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**Introductions**

The emergence of connected and autonomous vehicles (CAVs) continues to create many new legal challenges.

We published our first edition of this paper two years ago and in that short time we have already seen significant developments across the sector both in terms of the technologies and the regulatory frameworks.

It is estimated that the market for connected cars in the UK will more than triple between 2017 and 2021 and that 100% of cars will be network-connected by 2025. These predictions demonstrate the rise of the “connected car” and the continued push towards autonomous vehicles.

From personal computers to smartphones, we have become accustomed to technology transforming our everyday activities. The effects of these changes have been dramatic and far reaching. Business models have been disrupted, customers’ behaviour has changed and regulators and lawmakers have struggled to keep up with the pace of change in relationships and responsibilities among those they regulate.

We are now facing another potentially dramatic transformation in a familiar aspect of our lives with the development of CAVs. This will not only bring significant practical changes but also profound cultural and social change as the whole nature of driving and car ownership is transformed.

As well as disrupting car manufacturers’ business models and revenue streams, autonomous vehicles, and the shift in liability they bring, could require a wholesale rewriting of road traffic law, insurance provisions and contractual relationships across the supply chain. All this brings potentially complex legal changes and challenges, as well as a great deal of uncertainty. In some jurisdictions, e.g. Germany, traffic law has already been amended to permit highly automated driving. In the UK and Spain, legislators are currently in the process of defining new rules.

Until recently, it has been easy to see these debates as theoretical and assume that the self-driving car is still in the realm of science fiction. However, that is changing rapidly and CAVs are now a reality and being tested in real world conditions. Whilst motor enthusiasts argue that autonomous cars will never become socially acceptable, our view is that society will ultimately embrace connected and autonomous cars if they enhance quality of life, productivity and our wider environment.

In this edition, our lawyers across Europe consider some of the key commercial, regulatory and legal issues surrounding the development of CAVs. We seek to help those involved navigate through this fast changing and uncertain world.

We are fortunate to have further insight from the PETRAS Internet of Things Research Hub, Bosch, Starship Technologies and Warwick Manufacturing Group. We are very grateful for all of their contributions and insights.

**We hope you enjoy this edition.**
The rapid development of technology in many sectors has left regulatory regimes struggling to keep up and any move to commercialise fully autonomous cars is likely to require the redrafting of road traffic laws in a number of jurisdictions.

While manufacturers are taking a phased approach, initially developing partially and highly autonomous vehicles rather than fully autonomous vehicles, there will still be real challenges in interpreting existing laws and how they might apply to an emerging technology. This will undoubtedly be complex as current legislation is unlikely to fit the particular circumstances of every new vehicle and is likely to vary across jurisdictions. The challenge for manufacturers will be to influence what future legislation might look like; perhaps by using the information they have gained through testing to achieve clarity. In particular, they will need to make sure that any technology they adopt in their vehicles is not ruled illegal and that they can manage what may be a phased process to change the law.

A key challenge will be how to deal with level 3 and level 4 technology which is highly but not fully autonomous. This is because it might be difficult to objectively determine when a driver may reasonably be expected to take back control of a vehicle, and how quickly.

Governments are beginning to review legislation
The UK Government has acknowledged that these issues need to be addressed and its publication, The Pathway to Driverless Cars, promised that it would review and amend domestic regulations to accommodate driverless vehicle technology. This has been followed by public consultations on how liability and insurance issues may need to be dealt with going forward, and the establishment of the Centre for Connected and Autonomous Vehicles (C-CAVs). This has been bolstered by the announcement of a comprehensive review of driving laws by the Law Commission to ensure the UK is ready and able to support the widespread introduction of CAVs onto its roads.

We have also seen the publication of the Automated and Electric Vehicles Bill which, amongst other things, extends the compulsory motor insurance requirement to include automated vehicle owners and sets out provisions in relation to electric vehicle infrastructure. This Bill is currently being read in the House of Lords and may be subject to further amendment to allow future legislation in this area to be more agile and able to adapt to rapidly developing technologies.

As part of C-CAVs rolling programme of reform, we have recently seen consultations proposing changes to the law to permit the use of remote control parking and motorway assist. The changes remove potential obstacles to this functionality and technology being used and clarify certain “grey areas” in existing legislation. We expect similar consultations and changes to the law to follow as such functionality and technology comes closer to being a marketable reality.

Global considerations
Similar developments have also taken place in a number of jurisdictions. The European Commission and the US Government have both released white papers which discuss their own plans for developing a regulatory framework and stress the importance of a harmonised set of rules that apply across different states.

