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**Exemplary Conditional Automation (Level 3) Use Case Description
Submitted by the Experts of OICA as input to the IWG ITS/AD**

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Conditional automation (Level 3): Example use cases

Approach

Two functions have been selected as examples, a Traffic-Jam function and a Motorway driving function. A typical journey is described, in which unusual situations are exaggerated in order to clarify the full capabilities of the conditional automated functions. For the purposes of understanding, comparisons are not made against assistance systems that are already available in the market. The use-cases are therefore limited to the scenarios manual driving (“driver only”) and “conditionally automated”.

The description of display and control functions is necessary to describe the use of the driving functions, but should only be considered as an example, in product implementation the user interface will differ between manufacturers. However there is consensus that the basic principles behind the driver to vehicle interaction should be standardised and therefore consistent across vehicle manufacturers. Deeper analysis is required to define the standard at an appropriate level.

In the following examples, the status of the automated driving function is communicated via a central display symbol (e.g. a tell-tale) within the field of view of the driver. For example a graphic showing a steering wheel and foot pedal or a steering wheel within lane lines, etc. could be used. The graphic could be green (function active and thus system is in charge of the driving task), yellow (optional takeover request: function is active, may be used as a possible heads-up that the driver soon has to takeover driving task), red (takeover demand as part of the escalating warning cascade: system active, driver must resume-the driving task in a few seconds). When the status light is not lit the function is not available (inactive). During the handover period the system still remains in charge of the driving task. Once the time has elapsed the driver is again in charge of the driving task.

The driver receives additional information relevant to the automated function status.

Activation of the system:

The display symbol turns to green. In addition an audio signal coincident with the display symbol turning to green may notify the driver that the function is active.

Optional takeover request:

The display symbol may optionally turn to yellow to inform the driver of the need to be prepared to take over control if requested, e.g. by a text message in the instrument cluster.

Takeover Demand:

The display turns to red. In addition a non-visual alert will appear. It could be e.g. an acoustic or haptic alert.

To simplify the readability of this document the use cases focus on the colour changes of the display symbol. Additional audio visual interfaces associated with the transitions are to be thought of as complementary.

Example A: “Traffic Jam function”

We are driving on a lane of the motorway between 0 – 60 km/h without changing lane. The function can only be activated when a vehicle ahead is detected. The vehicle has an instrument cluster built in behind the steering wheel and no additional display in the dash board. In this example all typical situations associated with surrounding traffic will be described.

Mrs. A is driving her daily route to work. As every day, Mrs. A sits her 2-year old daughter in the baby seat in rear right seat, with Teddy Bear, because she will drop both the little passengers to the nanny, who's living close to the office. She leaves home driving manually through her hometown, via rural roads until she reaches the motorway. She joins the motorway and encounters the familiar light traffic conditions travelling at 80 – 120 km/h. As she gets closer to the town where she works the traffic density on the motorway increases and the speed reduces.

As the speed drops for the first time below 60 km/h Mrs. A pushes the button on the steering wheel to activate the traffic Jam function. She acknowledges a green symbol in the instrument cluster. The graphical design of the instrument cluster changes e.g. the road speed dial becomes smaller and the revolution counter etc. fade away. She recognises that the function has taken control; the vehicle speed is relative to the vehicle ahead despite her no longer pressing the pedals. The steering wheel turns automatically, positioning the vehicle in the centre of the motorway lane. Mrs. A removes her feet from the pedals and her hands from the steering wheel. Via a touch pad integrated into the middle console she selects the new content to be displayed in the instrument cluster. She can watch a film, read and answer emails or simply surf the internet.

The speed of the surrounding traffic increases above 60 km/h, the vehicle ahead gradually pulls away as the traffic congestion eases. Mrs. A hadn't noticed the changing traffic conditions, but recognises immediately when e. g. the design of her instrument cluster started to change. The display symbol turns from green to yellow, the email that she was reading fades away and the instrument cluster returns to driving mode. Mrs. A deactivates the system via the button on the steering wheel, places her hands back on the steering wheel, her feet on the pedals and resumes the driving task manually. The display symbol is no longer visible and Mrs. A knows that she was again in control. In the next area of congestion where the traffic flow again drops below 60 Km/h Mrs. A again activates the traffic Jam function by a button press. The green indicator appears and she continues with her emails.

