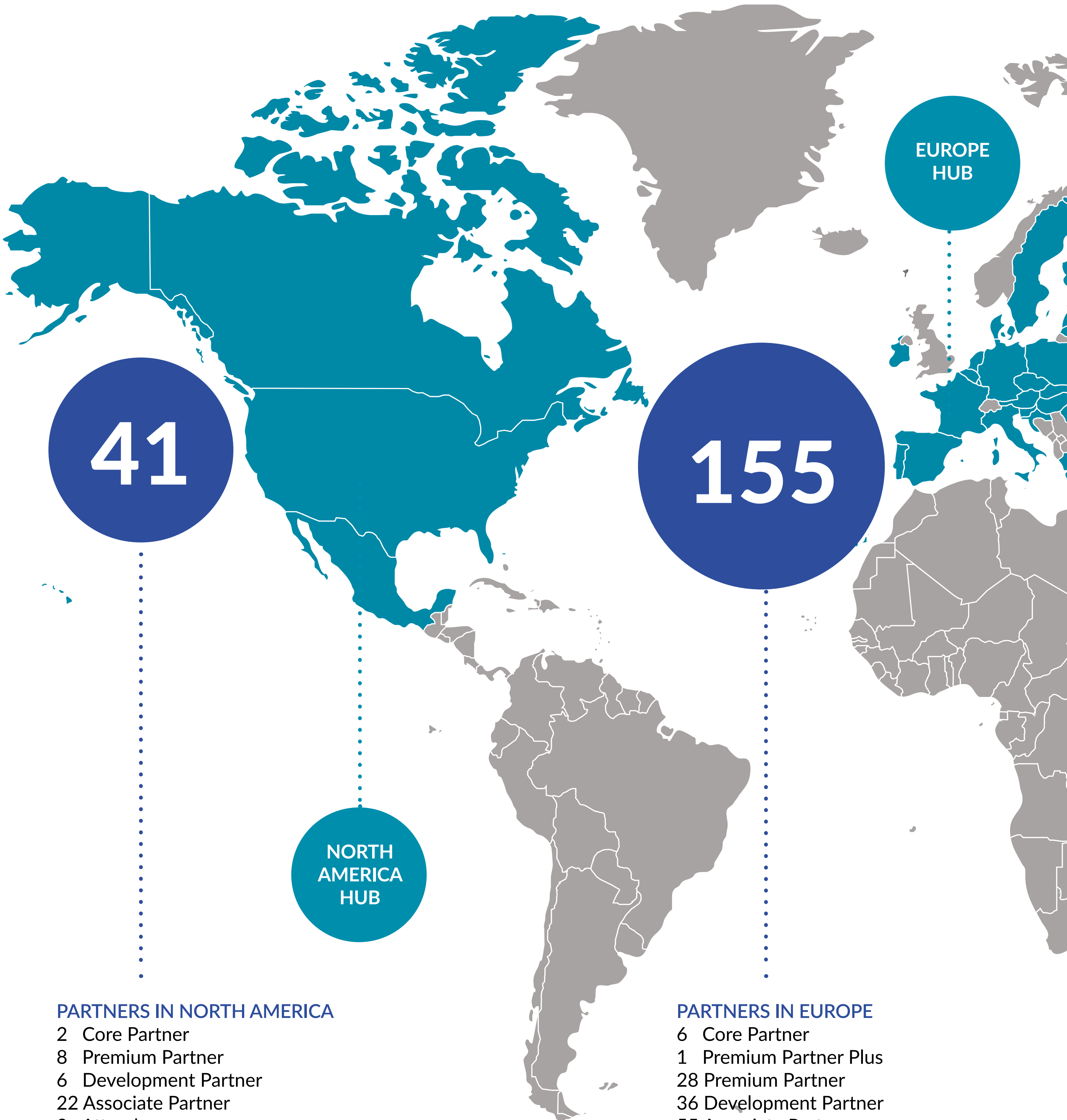
Figure 1
Partner Development of the AUTOSAR development cooperation

As the Adaptive Platform becomes more mature for series production, we see a steady increase in the number of big players in the industry who contribute actively to the development of standardization as Premium Partners. This is why AUTOSAR has replaced the Strategic Partner with the Premium Partner Plus Program in 2022, thus creating extended opportunities for interested companies to shape the standardization in AUTOSAR. It is particularly noticeable that the interest of smaller and medium-sized companies is growing and numerous of them are contributing their expertise as Development Partners to the standardization process.

With the Attendee partnership we primarily address universities and comparable educational institutions as well as 3rd party organizations. The growth in this sector is also encouraging and will be further expanded in the future, because we want to support our AUTOSAR Partners in cooperation with the educational institutions so that the qualified talents can already start their professional career with sound prior knowledge. At the same time, partnerships on this basis enable us to engage in the necessary exchange with other organizations that want to work closely with us to shape an efficient and concerted automotive development ecosystem.

AUTOSAR Partnership

GLOBAL DISTRIBUTION OF AUTOSAR PARTNERS



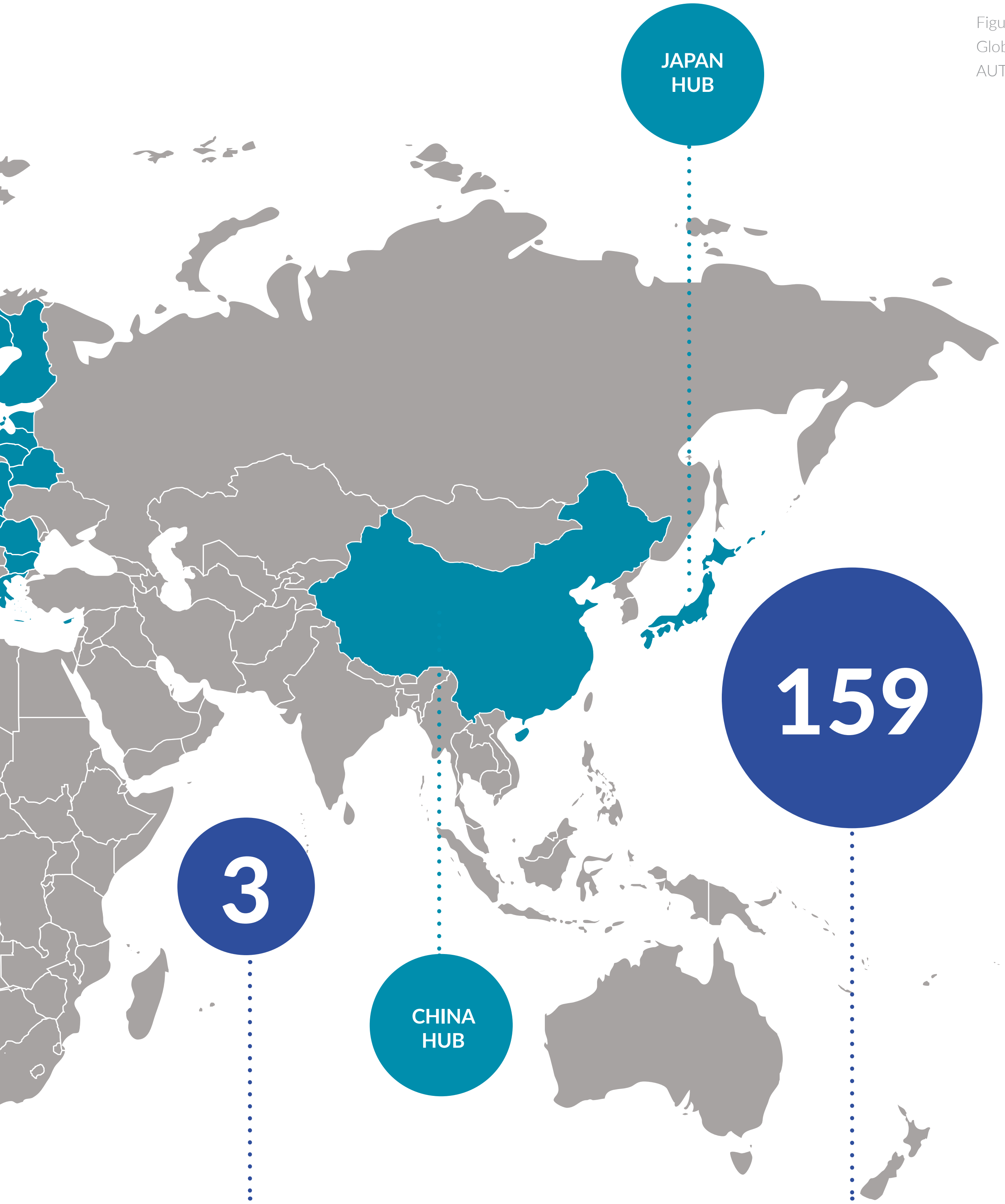
PARTNERS IN NORTH AMERICA

2 Core Partner
8 Premium Partner
6 Development Partner
22 Associate Partner
3 Attendee

PARTNERS IN EUROPE

6 Core Partner
1 Premium Partner Plus
28 Premium Partner
36 Development Partner
55 Associate Partner
29 Attendee

Figure 2
Global distribution of AUTOSAR Partners



PARTNERS IN AFRICA
2 Development Partner
1 Attendee

PARTNERS IN ASIA
1 Core Partner
2 Premium Partner Plus
28 Premium Partner
33 Development Partner
88 Associate Partner
7 Attendee

AUTOSAR'S GLOBAL PRESENCE

Europe has been the headquarters of AUTOSAR since its foundation 20 years ago. In addition to the AUTOSAR Spokesperson, the essential management and technical support functions are also based here. The worldwide distribution of AUTOSAR partners (see figure 2) reflects with some delay the shift in the automotive industry in recent years. The historical focus on Europe continues to dissolve and AUTOSAR as a global standard takes this into account as part of its adaptation to the changing environment of the automotive industry.

With the establishment of the regional hubs in North America, Japan, and China, each with a local spokesperson, AUTOSAR is creating much better opportunities to promote the partnership in these regions and make it much easier for new members to access AUTOSAR in the regions than in the past. In addition, with the local presences, it becomes more feasible for AUTOSAR to collaborate with the regional 3rd party organizations and to leverage regional requirements into standardization in this way.

In this chapter, we would like to give the regional spokespersons the space for a short introduction.

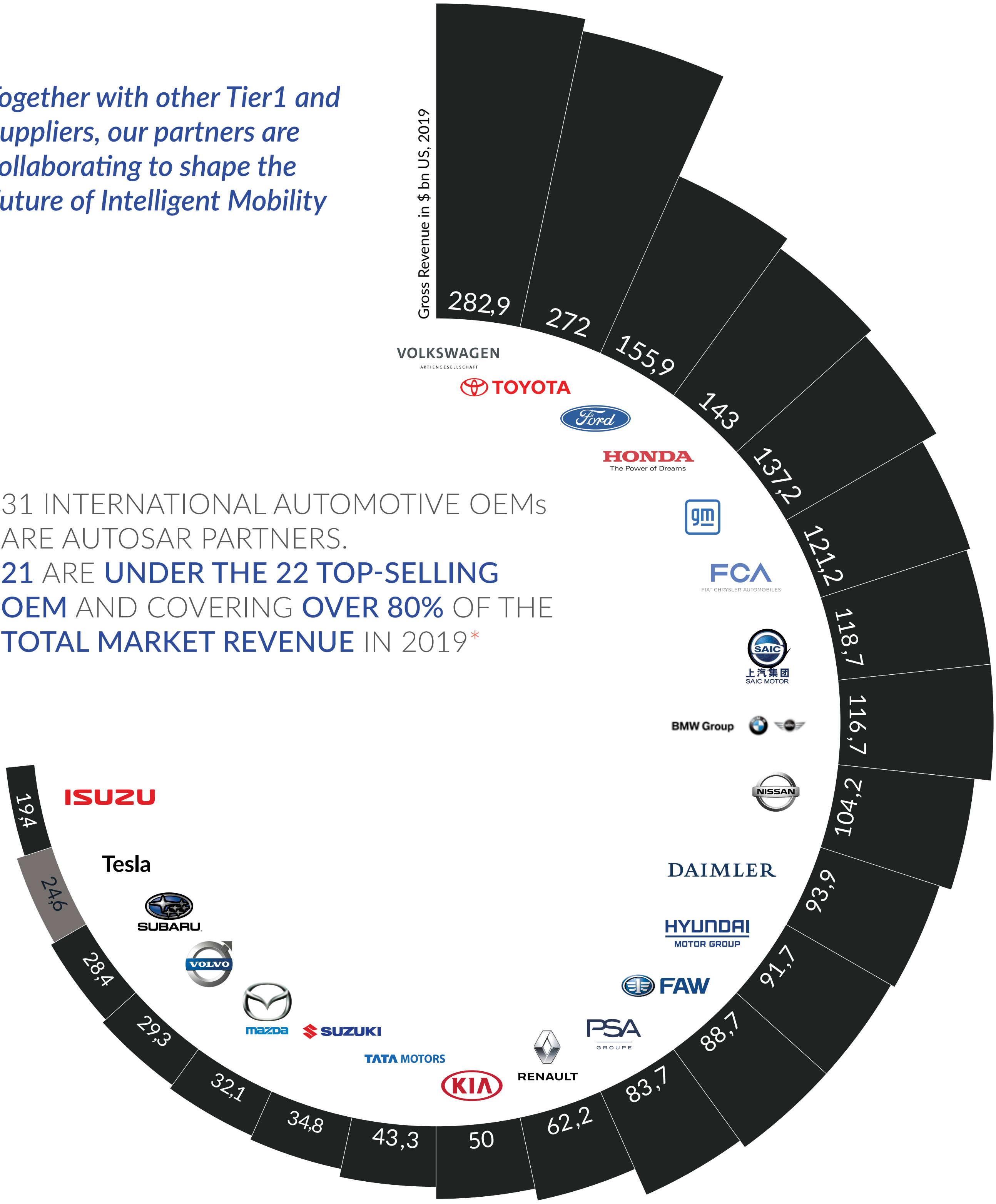
THE ADVANTAGE OF A STRONG COMMUNITY

AUTOSAR is a global partnership of leading companies in the automotive and software industry to develop and establish a standardized software framework and open E/E system architecture for intelligent mobility. Based on established, high-quality standards, mature processes, strong capabilities for exchange and collaboration within this organization, AUTOSAR has mastered challenging market trends in the automotive industry such as internet access in cars, highly automated driving and vehicle-to-vehicle communication. An overview from the year 2019 shows that among the AUTOSAR partners at that time there were already 31 internationally operating OEMs, of which 21 belonged to the 22 top-selling OEMs and these together generated more than 80% of the total revenue in the vehicle market (see figure 3).

