DCAS testing campaign

Driver Monitoring System

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DMS in brief

- A DMS is a system or a set of systems whose aim is to monitor drivers action within a vehicle.
- This encompasses:
  - Hands/feet monitoring
  - Seatbelt monitoring
  - HMI use
  - Visual focus
  - Impaired states – alcohol, drowsiness/fatigue, workload

The importance for DCAS

With increasing freedom – drivers will be able to take hands off and eyes off for some time – there is an increasing need for a better understanding of how to address cooperation between DCAS and drivers.

In the following slides we will propose some suggestions based on the findings of the testing campaign:

- DMS requirements
  - Sensing capabilities
  - Hands-on Request & Eyes-On-Request
- Controllability definition in relation to:
  - System Initiated Manoeuvres
  - ODD

Suggestion towards the current text

Making sure that gaze is tracked correctly and reliably

When wearing sunglasses drivers were able to stay distracted indefinitely without receiving any warning from the DMS.

The DMSs under testing allowed for the following observations:

Some **DMS** works **in the RGB** spectrum and are inherently **unable to prevent** this kind of misuse. They mostly **relied on head position** allowing drivers to watch Netflix or reading a book, as long as placing it high enough (e.g., on the steering wheel or in front of the IC)

The ones working in the infrared (**IR or NIR**) decided to **discard data from eyes** and consider only the head orientation, **allowing the same behaviours** as for RGB cameras. To be noted that, both sunglasses with high and low transmittance have been adopted. If this is **admissible with low transmittance** sunglasses, it shouldn't be condoned with the others, which looks as normal corrective glasses to the camera.

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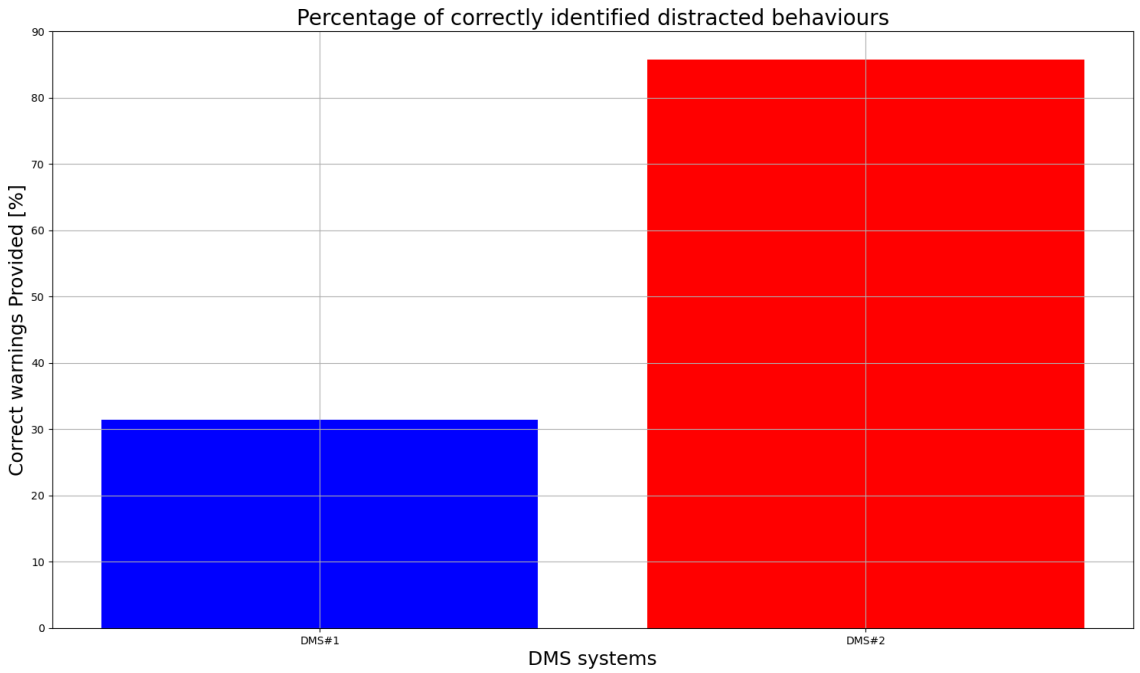
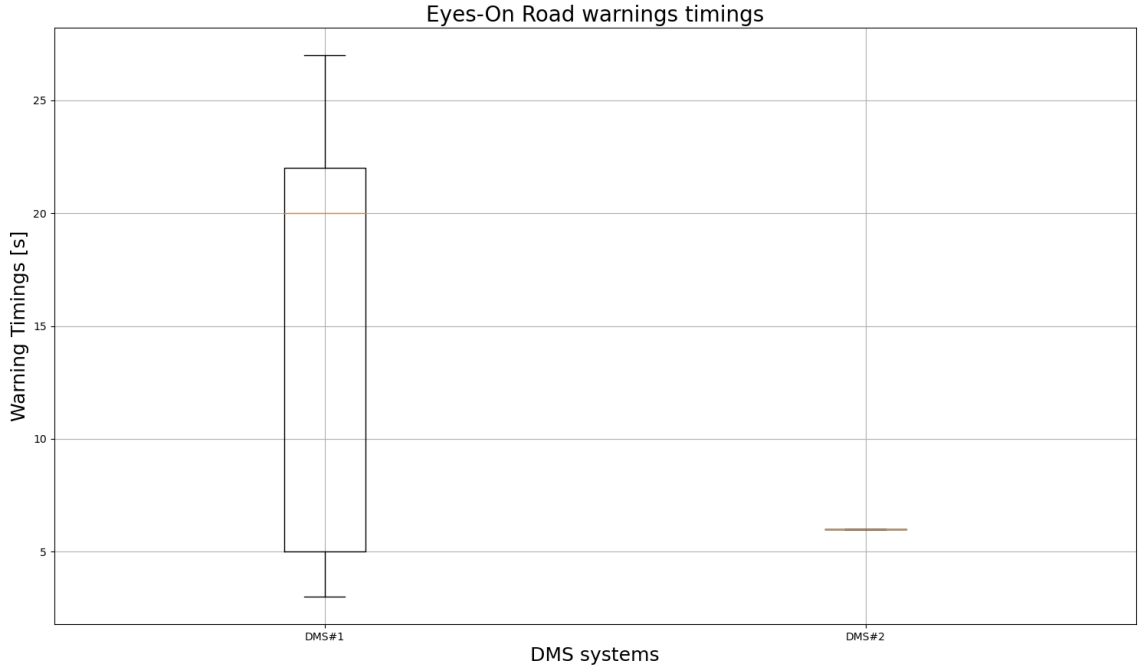
Suggestion towards the current text

