The Software-Defined Car

Developments in In-Car Software

PART 1
Future Mobility Series
Automotive industry facing CASE and digitization

Never before in its more than 100-year history has the automotive industry faced such fundamental and sustainable changes. CASE/ACES (connected, autonomous, shared, electrical) and digitization offer a wealth of revolutionary potential, but also – as usual with any revolution – a whole range of challenges.

The race for the first fully autonomous car has flared up. Governments like Norway, for example, will decide to abolish the internal combustion engine by 2025. At the same time, more and more young people are deciding not to own a car and are opting for alternative, usage-oriented mobility models. And connectivity functions are already indispensable in modern cars – the most popular example is the E-Call, which has had to be installed as standard in new cars since 2018.

Cars are no longer just (electro) mechanical objects, but are becoming rolling computers and part of the Internet of Things. The trend towards the "intelligent" car is irreversible. The intelligence first arises in the car itself through sensors and integrated computing units, but also comes from cloud backends, edge computing instances or through interaction with other objects. The intense integration of and interaction with IT and telecommunications components also makes the car a prioritized object of digitization.

In our white paper series we will present the effects of CASE and digitization on specific automotive topics. In this first paper we address the developments in the area of in-car software.

Development of E/E platforms

Since around 2007, the automotive OEMs have been using platforms in the development of vehicles that focused on standardizing the configuration of the internal combustion engines used. 2020 is the first major upheaval, as platforms are created that will reflect the requirements of the new world of hybrid and purely electric drives. This developments will center the E/E architecture (electro/technical) and vehicle software.

The E/E architecture usually consists of three components: sensors, control units and actuators. The control units are the "brain" of the vehicle – they provide the hardware and software for on-board data processing. A premium vehicle has over 100 such control units installed within the old architectures, which control various functions such as infotainment, navigation, windscreen wipers, door openers, lights, but also safety-related functions such as brakes and airbags. The control units are distributed all over the car – with the corresponding challenges for the conception and design of a new car. Such decentralized architectures are difficult to reconcile with the CASE requirements: they are too complex and do not scale appropriately. This complexity becomes an impediment for efficient and fast vehicle development. To reduce the time to market for new developments, new E/E architectures and software concepts have to be established.

Cars of the future need central and consolidated architectures. Functionalities are then bundled in new, more powerful control units, for example in high-performance computers based on processing units. In this way, not only the number of control units is drastically reduced, but hardware and software are also increasingly decoupled from one another and standardized. Virtual control units run on the high-performance infrastructure, sensors and actuators take on some of the processing tasks. Powerful microprocessor-based all-round computing units that can be used for a wide range of tasks are thus replacing specialized microcontrollers. The brain of the car is being rebuilt.
Meaning of In-Car Software

The E/E architecture covers five domains starting with the infrastructure, which manages topics such as routing, security and vehicle condition management. The second domain, vehicle motion and energy, covers e.g. steering, braking and charging – this area will gain additional relevance through the electrification of cars.

The third domain covers an area that is currently being intensively discussed, semi-autonomous and autonomous driving (ADAS Level 1-5) as well as safety functions for driving. Body & comfort includes functions for lights, locking systems and gateways as central data interfaces into the vehicle BUS system. The fifth domain includes infotainment functions for vehicle occupants. This includes navigation, entertainment and telephony.

All these functions must be mapped in software. This turns the software into a make-or-break factor for the future of mobility. Depending on the criticality of the functions, the corresponding software suppliers need specific certifications. Another important point in the discussion about the development of embedded software are over the air updates. In the future, this possibility will offer automobile manufacturers new options for greater agility in software delivery – and thus for an intensification of the customer relationship. Over the air updates additionally allow new business offers automobile manufacturers new options for greater agility in software delivery – and thus for an intensification of the customer relationship. Over the air updates additionally allow new business offers.

McKinsey expects the in-car software market to grow by around nine percent over the next ten years (2020 – 2030). The growth is mainly driven by the operating system and middleware, body and energy, infotainment as well as autonomous and supported driving. The latter accounts for about half of the overall market.

In the past, automotive OEMs mainly focused on integration in the area of electronics and software. E/E topics, especially in-car software are currently being re-evaluated, and its strategic importance for the implementation of CASE strategies has been recognized: OEMs, but also tier 1 suppliers, have been increasingly involved in the past few years to ramp up the necessary coding capabilities via mergers & acquisitions and the establishment of international competence centers. In the long term, OEMs want to implement more than half of the in-car software services on their own. They want to use software providers for the other half.

