Drive autonomously with confidence

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The vision of "autonomous driving" promises users exceptional mobility and travel comfort. The prerequisite is that diverse components and functions reliably interact in a coordinated manner without errors. It will only be possible to turn this idea into reality when all market players reach a consensus, when highly reliable components are available and when multivendor interoperability is a given.

Autonomous driving, in which the user hands full control over to the vehicle, is attracting an increasing amount of attention. Almost daily, car manufacturers announce market-ready vehicles sporting the very latest automation features. Autonomous driving promises users more safety and comfort, while society benefits from sustainable mobility and improved traffic efficiency. At the same time, it is expected that accidents will be reduced. Targeted public policies in many countries will support this initiative.

This major challenge not only requires the melding of various sensor technologies, including radar, cameras and lidar, but also precise location determination and highly accurate map material. This information is updated continuously by using cellular technologies with backend servers to network vehicles. Enhanced data exchange between multivendor vehicles will add cooperative elements to autonomous driving. Predictive route and maneuver planning substantially improves safety, comfort and efficiency. This is particularly important during poor weather conditions that impair onboard sensors.

From consensus to cooperation

Today, mobility is currently undergoing the greatest transformation since the car replaced the horse and carriage. Until just recently, auto manufacturers and their direct suppliers dominated the market. Today, completely different industries are involved. The primary objective of these industries is to play a key role in paving the way for autonomous driving. Sensors are important components in self-driving cars and are already used for various driver assistance functions such as park assist and adaptive cruise control. These functions will mature even further in the future and become intertwined until they are capable of independently keeping a car within a lane, changing lanes, detecting other road users and obstacles in a timely fashion and responding appropriately. However, many critical traffic situations cannot be resolved effectively without communicating with the environment itself. In heavy traffic, the ability to recognize intent is key to cooperative execution of complex traffic maneuvers, such as changing lanes in moving traffic or merging onto the roadway. Cellular systems make it possible to communicate this intent. In order for cars to drive themselves in the future and to be able to relieve drivers of full liability in the mid-term, everyone involved in the value chain, including those from the extended market environment, has to come to a consensus.

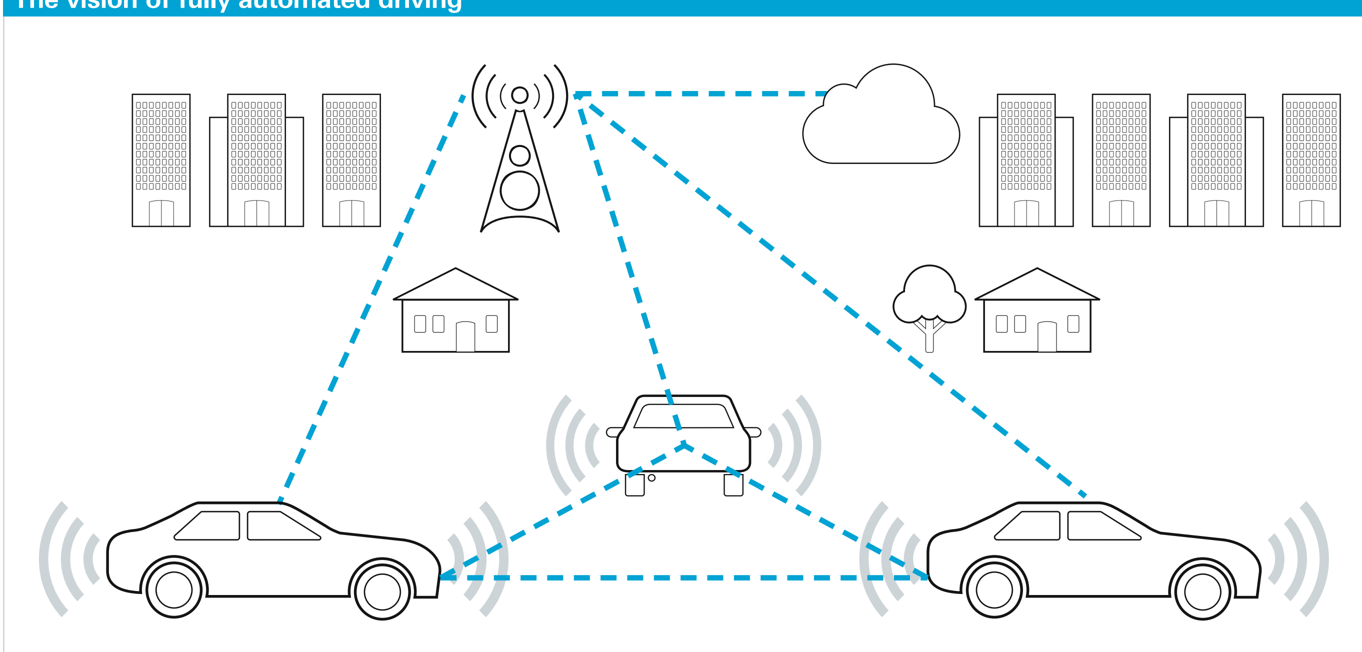
Cellular communications for mobility of the future