All AUTOSAR partners in the entire automotive value chain have contributed to this success because they understand the advantages of a strong community in standardization and can be successful in the following competition with convincing marketable solutions. Therefore, in the following we would also like to offer our partners the opportunity to tell us about their individual success stories.

Together with other Tier1 and Suppliers, our partners are collaborating to shape the Future of Intelligent Mobility

31 INTERNATIONAL AUTOMOTIVE OEMs ARE AUTOSAR PARTNERS.
21 ARE **UNDER THE 22 TOP-SELLING OEM** AND COVERING **OVER 80%** OF THE **TOTAL MARKET REVENUE** IN 2019*



*ref. to The 2019 Strategy & Digital Auto Report, strategy&- part of the PwC network

Figure 3
AUTOSAR Partnership,
the Advantage of a Strong Community

AUTOSAR's China Hub

A VALUABLE RESOURCE FOR CHINESE AUTOMOTIVE PARTNERS

by Jing Zhe, AUTOSAR Regional Spokesperson China

AUTOSAR's establishment of a local presence in China has led to the adoption of the software standard in the Chinese automotive industry. The AUTOSAR China Hub has proven to be a valuable resource for Chinese Partners.

Almost ever since AUTOSAR was born, China has been a keen observer of AUTOSAR. By 2011, AUTOSAR had already begun establishing a local presence in China, dedicated to supporting the communication and application of the standards in the region.

Initially, only a small group of companies and universities in China were using AUTOSAR, but even then, there were commercial AUTOSAR software products developed locally.

Fast-forward to today, and AUTOSAR has become an established staple of the Chinese automotive industry. Whenever an automaker starts developing their own software for mass production, AUTOSAR is the go-to standard for ensuring future readiness. It provides a common language for software experts to exchange ideas, such as using "CP" and "AP" to denote software on the embedded ECUs side and microprocessor-based computer side, respectively.

AUTOSAR's partnerships in China are becoming more diverse, including OEMs, Tier1 suppliers, software vendors, engineering firms, semiconductor vendors, and even universities. In 2022, AUTOSAR established the China Hub, which serves as a valuable resource for Chinese partners to reach out to.

Led by Mr. Jing Zhe and supported by Miss Echo Wang, the China Hub is quickly becoming a favorite office, attracting volunteers to work together and provide technical and administrative contributions. Overall, AUTOSAR's commitment to supporting the Chinese automotive industry through the establishment of the AUTOSAR China Hub has proven to be a resounding success.

Jing Zhe, Director Systems Engineering & Technical Strategy (M/NE) Bosch (China) Investment Ltd.

AUTOSAR's Japan Hub

PAST, PRESENT AND FUTURE OF AUTOSAR FOR JAPANESE PARTNERS

by Masahiro Goto, AUTOSAR Regional Spokesperson Japan

AUTOSAR was used partially in past, but now the technologies and required conditions are changing. The Japan Hub starts to make more tight and efficient collaboration between AUTOSAR and JASPAR for Japanese Partners.

Masahiro Goto, Project Director, Engineering Development Promotion Division DENSO CORPORATION

In the past, Japanese partners did not use the full AUTOSAR Classic Platform, but parts of stacks such as COM, OS or DIAG, and so on were used as a standard solution, as the policy for ECUs development was different from the European one. The collaboration with JASPAR was started, but was not very close at first.

At present, it is possible to use SoC and high-speed communications like Ethernet with almost unlimited resources to implement the AUTOSAR Adaptive Platform. The Japanese automotive industry has begun to restructure the E/E architecture according to the rich computing resources and high-bandwidth communications to cope with the challenges from connected, automated, shared and electric mobility (CASE). To realize a smooth and seamless introduction of AUTOSAR solutions, which means not only the Adaptive Platform but also the Classic Platform, the preparation and improvement activities for the entire development environment to use the full AUTOSAR solution have been started. To achieve this goal, a stronger and closer collaboration between JASPAR and AUTOSAR have been established based on the AUTOSAR Attendee agreement. Subsequently, the regional AUTOSAR Hub in Japan was established to lead the collaboration and stronger involvement of Japanese Partners.

In the future, Masahiro Goto, as regional AUTOSAR spokesperson, will lead the expansion of efficient and close cooperation between AUTOSAR and JASPAR. This will allow AUTOSAR solutions to be promoted to Japanese partners while also more effectively contributing regional industry requirements to standardization at AUTOAR. Through these activities, Japan Hub aims to contribute to the Japanese automotive industry.

AUTOSAR's North American Hub

ADVANCING AUTOSAR THROUGH PARTNER INTERACTION

by Steve Crumb, AUTOSAR Regional Spokesperson North America

The AUTOSAR North American Hub coordinates partner interaction and new partner recruitment through user groups, topical sub-groups and NA-based events resulting in improved standards and adoption.

Steve Crumb, Executive Director at Inventures

AUTOSAR is a worldwide development partnership including many North America-based vehicle manufacturers, suppliers, service providers and companies from the automotive electronics, semiconductor and software industry.

Global distribution is a benefit, in that AUTOSAR standards represent a global set of requirements and use cases, as well as a liability, in that partners can feel distant and disconnected from each other.

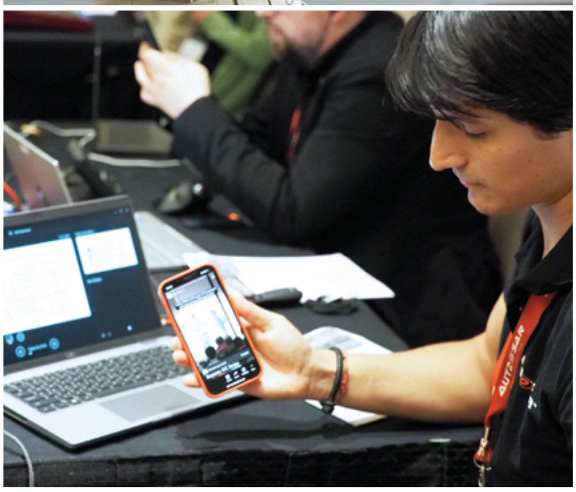
One solution is to use regional hubs, such as the AUTOSAR North American Hub (Hub-NA), to bring together partners that are located in a single region. Interactions can take the form of User Groups and regional events. Hub-NA is best positioned to coordinate partner gatherings, reach out to prospective new partners and represent AUTOSAR at in-region, industry events.

In addition to facilitating User Group meetings, during which partner volunteers share insights on the usage and extension of AUTOSAR standards, Hub-NA also works with NA-based collaborative bodies, open projects and universities to extend the reach of AUTOSAR into other organizations. Specially, Hub-NA is coordinating the relationship with COVESA based on the Vehicle API concept, which links AUTOSAR Adaptive Platform to COVESA's Vehicle Signal Specification. The AUTOSAR/COVESA relationship is also essential to AUTOSAR realizing its openness strategy that enables AUTOSAR partners to develop new intellectual property in open-source licensed projects.

Finally, Hub-NA represents AUTOSAR at several high-profile industry events like Consumer Electronics Show (CES), SAE WCX World Congress and AutoTech Week:Detroit. Hub-NA is pleased to be the regional hosts of this year's AUTOSAR Open Conference.

AUTOSAR 14th AOC

SAN DIEGO, MAY 11TH-12TH 2023



Our 15th AOC will take place in Japan in 2024

Shaping the future of dependable mobility together

The 155 Participants of the 14th AUTOSAR Annual Open Conference in San Diego, California.
May 12th 2023. Photo: Co/Créa Studio

*Effectively, change is almost impossible without **industry-wide collaboration**, cooperation, and consensus.*

- SIMON MAINWARING

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PREMIUM PLUS PARTNERS

Drive the technical standardization of AUTOSAR

DENSO

Huawei Technologies Co., Ltd.

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Design and use the AUTOSAR standards

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Cognizant Mobility GmbH
Cummins, Inc.
DASSAULT SYSTEMES
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Budapest University of Technology and Economics, Department of Measurement and Information Systems
CAN in Automation (CiA) e. V.
Chair for Compiler Construction (CCC)TU Dresden
Deutsche Industrie- und Handelskammer in Marokko - DIHK
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Instituto Tecnológico de la Energía
Istanbul Okan University
Khronos Group, Inc.
KLE Technological University
Navigation Data Standard e.V.
Ostfalia HAW
OTH Regensburg
Purple Mountain Laboratories
Reutlingen University
South East Technological University
Southeast University
Southwest Research Institute
Technische Hochschule Ingolstadt
Technische Hochschule Nürnberg Georg Simon Ohm
Technische Universität Braunschweig
Technische Universität Clausthal, Institute for Applied Software Systems Engineering (IPSSE)
Technische Universität Darmstadt
Tecip Institute Scuola Superiore Sant'Anna
Universidad Pública de Navarra
Universität Paderborn
UNIVERSITAT POLITECNICA DE VALENCIA
Virtual Vehicle Research GmbH
Xidian University

Chapter 6

My Motivation

"It's not a faith in technology. It's faith in people."

- Steve Jobs

AUTOSAR – A Personal Retrospective

by Stuart Mitchell
ETAS

This personal retrospective starts by considering AUTOSAR history from the perspective of a long-term contributor to the AUTOSAR Standards before looking how I personally view the challenges that AUTOSAR has faced when seen from the perspective of a Premium member. Finally, I consider how AUTOSAR might continue to evolve over the next 20 years both for ETAS customers and to support automotive ECU development in general.

For the past 20 years, AUTOSAR has been an industry standard and a personal endeavor. In this presentation, I look at AUTOSAR history from my individual perspective and from the perspective of a Premium AUTOSAR partner while trying to identify the challenges and rewards of working in such a huge consortium of cooperating and competing interests.

In 2004, I was the ETAS representative at the very first AUTOSAR kick-off meeting in Frankfurt. But prior to that, I had worked with one of the Core Partners on the design of the RTE, and it was extremely gratifying to see that work become the foundation for the heart of the later Classic Platform. Since then, I've been constantly working to develop AUTOSAR both within the consortium and within ETAS.

During the past 20 years, AUTOSAR has grown with general ECU development by always aiming to bring the industry together and to support the latest techniques and technologies. I'm immensely proud to have – in some small way – contributed to that development and to bring the benefits of a coherent middleware solution to ETAS customers.

Due to AUTOSAR, ETAS customers have seen an acceleration of their ECU project developments and an increase in ECU robustness that matches the increase in feature complexity supported atop a feature rich AUTOSAR platform.

AUTOSAR has enabled ETAS to help their customers worldwide and to establish a solid market presence with billions of ECUs deployed in vehicles worldwide – all built on AUTOSAR! And the potential of AUTOSAR will only increase as it realizes the benefits from integration of new concepts supporting next generation hierarchical ECU architectures.

Joining an AUTOSAR workgroup during a pandemic

by Dave George
ETAS

As part of the development team of an RTE generator, I joined the RTE workgroup because I wanted to achieve two things:

1. To understand the overarching use cases and context of why certain things are in the RTE specification.
2. To try and bring some feedback on what does and doesn't make sense when implementing those use cases in 'real world' code generators.

An extremely skilled software developer once told me that it's always important to keep trying to find the 'why' when thinking about customer requirements.

As an RTE implementer, we very rarely get the 'why' in our specification. My goal in joining the RTE workgroup was to try and understand the high level use cases which led to our specification being the way it is, and hopefully to bring more of that context into our specification in future.

As you might expect it can be difficult to create a good professional rapport with contributors when you've worked closely with them for two years but never seen their faces, as happened during the COVID pandemic. With that in mind, the RTE group have been fantastically welcoming. Clearly the RTE group operates around a core group of contributors who know each other well, but despite this they're exceptionally welcoming for new members. My interactions across other workgroups also show that this mentality extends elsewhere (such as MT, A, IVC and so on).

The 'why' of AUTOSAR is, fundamentally, all about top level use cases for automotive software functionality. Unfortunately, this 'why' sometimes gets lost in between the concept stage and individual specifications. I think we can do better in this area and I intend to prove it.

