Driverless cars: liability frameworks and safety by design

VENTURER Insurance and Legal report 2018

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About VENTURER

VENTURER brings together public sector, private sector and academic experts to understand the blockers and enablers to wide scale adoption of Connected and Autonomous Vehicles (CAV).

The VENTURER trials are intended to develop understanding of the insurance and legal implications of increased vehicle autonomy. The project is now in its third and final year and takes place in the Bristol and South Gloucestershire region.

VENTURER is made up of organisations from various sectors:

University of Bristol · Bristol City Council · AXA · First

UWE Bristol · Atkins · Fusion Processing · South Gloucestershire Council

Williams · BAE Systems Inspired Work · brl Bristol Robotics Laboratory · Burges Salmon

Introduction

As the VENTURER project's 3 year trials formally conclude, we have pleasure in presenting Burges Salmon and AXA's third legal and insurance report.

At the time of writing, the Automated and Electric Vehicles Bill (AEV Bill) has only just completed its committee stage in the House of Lords, so key legislation has not yet been finalised, but we expect the content of this report to remain equally valid after its enactment[1].

This report will consider legal and insurance issues for automated vehicles (AVs) in the context of a number of collision scenarios, with particular focus on the mechanics and limitations of machine to human handover arising from VENTURER's research. Questions as to "who is liable?" and "who will pay?" in the event of an accident involving a self-driving vehicle have been understandably asked for as long as the concept of self-driving vehicles has existed. From time to time, the questions become more vocal as questions take on real world significance through events involving AVs in testing or advanced driver-assistance systems (ADAS).

This report aims to help demystify the legal and insurance analysis around a number of example scenarios and, where possible, offer practical commentary or recommendations and identify further areas for reform, investigation or consultation (particularly in light of VENTURER findings).

Whilst there have been a number of reported incidents involving driver assistance technology, such features (according to their terms of use) are not considered true self-driving functions but rather partial automation features requiring the driver to keep hands on the wheel and attention on the road at all times. The distinction between levels of automated driving is not straightforward but is important for legal and insurance purposes, and it is explored further below. The fatal incident of 19 March 2018 in Arizona involving a trial autonomous vehicle was a significant moment which both raised questions as to how trial vehicles were being operated (particularly in the USA) and highlighted how high profile media reporting on AVs can lead to misconceptions as to relative vehicle safety.

It is important to acknowledge that the ways in which trials of AVs are being conducted in the UK under the existing code of practice[2] and investment into physical and digital test beds are substantially different to the regime in the USA and other countries. This structured approach looks to continue as the Government now considers the next phase of testing approvals for highly automated vehicles, potentially with no on-board driver at all.[3] Taken together these provide a high degree of assurance as to how the UK intends to bring 'market-ready' AVs to public roads in a safe manner that realises all the safety benefits of eliminating human error but minimises residual risk as far as practicable.

We are mindful that the Law Commission has been (from March 2018) undertaking the scoping phase of a three year project to assess the requirements for legal reform to accommodate automated vehicles and it is hoped that this report will contribute to that exercise[4] . That will be an important process and reinforces the UK's approach to developing technology and regulation in parallel. For the purposes of this report, we focus on the law applicable to England and Wales and aspects of civil liability arising from collision incidents. However, we highlight additionally a number of criminal law and regulatory aspects (particularly as to safety and approvals) arising from the civil liability analysis which will merit further consideration when analysing overall legal implications of AVs and AV systems.

We would like to thank all of our VENTURER partners for their invaluable work and assistance on the project and to our colleagues for their work on this report in particular Brian Wong at Burges Salmon and Daniel O'Byrne at AXA.

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[1] https://services.parliament.uk/bills/2017-19/automatedandelectricvehicles.html
[2] DfT Publication "The Pathway to Driverless Cars: A Code of Practice testing" 2015
[3] See in particular Transport Systems Catapult papers supported or commissioned for CCAV on standards ("Connected and autonomous vehicles: A UK standards strategy", March 2017 with BSI), approvals specification ("Specification Information to Inform Approvals for Advanced Vehicle Trials", February 2018) and simulation and modelling ("Regulating and Accelerating Development of Highly Automated and Autonomous Vehicles Through Simulation", March 2018)
[4] https://www.lawcom.gov.uk/project/automated-vehicles/

Executive summary

The full report findings and recommendations have been collected in the separate Appendix. However, the key emerging findings and recommendations are as follows:

Definitions of “automated vehicle”

Internationally, the SAE Levels have been widely publicised and adopted by industry to categorise and define development of automation in vehicles. However, they are not being adopted for definition purposes in legislation. This is certainly the case for the UK and reflected in the current AEV Bill. This disconnect potentially creates legal, market and consumer uncertainty (particularly as to SAE Level 3 - see below).

We would encourage the Government to be as clear as possible in defining “automated vehicles” as a legal category and how it sits with other recognised taxonomies of automation being used by industry and organisations (e.g. SAE J3016 and UN Reg. 79 ACSF).

SAE Level 3 Vehicles (conditional automation/human driver fall-back)

The UK Government does not consider that such vehicles will be “automated vehicles” under the AEV Bill. The analysis in this report and from the VENTURER project demonstrates that, from a safety, insurance and legal liability point of view, the policy position around use of automated driving features in Level 3 vehicles raises important issues. To date, commercially available vehicles are not intended to operate beyond Level 2 (advanced driver assistance). However, the industry is now starting to roll out Level 3 capable features and models.

We call on the Government to consult and be as clear as possible with industry on the regulatory policy pathway as regards use and adoption of SAE Level 3 vehicles.

Special product characteristics of automated vehicles

As ‘products’, automated vehicles have safety-critical functions but may be highly differentiated from each other. They are also dependent on a package of ongoing services and updates after supply to remain safe and functional (indeed they may acquire additional functionality ‘over-the-air’). An automated vehicle product combines both a vehicle and a virtual ‘driver’. Work is already underway at EU and national level to review product safety and liability regimes so that they adequately protect the consumer for these new technologies. However, complexity brings challenges to consumer understanding and the focus must above all be on safety in the first instance.

Government, industry and insurers should work together to ensure and promote consumer awareness and protection both in the current generation of advanced driver assistance features and coming automated driving technology.

Automated vehicle standards, approvals and licensing

Both in the UK and internationally, governments and regulators are beginning to grapple with the emergence of automated vehicle standards (in particular safety and data standards) and their safety regulation and management. Whilst standards and approvals for automated vehicles are likely to replicate the current international framework for automotive standards regulation, there is currently less certainty as to:

- What additional measures the UK may take to prepare and enhance its capability to regulate such vehicles in the UK (especially as to their complexity, systems and safety investigation and management); and
- How the UK (and other countries) will approach the issue of standards, testing, approvals and licensing of AV software (the ‘driver’ or ‘control’ component of the product) as opposed to the vehicle itself.

It would be helpful for Government and industry to review, consult and make necessary proposals to reform the current safety regulation and investigation framework for highways. In doing so, there should be recognition of the novel system characteristics of automated vehicles and learning and practice in respect of UK regulation of other transport systems (rail, aviation and marine) should be considered. It would also be helpful for the Government and industry to work together in parallel and inform developing performance, safety and testing methodology and standards applicable to AV software. Whilst there is an international standards aspect to this, it is (as importantly) a UK concern. The UK sets expected driver standards on UK roads, not only by reference to international standards, but also the Highway Code, criminal law, common law and its driver testing regime. By reference to appropriate testing regimes (whether real world or, importantly, simulation), the UK will logically need to have its framework for AV software testing and verification in place by the time automated vehicles are submitted for approval. The performance and safety standards or expectations set of automated vehicle driving should not be solely benchmarked or calibrated by reference to the capability of reasonable human drivers.

Automated vehicle use and design

Automated vehicles are safety-critical products and that needs to be recognised at the heart of the development process to secure public acceptance. Although often compared to other ‘smart’ technologies, there are obvious differences in development and marketing of automated vehicles compared to a smartphone or other non-safety critical ‘thing’ in the Internet of Things. Unreasonable human driver expectations and uncertainty over aspects such as machine to human handover or whose responsibility it is to keep software up to date do not benefit the industry.

Industry should ensure that consumer safety and experience is built into automated vehicles by design. This includes robust focus on fail-safes and the oversight and management of safety-critical systems and software (e.g. through automatic over-the-air updating). The risk of misuse (whether accidental, negligent or deliberate) of automated vehicles must be reduced to acceptable minimums. Insurance pricing models should clearly incentivise safety by design.

Executive summary continued

SAE Level 3 and 4 Machine to Human Handover

VENTURER demonstrates that this area is clearly challenging from the perspective of safe and optimal driving during the 'handover period' (i.e. where the driving task is transferred from machine to human). The safety of rapid and/or regular machine to human handover has not been demonstrated. This has direct implications for Level 3 vehicles where vehicles may need to hand over control for safety reasons whilst driving. However, it also has implications for Level 4 vehicles which do not need to hand over control for safety reasons whilst driving but where, on current research, doing so may create unnecessary safety risk.

AXA and Burges Salmon call for more study and research, building on VENTURER, to understand better the limits and characteristics of 'safe' handover or to demonstrate the safety of handover protocols (such as a 'request-acknowledge-confirm' system).
This should include not only an assessment of human factors but also the ways in which the vehicle and its environment could best be adapted to assist effective handover.

Government will want to include in due course into safety standards for automated vehicles robust standards regarding handover functionality (including the circumstances in which it is appropriate) and put in place structures so that they form part of the safety requirement to be built into any standards and approvals for vehicles equivalent to Level 3 and/or 4.

Automated vehicle external dependencies

It is clear that, at least in the short to medium term, automated vehicles will have key dependencies on external environments, conditions and services. This may relate to highway condition, highway signage/markings or communications and network connectivity. It is unlikely that those dependencies or the quality of them can be guaranteed at all times or that any enhanced provision (above current provision) can be easily achieved.

Industry will need to ensure that automated vehicles are developed and designed to cope with conditions as they would reasonably expect to find them or otherwise to fail safe when these interfaces are not working or sub-optimal. They should not be designed for the conditions as OEMs would hope to find them. To the extent that there are dependencies or requirements for enhanced external conditions which cannot be mitigated, the industry needs to engage relevant stakeholders early in development.

Automated vehicle criminal law issues

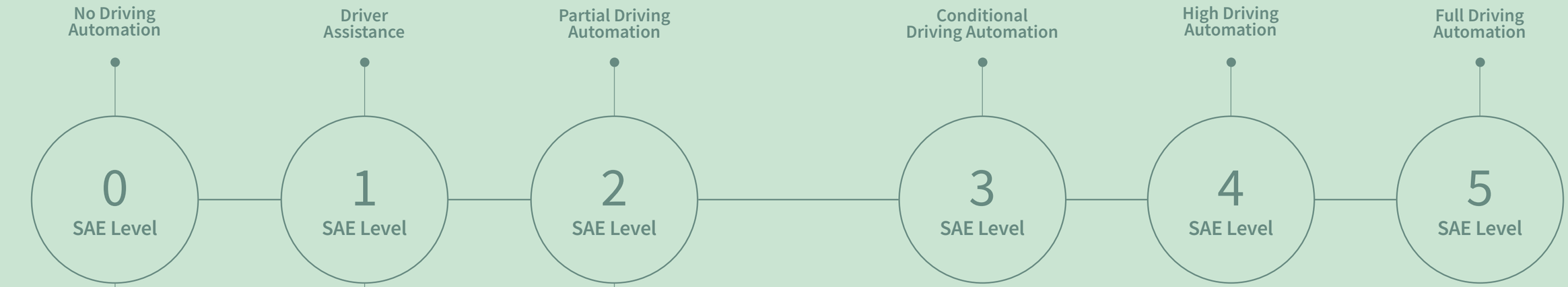
It is clear that automated driving is a complex activity, very different to human driving, and so we would caution against adopting a starting position which is overly reliant on the existing body of driving offences. The starting point is to consider the operation of automated vehicles and automated vehicle systems and the behaviours which, as a matter of policy, should be discouraged by criminalisation. There are existing criminal human driving behaviours which do not need to be extended to automated vehicles and many which would apply equally to automated driving. There will also be some adverse behaviours which are unique to automated driving and systems and their use.

Punishment and sentencing will also have to be reviewed to fix liability appropriately and set sentencing accordingly bearing in mind the multiple purposes of criminal sentencing and penalties.

We would encourage the Government and the Law Commission in its review of legal reform for automated driving to adopt an open approach to the review of criminal law for automated driving and not take as an automatic basis an approach of adapting the existing body of driving offences.

Terminology

Where appropriate, this report gratefully adopts the taxonomy and definitions described in SAE International's Recommended Practice J3016 (2016-09)[5] which has become a common reference point in discussions around automated driving systems[6]. In particular, the paraphrased taxonomy of levels of automation below (drawing out the expectations on human drivers at each level) is adopted for this paper:



Description

Driver has full control notwithstanding that the vehicle may have some active safety systems such as Autonomous Emergency Braking (AEB) or basic fixed speed cruise control

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Driver expectation

Full control of vehicle at all times

Description

Vehicle can execute under specified circumstances sustained longitudinal control (e.g. adaptive cruise control) or lateral control (e.g. lane assist) whilst driving but not both.

Driver expectation

Active monitoring and supervising automated driving functions at all times when engaged.

Full control of vehicle in all other respects at all times.

Description

Vehicle can execute under specified circumstances both sustained longitudinal and lateral control whilst driving.

Current Tesla, GM and Volvo production models would be considered Level 2.

Driver expectation

Active monitoring and supervising automated driving functions at all times when engaged.

Full control of vehicle in all other respects at all times.

Description

Vehicle can under specified circumstances assume full driving function

The Audi A8 L model (offered from late 2018) will be the first production model to be considered to offer SAE Level 3 autonomy through its 'traffic jam pilot' but as the name suggests it is only to be used in very limited circumstances including relatively low speed operation (60kph) and benign road conditions

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Driver expectation

Driver does not need to actively monitor or supervise when automated driving functions engaged – the system monitors. However, driver must be alert and ready to resume driving safely upon system request or in the event of a performance-relevant system failure.

Full control of vehicle in all other respects at all times.

Description

Vehicle can under specified circumstances assume full driving functions without the need for driver intervention

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Driver expectation

When automated functions are engaged, there is no expectation of any driver intervention at all. Vehicle may request an intervention but if there is no response, the vehicle can itself ensure vehicle safety.

In the few remaining circumstances where automation cannot be activated, the driver is expected to have full control of the vehicle. Consequently a Level 4 vehicle will still have manual driving features.

Description

Vehicle can drive itself in all circumstances.

Driver expectation

No expectation at all of any human intervention. There is not in fact any need for a 'driver' or manual driving features in any circumstances.

[5] https://www.sae.org/standards/content/j3016_201609/

[6] It is recognised that other taxonomies exist in common use such as the Automatically Commanded Steering Functions (ACSF or A-E) model used by the UNECE and the Working Party for Harmonization of Vehicle Regulations (Working Party 29)

Terminology

The Government has consciously avoided referring directly to the SAE Levels in, for example, the AEV Bill because these are industry standards that could change over time, and that outline broad capability rather than a specific function which makes it challenging for them to be type approved or standardised. So whilst the SAE Levels are in common industry usage they have not been formally adopted by the UK, EU or the UN.

In respect of the Automated and Electric Vehicles Bill, the UK adopts the term "automated vehicles", being vehicles which are specifically prescribed by the Secretary of State for Transport. A vehicle cannot be so prescribed unless it is capable of "driving itself" (that is to say in a mode in which it is not controlled by an individual or monitored by an individual) at least in "some circumstances or situations" and "safely". There was some debate during the Second Reading of the Bill in respect of the legal definition of an 'automated vehicle' and that, strictly speaking, it could potentially include vehicles at SAE Level 3 and above[7].

Baroness Sugg, Parliamentary Under Secretary of State for Transport, outlined that the Government position is that the AEV Bill is intended to cover vehicles which are broadly equivalent to **SAE Level 4 and 5**, and does not cover conditionally automated (broadly equivalent to Level 3) vehicles[8]. Read against the current wording of the AEV Bill, the Government position is that, notwithstanding any ability that a Level 3 vehicle may have of "driving itself" in at least some circumstances[9] , it would not consider the vehicle to be "safely" doing so[10] . However, whether or not, a Level 3 vehicle can drive itself "safely" cannot be stated with certainty at this point. As the Government has noted "The vehicles will be certified through the type approval process, following what has been agreed at international levels. That is what will decide whether or not those vehicles are safe. Once that type of approval process has happened, those vehicles will then go on the Secretary of State's list, which is purely for insurance purposes, so that insurance companies and purchasers of vehicles can understand whether those vehicles require automated vehicle insurance[11]" .

The Government's position on the AEV Bill is broadly welcomed as the UK insurance industry has reservations in respect of the potential breadth of capability encompassed in Level 3 and issues of machine to human handover as investigated in VENTURER. The UK insurance industry's position is in line with the Government's, that Level 3 vehicles should not be included under the provisions of the AEV Bill other than exceptional circumstances and have stated' that "these should only be permitted with high levels of robustness and redundancy that largely mimic SAE L4 functionalities"[12] capable of demonstrating adequate levels of safety. However, the definition of "automated vehicle" in the current AEV Bill leaves room for doubt.

