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NEWS RELEASE

Ko-HAF: Investigating the takeover processes for highly-automated driving

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Imagine being behind the wheel of your car, but not having to concentrate on steering, clutch control, or the road ahead. For upcoming generations of vehicles with Level 3 automation, drivers will experience increased flexibility as they are not required to have their hands on the steering wheel at all times or monitor the surroundings constantly like before. Recognizing the opportunities as well as the HMI challenge this scenario poses, Visteon took the lead in the human-machine interaction (HMI) works stream in the German Ko-HAF research project promoting greater road safety and efficiency through highly-automated driving.

Highly-automated driving has been the guiding vision of the German research project led by **Kooperatives hochautomatisiertes Fahren** (Ko-HAF), which started in 2015 with strong support from industry and governmental bodies – including the German Ministry for Economic Affairs and Energy. A selected circle of renowned car manufacturers, suppliers – Visteon among them – and research institutes have committed themselves to investigate this important topic.

The project goal is to increase safety and efficiency on the road by means of cooperative and highly automated driving at speeds up to 130 km/h (80 mph). Cooperative vehicles collect information about road incidents and send them to a central server. The server aggregates, evaluates, and condenses the information and disseminates it back to following vehicles to augment their sensor horizons. Five different working groups were created in order to gain specific insight, focusing on the safety server, front-end and HMI, function development, and validation and test.

Visteon's Dr. Christian Müller-Tomfelde, principal software engineer; and Jochen Klaus-Wagenbrenner, manager, engineering; were part of the work stream covering HMI - with a focus on investigating the takeover processes for

highly-automated driving.

As Level 3 autonomous vehicles starts to appear on the road, new concepts for human-vehicle interaction for automated driving systems need to be developed. However, the safe transition from automated back to manual driving – for example, from Level 3 back to Level 2 – must be ensured first.

A Level 3 driver pursuing a non-driving related task needs to always be receptive for notifications from the driving system and ultimately understand and accept the request to take back control of the vehicle. At the same time, the driving system needs to yield enough temporal leeway to drivers to allow them to complete their current activity and transition to the manual dynamic driving task.

Driver monitoring technology bears the potential to deliver a significant step forward but also comes with a dilemma when trading off safety and acceptance in the takeover management - a diligent HMI design can help to mitigate this problem. Visteon suggests a HMI request cascade with rising urgency. Pre-requests of the cascade strengthen the safety of the takeover as the function limit of the automated driving system is notified to the driver with more than enough leeway to transition to manual driving. Furthermore, the driver can choose a point in time for taking over that suits their situation.

Another advantage lies in the following case: If an unexpected event happens after the first pre-request, the overall time available for the takeover shrinks, but the request cascade remains the same, except the timing. Finally, pre-requests can also be perceived by other passengers - who can then contribute actively in getting the driver back into the dynamic driving task.

Automated driving at Level 3 and higher reorders the role of the driver and the automated driving system. The driving system needs to signal the takeover to the driver – who is occupied with a non-driving activity – with an appropriate leeway. Therefore the data from driver monitoring sensors focused on the driver's state inside the vehicle needs to be fused with that concentrated on the driving situation outside the vehicle.

Transitioning from Level 3 back to Level 2 (assisted driving) requires a new system component for managing the takeover. The component remains dormant in automated driving mode until a functional limit appears. Once a limit – such as the end of highway travel or adverse weather conditions – is determined by the driving system, the takeover is planned by the management unit. The result of the planning needs to be updated with every new fused data stream reaching the management unit.

Commencing in June 2015 and running until November 2018, the project involved more than 14 partners from the automotive industry with a total cost of approximately €36m ($41m). Key project contributors included automakers Opel, Audi, BMW and Daimler; as well as suppliers – Visteon, 3D Mapping Solutions, Bosch and Continental – and

scientific and academic partners from Braunschweig, Würzburg and Munich.