Defining Safe Automated Driving

Insurer Requirements for Highway Automation

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October 2019

Thatcham Research

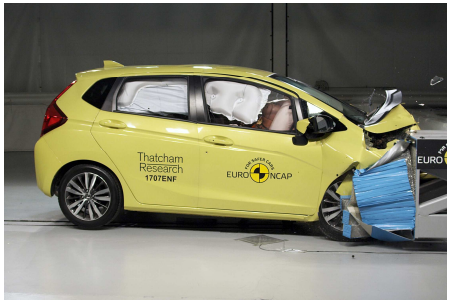
50 YEARS DRIVING CHANGE

Contents

About Thatcham…

…Safer cars, fewer crashes

- Formed in 1969
- Not for profit
- Funded by UK Motor Insurers
- Annual turnover £16M



Euro NCAP has helped reduce UK in-vehicle KSI by 65% over 20yrs

New collision avoidance technology will reduce KSI further towards Vision Zero……

Today Thatcham's role is as important and unique as ever…

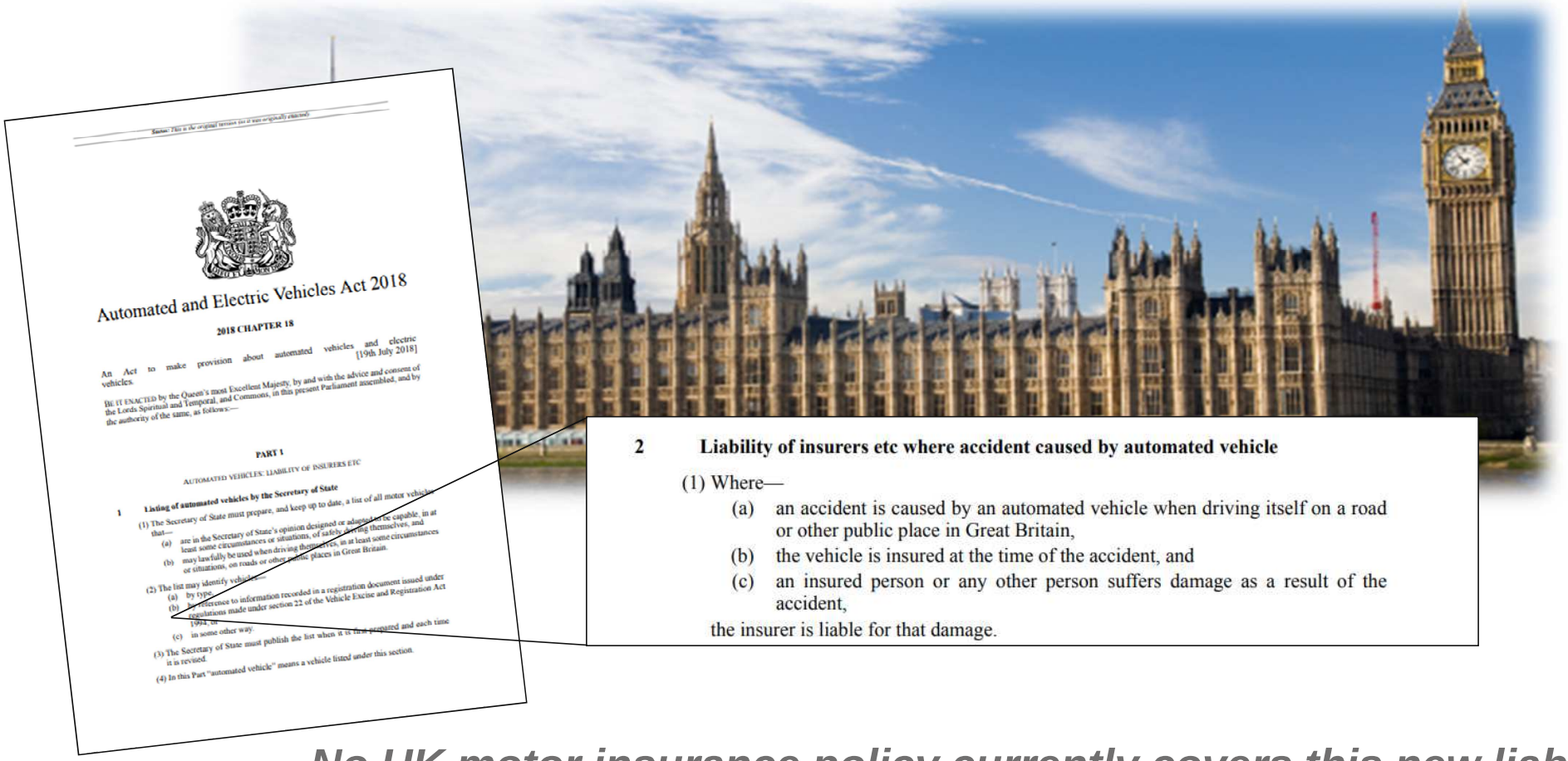
- The Insurance industries Research faculty
- Understanding tomorrows cars on tomorrows roads
- A key member of Euro NCAP defining new safety tests
- Leading International research into assisted and autonomous vehicles
- Lobbying International regulators for safety related technology
- Creating methods to efficiently and safely repair cars
- Vehicle security testing including Cyber research
- Training the bodyshop technicians of the future

3%	16%	75%
≤★★★	★★★★	★★★★★

Today 94% of all cars have a valid Euro NCAP Rating

Automated and Electric Vehicles Act 2018

The Challenge to UK Insurers



Automated and Electric Vehicles Act 2018

2018 CHAPTER 18

An Act to make provision about automated vehicles and electric vehicles. [19th July 2018]

BE IT ENACTED by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

PART 1

AUTOMATED VEHICLES: LIABILITY OF INSURERS ETC

1 **Listing of automated vehicles by the Secretary of State**

(1) The Secretary of State must prepare, and keep up to date, a list of all motor vehicles that—

(a) are in the Secretary of State's opinion designed or adapted to be capable, in at least some circumstances or situations, of safely driving themselves, and

(b) may lawfully be used when driving themselves, in at least some circumstances or situations, on roads or other public places in Great Britain.

(2) The list may identify vehicles—

(a) by type,

(b) by reference to information recorded in a registration document issued under regulations made under section 22 of the Vehicle Excise and Registration Act 1994, or

(c) in some other way.