There is a disconnect between the current SAE Levels of driving automation which categorise any vehicle from Level 3 above to be driving itself while its Automated Driving System is engaged and the AEV Bill definition of "automated driving" which the UK Government intends to apply only to vehicles of Level 4 and above. As Level 3 vehicles are coming into production, Burges Salmon and AXA recommend that:

- **To avoid the potential for litigation as to whether or not the Secretary of State could be required to designate Level 3 vehicles under the AEV Bill, the Government should provide greater clarity in the AEV Bill or its accompanying guidance; and**
- **As part of that clarification, the Government should set out how it would separately approach regulation and approval of Level 3 vehicles if they are not to be designated "automated vehicles".**

[7] See Hansard HL Deb 20 February 2018 vol 789 cc 36 and 59; the SAE takes the view that a Level 3 vehicle is driving itself entirely while engaged and does not require the driver to monitor the task but only to be receptive to system alerts. SAE J3016 states clearly at page 10, Note 3 that "The driver state of being receptive to alerts or other indicators of a [Dynamic Driving Task] performance-related system failure, as assumed in Level 3, is not a form of monitoring".
[8] http://data.parliament.uk/DepositedPapers/files/DEP2018-0264/Baroness_Sugg_-_Baroness_Randerson_AEV_Bill_2nd_reading.pdf
[9] Although it should be noted that there appears to be some suggestion of confusion in Parliament as to what Level 3 is and whether it does or does not currently exist. See Hansard HL Deb 9 May 2018 cc 167, 173 and 17510
[10] Hansard HL Deb 9 May 2018 vol 791 c188 per Baroness Sugg
[11] Hansard HL Deb 9 May 2018 vol 791 c175 per Baroness Sugg
[12] "Regulating Automated Driving: The UK Insurer View" (July 2017) Thatcham Research and ABI - p6

The distinctions between categories can be very fine – particularly between SAE Levels 2 to 4 – and the categories themselves very broad in terms of relative capabilities to vehicles (e.g. in terms of the specified circumstances in which automated functions can be used and the extent to which they can be used). These potential definitional issues are potentially very significant and may be exacerbated by product marketing and expectation which do not match reality and will be more acute for users who do not own and are not familiar with a particular vehicle (e.g. hirers). The position may also be complicated by the fact that autonomy levels are not necessarily fixed at the point of purchase but may change whilst 'on the road' – a feature intended to future–proof vehicles and mitigate obsolescence. In 2015, Tesla delivered its Autopilot software 'over the air' to existing Model S owners; in effect upgrading their cars from SAE Level 1 to SAE Level 2. This connected aspect of AVs would also in principle allow a car's automated features to be dialled back. For example, if a safety issue was identified, it would be possible within the current state of the art to temporarily suspend features over the air as part of a debugging/fixing or product recall or safety strategy. **Safety approval, regulation and management and consumer protection and product liability regimes must take into account and be capable of dealing with AV differentiation of functions and functions which evolve from the initial point of supply.**

Given the ramifications in respect of insurance and legal liability (explored further below), there is a clear risk of consumer confusion as to the automated capability of vehicles whether within the broad categories established by SAE Levels 2 to 4 or the AEV Bill's definition of "automated vehicle". In using AVs 'improperly' beyond their terms of use, users are exposed to both safety risk for themselves and others and the risk of personal liability. In its Second Reading of the AEV Bill in the Lords, the Government indicated that it expected "vehicle manufacturers will design [a] system so that it provides prompts to the driver, making them aware when it is legitimate for them to hand over control"[13]. **More work logically needs to be done to explore ways in which gaps in consumer understanding could be mitigated or prevented by design (e.g. the SAE intends that vehicles at Level 3 and 4 should only permit automated driving to be engaged when within its operational parameters) and to ensure that drivers are educated as to the capabilities and terms of use of the specific AVs they may drive.**

In our Second Report, we noted that academic commentators had suggested the possibility of additional and/or specific driving tests or driver licenses for AV use[14] . That can be seen as part of a strategy to ensure that drivers know the capabilities of the AVs they use and, in some ways, reflects enhanced training and assessment strategies adopted for pilots and aircraft[15]. However, there are plainly limits in practical, human factors and commercial terms as to how much additional responsibility can be safely placed onto drivers and indeed, as consumers, that they will be prepared to accept. The vast majority of drivers are not 'professional' drivers and to take the view that they become AV 'pilots' would logically be a major behavioural and cultural change. The difficulty is reinforced where specific functions and capabilities of AVs may differ from one manufacturer or model to another or indeed may change by way of update during a specific AV's lifetime. **From the perspective of AV manufacturers and markets, there are clear benefits to designing AVs from the outset with appropriate fail-safes and human machine interfaces which require the least possible additional effort or expertise from consumers to understand and use safely.**

[13] Hansard HL Deb 20 February 2018 vol 789 c 62
[14] "Are we ready to 'handover' to driverless technology?" (April 2018) AXA and Burges Salmon - page 23
[15] See "Flight Crew Reliance on Automation" (December 2000) CAA Paper 2004/10 or "Enhanced FAA oversight could reduce hazards associated with increased use of flight deck automation" (January 2016) FAA Report AV-2016-013

The Level 3 Audi A8 L

Audi plan to be the first car manufacturer to launch a vehicle with Level 3 features known as “Traffic Jam Pilot”. This will be the next A8 L, due late-2018. This is a significant development because current vehicles which profess to be autonomous are only Level 2 or perhaps what you might call “Level 2+”.

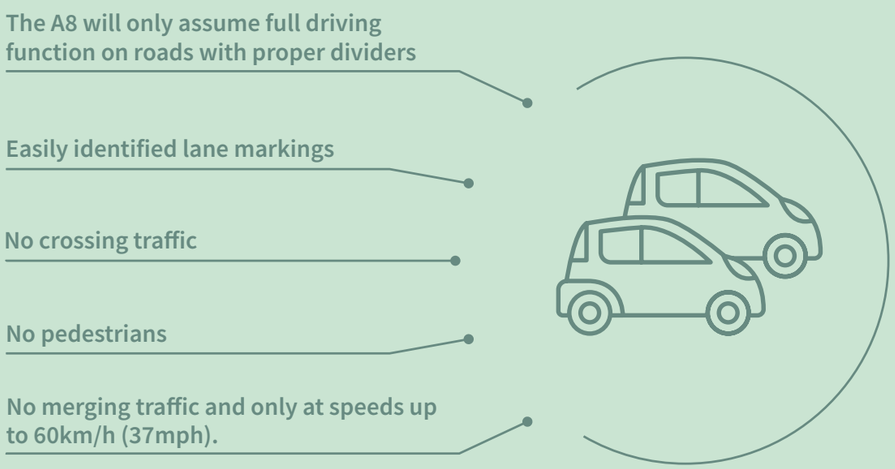
Based on current reports, as a Level 3 car, the A8 will only assume full driving function under specified circumstances. How the Level 3 functionality works demonstrates the limitations of Level 3 in real-world driving.

The A8 will only assume full driving function on roads with proper dividers, easily identified lane markings, no crossing traffic, no pedestrians, no merging traffic and only at speeds up to 60km/h (37mph).

The limitations are partly due to the A8 lacking a driver-facing camera which monitors whether the driver is capable of taking back driving control. This is, in part, due to Germany’s privacy laws.

The Level 3 features are operated by pressing a button. At this point, the car is responsible for the driving. When it needs to hand back control to the driver, it gives the driver notice. Given the restrictions, this can happen often, including where there is: oncoming traffic; merging traffic; parallel traffic; cross traffic; roundabouts; cars veering at you; or footpaths.

As such, drivers may have to switch back to driving often, quickly and repeatedly. The ability for drivers to do that has been tested in the VENTURER research and has been shown to suffer from significant limitations.



Identification of incident cause

The liability and insurance scenarios explored in this paper proceed on the basis that incident cause has already been identified. However, it cannot be assumed that identification of incident cause (and associated safety management issues) will be a straightforward issue and will be unchanged with the arrival of AVs.

Automated driving has the potential to eliminate human error driving risk factors such as fatigue, distraction or alcohol and drugs and that in itself remains the biggest prize in safety terms as some 94% of serious crashes are caused at least in part by human error[16]. The likely gains from eliminating human error should logically in due course make AVs significant safer than other vehicles.

However, crashes will never be completely eliminated and where an AV is involved in an incident, there will be a need to identify incident cause and some of those causes will be 'novel' in the context of road traffic accidents.

As more is understood about the mechanics of AVs and AV systems, it is clear that the components, dependencies and services underlying AV operation are becoming increasingly complex. Both at vehicle and at system level, operations depend on complex interaction between (amongst other things) on-board hardware, software, connectivity infrastructure, navigation systems, data and proprietary rules engines and algorithms. Once AVs have been widely deployed, the importance of understanding incident cause is reinforced by the risk that underlying causes may be relevant not only to the individual AV but to wider systems or standards supporting the AV ecosystem.

The ways in which AV incident data are recorded and shared and incident investigations are conducted are outside the scope of this report. However, these are plainly aspects which merit further investigation and consideration by industry stakeholders and regulators[17] .

This concern has been echoed by the insurance industry. The Association of British Insurers and Thatcham Research noted in their joint response to the Government consultation on insuring AVs, that insurance must be underpinned by effective data sharing. Insurers must be confident that they will have access to appropriate data to settle a claim fairly[18].

As the industry begins to consider the emergence of AV standards, we recommend that a parallel process of dialogue should take place with Government on developing safety standards, regulation and management.

[16] "2016 Fatal Traffic Crash Data", US Department of Transportation Press Release, 6 October 2017
[17] See "FLOURISH: Insurance and Legal Report 2017", Burges Salmon and AXA
[18] ABI and Thatcham Research consultation response to "Pathway to Driverless Cars", 2016

As AVs increasingly take on characteristics of a connected and automated transport system, there are likely to be cross-modal lessons and practices to be learned from the safety regulation of other existing transport systems such as rail and aviation[19].

Factors to be considered should include:

- **Minimum standards for AV data capture, retention and regulated and/or open sharing for incident investigation and analysis.** The UK insurance industry (through the ABI and Thatcham) has made its requirements for a "Data Storage System for Automated Driving" (DSSA) clear for the purposes of efficient and fair insurance claims processes. However, the case for sharing or mandating requirements for data is equally compelling from the perspective of safety regulation and management, highway maintenance and management as well as law enforcement and potentially security service requirements[20] .

- **Incident reporting duties and systems (including near miss / operational anomaly reporting).** Where AVs are sold as consumer products, the General Product Safety Regulations 2005 (GSPR) would apply - including the obligation in Regulation 9 of a producer or distributor to notify an enforcement authority (the Driver and Vehicle Standards Agency – see below) if they become aware that their AV is or is potentially unsafe. It is a criminal offence not to do so. The Network and Information Systems Regulations 2018 may also require reporting in certain circumstances of system level cyber-threats or interruptions. These reporting regimes may need to be expanded upon to encompass non-consumer and less overtly 'serious' incident reporting if safety risks and/or system level risks and threats are to be identified in a timely manner. This could be through extension of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) (which applies to reporting of railway incidents to the Office of Rail and Road for example) or separate legislation such as that in other transport modes for mandatory reporting to the Rail Accident Investigation Branch (RAIB)[21] , the Air Accident Investigation Branch (AAIB) [22] or the Marine Accident Investigation Branch (MAIB)[23] .

- **The role for an overall safety regulator for automated vehicles (such as the Office for Rail and Road for rail or Civil Aviation Authority for aviation) engaged at national and international level and an independent and non-fault incident investigation body (such as RAIB or AAIB):**

[19] For more analysis see report of Dr Chris Elliott, 5 May 2009: https://www.racfoundation.org/assets/rac_foundation/content/downloadables/transport%20safety%20-%20elliott%20-%20050509%20-%20report.pdf
[20] The European wCommission has indicated that it will be regulating data records as part of revision of the General Safety Regulations. See European Commission communication "On the road to automated mobility: An EU strategy for mobility for the future" (17 May 2018) COM(2018) 283
[21] The Railways (Accident Investigation and Reporting) Regulations 2005
[22] Regulation (EU) No. 376/2014
[23] Merchant Shipping (Accident Reporting and Investigation) Regulations 2012

Identification of incident cause

–There are a number of agencies or other bodies that the Department for Transport (DfT) works with in respect of highways, licences and motor vehicles. These include the Driver and Vehicle Licensing Agency, the Driver and Vehicles Standards Agency (DVSA), the Vehicle Certification Agency, Highways England and the Office for Rail and Road. The Centre for Connected and Autonomous Vehicles (CCAV – part of DfT and BEIS) is tasked with working across government to enable government policy to maximise the economic and social benefits of the technology without compromising safety, security or privacy and is, for example, assisting the DfT on issues in connection with safety approvals for trials. However, none of these bodies are as yet specifically constituted to be able to monitor or regulate safety issues for AVs and AV systems (beyond certifying to type approval once established). Unless the role of CCAV is significantly changed, it is likely that the DVSA (and its Vehicle Safety Branch) will expand its existing enforcement role to include AVs and AV systems, including the management of any product recalls and safety issues reported to it by manufacturers, producers or distributors or members of the public. However day-to-day enforcement powers are principally dealt with at local authority level (e.g. Trading Standards) and not led by DVSA and the DVSA itself has been the subject of criticism as to its proactivity and resources (most notably by the Transport Select Committee [24]).

– The potential importance of an expert and independent investigation body or "Highways Accident Investigation Branch" with statutory powers to investigate incidents begins to emerge as one considers the increasing complexity of AV incidents and the extent to which data may be bound up in multiple proprietary systems. The investigation of road traffic accidents in the UK is primarily left to local police forces but that approach is unlikely to be sustainable in the event of complex AV incidents. Whilst not every accident needs in-depth investigation, the DfT already has a policy interest in understanding the causes of road traffic accidents so as to contribute to the development of safer roads and vehicles and in doing so it currently contracts with expert organisations such as Transport Research Laboratory to conduct ongoing Road Accident In-Depth Studies (RAIDS)[25] alongside certain police investigations. Separately, infrastructure managers such as Highways England also conduct safety studies within their remit [26]. The possibility of an expert multi-disciplinary independent investigation body investigating highways accidents on a non-fault basis, (i.e. prioritising safety improvement) has already been argued for before the likes of the Parliamentary Advisory Council for Transport Safety (PACTS)[27] , UNECE [28] and by the RAC Foundation[29] . In respect of the emergence of semi-autonomous and AVs at least, there is recognition by the DfT that there is a distinct need to consider how incidents involving these vehicles are led and resourced in future[30] and a Highways Accident Investigation Branch may be part of that answer.

International perspectives

The US perspective:

The National Highway Traffic Safety Authority is an agency of the US Department of Transport. NHTSA is responsible for developing, setting, and enforcing federal motor vehicle safety standards and regulations for motor vehicles and motor vehicle equipment. The NHTSA also investigates automotive safety issues. The NHTSA is also involved in research to evaluate new technology, including the safety and effectiveness of features required for AVs, as well as performing crash testing

The National Transportation Safety Board (NTSB) is an independent US government investigative agency responsible for civil transportation accident investigation. The NTSB has the authority to investigate and establish the facts, circumstances, and cause or probable cause of all highway accidents and incidents and has taken the lead in a number of AV incident investigations. The NTSB's investigation takes priority unless there has been a criminal act, in which case the FBI takes priority. The NTSB has no formal authority to regulate the transportation industry. The NTSB issues formal safety recommendations to agencies and institutions with the power to implement those recommendations

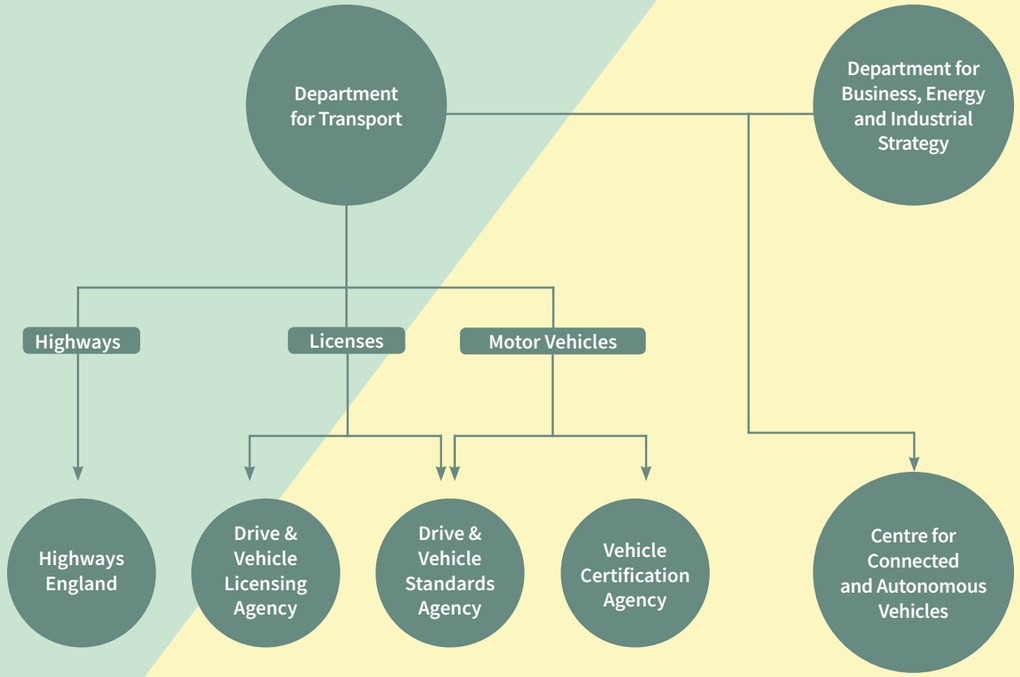
States remain the lead regulator when it comes to licensing, registration, traffic law enforcement

The Finnish perspective:

In Finland, legislation requires that the investigation of road accidents is undertaken by independent multi-disciplinary road accident investigation teams drawing from the police, medicine, vehicle technology, road maintenance and behavioural sciences sectors amongst others.