Making sure that gaze is tracked correctly and reliably

Some **DMS did not warned** for distraction in a **consistent** way.

Some drivers sometimes (not always) **received warning** for looking at AOI (side mirrors, rear mirror, central console) **while other** drivers **never** got the same warning.





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Suggestion towards the current text

Making sure the drivers comply with instructions from the systems

All tested **DMS did not hinder** drivers behavior of **nudging the steering wheel to** keep on **stay disengaged** after the system request an Hands On the steering wheel

All **DMS did not hinder** drivers behavior of **quickly glancing towards the road** as a response to an EOR for **then carry on staying distracted** until the successive EOR – without actually stay visually engaged

Suggestion towards the current text

System should ensure the driver is engaged with the driving task and aware of the system intentions

5.3.5. Response to System boundaries

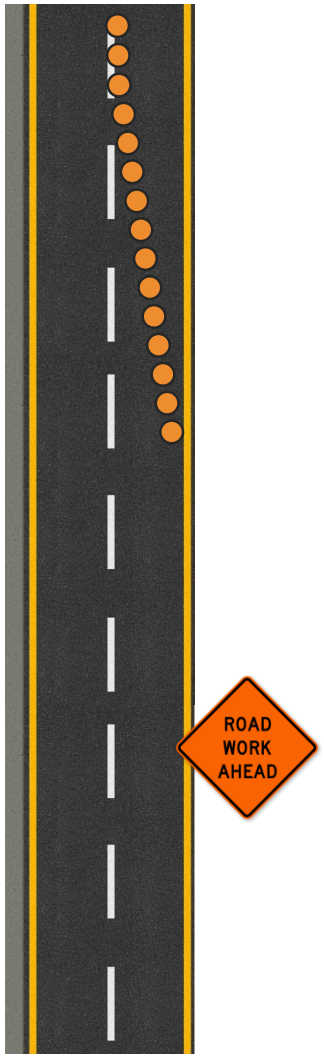
5.3.5.1. The system shall aim to detect the applicable system boundaries when DCAS or a feature of DCAS is in 'on' mode. If the system identifies that the system or feature boundary is exceeded, it shall transition into 'stand-by' mode and immediately notify the driver in accordance to the strategies described by the manufacturer as outlined in paragraph 5.3.5.2. and according to the HMI requirements defined in paragraph 5.5.4.1.

