Highly automated driving for commercial vehicles

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P.E. Pfeffer (Ed.), *6th International Munich Chassis Symposium 2015,* Proceedings,
DOI 10.1007/978-3-658-09711-0_2

Summary

Highly automated driving is a further decisive step towards accident-free driving based on intelligent interaction of driving assistant systems, which in turn will result in increased road safety. In addition, this concept will reduce the stress to which drivers are subject and increase their comfort level in monotonous traffic situations (e.g. long stretches of highway driving or stop-and-go situations), provide greater efficiency and economy and contribute to ecological sustainability. The Future Truck 2025 has now demonstrated for the first time how much freedom for new tasks can be created in the logistics field, even while the vehicle is in motion, to improve the working environment of truck drivers. This shift of emphasis from being “just” a driver to being a transport manager offers enormous potential, but is accompanied by a new kind of driver/vehicle interaction.

The first phase describes the overall functionality and the components required. By adding connectivity through V2V, V2I and the Internet, all functionality is enhanced still further, making additional opportunities available to both the customer and driver.

Tomorrow's driver's cab shows very clearly that providing a corresponding interior and actively involving the truck driver in the vehicle's functionality generates understanding and, as a result, a higher level of user acceptance. To this end, it is essential to provide reproducible driving behavior that is transparent and fully understood by the driver.

1 Highly automated Driving in the Future Truck 2025

The Future Truck 2025 was presented to the public at the IAA Commercial Vehicles Trade Show in 2014. Technical demonstrations followed on a limited section of the A14 highway in Magdeburg. The vehicle convincingly demonstrates how efficiency and safety can be maximized by the use of highly automated driving.

1.1 Motivation

The considerable increase in goods traffic anticipated in coming years in conjunction with a slowly growing infrastructure shows how crucial it is to make optimum use of existing resources. [1] In addition, forwarders are subject to increasing pressure from costs, in particular fuel costs, highway toll charges and a lack of suitable drivers. There is a suitable solution to these issues:

We must make better use of the existing infrastructure, apply assistance and telematics systems to a greater extent and interlink them more efficiently and make the truck driver's job much more attractive.

1.2 Functionality

The core function of this concept is highly automated driving on highways without the need for the driver to grasp the steering wheel and thus allowing him to perform other activities that are not directly related to driving the vehicle.

After entering the highway, the driver of the Mercedes-Benz Future Truck 2025 takes up a position in the traffic flow in the appropriate lane. The system then offers the driver the "Highway Pilot". If the driver activates the “Highway Pilot functionality” , the system switches to highly automated mode. Fig. 1

Fig. 1: Instrument display in the Highway Pilot mode and the instruction to the driver to take over control later on

Depending on the current traffic situation, the Future Truck 2025 operates highly automated and does not require another vehicle in front to guide it through traffic. Within its traffic lane, it runs highly automated. If another vehicle is driving in front of the truck, it can use that vehicle's speed as a guide within the permitted speed limits and maintain the required safe distance. As a result, there is no inherent danger if another vehicle moves in in front of the truck. Safe distances are automatically maintained – the Mercedes-Benz Future Truck 2025 adapts perfectly to its surroundings. The Future Truck 2025 operates independently of other vehicles. Through its additional networked systems, it is fully aware of its infrastructure and is thus able to improve its logistical efficiency. Open standards and communication protocols are a prerequisite for this functionality.

1.3 Challenges facing highly automated Driving

The technical preconditions have been demonstrated for the first time in the Mercedes-Benz Future Truck 2025, but adjustments to the legal framework will be required to permit this new driving standard to come public roads. Further adaptation of the Vienna Convention on Road Traffic (1968) [2], which has been signed and ratified by almost all European States, is in progress. This is an international treaty designed to increase road safety by establishing standard traffic rules among the contracting parties and states that the driver must at all times and in all circumstances be in control of his vehicle.

UN/ECE Regulation R 79 for steering systems, which is based on the Vienna Convention on Road Traffic, permits corrective steering functions but does not allow automated steering at speeds in excess of 10 km/h. This is a crucial aspect in permitting automated parking assistance and stop-and-go control systems.

Technically and legally it is a further requirement that data shall be transmitted safely and surely. This applies both to actions from outside affecting an individual vehicle, and the transmission of data in V2V and V2I communications and the Internet.

