AVERE Input

On lane keeping and lane changes (in relation to ADAS 01-02)

AVERE Input

B1

Concerns

- The existing lane keeping provisions have been primarily developed with a highway environment in mind

- Some of the use cases presented by industry will require a fresh review of requirements, for instance with respect to the approach to lateral acceleration.

- Rural, interurban and urban in Europe often have a historic heritage and may not yet meet modern infrastructure design requirements

- ADAS systems, just like ADS systems, should aim to provide consistent support in a variety of environments and dynamic traffic situations

- It should be clear to the driver when a system is able to provide support or not, or when the limits of its ODD are reached.

Example case
## Norway Roundabout + Ramp to highway

- Human driving, going through roundabouts can induce +3 m/s² values at low speeds

- The change in radius of the ramp results in a spike of lateral acceleration experienced by the system, experienced at <u>low speeds</u> while following normal traffic

- In this instance, the driver received HMI warnings (audible and visual) that the system is reaching lateral acceleration limits and is warned

- A CSF intervention could have made sure the system could stay centered in the lane, but R79 does not allow resumption of B1 after a CSF

- The best case, with respect to safety, in these situations is for the system to provide support if it is capable of safely doing so

Lateral acceleration (m/s²)
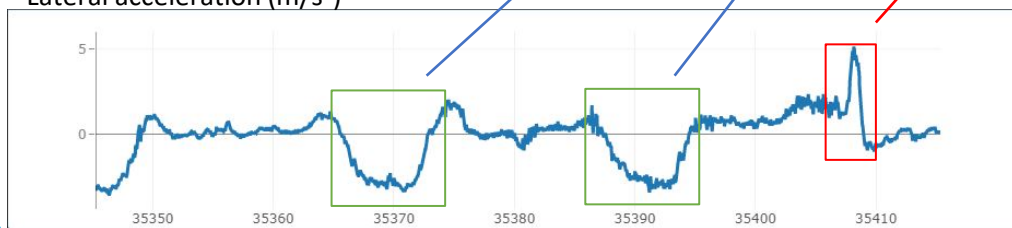
Speed (mps)
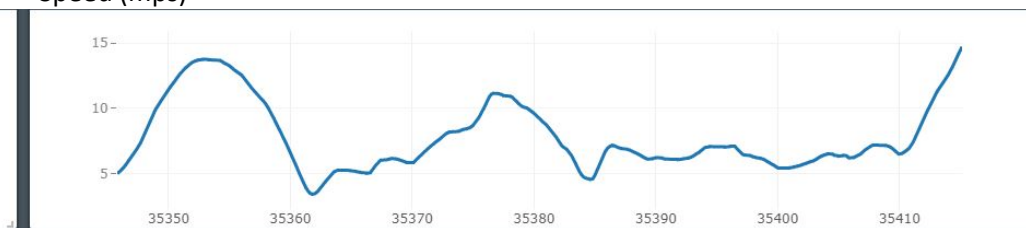
Response to comments relating to B1
GRVA 2021/07

- We agree with concerns that in inappropriate conditions (i.e. winter road conditions), the ODD could be limited, and appropriate warnings should be provided to the driver. Industry already implements such constraints.

- Industry, from a comfort and safety perspective, will always target low lateral acceleration if possible

- Industry is requesting recognition of proper system response to lateral acceleration spikes

- Lane keeping should be reconsidered in view of other infrastructure environments
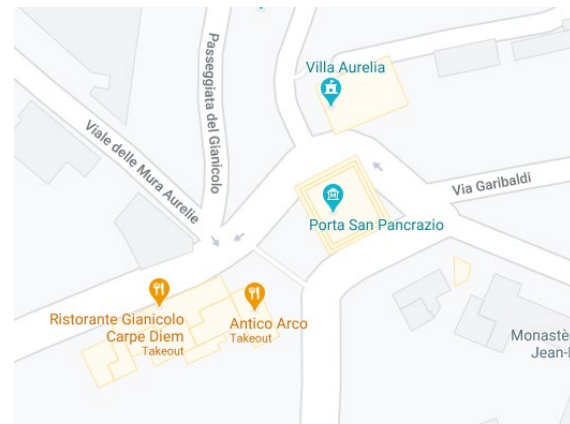
Consider other lane keeping cases

