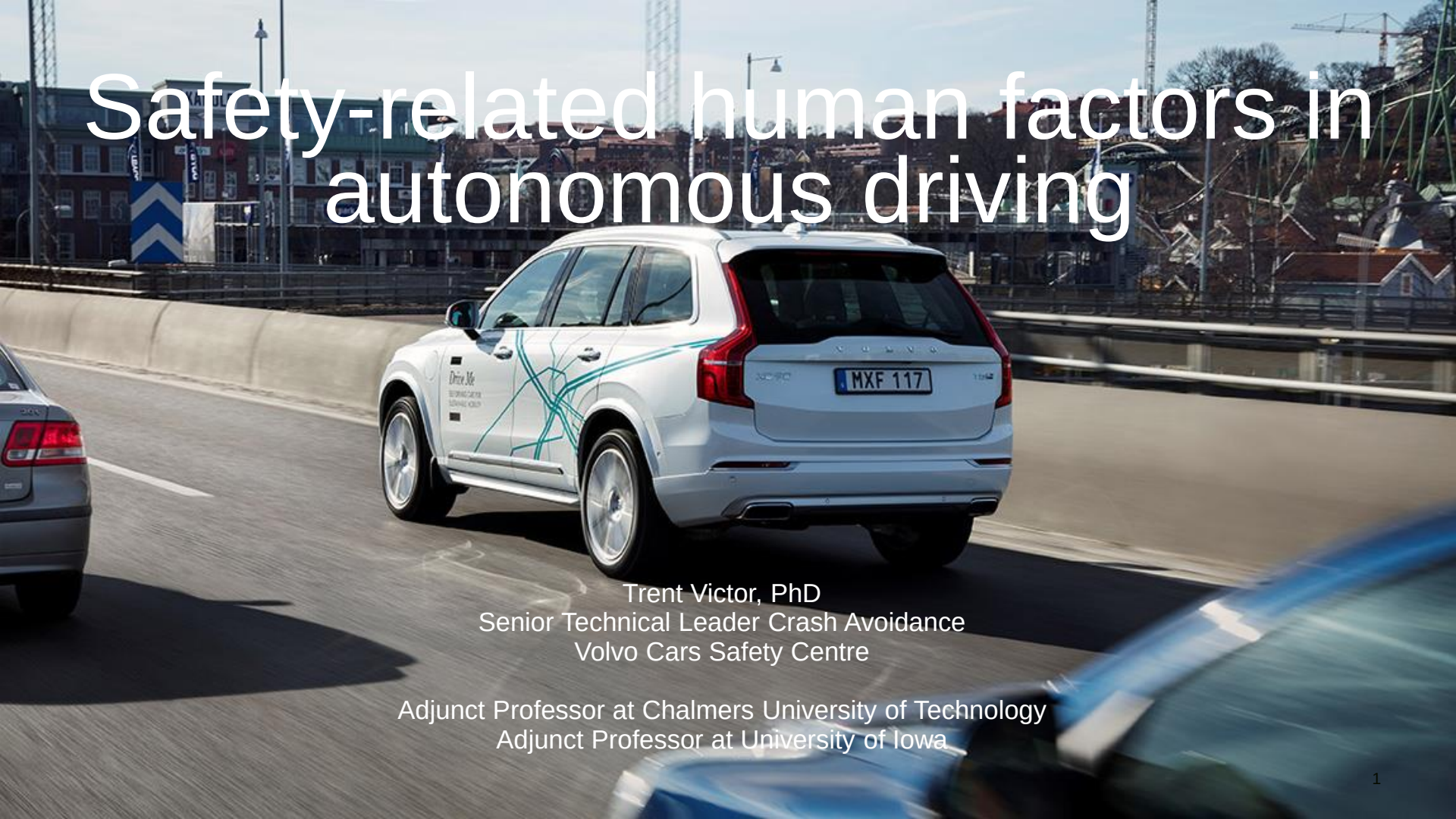
Safety-related human factors in autonomous driving