The teams determine the underlying reasons for the accident for the purpose of safety improvements. They do not determine fault, guilt or liability issues. They are however empowered by legislation to access incident scenes, inspect and gather evidence.

The teams are co-ordinated by and their report outputs maintained on registers by the Finnish Crash Data Institute (OTI)[31]



[24] Transport Commitee, "Vauxhall Zafira fires: Government Response to the Committee's Tenth Report of Session 2016-2017" 2 November 2017 HC 516
[25] "Road accident in-depth studies (RAIDS)", DfT, 23 December 2013
[26] See for example "Tyre-related deaths and injuries preventable say Highways England and Bridgestone", Highways England press release 24 April 2018
[27] See TRL presentation to PACTS conference, 22 March 2017, "The case for a Road Collision Investigation Branch" http://www.pacts.org.uk/wp-content/uploads/sites/2/Cuerden_the-case-for-a-RCIB-v7.pdf
[28] "Consolidated Resolution on Road Traffic: Multi-Disciplinary Crash Investigation" (October 2015) UNECE (ECE/TRANS/WP.1/2013/6/Rev.2)
[29] "Towards an Accident Investigation Branch for Roads?" (December 2017) RAC Foundation
[30] See DfT presentation to PACTS conference, 22 March 2017, "Road Accident in Depth Studies" http://www.pacts.org.uk/wp-content/uploads/sites/2/Ian-Yarnold.pdf
[31] See http://www.oti.fi/en/oti/

Structure of the automotive market

Figure 1 shows a simplified diagram of the conventional automotive value chain for new car sales.

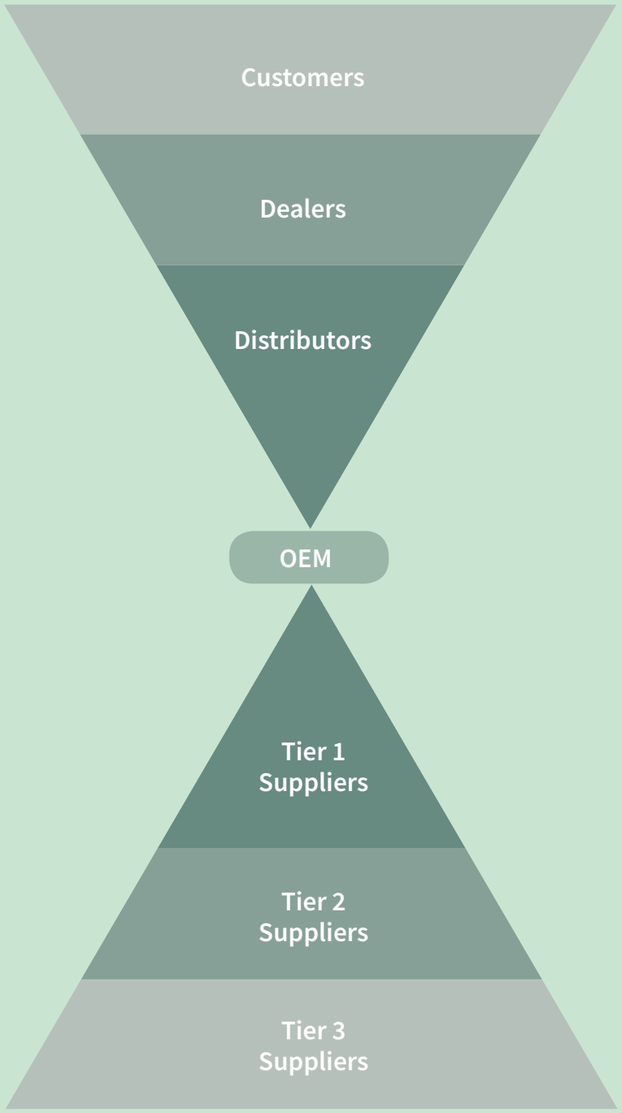


Figure 1

"OEM", or Original Equipment Manufacturer, is used here to mean the primary aggregator producing the final product to take to market.

A fundamental change accompanying the electronic development of cars and in due course AVs is and will be the increasing importance of the digital and electronic value chain bringing with it a significant and continuing 'aftermarket' service-orientated architecture that closely mirrors the development pathway of smartphones and app markets[32]. We are already seeing these actors begin to feature heavily in the Tier 1 and Tier 2 supply levels as electronic systems of vehicles become increasingly complex and functions and operations become increasingly dependent on or managed by software.

AVs (and before that electric vehicles) will also see changes in the relative value attributable to certain system providers in the chain e.g. the AV system, cyber-security system, battery and powertrain provider, etc.

As the shifts occur in relative importance and value of mechanical hardware, electronic hardware and software in vehicles, there is already evidence of consolidation amongst technology actors (e.g. Intel acquiring Mobileye), technology acquisitions and investments by traditional OEMs (e.g. Ford and Argo AI, Velodyne, Autonomic and Chariot) as well as technology companies entering or potentially entering manufacturing (e.g. Easymile, Dyson and arguably Tesla). The OEM is likely to see increasing differentiation with traditional manufacturing OEMs adopting a number of models from current forms to sharing economy operators or contract manufacturers.[33]

[32] See further: "How Automakers Can Survive the Self-Driving Era" (2016) A. T. Kearney Inc or "Rethinking car software and electronics architecture" (February 2018) McKinsey & Company collaborating with Global Semiconductor Alliance
[33] See "The Future of the Automotive Value Chain: 2025 and beyond" (March 2017) Deloitte

Scenarios and assumptions

As stated, this report will focus on civil liability and insurance in respect of collision scenarios where cause or causes have been identified as own driver or own AV fault.

It primarily looks at the direct parties (drivers, passengers, insurers, OEMs, etc) but it is important to note that if there has been fatalities in an incident then dependents of the deceased may be able to bring separate derivative claims under the Fatal Accidents Act 1976.

Outside of these specific scenarios of course there will be many other issues of civil liability not involving collision in respect of AVs which will need to be addressed including in respect of specific emerging risks and threats such as cyber-security and protection of personal data.

For the purposes of these scenarios only, a number of reasonable assumptions are made in the context of the deployment of market-ready AVs at SAE Level 3 and above. These scenarios assume:

- Laws (e.g. road traffic laws) will be amended or put forward to make automated driving, at a minimum, legal. This is already the subject of consideration and will also form part of the Law Commission's review.[34]

- Full commercial deployment of AVs and mature technology, not just the testing phases currently in place;

- Single vehicle accidents; not platooning. Issues involving platooning of vehicles and the additional rules which must necessarily be developed to deal with them are outside the scope of this report;

- The Motor Insurers' Bureau (MIB) will continue to meet its function as third party insurer of last resort[35] but no assumptions are made as to how the industry may need to reform it as a result of AVs. The Road Traffic Act 1988 requires that every insurer that underwrites compulsory motor insurance must be a member of MIB and contribute to its funding. As a fund of last resort, MIB deals with all third party claims caused wholly or partly by uninsured or untraced drivers;

- Where complexity or uncertainty is highlighted below as to liability and insurance issues within AV ecosystems, there are opportunities for stakeholders to consider and agree, at an industry level, arrangements for claims liability and handling arrangements to mitigate the effect of those. For example, UK rail industry stakeholders participate in an overarching Claims Allocation and Handling Agreement (CAHA) to minimise disputes over meeting third party claims and settle intra-industry claims;

- Third party insurance will remain compulsory although increasing vehicle connectivity and technology-led "insurtech" offers may well mean a falling incidence of vehicles and drivers driving without valid insurance or untraced drivers in the event of an accident. It is conceivable in future that connected AVs will not permit themselves to be driven without valid insurance in place and will at least be able to identify its occupants in the event of an accident;

- The focus is on third party claims in the sense of damage and loss caused to others outside the relevant AV – own loss insurance provisions, excesses, no claims discounts, etc are not covered in this report (save as dealt with below in the context of the AEV Bill);

- Issues as to public transport operations and vehicles as workplaces are excluded. It follows that these will comprise added levels of regulation on top of AV regulations;

- By and large, AVs will follow the established route of internationally agreed testing, standards and type approvals developed for existing automobiles currently found at EU level in particular in the General Vehicle Safety Regulation and Pedestrian Safety Regulation but suitably amended;[36] and

- **There will be necessary reform in product liability and safety regimes to deal with certain aspects of AV product architecture and dependency or the AV industry itself will take steps to address consumer liability concerns[37]. In particular, there are some known issues as regards applicability of existing product liability regulation in respect of internet connected products and their operating software including artificial intelligence[38].**

This paper explores how these emerging technological characteristics are intrinsic to AV safety, regulation and management and consequently likely to be at the heart of public acceptance and take-up of AVs; their resolution is therefore assumed as a pre-condition of the adoption of AVs underpinning these scenarios.[39] The basis of the current product liability regime in the UK is an EU directive dating from 1985 and it is out of date, most notably in the area of digital content, products and services. Known issues include uncertainty as to whether embedded software and updates to those constitute a product or whether ongoing tied service dependencies (e.g. connectivity network) or cyber-security are part of a product as well as the suitability of criteria for defectiveness, limitation and defences which are referenced to standards and knowledge at a fixed point of time. It is commonly accepted that this regime does not sit well with digital economy 'Internet of Things' products of which AVs will be a high profile example (along with other technologies such as 3D printing). AVs will be functionally dependent on software and post-factory updating to take into account real world developments to physical and digital infrastructure and cyber-threats so as to ensure vehicle and public safety. This type of product does not fit a 1985 paradigm which assumes that products emerge from a factory 'finished' and indeed, where capable of true machine learning, an AV would be by definition 'unfinished' at the point of market supply. Similar reform may be needed to aspects of the complementary product safety regime. The Government expectation is that "we certainly expect safety throughout the vehicle's life to form the basis of future regulation" [40].

- **There needs to be an understanding that in product terms, an AV integrates two core concepts – the supply of a vehicle and, inextricably, supply of software capable of driving that vehicle safely by itself. The latter function is closer in some respects to an ongoing bundled service than a conventional product.**

The expectation on that function is that its effectiveness and safety is not fixed as at the point of supply but that it will update and improve.

[34] Specification information to inform approvals for advanced vehicle trials" (February 2018) Transport Systems Catapult and https://www.lawcom.gov.uk/project/automated-vehicles/
[35] As per Hansard HL Deb 9 May 2018 vol 791 c 235 per Baroness Sugg
[36] See European Commission communication "On the road to automated mobility: An EU strategy for mobility for the future" (17 May 2018) COM(2018) 283 on emerging EU position and proposals for reform of the General Safety Regulation and Road Infrastructure Safety Management Directive and additional regulations under the Intelligent Transport Systems Directive
[37] OEM announcements such as that of Volvo concerning accepting "full liability" when its cars are in automated mode may be seen in this context, although the devil is obviously in the detail and Volvo made clear at the same time that its preference was for regulators to solve questions over legal liability. See "US urged to establish nationwide guidelines for autonomous driving" (7 October 2015) Volvo press release

[38] See "Autonomous systems in aviation: between product liability and innovation" (November 2017) Emanuilov, SESAR Joint Undertaking
[39] See European Commission communication "On the road to automated mobility: An EU strategy for mobility for the future" (17 May 2018) COM(2018) 283 on emerging EU position and proposals for reform of the General Safety Regulation and Road Infrastructure Safety Management Directive and additional regulations under the Intelligent Transport Systems Directive
[40] Hansard HL Deb 9 May 2017 c 196 per Baroness Sugg.

Scenario and assumptions

Recognising these issues, the European Commission has been evaluating and consulting on the relevant legislation with a view to updating provisions to ensure that adequate consumer protection is in place for such products .[41] Although consultation has concluded, the European Commission does not plan to issue guidance on the interpretation of the Product Liability Directive in light of technological developments until mid-2019[42]. The results of an initial study conducted by the European Commission:[43]

- Confirm that there is a risk that uncertainty as to product liability will hold back the take up of such technology and products;

- Agree that "existing product liability concepts based on tangible products whose characteristics do not change over time may cease to be adequate"[44];

- Suggest equally that legislation in haste could be counter-productive and that the preferred option may be that non-legislative measures (generally or by sector) be encouraged in the first instance but with the EU "ready to regulate when and if it is necessary"[45]

- Necessarily, this report does not speculate on the outcome of the UK's exit from the European Union and its effect on the insurance and legal analysis. As the European Union (Withdrawal) Bill progresses through Parliament, and following the political agreement reached on a transition period, the assumption is that, provided the Withdrawal Agreement is successfully reached and ratified, UK laws will remain the same as or align closely with EU laws until at least December 2020. From January 2021, it may be the case that the UK chooses to diverge from EU rules in this area. It is noted that relevant aspects of UK legislation in respect of (amongst other things) motor insurance, product liability, data protection and automotive regulation are heavily derived from EU legislation. That said, certainly in respect of standards, emerging AV standards and requirements are, like existing automotive standards, likely to continue being promoted on a European and/or international single standard model for sound competition and market reasons[46].

[41] "A common EU approach to liability rules and insurance for connected and autonomous vehicles" (February 2018) European Parliament study and "Evaluation of the Directive 85/374/EEC concerning liability for defective products" (2016) European Commission
[42] Press release, 25 April 2018 http://europa.eu/rapid/press-release_IP-18-3362_en.htm
[43] See"Study on emerging issues of data ownership, interoperability, (re-)usability and access to data, and liability" (24 April 2018) European Commission
[44] Ibid, p17
[45] Ibid, p18
[46] For example, see BSI's stated ambition to remain a full member of both CEN and CENELEC post-Brexit in "Forward Progress: An introduction to the use and benefits of standards in the automotive sector". (https://www.bsigroup.com/en-GB/standards/british-standards-online-database/BSOL-Automotive/BSOL-Automotive-Form1/?gclid=EAIaIQobChMI-ZvJ24fT2gIVCr7tCh3ycgSaEAAYASAAEgLGj_D_BwE) and the ongoing role of UK experts in shaping EU reforms in this area: https://trl.co.uk/news/news/uk-continues-shape-future-eu-automotive-safety-despite-brexit

Scenarios summary

No.	Root cause	SAE Levels	3rd Party recovery route	Ultimate legal liability
1	Human driver and error	0 - 4	Compulsory motor insurance or MIB	As per current framework, usually motor insurer liable and where MIB, in principle the uninsured driver. Under current AEV Bill activating automated driving “inappropriately” is effectively treated as driver error.
2	Human driver and hardware vehicle / component failure	0 - 4	Typically compulsory motor insurance or MIB in the first instance but where known product issue may have to be relevant OEM/supplier/producer	If original part or component, relevant OEM / supplier / producer (subject to any product liability defences). In turn, risks and costs may have been allocated throughout the OEM value chain. If post-supply modification or part, may be relevant parts producer/ supplier/retailer or whoever may have negligently installed or modified
3	AV system driving, driver fails to respond to handover request	3 - 4	Level 4 – AEV Bill provides for compulsory motor insurance or MIB Level 3 – inconclusive – may be human driver fault or may be vehicle deficiency. Or OEM may offer third party indemnity in the first instance.	Level 4 – typically OEM / supplier / producer (subject to any product liability defences). In turn, risks and costs may have been allocated throughout the OEM value chain. Level 3 – depends on reasonableness of handover protocol, effectiveness of terms of use, safety approvals, etc as to whether or not liability may primarily sit with the driver and/or the OEM / supplier / producer (subject to any product liability defences). Handover standards and protocols underlying vehicle approvals will be relevant
4	AV system driving; failure to update AV software	3 - 5	Level 4 or 5 – AEV Bill provides for compulsory motor insurance or MIB Level 3 - inconclusive – may be human driver fault, OEM updater fault or may be vehicle deficiency. Or OEM may offer third party indemnity in the first instance.	Level 4 or 5 – typically OEM / supplier / producer (subject to any product liability defences). In turn, risks and costs may have been allocated throughout the OEM value chain. Level 3 – depends on who is responsible for installing safety-critical updates and the reasonableness of that, effectiveness of terms of use, safety approvals, etc as to whether or not liability may primarily sit with the driver and/or the OEM / supplier / producer (subject to any product liability defences). Handover standards and protocols underlying vehicle approvals will be relevant. However, it seems likely that safety standards ought to require by design that these safety-critical updates are automatically uploaded or that the vehicle fails safe
5	AV system driving; failure due to external infrastructure dependency	3 - 5	Level 4 or 5 – AEV Bill provides for compulsory motor insurance or MIB Level 3 - inconclusive – may be external dependency fault or may be vehicle deficiency. Or OEM may offer third party indemnity in the first instance.	Depending on facts could be at least one or more of: • OEM / supplier / producer • Dependency provider • Malicious third party However, as regards dependency providers, whether they are data or connectivity providers or physical infrastructure owners, their liabilities are likely to be limited under terms of service or legal or statutory duty. There will also be a question of whether the extent of dependency in question or lack of fail safes or mitigations is ultimately a product design fault or not. Generally vehicles need to take the conditions as they are reasonably expected to find them.
6	AV system driving; failure to assure safe driving mode	3 - 5	Level 4 or 5 – AEV Bill provides for compulsory motor insurance or MIB Level 3 - inconclusive – may be human driver fault or may be vehicle deficiency. Or OEM may offer third party indemnity in the first instance.	Depending on the facts, the root cause may be a hardware and/or software deficiency. However, whether they may constitute a defect for which an OEM / supplier / producer could be liable depends on, amongst other things: • Compliance with vehicle safety standards and approvals including standards set for the performance of the AV system • Available product liability defences such as state of technical or scientific knowledge • Marketed performance or objective fitness for purpose As long as safety standards and approvals are robust and acceptable performance of AV systems established, tested and verified upfront by regulators, then liability probably would not attach to an OEM / supplier / producer. Indeed, with relevant data, it may be possible to verify product ‘performance as intended’ through simulation modelling based on the pre-set standards.