Besides vehicle homologation issues, there are also matters relating to road traffic law, such as liability for traffic violations and in the event of accidents, which it will not be possible to prevent all together. The same applies to such matters as insurance and product liability. Fig. 2

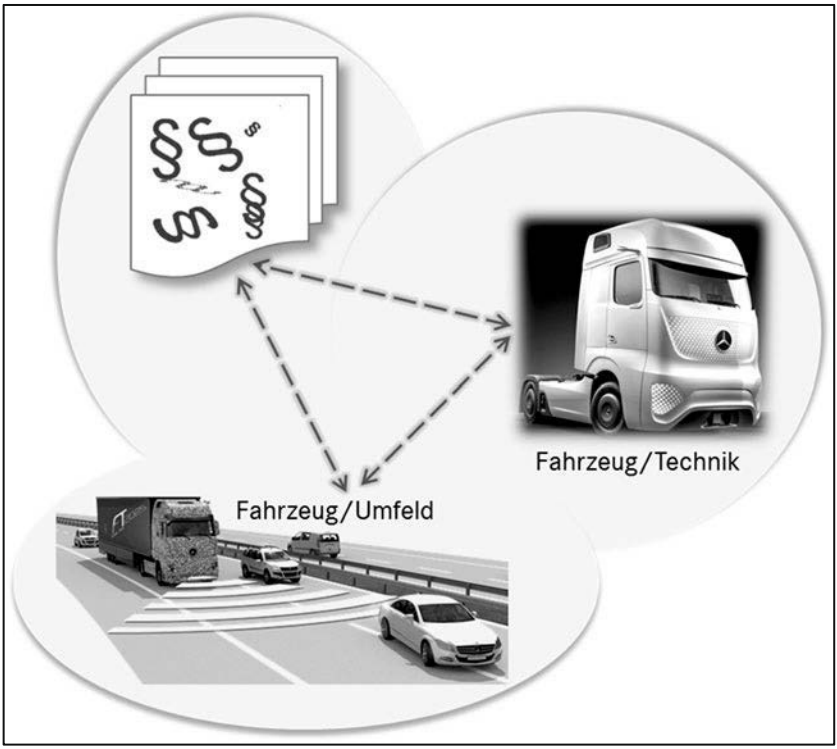

Fig. 2: The legal framework and data protection will also influence highly automated driving

2 The Technical Background of the Future Truck 2025

To enable highly automated driving, a system has been installed on-board that provides basic functionality even when connectivity is interrupted. V2X and Internet connectivity cannot be reliably guaranteed at all times because they are dependent on the strength of the network and the density of usable V2V vehicles.

2.1 Radar Sensors and a Camera Scan the Surroundings

Highly automated driving in the Mercedes-Benz Future Truck 2025 is enabled by means of two independent kinds of sensors. Camera and radar systems detect and monitor the environment around the vehicle for highly automated driving. Fig. 3

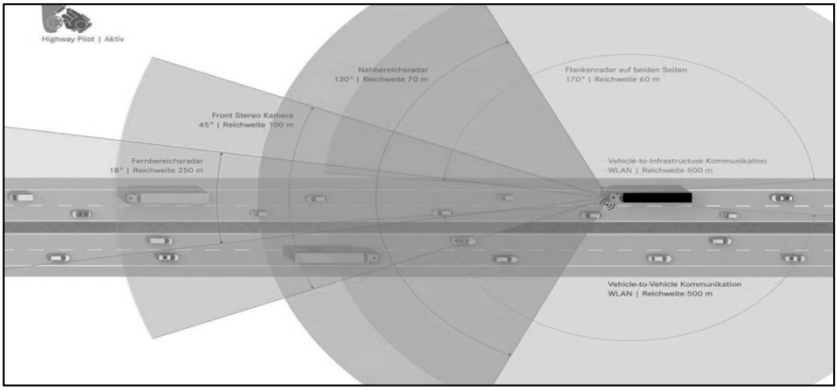

Fig. 3: Detecting the surroundings using radar and camera sensors

In the lower part of the vehicle front, a radar sensor scans the near and far ranges to the front. The front radar sensor covers a range of 250 m and a spread of 18 degrees. The close-range sensor covers 70 m and has a spread of 130 degrees. The radar sensor forms the basis for such safety systems as adaptive cruise control and emergency braking assistance, which are already in production today.

Additionally, there is a stereo camera system installed above the dashboard behind the windscreen that monitors the space in front of the vehicle. In today's optional lane keeping assistance systems, there is a mono-camera in this position. The stereo camera has a range of 100 m and covers a horizontal spread of 45 degrees and a vertical spread of 27 degrees.