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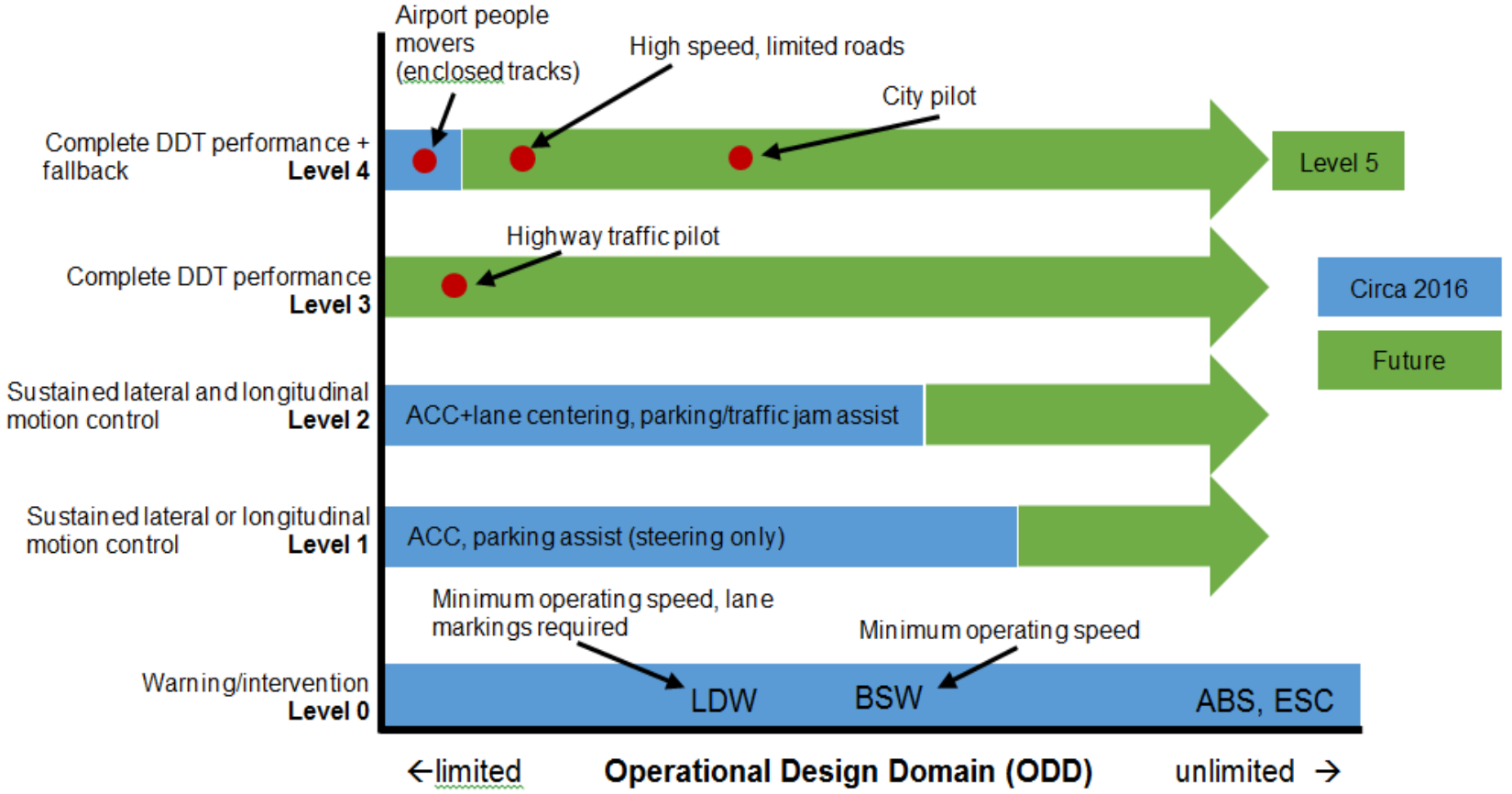
New sAE J3016



role of the driver defines Autonomou

Unsupervised AD
Level 4

Intellisafe Autopilot → **Level 5**

- Driver delegates full control and responsibility
- Volvo assumes liability
- Designed for complete driving control & crash avoidance
- Driver free to do something else

Supervised AD
Level 1&2

Pilot Assist, ACC, LKA

- Driver is always responsible and shall remain in control
- Designed for driver involvement
- Driver *not* free to do something else