(3) The Secretary of State must publish the list when it is first prepared and each time it is revised.

(4) In this Part "automated vehicle" means a vehicle listed under this section.

2 **Liability of insurers etc where accident caused by automated vehicle**

(1) Where—

(a) an accident is caused by an automated vehicle when driving itself on a road or other public place in Great Britain,

(b) the vehicle is insured at the time of the accident, and

(c) an insured person or any other person suffers damage as a result of the accident,

the insurer is liable for that damage.

No UK motor insurance policy currently covers this new liability

Assisted Driving Testing

A Journey to Automation

› The Insurer View – Assisted or Automated

2018 AD assessment fleet

- The first grading of Assisted Driving technology

Audi A6

BMW 5

DS 7

Ford Focus

Hyundai Nexo

Mercedes C

Nissan Leaf

Tesla S

Toyota Corolla

Volvo V60

Testing Assisted Driving

- Test protocols

HMI
(Desk Based Assessment)
HUMAN MACHINE INTERACTION

- System Name
- Official Media
- System Features
- User Manual

ACC
(Track Based Assessment)
ADAPTIVE CRUISE CONTROL

- Stationary Car
- Slower Moving Car
- Braking Car
- Cut-in
- Cut-out

LC
(Track Based Assessment)
LANE CENTERING

- Obstacle Avoidance
- Steering In S-curve

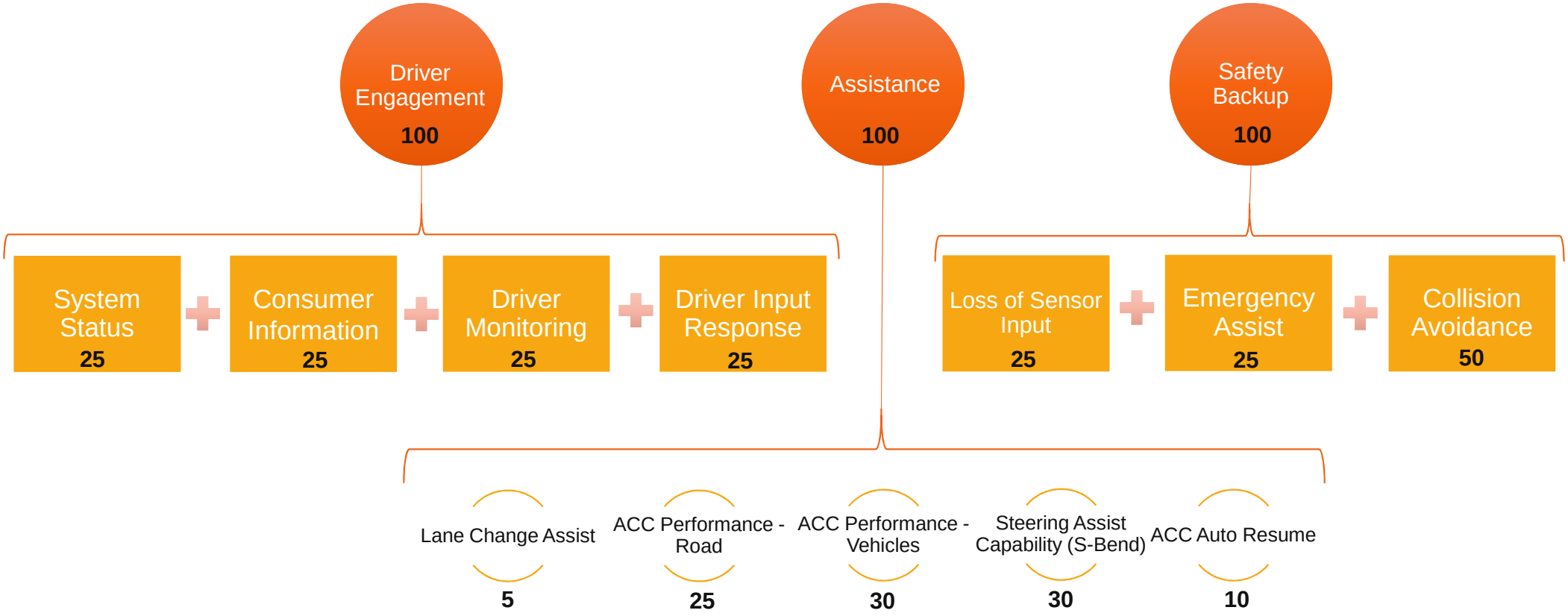
Assisted Driving testing

- Assessment

2018 testing

- Summary

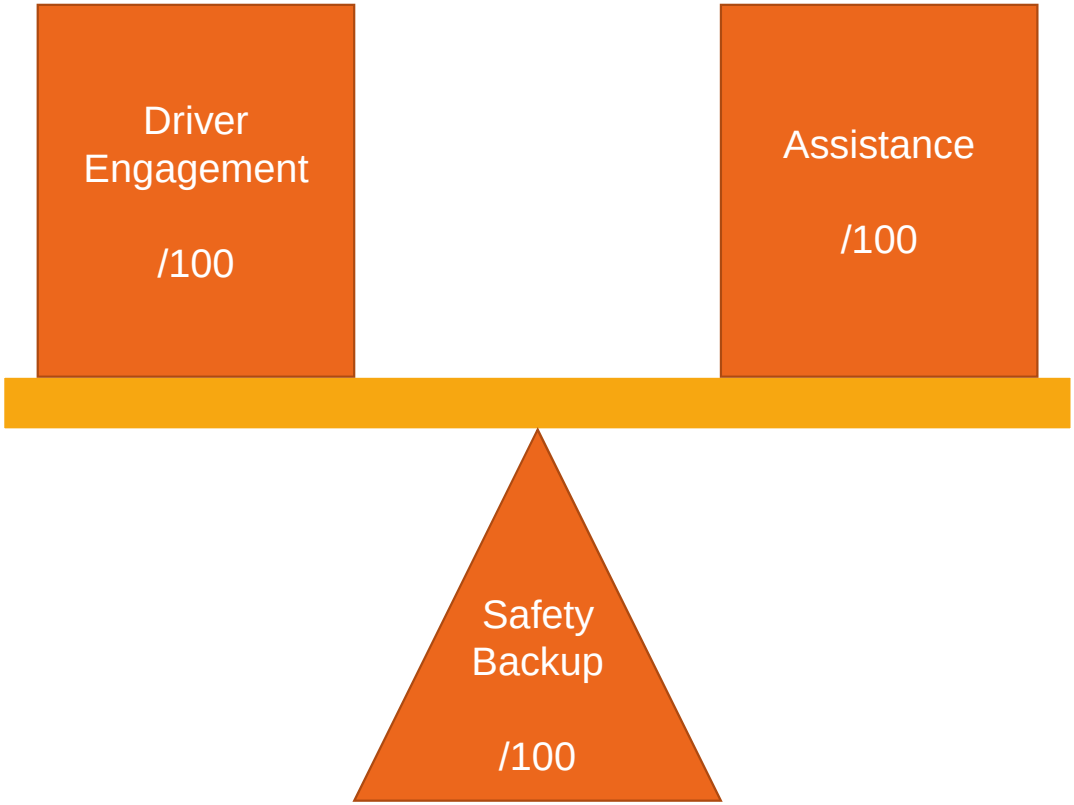
2019 Assisted Driving Assessment Framework