Roundabouts

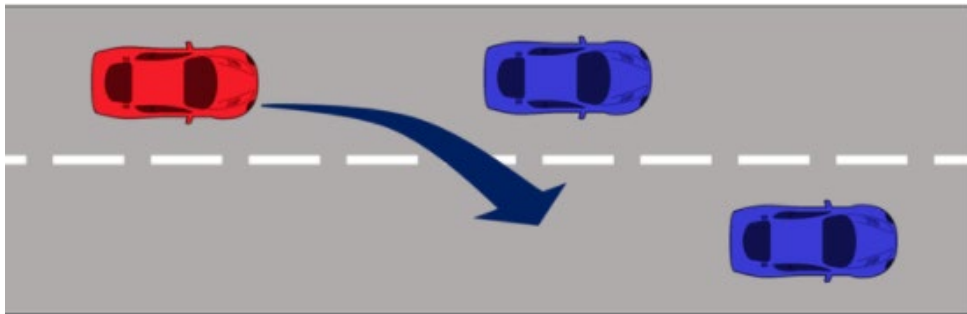Lane travel through intersections
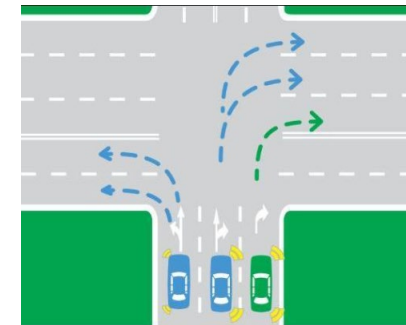
Urban streets