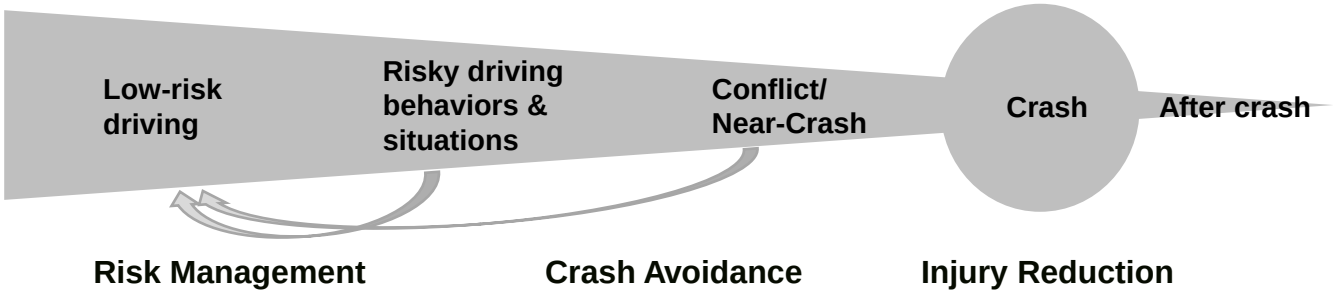
Manual
Level 0

City Safety, ESC etc

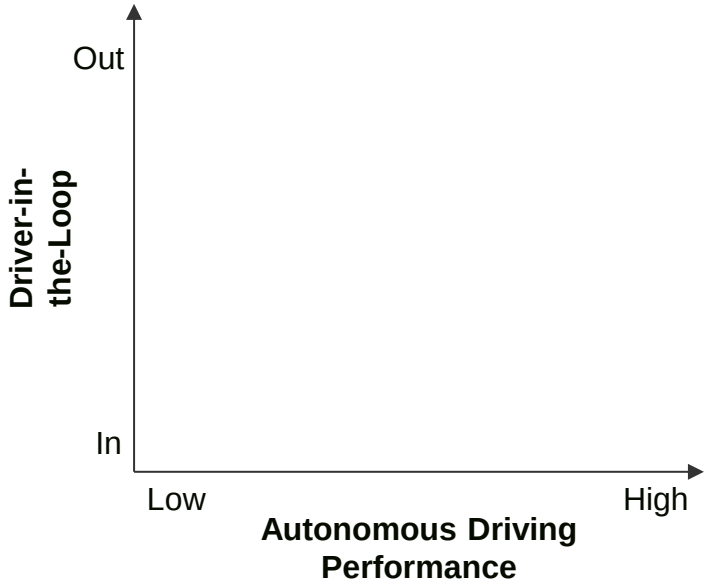
- Driver is always responsible and shall remain in control

Limited → **Unlimited**

Operational Design Domain


Low-risk driving
Risky driving behaviors & situations
Conflict/ Near-Crash
Crash
After crash
Risk Management
Crash Avoidance
Injury Reduction

DiL performance measures
- Visual behavior
- Reaction performance
- Subjective ratings (e.g. trust)



Vehicle performance measures
- Safety margin precision
- Frequency of situations needing supervision or intervention