Euro NCAP AD grading

- **Basic**
- **Intermediate**
- **Advanced**
- **Superior**

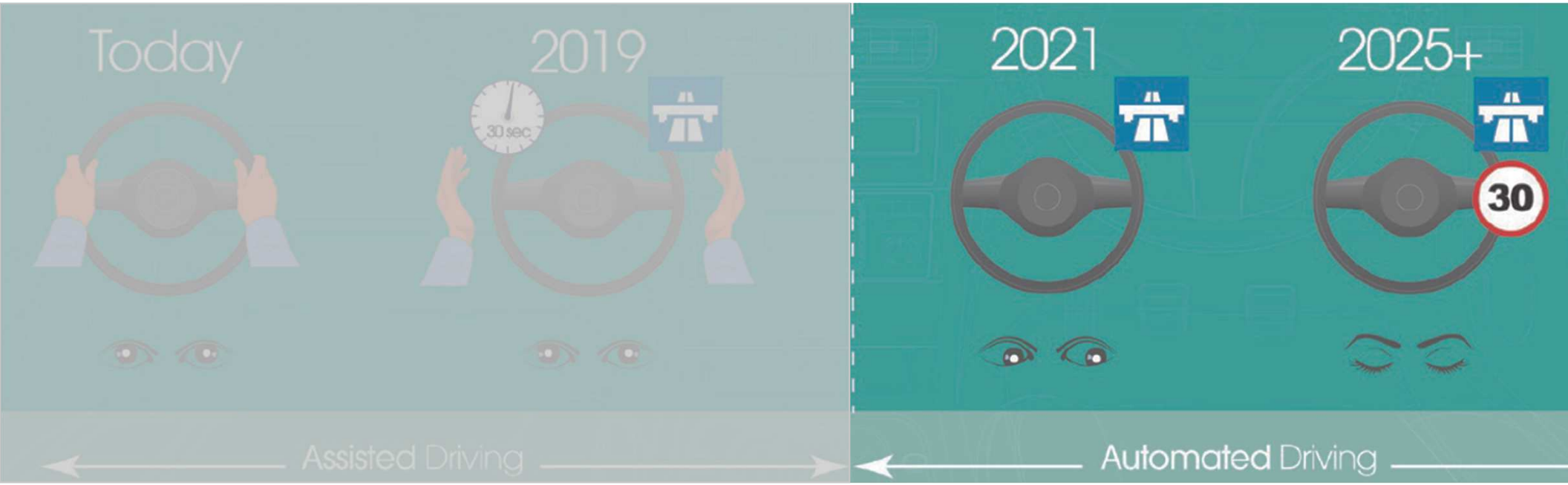
- Sits alongside 5 star safety rating
- Mid 2020 launch



Safe Automated Driving proposal and validation requirements

A Journey to Automation

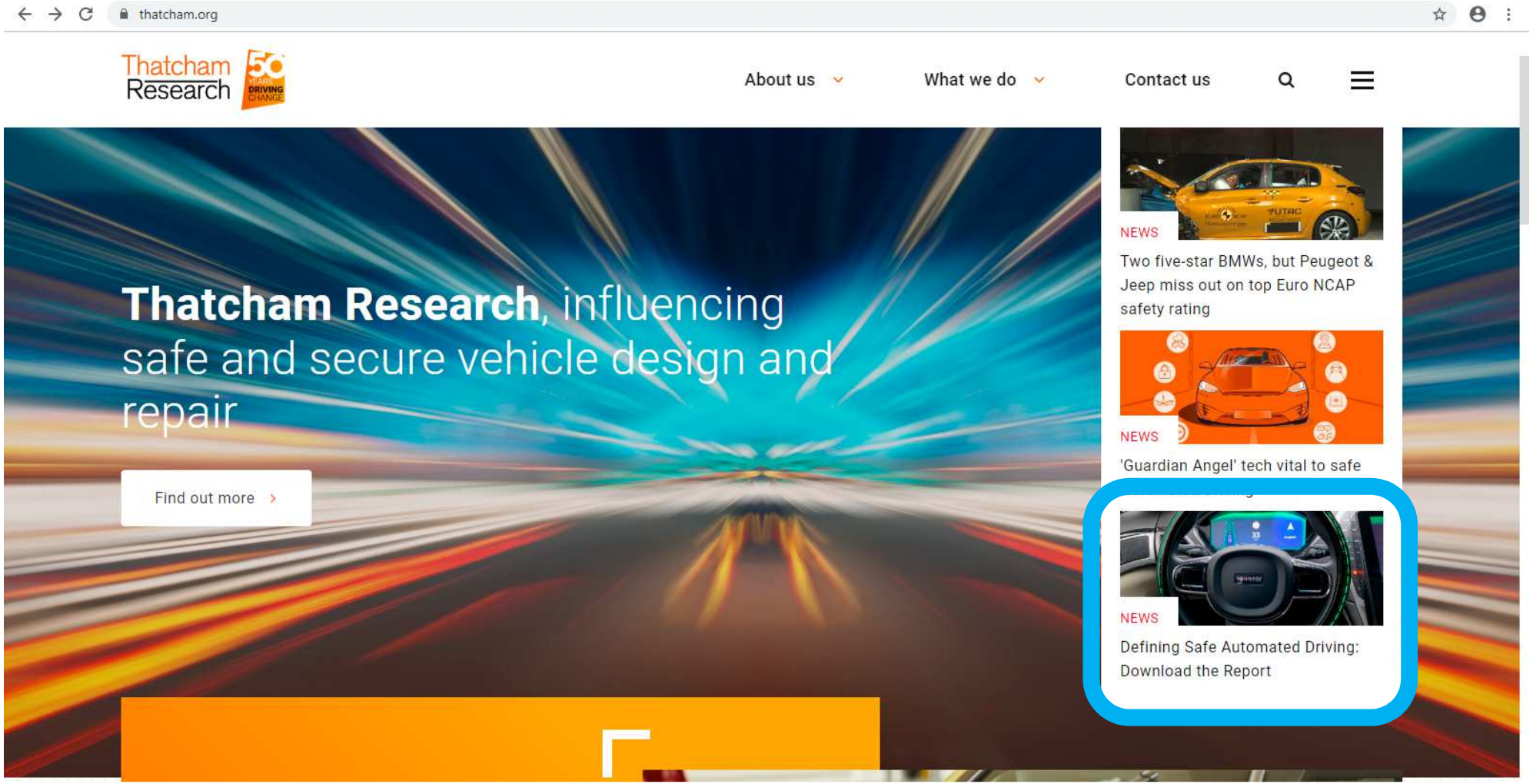
- The Insurer View – Assisted or Automated

