The Human Factors of Automated Driving

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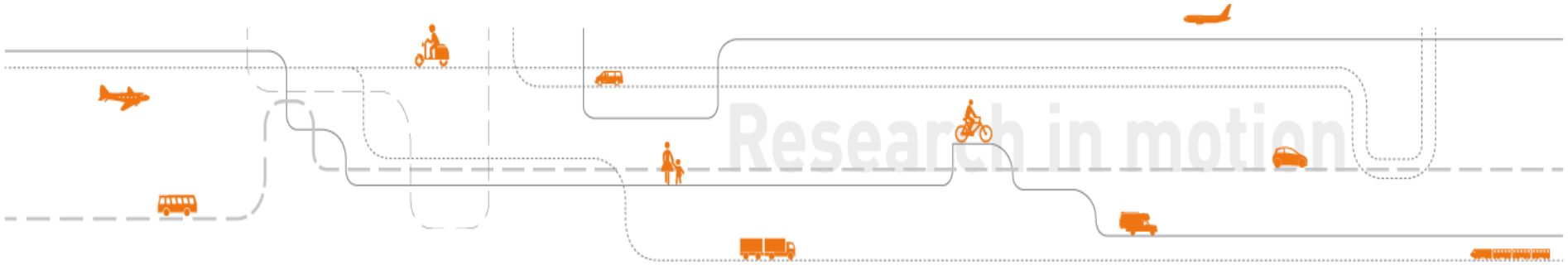
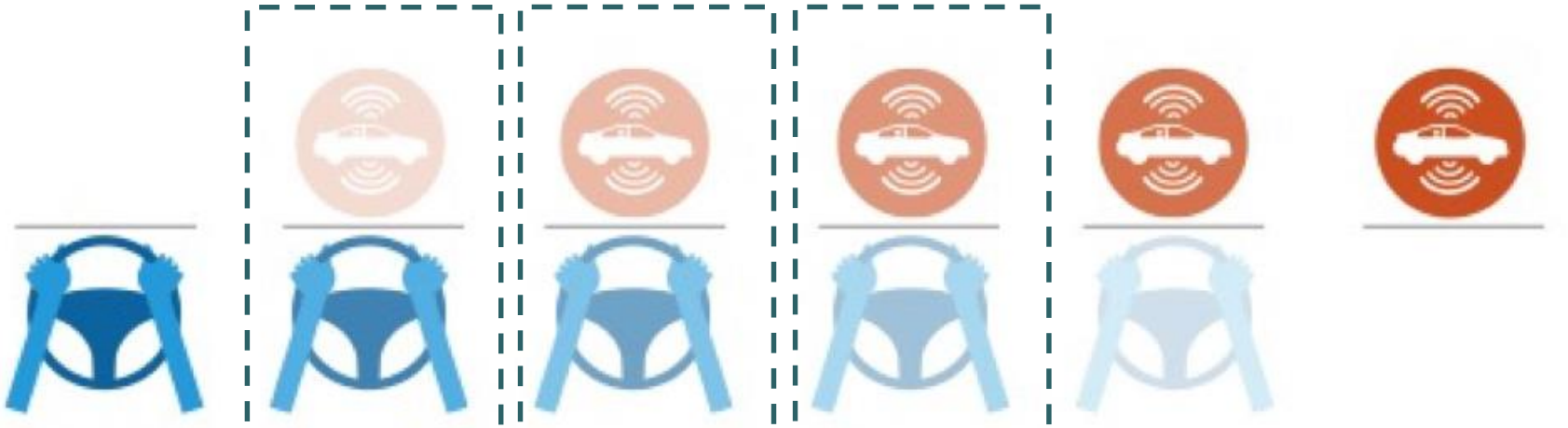
SAFER visit @ TOI
16/1-19



Five Levels of Vehicle Autonomy



Level 0

No automation: the driver is in complete control of the vehicle at all times.

Level 1

Driver assistance: the vehicle can assist the driver or take control of either the vehicle's speed, through cruise control, or its lane position, through lane guidance.

Level 2

Occasional self-driving: the vehicle can take control of both the vehicle's speed and lane position in some situations, for example on limited-access freeways.

