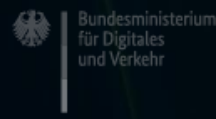
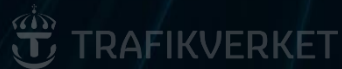
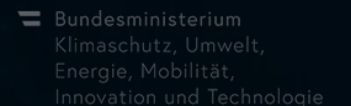
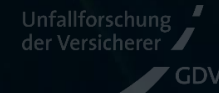
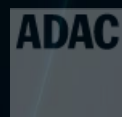


# FOR SAFER CARS EURO NCAP



Rijksoverheid





# Assessment Approach for Occupant Status Monitoring

Adriano Palao – DDI 2022

19 October 2022

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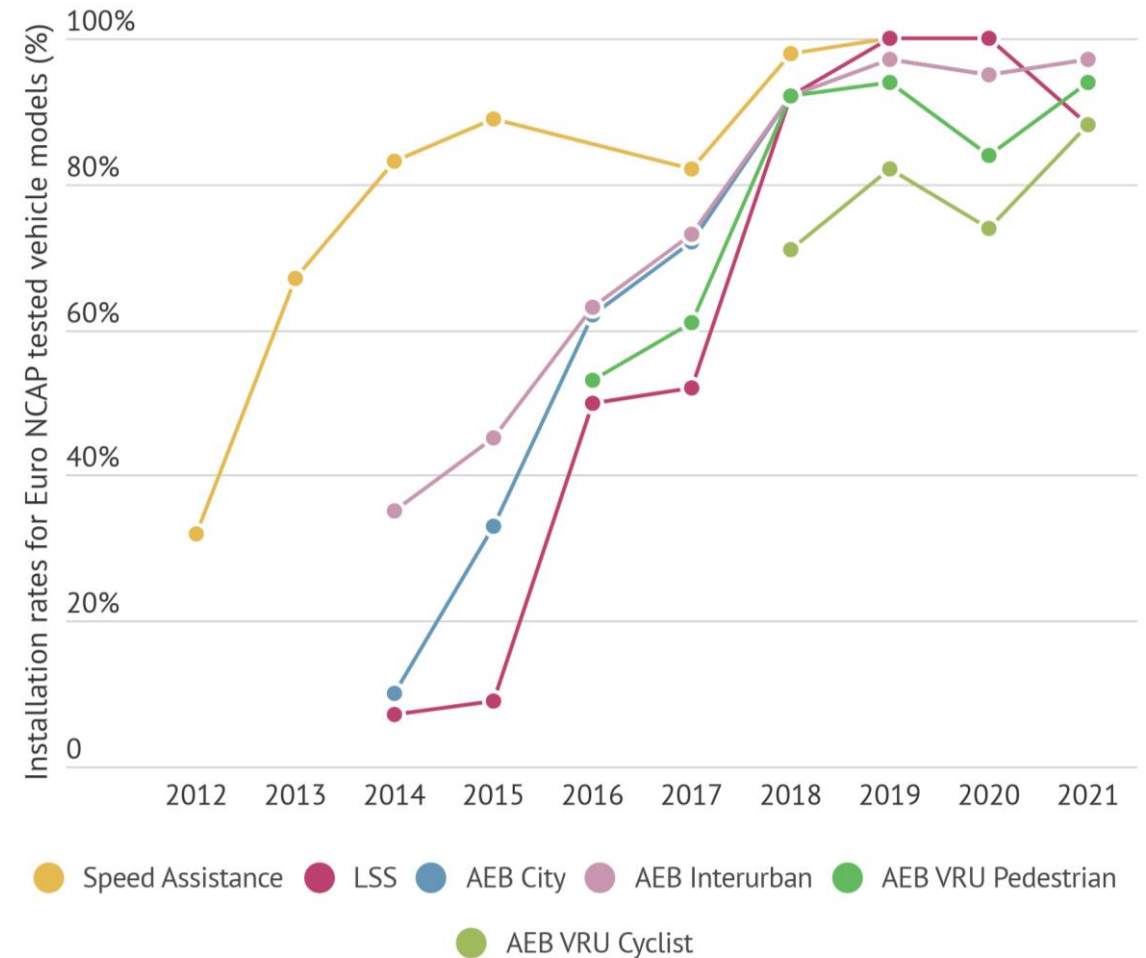
DSM Dossier, Spot Testing

05

**DSM Verification Outlook**

# About Euro NCAP

- Celebrating 25 years
- Encourage manufacturers to exceed the legal safety requirements
- Promote standard fit across the European market,
  - Example: AEB evolution →





# DSM: Implementation

- 2023: First-ever [direct] driver monitoring assessment
  - Part of the Euro NCAP's "[Safety Assist](#) – Safe Driving" protocol
  - Aimed at promoting standard fitment of driver monitoring systems that effectively detect **impaired** and **distracted** driving, eventually triggering the appropriate vehicle response strategies to warn driver and/or mitigate risks.
- Future:
  - Driving Under Influence,
  - DSM interaction with ADAS
  - Determination of Driver State beyond facial monitoring
  - More fool-proof seat belt reminders;
  - Occupant classification for passive restraint optimization;
  - Child Presence Detection (Direct Sensing systems)



@ Subaru



@ MESSRING

# 2023 DSM requirements

## ■ General requirements

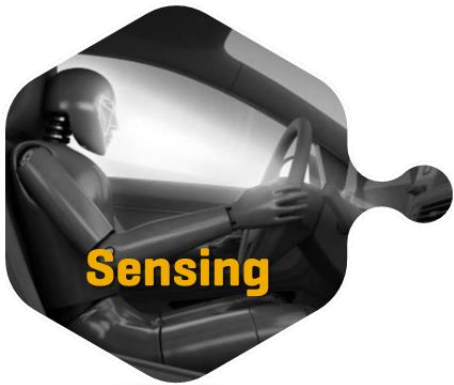
- Default ON system, active  $\geq 10$  km/h
- Initial learning phase (1 min) permitted at start of journey
- Deactivation must not be possible with a momentary single push of a button