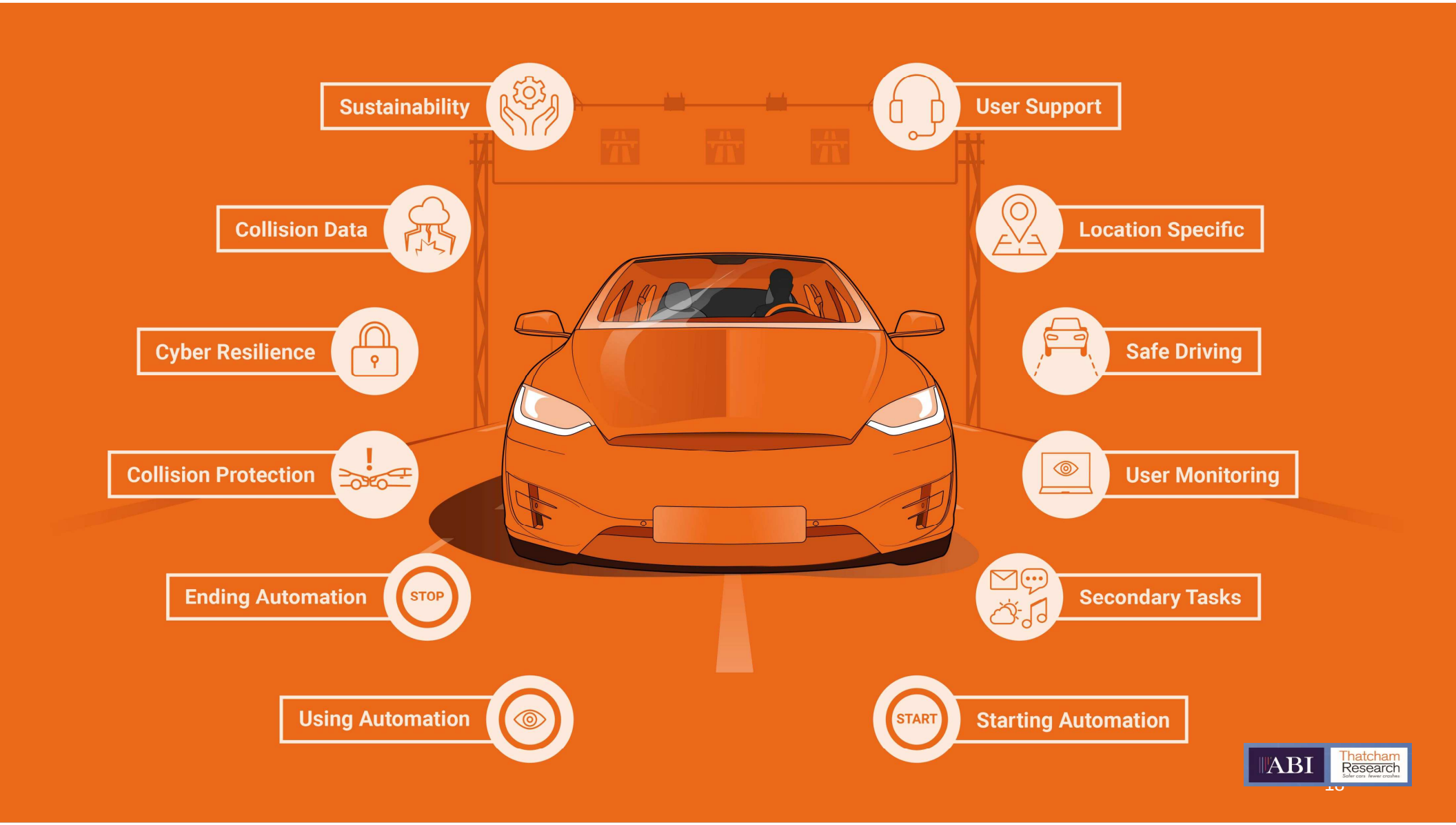


Automated Driving – Keeping it Safe

- UK Automated and Electric Vehicle Act **AEVA** facilitates Automated Driving by 2021
- Allows “user in charge” to undertake “secondary tasks”
- Insurers liability moves from the person to the car
- Changes to UK **Road Traffic Act** to allow public use
- Act defines Automated Vehicles – UN GRVA provides basis of functional definition
- International Insurers have defined “Safe Automation”– ***www.abi.org.uk/defining-safe-automation.pdf***
- Identifies **12** Key requirements for Highway domain

www.thatcham.org




Sustainability
User Support
Collision Data
Location Specific
Cyber Resilience
Safe Driving
Collision Protection
User Monitoring
Ending Automation
STOP
Secondary Tasks
Using Automation
START
Starting Automation
ABI
Thatcham Research
Safer cars. fewer crashes

#1 User Support
Naming and training

- Automated modes must be clearly differentiated from Assisted/Manual modes both in terms of information and implementation.
- The ADS must inform the driver of their obligations when using the system and the driver must accept these prior to using.
- Vehicle manufacturers must declare dynamic VIN level functionality data for individual vehicles including the latest software release to reflect changing capability.