Globalization possibilities with the AUTOSAR Standards

by Nelya Rudnytska, Oleksandr Nazarov, Olha Bohun
INTELLIAS

Intellias is a global technology enabler and provider of software development services for the mobility industry. To continue to evolve, diversify, and accelerate innovation across the automotive domain, we partner and develop expert groups with the respective vendors. AUTOSAR is undoubtedly one of the major vendors and representatives of innovative technologies.

Partnering with AUTOSAR allows Intellias to expand the range of embedded solutions, making them more complex and up to date. Our automotive practice is backed by years of experience, but there's always room for growth. With the need to scale our business and cover a broader scope of client needs, we advance our software engineering capabilities with AUTOSAR frameworks and standards.

AUTOSAR is one of the key components of full-cycle development and delivery of complex solutions from HMI to ADAS. And we couldn't miss the opportunity to cover the whole spectrum of services for our existing and potential clients.

With a focus on building safe and adaptive software, we started projects on AUTOSAR Rust and C++ that allowed us to build up and amplify the expertise inside our company. Those directions were so interesting and engaging for our engineers that we decided to grow them more intensively. Since we had compelling in-house expertise, our specialists started recommending Intellias to their fellow colleagues. It was an essential boost to the company's growth — we were able to mature and thrive faster in such regions as Portugal and Poland.

The opportunity to offer challenging AUTOSAR Rust and C++ projects became a powerful driver of Intellias global expansion.

AUTOSAR partnership allows to develop expert communities globally, as professional's team up around and approach, technology, and open communication, which AUTOSAR cultivates.

My motivation to contribute to AUTOSAR

by Tobis Kühnel
LUXOFT

All-WG Meeting in Regensburg.

My personal journey with the AUTOSAR consortium started during the creation of my Master's Thesis back in 2017, in which I elaborated a tracing approach for Adaptive Applications. During that time, I joined my first AUTOSAR calls with the L&T group, to get their feedback, opinions and support in using the Adaptive Platform Demonstrator. Afterwards I started to contribute to WG-RES and do it ever since (now WG-IVC)

I liked this consortium approach right from the beginning. Many companies with different scopes and interests work together to define a standard, for the automotive industry.

It feels great to be part of this, build up expertise, to contribute with your knowledge and to know that parts of your work are now integrated into a new AUTOSAR version.

I learned and I am still learning a lot about technical topics, but also about challenges in standardization and about political discussions, when different companies are involved.

Apart from that I also like the community aspects of AUTOSAR. I got to know many interesting people during the different F2F-Meetings and had nice evenings. I like to remember that one F2F-Meeting during Christmas time when all of us met at a colleague's home to have dinner and afterwards watch a subtitled version of the movie "Feuerzangenbowle", while drinking Feuerzangenbowle, to show our Non-German colleagues this tradition.
I worked a lot with other contributing Luxoft colleagues, who I only knew via web conferences. My first personal meeting with them was at the All-WG Meeting in Regensburg, where I also met Rinat - our former AUTOSAR coach - for the first time. It was a fantastic opportunity to talk and have some beers together. These Get-Togethers, nice conversations and in general the community feeling make AUTOSAR so special and successful.

My experience with System Tests Standardization

by Tetsuro Ayano
SCSK CORPORATION

SCSK has been a premium partner since 2017 and works for the WG-AP-ST for the standardization of AUTOSAR Adaptive system test. Also I have contributed as a speaker for two years since Mar/2020.

WG-AP-ST mainly creates Test Specification and implements Test Applications for APD. CI/CD for application development is important for efficient implementation. In addition to implementation, we have also worked on automating system test. In building the test environment on the actual target board, we visited the AUTOSAR Technical Office and had discussions about our ideas on the test environment, which helped us build the test environment efficiently.

Moreover, I gave a presentation at the ALL WG Meeting so that AUTOSAR members could know about our activities. The number of Functional Clusters (FCs) of the AUTOSAR specifications have increased compared to when they first started and the FCs configuration has become more complex lately. Therefore, the implementation of APD was delayed and it was difficult to make progress on the WG-AP-ST. So, we could improve the presence of the WG-AP-ST by telling the WG members not only the test specifications but also the test environment that is unique to WG-AP-ST and they are interested in.

Finally, SCSK challenges to develop “new solutions to streamline the process from Adaptive Application development to test.” based on our experience in the WG-AP-ST.

The experience of AUTOSAR WG activities not only benefits participating companies but also improves the skills of individuals.

We hope you will be interested in contributing to the AUTOSAR WG.

AUTOSAR family:

SHAPING THE FUTURE OF INTELLIGENT MOBILITY – IN AN EXCITING WAY!

by Ahmed Majeed Khan
SIEMENS DIGITAL INDUSTRIES SOFTWARE

WG IVC F2F around Oktoberfest

I have had the honor and pleasure for a long association with AUTOSAR. During this journey, I have seen it evolve as I reminisce about my days in WP-A2 (Work Package COM), revel in my time at WG-IVC (Working Group In-vehicle Communication) and more recently, as a Company Contact for Siemens. There are several factors that make this journey fascinating and I'd like to highlight two of those.

First and foremost is its association with a sense of purpose! Automotive industry is at the verge of disruption due to its mega-trends of autonomous driving, electrification, connectivity, and shared mobility.

It's captivating to be part of a squad that is shaping the future.

I take joy in imagining myself to be a proud grandpa, who was at the helm of mobility innovation, and got tons of collective success tales for his grand-children from standardization and collaboration efforts – which led to the transformation!

Second is the team spirit; it's a strong cadre where the affiliates anchor on their communalities while renouncing their disparities.

Collaborators from across the globe, representing diverse organizations who may compete otherwise, gather to realize a common dream.

An epitome of depiction for this trait befalls during face-to-face working group interactions. A picture is worth a thousand words and I include one of my favorites, which was taken during a F2F around Oktoberfest. Yes, it's certainly enviable to be a part of the AUTOSAR family.

AUTOSAR Open 2014 Detroit – Automotive Ethernet

by Brendan Morris
SIEMENS DIGITAL INDUSTRIES SOFTWARE

AUTOSAR has a long history of including relevant technologies, working with appropriate standards bodies to support the users of the AUTOSAR standard. The first AUTOSAR Open Conference I attended was a good example of this, back in 2014 in Detroit, supported by GM and coordinated with the Open Alliance (SIG) and IEEE-SA to enable many interested parties to discuss and align on how best to develop and support automotive ethernet in the IEEE-SA and AUTOSAR. At that time I represented Jaguar Land Rover, where, John Leslie and I covered the various coordinated conference and meeting elements over the week, joining up for the IEEE-SA and AUTOSAR joint session. The week proved to be a good opportunity to meet experts from other OEM's, Tier 1's, and solution vendors such as Siemens (Mentor Graphics back then), several of which I still discuss conference topics and standards development with today. Notes compared over coffee during the day, and at the bar in the evening.

The week illustrated the potential of collaboration between the experts from the AUTOSAR and software world with those from automotive networking and ethernet technology, bringing in the use cases and requirements of a selection of OEM's from round the globe, as AUTOSAR still does well.

It was of course also a chance to see a little of Detroit, there were stories of adventurous walking tours, which I missed, albeit I did walk from my hotel, via the GM Renaissance Center to the Cobo Center to get a small taste of the center of Detroit, a city I've returned to multiple times since.

Since this time I have worked within the Work Package WP-A2 Com (as was), and in various other ways connected to AUTOSAR, supporting the project and its ongoing relevance to the automotive industry and more.

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Sailing the sea of AUTOSAR

by Leticia García Herrera
VECTOR INFORMATIK GMBH

Starting up as an inexperienced graduate of embedded software engineering at Vector Informatik, I was confronted by the broad and deep ocean of the AUTOSAR, its terminology, development, and standardization procedures.

I looked up to the experts that seemed to navigate skillfully in the rough waters of software complexity, data exchange formats, and abstract layers. Although scary, I decided to take a dive and understand the ins and outs of the standard.

Over time, I've learned to appreciate requirements' modularity, functionalities' scalability, and features' reusability and transferability.

I've seen AUTOSAR making headway as the automotive world grows towards full connectivity and electrification. I've even witnessed the birth of new modules, from which the cybersecurity ones made my eyes sparkle.

Who would have thought that the polar star would shine my way and I would be standardizing a module myself by becoming document owner of the Intrusion Detection System Manager?

Monitoring systems to discover violations, malicious activities, or untypical behaviors are well-known concerns in the informatics scene, but how to detect these hackers, these pirates inside my car??

A great deal of teamwork between work colleagues and AUTOSAR peers from the workings groups was necessary to standardize and launch the first version of the SWS. I experienced first-hand that collaboration is vital, regardless of your working company; all these talented people with a variety of experience united to define a specialized module with a functional, efficient, and meaningful behavior.

It has been an opportunity to exchange know-how and realize that we are indeed navigating on the same ship, taking technology in the same direction, and covering the needs of most AUTOSAR partners.

From a novice sailor to an experienced navigator who can count on her crew: the AUTOSAR peers, moving standardization forward. I would like to invite potential members to get on board by plunging into the automotive software field and endeavor to understand the world of classic and adaptive AUTOSAR.

Chapter 6

Success Stories

"Success is best when it's shared."

- Howard Schultz

Providing AUTOSAR Consultancy to OEMs and Tier 1 Suppliers

by Huzaifa Saadat Homburg, Markus Kohlwig
ALTEN

Starting modestly with a 3-person AUTOSAR team, we got the honor to present the Adaptive Platform Demonstrator for the first time at the 10th AUTOSAR Open Conference in 2017 in the Computer History Museum in Mountain View, California.

Today as a part of the ALTEN Group the Center of Excellence (CoE) AUTOSAR falls under the umbrella of the ALTEN Center of Excellence – Automotive Embedded Software (ACE-AES) with over 500 specialists in Germany alone. ALTEN is a Premium Partner of the AUTOSAR consortium. Furthermore, ALTEN is supporting AUTOSAR in its internationalization efforts, the AUTOSAR Hubs, by providing Hub Managers and premises for the Hubs in the US, Japan and China.

The CoE AUTOSAR serves several OEMs and tier 1 suppliers, with their expertise in AUTOSAR specifications, architectural design, AUTOSAR integration and configuration as well as debugging and bug fixing.

The more well-known CoE AUTOSAR projects include: Representing a Premium OEM in the AUTOSAR consortium, supporting another commercial vehicle producer to move from their legacy Linux based ECU to Adaptive AUTOSAR, function ownership for different platform features for an Adaptive AUTOSAR like system, writing AUTOSAR safety guides for a tier 1 supplier and integrating plus configuring an AUTOSAR stack in a gateway ECU for a tier 1 supplier.

AOC AUTOSAR, 2017
Markus Kohlwig, Huzaifa Saadat, Manfred Zajicek

Success Story of a Start-up by exploitation of AUTOSAR Standard

by Siva Nageshwar Rao Kodali, Venkatesan V, Hemal Bavishi
AVIN

A handful of industry experts founded AVIN Systems to provide automotive products and services based on AUTOSAR standards. The vast experience of its members in automotive electronics helped develop the robust AGNOSAR® Basic Software and Tools based on Classic AUTOSAR Specification version R4.3.1/ R4.4. This includes Safety AUTOSAR OS, Safe RTE, CAN, LIN, Ethernet, Memory, and Watchdog modules, including ECU Configuration Tool and SWC Editor. This product and its advanced automation features benefit ECU suppliers by reducing the time to integrate BSW with an Application and the cost of BSW product and its integration.

The AGNOSAR® classic platform is functional safety compliant, which could be used in safety-critical applications.

AVIN could scale down the AGNOSAR® classic platform for microcontrollers with limited resources to effectively deploy the same or smaller ECUs.

AVIN developed bootloaders in conformance with various OEM specifications. The highly modular bootloader design is inspired by the AUTOSAR layered architecture.

AVIN developed a base embedded framework and configuration tooling framework for its AUTOSAR Adaptive Platform.

AVIN supports its customers in developing complete AUTOSAR Adaptive Platform Functional Clusters and Configuration and Generation Tools. Their role-based configuration features, effective schema validations, and separable configuration features result in high productivity. This aids customers in developing Software Defined Vehicle (SDV) with Zone Controller ECUs and Vehicle Computer ECUs.

AVIN provides services to update the adaptive platform for functional safety and cybersecurity compliance. Moreover, AVIN includes over-the-air (OTA) update solutions using AUTOSAR Adaptive Platform D-PDU APIs and OTA Client and other higher-level modules. AVIN enhanced conventional bootloaders with additional features such as Memory A/B partitioning, enabling vehicle-wide OTA implementation. With OTA enablement, cybersecurity becomes essential, and AVIN provides bootloaders with advanced cybersecurity needs and trending use cases. This aids its customers in deploying SDVs effectively. AGNOSAR® Classic BSW products and bootloaders are used in many production programs. Vehicles loaded with these programs are on the road already.

AVIN has grown into a 300+ member organization supporting Middleware, Camera-based ADAS Services in High-Performance Computer (HPC), Electric Vehicle (EV) Development Services, Body Safety and Gateway Application development services, functional safety, and cybersecurity consultancy.

The automotive industry is shifting from complex hardware design to software-defined vehicles.

The scope of the software is no longer limited to a car but extended to the interaction between onboard and offboard software, representing a complete software-defined vehicle. To foster this development, AVIN is closely associated with AUTOSAR Consortium and participates in WG-CLD to connect the AUTOSAR domain to the cloud domain. With deep technology know-how, AVIN participated in various activities of AUTOSAR Consortium, including concept validation, and provided valuable contributions in the form of results and feedback.