## ■ System requirements



# 2023 DSM requirements

## ■ Sensing: Noise Variables



Driver Characteristics	Occlusion		Other Behaviours
Prerequisite	Prerequisite	Inform (if degraded)	Monitoring
<ul style="list-style-type: none"><li>Age [16-80]</li><li>Gender [All]</li><li>Stature [AF05-AM95]</li><li>Skin [Fitzpatrick type 1-6]</li><li>Eye lid aperture [From 6.0 mm to 14.0 mm]</li></ul>	<ul style="list-style-type: none"><li>Lighting [Daytime-Nighttime]</li><li>Eyewear [Clear glasses, light shades]</li><li>Facial Hair [short facial hair]</li></ul>	<ul style="list-style-type: none"><li>Hands on wheel</li><li>Eyewear [Dark shades]</li><li>Facial Hair [Large beard]</li><li>Facial occlusion [Face mask, hats, long hair]</li></ul>	Secondary behavior: <ul style="list-style-type: none"><li>Eating,</li><li>Talking</li><li>Singing,</li><li>Smoking/ Vaping,</li><li>Eye scratching/rubbing</li><li>Sneezing</li></ul>

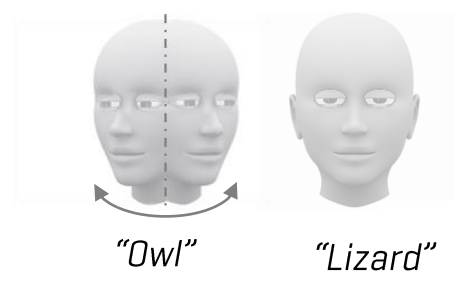
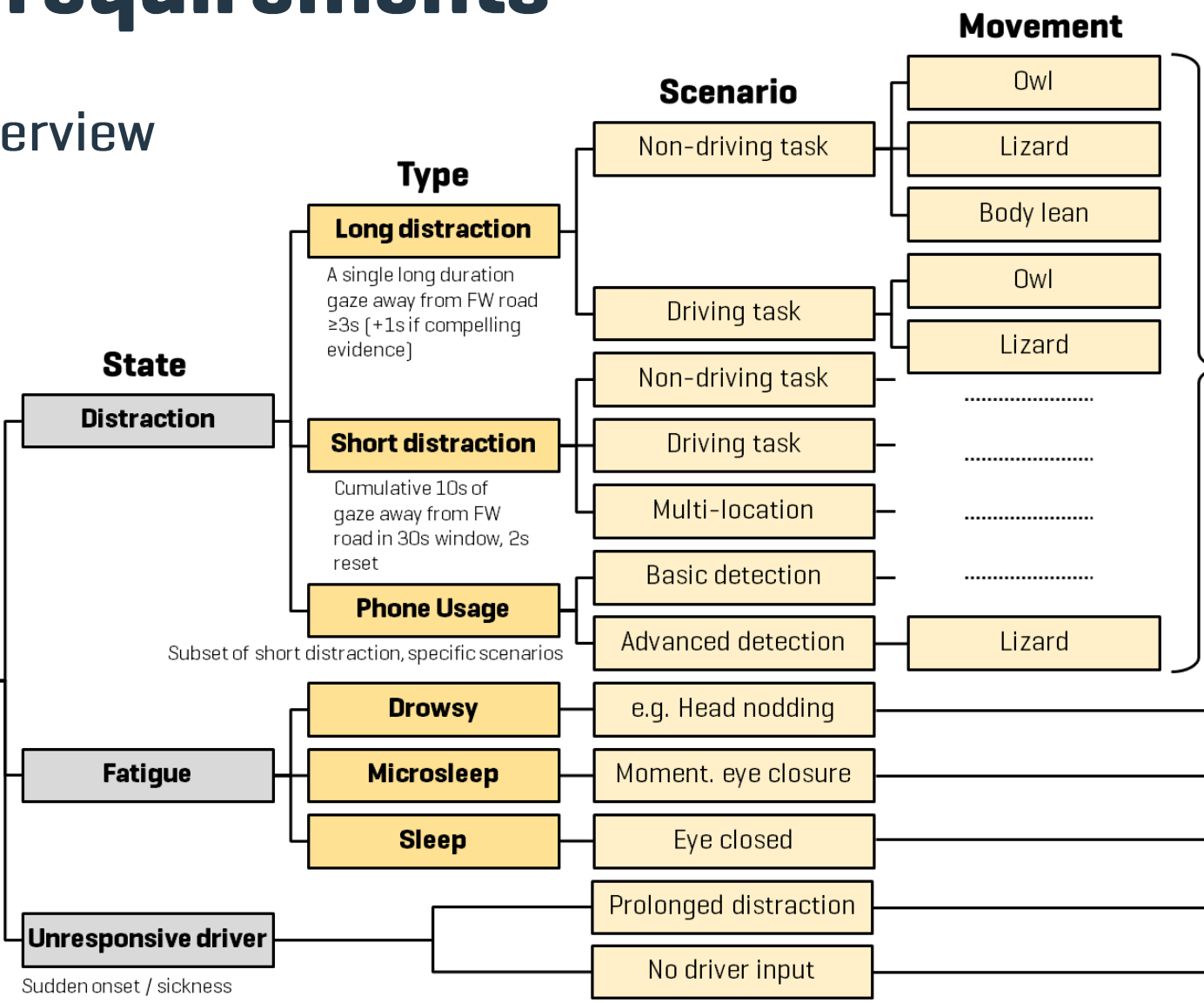
**\*Monitoring:** No performance requirements