#1 User Support
Validation Requirement

- Consistency of consumer information describing driver role and responsibility regarding automation
  - Marketing material compared to vehicle ‘handbook’ – appropriate descriptive language and illustrations
  - When starting, using and ending automation

- Clear and consistent information for using automation – displaying status to reinforce change of driver role
  - Visually indicating when automation is in use, clearly different from manual/assisted driving
  - Displayed within driver forward vision (e.g. steering wheel) and on user interface
  - Refer to Euro NCAP assisted driving assessment ‘System Status’ – icons, sizes and colours etc.

- Confirm driver acceptance of obligations
  - To be acknowledged when automation is first engaged on each journey, or
  - Use DMS to recognise drivers that have undergone training and permit operation

#2 Location Specific
Operational Design Domain (ODD)

- ODD requirements may include static (e.g. road type) and dynamic (e.g. traffic) features.
- The vehicle manufacturer must publish a definition of the ODD in which the ADS functions
- The ADS must be capable of accurately identifying when all conditions defining the ODD are met and predicting when they will be no longer met.

#2 Location Specific
Validation Requirement

- Must provide clarity regarding ODD for driver to understand system
  - Clarify system capability and managing driver expectation
  - Support driver predicting and understanding end of automation

- Provide outline ODD structure for system classification
  - E.g. Highway automation: Traffic queuing Limited speed driving Full speed driving
  - Limited number of driving characteristics defining ODD for driver e.g. road, weather, speed, traffic…
  - Plus vehicle operational integrity requirements – ISO 26262

- On-road testing to validate virtual testing
  - Correct operation within and denial outside of ODD
  - Breakdown of the ODD from both environment and vehicle perspective

#3 Safe Driving

- The ADS must perceive and safely react to all foreseeable events encountered within the ODD.
- The ADS must interact and drive in a predictable and safe way with other safe and legal road users.
- Where software updates change capability or performance the VM must demonstrate that it complies with the required standards.

#3 Safe Driving
Validation Requirement

- 1. Maximise safety, 2. Make progress and maintain free movement of traffic, 3. Ease and simplicity for users

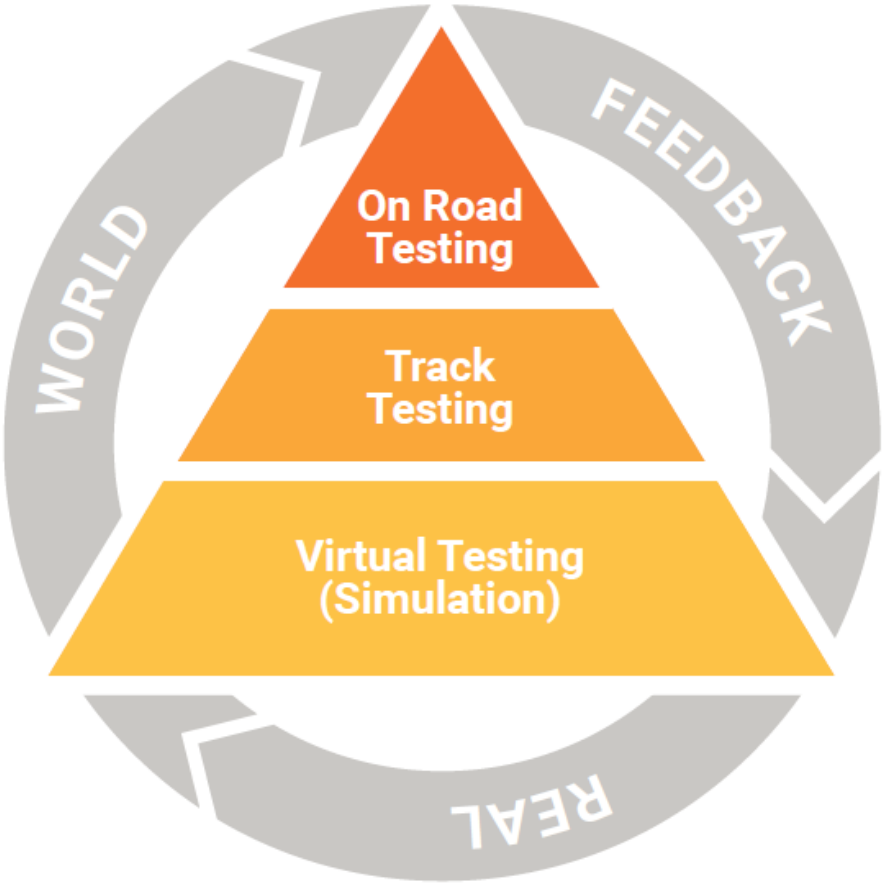
- Technical safety requirements based on:
  - Defined set of key principles embedded within driving rules
  - The most important safety related rules
  - Adapted to the immediate situation acknowledging the road, traffic and prevailing conditions

- Select relevant cases for virtual testing from an exhaustive library of scenarios based on the system ODD
  - Pegasus, OmniCAV, COSMOS, VeriCAV, D-Risk, Sim4SafeCAV, Musicc, Headstart etc.

- Technical requirements must be met in physical track testing, the results of which must fall within an acceptable tolerance of the result of the equivalent simulated test

Proposed four part test and assessment cycle:

- Virtual Testing (Simulation)
- Track testing
- On Road testing
- Real world feedback – Insurance data



#4 User Monitoring

- Vehicles with ADS must have User-in-Charge monitoring systems capable of determining user status when starting, during and ending automation.

- During automation user attentiveness status must be used by the ADS to determine the best strategy for managing handover in a safe manner.

- When ending automation user monitoring must assess user status and the ADS must provide support until the user is reengaged with the dynamic driving task (DDT).

#4 User Monitoring
Validation Requirement

- Continuous, reliable identification of the various users states for automation
  - Alert, monitoring the road ahead, engaged in appropriate secondary tasks, reengaged in the DDT

- Simulation to evaluate performance of the system for:
  - Various human facial attributes with face and headwear
  - Across all feasible seating positions and postures
  - Under various ambient conditions

- To be evaluated in physical track testing, the results of which must fall within an acceptable tolerance of the result of the equivalent simulated test

#5 Secondary Tasks

- The ability for a User-in-Charge to undertake distracting secondary tasks is a key motivation for using automation.