AUTOSAR enabled a young and fast-growing organization like AVIN to become a stakeholder in the automotive ecosystem.

AUTOSAR – Next Generation

by Dr. rer. nat. Wolf-Hendrik Kaps
BOSCH

Automotive software expands into new domains such as cloud connectivity, interaction between micro controller and microprocessor-based systems, and automated driving. Several standards and technologies define software architectures for these domains.

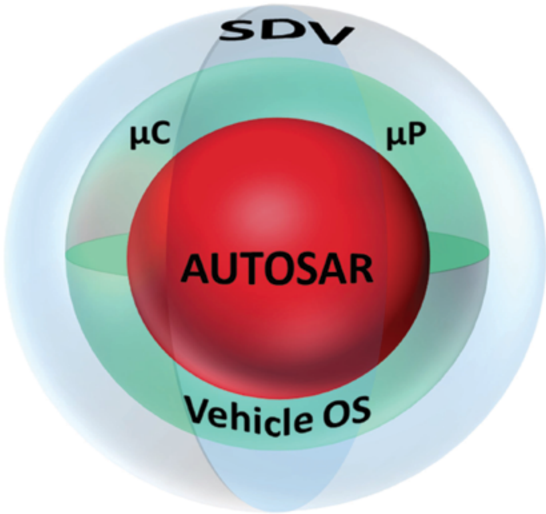
AUTOSAR, as one of the major standards, has proven to handle complex software systems over the last 20 years by applying a technical framework to day-to day operations.

This pool of experience clears the way for mastering the more complex software infrastructures of the future. The essential value propositions of AUTOSAR are:

- common functional understanding between involved parties by standardized vocabulary
- a meta-model supporting flexibility, modularity, scalability,
- variety of software functionality in classic (micro controller based) and adaptive (microprocessor based) platforms,
- seamless software exchange between development partners through solid methodology and well-defined file formats

As a founding member of AUTOSAR, Bosch contributes to the standard particularly by long time experience in software and tool development as well as profound system integration know-how. We are convinced that the AUTOSAR standard enables a variety of collaboration models with vehicle manufacturers and other suppliers.

Bosch proves this claim by having successfully brought a large number of high-volume AUTOSAR-based products to the streets.



AUTOSAR, SDV and Vehicle OS

The AUTOSAR standard is the core of a technological evolution started with the abstraction of microcontroller-based systems manifested in the Classic Platform of AUTOSAR. To open a new dimension of automotive systems as POSIX based environments on microprocessors, the standard was extended by the Adaptive Platform. Both platforms are essential parts of operating systems for vehicles, forming a kind of shell around the core. The next generation of AUTOSAR, along with other standards like COVESA and Eclipse SDV, plays an important role in providing and processing native automotive data for software defined vehicles (SDV).

AUTOSAR will be the reliable and secure enabler for future software based automotive development due to its deeply hardware related connected services.

This strong commitment should be achieved by highly beneficial features of the AUTOSAR standard, such as machine-readable specifications, facilitate seamless data processing in code-driven development environments and data base systems. This accelerates development cycles, since, due to always having up-to- date AUTOSAR requirements available directly in the software development environment.

Beside this technical motivation also another efficiency gain is provided by AUTOSAR methodology features like variant handling, file splitting support and blueprints, just to mention a few. These fundamental functional methods are indispensable to support a variety of vehicle OSs from various manufacturers, knowing their individual needs regarding to integrate AUTOSAR functionality.

Due to the fact that new players enter the automotive software market who also demand new use cases, AUTOSAR has to adapt to these changing technical conditions but may not lose its strengths in the fields of reliability, safety and security, as requested by the automotive market.

The achievements of the last 20 years of AUTOSAR paved the way towards the automotive future: AUTOSAR - next generation.

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Continental – proud of our 20 years history with AUTOSAR

by Andreas Pittner, Dan-Gabriel Manole, Michael Niklas-Höret
CONTINENTAL

20 years could be a long journey or just a blink of an eye. For Continental and AUTOSAR it is both.

As founding member of the AUTOSAR consortium, we strive with our partners for a harmonization of standards, interfaces and methodologies – overall for improvements in collaborative development of automotive software.

Our experience started with a team from various business areas, sharing expertise from embedded software to tooling development. We see the open and common mindset straight from beginning, as “ignition spark” for Continental’s AUTOSAR success. First practical activities were for AUTOSAR 1.x, integrating a solution and proving the AUTOSAR concept as working. We found shortcomings, overcame those and specifications got updated upon our feedback. Many ideas consolidated around the RTE and VFB, enabling answers to one of the most complex challenges of automotive software development at that time: porting applications from one hardware platform to another.

Continental was selected by a German OEM to put that in practice for a Body Control Unit based on AUTOSAR 2.1. The challenge was to use the AUTOSAR concept in an efficient way, whereas many ideas were not proven yet and also less experience in performance optimization was given. Thanks to persistent teamwork, Continental was able to deliver a stable and highly functional implementation in time – one of the first AUTOSAR compliant solutions on the market.

Next years showed a consolidation of AUTOSAR as standard architecture, especially for domain controllers in body and powertrain area. Continental was selected to develop different large ECUs for European OEMs. Based on AUTOSAR 3.x specifications, we witnessed the first adoption in whole carlines. Continental could pilot multiple concepts related to power management, elaborated with latest features of the EcuM. Further, the diagnostic stack was perceived as highly evolving. ISO 26262 brought end-to-end protection implemented across the network, but also new challenges.

Following and defining the AUTOSAR methodology and implementation of standards was again Continental's "key" to be successful with OEM partners and projects.

In AUTOSAR 4.0.3 we saw the adoption of Partial Networking as a solution to optimize communication and power management. A Swedish OEM introduced it in one of his platform architectures. Continental accepted the challenge in 2010 and provided a tailored solution for that customer. Applied techniques by Continental benefited the AUTOSAR consortium and were added to the standards.

In 2016, Continental cooperated with global OEMs to introduce harmonized implementations for cyber security requirements, applicable in the complete car. Concepts as defined by AUTOSAR 4.3 were implemented in conjunction with specific OEM requirements, enabling a secure ECU over lifetime. AUTOSAR 4.3 provides scalable solutions for increasing security demands and a structured cooperation between OEMs and software suppliers.

Continental's first "Body High Performance Computer" was started in 2017. It combined Classic AUTOSAR for real-time requirements with the computing power of Adaptive AUTOSAR partitions. More than 500 software engineers globally collaborated to successfully release this digital milestone and "brain" for a major German OEM's electrical vehicle platform. Modules were largely provided by Elektrobit, AUTOSAR Premium Partner and 100% subsidiary of Continental. Latest concepts of AUTOSAR Classic and Adaptive were proven to be effective in large scale ECUs, fostering the transformation of the "mechanical car" towards a "software defined vehicle".

For 20 years of AUTOSAR, Continental witnessed and elementally contributed to the evolution of automotive software development. AUTOSAR was and is seen as "companion", facilitating the change to a software-based industry and giving answers to automotive challenges and complexities of our time. The standards are proven to be an "enabler" for defined and efficient collaborations, on which Continental builds for developing and delivering great solutions to our customers.

The benefits and challenges of global standardization

LOOKING BACK AT 20 YEARS OF EXPERIENCE

by Kazuo Tsubouchi, Jennifer Neumüller
DENSO

DENSO is a global manufacturer of automotive components offering advanced automotive technologies, systems, and products. DENSO was a small company born in Japan and has grown to become a global Fortune 500 company. Over the last 20 years, DENSO has continuously strengthened our contribution to AUTOSAR. Joining as Premium Partner, expanding our role as one of the first Strategic Partners, and now as Premium Partner Plus.

When AUTOSAR was founded in 2003, DENSO realized the advantages of a global standard for automotive systems. We became one of the first Premium Members, joining as early as 2004.

At that time, Adaptive Cruise Control and pre-crash products were just starting to be released, and DENSO had issues with the increasing complexity and scale of these systems. AUTOSAR provided the opportunity to standardize application interfaces, which increased the reusability of software artifacts. Accordingly, one of DENSO's first contributions were in the standardization of interfaces for sensors and sensor fusion. DENSO was also an early adopter of Classic AUTOSAR with first prototypical implementations dating back to the Release 1.0. DENSO's efforts were rewarded with an AUTOSAR Premium Member Award in 2008.

Since then, recent trends such as automated driving and software-defined vehicles are expanding the world that AUTOSAR is aiming for. AUTOSAR has answered these challenges by developing the Adaptive Platform and continuously expanding the Classic Platform.

In an automotive world where software becomes more and more important, AUTOSAR is a crucial element to our future business.

DENSO has been contributing to AUTOSAR Adaptive since the initial kick-off with the Working Groups in 2014. One of the key features required by software-defined vehicles is the support for over-the-air updates. DENSO has contributed strongly to these features for both Adaptive and Classic Platform.

One of the organizational challenges we faced in the early days was that most standardization meetings were happening in the EU. DENSO compensated for distance and time-zone issues by installing dedicated engineers in DENSO Germany as interfaces to AUTOSAR, who can synchronize with DENSO engineers in Japan. However, not all companies have the necessary resources to apply such a scheme.

In order to incorporate more Japanese partners, DENSO is very much involved in plans to establish a regional AUTOSAR hub in Japan. Assisting us with this is our AUTOSAR regional spokesperson for Japan, Masahiro Goto. The target of the regional hubs is to minimize any barriers for prospective new partners, and to ease contributions from several regions (including Japan) to AUTOSAR, ensuring that AUTOSAR continues to be a truly global standard.

Taking AUTOSAR's organization to the next level

by Dr. Martin Jung, Dr. Niko Pollner, Nadym Salem
DEVELOP GROUP

As domain-agnostic software-engineering experts, DevelopGroup's journey with AUTOSAR started in 2019. We were awarded as a contractor for the analysis of the architecture of AUTOSAR's Adaptive Platform and the methodology for creating this architecture. While we already had experience with systems engineering, software engineering, and process consulting in the automotive domain, we were new to AUTOSAR. This view from outside helped us finding issues that an insider may have overlooked.

In combination with our extensive experience in software-architecture and process consulting, we identified several possibilities for improvement.

After the initial analysis, we worked together with Working Group *Architecture* to realize these improvements. The deep and sometimes tough technical discussions with the highly skilled members of the working groups were always inspiring and led to several changes and additions to the standard: Among other improvements, we introduced explanatory documents that describe the software architecture of the Adaptive Platform, document the architectural decisions, and record the basic quality requirements as a foundation of the Adaptive Platform.

We established informal subgroups for specific topics with dedicated experts in order to decrease the workload in the calls and meetings of the complete Working Group Architecture.

The collaboration has since broadened and deepened. We still provide improvements on the methodology and the architecture of the Adaptive Platform standard while picking up the specifics and intricate details of the automotive software ecosystems. The implementation of spikes is often helpful for making sound architectural decisions. Thus, it was quite natural for us to step up and contribute to the Adaptive Platform Demonstrator (APD) development when AUTOSAR was looking for additional software development support.

Since 2022, we took over a large part of the *AUTOSAR Technical Support Functions*, including technical, quality, change, and release management, quality assurance, and the technical office. We are glad to maintain and improve these organizational and technical fundamentals for the standardization work.

We use our experience in these topics from numerous projects for the benefit of AUTOSAR while we have the chance to learn a lot about the specifics of such a large and international standardization effort.

Our partnership with AUTOSAR and the great collaboration has allowed us to broaden our business in the automotive domain. Amongst others, we participate in the implementation of a commercial AUTOSAR Adaptive Platform stack for one of our customers. This enables us to feed back even more detailed improvements to AUTOSAR. We appreciate the engagement of AUTOSAR in the important topic of the *Software Defined Vehicle* (SDV). The increasing connectivity of vehicles and interaction with backend systems, the transformation and acceleration of the software engineering processes in the automotive domain and the adoption of methodology from software engineering in other domains are a perfect match with our business model of providing software engineering excellence across domains.

We are happy to exploit our expertise for the future development of AUTOSAR, in particular also with our contribution to Working Group *Cloud*.

AUTOSAR Standardization – Reshaping a Tool Vendors Portfolio

by Joachim Stroop, Carsten Homburg, Ulrich Kiffmeier
dSPACE

As the AUTOSAR partnership reaches its 20th anniversary in 2023, it can look back on an extraordinary success story. AUTOSAR exchange formats and methodology have become an accepted common language that triggered new solutions from tool vendors like dSPACE and re-shaped the whole automotive tool chain.

For two decades, AUTOSAR has constantly adapted to technological changes in the automotive domain and will continue to address future challenges, like the software-defined vehicle.

Likewise, dSPACE offerings have evolved with AUTOSAR, helping OEMs and suppliers bring AUTOSAR on the road. The impact of these standardization activities on the product portfolio and the scope of each solution is highlighted in the following figure.

Existing offerings like the production code generator TargetLink have been extended to support the model-based development of AUTOSAR components. TargetLink generates standardized APIs for the AUTOSAR Classic or Adaptive Platform, along with descriptions to be reused in subsequent process steps. Using standardized data exchange via AUTOSAR file formats, TargetLink can be combined with an AUTOSAR architecture design and integration tool such as SystemDesk. A software architecture with multiple components is specified in the architecture tool, while TargetLink is used to design and implement the individual software components.