Supervised AD

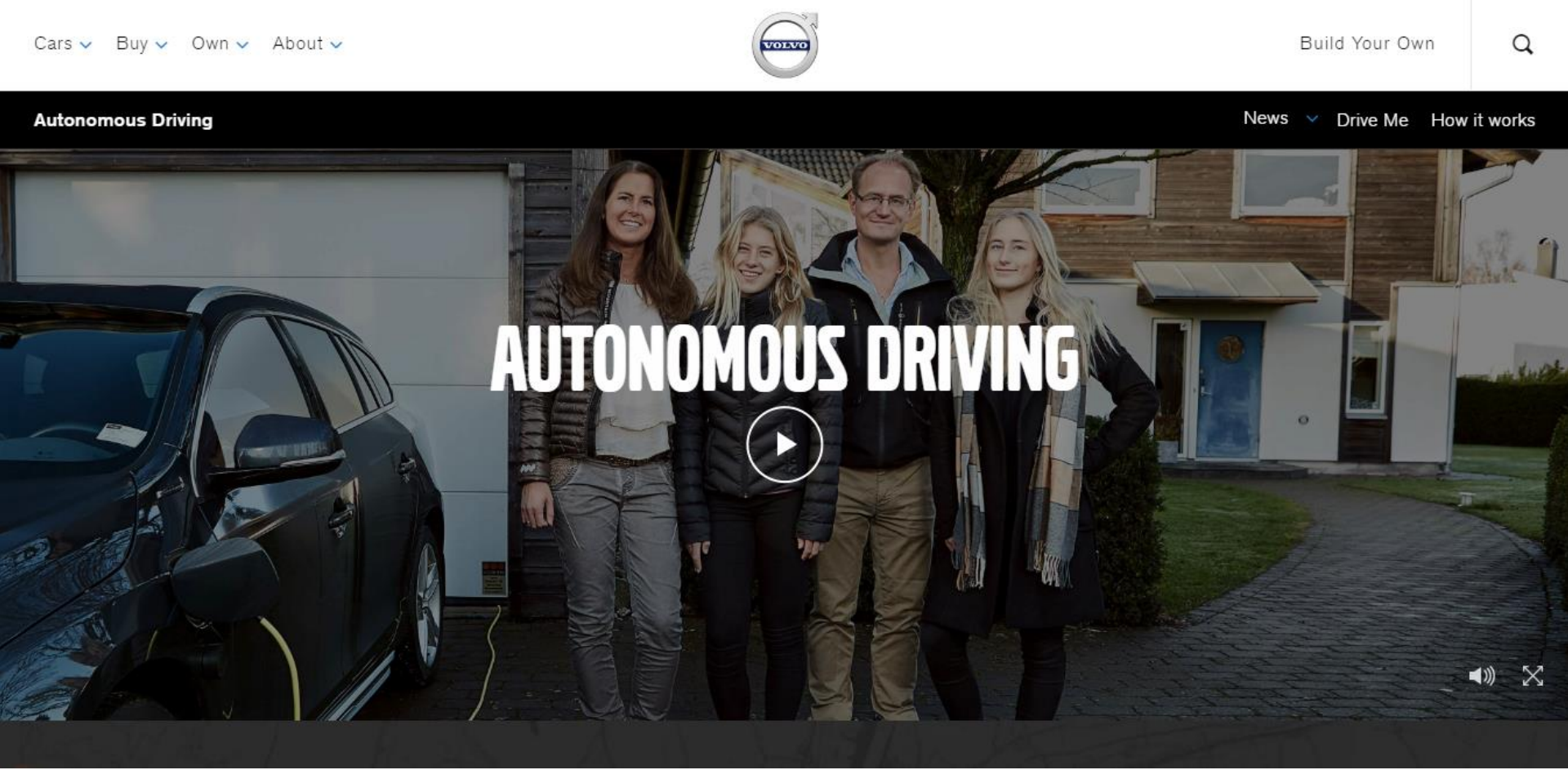
- How do we mitigate for the classic **irony of automation** (the better the automation, the less attention drivers will pay to traffic and the system, and the less capable they will be to resume control)?
- How do we **secure driver-in-the-loop**? The driver may be inattentive or “out-of-the-loop” – may not monitor the driving environment
- How should we **communicate system limitations**? Help drivers understand what they should be watching out for
- How do we handle if the **driver does not provide suitable fallback performance** of the dynamic driving task?

Unsupervised AD

- How do the self-driving vehicle and the **driver react in safety conflict situations**?
- When using AD, are **unsafe passive safety states and unsafe driver states** more common?
- When using AD is there **misuse**?
- Are there **unsafe behaviors when transferring** to and from AD,?
- What determines a **positive safety experience (trust)**?

How do we design to make the status AD observable, and to be able to see what automation will do next?

How should mismatches in driver perception of a conflict and the vehicle sensing be made transparent / displayed to the driver (e.g. silent failures)?



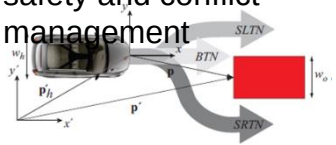
www.volvocars.com/autonomou

Volvo Predictive Safety Impact Analysis

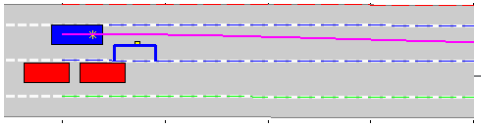
1) Self-driving conditions

2) Definition of safety conflict situations

3) New precautionary safety and conflict management

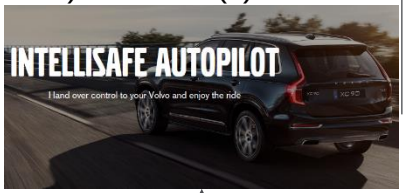


4) Virtual CAE verification v1

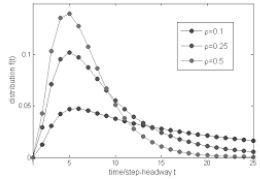


5) Vehicle design to prevent new risks e.g. *Driver's role, handovers, misuse, seating positions, drowsiness etc*

6) Field test(s)

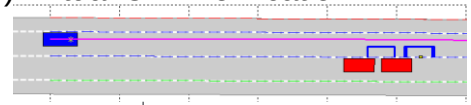


7) Safety performance indicators



8) Determine if new risks emerge

9) Virtual CAE verification v2



10) Sum all safety evidence