The local environmental model is enhanced with additional information gained from vehicles networking with each other and with the backend system. This model is generated based on vehicle sensor data and permits enhanced situational analysis. The locally obtained information is useful in allowing other vehicles to make traffic decisions. While applications based on the first generation of the intelligent transportation system (ITS) are nearly exclusively oriented toward the car driver and allow the driver to make all final driving decisions, future vehicle network services will permit direct intervention. This is a fundamental requirement for removing control of the automobile from the driver, and it leads to further requirements regarding vehicle functions. The execution of cooperative driving maneuvers, enhanced exchange of sensor data and continuous updating of map material require a high data rate, short latency and constant network availability, depending upon the application. It is critical that this functionality remain reliable in situations that prove challenging for cellular systems, including high subscriber density such as might occur during heavy traffic or at very high relative speeds. These scenarios fully tax the capabilities of today's cellular networks.

Cellular communications – the link between man and machine

A cellular system that can perform reliably at the expected high level can support humans in an early stage of autonomous driving. One example is on highways, where the expected situations are less complex. Critical is the section between the home/office and the highway. This is due to both the special traffic infrastructure at these locations, which are used by a variety of road users, and the high traffic density, which results in very complex scenarios. Teleoperated driving is one of the solutions

The vision of fully automated driving



under discussion for managing such situations. In this case, a remote driver is connected to the vehicle via the cellular system. He steers the car based on camera images that are captured and transmitted with only a very brief delay. Technical challenges and legal frameworks make large-scale commercial implementation a mid- to long-term goal.

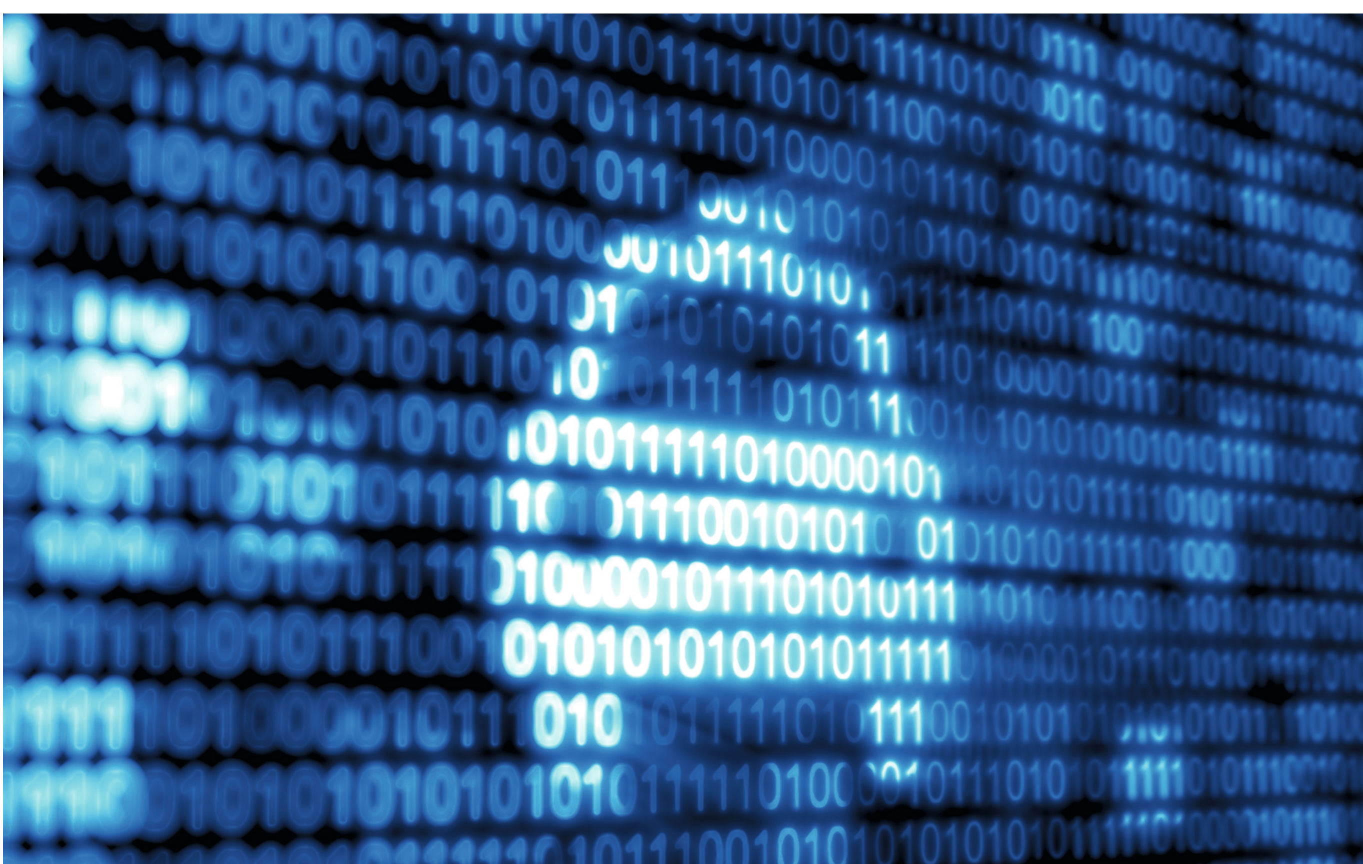
Ensure interoperability through common standards