Level 3

Limited self-driving: the vehicle is in full control in some situations, monitors the road and traffic, and will inform the driver when he or she must take control.

Level 4

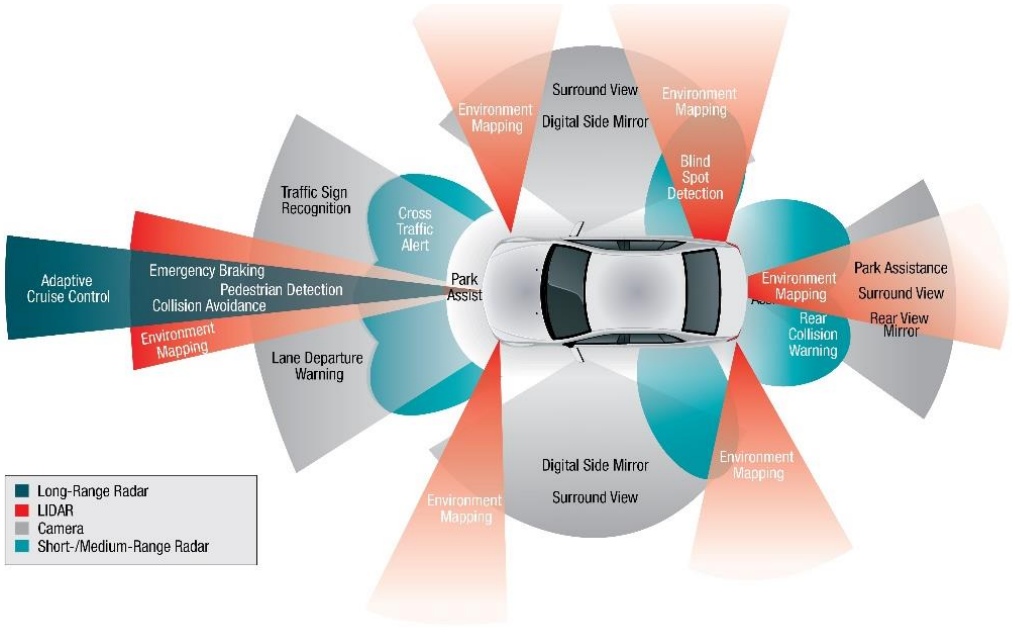
Full self-driving under certain conditions: the vehicle is in full control for the entire trip in these conditions, such as urban ride-sharing.

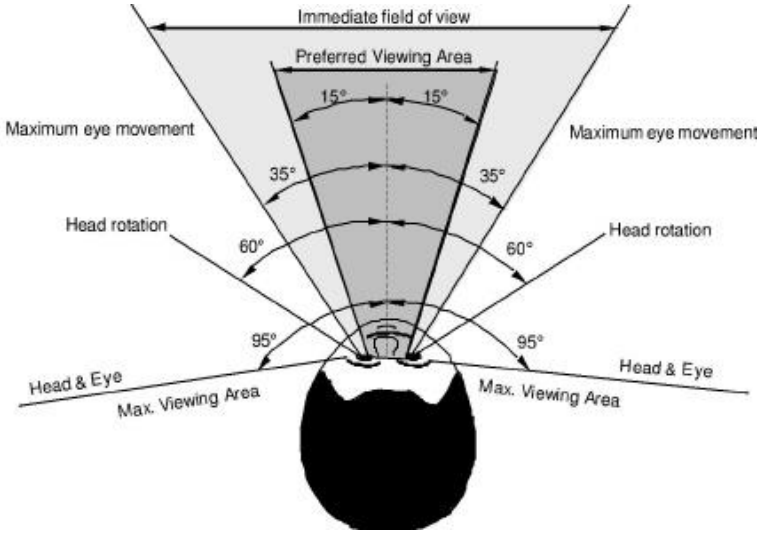
Level 5

Full self-driving under all conditions: the vehicle can operate without a human driver or occupants.

Source: SAE & NHTSA

How does an automated vehicle percieve the world?





Automation and ITS saves plenty of lives..