The stereo camera fitted to the Mercedes-Benz Future Truck 2025 identifies single- and two-lane roads, detects pedestrians, moving and stationary objects, and all other objects within the area monitored. The camera detects everything that stands out in some way from its background and can, as a result, accurately detect empty space. The front stereo camera also detects the information presented by road signs.

As well as detecting objects and free space, this stereo camera system can detect lanes, which is a key function for highly automated driving.

The road areas to the left and right of the truck are monitored by radar systems mounted on the sides of the vehicle. They are mounted to the left and right in front of the rear axle of the vehicle. Their range is 60 m and they cover a spread of 170 degrees in a longitudinal direction.

Drawing together all this information, the system generates a model of the truck's environment that contains all the objects relevant to highly automated driving. Based on this model, the system calculates the vehicle's speed and steering angle and transmits these to the drive train and superimposed steering system.

2.2 Connectivity

All the sensors on-board the Future Truck 2025 are interlinked to each other (multi-sensor fusion) and contribute to a comprehensive view of the environment. The sensors detect every stationary or moving object in the area around the truck.

All the data supplied by the individual sensors covering the entire area in front of and beside the truck is brought together in the high-performance multi-core processor in the central computer.

The sensor and camera technology is designed to work efficiently up to the permitted maximum speed for heavy goods vehicles (HGV). The system ensures the truck retains its position in the center of its lane by means of fully-automatic steering adjustments. The system also has a digital three-dimensional map on board as already available as Predictive Powertrain Control (PPC) systems. The truck is, therefore, always fully aware of the intended route and the surrounding topography.

2.2.1 V2V and V2I for highly automated Driving

The Highway Pilot is ideally supplemented by V2V and V2I communications. The messages exchanged should contain the following information: Vehicle position and type, vehicle dimensions, direction of travel and speed, any acceleration or braking activities and the currently steered curve.

The frequency of the transmission of that information will depend on the speed of the vehicle and the intensity of its changes of direction. The transmission frequency ranges from one telegram per second during uneventful driving to ten-times as often where noticeable changes occur.

Transmission uses WLAN technology over the pan European uniform G5 frequency at 5.9 gigahertz. The basis for this is the ITS Vehicle Station (Intelligent Transport Systems and Services) on-board the vehicle.

Communication between the Future Truck 2025 and other vehicles (V2V) covers a range of approx. 500 m in all directions. Using this medium, vehicles can mutually communicate details of their motions and can respond in good time where necessary. This includes, for example, response to vehicles pulling in in front of the truck on the highway or the approaching end of a tailback. The more vehicles communicate in this way with each other, the more dynamically and flexibly they can respond to each other and the current situation.

Ideally, this will result in an uninterrupted chain of communication along the road which will notify the drivers and vehicles as required about the exact traffic situation even far ahead of the vehicle.

Vehicle-to-infrastructure (V2I) communication means that all these notifications and signals are also sent to external recipients, such as traffic management and control points. These organizations can respond flexibly, for example, by adjusting the maximum permitted speed or opening up additional overflow lanes. In return, messages can be transmitted to vehicles to warn about short-term roadworks, for example. Fig. 4

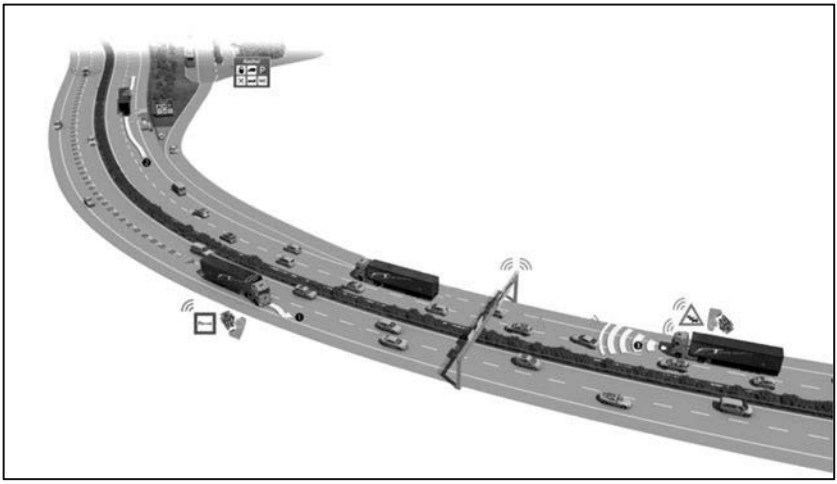

Fig. 4: V2V and V2I can optimize the traffic flow and increase efficiency

All this data informs the driver and the vehicle computer right away about events that are beyond their respective visual ranges. In this way, the driver and vehicle become aware of obstacles ahead long before a hazard situation can occur.