- Where the possibility exists for an **unplanned** handover from automation only tasks that link the user to the in-car infotainment system will be permitted. The use of nomadic devices, books, newspapers and sleeping will be prohibited.

- Where a **planned** handover can be ensured the use of nomadic devices will be permitted and in some circumstances sleeping may be permitted.

#5 Secondary Tasks
Validation Requirement

- Linked with User Monitoring testing

- Ideally automated vehicles will enable enforcement authorities to immediately identify system usage

- Confirmation on a test track that virtual testing identifies:
  - Only the prescribed secondary task(s) enable the continued operation of automation
  - Attempting alternative tasks initiates a warning cascade that ultimately escalates to a hand over request

#6 Starting Automation

- The ADS must continuously monitor the vehicle and environment to assess whether the ODD requirements for automation are met.
- Automation will be offered only where the requirements for the ODD are achieved. The driver will not be able to request automation.
- When met the ADS can be activated with a clear *'Offer and Confirm'* process.

#6 Starting Automation
Validation Requirement

- Linked with Location Specific testing – automation cannot be started unless all requirements of the ODD are confirmed by the vehicle

- Confirmation on a test track that virtual testing identifies:
  - That automation can be started when the ODD is met only by the driver confirming they want to commence automation
  - Vehicle factors that are not safe to test on the public road (e.g. damage or degradation) prohibit the starting of automation
  - Environmental factors that cannot be tested on the public road (e.g. weather or reduced surface friction) prohibit the starting of automation

#7 Using Automation

- During automation the vehicle must continuously indicate the ADS status.
- During automation the user may engage in appropriate secondary tasks.
- The user monitoring system must manage the user attentiveness to ensure they are ready for handover at the appropriate time.

#7 Using Automation
Validation Requirement

- Linked with User Support, User Monitoring and Secondary Tasks testing regarding the driver
- Linked with Safe Driving regarding the vehicle
- Confirmation testing on a test track that automation works as a whole system rather than as individual component tests

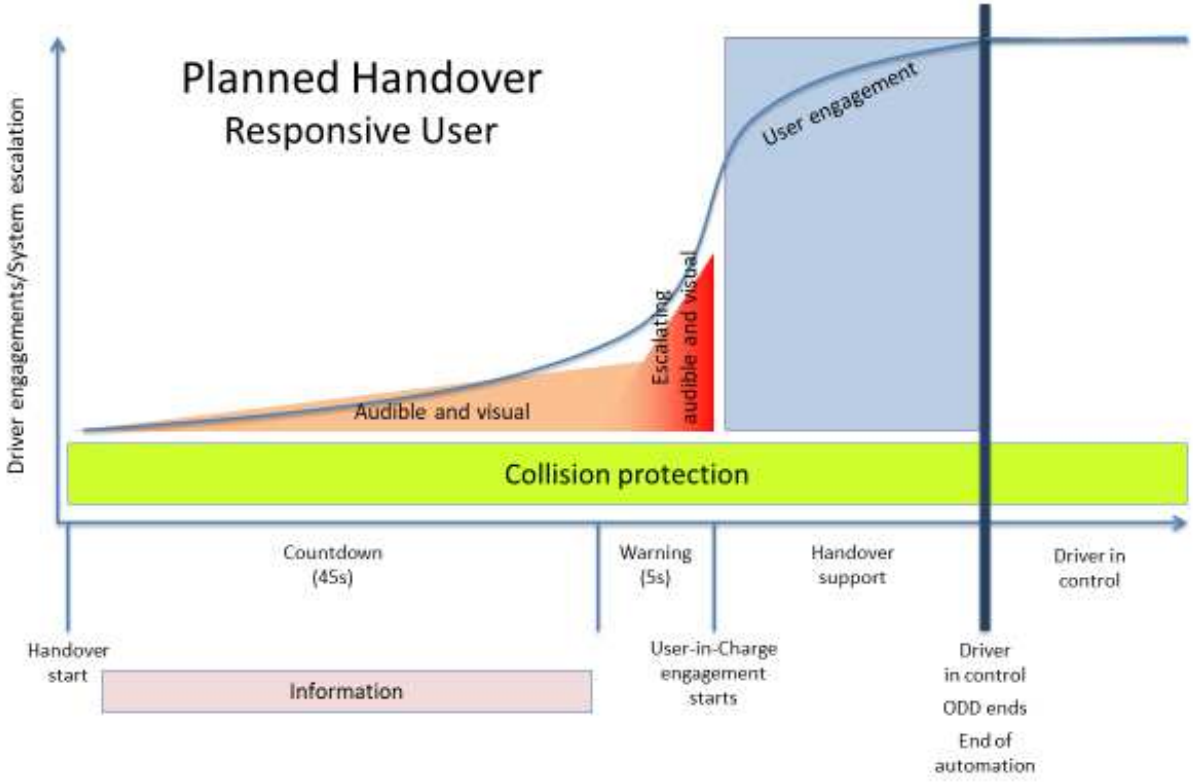
#8 Ending Automation

- **Planned** – ADS initiates a scheduled handover of control giving the User-in-Charge sufficient time to reengage with the DDT.
- **Unplanned** – ADS initiates a warning process to engage the User-in-Charge with the DDT immediately.
- **User-in-charge initiated –** User-in-Charge initiates an unplanned handover**.** Follows a multipath offer-and-confirm process to resume the DDT.
- **System Failure** – ADS initiates a warning process to engage the User-in-Charge with the DDT immediately. The system must maintain the capability to perform an MRM.