The system shall terminate assistance to the driver provided by the affected feature or the system in a controllable way. The assistance termination strategy shall be described by the vehicle manufacturer and assessed according to Annex 3.

The system would benefit if the driver are made timely and clearly informed about how they should react in order for the situation to stay controllable.

In short, anticipatory behaviour would largely benefit DCAS systems, especially Eyes-On-Warning only

An example from the test campain



Event:

Work zone in one lane in the highway

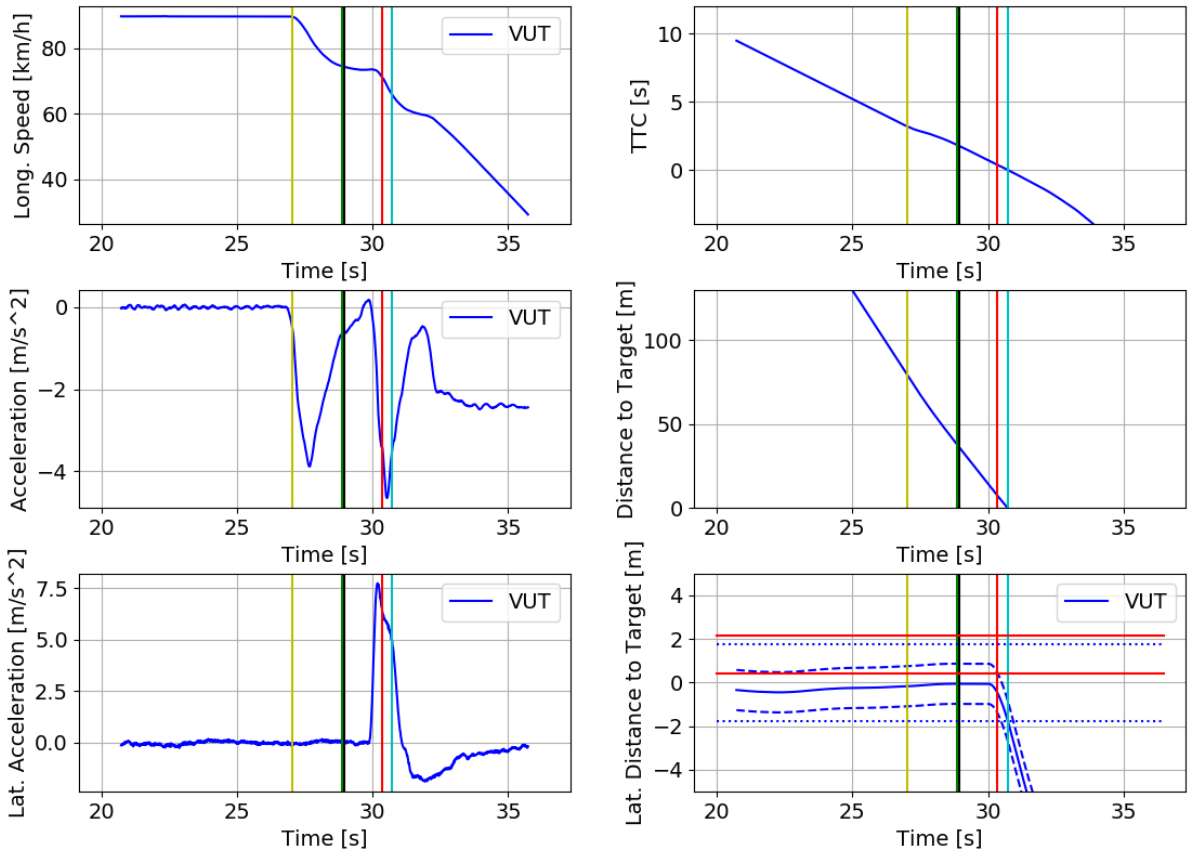
Observed behaviour from system #1:

System shows the cones are detected on the HMI and start a manoeuvre to move to the other lane

Observed behaviour from system #2:

System doesn’t show anything, doesn’t issue any warning. The driver thought the system would handle the situation but it did not, forcing the safety driver to brake and steer away

Controllability definition – System initiated



Acoustic	Optical	Mild_dec	AEB	Impact
28.95 s	28.85 s	27.03 s	30.35 s	30.73 s
TTC 1.75 s	TTC 1.83 s	TTC 3.18 s	TTC 0.37 s	Lat.Dist. -1.75 m
AEB 1.40 s	AEB 1.49 s	AEB 3.31 s	Speed red. 18.36 km/h	Speed red. 23.85 km/h

Event from system #1:

System warned for imminent collision at around 1.75s before collision (TTC)

Started decelerating when TTC was 3.31s

Safety drivers had to steer away to avoid crash at around 1s of TTC

Driver could notice 3.31s the deceleration and had little time to react.

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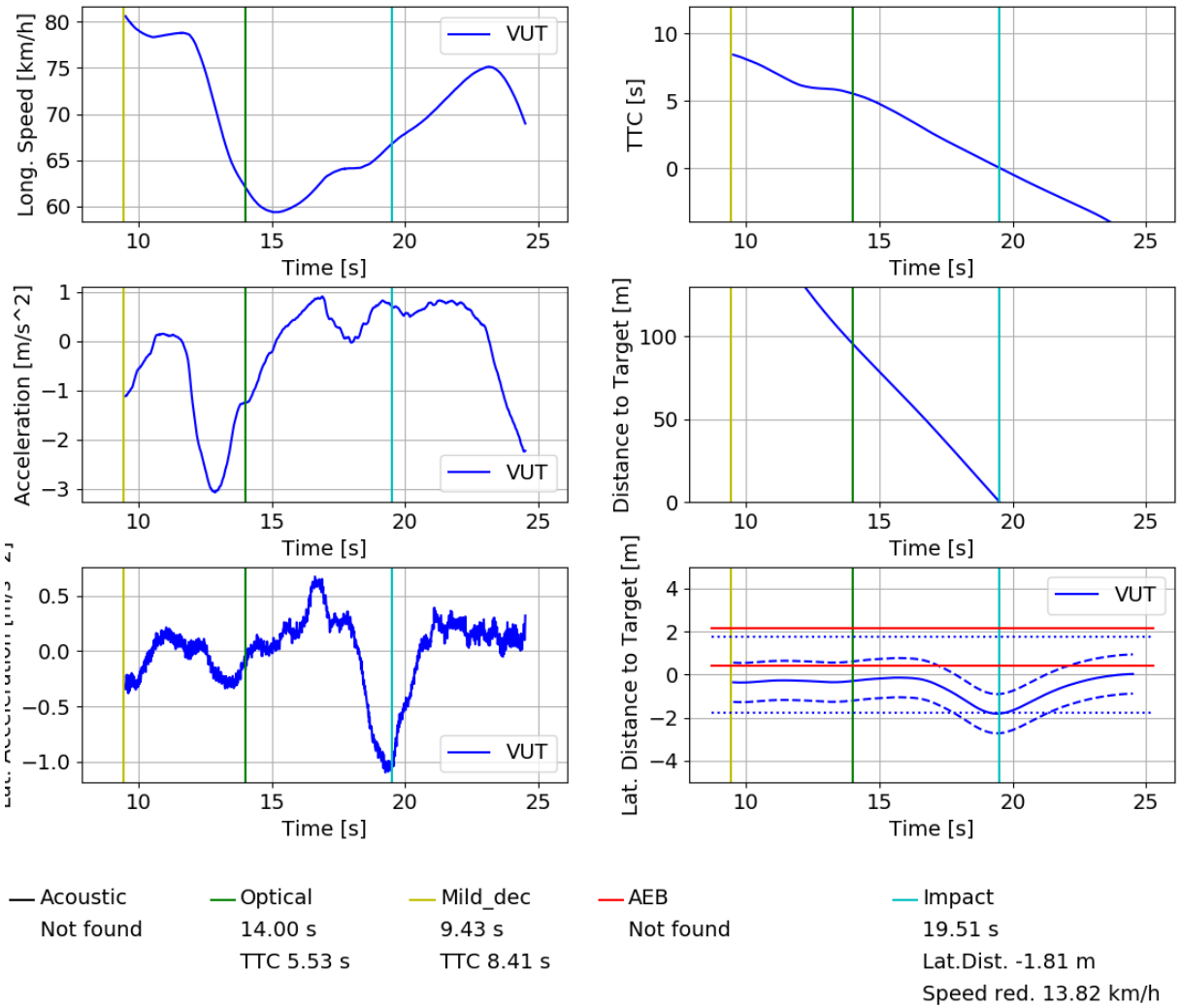
Controllability definition – System initiated