Baseline scenarios

Scenario 1 – Human driver and driver error

Incidents caused by driver error such as those routinely happening every day will continue to feature as long as humans have any role in driving. The incidence of human error will fall as the UK fleet profile shifts towards SAE Level 3 and 4 (simply by reason of the fact that AVs will be doing a greater share of the driving) but until every vehicle on public roads is SAE Level 5, there will continue to be human driver error accidents.

Where the vehicle is:

- SAE Level 0 - 2: the driver is driving at all times and is expected to be in full control and supervision of the vehicle at all times. A driver error can therefore happen at any time.
- SAE Level 3 and 4: the driver is assumed in this scenario to be driving only when:
  - The automated driving function is not activated; or
  - The driver has resumed control of the vehicle from automated mode after the designated handover period and protocol has been completed (see separate scenario below for discussion around incidents in and around the handover period).

Driver error causes can be categorised broadly into two further types: (1) driver negligence or (2) driver deliberate act/omission. The position where an automated function is improperly activated by a human is explored below.

Where there are issues of contributory negligence by the third party, legal liability and contribution will need to be agreed by the parties or determined by the Courts.

Third Party Insurance position

As is the case currently, where an accident has been caused by driver error, motor insurers will typically indemnify in respect of innocent third party claims. Where the driver does not have motor insurance (or if the driver is untraced) and no other insurance policy applies, the MIB meets innocent third party claims as the insurer of last resort.

Where an incident has been caused by a deliberate and/or criminal act of the driver, most motor insurers will exclude cover in these circumstances. In doing so, the driver in effect becomes uninsured and it becomes a matter for the MIB (assuming that there are no exclusions applicable to the MIB such as alternative insurance[47]).

In the absence of specific policy wording on the use of automated features, the position as to deliberate acts (or omissions) has significance in respect of driving decisions taken by the driver in the context of automated functions. This arises most notably in the case of expectations on the driver to activate and/or use the automated function appropriately and in accordance with the terms of use in Level 2 to 4 vehicles.

[47] See e.g. EUI Ltd v Bristol Alliance Ltd Partnership [2012] EWCA Civ 1267

To date, whilst AVs are in their nascent phase (Level 2 and below), there is no evidence that motor insurers are taking the widespread view, as yet, that failure to comply with strict terms of use of driver assistance features constitutes an invalidating deliberate act or omission as opposed to negligence. However, as the market matures and driver assistance features and AVs become more common, the position on the quality of the expectations on drivers may change. For example, where terms of use and AV capability are fully understood, a driver's decision to, say, sleep in a Level 2 or Level 3 vehicle is almost certainly to be considered a "deliberate act" in breach of a reasonable driver's duty of care and capable of invalidating a typical negligence-based policy. Although society remains some distance from it, there is also a related legal question as to whether or not, in due course, it could be considered unreasonable to the point of deliberately reckless in liability and/or insurance terms for a driver to decide not to activate automated driving, where available, since its function in large part would be as a safety device against human error.

Third party liability in respect of such incidents may therefore become a matter for the MIB in which case the motor insurance industry as a whole will have an interest in the policy approach to use of automated driving functions at Level 4 and below.

The AEV Bill makes clear the potential consequence of driver error in exercise of automated functions as regards the person in charge of the vehicle: where the driver has negligently allowed the vehicle to "begin driving itself when it was not appropriate to do so"[48] insurers are not liable. This means that a driver who negligently activates automated driving when not appropriate to do so, will not be able to claim for any of his own losses or personal injury from his own insurer.

However, whilst the insurance position on this may evolve, as stated above, the priority must be to avoid death, personal injury and property damage in the first place. Likewise, consumers are less likely to accept and use AVs where there are material risks to themselves from misuse, whether or not as to safety or liability or resulting from negligence or deliberate act**.**

AVs and AV systems should be designed as far as possible to be operated in a manner which from the outset mitigates or prevents at least accidental use in breach of terms of use. This should form part of a package of fail safes that regulators should consider as part of safety cases for vehicle approval.

Legal liability position

As above, where the driver's own negligent error has been the sole cause of the accident, they are legally liable in tort for damages and typically indemnified by their motor insurance policy for third party liability. Whilst the insurer may be able to exercise subrogated rights to make any claims in the name of the insured driver (e.g. for contributory negligence against a third party), the insurer cannot generally claim against its own insured.

Where the MIB acts as the insurer of last resort, it will enter into an assignment with the relevant claimant to acquire their tortious rights of recovery against the uninsured driver. Consequently the MIB can pursue civil proceedings against the uninsured driver in the name of the claimant to recover its outlay if the driver can be blamed for acts that have voided his insurance policy.

We recommend that insurers are clear as to any policy condition implications for third parties and insureds of improper use of automated driving functions. This could form part of the behavioural approach to ensure that drivers are sufficiently educated as to the limitations of any AVs they may drive. Insurance pricing models should also reflect the risk profiles of and incentivise AVs which are designed to minimise or preventaccidental misuse of automated functions in the first place.

[48] AEV Bill Section 3(2)

Scenario 2 – Human driver and hardware vehicle/component failure

Vehicles and components do fail from time to time (although by comparison to human error very rarely) and can be expected to in future. In this scenario, it is assumed that the driver is driving the car under normal operational conditions in accordance with the vehicle's terms of use. This means for example that in all cases the car is maintained to a good roadworthy and legal standard (servicing, MOT, etc). It also means that in respect of a SAE Level 3 or 4 vehicle, the driver has assumed the driving function appropriately under normal conditions and not, for example, in degraded conditions.

Any failure to properly maintain a vehicle or drive it appropriately is generally considered another facet of human error (and potentially a breach of insurance policy terms) - see Scenario 1

This scenario assumes that cause is determined to be a hardware vehicle and/or component failure.

Third Party Insurance position

The strict position on third party insurance in this scenario is that the claim by the third party would be a product liability claim against the responsible producer, distributor or supplier and it would therefore be the liability insurers of these entities on risk for the claim.

In the UK, motor insurance policies cover the insured's use of the vehicle and not the vehicle itself. Therefore whilst a vehicle is being driven by a human, an incident which has been caused by something other than by the insured's negligence would not constitute an insured event (or would only partly be so where driver negligence was merely contributory). However, in these scenarios, it is very often the motor insurer that will respond in the first instance given that the insured driver was driving a car which failed at the relevant time. Again, if the driver was uninsured, the claim may be dealt with through the MIB. Additionally, the MIB may become involved where the motor insurer has grounds to void cover e.g. the car has been materially modified in a manner not notified to the insurer.

In principle if a motor insurer was aware from the outset or had reason to believe that the incident was wholly the result of a failed product, then it could deny third party liability on the basis that this was not an insured event. In practice, a motor insurer may be unlikely to be able to draw such conclusions at an early stage unless for example there is an existing relevant safety notice and/or product recall in respect of the vehicle or the incident was of a sudden catastrophic failure type. In respect of the latter, for example, there is often a suspicion of product defect in cases involving sudden tyre 'blow-outs' and a number of reported disputes where fault has been wholly attributed by courts to the tyre manufacturer[49].

In such cases, third party liability and insurance becomes a disputed issue and resolution, if not settled by agreement, could involve a prolonged court process. Where the motor insurer (or MIB) has compensated the third party (whether the insured was in law liable or not), they will subrogate to the rights of the driver to recover the outlay from any other party which might (also) be liable for the accident. This includes any liability which it transpires may attach to failed products.

A presumption of motor insurance coverage would likely be more rebuttable where the vehicle is an AV in a self-driving mode where any fault is more obviously that of the vehicle. This demonstrates the legislative need for the AEV Bill (see further below in the context of automated driving scenarios) so that third parties are not faced with delay and complexity in claiming as a result of disputes between drivers, their insurers and relevant vehicle/component manufacturers (and potentially others).

Legal liability position

Where a motor insurer or MIB has paid a claim in these circumstances, it will be able to subrogate to the rights of owner to pursue product liability claims.

Where an OEM product has failed, product liability may arise from a number of causes of action (which can be pursued concurrently):

- Part 1 of the Consumer Protection Act 1987 (CPA) imposes a strict liability (i.e. without the need to establish fault). If it can be demonstrated that the product was defective and that it caused (wholly or partly) damage, personal injury or death that is sufficient. As liability is joint and several, the claim can be made against the OEM alone or jointly with component manufacturers, although there is a longstop limitation date for claims of 10 years from the date of the product being supplied;

- A tortious action for negligence; and/or

- Liability in contract (e.g. in the contract for sale or manufacturer warranty) on terms such as fitness for purpose and quality whether express or implied through the Consumer Rights Act 2015 (consumer) or Sale of Goods Act 1979 (business to business). This claim could only be brought by the owner against the retailer with whom there is a contract.

If a claim is being pursued directly by the third party, that claim may proceed under either the CPA or tort route notwithstanding that the third party was not the owner of the product in question. There would not be any liability in contract between the relevant vehicle/component manufacturer and the third party

Given the applicability of strict liability, the CPA is typically the primary cause of action pursued in liability claims as factual negligence does not need to be established. For its part, the OEM will typically have contractual arrangements in place across its supply chain to support and recover warranties and product liability costs and liability insurers will be on risk across the entire value chain.

However, where the product failure can be attributed to parts or modifications installed after the original purchase of the vehicle, this may provide a defence to the OEM or original component manufacturer under the CPA, tort and/or contract (e.g. invalidated warranties). A break in the chain of causation caused by these actions may leave potential causes of action in product liability, negligence or contract claims (of which only the product liability and negligence could be directly pursued by a third party) including against:

- The relevant parts producer, supplier or retailer (which may be the OEM or original parts manufacturer or other aftermarket parts manufacturer or used part supplier); or

- The garage or mechanic that negligently serviced, maintained or installed the failed part or caused the defect on the original part in the course of providing services; or

- The owner himself if the root cause was defective or unauthorised self-installation of a sourced part or works on the vehicle undertaken by the owner himself

[49] Divya v Toyo Tire and Rubber Co Ltd (t/a Toyo Tires of Japan) [2011] EWHC 1993 (QB) Carroll v Fearon & Ors [1998] PIQR P416

Automated scenarios

Scenario 3 – AV system driving; driver fails to respond to handover request

This scenario applies to SAE Level 3 and 4 vehicles only. The "handover" scenario, contrary to the expectation of some, does not apply to SAE Level 2 vehicles where full control is never at any point to be given to the vehicle AV system and the driver is expected to be actively monitoring and supervising at all times.

Handover in this scenario comprises the process by which driving function control is handed over by machine to human (as investigated in VENTURER) and explored in more detail in the Second VENTURER report[50]. It is in this scenario that the expectations of drivers are particularly pertinent and the issues as to human factors and human machine interaction are especially acute. Relatively-speaking the process by which driving control is handed over from human to machine under the specified conditions is more straightforward. As stated above, the main issue is mitigating the risk of a human improperly activating an automated driving function but, assuming that can be resolved, the AV system can be expected to take control of the driving task rapidly and optimally.

It is worth noting the different purposes for which SAE Level 3 and 4 vehicles may request and/or expect to handover to a driver.

At SAE Level 3, the expectation is that the driver must be alert and able to accept a handover request in a timely manner at any time when the AV is driving (the SAE calls this being "receptive" as opposed to monitoring). The primary reason for this is that a SAE Level 3 vehicle may be unable to fall back safely to a condition which minimises the risk of a crash. If a request to intervene is not accepted by the driver then there is a real and imminent safety risk. Consequently a Level 3 vehicle that is self-driving will:

- Issue a "timely" request to intervene to the driver in the event that it is approaching its operational limits (e.g. coming off the motorway if rated just for motorway driving) or experiences a performance-relevant system failure; and
- Disengage:
  - after "an appropriate time" after issuing the response to intervene; or
  - immediately when requested by the driver (most notably where the driver voluntarily decides for himself that he has identified an issue which the AV system has not).

By way of contrast, at SAE Level 4, there is no expectation that the driver will accept a handover request at all whilst the AV is driving. A SAE Level 4 vehicle can in all circumstances within its operational limits bring itself safely to a condition which minimises the risk of a crash:

- The vehicle may issue a timely request to intervene (and presumably will invariably do as it approaches its operational limits);
- However, if there is no response, the vehicle will bring itself safely to a minimal risk condition including safely stopping (e.g. to prevent itself driving beyond its operational limits without the driver taking over);
- A driver may request an intervention but the vehicle may delay disengagement (mostly likely until the AV considers conditions safe to do so);
- In any event, the vehicle will not disengage automated driving until it has achieved a minimal risk condition or the driver takes over after a request;
- Consequently, handover need only happen for functional reasons and never for critical safety reasons.

[50] "Are we ready to 'handover' to driverless technology?" (April 2018) AXA and Burges Salmon

VENTURER key trial findings on handover

1

Under trial conditions, planned handover testing nevertheless demonstrated that participant could react to take control after about 1 second but needed between another 1 to 2 seconds to resume 'active' driving control (a total response time of between 2 – 3 seconds)

2

However, they tended to drive sub-optimally (e.g. slower) for much of a handover period extending up to 55 seconds

3

These trends were observed at all speeds tested (30, 40 and 50 mph) but at 50 mph would mean that a car would travel nearly 45 metres before a driver had active control of the vehicle.