#8a Ending Automation

Responsive driver

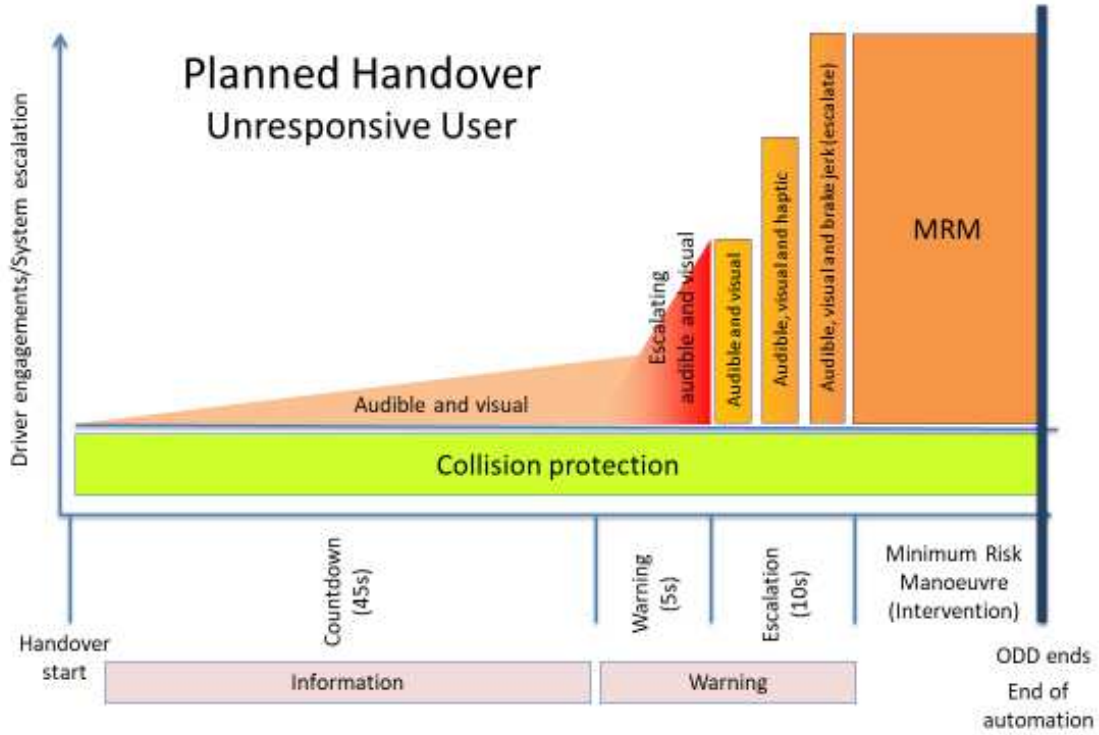
- A **planned** handover**:** e.g. when a static, predictable ODD condition such as a highway exit is approached.
- ADS initiates a **planned** handover of control informing the user-in-charge with sufficient time to reengage with the Dynamic Driving Task (DDT).
- User monitoring must assess user status and the ADS must provide support until the user-in-charge is reengaged with the DDT.



#8a Ending Automation

Unresponsive driver

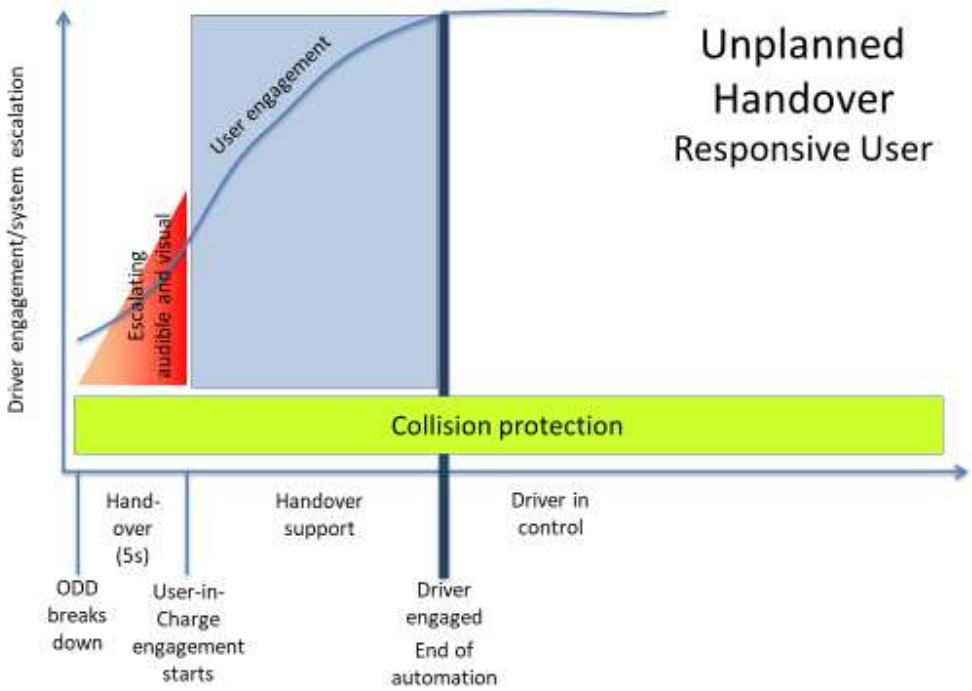
- A **planned** handover**:** e.g. when a static, predictable ODD condition such as a highway exit is approached.
- ADS initiates a **planned** handover of control informing the user-in-charge with sufficient time to reengage with the Dynamic Driving Task (DDT).
- User monitoring must assess user status and the ADS must provide support until the user-in-charge is reengaged with the DDT.



#8b Ending Automation

Responsive driver

- An **unplanned** handover**:** e.g. when a dynamic ODD condition such as a traffic dissipating or unpredictable inclement weather occurs.
- ADS initiates a warning process to reengage the user-in-charge with the DDT immediately.
- User monitoring assesses the user-in-charge state and the ADS provides sufficient support to ensure they have fully reengaged with the DDT.



#8 Ending Automation
Validation Requirement

- Evaluate warning cascade for unplanned and planned ODD exits
- Method as per the Euro NCAP Assisted Driving “Emergency Assist” provoking the vehicle to trigger escalation to the MRM state by deliberately remaining unresponsive during track testing to prove escalation strategy
  - Insurers do not consider stopping in lane as a sole safe solution
  - MRM appropriate to the prevailing driving conditions must be considered with the ability of the vehicle to move to safe harbour
- For driver initiated takeover of control, multipath process to ensure driver does not reengage in error, with appropriate engagement with driving task confirmed by user monitoring system.
- The Euro NCAP Assisted Driving “Loss of Sensor Input” test can be used as a basis for further development to simulate system failure and hand over escalation event

#9 Collision Protection

- Automated vehicles must be equipped with emergency collision avoidance technology that can react to all foreseeable critical situations in the driving domain.
- Emergency collision avoidance technology must engage when ADS is operating.
- Vehicles will require state-of-the-art passive safety protection.