Counter example of system #2:

System started decelerating when TTC was 8.41s

Driver had plenty of time to acknowledge the manoeuvre

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Suggestion towards the current text

Making sure the drivers are aware of the current situation

5.3.7.2.1.2. The system shall only be permitted to perform a manoeuvre if the vehicle is equipped with detection capabilities with sufficient range to the front, side and rear with respect to the manoeuvre.

5.3.7.2.1.3. A manoeuvre shall not be initiated if a driver disengagement warning is being given to the driver.

5.3.7.2.1.4. A manoeuvre shall not be initiated if a risk of collision with another vehicle or road user is detected in the predicted path of the DCAS vehicle during the manoeuvre.

5.3.7.2.1.5. A manoeuvre shall be predictable and manageable for other road users.

5.3.7.2.1.6. A manoeuvre shall aim to be one continuous movement.

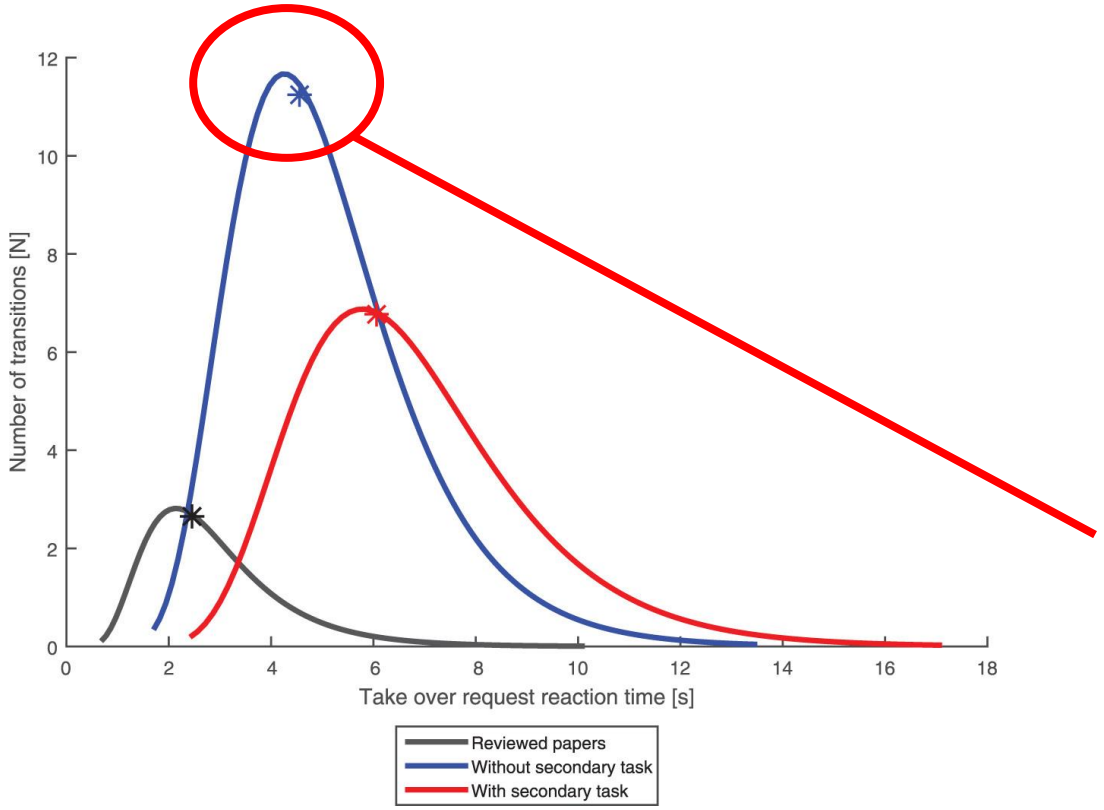
5.3.7.2.1.7. A manoeuvre shall be completed without undue delay.