Standardization of previously highly diverse ECU software architectures also prepared the ground for new offerings, enabling large-scale virtual validation of the software-defined vehicle. Having AUTOSAR descriptions available in a project accelerates the automated and safe integration of virtual ECUs (V-ECUs) on different levels of abstraction. In the AUTOSAR Classic Platform context, a virtual ECU can contain production code for the features to be tested, either only at the application level or including the basic software to the extent required. Following the AUTOSAR methodology, large parts of the ECU basic software can be automatically configured and generated. In addition to the conventional context, virtual ECUs can also be based on dynamic architectures. This includes both POSIX applications and AUTOSAR Adaptive Platform.

These virtual ECUs then enable to shift tests to an early project phase using simulators such as VEOS, a PC-based simulation platform for validation of many different models – from function models to networks of virtual ECUs, ECU network communication systems, and vehicle environment models. The ultimate goal is to prepare the path for the production ECU with high-quality software that is proven in dedicated software and hardware-in-the-loop tests (SIL and HIL), with a seamless transition between the two stages based on AUTOSAR formats.

Another example is the standardized bus and communication description format for the various and still evolving automotive communication protocols. Having these standardized descriptions in place eases, e.g. the automatic generation of residual bus models for SIL and HIL testing. It also facilitates network monitoring in experiment tools.

The ability to contribute to the standard in a joint effort of OEMs, suppliers, and tool vendors has motivated our commitment to the partnership right from the beginning.
As a result, the productivity of our dSPACE solution portfolio benefits enormously from this global standardization activity. AUTOSAR is in daily use in large parts of the tool chain.

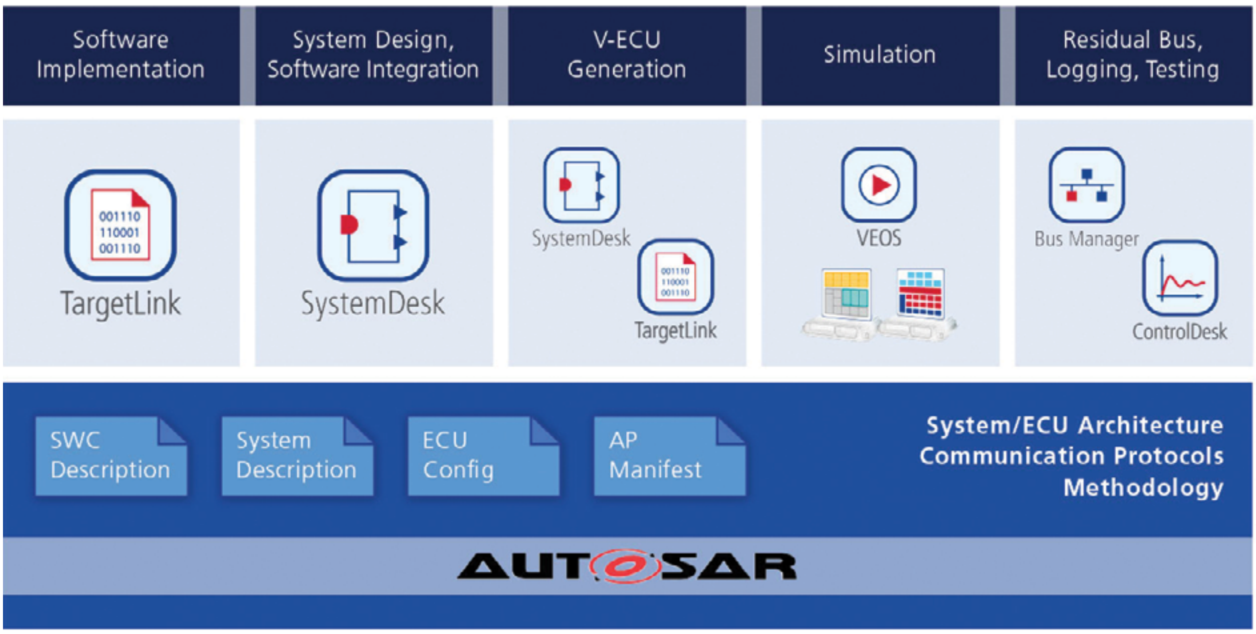


Figure 1:
Impact of these standardization activities on the product portfolio and the scope of each solution

Hyundai AutoEver: En Route to World-Class Automotive Innovations with MaaZ

by Joey Cuong Truong
FPT SOFTWARE

OUR CLIENT

The future of the automotive industry lies in-vehicle software innovations. The increasing complexity of automaking has undoubtedly presented several challenges and driven global auto manufacturers into a quest for strong software capability, software independence (from Tier 1 supplier), abundant human resources, and highly efficient vendor with world-class standard compliance.

The future of the automotive industry lies in in-vehicle software innovations

In an attempt to solve these issues, our client – Hyundai AutoEver, has turned to FPT Software's AUTOSAR solution – MaaZ. Hyundai AutoEver is a "mobility software provider" and is a member of the South Korean-based multinational automotive manufacturer – Hyundai Motor Group. With a mission of actualizing the Hyundai Motor Group's mobility vision, Hyundai AutoEver provides an automotive development platform (BSW Classic and Adaptive) to all ECU applications for the OEM to be applied in current and new model cars. Since the cooperation, Hyundai AutoEver has become one of FPT Software's strategic clients in terms of developing and implementing AUTOSAR technology.

THE BUSINESS NEEDS

Hyundai AutoEver was in need to develop AUTOSAR BSW SRS/SWS List for 4.4.0 and HMC ES SRS on target board Aurix TC3xx, as well as safety modules with ASIL-D and ASPICE Level 1. And MaaZ was proudly trusted to accompany Hyundai AutoEver on this mission for exhibiting solid capabilities, with proven experiences (12+ years of experience), high efficiency and flexibility to complete this important task.

THE CHALLENGES

Time pressure was a major issue for our software engineers – they were required to develop 76 modules with ASPICE Level 2 compliance within just 12 months. At the peak time, 180 engineers worked in parallel with only 8 hardware/licenses. Besides, four different test levels were applied: Static check, Unit test (100% coverage), Integration (100% coverage), and System Test. ASPICE processes are a MUST, and Safety (ASIL-D) certification needs to be achieved.

SOLUTION

To ensure a high-quality service delivery within the time pressure, two solutions were adopted. Firstly, Hyundai AutoEver and FPT Software utilize advanced technology and method for speed-up development. Jenkins was applied to automatically run 24/7 for early bug detection. And automation was strictly applied to reduce 90% of the required workload for development and integration. Besides, Continuous Testing (CT) was utilized to optimize the use of hardware and licenses, and the x86 framework was developed to solve module dependency constraints. In addition, we ramp-up the resource quickly.

With FPT Software's presence in 27 countries and 22 development centers, as well as MaaZ's 5,000 automotive software engineers and 500 AUTOSAR experts readily available, manpower was accessible and easily scaled up to accelerate the development process.

VALUES

The results are tangible and long-lasting. MaaZ has successfully helped Hyundai AutoEver achieve the necessary world-class certifications (AUTOSAR, ASIL-D and ASPICE) before the committed deadline. Despite the time pressure, our engineers have dedicated their hearts and mind to delivering a high-quality service for our client. Defects were found before the formal validation phase with CT, and the process was sped up thanks to the simulation test applications that allow engineers to self-test at their desks. Furthermore, 180 engineers work in parallel with only 8 hardware/licenses, with as many as 5,000 automotive engineers and 500 AUTOSAR experts standing by.

Building Bridges for the Automotive Industry

by Ákos Horváth, PhD, Co-Founder & CTO
INCQUERY LABS

TWO SWORDS FOR TWO GORDIAN KNOTS

Until 2003, one of the most vexing problems automotive companies faced was that the software often had to be rewritten from scratch whenever even the slightest alterations were made in a given model.

The inception of AUTOSAR spectacularly changed all that: motivated by the increasing complexity of modern vehicles, automotive manufacturing giants came together to make software independent from hardware, setting AUTOSAR as an industry-wide standard – the silver bullet for making reusable automotive software components. Additionally, the Unified Modeling Language (UML) provides a standard way to model and visualize the design of a system. Since UML has been a standard defined by the Object Management Group (OMG) and published by the International Organization for Standardization (ISO), system engineers have been looking for ways to combine UML and AUTOSAR modeling into a coherent system engineering approach.

ENTER THE INCQUERY SUITE

The IncQuery Model Integrator is an application for realizing seamless information flow in your toolchain by providing automated, traceable, and customizable transfer between the most important engineering domains. The Automotive Relevant Integrator (ARUML) offers several industry-relevant bridges to cover the relevant aspect of the V model sequence:

- Both the translation from High-Level Design (defined in UML) to Architecture Design (captured using the AUTOSAR System Template), following the guidelines outlined in the Modeling Guidelines of Basic Software EA UML Model document,
- And the refinement of the Component Design (defined in *AUTOSAR Software Component Template*) with the (Component) Behavior Design, where UML Sequence Diagrams and State Machines are used to specify the exact messaging order between the Runnables and the RTE.

ARUML bridge provides even more by mapping AUTOSAR element identifiers to those within UML. It provides an embedded traceability feature, thus making it easy to comply with the crucial certification requirements outlined in the ISO26262 standard.

In addition, the bridge tightly integrates with Enterprise Architect and Cameo Systems Modeler, providing additional advanced features like (i) static model validation support to ensure that both external and in-house model standards are strictly followed, (ii) seamless incremental updates to help understand the changes initiated in the AUTOSAR domain and (iii) a well-defined roundtrip engineering specification from UML-to-AUTOSAR and back with the possibility to customize them to your model translation approach.

GOING FORWARD

At the same time, as the world makes bold strides toward automotive electrification and a highly connected environment like the many aspects of Car-to-X integrations, the automotive industry faces supply chain disruptions. The fluctuating price and availability of certain parts like Electronic Control Units (ECU) make the capability to expeditiously implement changes in design increasingly important. The IncQuery Solutions already provides engineers at several OEM and Tier one partners with the necessary toolchains to navigate between domains in a standard compliant, traceable, and updateable way, allowing faster reaction and adaptation in an ever-changing world.

Intellias and AUTOSAR Success Story

by Nelya Rudnytska, Oleksandr Nazarov, Olha Bohun
INTELLIAS

Just as AUTOSAR enables continuous innovation, Intellias enables change and transformation across the automotive domain.

We aim to generate long-lasting value for businesses and communities, putting the power of digital technology to work and advancing the industry.

As an Associate Partner, Intellias maximizes AUTOSAR advantages in customer projects. One of our latest success stories was building AUTOSAR-compliant software to ensure ultimate automotive infotainment system development according to the highest industry standards.

The challenge of the project was to develop an infotainment system for a line of sports cars for one of the leading Italian OEMs. Our client had an initial solution that wasn't AUTOSAR-compliant, thus leading to additional issues, extra maintenance, and excessive support. One of our client's most significant problems was integrating this solution with other AUTOSAR-compliant solutions and ensuring it's reliable enough to use in the demanding and quality-oriented automotive industry. It was the case for the OEM to turn to Intellias with the request to develop an AUTOSAR-compliant solution based on initial requirements and architecture.

Having set the gold standard for automotive software, AUTOSAR framework was the only choice to continue with.

Intellias took over the entire infotainment system development cycle, relying on strict AUTOSAR standard specifications so that our client could easily integrate their initial concept with the following delivery and supply cycles.

We established a team of best-in-class experts with industry knowledge and communicated with AUTOSAR specialists on the expertise level to ensure we align with the best AUTOSAR practices.

Our architecture expert group had hands-on experience in AUTOSAR Classic Platform, diagnostics, cybersecurity, and in-car networking.

After several weeks of intensive and productive work shoulder to shoulder with our client, we identified key requirements, needs, and dependencies. Intellias working group provided all-inclusive discovery services and helped the OEM to choose the suitable AUTOSAR modules to implement the solution.

We started the actual development process by taking the client's concept as the foundation. Intellias was instrumental in enabling the detailed design of components that ensure cybersecurity on the integration and communication levels with other elements. The team brought its in-depth software engineering expertise to ensure the entire system is securely diagnosed and eliminate potential breaches. We implemented a set of components necessary for the communication between the infotainment system and other car parts.

With a focus on a go-to and high-quality solution, we planned the entire testing scope on the client's equipment. Our team implemented further testing automation based on AUTOSAR testing frameworks and best practices.

Intellias full-scale involvement in developing an AUTOSAR-compliant infotainment system for our client led to an excellent result.

Next year, the entire line of their cars will have this infotainment system integrated with other car components in a certified way that aligns with the best AUTOSAR practices. Leveraging the solution developed by Intellias, our client will be one of the OEMs having the most up-to-date infotainment system in terms of cybersecurity and AUTOSAR standards compliance.

IP Camp Success Story with AUTOSAR

by Dániel Faragó
IP CAMP

IP Camp has developed a fully AUTOSAR compliant model editor and modeling tool platform to facilitate common modeling tasks in an intuitive and efficient way. The platform includes scriptable model generation/transformation, code/report generation, model comparison and merge, and custom views for visualizing different aspects of the model. It is often referred to as a “Swiss Army Knife for modeling” due to its versatility.

The platform relies entirely on the standard documents for processing, splitting, and persisting models, ensuring that it is entirely compliant with AUTOSAR. The tool’s architecture is designed to be flexible and efficient, allowing it to be easily integrated into existing products and enhance them with AUTOSAR functionality.