# 2023 DSM requirements

## ■ Driver State: Overview



**Driver State**



**Requirement**

For each movement type, the protocol lists several gaze locations for which distraction must be detected, *e.g., passenger face, in-vehicle entertainment, rearview mirror, driver lap, etc.*

- Sleepiness grading, e.g., KSS>7
- Eye closure of duration <3s
- Eye closure of duration >3s
- >6s eyes off-road or eyes closed
- >3s not responding to warnings



# 2023 DSM requirements

## ■ Driver State: Distraction

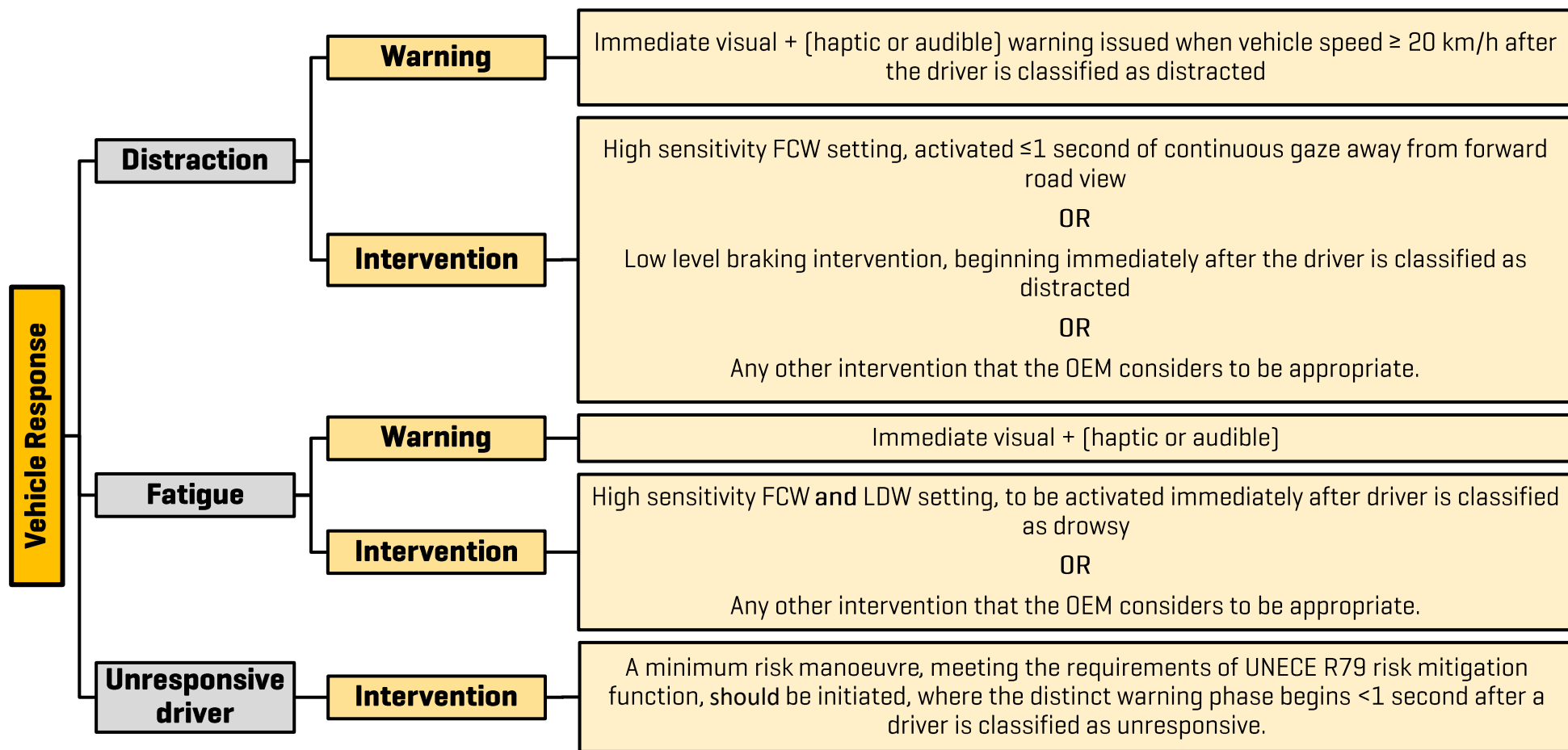


Distraction Type	Distraction Scenario	Movement type	Gaze Location	
Long Distraction	Non-Driving Task	Owl	<ul style="list-style-type: none"> <li>Driver Side Window</li> <li>Passenger Side Window</li> </ul>	<ul style="list-style-type: none"> <li>Passenger Footwell</li> <li>Passenger Face</li> <li>IVI Display</li> </ul>
		Lizard	<ul style="list-style-type: none"> <li>IVI Display</li> </ul>	<ul style="list-style-type: none"> <li>Glovebox</li> </ul>
		Body Lean	<ul style="list-style-type: none"> <li>Passenger Footwell</li> </ul>	<ul style="list-style-type: none"> <li>Rear Passenger</li> </ul>
	Driving Task	Owl	<ul style="list-style-type: none"> <li>Rear Mirror</li> </ul>	<ul style="list-style-type: none"> <li>Passenger Side Mirror</li> <li>Driver Side Mirror</li> </ul>
		Lizard	<ul style="list-style-type: none"> <li>Instrument Cluster</li> </ul>	<ul style="list-style-type: none"> <li>Driver Side Mirror</li> <li>Rear Mirror</li> </ul>
Short Distraction [VATS]	Driving Task	Owl	<ul style="list-style-type: none"> <li>Passenger Side Mirror</li> <li>Driver Side Mirror</li> </ul>	<ul style="list-style-type: none"> <li>Rear Mirror</li> </ul>
		Lizard	<ul style="list-style-type: none"> <li>Driver Side Mirror</li> <li>Rear Mirror</li> </ul>	<ul style="list-style-type: none"> <li>Instrument Cluster</li> </ul>
	Non-Driving Task [Single Target]	Owl	<ul style="list-style-type: none"> <li>Passenger Side Window</li> <li>Passenger Footwell</li> </ul>	<ul style="list-style-type: none"> <li>IVI Display</li> </ul>
		Lizard	<ul style="list-style-type: none"> <li>Driver Side Window</li> </ul>	<ul style="list-style-type: none"> <li>Passenger Footwell</li> <li>IVI Display</li> </ul>
	Non-Driving Task [Multiple Targets]	Lizard	<ul style="list-style-type: none"> <li>Any combination of non-driving task locations</li> </ul>	
		Lizard	<ul style="list-style-type: none"> <li>Any combination of non-driving task locations</li> </ul>	