Today's active and passive safety systems, such as safety belts, airbags and antilock braking systems, function independently of information sources from outside the vehicle. They are tested for functional safety based on ISO standard 26262. However, if a cellular system is used as an integral part of vehicle functionality, then automobile manufacturers, users, network operators, infrastructure manufacturers and service providers must redefine the rules of the game. This is important, because autonomous and cooperative driving will only be possible if all system components interact reliably. This won't be the first time the cellular world has accomplished this. The establishment of a common framework for interoperability testing over the entire value chain formed the foundation for a global cellular network.

Certification – a success story for the global market

In 1982, Group Special Mobile (GSM) within the European Telecommunication Standards Institute (ETSI) was entrusted with the task of defining rules for the establishment of a European digital cellular network. The objective of the resulting standard was to make it possible to set up and operate the network independently of cellular device manufacturers, network operators, infrastructure manufacturers and SIM cards. Prior to that time, not only were cellular networks based on analog technologies, they were also confined within national borders, networks and sometimes even regions. The first digital cellular standard in Europe intended to change all this. GSM fulfilled the important prerequisite for ensuring rapid implementation: the inclusion of all market players, including device manufacturers, network operators and governmental regulators. The objective was achieved and today GSM stands for global system for mobile communications, a name that reflects the global success of this technology. In 2000, GSM transitioned into the 3rd Generation Partnership Project (3GPP).

3GPP is a global cooperation of six independent standardization committees that define specifications for cel-



Connecting the automotive and wireless worlds

lular standards. It forms the technical basis for a global marketplace with a large number of manufacturers. The Global Certification Forum (GCF) is responsible for ensuring adherence to test specifications and also for questions regarding practical implementation of tests. The interest group of about 140 cellular network operators, device manufacturers and test houses verifies test specifications for the European and Asian markets. It also groups and prioritizes the specifications based on the sequence in which new functions will be implemented in cellular networks. As a prerequisite for actively marketing devices, network operators require that device manufacturers prove the quality and performance of their products through testing. Validated test cases are performed by accredited test houses and must be passed by both chipset and device manufacturers in order to obtain certification for their products. As a global provider of standard-compliant test systems, Rohde & Schwarz is involved in the definition of the 3GPP test specification and supports module and consumer device manufacturers by efficiently implementing the test cases in test systems.

Communications used for safety functions must function even more faultlessly than voice and data services between all vehicle classes – regardless of manufacturer, in every situation, and at all times. Automobile manufacturers must guarantee this, and the functionality cannot be based on the price class of an automobile. Proof of conformity with respect to cellular standards can be covered by existing cellular industry processes. However, there remains the question of how conformity will be ensured after successful integration into the vehicle. Any solutions must take into consideration the product lifecycle, which is many times longer than that of cellular devices.

5GAA – creating a common understanding

Tasks such as defining new test requirements or establishing the necessary consensus for interoperability were taken on by the 5G Automotive Association e.V. (5GAA). In 2016, 5GAA was founded by representatives of the automotive industry, chip industry and network equipment suppliers. Today, 5GAA has more than 30 international members, including many major network operators and automotive suppliers. The goal is to encourage the global development of solutions for autonomous and cooperative driving in the context of networked mobility. The developed solutions will be based on the results of a use case analysis, a technical (cellular) implementation, a study of a certification process, regulatory considerations and a study of the global market. Based on the global nature of this alliance and its member structure, it is conceivable that the developed studies and proposals will include previously raised questions with respect to assessing performance. 5GAA would be able to use these to define the necessary harmonizing approach and to make regulatory recommendations.

Summary

When highly automated driving requires a connection to a backend server, to the infrastructure and to other vehicles, communications will become a fixed component within the automobile – requiring a complete rethinking. In the past, auto manufacturers could independently determine whether and to what extent they wanted to implement driver assist and infotainment systems and use them to differentiate themselves on the market. As automated driving advances, it is necessary to standardize a jointly defined, minimum level of system performance. That will ensure the necessary communications between all road users at the highest level of automation and will allow prior testing based on jointly defined criteria. This means implementing necessary functions that also work between luxury class and compact cars.

The industry's greatest challenge in introducing automated driving is mixed-traffic scenarios, i.e. when automated, partially automated and manually operated vehicles are all on the road at the same time. This requires an additional component for artificial intelligence. The fully automated vehicle must be able to predictively and correctly detect manually steered vehicles within fractions of a second. A simple "if – then" statement such as commonly seen in computer programs today will no longer be sufficient. These systems require many years of training in a variety of different situations so that they can respond appropriately at the decisive moment. It will be some time before fully automated vehicles take over the steering wheel. However, the way is already being paved today by advancing standardization, the development of the technological fundamentals and the precedent-setting definition of legal frameworks. Safety and liability will be the deciding criteria in making automated driving a success, and they will figure prominently as considerations in every automobile purchase. Because man has always had zero tolerance for machine error.

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