Implementing a solution for the complex meta-model and model handling rules defined by AUTOSAR is a significant accomplishment.

IP Camp is proud to have developed a tool that addresses the challenges of AUTOSAR compliance while providing a useful basis for future products.

One of the most significant advantages of the platform is its fast and efficient model parsing capabilities. The parser is generated based on the AUTOSAR meta-model, allowing models to be parsed quickly and accurately. Thanks to the parser being generated based on the meta-model it is also easy to adapt the tool to new versions of the standard. Additionally, the platform supports multi-ARXML handling, enabling users to work with AUTOSAR models split into multiple files. It is also possible to open different modeling projects simultaneously and perform operations between them.

Another key feature of the platform is its scripting capability, which enables users to generate and analyze models using a scripting language. This feature makes it easy to automate common modeling tasks and customize the platform to meet specific requirements.

The platform also includes code and report generation capabilities, which enable users to generate code and reports directly from the model. This feature can save significant time and effort by automating the code generation process and ensuring that the generated code is compliant with AUTOSAR standards.

Finally, the platform includes custom views that allow users to visualize different aspects of the model easily. Custom views can be created using a simple interface, making it easy to customize the platform to meet specific modeling needs.

In summary, IP Camp’s AUTOSAR compliant model editor and modeling tool platform is a significant achievement in the field of modeling.

The platform is designed to be efficient, flexible, and easy to use, providing users with a versatile tool for common modeling tasks.

Its compliance with AUTOSAR standards ensures that it is a reliable and useful tool for industry professionals.

KPIT Success Story with AUTOSAR Consortium

by Meenal Awachat, KPIT AUTOSAR Team
KPIT TECHNOLOGIES

As a Software Integration partner to global OEMs and Tier-1s, KPIT offers middleware/platform solutions, especially enabling our automotive clients and partners to accelerate transformation for software-defined vehicles (SDVs).

KPIT's efforts towards software standardization over the years, specifically AUTOSAR, coupled with our domain expertise in CASE (Connected, Autonomous, Shared, and Electric) technologies, has helped clients keep pace with rapidly increasing software requirements in a vehicle.

EARLY YEARS WITH AUTOSAR

KPIT Technologies has been a premium member and close collaborator of the AUTOSAR Consortium since 2005. KPIT's association with AUTOSAR has been as an early adopter. Our early efforts for software standardization resulted in an optimized network stack called eNOS with effective memory utilization, which was implemented into multiple OEM programs. KPIT also started work on the early R4.0.3 standard and developed one of the world's first AUTOSAR R4.0.3 compliant solutions. Since then, it has grown into a well-evolved stack supporting CAN, LIN, and Ethernet and is extendable for OEM customizations.

EFFORTS TOWARD SDV ARCHITECTURE

With hardware-software separation and an increased focus on software standardization, the automotive industry is transforming toward Central Compute-based Zonal Architectures. KPIT is involved in 6 SDV programs within the automotive ecosystem and now offers Chip-to-Cloud services from hardware abstraction, middleware development, application software, software integration, and Cloud-enabled data services. With the recent acquisition of Technica Engineering GmbH, KPIT can enhance its offerings towards enabling OEMs to build E/E architectures through high-speed ethernet solutions combined with KPIT's software integration expertise. KPIT and Technica can now be an integral part of the SDV program journey from pre-SoP to post-SoP, with system definition, architecture consulting, and rapid prototyping of high-compute hardware.

KPIT'S WELL-EVOLVED AUTOSAR PRODUCTS AND SERVICES

KPIT is a one-stop solution provider for AUTOSAR and middleware products and services. KPIT has developed several AUTOSAR-based platforms, solutions, and accelerators- including KSAR Adaptive, KSAR Classic, KSAR OS, KSAR Secure Bootloader, C4K Configuration tool, and Base Software Integration Kit (BaSIK)- and also offers services like OEM-specific extensions, configuration and deep customization of BSW stack, porting, adaptation, and virtualization and validation services.

KPIT's KSAR Adaptive platform has been developed to suit the current requirements of High-Performance Computing chipsets. Moreover, KPIT's Cloud-Native Engineering Workbench on AWS- the world's first to be available on AWS Graviton for Virtual Engineering and Testing- provides out-of-the-box Adaptive AUTOSAR cloud instances that allow jumpstarting HPC platform and feature development on AWS.

KPIT has also emerged as a 'Talent Academy'- by being a training ground for over 8000 AUTOSAR professionals, who now hold key positions within KPIT and beyond.

EXPERIENCE WITH OEMS AND TIER-1S

Over 10 OEMs have approved the KSAR stack so far. We have over 20 active engagements with global OEMs and Tier-1s in the AUTOSAR domain, and the KPIT network stack has been included in over 300 production programs. Our consistent focus and investments towards developing cutting-edge automotive software will help us enable OEMs and partners to make software-defined vehicles a reality!

The Adaptive Platform Demonstrator as a flexible prototyping and validation framework

by Tobias Kühnel, Christoph Hennig, Ralph Michels, Maurice Sebastian
LUXOFT

Throughout the past years, Luxoft built a strong experience in AUTOSAR, particularly in the Adaptive Platform Demonstrator (ADP). We are intensely involved in the CCT working group, provided significant improvements to the ADP code, and spent major efforts in several Functional Cluster implementations for the respective working groups (e.g., EM, Com, Crypto API ...). This led to our major AUTOSAR success story, which we want to share.

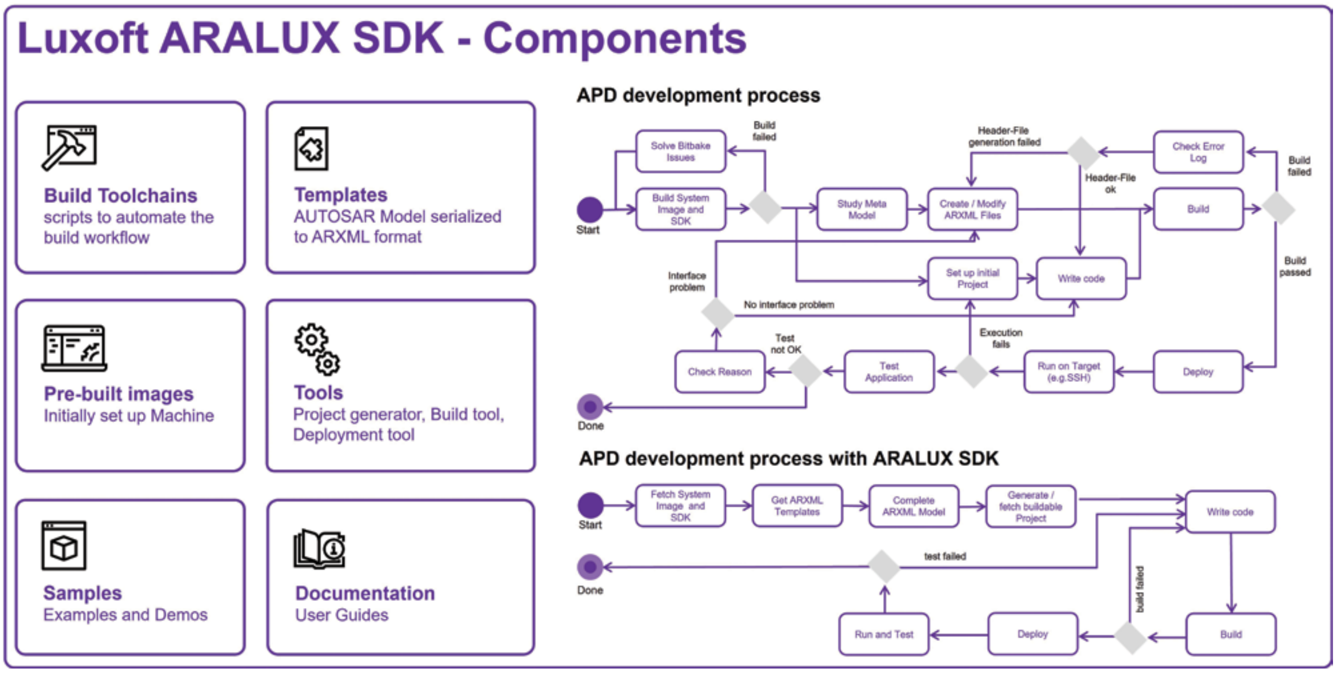
The APD implementation offers plenty of opportunities besides specification validation and interoperability reference purposes.

During our activities in the consortium, we identified the potential of the APD for internal upskilling, training, and to be used as a flexible prototyping and validation framework. This will decouple the development from production ECUs and Stacks, which might significantly speed up the adaptive prototyping. But we faced some difficulties with using the Demonstrator.

The most problematic is the high entry barrier in using it and getting used to the overall methodology.

Luxoft approached this by creating the internal ARALUX SDK, which helps our developers get up to speed and easily pass the entry barriers to quickly enable maximum productivity in prototyping and Proof-of-Concept (PoC) projects.

This SDK contains different components - prebuilt images for other targets, methodology-aligned built toolchains, templating mechanisms to enable reusability, detailed manuals, and tools.



We use the APD as a code base for our ARALUX SDK, targeting PoC and prototyping projects for different customers. This includes AUTOSAR Adaptive applications and platform feature prototyping, ECU containerization, and PoC implementations for the AUTOSAR consortium itself, OEMs, Tier1s, and even Silicon Vendors to prove their chip compatibility with the Adaptive Platform. The suitability of the Demonstrator, together with the ARALUX SDK, for such developments, has been demonstrated in several projects.

One major initiative, Luxoft is working on, is an overall End-to-End approach to show the whole development cycle, beginning from the very first requirements, over the first target and platform agnostic feature designs, automatic ARML generation, up to final software, and feature validation.

This approach shows the possibility of decoupling SW from HW to reach an advanced SW maturity state without any target dependencies. The ARALUX SDK and the APD implementation showcase this development process on an actual AUTOSAR implementation.

Demonstrating this approach and the creation of the SDK showed Luxoft's AUTOSAR expertise in front of our customers. It even helped to convince potential customers of our ability to execute their series projects. Additionally, it helps to identify improvement potentials in the specification, contribute solutions and, in the end, improve the standard's quality.

Without our AUTOSAR contribution over all these years, this success story would not have been possible. Luxoft's employees build strong expertise in the standard itself and in using and developing AUTOSAR components and applications by contributing to different working groups. This contribution established Luxoft's image as a reliable and professional AUTOSAR partner.

Figure 1
Luxoft ARALUX SDK - Components

Custom Toolchain as Bridge between OEM Specific Needs and Standard Software

by Andreas Vetter, Philipp Schumacher
MERCEDES-BENZ

THE AUTOSAR METHODOLOGY SPLITS THE WORKFLOW INTO FIVE PARTS: System, Virtual Functional Bus (VFB), Basic Software (BSW), Software Component (SWC), and Electronic Control Unit (ECU). Mercedes-Benz models System and FB in-house. BSW and vehicle wide used SWCs comes from Stack Vendors. ECU suppliers integrate BSW, System model, and SWCs and develop custom SWCs to realize the functionality specific to their ECU.

1. OUR TOOLCHAIN

The AUTOSAR methodology splits the workflow into five parts: System, Virtual Functional Bus (VFB), Basic Software (BSW), Software Component (SWC), and Electronic Control Unit (ECU). Mercedes-Benz models System and FB in-house. BSW and vehicle wide used SWCs comes from Stack Vendors. ECU suppliers integrate BSW, System model, and SWCs and develop custom SWCs to realize the functionality specific to their ECU.

In 2004 work in the DIS Collaboration Platform was started. The primary motivation was to have a multi-user Collaboration Platform that covers not only single bus types but a complete E/E platform with all bus types and gateways.
In 2007 AUTOSAR was introduced in the Platform. From 2008 on, AUTOSAR was the default export format for the network communication description - CD and software components - SWC development; since then, newer Versions of AUTOSAR have been integrated continuously.

Due to the extensive interoperability of AUTOSAR Versions, it is possible to support E/E Platforms with a mixture of AUTOSAR Versions.

DIS covers the NCD development and the SWC design in the E/E development at the lower part of the V-cycle (see Figure 1). More details about AUTOSAR Toolchain, SWC Design, and model-based development can be found in [1] and [2].

1.1 XDIS COLLABORATION PLATFORM

The DIS Collaboration Platform covers the central part of the AUTOSAR Custom Toolchain (see Figure
2). The Change Management part [3] works on a FB-like view and implements the bridge from predecessor non-AUTOSAR processes to AUTOSAR processes. In DIS, expert groups can develop the NCD and design the SWC, which follows the AUTOSAR methodology. Finally, the work artifacts are exported to AUTOSAR Exchange Formats and distributed internally and externally to suppliers.