Shortly afterwards Mrs. A notices that she is travelling faster than the vehicle in the adjacent lane. She decides to change lanes. She takes manual control of the vehicle, (the traffic jam function recognises the intervention), and switches itself off. It turns off the green indicator light and applies no further control on the steering wheel or pedals. Settled in the new lane Mrs. A re-activates the traffic jam function, acknowledges the green indicator, feels the intervention of the automated function, removes her hands and feet from the controls and returns to her emails.

A few minutes later, Mrs. A's daughter starts to cry. Thanks to driving delegation, Mrs. A is able to look back for checking what is happening without any danger. Teddy Bear is unfortunately lying on the floor between FR and RR seat. She can pick Teddy Bear up from the floor and holds it back to its little owner. Thanks to the Traffic Jam function, crying time is over. Mrs. A has a few tender words for her daughter when the congestion eases again and the instrument cluster reverts to its driving

configuration, switching the traffic jam indicator symbol from green to yellow, informing Mrs. A that she must again resume the driving task manually. After several seconds Mrs. A still has not responded the function escalates the handover request; switching the yellow indicator symbol to red. Mrs. A still fails to respond, the system triggers an intensified optical and audio warning, and the vehicle brakes gently to increase her awareness. Mrs A. responds and takes over control, the automated braking and warnings stop immediately, the conventional instrument cluster appears. The red indicator disappears, meaning that the system has recognized the driver takeover.

Comment: The escalating warnings in the function control and display concept ensure that the driver is notified of the handover request. If in this situation Mrs. A fails to respond to (or disregards) the request and the warnings the vehicle will brake to a standstill. Other road users are informed by the automatic activation of the hazard warning lights. Mrs A. is requested to take control with increasing intensity. She can abort the automatic braking at any time by resuming control.

The traffic congestion has not cleared; Mrs. A reactivates the traffic Jam function. Her exit junction is now approaching and she must leave the motorway. She deactivates the function via the button on the steering wheel (the green indicator symbol goes off); the instrument cluster reverts to its conventional configuration. She manually changes lanes to exit the motorway and completes her journey to work through the town manually.

Example B: "Motorway driving function"

We are driving on the motorway using different lanes, travelling between 0 - 130 km/h. No complex traffic situations will be taken into consideration e.g. driving in road works, driving through petrol stations / motorway service or parking areas. The description places particular emphasis on added customer value (in addition to the display in the instrument cluster a particularly large screen is built in the dash board).

Mr. B is on a 3-hour business trip. He already has programmed the destination into the navigation system using a computer. He leaves home manually using his navigation system, drives through his hometown via the A and B roads until he reaches the motorway. He joins the motorway and encounters free traffic conditions travelling at 140 – 160 km/h. After a while the traffic density increases.

After travelling below 130 km/h for a while Mr. B pushes the button on the steering wheel to activate the motorway driving function. He acknowledges a green illuminated symbol in his field of view indicating that the function is active and in control. The road speed dial in instrument cluster display becomes smaller, the rev counter fades away. He recognises that the function has taken control; the vehicle speed is relative to the vehicle ahead despite him no longer pressing the pedals. The steering wheel turns automatically, positioning the vehicle in the centre of the motorway lane. Mr. B removes his feet from the pedals and his hands from the steering wheel. The cluster display content shifts to journey and productivity related topics e.g. expected journey time, alternative routes, traffic and weather information, break possibilities, today's calendar and missed calls. On the large central display in the dash board there is a selection of infotainment applications visible (e.g. read and write emails, watch movies, stream music) as well as a green indicator showing the motorway driving function is active. Via a touch pad integrated into the middle console he is able to control the central display and select his infotainment applications.