#9 Collision Protection
Validation Requirement

- Linked with Safe Driving regarding collision avoidance

- Confirmation that emergency control interventions are achieved in physical track testing, the results of which must fall within an acceptable tolerance of the result of the equivalent simulated test

- Consider equipment and methods used for Euro NCAP Assisted Driving ‘Emergency Intervention’ tests
  - Stationary vehicle ahead and around a curve, cut in and cut out etc.

- For passive safety equivalent protection is required for non-conventional occupant positions if permitted
  - Restraints moving with seating positions rather than fixed to body

#10 Cyber Resilience

- ADS must be designed, developed and maintained to minimise the vulnerabilities and the consequences of cyber intrusion.
- ADS must meet UN ECE WP 29 regulations on cyber security and over-the-air software updates.
- Vehicle manufacturers, sub-brands, supply chains and vehicles must meet the ISO/SAE 21434 Automotive Cyber Security standard (due 2020).

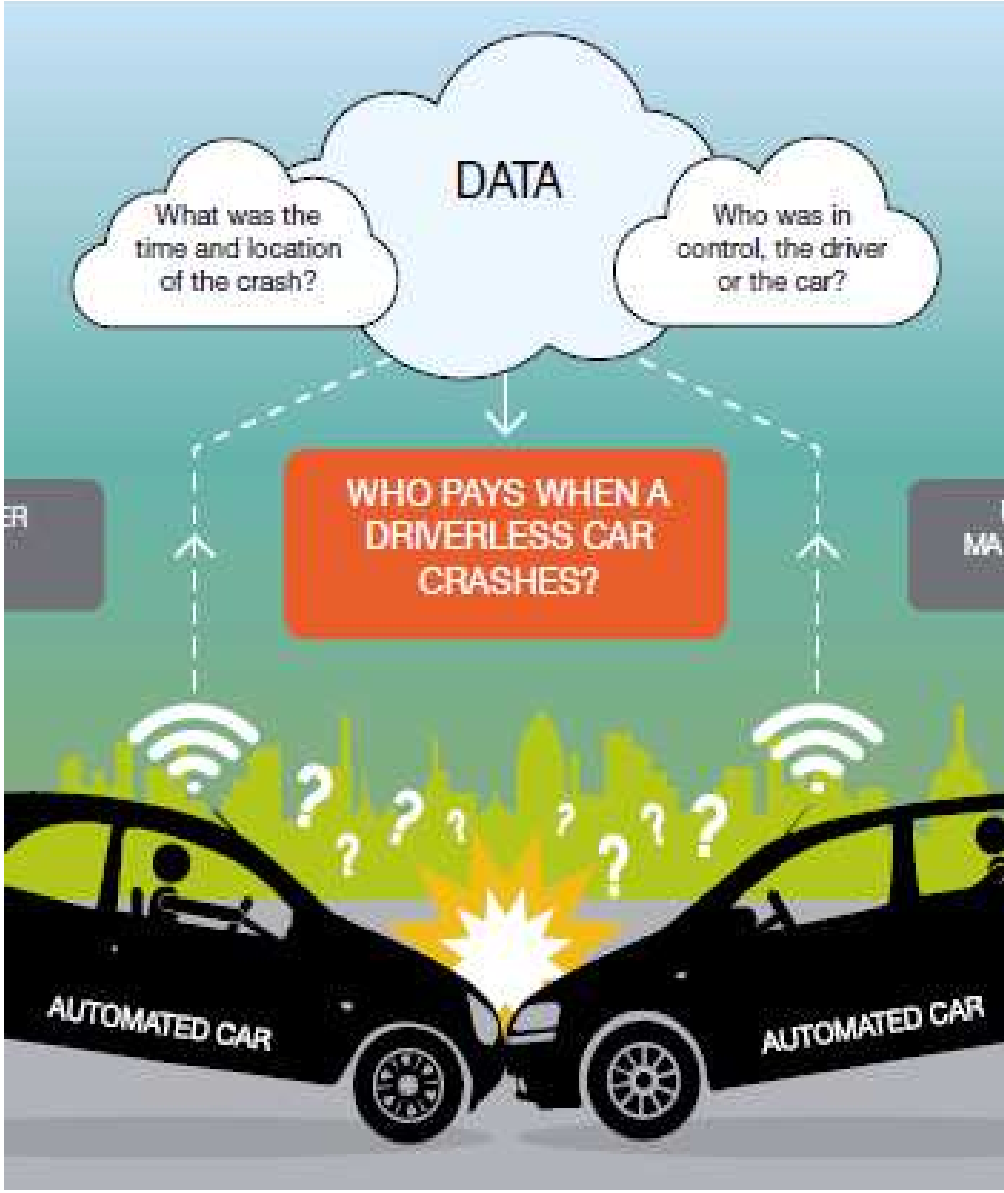
- Refer to CS/OTA IWG

#11 Collision Data

- Vehicle manufacturers must make a limited data set available to insurers confirming whether the ADS or the driver was in control leading up to a collision which must trigger in all collision situations

- GPS-event time stamp
- Activation status of each automated driving feature
- Driver acceptance between automated/manual mode time stamp
- Record of Driver Intervention of steering, braking, accelerator or gear-shift
- Driver Seat Occupancy
- User Engagement Commenced
- Has Minimum Risk Manoeuvre (MRM) been triggered
- System status (linked to fault code)

- Refer to DSSAD IWG



#12 Sustainability

- The emergency collision protection system shall be tolerant of sensor and vehicle degradation, maintaining full functional performance for at least 10 years including software support.
- Systems must be designed to be self-healing in case of minor damage or enable safe and cost-effective repair.
- A tell-tale must be displayed and system operation denied should system integrity checks detect a fault. This will be included in the data recording.

#12 Sustainability
Validation Requirement

- Lifetime operational requirements like ACSF – simulating system degradation

- Specify and introduce minor misalignment representative of typical real world damage
  - Confirm system automatically recalibrates to restore full functionality, or
  - Provides information warning driver of fault condition and denies system operation until damage is repaired

- Specify and introduce major misalignment representative of typical real world damage
  - Confirm system provides information warning driver of fault condition and denies system operation until damage is repaired

- Confirmation at PTI confirming correct operation of emergency collision avoidance systems

Thank You & Questions