Phone Usage	Basic	Owl	<ul style="list-style-type: none"> <li>Driver Side Knee</li> <li>Passenger Side Knee</li> <li>Driver Lap</li> </ul>	<ul style="list-style-type: none"> <li>Driver Side Dashboard</li> <li>OEM Charging dock</li> </ul>
		Lizard	<ul style="list-style-type: none"> <li>Driver Side Knee</li> <li>Passenger Side Knee</li> <li>Driver Lap</li> </ul>	<ul style="list-style-type: none"> <li>Driver Side Dashboard</li> <li>Upper Wheel Rim</li> <li>Center Steering Wheel</li> <li>OEM Charging dock</li> </ul>
	Advanced	Lizard	<ul style="list-style-type: none"> <li>Held At On Road</li> <li>Held At Instrument Cluster</li> </ul>	<ul style="list-style-type: none"> <li>Mounted At On Road</li> </ul>
		Lizard	<ul style="list-style-type: none"> <li>Held At On Road</li> <li>Held At Instrument Cluster</li> </ul>	<ul style="list-style-type: none"> <li>Mounted At On Road</li> </ul>

- Total of 43 distraction test cases (gaze locations) split into Driving vs Non-Driving tasks, to be accomplished via Owl, Lizard and Body Lean movement types.

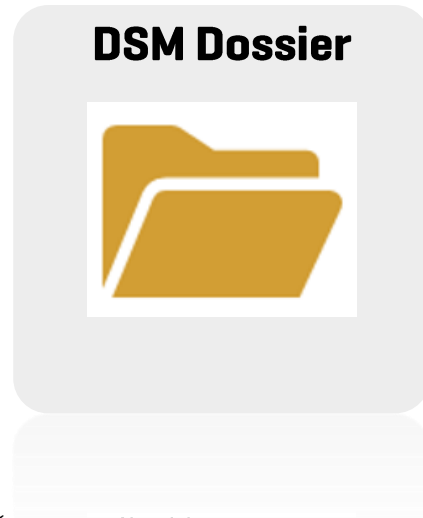
# 2023 DSM requirements

## ■ Vehicle response

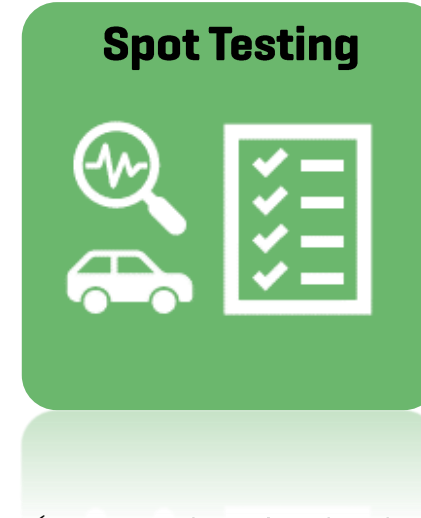


# Assessment & Verification

- The Euro NCAP Secretariat will review the DSM dossier provided by the OEM and will ask the test laboratory to spot check several Distraction, Fatigue and Unresponsive Driver situations before awarding the points.



- ✓ Supplied by OEM
- ✓ Consolidating compelling evidence of system performance
- ✓ Review & Requirement cross-check by Euro NCAP
- ✓ [Technical Bulletin – TB036](#)



- ✓ Scenario selection by Euro NCAP
- ✓ Performance verification by test laboratory
- ✓ At daylight, no glare, no rain...
- ✓ Test subject randomly chosen
- ✓ [Technical Bulletin – TB039](#)

# Assessment & Verification



## ■ DSM Dossier:

- Report provided by the OEM containing comprehensive information of the DSM system.
- Contents:
  - **System Overview:** All technical details, sensor type and location, etc.
  - **Sensing:** Evidence of system detection coverage & limitations
  - **Driver State:** Evidencing ability to detect distraction, fatigue and unresponsiveness
  - **Vehicle Response:** Details of the vehicle warnings and intervention strategies
- Containing videos and schematics
- KPI's reported on a basis of TPR.
  - Reporting Example:
    - Test case count for each detection requirement.
    - Average and standard deviation of the TPR for each detection requirement, across all subjects in the dataset.
    - Content of the dataset used to measure performance, with categories for all the demographic aspects and noise factors specified in the protocol.

