Press release

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Increasing the resilience of connected automated mobility systems

ConnRAD research project presents results

- Foundations for secure communication via cellular networks for connected automated driving.
- Various concepts for increasing the resilience of distributed traffic systems.
- Demonstration on the Bosch test track in Renningen.

Stuttgart, Germany – In the future, connectivity and digitalization will play an increasingly important role in road traffic. While this will bring about improvements in efficiency and safety, it also poses challenges with regard to the reliability of data exchange. This is where the three-year ConnRAD research project comes in. It provides important foundations for ensuring that connected mobility systems function reliably in road traffic, even when supplied with incomplete or uncertain information. The key word here is "resilience." The acronym ConnRAD stands for "connectivity & resilience for automated driving functions in Germany." Under the consortium leadership of Bosch, a project team – consisting of the Daimler Center for Automotive Information Technology Innovations (DCAITI), Fraunhofer-Institut für Offene Kommunikationssysteme (FOKUS), Fraunhofer-Institut für Entwurfstechnik Mechatronik (IEM), Hochschule für Technik und Wirtschaft des Saarlandes – htw saar, Infineon Technologies AG, Technische Universität München, TÜV SÜD, Universität Ulm – researched how connected transportation systems can be designed, developed, and released in a robust manner in the future. The project was funded by the Federal Ministry of Research, Technology and Space.

ConnRAD results help to make left turns safer

The exchange of information with other vehicles in the environment as well as with the infrastructure, such as traffic lights, increases the efficiency of automated driving functions. In technical jargon, this is referred to as V2X communication (Vehicle to Everything). The reliability of this data, however, can vary considerably. Depending on the traffic situation, weather conditions, or the source of the information, it may be limited, of poor quality, or completely unavailable. To remain resilient to such shortcomings and to make optimum use of the available data, automated driving systems require a quantifiable degree of reliability of the exchanged information and data channels.

This is exactly where ConnRAD comes in: the project team developed mechanisms that allow the communication partners in road traffic to verify and evaluate their own and each other's reliability and suitability. Based on this evaluation, the receiving vehicle's system then decides whether a specific communication partner and the transmitted information are sufficiently qualified and trustworthy to support safety-critical driving functions. Only then is the received V2X information used for such purposes. This enables smart filtering of the data and significantly increases the safety of automated driving functions.

A particularly illustrative example relates to left turns at urban intersections, which Bosch, FOKUS, and DCAITI helped to make safer as part of the project. To this end, the surround sensors of the road infrastructure – such as radar or lidar systems in this case – communicate directly with the vehicles. The ConnRAD methods allow the vehicle to assess the reliability of this infrastructure data based on its origin and quality. Specifically, it was found that if a vehicle merely receives a blanket intersection clearance without any metadata, this would result in an accident, if drivers did not intervene. However, if meta data from the surround sensors are also provided, the vehicle can assess the reliability. If, for example, only a radar signal is provided, which may not be sufficient for particularly complex scenarios, the vehicle will abort the turning maneuver. Only with joint confirmation from multiple high-quality surround sensors, such as radar and lidar, can it turn safely. In another example, htw saar uses plausibility checks to assess the trustworthiness of the V2X communication and thereby prevent rear-end collisions at the end of traffic jams.

Robust overall system for efficient V2X communication
ConnRAD developed an innovative communication architecture to form the basis for a robust and resilient overall system. This architecture considers not only aspects of cybersecurity (to protect against attacks) and functional safety (for reliable operation) but also takes relevant regulatory and organizational framework conditions into account.

At the heart of the architecture are extensions of existing message protocols and interfaces. These extensions allow the communicated information to be evaluated and verified on a continuous basis during operation. Specifically, the quality and reliability of data has been made measurable, assessable, and verifiable. When faced with declining data quality, the driving system can thus safely and automatically initiate suitable countermeasures – for example, by switching to alternative sources of information or adapting the driving behavior. An important contribution in this regard was made by the project partner Infineon Technologies AG: the company devised concepts for a hardware-based authentication of the communication partners. In this case, inherent signatures of the cellular components are effectively used as an unchangeable "fingerprint," thus allowing the transmitted data to be uniquely identified as genuine and originating from this specific hardware. This greatly increases security since the authenticity and origin of the data is guaranteed directly via the hardware of the communication partners and any attempt at manipulation is rendered significantly more difficult.

The Technische Universität München devised novel approaches to increase the safety of teleoperated driving (remote control of the vehicle via a secure connection) with reduced communication bandwidth. These include, for example, the "Ability Awareness Protocol" in combination with trust metrics, which helps the system to clearly allocate its own capabilities across subsystems, recognize boundaries dynamically, and respond accordingly. This is complemented by the "Network Predictive Quality of Service." The latter is an approach for the predictive assessment of network quality to facilitate early intervention in the event of potential communication problems.

The simulation results from the University of Ulm for a probability-based trust assessment also confirm a significant improvement in system resilience. The Fraunhofer IEM extended the development process to systematically incorporate the resilience requirements of distributed driving functions into system development. The legal and regulatory framework conditions were assessed by TÜV SÜD. Based on the experiences gained and the simulations completed, the ConnRAD partners were able to derive a reference architecture along with a comprehensive set of methods for developing resilient driving functions in connected, distributed systems. Thanks to the ConnRAD approach, the scalable approval of safety-related driving functions in distributed systems is now possible.

A cooperation of ConnRAD research project

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