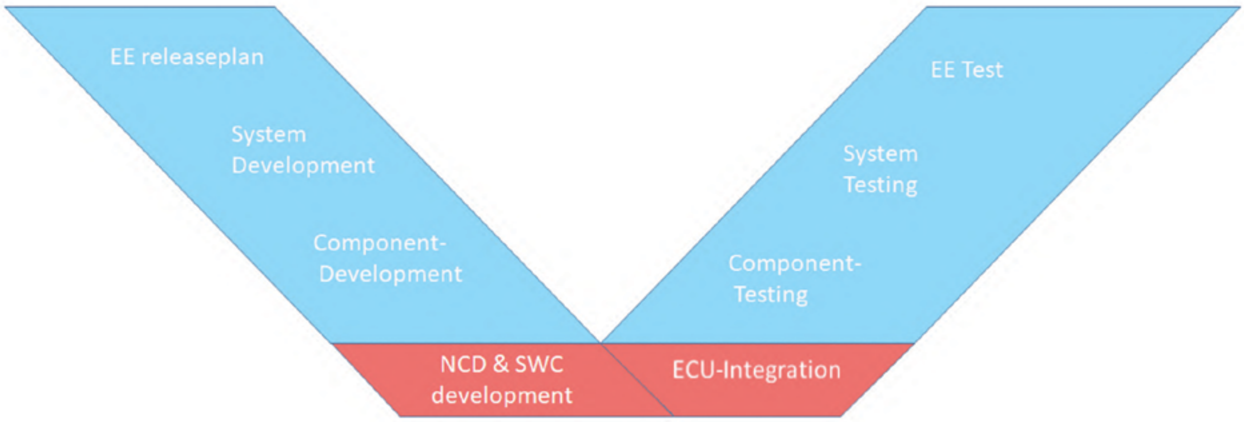


Figure 1
V-Cycle

1.2 VISUALIZER

The ARXML-Visualizer is the Swiss Army knife of ARML-file handling. In theory, it has no place in the AUTOSAR workflow. In practice, the Visualizer simplifies the daily work of engineers all along that workflow at Mercedes-Benz and our suppliers. The different views and scripting features have been tailored to our needs and can quickly be adapted when necessary. The tool offers a hassle-free user experience, requiring neither installation nor licensing. The various views of the model and an AUTOSAR meta-model-aware compare mechanism have proven invaluable in debugging integration issues. It is also used for automated post-processing of files generated by DIS, using its sophisticated scripting mechanism to enable last-minute schema modifications, if needed.

2. SUCCESS OF AUTOSAR

AUTOSAR is a massive success because the standardized exchange format enables the combination of tools, essential software, and SWCs of different vendors.

We can model the system in our own tool, meeting our engineers' expectations. All of our CU suppliers can import the extracts, integrate them with the SW of different software suppliers, and reuse SWCs familiar to all ECUs. Finally, the ECU based on other BSW stacks can be combined into one vehicle. Without AUTOSAR, we would still be able to build great cars, but we would not be able to mix and match tools B5Ws and SWCs to achieve the optimal development experience and a competitive procurement environment.

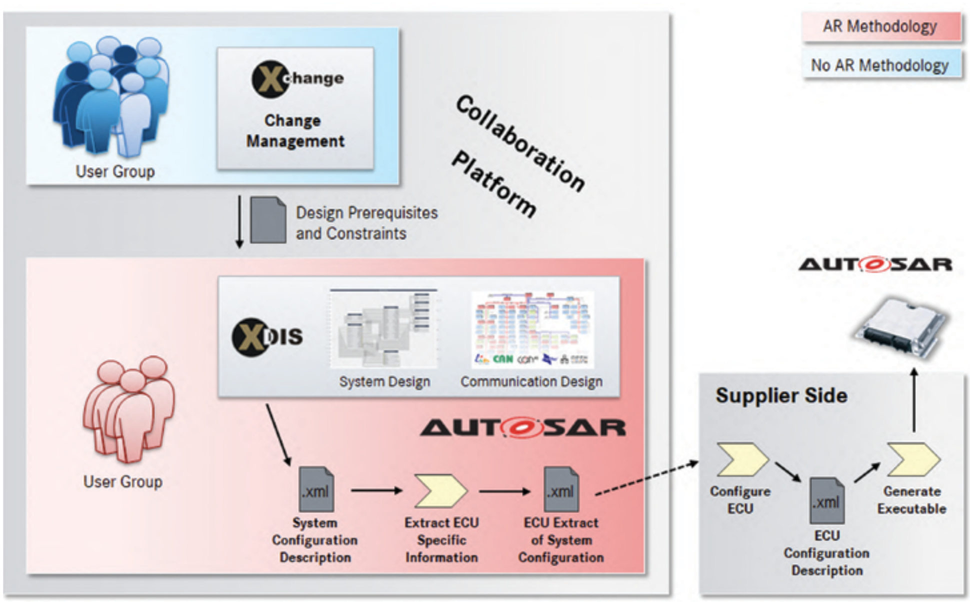


Figure 2
XDIS Collaboration Platform

Bridging regional Chinese and global standardization

by Yiwei Lv, Diana Mao
NEUSOFT REACH AUTOMOTIVE TECHNOLOGY INC.

NEUSAR DS RELEASE

In the era of software-defined vehicles (SDV), Neusoft Reach builds a complete technology ecosystem with its automotive basic software NeuSAR and big data technology as its strategic core to provide customers with convenient and efficient products and services with strong local support. NeuSAR is the basic software platform developed by Neusoft Reach for Next Generation Intelligent Connected Vehicle (ICV).

Based on AUTOSAR Adaptive Platform, NeuSAR consists of basic software modules and a suite of development tools to help build the E/E architecture for next generation automobiles. NeuSAR is designed for high performance and high bandwidth communication ECUs, such as L3+ domain controller, vehicle central computing unit, V2X and so on. NeuSAR has comprehensive safety and security mechanism to ensure the safety and reliability of production vehicles.

In 2022, NeuSAR product expands its portfolio with its domain controller oriented system solution (NeuSAR DS), including software package, development tool chain, development and verification platform components, etc. Based on S32G, TDA4 and other main chip solution, NeuSAR DS provides a full set of one-stop development and debugging environment, including support for AUTOSAR Adaptive Platform (AP) and Classic Platform (CP) and the required tools, to the customers.

This allows users to avoid tool switching between basic environment and other low-level development and configuration in the development process, so that they can reduce development time and focus more on application feature development.

AUTOSEMO SUPPORT AND PROMOTION OF AUTOSAR

Neusoft Reach is the key founding partner of AUTOSEMO which started in 2020 with 10+ partners, now almost 90 partners within less than 2 years, and is the first-year chair company at AUTOSEMO.

Neusoft Reach has actively promoted the AUTOSAR standard and ecosystem in the energetic wave of software-define-vehicle and service-oriented-architecture implementation efforts by China domestic OEMs and Tier 1s.

Neusoft Reach NeuSAR has been implemented on 24 vehicle platforms amongst 13 local OEMs and 30+ Tier1s within 2 years.

ACTIVITIES IN THE GLOBAL STANDARDIZATION

Neusoft Reach acts as the leader and key contributor for AUTOSEMO ASF (AUTOSEMO SERVICE FRAMEWORK) working team. The working team is focused on the vehicle service framework specification standardization which is one of the key missions for AUTOSEMO.

The purpose of the working team is to promote the underlying SOA and other infrastructure reusing the CM and other modules defined by AUTOSAR AP/CP to provide more service-oriented development functions for upper applications. The working team includes representatives from OEMs, Tier 1s and software companies.

The findings are shared within AUTOSEMO white paper 1.0, 2.0 and 3.0 which are publicly available and well accepted. Those standards proposed are officially considered by Chinese automotive standardization institutions, and later hopefully to be shared with AUTOSAR partners outside China as well. These activities will allow Neusoft Reach to be the most trusted SDV partner for OEMs and Tier 1s.

AUTOSAR C++14
– Best Coding Guidelines for the World

by Jill Britton
PROGRAMMING RESEARCH, PERFORCE SOFTWARE

In 2017, Programming Research were approached to assist with development of the ‘best coding standard in the world’ for C++ under the direction of AUTOSAR. This was necessary as the Adaptive Platform is written using a version of C++ that is later than the version covered by MISRA C++ 2008.

As we had already had extensive experience of coding guidelines, being the authors of High Integrity C++ and members of the MISRA C++ working group, we gladly accepted this challenge. We were already aware that a more up to date coding standard was needed and felt that we would be able to make a significant contribution.

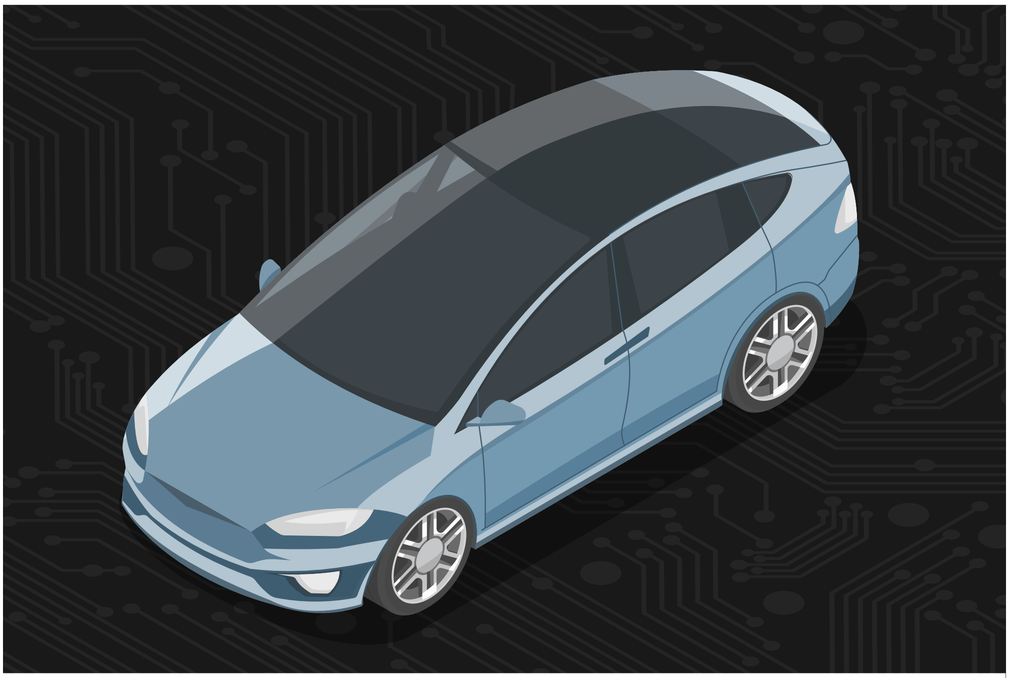
Starting from the basis that MISRA C++ was good, but needed updating, rules from many other C++ coding guidelines were considered including CERT C++, High Integrity C++, Joint Strike Fighter Air Vehicle C++, C++ Core Guidelines and Google C++ Style Guide. The plan was to include everything, review if it was already included in MISRA C++ and then if it was really a good rule for an AUTOSAR project.

During the review, it was interesting to see how “modern” C++ removed the need for some of the Guidelines.

AUTOSAR C++14 added an important classification of the rules – whether they could be automated.

Automation allows the rule to be enforced by Static Analysis. The majority of the rules are classified as automated. We implemented analysis according to our QAC++ analyzer to prove that it was possible to automate them and to show that the test projects really did comply with the rules. As with any new standard, this highlighted areas for improvement, but ensured that the final product was high quality and could safely be used in any automotive C++ project.

In the development of these coding guidelines AUTOSAR continued the trend where “users” of the rules took an active part in reviewing.



An update to the standard was published in 2018 which added traceability to many parts of ISO 26262 parts 6 and 8. Although there have been no further updates, the standard is widely used and will continue to be used extensively both by those working with the adaptive platform and also by those in other sectors that have a requirement for high quality coding guidelines for more modern versions of C++.

It was handed over to the MISRA C++ working group in 2020 and they have subsequently refined the ruleset for C++17 and later. This standard will be released by MISRA later in 2023. Again, users were invited to take part in a public review, some of whom had contributed to the original AUTOSAR coding guidelines.

The experience of working with AUTOSAR gave the Programming Research team a valuable insight into the requirements of the automotive industry.

This allowed those now working on the new MISRA C++ standard to bring a perspective of the Adaptive Platform to the discussions.

Programming Research is now part of Perforce Software and continues to work on the development and improvement of coding guidelines for use throughout the automotive industry.

Figure 1
Illustration from Programming Research Contribution

Success stories about QINeS AUTOSAR solution

by Yuushi Gogami
SCSK

SCSK released QINeS-BSW, a BSW for AUTOSAR Classic, in 2015. Since then, we have provided solutions that support high-quality and high-efficiency in-vehicle software development centered on QINeS-BSW, including tools, support for building processes, training, AUTOSAR implementation, and application development.

By providing these services as a one-stop solution, we have promoted the use of AUTOSAR and improved software quality and productivity for automobile manufacturers and suppliers.

I want to introduce one of these initiatives, AUTOSAR implementation support. When our customers applied AUTOSAR to their services, many had no experience with AUTOSAR implementation and needed to learn how to do it for the first time. To solve their various technical issues, we have implemented AUTOSAR quickly and efficiently through the AUTOSAR Implementation Support service by providing detailed support tailored to the customer's situation based on the standardized process.

For the AUTOSAR implementation, we have provided our customers with the following services to solve their issues.

First, we conducted a Fit and Gap analysis with AUTOSAR specifications based on software requirements. Specifically, we have classified whether the software requirements meet AUTOSAR specifications. We have considered how to realize the software requirements that can be met, and we have proposed alternative methods for those that cannot be met. As an achievement, the customer has resolved their concerns about AUOTSAR and decided to adopt it.