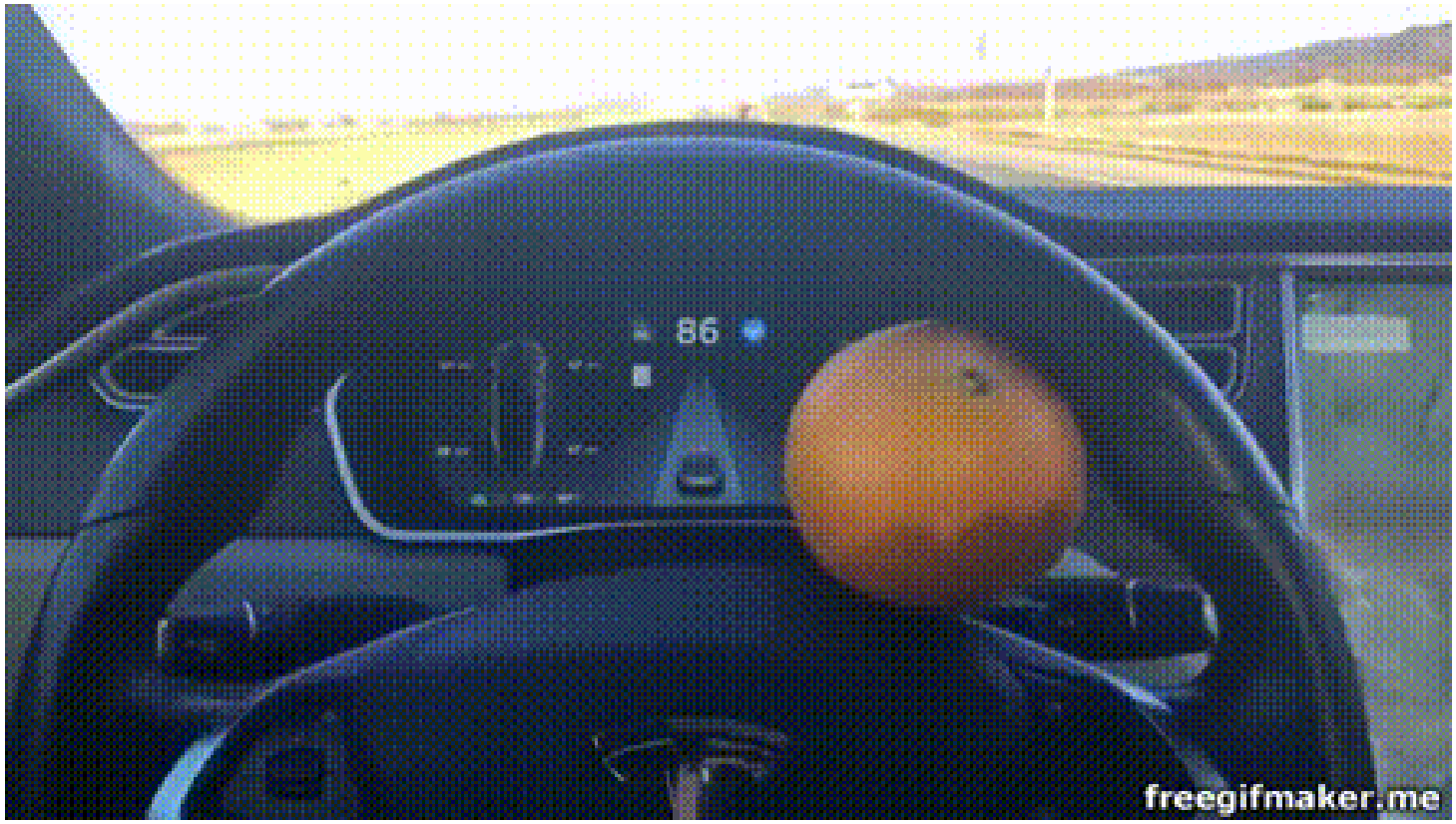
- AEB has been shown to reduce such collisions by 38%, according to research by the safety organisation Euro NCAP.
- ACC - At high speeds (~110kph) jamming occurs for concentrations of ACC vehicles of 10% or less. At 20% no jams are formed[2].
- By 2020, 2.7% of single-vehicle lane departure crashes could be avoided if 8.5% of the fleet has Lane Departure Warning with 20% effectiveness[1].
  - *If the LDP system is 100% effective by 2045, 66.5% of the single-vehicle lane departure crashes can be prevented.*
  - *LDW - Vehicles with LDW had significantly lower involvement rates in crashes of all severities (18%), in those with injuries (24%), and in those with fatalities (86%)[3]*
- blind-spot detection systems—usually warning lights in side mirrors—found the systems lower the rate of all lane-change crashes by 14 percent and the rate of such crashes with injuries by 23 percent[4].