One challenge that has been overcome is the Vienna Convention on Road Traffic which was developed to set international traffic rules and which stipulates that every car should have a driver. However, an amendment has now been agreed which allows for autonomous operations, as long as there is a manual override option available in the vehicle. Although this can be seen as a positive development, further amendments to the Convention will be required to permit fully autonomous vehicles where the user is not in a position to manually override the vehicle’s autonomous operation.

The UK approach to testing
This underlines that all those involved in developing connected and autonomous vehicles will need to keep a close watch on any changes to road traffic laws and understand how such changes affect the development, testing and commercialisation of connected and autonomous vehicles globally. Indeed, before connected and autonomous vehicles can go on sale they will need to be tested in real road conditions, and traditional manufacturers and new entrants to the automotive sector are now moving into that stage of development.
However, one of the key challenges facing the manufacturers is that governments are taking different views on testing regulations or have yet to develop their testing regimes altogether. Notwithstanding this, some governments are moving quickly. In July 2015, the UK government, which has taken a clear position in supporting autonomous vehicles, published a code of practice for the testing of driverless vehicle technology.

The starting point of the UK’s approach is that those wishing to test will not be required to obtain permits or provide surety bonds, as is the case in other jurisdictions such as the USA. Equally, the UK has acknowledged that developing a detailed legally binding regulatory framework for testing could take years and deters development. It has therefore taken a “light touch” approach to regulation and so the code of practice is relatively short and high level in its requirements. In broad terms, the code allows driverless vehicles to be tested, provided a test driver is present and takes responsibility for the safe operation of the vehicle.

The vehicle also needs to have successfully completed testing on closed roads or test tracks, and testers should keep a complete and accurate audit trail of their findings during testing. In the event of a future collision or dispute this could be vital in showing that the testing organisation has acted reasonably. The code also applies the same traffic rules to autonomous vehicles as to conventional ones. Test drivers must hold a valid driving licence, even if the vehicle is entirely in automated mode. It is “strongly recommended” that the driver also has several years’ experience of driving the relevant category of vehicle. In addition to this, the driver must always be capable of implementing a “manual override” at any time. The question of whether this kind of manual override will be required if fully autonomous cars go on sale to the public raises a number of complex practical and liability issues which are not addressed by the testing regime.

**Developments in France and Germany**

In France, a number of partnerships have been announced and collaboration between automotive and technology providers continues to grow. For instance, Ericsson, Orange and PSA Group have announced that they will test 5G network technology for connected vehicle applications as part of the “Towards 5G” initiative. Similarly, the Renault-Nissan Alliance and Transdev are developing a driverless vehicle fleet system that will enable clients to book rides and mobility operators to monitor and operate self-driving electric car fleets.

The German federal government has approved a Bill changing the country’s Road Traffic Act to allow the use of automated vehicles on public roads. The Bill defines what constitutes a highly- or fully-automated vehicle. The system must, amongst other things, be able to comply with traffic rules, recognise situations that require human input, and allow override by the driver at any time. It does not cover ‘automated’ vehicles – referred to as level 5 vehicles – that do not need any driver or that do not have a steering wheel and pedals.

Under the new rules, drivers must only operate automated vehicle functionality within the manufacturer’s instructions on the “intended use” of such function and the vehicle must itself be able to inform the driver if they are using it outside the limits of its intended use.

It remains to be seen whether this “intended use” concept works out as it leaves it to the manufacturers to define under which circumstances the vehicle
actually may be operated in automated mode. It is a flexible and technology neutral approach which gives manufacturers freedom to design and define the level of automation considering what their car can and what it can’t handle, but some argue that it also opens the door for extensive disclaimer language in the original equipment manufacturer’s (OEM’s) system description for the purpose of limiting their liability.

The requirement under the Act that the vehicle must be designed to point at any use contrary to the system description might have a limiting effect in this context, though. At the same time this requirement might become a challenge for OEMs to develop technology that reliably foresees and detects such unintended use. Failing to do so would, strictly speaking, disqualify the vehicle from being a ‘vehicle with highly- or fully- automated driving functions’ resulting in the driver not being permitted to use the functions on the one hand, and warranty and liability implications for the OEMs or car dealers that have sold the car as a ‘highly- or fully- automated car’, on the other.

Ultimately, it seems worthwhile for industry to come up with an industry standard on “intended use”, not the least to promote safety, as it seems practically impossible even for educated drivers to reliably apply and comply within the limits of “intended use” if this term would have a different meaning depending on which car you drive. This issue could become more prevalent in a future scenario of extensive car sharing when the use of multiple shared car makes will be common place.