In light of these findings, there are a number of key emerging themes:

- As suggested in a number of prior studies and investigations both in terms of road driving[51] and other modes such as aviation, there are known issues in the human response to a machine to human handover request;
- These human factors impacts will vary from person to person but even in the 'best case' conditions trialled in VENTURER there will be a significant time lag (given distance travelled during that lag);
- There is some evidence from VENTURER that even upon accepting handover, drivers do not necessarily drive optimally in the immediate aftermath but instead over-cautiously. Indeed, upon first reacting to a request by engaging controls, the evidence suggests that active control is not in fact fully assumed but that there is a further time lag. This has ramifications for when an AV can safely assume that it can disengage since a situation is possible whereby "the autonomous system has ceded control, the human has signalled acceptance, but in practice he or she has not exerted control and could not be regarded as being in control"[52] ;
- Given the need to accommodate all possible reaction times, what would be considered a "timely" request in the context of the SAE Level 3 and 4 definitions is unclear. Any such time period would have to be able to accommodate the slowest possible response time within the range of 'reasonable' response times and this has not been determined;
- It is conceivable that a timely request of sufficient advance notice could at least be given in respect of planned handover events such exiting a motorway. However, it is unclear whether timely notice of sufficient length could be given so as to counteract any human factors limitations of handover in more dynamic and reactive situations; and

[51] Morgan, P., Alford, C. and Parkhurst, G. (2016) "Handover issues in autonomous driving: a literature review" UWE, Bristol
[52] "Are we ready to 'handover' to driverless technology?" (April 2018) AXA and Burges Salmon p14

Automated scenarios continued

- If SAE Level 3 and 4 vehicles are to be deployed, we would recommend there should be **a robust standard or protocol developed for effective handover and a clarification of handover expectations and disengagement process at SAE Level 3 and Level 4 prioritising human safety above functionality.** This research and development should include:

  - **Significant further human factors investigations into what the reasonable range would be for the purposes of a "timely" request to intervene or whether, as suggested by the ABI[53] , it is preferable to instigate a 'request-acknowledge-confirm' type arrangement which would at least import active consent to assumption of control (and indeed liability) and mitigate any issues around accepting handover by instinctive reaction without yet being fully able to exert active control;**

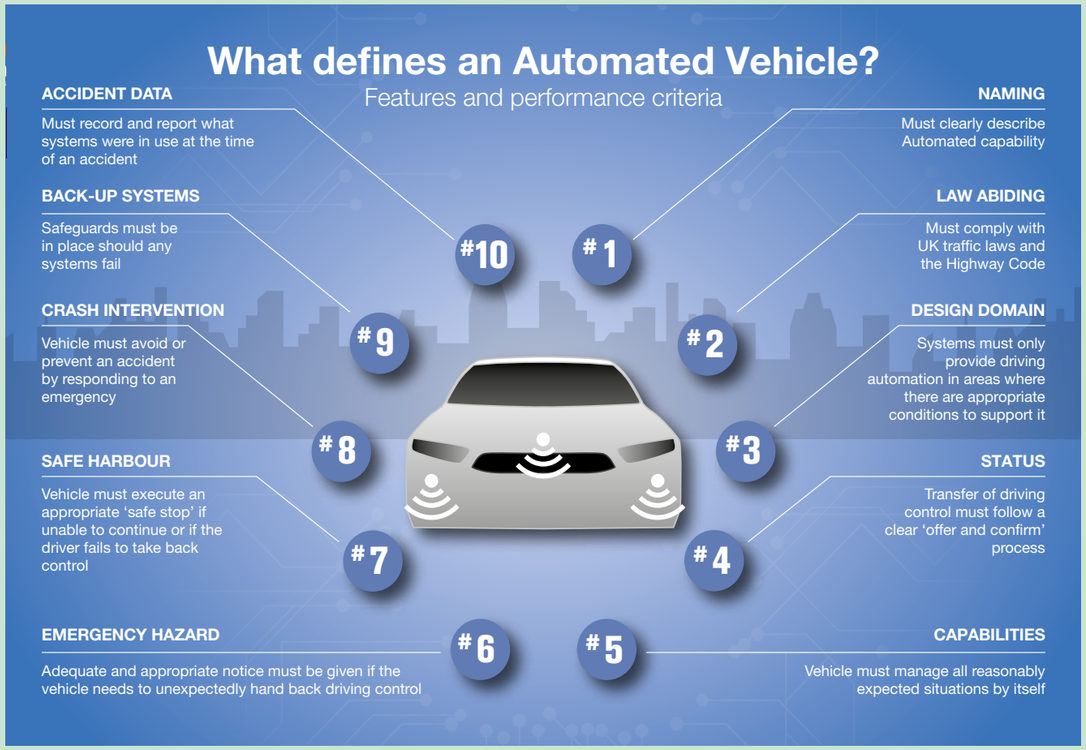
  - **Strategies and mechanisms by which, amongst other things, user interfaces, vehicle interior and exterior environments, V2X connectivity and highway infrastructure could both improve and support the handover process and communicate status to surrounding road users (e.g. sensory or haptic technologies, hazard lights and other visual aids, sliproad junction designs, etc);**

  - **Detailed consideration of the safety case underlying any ability of a SAE Level 3 vehicle to disengage after "an appropriate time after issuing a request to intervene" if there is no handover as expected, as opposed to attempting a form of fail-safe even if sub-optimal to a human fall back;**

  - **Detailed consideration of the safety case underlying any ability of a SAE Level 4 vehicle to request an intervention or to accept a user request for intervention whilst driving within its operational limits. If the vehicle is capable of the driving task or otherwise safely falling back to a minimal risk condition itself, logically and given the human factors issues touched on above, handover would appear to import an element of additional and unnecessary safety risk or at the very least a brief period of sub-optimal driving; and**

The ABI and Thatcham have proposed model criteria for the safety features and performance of an automated vehicle as below[54] which Burges Salmon and AXA endorse.

[53] "Regulating Automated Driving: The UK Insurer View" (July 2017) Thatcham Research and ABI p15
[54] "Clarity in an uncertain world: A model for automated driving" (November 2017) ABI and Thatcham Research



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The Level 3 Audi A8 L – handover

As discussed above, there are occasions when the Audi A8 needs to hand back driving to the driver.

To do that, there is a gradual increase in driver alerts. There is an audible beep, the digital instrument cluster changes and the infotainment screen is interrupted.

If that is ignored, the A8 starts to apply the brakes to a gradual stop. Once the car has stopped, if the driver has not taken back control of the steering wheel for a further 15 seconds, the car dials Audi's emergency hotline for assistance[55].

The warning systems assume that the driver is able to resume driving.

How the driver's ability to resume driving is monitored during Level 3 operation, especially when the driver-facing cameras are disabled and without physically restricting the driver's movement, is not clear. It is also not clear, in real world driving conditions, what the handover mechanism is for incidents of a sudden nature, where a driver may have a very short time to take back control.

[55] "The Level 3 Audi A8 will almost be the most important car in the world", Forbes.com (10 September 2017)

Automated scenarios continued

Third Party Insurance position

As discussed above, under the current provisions of the AEV Bill, vehicles of SAE Level 3 or Level 4 would potentially fall within the definition of "automated vehicles" under the legislation where "in the Secretary of State's opinion [they are] designed or adapted to be capable, in at least some circumstances or situations, of safely driving themselves". However, the Secretary of State does not as a matter of principle consider a Level 3 vehicle to be capable of driving itself "safely" within the permitted circumstances of its automated function. This view could certainly be justified by reference to some of the particular difficulties arising from safety-critical handover which is a feature of SAE Level 3. As stated above, Burges Salmon and AXA would nevertheless encourage the Government to be as clear as possible on the distinction either in the Bill or accompanying guidance as well as to make clear its position on regulation and approval of Level 3 vehicles.

Certainly, as regards a Level 4 vehicle, it seems clear that these will be "automated vehicles" under the AEV Bill. As a result the current third party liability regime will be extended to cover the automated vehicle whilst driving itself. The AEV Bill will provide that where the AV is driving itself and causes an accident, the motor insurer will be liable for third party liability on a strict liability basis (subject to any contributory negligence by the relevant third party or the driver where the driver has inappropriately activated the automated function). Furthermore, the Bill provisions and proposed consequential amendments to the Road Traffic Act 1988, mean that where the driver is uninsured, the MIB framework will also apply to such circumstances.

This aims to provide the third party with a single point of recovery in the first instance and eliminate the risk of any delay where there is a dispute or uncertainty as to who was driving the vehicle at the relevant time. The AEV Bill gives motor insurers the right to pursue recovery of its outlay from any other person liable to the injured party for the same incident. From the perspective of a third party, issues in relation to handover should not therefore impact on their ability to recover from the motor insurer or the MIB. Assuming that vehicle approval / type approval of vehicles goes hand in hand with designation as an "automated vehicle" under the AEV Bill then there should not be any inconsistency. However, there is a suggestion in the AEV Bill that there may be vehicles on the roads which are capable of driving themselves but not "safely" so and so are not designated. This perception is unhelpful in respect of public confidence, consumer clarity, liability and insurance.

Following enactment of the AEV Bill it would be helpful for the Government to clarify that no vehicle will be approved or permitted to drive itself as an automated vehicle unless it has been approved as safe and therefore designated under the AEV Bill (i.e. that there will be no discrepancy between approved 'automated vehicles' for the purposes of automotive regulation and 'automated vehicles' for the purposes of the AEV Bill). This issue is linked to the issue of how the Government intends to regulate Level 3 vehicles.

Burges Salmon and AXA ascribe to the view (taken by the ABI and others) that an over-reliance on the SAE Level taxonomy in this respect may not be wholly helpful and that the UK approach should focus on the criteria by which automated vehicles capable of self-driving are approved as safe and designated as such.

As part of that, **standards governing handover expectations and processes must be adequately addressed at approval and designation stage as part of the safety case assessment for vehicles and for designation of automated vehicles (since handover functionality capability is a key distinction between Level 3 and 4 vehicles). In doing so, there is an independent expert assessment of safety standards and methodologies against which handover protocols and expectations of drivers can be gauged to minimise safety risk. That approval process must be continually reviewed where operating systems are updated and as more data emerges. If Level 3 vehicles are outside the AEV Bill, the basis on which they are approved for use on the roads (including handover) will be important for third party liability purposes.**

If Level 3 vehicles are outside of the AEV Bill, then in the event of an incident caused by the vehicle during handover, the third party is potentially caught between Scenario 1 (driver claim) and Scenario 2 (product claim) but with a potential legal gap where the vehicle actively disengages according to its terms of use and is no longer driving itself but neither is the driver who may argue that failure to assume control was not negligent in the circumstances. This is unsatisfactory as the third party is pulled into a highly technical dispute between the driver and vehicle manufacturer as to nature and expectations of the handover protocol and who, if any of them, is culpable. Assuming the vehicle's approval by the Secretary of State includes a full safety assessment including as to the handover process, compliance with those standards will almost certainly form the starting basis of any defence by the OEM that the vehicle had reasonable handover arrangements and that any failure to comply is therefore the fault of the driver.

AXA and Burges Salmon anticipate that, if Level 3 vehicles are approved for use on the public roads by members of the public as in these scenarios, it may be the case that their public acceptance and adoption would, as a minimum, be dependent on further legal changes and/or OEM indemnities to ensure a level of third party protection similar to that afforded by the current compulsory insurance regime. Such steps would give third parties similar assurance to that in the AEV Bill (in respect of Level 4 and above) that in the event of an incident caused by a Level 3 vehicle and failed handover, there would be a clear party against whom to make a claim in the first instance. If not then, post-enactment of the AEV Bill, third party liability protection will be materially worse in the event of a Level 3 vehicle automated accident compared to one involving any other form of road vehicle.'

Automated scenarios continued

Legal liability position

In terms of ultimate legal liability and regardless of who may meet any third party liabilities in the first instance, where a driver fails to respond to a handover request and there is an incident:

- In the case of a SAE Level 4 vehicle, it will most likely be considered a vehicle failure. A Level 4 vehicle in automatic driving mode should in most forseeable circumstances be able to drive safely and if necessary fall back to a minimum risk condition. The terms of use would not place a requirement or expectation on the driver to accept a handover request whilst driving and the AV would be driving itself. Consequently, the indemnifying insurer under the AEV Bill should be able to subrogate and recover its outlay from the OEM and/or any other responsible party through product liability avenues. It is assumed that the AV system is integral to an AV and that product liability claims can therefore be pursued against the OEM and the OEM is not able to rely on available product liability defences. In turn the OEM will have in place contractual recovery or contribution rights against its relevant suppliers in the chain supplying the AV system.

- In the case of a SAE Level 3 vehicle, in principle failure to respond to a handover request in breach of terms of use would be considered a driver error in which case the motor insurer would not have any further recourse to recover its outlay since any claim would be circular. Fundamentally, drivers of a SAE Level 3 vehicle driving itself need to remain alert and receptive to a handover request. However, in human factors terms, VENTURER demonstrates that this is difficult in practice (and foreseeably so) and, in law, the position on liability could be dependent on a number of factors including those set out below. In short, it is not a complete answer for the OEM to assert that the handover function performed as intended:

  – In accordance with the Consumer Rights Act 2015, consumer protection regulations and common law, contractual terms of use, consumer notices and exclusions of liability may not be legally binding on consumers if, objectively, the obligations and expectations placed on them are unfair, unreasonable or, indeed, impossible;

  – For consumer contracts, certain types of exclusion or limitation clauses are prohibited by law including clauses which purport to exclude or limit liability for defective goods, damage caused by defective products or for death or injury caused by negligence;

  – The legal protection of consumers may be of particular concern where the marketing of products or public statements made in respect of them are potentially misleading including as to consumer rights and risks or the extent it was reasonably foreseeable or known that expectations of users were unreasonable. At the extremes, to the extent any of these ever amounted to fraudulent misrepresentation, liability for that cannot be excluded at all;

  – For business purchasers, provisions of the Unfair Contract Terms Act 1977 likewise provide that liability cannot be limited or excluded for personal injury or death caused by negligence and in all cases are always limited to the extent that it is reasonable; and

  – In any event, the rights of the third party to pursue a product liability claim for damage, personal injury or death caused by defective products against the OEM are not restricted by any provisions as to use between the driver and the OEM. There may be particular reasons why a third party would prefer to seek compensation from an OEM.

Given the challenges in the concept of handover (as investigated and largely affirmed in VENTURER), ultimate liability when a driver fails to respond to a handover request from a SAE Level 3 vehicle, is therefore likely to involve a substantive dispute as to whether or not the established handover function and protocol is reasonable, negligent, unsafe and/or otherwise renders the product defective. This would require multi-party complex litigation to resolve but the crux of the matter would ultimately be the question: is the handover function safe? As stated above that is a question which the Secretary of State for Transport can be expected to have satisfied himself of prior to approving the vehicle for use on the road (most likely through the type approval regime at international level). Consequently, rigorous regulatory approval and compliance with standards ought to provide a degree of comfort for any OEM that its handover process is a reasonable and safe one, at least initially. That said, it is not necessarily a complete answer if, for example, the OEM has since updated arrangements, become aware of issues or more effective safety mitigations after approval or has, for example, misrepresented the function to its consumers or the general public in advertising.

In the circumstances, standards ensuring a safe handover function as part of the overall safety assessment for vehicle approval and designation are not only essential to statutory approval functions and to ensure that residual safety risk is mitigated to a level as low as reasonably practicable (ALARP) but also important for establishing consumer confidence, expectations and liability.

Scenario 4 – AV system driving; failure to update AV software

In this scenario (which could involve any AV from SAE Level 3 to 5), the cause of an incident has been identified as being a failure to update AV software

Where this has occurred in a Level 3 vehicle driving itself and the AV system has initiated a handover request due to the issue with an expectation of acceptance (as in Scenario 3 above), it is assumed in this scenario that any failure by the driver to accept handover has been discounted as a cause.

This scenario is considered distinctly as it will be a characteristic of connected AVs in future that basic AV operational systems will have a critical dependency on software. To some extent this process is already demonstrated in practice today in respect of the existing electronic capabilities of vehicles and the over the air software updating of various automated driver assistance features and on-board entertainment features. The importance of software is also illustrated by the increasing proportion of physical product recalls undertaken in specific relation to updating software (or specifically firmware).

Given the operational and safety-critical nature of AV software, it is assumed that updates for this software (like most existing software and firmware in the automotive industry) will be supplied through official approved OEM channels.

Third Party Insurance position

Under the AEV Bill, the third party liability position will be straightforward as long as the AV is a designated automated vehicle driving itself at the time. The relevant motor insurer is strictly liable to the third party (subject to contributory negligence on their part). The Government position is that this will apply for vehicles of Level 4 and above.

As in Scenario 3 above, where the vehicle is a Level 3 vehicle on the other hand, notwithstanding its provisions, the Government position is that this will not be covered in the AEV Bill. Consequently, if legislation and/or industry arrangements have not been put in place (as discussed in the scenario assumptions above), third parties would be exposed to liability disputes between the motor insurer insuring the driver, the OEM and potentially the software producer in particular. Furthermore, if product liability regimes have not been updated as assumed above, third parties will additionally be exposed to the added complications of a product liability regime which may not protect them at all or fully for defects in software or post-supply software updates. It should be clear that this position would be highly unsatisfactory and make a Level 3 vehicle quite unattractive as a result.

Again, Burges Salmon and AXA anticipate that, if Level 3 vehicles are approved for use on the public roads by members of the public as in these scenarios, it may be the case that their public acceptance and adoption would, as a minimum, be dependent on further legal changes and/or OEM indemnities to ensure a level of third party protection similar to that afforded by the current compulsory insurance regime. Such steps would give third parties similar assurance to that in the AEV Bill (in respect of Level 4 and above) that in the event of an incident caused by a Level 3 vehicle, there would be a clear party against whom to make a claim in the first instance. If not then, post-enactment of the AEV Bill, third party liability protection will be materially worse in the event of a Level 3 vehicle automated driving accident compared to one involving any other form of road vehicle.

Automated scenarios continued

Legal liability position

In terms of the legal liability position, this depends in large part on which party has assumed responsibility for maintaining the AV software and in addition possibly what, objectively, a safe product or system should reasonably have required.

If the responsibility and decision to install AV software updates lies with the insured (primarily through product terms of use), then a failure to do so may be considered negligent where it has caused loss and damage. To the extent that iwt obviously relates to safety-critical aspects, failure to update software may additionally be a breach of insurance conditions to ensure that the vehicle is "roadworthy".

Indeed, the importance of this responsibility is highlighted by the AEV Bill which provides that insurers may include policy provisions to aexclude or limit liability to its own insured and to permit them to recover third party outlay from their insured where it resulted from the insured's "failure to install safety-critical software updates that the insured person knew, or ought reasonably to have known, were safety-critical".

This begs the question of what software is "safety-critical" (which is not currently defined in the AEV Bill) and the level of understanding of that required of an insured lay person. Practically speaking, it would have to be made clear by the OEM supplying the update or its approved software supplier. However, that knowledge as to the safety of its own product creates obligations on the OEM itself.