Likewise, we see that decision-making process must be considered to ensure controllability during manoeuvres.

This means that the system should make sure the drivers were aware of the situation before initiating (SIM) or proposing (DCM) a manoeuvre

How long would driver need to decide to act?

No data around DCAS but can we consider L3 systems?



- Lv.3 (here presented as ACC+LKA as a normal L2) in non-critical situation, without secondary tasks (drivers were not visually disengaged)
- Highway driving

Median and average time to take back control was **between 4 and 6 s**

And this was **obtained with unambiguous** take-over **requests**

Eriksson, A., & Stanton, N. A. (2017). Takeover Time in Highly Automated Vehicles: Noncritical Transitions to and From Manual Control. *Human Factors*, *59*(4), 689-705. https://doi.org/10.1177/0018720816685832

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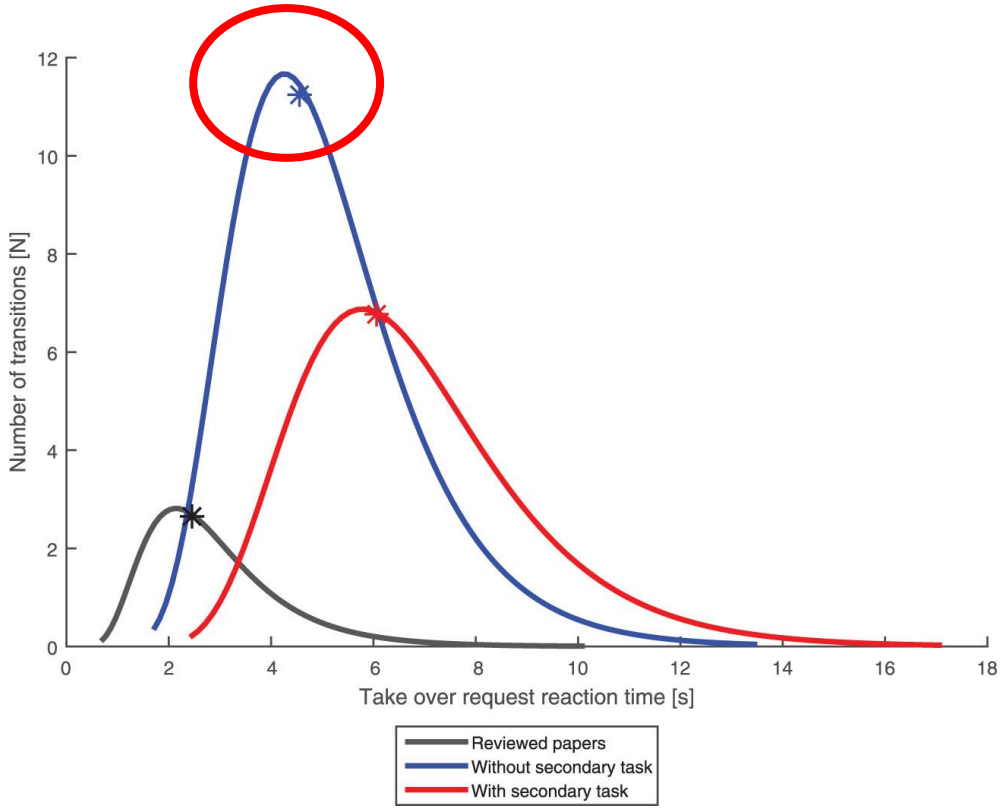

- If we would transpose these findings within DCAS, we would need to consider that:
  - Drivers are supposed to be already attentive with DCAS systems (1 s to redirect gaze won't be needed)

This leaves us with around 3 to 5 s that drivers might benefit from when supervising and/or confirming a manoeuvre

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Thank you

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