Position Paper on:

Connectivity for Automated Driving

Summary

Vehicle connectivity is a term used to describe the communication technology which allows vehicles to access services through a wireless connection. It is sometimes referred to as V2X for Vehicle-to-Everything connectivity. Vehicle connectivity uses any of a number of different wireless communication technologies to communicate with other vehicles (V2V), road network infrastructure (V2I), and the network (V2N).

Once the basic technology is in place, an array of applications can be developed, some of which cannot be foreseen today but could include remote diagnostics, over-the-air updates, product monitoring and usage, emergency and breakdown calls, data analytics, etc. Additionally, it is used to receive a set of information to improve user experience for a variety of Advanced Driver Assistance Systems (ADAS). Thereof, connectivity would contribute to improve road safety by notifying about potentially dangerous situations, assist in reducing congestion through optimal routing, improve traffic flows using speed recommendations, reduce environmental impacts by optimising power train management and avoiding unnecessary stops, etc.

A specific instance of vehicle connectivity is the so-called cooperative systems which adds the capability to directly interconnect with neighbouring vehicles (V2V) to share essential data as an additional vehicle sensor would do (position, speed, direction, type of vehicle, etc.).
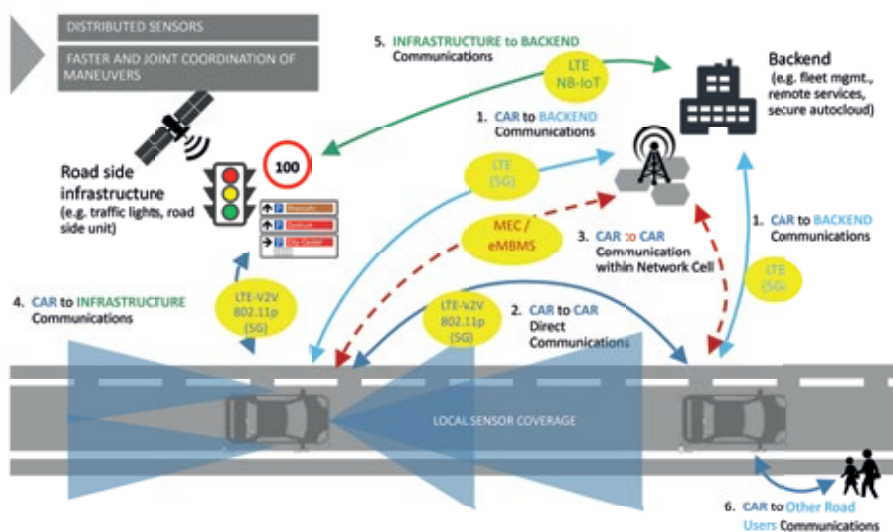
Figure 1: Communication technologies helping automated vehicles to operate safely.

Source: Deutsche Telekom - modified from original

There are still remaining challenges to be addressed to create the most suitable framework conditions for successful market introduction and sustainable operations of connectivity for CAD:

- Does a Level 2 CAD vehicle need back-end connectivity? Can it solely rely on its own sensors?
- Will higher levels of automation (i.e. L4 and above) require connectivity to a back-end? If yes, what performances are required? What if the communication fails?
- How do we ensure that incidents on the roads are swiftly detected and reported to all relevant vehicles? Where should this information be published? By extension, where should geo-located traffic information be published and disseminated? In short range, on an access point or/and on an IoT platform?
- Will privacy and security concerns be addressed in order to build up trust among the users?

Moreover, for safety-critical decisions and low-latency manoeuvres, current systems could but do not take into account data from devices in the direct surrounding of the vehicle. This brings a set of additional challenges:

- Should CAD vehicles mostly rely on their own sensors to make safety critical decisions? Can V2V data be considered as another sensor?
- Should higher levels of automation wait for higher penetration of V2V equipped vehicles?
- Are CACC and platooning the best level 1-2 applications motivating V2V equipped vehicles?
- How can a CAD vehicle include V2V data in its safety-critical decisions?
- How do we ensure safety of all road users? How do pedestrians, bicyclist and bikers participate to V2V?

In collaboration with CARTRE, one of the GEAR 2030 working groups formulated the following conclusions about the immediate need for connectivity to accelerate CAD deployment:

- Vehicle-to-everything (V2X) connectivity, in its various forms, will act as an additional enabler for the highly and fully automated vehicles.
- Industry efforts to develop V2X for highly and fully automated vehicles have accelerated significantly and will eventually lead to 5G working jointly with standards such as ITS-G5 and C-V2X. Technology neutrality will be essential to ensure the best solutions can be developed, and can continue to be evolved, by the market in line with public policy priorities.
- The development of viable business models will be as essential to successful V2X deployments as the technology itself, which can act as an enabler. Flexible regulatory approaches are needed to allow industry and public bodies to generate the considerable investments needed to deploy V2X connectivity in vehicles and infrastructure (road and telecoms) in a sustainable manner, in line with public policy priorities.

On this basis, expert discussions within CARTRE further elaborated a series of recommendation, most of which led to identification of gaps and research recommendations in the CARTRE reports:

- Lower levels of automation cannot (and will not) wait for wider penetration of the V2V/V2I short range communication: Level 2 automated vehicles will rely essentially on its on-board sensors and may additionally include Internet connectivity to connect to a back end service (e.g. vehicle cloud).
- Current C-ITS standards do not yet answer the needs of automated driving especially for safety critical functionalities: There will be a need for a next generation of V2V-V2I protocols and communication technologies e.g. short range secured exchange of sensor and manoeuvring data with high degrees of reliability and quality control. In addition, C-ITS standards need further work in order to guarantee independence of the communication stacks so that newer lower layer communication technologies are interoperable. These new Work Items need to be addressed by relevant SDOs.
- Higher levels of automation will require reliable and low latency connectivity to a vehicle cloud or back end to operate safely. Only on this basis, Automated Driving "service suppliers", most likely OEMs, will take the responsibility of the driving task. Would this connectivity fail, the vehicle should ask the driver to pay attention to the road situation e.g. L2. On the other hand, V2V, if available, will increase the LoS especially for applications such as CACC and Platooning.
- Internet of Things may solve many current issues using common horizontal approaches on data privacy, cyber security, data location, publication and access, service discovery, etc. Many of these issues are highly relevant but not specific to CAD. Cooperation with ICT communities is more than needed in order to bring these issues at a wider horizontal level in transport and avoid designing specific road transport solutions.
- Vehicle clouds as an extension of the vehicle on-board sensor platform and their interfaces to the service clouds will offer a viable solution to the connectivity with traffic managers, road operators and other services of public interest. It will reduce security vulnerabilities and ensure relevant parties are involved in the CAD operations. However, it will be important to guarantee fair access to data and freedom of choice.
- Connectivity reliability, quality, coverage will always remain an issue today or in 2040 but at different levels of QoS. It is essential to address the connectivity needs on a long term road map considering gradually higher levels of automation as new communication technologies are being deployed.

The CARTRE CAD expert community strongly encourages further research and innovation on the connectivity for CAD, including cross-fertilisation actions with the ICT sector. It welcomes active contributions of current and future initiatives helping to define connectivity for higher levels of automated driving.