1. Penmetsa, P., Hudnall, M., & Nambisan, S. (2018). Potential safety benefits of lane departure prevention technology. *IATSS Research*.
2. Davis, L. C. (2004). Effect of adaptive cruise control systems on traffic flow. *Physical Review E*, *69*(6), 066110.
3. $Cicchino, J. B. (2018). Effects\ of\ lane\ departure\ warning\ on\ police - reported\ crash\ rates. Journal\ of\ Safety\ Research, 66, 61 - 70.$
4. https://phys.org/news/2017-08-automated-safety-car.html#jCp

Adaptive cruise control

- Adaptive cruise control comes with many advantages
  - *Offloading the driver*
  - *More efficient traffic flow*
  - *Safer following distances*

- But…
- Most contemporary ACC systems ignore stationary objects
  - *E.g. Tesla crashes with stationary EMS vehicles on the hard-shoulder*
  1. *Handan, China (January 20, 2016) – stationary vehicle*
  2. *Williston, Florida (May 7, 2016) – tractor trailer*
  3. *Culver City, California (January 22, 2018) – fire truck*
  4. *Mountain View, California (March 23, 2018) – concrete barrier*
  5. *South Jordan, Utah (May 11, 2018) – fire truck*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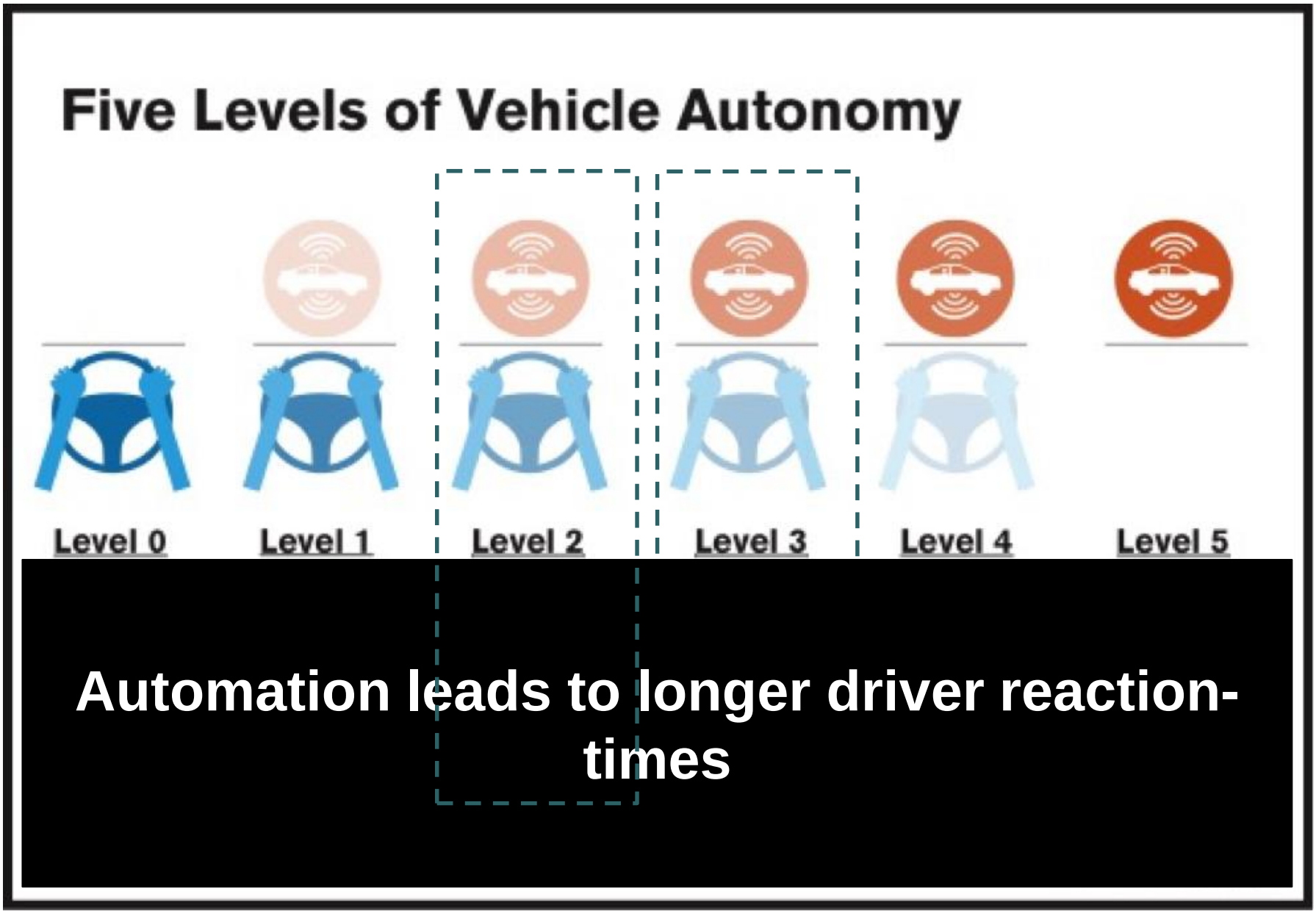
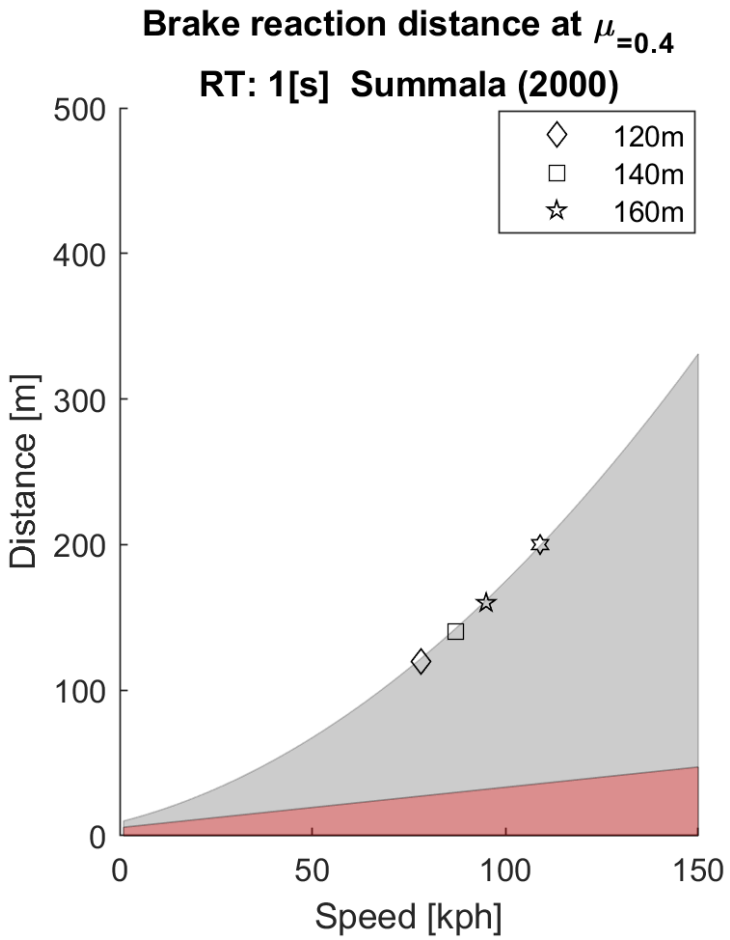
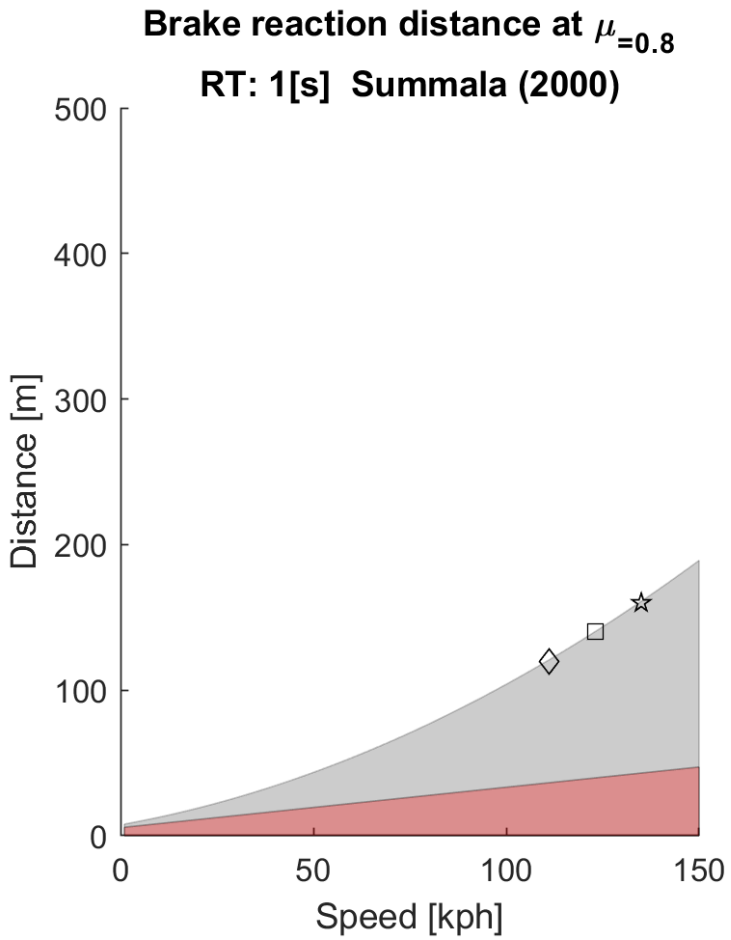
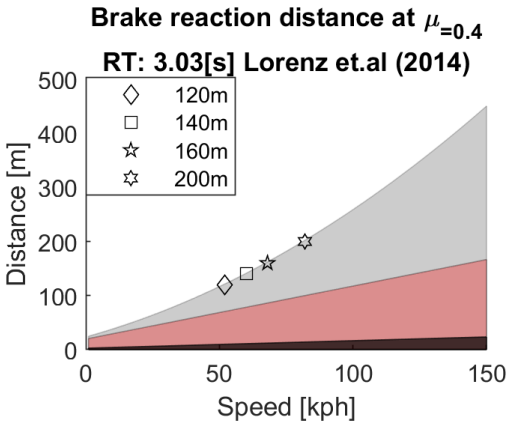
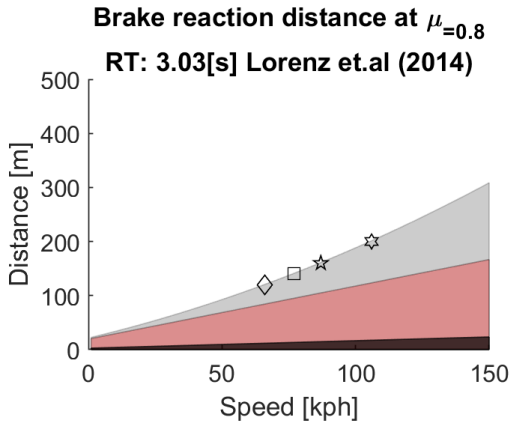