AVERE Input

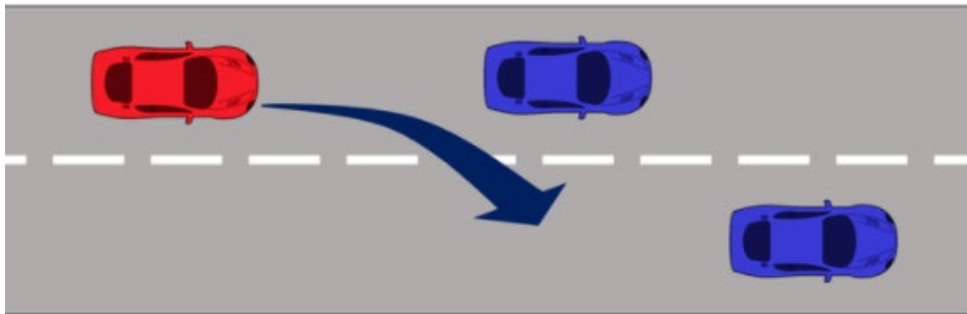Lane changes

Lane Change Systems
High-level review

1. Identify the need to change lanes (system and driver)

2. Identify the correct lane (system or driver)

3. Check/detect whether it is safe to perform a lane change (system and driver, continuous)

   i. Objects/vehicles next to the ego vehicle

   ii. Upcoming and nearby traffic

   iii. Relative speeds and braking/acceleration potential of vehicles, incl ego

4. System indicates intent to lane change to other road users

5. System begins movement into the appropriate lane as soon as it is safe to do so

6. System completes lane change / returns to original lane due to unsafe or critical situation
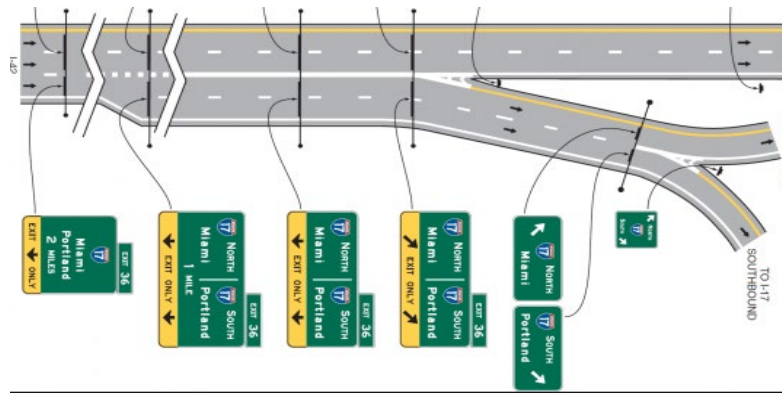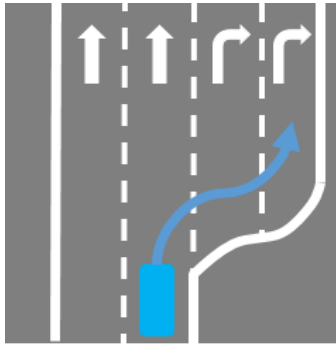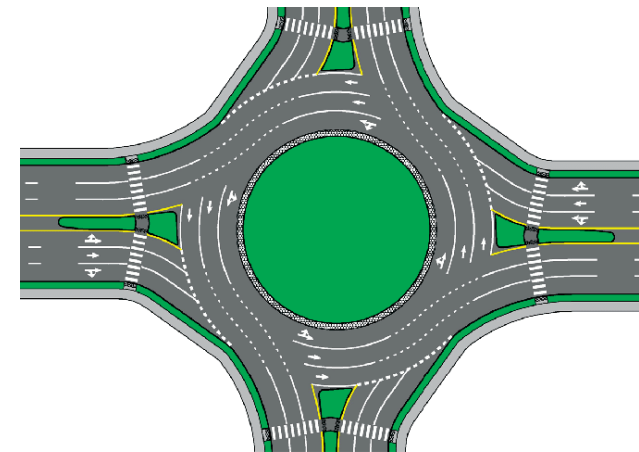
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Lane Change Systems
High-level review

- What about double lane changes?

- What about rapidly successive lane changes?

- What about lane changes on roundabouts?

Lane Change Systems
How to handle appropriate behavior ideology differences between countries

NL comments (from ADAS 02-05)
"*One is taught to ensure that there is sufficient space to make a lane change and not hinder upcoming traffic before using the direction indicator. In the Netherlands, <u>one usually uses the direction indicator about two or three seconds before the manoeuvre. Indicating direction for a long time to 'claim' space from other roads is undesirable.</u> […]*"

VS

From the UK highway code (2. Signals – 103 to 106):
"*103. Signals warns and inform other road users, including pedestrians […], of your intended actions. You should always*
- *<u>give clear signals in plenty of time, having checked it is not misleading to signal at that time</u>*
- *use them to advise other road users before changing course or direction […]*"

Certain countries recommend longer indicator times to appropriately 'inform' traffic and to request space from other drivers (especially in heavy traffic)

Human lane change behavior in many markets similarly feature longer indicator use expectations

➢ How can industry appropriately adapt systems to local traffic rules and driving behavior in the current R79 approach?

➢ Quid situations such as traffic jams where lane changes may take a long time or where lane change opportunities may be brief?

➢ Quid current disconnect between 'driver command' and actual movement of the system?

- The system shall perform the lane change manoeuvre as soon as it is safe to do so
- The system shall appropriately indicate the intent to perform a lane change to other road users

Lane Change Systems
Other possible system requirements

- The system shall perform the lane change manoeuvre as soon as it is safe to do so

- The system shall appropriately indicate the intent to perform a lane change to other road users

- The system shall only perform a lane change if it is appropriate to do so (e.g. command from the driver, based on destination, etc.)

- The system shall appropriately react to other road users, taking into account relative speed, acceleration or decceleration potential

- The system shall not induce a braking event in excess of [3.5] m/s² for other road users as a result of its manoeuvres, unless required due to an emergency situation

- The system shall perform the lane change in comfortable, predictable manner for the driver and other road users

- The system may dynamically adapt to changing road and traffic conditions

- The system shall refrain from performing successive lane changes, unless required to do so (e.g. command from the driver, based on destination, etc.)

Consider lane changes for other use cases

Overtaking or parked vehicle in lane
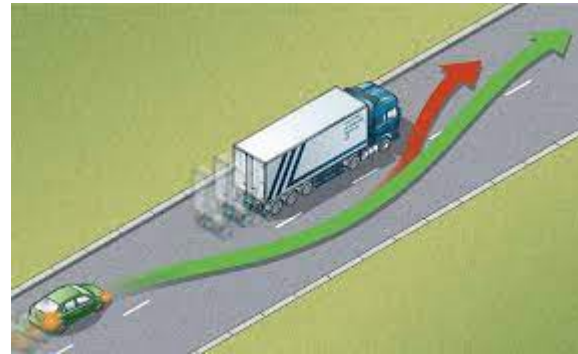
'Lane change' required due to blocking object

Lane changes without lane markins (i.e. at intersections)