The new laws do not require drivers to remain focused on the road at all times, but they must be able to react “without undue delay” if the system prompts them to do so, or they themselves realise it is needed. That scenario triggers further questions such as, what activities is the driver allowed to partake in when in the vehicle? Sleeping will obviously be out of the question. And how quickly must the driver take over control i.e. what does the term ‘without undue delay’ mean in practical terms?. We may see a discussion about whether the use of tablets, smartphones and other electronic means of driver distraction in future cars will need to be connected to the car’s system so that in the event of a required handover, the vehicle can switch off all potentially driver distracting applications to ensure a driver’s full attention and allow them to assume control without undue delay.

Where the new law requires the drivers to take over when they realise, or ‘due to obvious reasons’ must realise, that the preconditions for automated driving mode is no longer fulfilled, it will be the courts that eventually define under which circumstances this is the case and how this relates to the general freedom the legislation provides to drivers to avert their attention to traffic and from controlling the vehicle. This could cause uncertainty for early adopter drivers of such cars.

Twenty nine European countries, made up of members of the EU and of the European Economic Area, agreed in March to increase cooperation on testing CAVs. Cooperation would also be welcomed on setting new legal frameworks to account for the use of automated vehicles, because without enactment of similar legislation throughout Europe, automated cars permitted in Germany might not be allowed to operate in other countries, or at least would need to have their automated systems disabled every time they cross the border.

With different jurisdictions being at varying stages of implementation and potentially adopting inconsistent testing regimes, running legally compliant tests will be a challenge for companies wishing to trial their driverless technology in a country where they are not domiciled or lack legal expertise. As a result, it will be important to have access to expert guidance on the latest codes of practice, issues that have emerged from early testing and any risks they will need to manage in order to ensure that they comply with local legislation.

The challenge for manufacturers will be to influence what future legislation might look like
The transformations emerging from CAV technologies raise questions about the readiness of current regulatory approaches to vehicle safety and cyber security, ownership and liability, and data protection.

In March 2018, an Uber vehicle operating in autonomous mode, struck and killed a pedestrian in Tempe, Arizona. At the time of writing, there are no conclusive findings on where exactly the fault for this accident lies. Further investigation will reveal whether the technology - which is meant to detect and respond to pedestrian movement, traffic and road infrastructure - had failed, whether it was a case of human error, or, perhaps a combination of the two. The resulting news coverage has reignited debates between those who argue for the necessity of limited and carefully governed trials of CAVs in public places, and those who believe that the regulatory gaps between ‘old’ and ‘new’ motor vehicles are simply too significant to accommodate CAVs on the road.

In fact, the complexities of implementing suitable safety and security frameworks for CAVs are indicative of interdependencies in most cyber-physical systems that integrate computation, communication processes and physical systems in smart environments. Managing these systems requires a holistic evaluation and governance of critical factors, which involve overlapping risks associated with data protection, security and safety, liability and corporate responsibility1. These factors fundamentally challenge existing mechanisms that have been used to govern traditionally discrete sectors. Looking at these issues through the lens of CAVs can provide insight into the governance of complex cyber-physical systems, well beyond motor vehicles. The dynamics that can emerge between the physical, the automated and the connected dimensions of CAVs create new and unique challenges for drivers, public authorities, car manufacturers, service providers and insurers. They require us to think about how risk and liability are framed in current legislation, and whether we need to consider new approaches to the governance of CAVs.

Regulatory implications of emerging cyber-physical risks in CAVs

Technological advances in connectivity are allowing transport systems to evolve rapidly. Coupled with changes in business models and travellers’ needs, we are witnessing an increasing move to Mobility as a Service (MaaS). The latter means that vehicle manufacturers are now relying on partners to provide services that are beyond their capability and mission. An example of this complexity could be a person wishing to travel from Peterborough to Birmingham in a connected and autonomous vehicle. During the journey, the vehicle will utilise a range of infrastructures owned and managed by various entities. Responsibility for the road infrastructure will vary from local councils and authorities (such as in the case of the A15), to Highways England which manages the M6. Moreover, different service contracts may govern the management of the roadside infrastructure. Different communications service providers, telecommunications or wireless local networks may come into play throughout the journey. The technology within the vehicle will interact with these systems and networks. In addition, services for, and information about the passengers are delivered by and through these systems and networks. This example has several implications for how we regulate liability, supply chain management, safety assurance processes and cyber security.

Motor vehicles are treated as a product under the EU Directive on Liability for Defective Products (85/374/EEC) and the Framework Directive for Whole Vehicle Type Approval (2007/46/EC). Taken together, these legislations locate liability for any damage caused by a defective product with “the producer” (i.e. the manufacturer) or “the importer” of the finished product. This places responsibility on vehicle manufacturers and importers to ensure product conformity to safety standards. When applied to non-connected, non-autonomous vehicles, this framework has worked well as manufacturers could reasonably be expected to ensure conformity of production and could subject vehicles to fault-testing under the full range of physical, real-world operating conditions. CAV technologies, however, complicate these established assurance mechanisms. Like other complex cyber-physical systems, CAVs comprise of both hard- and software components, which conflate conventional

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The dynamics that can emerge between the physical, the automated and the connected dimensions of CAVs create new and unique challenges.