### System overview [template]

[Vehicle Make] – [Model] : [System Name]	
System Features & Functionality	Judgement
Default ON at the start of every journey	<input type="checkbox"/> Yes <input type="checkbox"/> No
Fitted as standard equipment	<input type="checkbox"/> Yes <input type="checkbox"/> No
Number of steps required to deactivate the system	
Monitoring type	<input type="checkbox"/> Direct <input type="checkbox"/> Indirect
Activation speed (Direct monitoring systems)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Activation speed (Indirect monitoring systems)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Fatigue Detection	<input type="checkbox"/> Yes <input type="checkbox"/> No
Distraction Detection	<input type="checkbox"/> Yes <input type="checkbox"/> No
Unresponsive Driver	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sudden Sickness Detection (For information)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Driver Under Influence Detection (For information)	<input type="checkbox"/> Yes <input type="checkbox"/> No

### Driver state – Live metrics [example]



### Warnings [example]



# Assessment & Verification



## ■ Test provisions:

- Defined conditions at the test track [daylight, no shadows, no rain...]
- Test laboratory randomly picks a qualified test driver, seat position adjusted to his/her taste
- Several scenarios are executed [distracted, fatigued, unresponsive driver] by driving on a straight lane at a speed range of [20 to 80 km/h]
- Repeat the scenarios where system was functional, with occlusion



## ■ Glance measurement method

- Synchronized GoPro cameras, Image analysis frame counting [at 25 Hz]
- Camera positioning
  - On forward road view – good detection of first eyes off road
  - On target – good detection of glance location
  - Vehicle warning

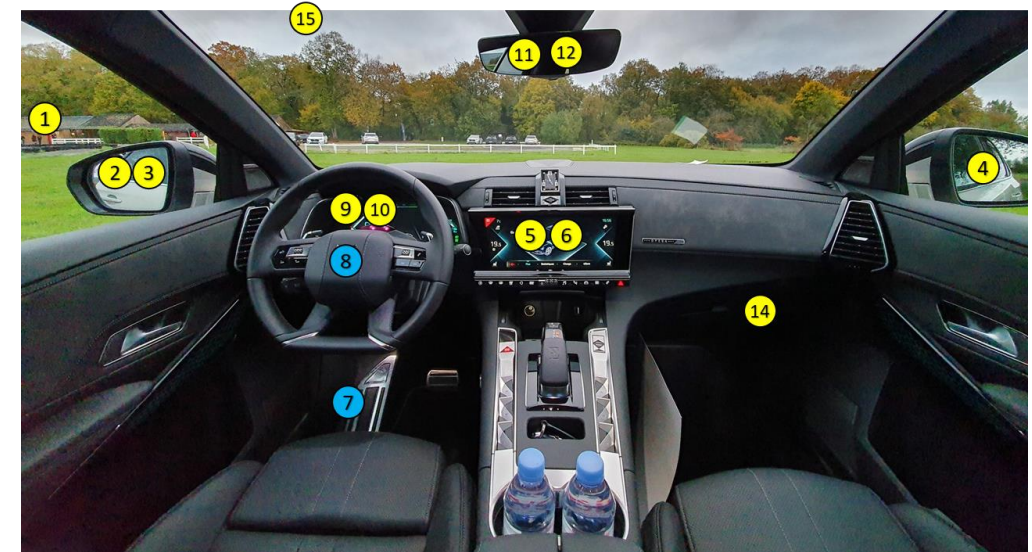




# Assessment & Verification



- Glance specification to be informed by OEM
  - Lizard – [xx s] transition from forward road to gaze location
  - Owl – [xx s] transition from forward road to gaze location
- Schematics to illustrate specific gaze locations to be informed by OEM
- Parameters used for video analysis method:
  - $T_0$  Start of test [ $T_{away} - 4.0s$ ]
  - $T_{away}$  First movement away from forward road view
  - $T_{gaze}$  First glance on gaze location OR stable eye and head position
  - $T_{warn}$  First instance of audio/visual warning



@ UTAC, DS

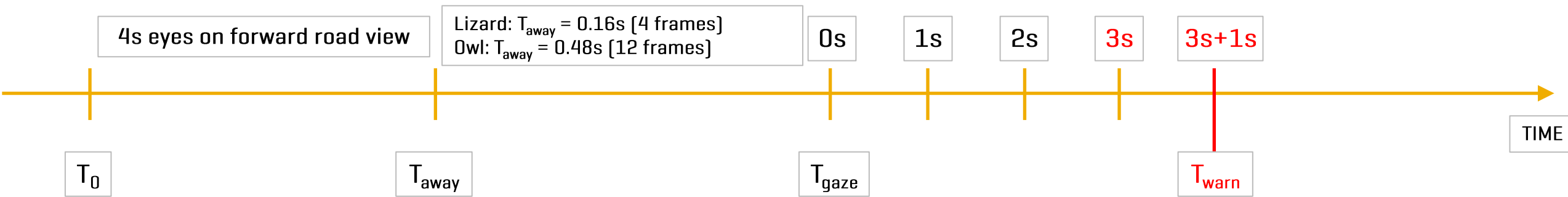
\* During the execution of the test, between  $T_0$  and  $T_{away}$  the driver must be fully attentive with eyes on the forward road view.