The updating process has been likened to the updating of firmware for smartphones, however, that analogy is not helpful when one appreciates that, unlike with smartphones, certain of these software updates are safety-critical to use of the product. The safety obligations of the OEM and of regulators must be to ensure that residual safety risk is mitigated to a level as low as reasonably practicable (ALARP). In the circumstances:

- The OEM would likely be required by reason of the General Product Safety Regulations 2005 to engage with its safety standards enforcing authority (currently DVSA) on:
  - the safety-critical issue with its product which necessitates a software update; and
  - any implications the identified safety-critical issue and/or the proposed update would have on vehicle approval status;
  - As with any other reported safety issue, the OEM must have a remedial strategy in place and that includes possible product recall. If the motor industry is capable of conducting mass recalls to rectify emissions software, then there is very little doubt that ALARP would require a recall strategy for safety-critical software updates. The associated expense and effort would probably be considered more than proportionate to the potential safety risk and particularly if the option of pushing out an over the air update is available which reduces the costs significantly;
- In the case of a SAE Level 3 or Level 4 vehicle, there is an identifiable product liability issue in respect of a connected AV which is permitted by design to enter automated driving mode in full knowledge that it is unsafe because it is in default of a safety-critical update. In circumstances where these vehicles are designed to fall back to a human driver or pilot themselves to a minimal risk condition if they detect a safety issue whilst driving, it is unclear why it would be considered safe to permit commencement of automated driving with a known safety-critical software deficiency. This will be reinforced by OEM general and specific requirements to ensure safety as part of type approval regulations; and

- **In Burges Salmon and AXA's view automated vehicles ought to verify that safety-critical software is up to date before permitting the driver to activate automated driving (i.e. allow manual driving only in SAE Level 3 and 4 and not at all in Level 5). Verification of safety-critical software status could be considered an integral part of any AV's 'Operational Design Domain'.**

Taking the above into account, it would appear that where an incident has been caused by an AV driving itself as a result of not having up to date AV software, there is a credible case that that is a defect in product design. At the point of supply that is a known and probable safety risk with foreseeable consequences. This is notwithstanding current issues with the product liability regime since this functionality and design would have been an integral part of the product at the point of supply.

Consequently, it appears that any motor insurer compensating a third party would potentially have the benefit of product liability remedies against the OEM in this scenario and, notwithstanding any policy rights against the insured, it may prefer the possibility of a risk based recovery against the OEM rather than fault based action against an individual insured.

Finally, notwithstanding liability and insurance issues, as stated above, from a safety perspective, preventing the scenario from occurring at all would be the optimal solution. Indeed, given the 'always on' connectivity of AVs and the aligned mutual interests of both OEMs and owners, it would appear likely that a technological solution such as pushed updates and automatic downloading and installation of safety-critical software updates is feasible and preferred. This reflects the position of the Government expressed through the Second Reading of the AEV Bill that "Based on discussions with manufacturers, we expect that they will inform the owners of cars when a safety update to the vehicle software is needed. However, the overwhelming majority of these updates will be made automatically. The wording in the Bill places the onus on the manufacturer to communicate effectively about the need to install updates, but it is a complicated issue. As and when software updates are developed further, we will need to ensure that there is clear guidance on this for both manufacturers and vehicle owners so that it is clear where the responsibilities lie.[56]" . It is suggested in this report that through a combination of a proactive safety regulation approach, product liability concepts and consumer expectation and risk appetite, responsibility is most likely to fall on or be assumed by manufacturers who may as a result meet that responsibility through technology controls implemented by design.

[56] Hansard HL Deb 20 February 2018 vol 789 cc 62 and 63

Scenario 5 – AV system driving; failure due to external infrastructure dependency

In this scenario, we consider two specific aspects of infrastructure dependency: connectivity (e.g. loss of network signal or failure of signalling infrastructure) and physical (e.g. degraded highway condition). Where this has occurred in a Level 3 vehicle driving itself and the AV system has initiated a handover request due to the issue with an expectation of acceptance (as in Scenario 3 above), it is assumed in this scenario that any failure by the driver to accept handover has been discounted as a cause.

In particular, this scenario explores the significance of the potential high dependency of AVs on "Vehicle to Everything" (V2X) connectivity and communications and potential need for a higher standard of highway maintenance[57] .

Third Party Insurance position

Under the AEV Bill, the third party liability position will be straightforward as long as the AV is a designated automated vehicle driving itself at the time. The relevant motor insurer is strictly liable to the third party (subject to contributory negligence on their part). The Government position is that this will apply for vehicles of Level 4 and above.

As in Scenario 3 above, where the vehicle is a Level 3 vehicle on the other hand, notwithstanding its provisions, the Government position is that this will not be covered in the AEV Bill. Consequently, if legislation and/or industry arrangements have not been put in place (as discussed in the scenario assumptions above), third parties would be exposed to liability disputes between the motor insurer insuring the driver, the OEM and relevant service operator (e.g. communications provider) or infrastructure owner (e.g. signal infrastructure owner or highway authority) or infrastructure maintainer. The involvement of a third party in this type of complex multi-party dispute involving the AV supply chain and the wider AV ecosystem is a highly undesirable outcome.

Again, Burges Salmon and AXA anticipate that, if Level 3 vehicles are approved for use on the public roads by members of the public as in these scenarios, it may be the case that their public acceptance and adoption would, as a minimum, be dependent on further legal changes and/or OEM indemnities to ensure a level of third party protection similar to that afforded by the current compulsory insurance regime. Such steps would give third parties similar assurance to that in the AEV Bill (in respect of Level 4 and above) that in the event of an incident caused by a Level 3 vehicle, there would be a clear party against whom to make a claim in the first instance. If not then, post-enactment of the AEV Bill, third party liability protection will be materially worse in the event of a Level 3 vehicle automated driving accident compared to one involving any other form of road vehicle.

[57] See "Readiness of the road network for connected and autonomous vehicles" (April 2017) Johnson, RAC Foundation

Legal liability position

In the two scenarios contemplated, the question of where ultimate liability may lie (with one or more parties) is potentially complicated by a number of factors:

- V2X communications may rely on one of or both of Dedicated Short Range Communication (DSRC) wireless technology (such as ETSI ITS-G5) or wireless mobile systems such as 4G LTE or, in future, 5G. These may be provided by a multitude of network providers and through separate network infrastructure (e.g. signal equipment) providers. In turn network infrastructure may be maintained by other parties;

- AVs may also rely on satellite-based standard communication systems such as the current US-backed Global Positioning System (GPS) or future equivalents such as EU-backed Galileo positioning system for geolocation and navigation purposes. Those in turn may be augmented by additional satellite systems, wireless networks, high definition maps or on-vehicle hardware and software systems to provide the level of accuracy required to guide AVs;

- Connectivity may be made available to AVs as part of the product 'package' or separate connectivity software and services may be provided as a service through a contract or a pay as you go model (in a manner analogous to mobile telephone models);

- Any communications issue may itself be the result of a third party 'hacking' incident or the result of interference by other external actors, infrastructure or events. This may be malicious but is commonly not. V2X trials are already investigating and experiencing the limits of current and future communications technology whether wireless network or satellite; and/or

- Whilst AVs may require a higher standard of highway condition to operate effectively, they could also (eventually) be more likely through hardware and connectivity to be able to know or predict degraded conditions along a journey path. In principle, all open data sources as to highway condition would be available to AVs (including e.g. FixMyStreet). However, as part of the "Internet of Things", AVs would become powerful mobile highway condition sensors in their own right adding exponentially to this dataset (at a faster and more accurate rate than humans) subject to data sharing arrangements.

In principle, claims could lie against any one or more of:

- The OEM and/or other relevant product manufacturer under the product liability regime;

- The network provider, network infrastructure provider or maintainer or navigation system provider under the contractual terms of a relevant network contract for interruption of service. As discussed above, this assumes that issues in the product liability regime in respect of standalone communications software and whether they constitute "products" have been resolved by regulators or industry;

- An unauthorised hacker of communications infrastructure or other external interference source;

- A highway authority under a relevant statutory obligation in respect of an adopted and maintained highway; and/or

- Landowners and occupiers in respect of any other roads

The availability of remedies would depend on the facts in any particular case although, given the nature of remedies availability, the strict liability product liability regime would be preferred where available.

As regards data and connectivity dependencies, terms of service are very unlikely to guarantee uninterrupted and optimum service and will incorporate corresponding liability exclusions. In those circumstances, it will relevant to consider how reasonable it may be for an OEM to design a product with safety-critical dependencies on services of such a nature without appropriate fail safes. Indeed, safety-critical communications systems (e.g. signalling) in respect of other transport modes and sectors tend to be bespoke and dedicated closed networks supported by their own infrastructure and operational fail safes (e.g. Global System for Mobile Communications – Railways (GSM-R)).

Automated scenarios continued

Highway Authority roads and signs maintenance

Highways authorities are responsible for maintaining highways at public expense[58] but that is not the same as improving them[59] - when dedicating a road as a maintained highway "Drivers of vehicles must take the highway network as they find it"[60] . The duty to maintain (which is owed to all road users) is limited to a duty to repair and keep in repair[61] and "in such good repair as renders it reasonably passable for the ordinary traffic of the neighbourhood at all seasons of the year without danger caused by its physical condition".[62]

Common law has established that a highway is a defined route over which "the public at large" can pass and repass as frequently as they wish, without hindrance and without charge. Highways can also be established by statute. Highway authorities are required to maintain a list of streets that are publicly maintainable highways[63] . However, the list may not be complete, accurate or up to date. Mapping software used by AVs will have to be able to identify which are maintained roads and which are not.

Each highway authority (of which there are a number depending on the category of highway) has primary liability for physical injury or damage resulting from a breach of their duties, subject to a special statutory defence: "that the authority had taken such care as in all the circumstances was reasonably required to secure that the part of the highway to which the action relates was not dangerous for traffic"[64]. In considering what constitutes reasonable care, the court will consider:

- The character of the highway and its traffic;
- The standard of maintenance appropriate for such a highway;
- The state of repair in which a reasonable person would have expected to find the highway; and
- Whether the highway authority knew, or could reasonably have been expected to know, that the condition of that part of the highway was likely to cause danger to users.

It is unclear whether or not and if so to what extent there would ever be any enhanced obligations imposed on highway authorities by statute or the common law to improve and maintain roads for the benefit of AVs. On the basis of the existing common law, the repairing obligation seems unlikely to stretch to improving or enhancing highways from their 'as dedicated' state for AVs who, like human drivers, will be expected to take the network as they find it. Any changes in the law on these aspects would have significant impacts (financial, environmental, etc). In the nearer term at least, the emphasis is more likely to be on dedicated road space or on OEMs to develop vehicles better able to adapt to at least a reasonable degree of highway degradation (e.g. improved active suspension or enhanced onboard or roadside sensor capability to mitigate signage and marking issues).

The repairing obligation may nevertheless be indirectly affected by AVs. To date, the repairing obligations of authorities have been limited to dealing with repairs as and when deficiencies are highlighted by periodic inspections or by reports made by humans. However, if AVs are capable of reporting road deficiencies much more effectively, then this may increase the burden on authorities and their liability risk. As stated above, knowledge of deficiencies is relevant to liability.

The maintenance/repairing obligation is limited to the physical or structural highway condition; not for example keeping roads clear of ice and snow[65] or to maintain road signs and markings[66]. It has been suggested that such aspects may fall within the obligations of authorities to promote road safety and take measures to prevent accidents .

However, the courts have tended to give the courts have tended to give authorities a wide discretion and it is unlikely to be liable unless there were exceptional circumstances or the failure to take action was wholly unreasonable[68] .

In the absence of additional legislation, it is unlikely that the existing position in law will require authorities to adopt any enhanced measures for road sign maintenance/repair to accommodate AVs. Again, any such additional legislation would have significant impacts (financial, environmental, etc). That said, as with road deficiencies, it is possible that repeated and increasingly efficient reporting of deficiencies by AVs may put authorities on notice of road safety issues and increase exposure to liability (e.g. it may well be wholly unreasonable to ignore repeated warnings).

Similar considerations to the above would apply for private landowners and roads on private property. It should also be noted that the common law does not recognise any general duty of owners of land adjacent to highways to prevent obstructions or impairments to visibility for road users[69] .

Given that the outcome of this scenario will have been a safety-related incident, the primary target of claims in this scenario is still most likely to be the OEM. The product liability issues would likely be based on:

- Connectivity and communications interruptions and highway imperfections being well within the ambit of foreseeability; and
- Products needing to have been designed in line with type approval requirements (1) take prudent measures to minimise residual safety risks to a state ALARP in the event of known actual risk and/or which (2) fail safe in the event of a risk materialising. If they do not, then there a risk of a product being deemed defective by design.

Fundamentally, the higher the dependency that an AV has on external conditions, the more safety mitigations and fail-safes should be in place to avoid any incidents as a result of dependency failure. This is potentially more difficult for factors which could not have been predicted at the time of supply but the development risks defence is available for that scenario (subject to issues around continuing responsibility to update).

Safety, liability and insurance expectations mean that AVs should be designed to cope with conditions as they would reasonably expect to find them or otherwise to fail safe; they should not be designed for the conditions as OEMs would hope to find them. This includes what can be reasonably expected as regards the reliability and integrity of external dependencies. To the extent that AV capabilities remain dependent on an enhanced level of reliability and integrity in these areas, the industry needs to start engaging with relevant stakeholders from the outset as there are complex technical, legal and commercial issues there.

[58] Section 41 Highways Act 1980
[59] Gautret v Egerton (1867) LR 2 CP 371
[60] Stovin v Wise [1996] 3 All ER 801
[61] Goodes v East Sussex County Council [2000] 1 WLR 1356
[62] Burnside v Emerson [1968] 1 WLR 1490, Diplock LJ at paragraphs 1496 to 1497
[63] Section 36 Highways Act 1980
[64] Section 58 Highways Act 1980
[65] Goodes v East Sussex County Council [2000] 1 WLR 1356
[66] Gorringe v Calderdale Metropolitan Borough Council [2002] EWCA Civ 595
[67] Section 39 of the Road Traffic Act 1988
[68] Larner v Solihull Metropolitan Borough Council (2000) LTL, 20 December; Gorringe v Calderdale Metropolitan Borough Council [2002] EWCA Civ 595
[69] Sumner v Colborne and others [2018] EWCA Civ 1006 (4 May 2018)

Scenario 6 – AV system driving; failure to assure safe driving mode

In this scenario, it is assumed that all components and systems are operating as intended and designed and that there are no unusual or unforeseeable external events but that the AV has still caused an accident.

Where this has occurred in a Level 3 vehicle driving itself and the AV system has initiated a handover request due to the issue with an expectation of acceptance (as in Scenario 3 above), it is assumed in this scenario that any failure by the driver to accept handover has been discounted as a cause.

Fundamentally, this scenario implies that the AV has experienced an event either

1 beyond the capabilities of its hardware so that relevant data has not been registered (hardware deficiency) or;

2 beyond the capabilities of its software or learning (software deficiency) such that the AV may have either:

(a) failed to appreciate accurately what the data represents; or

(b) on an objective standard, the system has taken a wrong and/or 'negligent' decision; or

(c) having taken a correct decision has failed to execute effectively a response.

An example of a hardware deficiency may include sensors being unable to detect an object at all or sufficiently early enough to be able to take action. An example of a software deficiency may include an AV system being unable to interpret detected data properly such as Volvo's past reported issues in developing its Large Animal Detection system which was confused by the hopping of kangaroos[70] .

[70] "Volvo admits its self-driving cars are confused by kangaroos" (1 July 2017) The Guardian https://www.theguardian.com/technology/2017/jul/01/volvo-admits-its-self-driving-cars-are-confused-by-kangaroos

Third Party Insurance position

Under the AEV Bill, the third party liability position will be straightforward as long as the AV is a designated automated vehicle driving itself at the time. The relevant motor insurer is strictly liable to the third party (subject to contributory negligence on their part). The Government position is that this will apply for vehicles of Level 4 and above.

As in Scenario 3 above, where the vehicle is a Level 3 vehicle on the other hand, notwithstanding its provisions, the Government position is that this will not be covered in the AEV Bill. Consequently, if legislation and/or industry arrangements have not been put in place (as discussed in the scenario assumptions above), third parties would be exposed to liability disputes between the motor insurer insuring the driver, the OEM, component producer or AV software provider. Furthermore, as regards software, again if product liability regimes have not been updated as assumed above, third parties will additionally be exposed to the added complications of a product liability regime which may not protect them at all or fully for defects in software or post-supply software updates. It should be clear that this position would be highly unsatisfactory and make a Level 3 vehicle quite unattractive as a result.

Again, Burges Salmon and AXA anticipate that, if Level 3 vehicles are approved for use on the public roads by members of the public as in these scenarios, it may be the case that their public acceptance and adoption would, as a minimum, be dependent on further legal changes and/or OEM indemnities to ensure a level of third party protection similar to that afforded by the current compulsory insurance regime. Such steps would give third parties similar assurance to that in the AEV Bill (in respect of Level 4 and above) that in the event of an incident caused by a Level 3 vehicle, there would be a clear party against whom to make a claim in the first instance. If not then, post-enactment of the AEV Bill, third party liability protection will be materially worse in the event of a Level 3 vehicle automated driving accident compared to one involving any other form of road vehicle.