Five Levels of Vehicle Autonomy
Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Automation leads to longer driver reaction-times

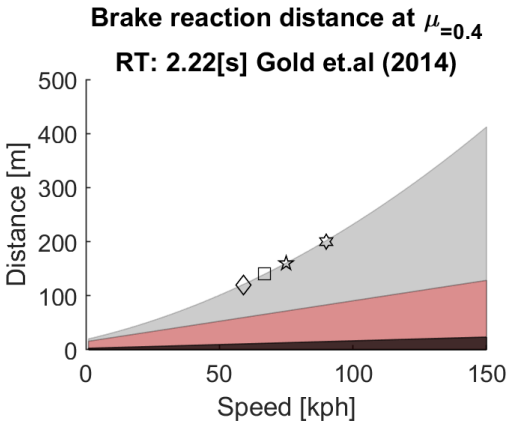


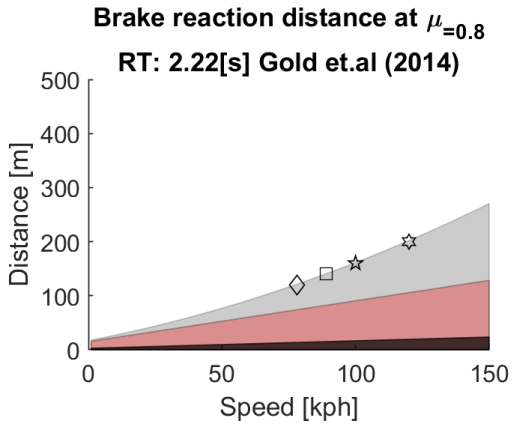


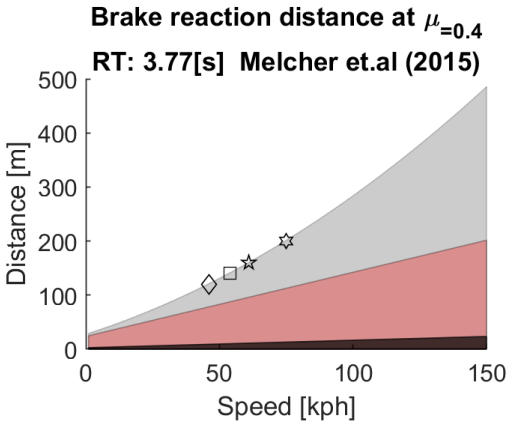
Institute of Transport Economics
Norwegian Centre for Transport Research

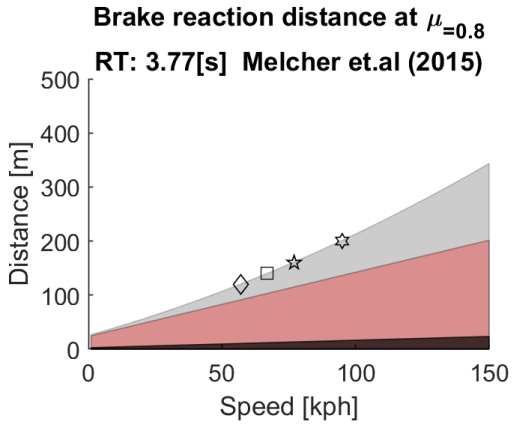

Brake reaction distance at $\mu_{=0.4}$
RT: 3.03[s] Lorenz et.al (2014)
120m
140m
160m
200m
Distance [m]
Speed [kph]


Brake reaction distance at $\mu_{=0.8}$
RT: 3.03[s] Lorenz et.al (2014)
Distance [m]
Speed [kph]


Brake reaction distance at $\mu_{=0.4}$
RT: 2.22[s] Gold et.al (2014)
Distance [m]
Speed [kph]


Brake reaction distance at $\mu_{=0.8}$
RT: 2.22[s] Gold et.al (2014)
Distance [m]
Speed [kph]


Brake reaction distance at $\mu_{=0.4}$
RT: 3.77[s] Melcher et.al (2015)
Distance [m]
Speed [kph]


Brake reaction distance at $\mu_{=0.8}$
RT: 3.77[s] Melcher et.al (2015)
Distance [m]
Speed [kph]