# Assessment & Verification



## Example: Long Distraction

- “Any single gaze away from forward road view of  $\geq 3s$  [+1 second with evidence for implementation]”



- $T_0$  Start of test ( $T_{away} - 4.0s$ )
- $T_{away}$  First movement away from forward road view
- $T_{gaze}$  First glance on gaze location OR stable eye and head position
- $T_{warn}$  First instance of audio/visual warning

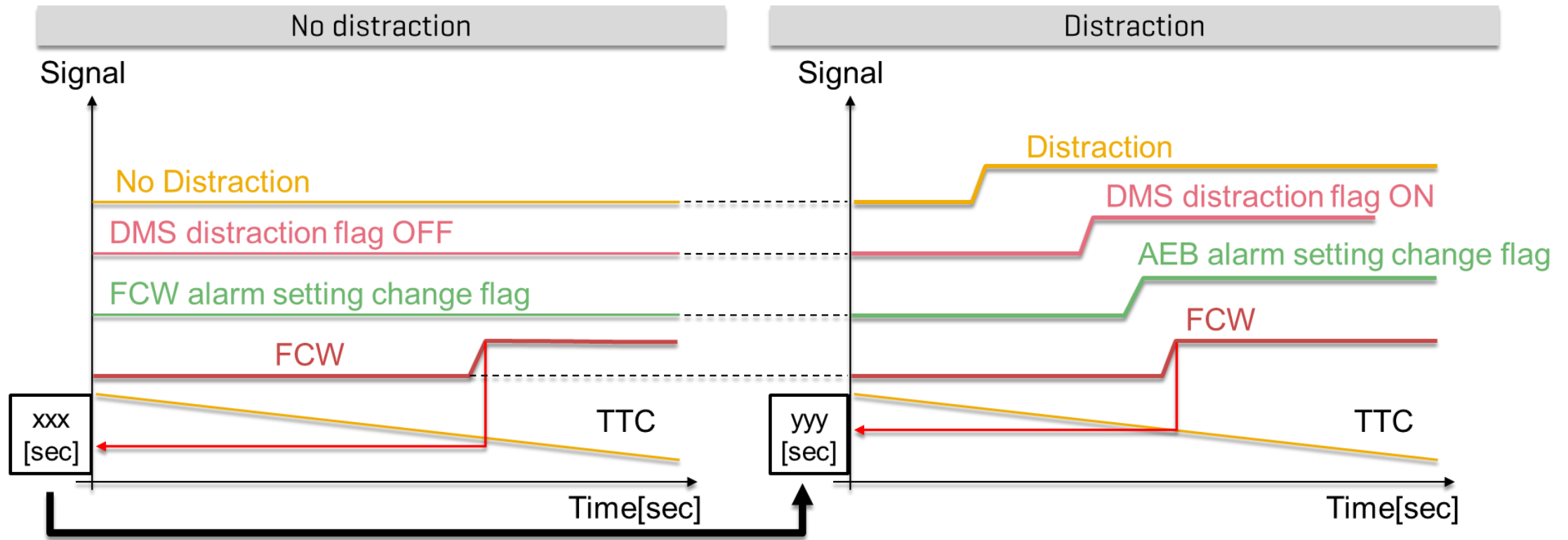
\* During the execution of the test, between  $T_0$  and  $T_{away}$  the driver must be fully attentive with eyes on the forward road view.

# Assessment & Verification



## ■ FCW Sensitivity change [Attentive vs Distracted]

- OEM informs about VUT's FCW timing [TTCs] at 'attentive' and 'distracted'

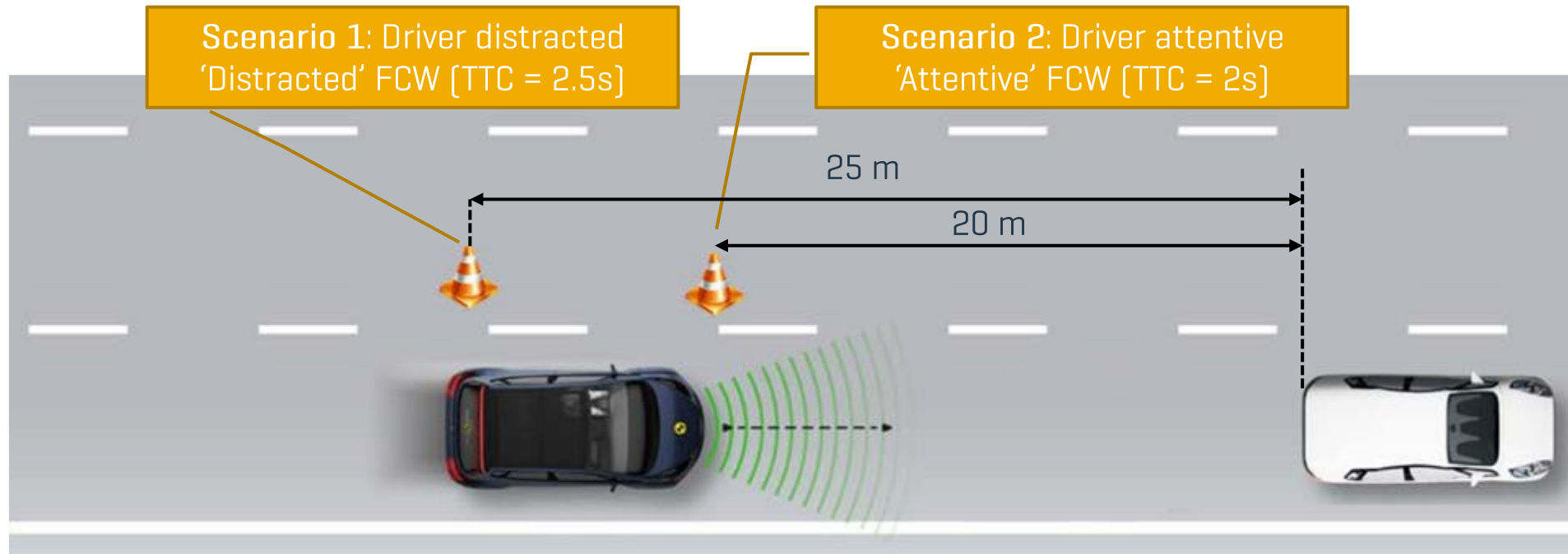


# Assessment & Verification



## ■ FCW Sensitivity change [Attentive vs Distracted]: Verification

- **Manoeuvre:** VUT travelling at 36 km/h [10 m/s] towards a stationary GVT [CCRs scenario].
- **Criteria:** Checking that FCWs are issued at a different timing [cones are just for reference]