Automated scenarios continued

Legal liability position

The issue as to liability in respect of hardware deficiencies will depend on the extent to which they constitute a "defect". Particularly pertinent issues will include the reasonable expectations of the customer of the product's performance, OEM representations of performance and the 'development risks' defence in relation to the state of scientific and technical knowledge at the time of supply. If a vehicle has been represented as having functions equivalent to SAE Level 3 or 4 and capable of driving itself, it would seem likely that, absent specific exclusions, the AV would be capable of detecting any reasonably foreseeable hazard that might be encountered by a vehicle on a highway (i.e. the sensor array would be tested across a variety of reasonable risks it may encounter in the market supplied to). Level 3 and 4 vehicles are by design supposed to be able to monitor the driving task fully whilst driving and can be expected by the consumer to do so – SAE makes clear that at these levels the driver is not expected to actively monitor driving in automated mode. Put another way, it is not at all clear how AVs at such a level could be approved or marketed successfully if they cannot be demonstrated to be fit for their automated driving purpose and supplied with warranties reflecting that or, alternatively, if they come with a lengthy list of exclusions.

As with existing vehicles, those who choose to use AVs are unlikely to rely entirely on the representation of OEMs or to choose or be prepared to use vehicles which cannot meet rigorous standards. It is likely to be standards and independent standards approvals and audit which set the reasonable expectations of the user in product terms just as they do currently, whether we are considering BS or ISO standards, UNECE regulations, regulatory type approvals or Euro NCAP ratings.

The question of what those standards should be is a matter currently being considered in the UK by the Government and standards and industry bodies including BSI[71] and being discussed internationally. From a user point of view, the minimum standard that a person might expect is that an AV is able to perform in automated mode as well as a human driver. However, that is unlikely to be the defining standard or expectation in all cases. For example whilst, overall, sensors on their own have probably yet to catch up with human perception ability, use of lidar and radar sensors should mean that AVs can perform much better at detection tasks than humans in certain conditions such as in the dark[72]. In such cases, standards ought to be set at an appropriate level by reference to the state of the art.

In this way, **product liability claims in respect of hardware deficiencies are likely to be assessed by reference to compliance or otherwise with the applicable standards and approvals. Those in turn will have been set (to be regularly reviewed) at regulator, standards bodies and industry level taking into account consumer expectations, safety cases and the state of scientific and technical knowledge from time to time.**

Issues as to liability with regards software deficiencies are potentially more complex. As discussed above, it is assumed for these scenarios that issues in the product liability regime in respect of whether software and upgrades constitute "products" and the need for product defects and safety to take into account the expectation of evolving risks and software development/ upgrades have been resolved by regulators or industry. If they have not, then this is a fundamental weakness in the product liability regime since it is expected for AVs that software will be continually updated for operational as well as safety reasons. The AEV Bill itself recognises that some software upgrades after supply will be safety-critical. Technological products otherwise become obsolete, unfit for purpose or unsafe at an unacceptable rate.

Conceptually, the role of the software responsible for the automated driving function of an AV can be equated to that of the human driver in that, whilst in automated driving mode, it both processes information around it and take decisions and actions accordingly. However, whereas there is at this point a well understood concept of the standard of care expected of a reasonably competent human driver what is the "standard of care" to be expect of a "reasonably competent AV"? And how can the concept of human driver negligence be reflected in the context of product liability?

It is (unsurprisingly) outside the scope of this report to determine what the standard of care expected of the reasonably competent AV is. However, as with hardware, it is suggested that:

- **assessment of AV driving performance and capability should not just be gauged against that of a reasonably competent human driver but also, where it exceeds human performance, by appropriate reference to the state of the art position;**
- **in a reflection of how human drivers are trained, tested and licensed as competent drivers and professional drivers, regulatory approval and licensing of AV systems should require rigorous testing of AV driving capability both from real world testing (including edge and corner cases) but also, importantly simulation;**
- **the ability to test and verify AV performance authentically (particularly in edge and corner cases) in high quality and high fidelity simulated environments will be crucially important for AVs and in demonstrating their capabilities. AV simulation technology is currently the subject of a Government funded initiative and simulation testing is expected to form a key part of the approvals process for AV trials and eventual deployment; and**
- **the standards which should apply to AV testing and approval will need to be set (to be regularly reviewed) at regulator, standards bodies and industry level taking into account consumer expectations, safety cases and the state of scientific and technical knowledge from time to time.**

Set in this context, **the question of whether an AV has been "negligent" may become a product liability question of whether its performance on the road met the performance standards to which it had been tested and approved. Indeed it may be possible to use the same testing and approval model to verify in retrospect (through simulation) whether or not an AV has performed as intended, as long as all relevant incident data is captured in a secure and protected manner and made available. In this way, the "reasonably competent AV" is considered to be one which meets the standards and requirements of the product testing regime established by regulators; just as the "reasonably competent driver" can be considered to be a human of equivalent experience who has passed a driving test.**

Trial data to date, suggests that, whilst not prone to human error, AVs are yet to approach the performance ability of human drivers. The issue has most often been observed to date, not in circumstances of unsafe driving but sub-optimal or over-cautious driving. This is particularly the case in situations such as pulling out from a junction. Equally it is not yet clear that passengers are wholly comfortable with the idea of AVs driving at a similar performance level of humans[73] . **Ultimately the standard expected of a reasonable AV may permit a performance range to accommodate the preference of users (e.g. from cautious to high performance) as well as driving conditions. It is unlikely that any approval or licensing process would expressly permit an AV to operate itself outside of that range in the course of its normal automated driving function given that, for example in the case of speed, driving too slowly as well as in excess of speed limits are both potential criminal offences. If it did, the circumstances for such anomalies should be captured for review and in case justification is required.**

[71] "Connected and autonomous vehicles: A UK standards strategy" (March 2017) BSI and Transport Systems Catapult
[72] https://www.wired.com/story/self-driving-cars-perception-humans/
[73] "Are we ready to 'handover' to driverless technology?" (April 2018) AXA and Burges Salmon

Criminal and safety regulation issues arising from scenarios

This report highlights aspects of civil liability arising from collision incidents most notably through tort and product liability. However, as we have emphasised above, vehicles are no ordinary 'product'. Their use (and misuse) inherently creates elevated levels of safety risk and the vehicle itself incorporates safety-critical systems, processes and design.

Current criminal law position

The potential risks and severity of consequences are reflected not just through civil law but also through the criminal law (including regulatory aspects of product safety), reflecting the fact that society has chosen to make certain acts or omissions criminal. Consequently, for example:

- In respect of dangerous products, OEMs and other parties in a supply chain (and potentially individuals within them) may be prosecuted and fined or imprisoned for breaches of the GPSR (see Regulation 20 for offences) and in particular the general safety requirement to adequately warn and comply with type approval safety requirements.. Each product supplied could potentially constitute a separate offence. For example (after notable criticism from the Transport Select Committee) the DVSA initiated a criminal investigation into a series of incidents (161 reported) of Vauxhall Zafiras catching fire[74] . To date, it has been fortunate that no one in the UK has been seriously hurt. However, notwithstanding the national nature of the problem, the peculiarities of the enforcement regime mean that principal responsibility for day-to-day enforcement lies with local authorities not DVSA. In this case, the investigation is led by Luton Borough Council's Trading Standards team;
- In principle, if an unsafe product did cause a fatality and the underlying factual issues showed **gross** failings at a level severe enough to pass the (high) hurdle for prosecution, a corporate entity (such as an OEM or supply chain entity) could be prosecuted under the Corporate Manslaughter and Homicide Act 2007. Sentencing and fines could be much greater than under GPSR. To date, successful corporate manslaughter charges have been rare and the majority of them have related to occupiers or employers in relation to site workers or employees. However, there have been convictions in relation to, amongst other things, defective installation and overriding of safety features of gates and defective maintenance of vehicle brakes (albeit on a crane). In principle, corporate manslaughter could apply to gross breaches of duty in supplying unsafe products causing fatalities. Any corporate manslaughter would be prosecuted by the police (and/or Health and Safety Executive). At the very least, the reputation of OEMs could be seriously affected[75] ; and
- In respect of drivers and owners, there are a host of separate vehicle and driving offences, many of which (e.g. speeding or driving without insurance) are strict liability offences. These in practice reflect the public policy position taken on driving and vehicles which is that they are a special category of product and activity to be regulated not only through the civil law but also, at its socially and politically unacceptable or intolerable peripheries, by the penalty of criminal liability. As long as human drivers remain in control of vehicles, these existing offences will continue to have relevance, notwithstanding growing prevalence of driver assistance features. In April 2018, Bhavesh Patel became the first known driver in the UK convicted of dangerous driving as a result of misuse of an Autopilot feature in a Tesla S. Whilst operating on a motorway, he had, in breach of terms of use, climbed over and sat in the passenger seat. He was prosecuted after the incident was filmed by a concerned third party although, ominously, he stated when arrested that he was the "unlucky one who got caught" and that his car was capable of something "amazing". This reinforces key points made above as to making drivers aware of terms of use and the capabilities of their AVs. This has consequences not just for civil liability and insurance but for criminal liability also.

The policy position that a driver should face criminal liability for how they operated a vehicle was established early on in the history of motor cars. The Offences Against the Person Act 1861, which still forms the basis for many criminal offences applicable today, includes the offence of "furious driving" (section 35). This offence is in respect of those "having charge of a vehicle" and, as part of the offence, requires the identification of a person (or possibly persons) who are responsible for harm caused.

The criminal law has since been added to and updated in order to reflect the changing nature and use of vehicles, as well as changing societal expectations. The Road Traffic Act 1988 includes many offences that will be familiar. For example, the offences which relate to causing death or serious injury, including by:

1. dangerous driving (section 1);
2. careless or inconsiderate driving (section 2B);
3. uninsured, unlicensed or disqualified drivers (section 3ZB); or
4. driving under the influence of drink or drugs (section 3A).

Each of these is defined based on the actions of the driver and identifies a person responsible. For example, death by dangerous driving is defined as "A person who drives a mechanically propelled vehicle dangerously on a road or other public place is guilty of an offence".

The criminal law does not only punish those who cause harm; punishment is also considered necessary for those who cause the risk of harm. For example, it is an offence to leave a vehicle in a dangerous position (section 22 of the Road Traffic Act 1988) but again this is defined in relation to a "person in charge of a vehicle".

[74] "Vauxhall Zafira fires face criminal investigation" (3 May 2018), BBC online http://www.bbc.co.uk/news/business-43987134

[75] For example, in December 2016, a driver was killed in the UK in the course of avoiding a collision with a car in front. The brake lights had failed in front car due to an electrical fault which was known of by the OEM, which it had not notified and which it had not instigated a recall over notwithstanding that there had been recalls in a number of countries other than the UK. As at the date of this report, the inquest continues: "BMW under fire over electrical fault" (2 May 2018) BBC online http://www.bbc.co.uk/news/business-43974179

Commentary on criminal and safety regulation issues arising from scenarios

Criminal law considerations for AVs

The emergence of true AVs capable of driving themselves will require consideration of at least three core issues:

- **reform of the product safety regime in line with the product liability regime to ensure that regulatory consumer protection measures will adequately deal with emerging safety critical technology features of AVs such as dependence on post-supply software updates and artificial intelligence/machine learning;**
- **as a matter of policy, what acts or omissions involved in this growing subset of driving should, like existing driving offences, be explicitly criminalised and how corporate liability can attach to those offences; and**
- **if appropriate, consideration of how some existing criminal offences could be adapted to cover automated driving.**

It is assumed that the Law Commission review will encompass all of these aspects in detail over its three years although we touch on some high level issues around these themes below[76] .

The special characteristics of AVs which require a different lens to be applied to product liability and product safety have already been explored above. Below we touch on issues arising from the other two criminal law themes we have identified.

Legislating or adapting law for AV criminal offences

It is clear that automated driving is a complex activity, quite different to human driving, and so we would caution against adopting a starting position which is overly reliant on the existing body of driving offences. To do so risks inadvertently constraining the scope of the exercise and may, if adaptation of existing legislation is prioritised, lead to strained legislation or provisions which are not fit for purpose.

The starting point in considering criminal law implications for AVs is to define the behaviours of and associated with automated driving which, as a matter of public policy, should be criminalised. Many of these will correspond to the existing paradigm of criminal behaviour associated with conventional driving by humans. However, many will also not, but will be distinct and novel.

There are plainly a subset of criminal behaviours which are not likely to be relevant to automated driving. These predominantly relate to specific human driver requirements or human fallibility offences such as drink driving or driving without a personal driving licence. However, these human offences may need to be adapted e.g. for safety, highways management or other policy reasons, it may nevertheless be clarified that any driver who may accept or be required to accept a request to intervene from a Level 3 or 4 AV remains legally "in charge" of the vehicle at all times and otherwise should also not be over the drink drive limit at any point even if just a passenger. This depends in part on what the functional expectations of the driver are in any given AV capability but it is also dependent on policy.

[76] https://www.lawcom.gov.uk/project/automated-vehicles/ - it is noted that, whilst relevant, the Law Commission expects matters relating to data, privacy, theft and cyber-security to be predominantly outside of its scope. The nature of AV technology means that some of these issues are considered core to AV operation, risk and safety regulation and management.

Commentary on criminal and safety regulation issues arising from scenarios

Equivalent AV criminal offences

For many vehicle behaviours or harms which the law has already deemed criminal, there may be no reason to take a diverging view for automated driving. Since these are not dependent on the nature of the driver alone, they are predominantly linked to the safety of the general public who may be affected by the relevant behaviour or harm. These offences range from speeding to causing death by dangerous driving.

From the starting policy position of concluding what automated driving behaviours should be criminal, any offences equivalent to existing human offences should be legislated for or, only if appropriate, adapted from existing legislation.

The necessary legislation or adaptations of specific AV offences is outside the scope of this report, but the following suggested issues may apply to adaptation for equivalent offences which may ultimately make introducing new offences preferable to adaptation:

- Where offences are worded in a manner which may be overly reliant on human driving concepts or definitions of "a person", explicit wording would need to be included to extend offences to automated driving. Stretching ancient and archaic concepts such as those applying to the likes of wanton and furious driving and settled definitions of "person" to modern concepts of automated driving would be unsatisfactory;

- Where offences are not strict liability but require a test against a threshold or standard, these would need to be mapped across to compliance with a relevant safety standard or approval for automated driving or define the mechanism for doing so;

- Where offences are strict liability, it can be expected that they will remain so for good reason e.g. speeding where operational limits for speed can be pre-programmed into the vehicle;

- Corporate or personal liability for automated driving offences will need to be legislated for. In doing so, it is unlikely for the majority of relevant offences to be appropriate to import the high threshold of corporate liability associated with the likes of Corporate Manslaughter. In the majority of cases, it is likely to be the OEM responsible for any criminally aberrant behaviour of their vehicle in automated mode since AVs can be programmed upfront with criminal offences in mind. Moreover, data relating to driving offence convictions would be available for assimilation into that prior learning process;

- It is beyond the scope of this report to opine on criminal liability concepts for decisions taken purely by artificial intelligence. There are fundamental issues relating to artificial intelligence which merit a separate Law Commission review. As above, in the majority of cases, avoiding committing a criminal offence is a matter of constraining driving behaviour and any AI should be subject to those constraints at least. In other cases involving pure AI decisions within those constraints, there are analogies in law by which certain actions can be attributed to third parties who are considered most responsible for the action. These may include concepts of agency or vicarious liability or even specific statutory liability schemes (such as that applying to control of animals and dangerous animals as a subset of that);

- Sentencing and fine levels of automated vehicle offences may need to be reviewed particularly where incidents do not cause actual harm. Since an aspect of sentencing is behavioural reinforcement/change and the prevention of further or future harm, it may be as important and socially valuable for an OEM to demonstrate how vehicles or systems have been updated for unforeseen aberrations to avoid any future recurrence; and

- To the extent that Level 3 vehicles are permitted, as discussed above, the handover process needs to be robust and clearly defined so that, as regards criminal offences, there can be no gap in liability where neither the AV system nor the human driver is in charge of the vehicle.