Level 3 Automation

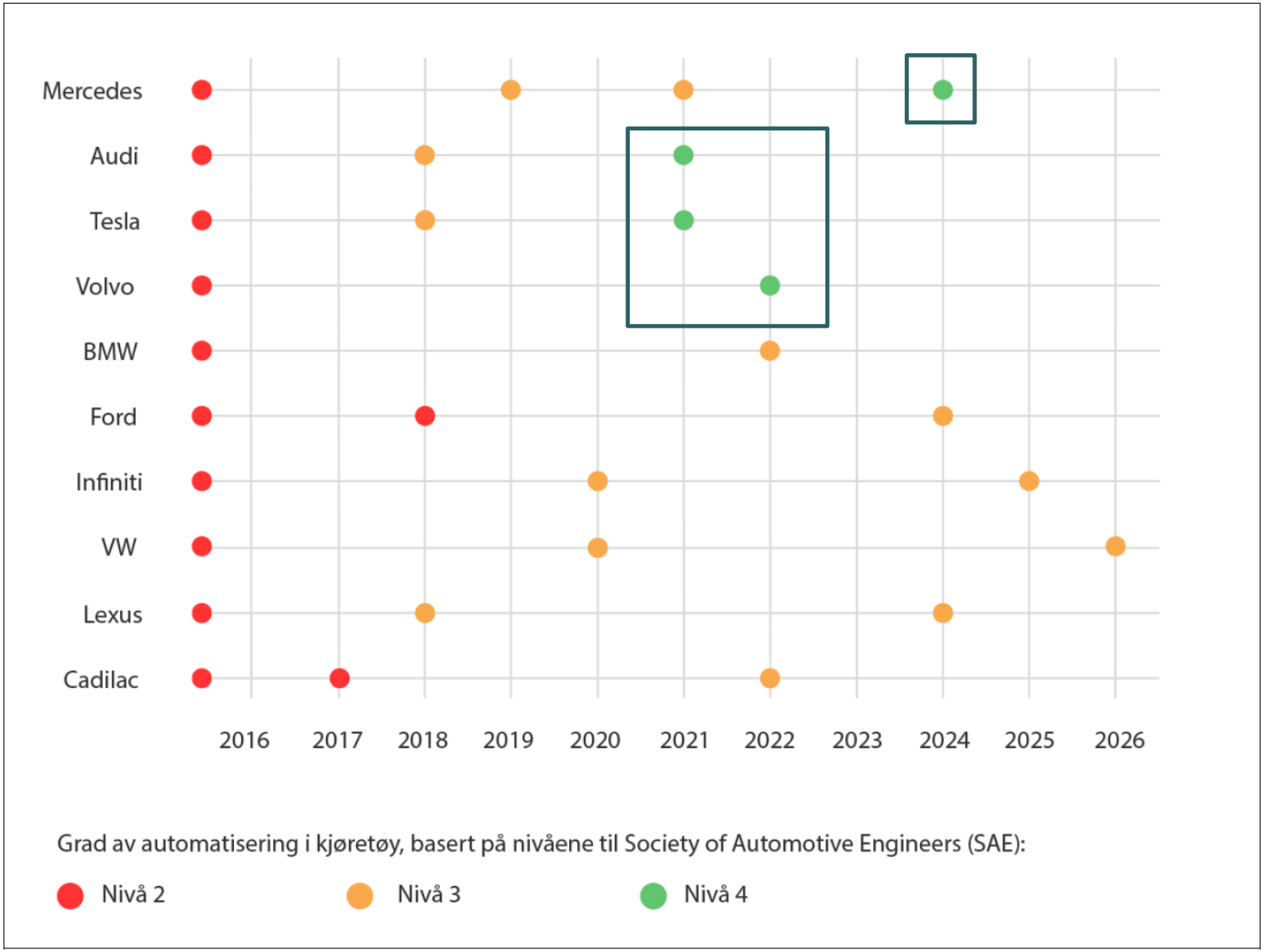
- *In the event of a DDT performance-relevant system failure in a level 3 ADS or in the event that the ADS will soon exit its ODD, the ADS will issue a request to intervene **within sufficient time** for a **typical person** to respond **appropriately** to the driving situation at hand"* (SAE J3016, 2016)

- Could be caused by:
  - *Sensor issues*
  - *Flat tire*
  - *Broken tire-rod*
  - *In essence, any vehicle related issue…*

- Humans are not very good at monitoring a situation with little changes for long durations,which leads to…
  - *Attention decrements*
  - *Loss of vigilance*
  - *Distraction*
  - *Long reaction times*
  - *Poor vehicle control*

The Uber crash in Tempe, Arizona

So for how long are we expected to interact with such problemtic systems?


Mercedes
Audi
Tesla
Volvo
BMW
Ford
Infiniti
VW
Lexus
Cadilac
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
Grad av automatisering i kjøretøy, basert på nivåene til Society of Automotive Engineers (SAE):
Nivå 2
Nivå 3
Nivå 4

Thank you for your attention!

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