*Example, figures are for illustration purpose only*

# Assessment & Verification



- Typical values observed during early testing with vehicle 'X'
  - Test early and late FCW settings at 'Distracted' and 'Attentive' status

	Normal Setting		Early Setting		Late Setting	
Run No.	TTC FCW [s] Attentive	TTC FCW [s] Distracted	TTC FCW [s] Attentive	TTC FCW [s] Distracted	TTC FCW [s] Attentive	TTC FCW [s] Distracted
1	2.04	2.52	2.5	2.5	1.1	2.5
2	2.07	2.55	-	-	-	-
3	2.07	2.53	-	-	-	-
4	2.06	2.57	-	-	-	-
5	2.11	2.51	-	-	-	-

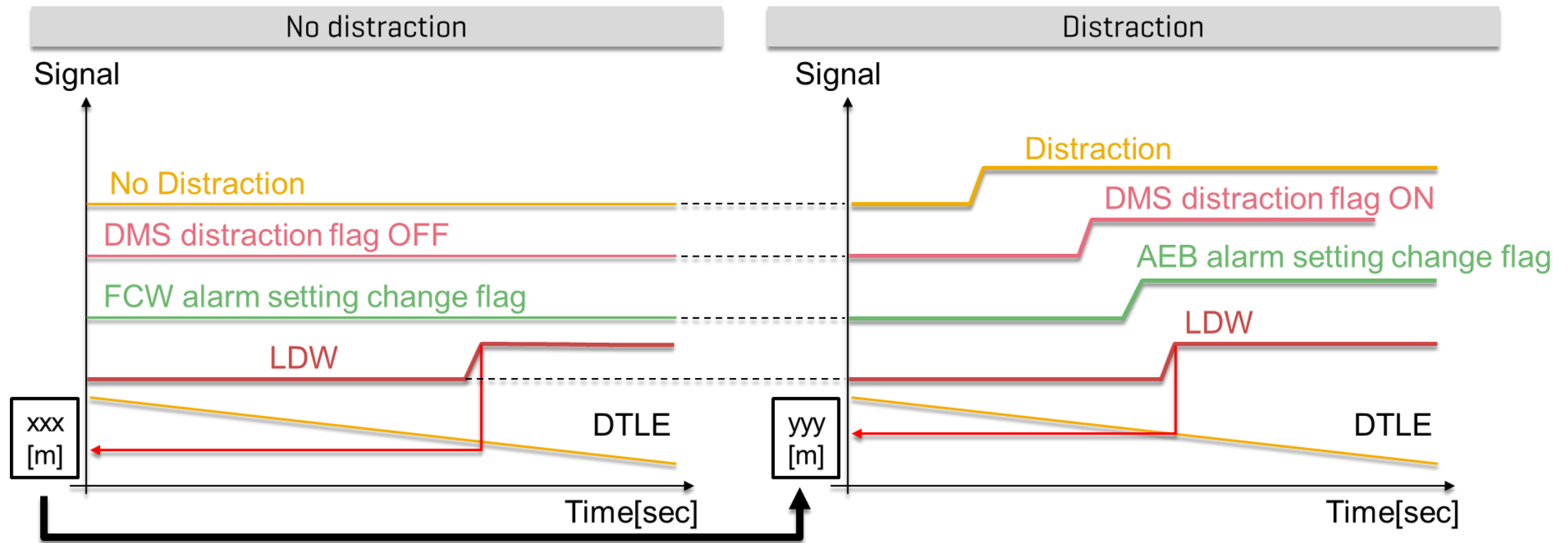


# Assessment & Verification



## LDW Sensitivity change [Attentive vs Distracted]

- OEM informs about VUT's LDW timing (DTLE) at 'attentive' and 'distracted'