Commentary on criminal and safety regulation issues arising from scenarios

Non–Equivalent AV criminal offences

The definition of what AV use behaviours should be criminalised is beyond the scope of this report and would require a review of the scope and duration currently being undertaken by the Law Commission. However, just from the analysis of the collision scenarios above, it would seem that the following distinct and new areas of criminal law may certainly need to be considered:

- **Specific regulatory offences enforcing eventual safety standards and approvals for AVs;**
- **Specific regulatory offences reinforcing any powers, duties and obligations of any AV safety regulator and/or investigatory bodies;**
- **Specific offences in respect of AV infrastructure and in particular digital and connectivity infrastructure on which safety-critical operations depend (such as those offences which are specific to the railway);**
- **Specific offences in respect of AVs as regards permissible third party maintenance or modification and in particular with regards to any firmware or operational or safety features (in particular, extending the illegal modifications concept into software);**
- **Specific offences in respect of interference with or tampering of AV data or AV cyber-security; and**
- **Transport-system style byelaws in respect of conduct on publicly-owned property associated with AV operation and in respect of use of AVs as public shared transport (mirroring requirements for rail, aviation and marine modes)**

Appendix

Report findings and reccomendations

Automated and Electric Vehicles Bill (AEV Bill)	
1	There is a disconnect between the current SAE Levels of driving automation which categorise any vehicle from Level 3 above to be driving itself while its Automated Driving System is engaged and the AEV Bill definition of “automated driving” which the UK Government intends to apply only to vehicles of Level 4 and above.
2	To avoid the potential for litigation as to whether or not the Secretary of State could be required to designate Level 3 vehicles under the AEV Bill, the Government should provide greater clarity in the AEV Bill or its accompanying guidance
3	Following enactment of the AEV Bill it would be helpful for the Government to clarify that no vehicle will be approved or permitted to drive itself as an automated vehicle unless it has been approved as safe and therefore designated under the AEV Bill (i.e. that there will be no discrepancy between approved ‘automated vehicles’ for the purposes of automotive regulation and ‘automated vehicles’ for the purposes of the AEV Bill).
4	Burges Salmon and AXA endorse the ABI and Thatcham proposed model criteria for the safety features and performance of an automated vehicle
SAE Level 3 Vehicles	
5	As Level 3 vehicles are coming into production, the Government should set out separately how it would approach regulation and approval of Level 3 vehicles if they are not to be designated as "automated vehicles".
6	If Level 3 vehicles are outside the AEV Bill, the basis on which they are approved for use on the roads (including handover) will be important for third party liability purposes.
7	If Level 3 vehicles are approved for use on the public roads by members of the public, it may be the case that their public acceptance and adoption would, as a minimum, be dependent on further legal changes and/or OEM indemnities to ensure a level of third party protection similar to that afforded by the current compulsory insurance regime. Such steps would give third parties similar assurance to that in the AEV Bill (in respect of Level 4 and above). In the event of an incident caused by a Level 3 vehicle, there would be a clear party against whom to make a claim in the first instance. If this is not in place then, post-enactment of the AEV Bill, third party liability protection will be materially worse in the event of a Level 3 vehicle automated driving accident compared to one involving any other form of road vehicle since the driver negligence / product liability issues may be uniquely complicated and challenging.
Special product characteristics of AVs	
8	Safety approval, regulation and management and consumer protection and product liability regimes must take into account and be capable of dealing with AV differentiation of functions and functions which evolve from the initial point of supply.
9	More work logically needs to be done to explore ways in which gaps in consumer understanding could be mitigated or prevented by design (e.g. the SAE intends that vehicles at Level 3 and 4 should only permit automated driving to be engaged when within its operational parameters) and to ensure that drivers are educated as to the capabilities and terms of use of the specific AVs they may drive.
10	From the perspective of AV manufacturers and markets, there are clear benefits to designing AVs from the outset with appropriate fail-safes and human machine interfaces which require the least possible additional effort or expertise from consumers to understand and use safely.
11	There is a need for reform in product liability and safety regimes to deal with certain aspects of AV product architecture and dependency or the AV industry itself will need to take steps to address consumer liability and safety concerns. In particular, there are some known issues as regards applicability of existing product liability regulation in respect of internet connected products and their operating software including artificial intelligence. These emerging technological characteristics are intrinsic to AV safety, regulation and management and consequently likely to be at the heart of public acceptance and take-up of AVs.
12	There needs to be an understanding that in product terms, an AV integrates two core concepts – the supply of a vehicle and, inextricably, supply of software capable of driving that vehicle safely by itself. The latter function is closer in some respects to an ongoing bundled service than a conventional product. The expectation on that function is that its effectiveness and safety is not fixed as at the point of supply but that it will update and improve.

Appendix

AV standards, approvals and licensing	
13	As the industry begins to consider the emergence of AV standards, there should be a parallel process of dialogue with Government on developing safety standards, regulation and management.
14	There must be minimum standards for AV data capture, retention and regulated and/or open sharing for incident investigation and analysis.
15	To effectively regulate AV and AV systems safety, incident reporting duties and systems (including near miss / operational anomaly reporting) should be reviewed and expanded as necessary.
16	The role for an overall safety regulator for automated vehicles (such as the Office for Rail and Road for rail or Civil Aviation Authority for aviation) engaged at national and international level and an independent and non-fault incident investigation body (such as RAIB or AAIB) should be explored.
17	Product liability claims in respect of AV hardware deficiencies are likely to be assessed by reference to compliance or otherwise with the applicable standards and approvals. Those in turn will have been set (to be regularly reviewed) at regulator, standards bodies and industry level taking into account consumer expectations, safety cases and the state of scientific and technical knowledge from time to time.
18	Assessment of AV driving performance and capability should not just be gauged against that of a reasonably competent human driver but also, where it exceeds human performance, by appropriate reference to the state of the art position
19	Reflecting how human drivers are trained, tested and licensed as competent drivers and professional drivers, regulatory approval and licensing of AV systems should require rigorous testing of AV driving capability both from real world testing (including edge and corner cases) but also, importantly simulation
20	The ability to test and verify AV performance authentically (particularly in edge and corner cases) in high quality and high fidelity simulated environments will be crucially important for AVs and in demonstrating their capabilities. AV simulation technology is currently the subject of a Government funded initiative and simulation testing is expected to form a key part of the approvals process for AV trials and eventual deployment
21	AV driving performance standards which should apply to AV testing and approval will need to be set (to be regularly reviewed) at regulator, standards bodies and industry level taking into account consumer expectations, safety cases and the state of scientific and technical knowledge from time to time
22	The question of whether an AV has been “negligent” may become a product liability question of whether its performance on the road met the performance standards to which it had been tested and approved. Indeed it may be possible to use the same testing and approval model to verify in retrospect (through simulation) whether or not an AV has performed as intended, as long as all relevant incident data is captured in a secure and protected manner and made available. In this way, the “reasonably competent AV” is considered to be one which meets the standards and requirements of the product testing regime established by regulators; just as the «reasonably competent driver» can be considered to be a human of equivalent experience who has passed a driving test.
23	Ultimately the standard expected of a reasonable AV may permit a performance range to accommodate the preference of users (e.g. from cautious to high performance) as well as driving conditions. It is unlikely that any approval or licensing process would expressly permit an AV to operate itself outside of that range in the course of its normal automated driving function given that, for example in the case of speed, driving too slowly as well as in excess of speed limits are both potential criminal offences. If it did, the circumstances for such anomalies should be captured for review and in case justification is required.

AV use and design	
24	AVs and AV systems should be designed as far as possible to be operated in a manner which from the outset mitigates or prevents at least accidental use in breach of terms of use. This should form part of a package of fail-safes that regulators should consider as part of safety cases for vehicle approval.
25	AVs ought to verify that safety-critical software is up to date before permitting the driver to activate automated driving (i.e. allow manual driving only in SAE Level 3 and 4 and not at all in Level 5). Verification of safety-critical software status could be considered an integral part of any AV’s ‘Operational Design Domain'.
26	Given the 'always on' connectivity of AVs and the aligned mutual interests of both OEMs and owners, it would appear likely that a technological solution to safety-critical updates such as pushed updates and automatic downloading and installation of safety-critical software updates is feasible and preferred.
AV insurance	
27	Insurers need to be clear as to any policy condition implications for third parties and insureds of improper use of automated driving functions. This could form part of the behavioural approach to ensure that drivers are sufficiently educated as to the limitations of any AVs they may drive.
28	Insurance pricing models should also reflect the risk profiles of and incentivise AVs which are designed to minimise or prevent accidental misuse of automated functions in the first place.
Level 3 and 4 Machine to Human Handover	
29	A robust standard or protocol should be developed for effective handover and a clarification of handover expectations and disengagement process at SAE Level 3 and Level 4 prioritising human safety above functionality.
30	Significant further human factors investigations should be conducted into what the reasonable range would be for the purposes of a “timely” request to intervene or whether, as suggested by the ABI , it is preferable to instigate a ‘request-acknowledge-confirm’ type arrangement which would at least import active consent to assumption of control (and indeed liability) and mitigate any issues around accepting handover by instinctive reaction (without yet being fully able to exert active control)
31	Strategies and mechanisms should be investigated by which user interfaces, vehicle interior and exterior environments, V2X connectivity and highway infrastructure could both improve and support the handover process and communicate status to surrounding road users (e.g. sensory aids, hazard lights, sliproad junction designs, etc);
32	Detailed consideration should be given to any safety case underlying any ability of a SAE Level 3 vehicle to disengage after “an appropriate time after issuing a request to intervene” if there is no handover as expected, as opposed to attempting a form of fail-safe even if sub-optimal to a human fall back
33	Detailed consideration should be given to any safety case underlying any ability of a SAE Level 4 vehicle to request an intervention or to accept a user request for intervention whilst driving within its operational limits. If the vehicle is capable of the driving task or otherwise safely falling back to a minimal risk condition itself, logically and given the human factors issues, handover would appear to import an element of additional and unnecessary safety risk or at the very least a brief period of sub-optimal driving
34	Standards governing handover expectations and processes must be adequately addressed at approval and designation stage as part of the safety case assessment for vehicles and for designation of automated vehicles (since handover functionality capability is a key distinction between Level 3 and 4 vehicles). In doing so, there is an independent expert assessment of safety standards and methodologies against which handover protocols and expectations of drivers can be gauged to minimise safety risk. That approval process must be continually reviewed where operating systems are updated and as more data emerges.

Appendix

	AV external dependencies
35	It is unclear whether or not and if so to what extent there would ever be any enhanced obligations imposed on highway authorities by statute or the common law to improve and maintain roads for the benefit of AVs. On the basis of the existing common law, the repairing obligation seems unlikely to stretch to improving or enhancing highways from their 'as dedicated' state for AVs who, like human drivers, will be expected to take the network as they find it. Any changes in the law on these aspects would have significant impacts (financial, environmental, etc). In the nearer term at least, the emphasis is more likely to be on dedicated road space or on OEMs to develop vehicles better able to adapt to at least a reasonable degree of highway degradation (e.g. improved active suspension or enhanced onboard or roadside sensor capability to mitigate signage and marking issues).
36	To date, the repairing obligations of authorities have been limited to dealing with repairs as and when deficiencies are highlighted by periodic inspections or by reports made by humans. However, if AVs are capable of reporting road deficiencies much more effectively, then this may increase the burden on authorities and their liability risk.
37	In the absence of additional legislation, it is unlikely that the existing position in law will require authorities to adopt any enhanced measures for road sign maintenance/repair to accommodate AVs. Again, any such additional legislation would have significant impacts (financial, environmental, etc). That said, as with road deficiencies, it is possible that repeated and increasingly efficient reporting of deficiencies by AVs may put authorities on notice of road safety issues and increase exposure to liability (e.g. it may well be wholly unreasonable to ignore repeated warnings).
38	Safety, liability and insurance expectations mean that AVs should be designed to cope with conditions as they would reasonably expect to find them or otherwise to fail safe; they should not be designed for the conditions as OEMs would hope to find them. This includes what can be reasonably expected as regards the reliability and integrity of external dependencies such as communications networks, infrastructure or highway condition. To the extent that AV capabilities remain dependent on an enhanced level of reliability and integrity in these areas, the industry needs to start engaging with relevant stakeholders from the outset as there are complex technical, legal and commercial issues there.
	Criminal law issues arising from AVs
39	The emergence of true AVs capable of driving themselves will require consideration of at least three core issues: • reform of the product safety regime in line with the product liability regime to ensure that regulatory consumer protection measures will adequately deal with emerging safety critical technology features of AVs such as dependence on post-supply software updates and artificial intelligence/machine learning; • as a matter of policy, what acts or omissions involved in this growing subset of driving should, like existing driving offences, be explicitly criminalised and how corporate liability can attach to those offences; and • if appropriate, consideration of how some existing criminal offences could be adapted to cover automated driving.
40	It is clear that automated driving is a complex activity, quite different to human driving, and so we would caution against adopting a starting position which is overly reliant on the existing body of driving offences. To do so risks inadvertently constraining the scope of the exercise and may, if adaptation of existing legislation is prioritised, lead to strained legislation or provisions which are not fit for purpose.
41	There are plainly a subset of criminal behaviours which are not likely to be relevant to automated driving. These predominantly relate to specific human driver requirements or human fallibility offences such as drink driving or driving without a personal driving licence. However, these human offences may need to be adapted e.g. for safety, highways management or other policy reasons, it may nevertheless be clarified that any driver who may accept or be required to accept a request to intervene from a Level 3 or 4 AV remains legally "in charge" of the vehicle at all times and otherwise should also not be over the drink drive limit at any point even if just a passenger.
42	For many vehicle behaviours or harms which the law has already deemed criminal, there may be no reason to take a diverging view for automated driving. Since these are not dependent on the nature of the driver alone, they are predominantly linked to the safety of the general public who may be affected by the relevant behaviour or harm. These offences range from speeding to causing death by dangerous driving.
43	The necessary legislation or adaptations of specific AV offences is outside the scope of this report, but the following suggested issues may apply to adaptation for equivalent offences which may ultimately make introducing new offences preferable to adaptation: • Where offences are worded in a manner which may be overly reliant on human driving concepts or definitions of "a person", explicit wording would need to be included to extend offences to automated driving. Stretching ancient and archaic concepts such as those applying to the likes of wanton and furious driving and settled definitions of "person" to modern concepts of automated driving would be unsatisfactory; • Where offences are not strict liability but require a test against a threshold or standard, these would need to be mapped across to compliance with a relevant safety standard or approval for automated driving or define the mechanism for doing so; • Where offences are strict liability, it can be expected that they will remain so for good reason e.g. speeding where operational limits for speed can be pre-programmed into the vehicle; • Corporate or personal liability for automated driving offences will need to be legislated for. In doing so, it is unlikely for the majority of relevant offences to be appropriate to import the high threshold of corporate liability associated with the likes of Corporate Manslaughter. In the majority of cases, it is likely to be the OEM responsible for any criminally aberrant behaviour of their vehicle in automated mode since AVs can be programmed upfront with criminal offences in mind. Moreover, data relating to driving offence convictions would be available for assimilation into that prior learning process; • It is beyond the scope of this report to opine on criminal liability concepts for decisions taken purely by artificial intelligence. There are fundamental issues relating to artificial intelligence which merit a separate Law Commission review. As above, in the majority of cases, avoiding committing a criminal offence is a matter of constraining driving behaviour and any AI should be subject to those constraints at least. In other cases involving pure AI decisions within those constraints, there are analogies in law by which certain actions can be attributed to third parties who are considered most responsible for the action. These may include concepts of agency or vicarious liability or even specific statutory liability schemes (such as that applying to control of animals and dangerous animals as a subset of that); • Sentencing and fine levels of automated vehicle offences may need to be reviewed particularly where incidents do not cause actual harm. Since an aspect of sentencing is behavioural reinforcement/change and the prevention of further or future harm, it may be as important and socially valuable for an OEM to demonstrate how vehicles or systems have been updated for unforeseen aberrations to avoid any future recurrence; and • To the extent that Level 3 vehicles are permitted, as discussed above, the handover process needs to robust and clearly defined so that, as regards criminal offences, there can be no gap in liability where neither the AV system nor the human driver is in charge of the vehicle.
44	Proposed non-equivalent criminal offences may include: • Specific regulatory offences enforcing eventual safety standards and approvals for AVs; • Specific regulatory offences reinforcing any powers, duties and obligations of any AV safety regulator and/or investigatory bodies; • Specific offences in respect of AV infrastructure and in particular digital and connectivity infrastructure on which safety-critical operations depend (such as those offences which are specific to the railway); • Specific offences in respect of AVs as regards permissible third party maintenance or modification and in particular with regards to any firmware or operational or safety features (in particular, extending the illegal modifications concept into software); • Specific offences in respect of interference with or tampering of AV data or AV cyber-security; and • Transport-system style byelaws in respect of conduct on publicly-owned property associated with AV operation and in respect of use of AVs as public shared transport (mirroring requirements for rail, aviation and marine modes)

About the authors

Burges Salmon

Burges Salmon is an independent UK law firm. Our transport lawyers have unrivalled expertise in the transport sector across all modes. We combine that expertise with cutting-edge legal and regulatory experience and thought leadership though our Transport Technology and Intelligent Mobility practice. Our work includes feasibility, research and development and commercialisation projects and working with innovative mobility solutions providers. On Connected and Autonomous Vehicles, we lead on critical analysis and thinking on legal and regulatory reform, grounded in actual testing experience through our involvement in four government-funded CAV projects: VENTURER, FLOURISH, CAPRI and ROBOPILOT.

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AXA

AXA UK is part of the AXA Group, the largest insurance brand in the world and the largest insurer by revenue. We operate across 64 countries, with 103 million customers worldwide. AXA is committed to finding and developing ways to make our roads safer, and it may sound dramatic but as the cause of over 90% of road traffic accidents is driver error, we believe the way to achieve this is by removing the driver from the driving seat.

AXA has been heavily involved in the field of autonomous cars since 2014, recognising the positive societal impact the technology could have, and is currently part of five different trials across the country which are testing these vehicles ahead of their introduction onto British roads.

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Driverless cars:
liability frameworks and safety by design

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