Next, we have supported BSW integration to the issues of configuration complexity. The customer has been in charge of application development, and SCSK has been in charge of BSW integration, so we have developed ECU software together. Even though the customer did not know AUTOSAR, they have been able to establish AUTOSAR-compliant software as planned because we have taken charge of the BSW integration.

Finally, we have instructed the customers on how to develop AUTOSAR-compliant software independently. We have provided educational solutions such as the role of each module, the development method, and the details of the QINeS-BSW.

As an achievement, the customers can develop AUTOSAR-compliant software independently.

SCSK provides services that meet customer concerns and issues using AUTOSAR knowledge, and implementation support contributes to promoting the use of AUTOSAR for automobile manufacturers and suppliers. Currently, we mainly offer solutions for the Japanese market, but we are preparing to offer them to the global market together with our business partners in the future. We will continue expanding the service lineup and our activities so that many customers can adopt AUTOSAR and QINeS-BSW.

Major enabler for OEM engineering process maturity growth

by Armando Hernandez
STELLANTIS

Stellantis software in the early twenty-first century has been characterized by an explosive growth in both size and complexity, now easily exceeding 100 million lines of software code across the vehicle. Driving this complexity are new features such as driver assistance, drive by wire controls, and cloud connectivity, each of which bring along adjacent issues, such as functional safety and cyber-security.

But as the focus of automotive design innovation has shifted from mechanical systems toward software feature development, we have faced some very unique challenges in automotive, that are quite unlike other mature software development environments such as desktop, mobile and consumer electronics. In addition to issues of functional safety, automotive software is not centralized, rather it is distributed across maybe one hundred individual controllers, each with its own platform OS, and all connected through a web of vehicle interfaces and communications networks. Without a professional software development environment that is adapted to this environment, something akin to Windows on the desktop or Android on mobile, software innovation in the automotive space would have been stifled.

To answer this challenge, AUTOSAR Classic has emerged as the leading software development environment in the automotive domain.

The AUTOSAR model enables an architectural design that spans the entire vehicle software system, unconstrained by the limitations of the distributed vehicle network.

This design against the “virtual function bus” is then allocated and extracted to fit in the distributed model for component development.

The current AUTOSAR development model at Stellantis enables the seamless integration of software components through a global network of suppliers, each working to component interfaces designed against the complete vehicle software architecture.

The common AUTOSAR development environment facilitates the portability of software elements that has allowed Stellantis to take greater ownership of key intellectual properties by managing software as something other than an extension of the hardware.

With the shift to a common software development environment, gone is the ‘wrapper age’ of software integration, replaced with true software portability that is akin to other software product development environments that share a common development platform such as Android.

This enabled Stellantis to include our feature specific needs even if they were developed externally, as an example HMI and Car Behavior. Although many OEMs are migrating to increase the development inhouse, AUTOSAR was an enabler to allow for this even though not initially anticipated.

Interfacing with Classic AUTOSAR at arxml and code level

A TOOL VENDOR PERSPECTIVE

by Rudolf Grave
TASKING

As a tool vendor supporting the Classic AUTOSAR project, we want to share an experience showing the interaction with AUTOSAR specifications.

In our first use case, TASKING derives information from the AUTOSAR configuration files to generate a Configuration and Constraint file for a static analysis tool called Safety Checker. This tool supports the user's freedom from interference argumentation for ISO 26262 and covers a set of verification methods requested by the Tables in ISO2626:2018 part 6.

By reusing the existing AUTOSAR configuration, the developer saves time and gets the first results quickly.

Also, a workflow can be generated that avoids making changes to the configuration of multiple files; this avoids inconsistencies between the target software configuration and the Safety Checker configuration. Challenges in this area are the different solutions and detailed implementations from AUTOSAR suppliers as there is the "compete in implementation," therefore, the safety solution differs from vendor to vendor.

TASKING needs to adapt the importers for each AUTOSAR vendor, causing implementation and synchronization efforts. A wish for upcoming versions, especially in the direction of Adaptive AUTOSAR - as there is more innovation - is to specify the safety concepts highly.

This will lead to better tools and lower certification costs.

A second benefit of the AUTOSAR Standard is the defined interfaces, especially the RTE interfaces, as they enable us to create a product with nearly no interface adaptions for multiple customers.

In our products, these are complex device drivers (CDD) for the job handling to accelerator cores; based on the configured functionality, the RTE interfaces can be generated, imported, and connected in the AUTOSAR authoring tools.

A concrete use case is handling the parallel processing unit (PPU) on the Infineon AURIX. This accelerator assigns compute jobs with high parallelization capabilities, e.g., matrix multiplication, to a specific core.

The PPU will get the previous job from multiple parallel running cores; the AUTOSAR RTE and/or OS will communicate the inter-core communication. Depending on future use cases, a Master/Satellite pattern can be considered to do some job preparation or post-processing core locally and not on the core to which the CDD is assigned.

About the PPU, the usage of OpenCL inside the Classic AUTOSAR stack has been wished for years, TASKING might consider this in the future, but we lack a customer-driven use case – feel free to contact us.

Looking forward to TASKING's role in the AUTOSAR ecosystem, we are considering increasing our contribution, especially in the direction of RUST, which we see as a promising programming language for upcoming safety and security implementations in automotive.

Demystifying the AUTOSAR Complexity

POWERFUL AND MULTI-LAYERED SPECIFICATIONS

by Oliver Garnatz
VECTOR

A certain complexity is necessary to ensure system integrity with a given range of functions.

AUTOSAR celebrates its 20th anniversary this year. During this time, the development partnership has gone through the ups and downs of automotive software development. The result of this development are powerful and multi-layered specifications.

The standard provides comprehensive coverage for the development of ECU software. The extensive feature scope is a unique selling point and makes an essential component in current base layer and vehicle OS projects.

AUTOSAR is a success story. With the Classic Platform, AUTOSAR has created the automotive industry standard for software development on microcontrollers. This standard is continuously maintained and further developed by many partners. The evolution is reflected in the number of newly submitted concepts in AUTOSAR - release after release.

With the introduction of the Adaptive Platform, AUTOSAR oriented itself early on to the future trends of the automotive industry.

In the meantime, it has become an important component of microprocessor-based software systems. As an automotive middleware, the Adaptive platform is suitable for all vehicle functions relevant to driving, primarily because of its safety and security properties. In addition, it also plays a central role in the connection to the classic automotive infrastructure.

WHY DOES AUTOSAR SEEM SO COMPLEX?

AUTOSAR has certainly accumulated some ballast over the last 20 years. Sometimes features can be interpreted differently or are incompletely standardized. Furthermore, some features are rarely or never used, which is why the AUTOSAR standard will probably never be implemented in its entirety by a software supplier.

AUTOSAR is a superset of automotive use cases and must be tailored for each project.

Each vehicle manufacturer also has unique requirements that go beyond AUTOSAR, such as proprietary protocols.

In addition, the AUTOSAR methodology has a focus on reusability. This increases complexity, but has clear commercial advantages in terms of ECU and software takeover.

HOW CAN AUTOSAR BECOME EVEN MORE ATTRACTIVE?

AUTOSAR already shows its full strengths when it comes to the scope of features, but there is still potential for optimization that can be implemented quickly and easily:

1. AUTOSAR should be “cleaned up”. Features that have not been implemented for years or are no longer needed must be removed from the standard.
2. The Adaptive Platform must strengthen its position as a team player in the market. It complements POSIX environments with automotive use cases - it does not compete with them.
3. AUTOSAR needs to better document its features for end users. AUTOSAR already contains many conceptual ideas for efficient application development. These are not always obvious.

The “mindset” of joint work on the standard can certainly be further strengthened. It would be a great pity if AUTOSAR were to become a collection of individual interests. In any case, this requires a willingness to compromise on all sides.

CONCLUSION:

AUTOSAR is a Swiss army knife of sorts for the implementation of automotive requirements in E/E software development.

At the system level and regarding the scope of functions, there is currently nothing comparable.

AUTOSAR is the established standard in many areas but must continue to work on optimizing its weak points to retain this status.

AUTOSAR is challenging and the barriers to entry can be comparatively high. However, a certain complexity is necessary to ensure system integrity with a given range of functions.

Oliver Garnatz has been employed at Vector since 2000 and serves as Principal Solution Manager in the Embedded Software sector. In AUTOSAR, he is among others the speaker of the working group Architecture Adaptive Platform.

Protocols are for sharing

by Jan Hegewald
VW / CARIAD

Open communication protocols are of utmost importance to enable interoperable systems.

Since DARPA created TCP/IP and specified it in IETF (www.ietf.org) RFCs the backbone of our modern communication is based on open protocols.

The automotive industry has long relied on CAN, CAN-FD or LIN for reliable inter-ECU communication. The rise of Automotive Ethernet offers a bandwidth from 10 Mbit/s up to multiple Gbit/s, and a common protocol in this environment is SOME/IP (Scalable service-Oriented Middleware over IP) which is specified at the AUTOSAR consortium (AUTOSAR_PRS_SOMEIPProtocol.pdf at www.autosar.org) and was initially contributed in large parts by Lars Völker from BMW.

SOME/IP sits on top of IP addressing and allows applications to offer and consume services within the in-vehicle network and thereby supports a variety of automotive use cases like RPC , fire-forget messaging and optimized serialization. SOME/IP can be implemented on highly capable systems based on microprocessors as well as on small micro controllers in static RTOS systems with the promise to only send data when those systems are subscribed. Even though it is clear that pitfalls of service-oriented architectures also apply for SOME/IP-based communication, this article will focus on the value of open protocol specifications.

The AUTOSAR Opening Strategy, amongst other goals, aims to allow open-source implementations of protocols which formerly was not possible due to the regulations of the AUTOSAR development agreement. Having this kind of openness can bring several benefits to the overall automotive industry:

- Cross-supplier and OEM usage to reduce incompatibilities in integration cycles
- Community based hardening (e.g. with fuzzing) will allow for a more robust code base

- To a carmaker, a deeply embedded communication protocol can sure be regarded as non-differentiating for the end customer. Nevertheless, having several incompatible implementations of the same protocol from different sources is for sure a major drawback in vehicle integration.
- The whole industry will be able to attach code generators and validators on an openly available implementation.
- Easily available guidelines and documentation together with clearly defined "things-to-avoid" can help the whole industry.
- Support of new and promising programming languages for robust systems development can be added and the interaction on the codebase with other open initiatives can help very early in the project.

AUTOSAR's main focus is on specification work based on industry alignment and discussion in expert groups.

The IP still belongs to each party and is shared among members which has created a remarkable community with more than 350 members so far.

The Eclipse Foundation on the other hand, and its working group SDV (Software Defined Vehicle), is focused to provide the projects a governing structure and clear IP rules. The IP is owned by the Eclipse Foundation and each project is truly open under the terms of an open-source license. The best thing is, that the committers of a project have full ownership of the codebase without being forced into technical compromises. Adoption is up to the industry and community based on technical merit.

The combination of both approaches – like open implementation of AUTOSAR protocols – can create a new way of industry collaboration on a playing field that the automotive industry has not yet fully unleashed.

The trend that carmakers are more looking on software as key competence will further drive this trend in the upcoming decade.

Chapter 7

Afterword

"It's the desire to walk that creates the path ahead."

- Paulo Coelho

On the road, an afterword

SUCCESS STORIES OF THE PAST
ARE OUR COMMITMENT FOR THE FUTURE

by Dr. Peter Redlich, Deputy Chairperson

20 years of AUTOSAR-enabled software present in the products of all AUTOSAR partners is our joint achievement. This brochure provides a selection of representative examples of AUTOSAR applications.

In the technical part, some of our partners give us an insight into how they are addressing the currently dominant automotive development trends such as Vehicle Operating Systems and Software Defined Vehicles and how they are extensively using the AUTOSAR standards developed in the global community for this purpose. We also hear from our partners in short stories about how they have successfully built on these joint efforts, in some cases since the beginning of AUTOSAR.

Our challenge will be to continuously adapt to the changing industry boundary conditions by evolving AUTOSAR, starting from Classic AUTOSAR, to Adaptive AUTOSAR and to cloud interfaces in the future.

AUTOSAR will not only continue to react to the changing industry needs but also will shape future vehicle and cloud architectures in cooperation with its own partners and with other consortia in the industry.

The increased presence of AUTOSAR in the regions described above will also contribute to this mission.

The chip crisis we all experienced the last years requires more flexibility to alter ECU designs in case of shortages. Standardization of low-level software and hardware is a key enabler for more flexibility to manage this.

Let me conclude that the need for AUTOSAR today and in the future is even higher than 20 years ago. Given the continuous growth of software content and complexity in automotive products, no player could meet all these challenges without applying standards to enable reuse and leverage of software contributed by other players.

As AUTOSAR Partners, we are fully committed to face all challenges to come.

We'll be on the road.

For more information on how to join us visit **autosar.org**

Limited Edition 20th Anniversary Publication

20TH ANNIVERSARY
2003-2023

"This 20th Anniversary limited edition publication gives you a flavor of the spirit of AUTOSAR. Especially the spirit of the Project Leader team, the long-lasting support of the Executive Board, the vision of the Steering Committee and the engagement of the Support Functions, as well as the many experts actively contributing to the success of it. Without their enthusiasm, devotion and engagement this success would have not been possible. This publication is therefore also an appreciation of their great contributions.

You will read exciting stories on the further developments of AUTOSAR and how it will pave the path to the future of mobility."

- Günter Reichart, AUTOSAR Spokesperson

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