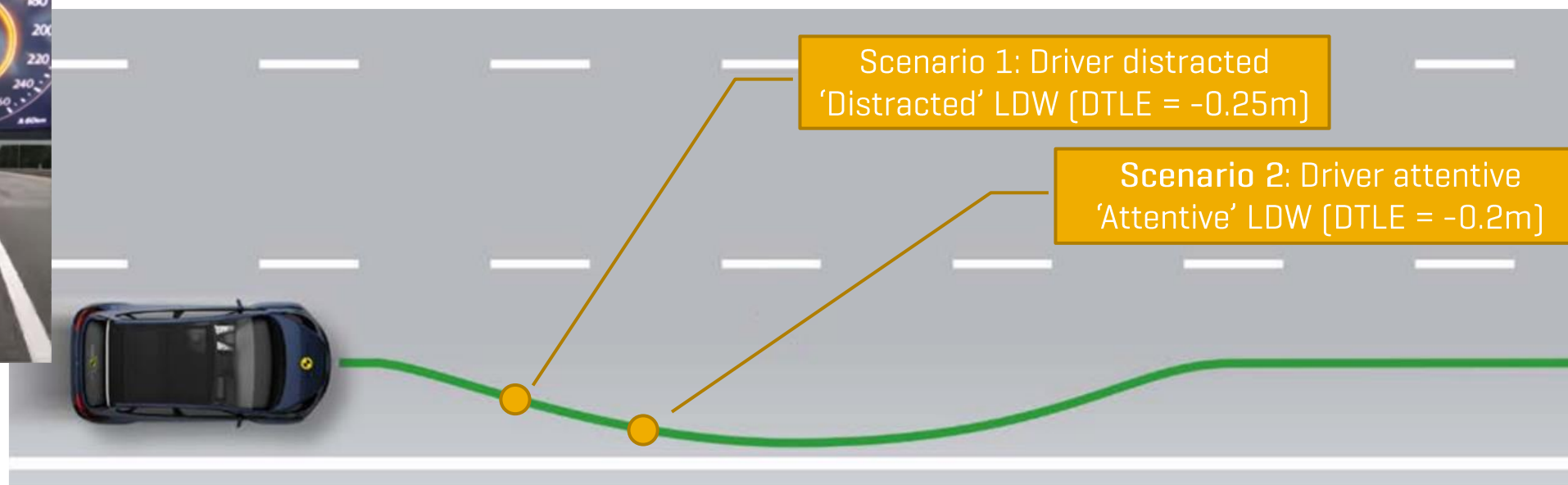


# Assessment & Verification



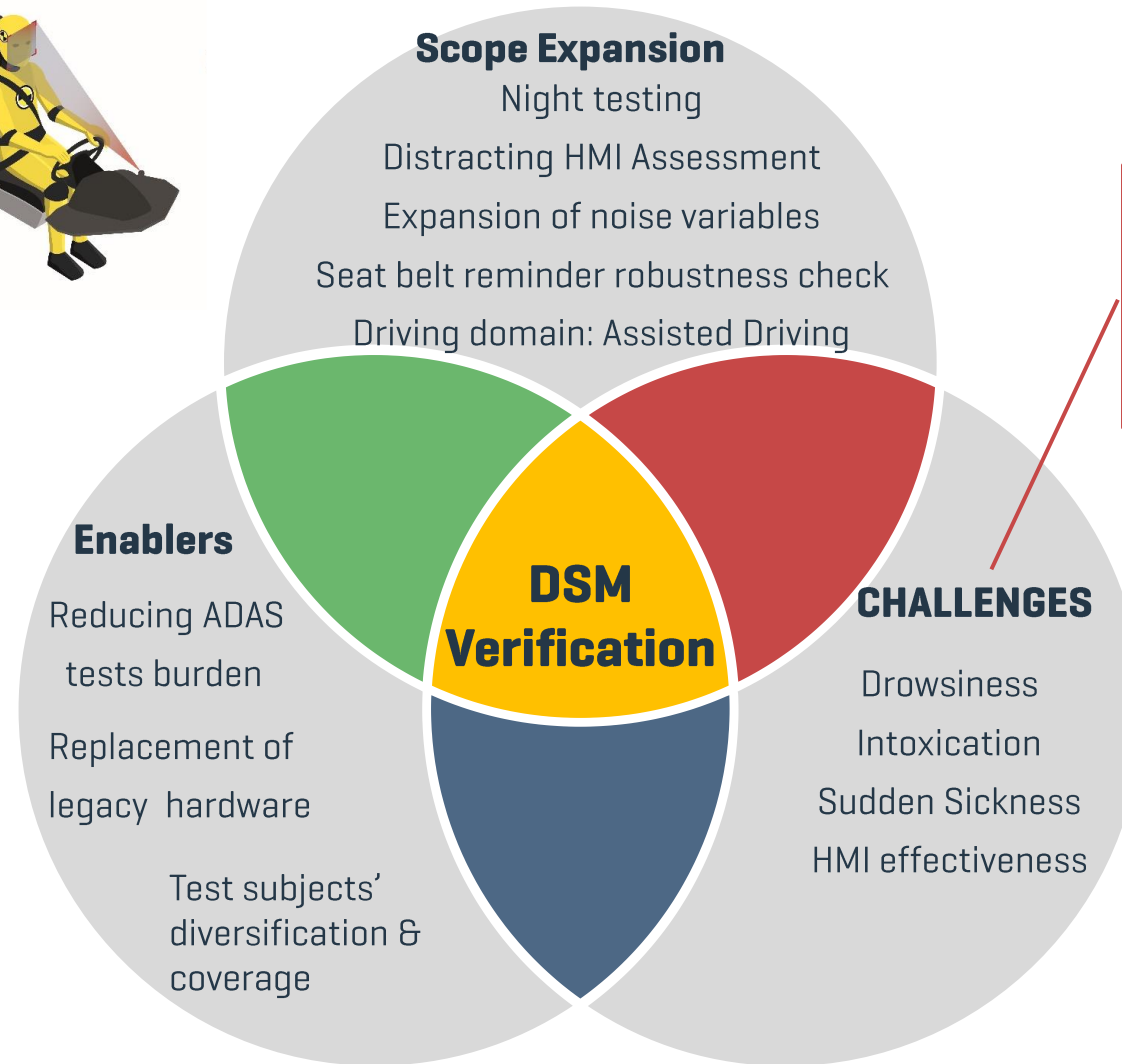
## ■ FCW Sensitivity change [Attentive vs Distracted]: Verification

- Manoeuvre: VUT travelling at 72 km/h, manual lane departure
- Criteria: Checking that LDWs are issued at a different DTLEs



*Example, figures are for illustration purpose only*

# DSM Verification Outlook



Considering the limitations of the programme:

- How to assess whilst remaining pragmatic?
- Which metrics to be used, beyond regulation?
- How to reduce subjective criteria?



**Thank you for your ~~fatigue~~**  
**Thank you for your ~~distraction~~**  
**Thank you for your attention!**

■ Special thanks to:

- Rikard Fredriksson – Swedish Traffic Administration
- Colin Grover– Thatcham Research
- Ashley Holmes – Thatcham Research
- Members of Euro NCAP Occupant Status WG

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