Before entering road works where the lanes become narrower the instrument cluster informs Mr. B with sufficient lead-time that he has to take over the driving task again. The display indicator in both displays turns from green to yellow; the infotainment applications on the cluster display fade away immediately. They are replaced by the indication that takeover request is required and driving relevant information (e.g. road speed dial and rev counter) fades in. The movie he was watching in the central display pauses. Before the indicator changes from yellow to red Mr. B places his hands back on the steering wheel, his feet on the pedals. The motorway driving function recognises the intervention and switches itself off and Mr. B resume the driving task manually by himself. Mr. B manually drives through the narrow road works. After clearing the roadworks he reactivates the motorway driving function. Mr. B again acknowledges the green indicator again and knows the function is active. He feels the interaction of the automated function and removes his hands and feet from the controls. Once more different applications (e.g. reading e-mails) are enabled on the large central display. Via a touch pad integrated into the middle console he selects the new content to be displayed in the instrument cluster and selects play to continue the movie in the central display.

In the conditional automated driving mode Mr. B's vehicle draws near to a slower moving vehicle ahead. In some advanced executions the motorway driving could initiate a lane change on its own. It would recognise the vehicle, verifies that the adjacent left lane is vacant, verifies for objects (other

vehicles or motorcycles) to the rear and subsequently initiates a lane change. It turns on the left indicator, displays an imminent lane change indication on the instrument cluster and steers the vehicle to the adjacent left lane. Mr. B notices the changing lane by the vehicle's movement, briefly looks at the vehicle's surrounding and the symbol displayed on the instrument cluster, everything is fine, he returns to his emails. The procedure is completed automatically, his involvement in the driving task is not required. After overtaking the slower vehicle Mr. B's vehicle returns to the right-hand lane in accordance with road traffic regulations. It automatically turns on the right indicator, displays the imminent lane change on the instrument cluster display and steers the vehicle to the adjacent right lane.

Shortly afterwards the situation repeats itself. As described above the system initiates a lane change, but suddenly detects a vehicle approaching from behind at speed. Taking this into account the system does not perform the lane change manoeuvre. Once the adjacent left line is clear the lane change is performed as described above.

Shortly afterwards the situation repeats itself again and the system initiates a lane change. Mr. B however wants to stop at a motorway station nearby. He interrupts the lane changing process by steering the vehicle to the right.

Since Mr. B takes over control the motorway driving function is at least temporarily overridden, and if his steering continues he may deactivate or the system may deactivate on its own. Applications on the displays return to driving mode. Mr. B manually steers his vehicle to the motorway station. After a short rest he continues his journey by steering back onto the motorway where he activates again the conditional automated driving function.

A little while later a thunderstorm approaches and it starts to rain. The vehicle has automatically activated the rain sensor and the windscreen wipers turn on. As the rain intensifies the motorway driving function adjusts the vehicle speed appropriately. The rain fall becomes even heavier and the yellow symbol is displayed, Mr. B takes over the driving task (the yellow illuminated symbol goes out and driving mode is restored in the vehicle displays).

As the rain eases Mr. B re-enables the motorway driving function by pushing the button on the steering wheel. He removes his feet from the pedals, his hands from the steering wheel and sees a green symbol in the instrument cluster and central display.

Subsequently Mr. B leaves the motorway and therefore deactivates the system via the button on the steering wheel (the green indicator symbol goes off); the instrument cluster reverts to its conventional configuration. He manually changes lanes to exit the motorway and completes his journey via rural roads through villages manually.

Appendix: Conditional automation in the context of the described use-cases

Conditional automation (OICA Level 3) means a system that performs the longitudinal and lateral dynamics of the vehicle. The driver does not need to monitor the dynamic driving task nor the driving environment at all times; however he must be attentive to and follow system's requests / warnings resume the dynamic driving task. As a market implementation scenario such functions will be initially

deployed on roads with constructional separation and where normally no pedestrians or cyclists (e.g. motorway) circulate.

The driver has to deliberately activate the system and be able to override or deactivate it at all times. Vehicle integrated infotainment systems may be used by the driver while the conditional automated driving function is active (e.g. email, internet, movies, TV via the vehicle displays and controls).

The system recognizes its technical limits but is not able in all situations to perform the minimum risk manoeuvre out of any scenario, whenever the driver fails to respond to the takeover request. This means that the driver must be at all times available as a fall-back since he/she will finally have to take-over the driving task. The system requests the driver to take over the driving task with sufficient lead time. The driver must respond to this request. In emergency situations, the conditional automated vehicle function does not request the driver to take-over the driving task, because the driver cannot be expected to take-over without a sufficient lead time.