Investments in software development per domains

<table>
<thead>
<tr>
<th>Domain</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>CAGR 2020-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>34</td>
<td>63</td>
<td>84</td>
<td>+9%</td>
</tr>
<tr>
<td>OS and middleware</td>
<td>8</td>
<td></td>
<td></td>
<td>+11%</td>
</tr>
<tr>
<td>Body and energy</td>
<td></td>
<td>9</td>
<td></td>
<td>+10%</td>
</tr>
<tr>
<td>Powertrain and chassis</td>
<td></td>
<td>6</td>
<td></td>
<td>+1%</td>
</tr>
<tr>
<td>Infotainment, connectivity, security,</td>
<td></td>
<td>14</td>
<td></td>
<td>+9%</td>
</tr>
<tr>
<td>connected services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADAS and AD</td>
<td>15</td>
<td>32</td>
<td>43</td>
<td>+11%</td>
</tr>
</tbody>
</table>

Source: McKinsey study *Automotive Software and Electronics 2030*
Added Value of External In-Car Software Providers

In-car software providers usually have a narrow focus on software development. Additional added value for the client arises when the in-car software provider can enable more comprehensive or even end-to-end approaches through additional skills.

This could be reflected, for example, in in-car software strategies that span the entire value chain – from requirements management to integration testing end to end.

This also includes security services (beyond the actual development), which will become increasingly important for the car of the future with its software-defined architecture. Security has two components: First, the functional safety of the systems on board of the car must be guaranteed (safety). An airbag or a brake must do their job reliably – even if they are software-defined. On the other hand, the IT on board has – supported by backend systems with near real-time capabilities – to recognize and withstand a wide variety of criminal intrusion attempts before any damage occurs.

Requirements for In-Car Software Providers

In-car software providers must offer a compliance setup that meets the client’s required process requirements. In addition, the functional safety of the software supplied must be ensured, especially compliance with ISO 26262, which is reflected in the Automotive Safety Integrity Levels (ASIL) A-D. Holistic approaches are characterized by the fact that the service provider also has in-car security expertise, so that he can offer penetration testing or intrusion detection software, for example.

The decisive factor for the performance of a provider is the quality and quantity of its in-car software developers as well as the associated functions for requirements and project management, testing and validation (also for XIL infrastructures). Introducing off-shore resources enable a well-balanced approach of onsite and remote services. In addition, the provider must know the respective E/E architecture and the associated product development processes of the OEM or tier 1 supplier.

Depending on the given reference model, the provider must master both agile and classic waterfall methods for software development and project management. Mastering the AUTOSAR® classic, AUTOSAR adaptive and MISRA C/C++ standards is also necessary for the software process. This also includes the use of standard tools such as PREEvision/Rational Doors and Jenkins.

A final important selection criterion can be that the provider actively participates in organizations that actively design development methods for in-car software.

Enterprises that involve external in-car software providers should therefore make sure from the outset whether they are not using the situation to choose a provider with expertise that goes beyond traditional software development. A holistic view of IT topics – from in-car applications to connectivity to the (cloud) backend including end-to-end security – is a core competency in the digital era that decides on success in international competition. International locations for development and testing might play an essential role for success as well.
T-Systems is one of the largest European ICT providers for the automotive industry. In addition to the provision of classic (outsourcing, on-premises) and modern (cloud, edge) IT infrastructures, the provider realized countless connectivity, integration and development projects for well-known automotive companies, thereof 13 of the top 20 OEMs and multinational tier suppliers. At in-car software, T-Systems focuses on the domains of information and communication, driver assistance (ADAS Level 0-3) and security, selected functions of body and comfort as well as infrastructure.

An overview of the white papers in this series:

• Part 1: The Software-Defined Car – Developments in In-Car Software
• Part 2: Over the Air Updates – Online Services for Automobiles
• Part 3: Teleoperated Driving – Remote Vehicle Control
• Part 4: Future Engineering – Reduce Time to Market

Sources:
[3] ASIL (Automotive Safety Integrity Level), IT-Wissen, 2019
[4] Automotive SPICE, Qualitäts Management Center im Verband der Automobilindustrie
[5] The standardized software framework for intelligent mobility, AUTOSAR