Position Paper on:

In-Vehicle Technology Enablers

Summary

In-vehicle technologies are key enablers for connected and automated driving (CAD). The foundation for current developments is driven by decades-long technical advances in Advanced Driver Assistance System (ADAS). These advances have contributed to recent Highly Automated Driving (HAD) developments. HAD will lead to a paradigm-shift in the driver-vehicle responsibility relationship. This shift will result in never-before-experienced demands on internal and external technical components. Additional new social and legal expectations are therefore emerging. The challenge is to cope with these new expectations, to master the growing in-vehicle and external networks complexities, while also reducing costs and time to market.

Challenges

In-vehicle enabler advancements will impose three main challenges:

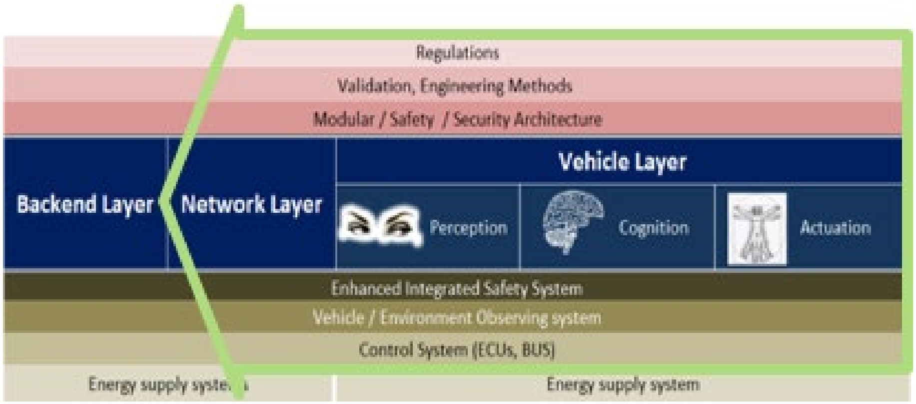
- **Societal expectations** like improved road safety, and reduction of pollution and congestion require a consensus on the application of these new technologies.
- **Costs / Complexity:**
    - Significant safety relevant system changes and extensions are required, which can lead to a strongly divergent solution space. Standardisation and harmonisation will cut down costs and reduce complexity.
    - Align developments within the digital/telecommunication and automotive industries through standardisation, which might pose additional challenges.
- **Time to market:** avoid that existing, inadequate and varying European regulations slow down development and deployment of automated driving.

Statements

Disruptive elements:

- **The physical change:** The actuation role of the driver and the role of the driver as sensor, decision maker and observer is transferred to the vehicle, that is the “driver is no longer a fail-safe backup”.

  Consequences: The driver cannot be considered a fall back. The system design has to cover “fail operational” abilities. The typical “fail operational” design of braking, steering and subsystems as e.g. the power-net requires further redundancies than “fail safe” requires. Interference of systems, e.g. with the power net, leads to a considerable complexity and thus to an enormous solutions space.
- **The change of responsibility:** Responsibility is transferred from the driver to the vehicle. Changes, uncertainties and risks of open word traffic originally handled by the driver are now to be handled by the vehicle itself, i.e. the “Driver is no longer responsible”. Consequences: product liability risks are being transferred to OEMs (and their tier-1 suppliers) and together with higher safety expectations - driven by societal expectations - result in a common and permanent observation and learning platform.
- **The change of the vehicle towards becoming part of the communication network**. The advances in the digital and telecommunication world will require the vehicle to be part of the network. Consequences: External mobility data will be part of driving functions including safety impacts. Vehicle subsystems impose needs for in- and external data exchange. The vehicle has to be able to handle failing communication links and include cybersecurity aspects (see figure below).



Input for research agenda

The European Commissions' future research agenda must enforce collaborative research and innovation by:

- Developing common safety assessment methodologies and regulations, which merge simulation, test tracks, and field operational tests with real-world data - to maximize safety and mitigate liability risks.
- Accelerating European-wide legal harmonization process and establishment of standards to foster development and deployment
- Developing cutting-edge, reliable, and cost efficient perception, cognition and actuation systems considering redundancy
- Fostering collaboration, standardization, and harmonization between digital/communication and automotive industry

Moreover, workforce and skills development in digital technologies should be fostered in order to cope with the increasingly complex mobility environment, including artificial intelligence such as deep learning.

Impact

Potential impacts, which are all dependent on each other, are:

1) **Technical:** The ongoing developments in CAD will result in crucial changes to the in-vehicle system boundaries. First, highly advanced sensor systems, high performance computing hardware, redundancy of actuators, and cutting-edge algorithms are required. However, these technical advances alone will not be sufficient. Both network and backend layers will expand the vehicle system and its subsystems (see figure). Layers only applicable to today's mobility sector still need to be expanded and should incorporate regulations, methods, and architecture.
2) **Societal and legal:** The paradigm-shift in the driver-vehicle responsibility relationship will lead to new social and legal expectations that should not hinder user acceptance or market deployment.
3) **Market:** All these developments will have to occur while also reducing costs and time to market.