2.2.2 For the Vehicle Owner and the Driver

However, in order to take full advantage in terms of logistical efficiency and to optimize the benefits provided by the infrastructure, interconnection between all the various systems would be beneficial. This development will, no doubt, progress step-by-step. Open standards and communication protocols are a prerequisite for this functionality.

Highly automated driving can take the pressure off the driver so he does not have to concentrate on the driving at all time, in particular on stretches that are monotonous and prone to induce drowsiness. Since the truck can regulate its speed automatically and can use the navigation system independently to find the optimal route, and since the freight forwarder, sender and recipient of the freight are all aware in real-time of the current location, progress of the journey and anticipated arrival time, there is far less pressure on the driver to keep to the schedule. It is this pressure that accounts to a large extent for stress in the driver's cab.

At the same time, the driver gains time for other tasks and can communicate safely with his environment. It is conceivable that the driver might take on tasks previously

dealt with by scheduling clerks or keep up with social contacts. In particular, self-employed drivers will be able to pursue office activities in comfort while traveling.

Taking on additional tasks will, in this way, make marked changes to the truck driver's profession by offering the opportunity to become more of a transport manager rather than just a truck driver. The truck driver's profession will become more attractive – highly automated driving is, therefore, a clear response to the problem of a lack of drivers. The truck and its driver team up through highly automated driving.

3 Tomorrow's Workplace

The interior of the Future Truck 2025 stands out because of the reduction of functions to only what is necessary and the purist design. The traveling workplace is designed to be unfussy and tidy, as one would expect of a modern, paperless office. Modern technology is in a fascinating contrast here to natural materials, warmth and comfort.

The dashboard is tidy and minimalist, displays take the place of instruments and outside mirrors. The displays appear to hover in front of the piano-finish surfaces in the cockpit. Instead of intrusive air jets, the air-conditioning system uses indirect air flows, the touchpad takes the place of traditional rows of switches. Fig. 5

Fig. 5: The workplace in the Future Truck 2025

When the truck is traveling in the highly automated mode, the driver can, if he so wishes, move his seat backwards and, at the same time, turn it through 45 degrees towards the open space – allowing him to take up a more relaxed, comfortable working position. The indirect lighting also brightens the interior of the cab without creating dazzle.

In the workplace of the future, the driver communicates while on the road via the tablet computer which is slotted into the new design of central console, ready to be taken out for other purposes. Using this tablet, the driver can process various documents, arrange schedules for new destinations, accept and plan new orders and organize his next break. The computer screen can be freely configured, allowing the driver to call up any of the journey data he may require.

Instead of the steering wheel and pedals, the tablet computer becomes the main work medium on long, highly automated journeys. The Mercedes-Benz Future Truck 2025 will result in a new form of work in the driver's cab of long-distance trucks. Fig. 6

Fig. 6: The driver works with the tablet PC and the driver's seat is swiveled through 45°

4 Summary and Outlook

Highly automated driving in commercial vehicles is a necessary move in view of continued increases in goods traffic to ensure the existing infrastructure is used to the optimum. At the same time, the Highway Pilot represents a further step towards improved road safety because interlinked communications will allow hazardous situations to be communicated much faster and appropriate action taken.

Highly automated driving on highways relies to a large extent on sensors integrated in the vehicle. Connectivity allows these driving functions to be optimized still further and opens up new opportunities. In addition to the technical challenges, there are issues to be discussed concerning data security, homologation and road traffic law.

State-of-the-art workplaces for truck drivers are a key challenge for the future involving harmonizing design and functionality with a feel-good factor. Confidence in highly automated driving must be quickly established, while ensuring that drivers are presented with sufficient challenges. Many HMI functions will be transferred from the steering wheel or dashboard to positions much closer to the driver.

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[1] BMVI Verkehrsprognose 2030 (2014) (Road-Traffic Forecast for 2030 by German Ministry of Transport (BMVI) (issued 2014)).

[2] 0.741.10 Vienna Convention on Road Traffic dated 8 November 1968, updated 15 Feb. 2013

http://www.springer.com/978-3-658-09710-3

6th International Munich Chassis Symposium 2015
chassis.tech plus
Pfeffer, P. (Ed.)
2015, XXI, 871 p. 471 illus., Softcover
ISBN: 978-3-658-09710-3