Safety standards with a whole range of data, network and device security standards. This safety-security nexus complicates liability frameworks that currently apply to “physical” products, raising questions about the responsibility that software developers and even consumers might have at ensuring that vehicle systems are kept up-to-date.

Recognising these emerging challenges, in 2017, the European Commission (EC) engaged in a public consultation to evaluate the fitness-for-purpose of Directive 85/374/EEC. The results of the consultation indicate that, for a large number of respondents, the application of the Directive might be uncertain or problematic for “products where software and applications from different sources can be installed after purchase, products performing automated tasks based on algorithms, data analytics […] or products purchased as a bundle with related services”. In response, the EC has recently released a call for experts to establish a group on liability and new technologies, tasked to assess the future-proof applicability of the Product Liability Directive.

In addition to these legislative efforts, and as CAV technologies continue to develop rapidly, vehicle manufacturers are faced with a complex supply chain of sensor manufacturers, software developers and operating system providers. In a context where car manufacturers do not have a long tradition of cyber security expertise, writing requirements for suppliers and ensuring that they meet minimum data protection and security standards can be a challenging task. If liability for damage caused by defects in CAVs continues to rest with vehicle manufacturers, then they will be faced with the considerable burden of ensuring that data protection and cyber security best practices are met by all entities in their supply chain.

Furthermore, ensuring the integrity of the cyber-physical dimensions of CAVs throughout their lifecycle brings new challenges to current procedures for testing and monitoring roadworthiness. In a connected environment, the rate with which existing cyber security vulnerabilities are discovered, and new ones emerge, requires almost continuous software updates and patches for a considerable number of components, from single sensors to vehicle control systems. These dynamics challenge current mechanisms for monitoring vehicle safety, such as annual MOTs, that are designed around the far slower dynamics of purely physical technologies, such as worn tyres, brakes, etc. To be effective, a cyber-physical MOT would require considerable changes to current assessment procedures and to their frequency, potentially requiring almost continuous automated or virtual assessment in order to monitor the integrity of the vehicle.

These issues become even more challenging when we consider the complex environment created by vehicle-to-vehicle, vehicle-to-infrastructure or vehicle-to-grid communications. In such dynamic operating environments, it is conceivable that an accident could be caused not by a defect in the vehicle per se, but rather because vehicle-to-infrastructure communications were obstructed due to network latency or limited bandwidth arising from overcrowding. Equally, an attacker may exploit a number of minor vulnerabilities that emerge as the result of component updates by different entities, each of little significance on their own, but with damaging interactive consequences for system integrity and vehicle safety within the connected environment. In this case, performing cyber security best practices – such as vulnerability patching – could be detrimental to vehicle and road safety.

Thus, CAVs raise critical challenges for current regulatory frameworks. Several cyber-physical interactions in CAVs are beyond the ability of the manufacturer to reasonably predict and test in advance. In this context, continuing to locate liability with the vehicle manufacturer for damage caused by a defect in the product could create a significant compliance burden. The regulatory challenge that consequently emerges is to create appropriately nested layers of liability, as well as developing and implementing performance evaluation methods for automotive cyber security that are carefully integrated with established safety procedures.

Emerging governance responses
Recently, there have been notable attempts at addressing the cyber-physical risks emerging in CAVs. Whereas most of these initiatives are non-legally binding, they contribute to the overall governance of risk in CAVs by proposing standards, guidelines and codes of good practice for entities operating in the CAV ecosystem.

In 2017, the Department for Transport (DfT) in the UK, in conjunction with the Centre for the Protection of National Infrastructure (CPNI), issued guidance on key principles of vehicle cyber security for CAVs, including a risk-based identification and assessment process that is managed appropriately and proportionately at the organisational level. A similar risk-based approach is developing in the US, where the National Highway Traffic Safety Administration (NHTSA) has published detailed guidance on the assessment procedures that manufacturers can follow and report on in order to ensure that all dimensions of safety – which include data recording, privacy, cyber security, human-machine interface – are considered in the development and testing of CAVs. Equally, in the EU, the Agency for Network and Information Security (ENISA) has proposed best practices that make a first step at integrating cyber security and safety in the car development lifecycle, including responsibilities for premarket and aftermarket suppliers that are increasingly relevant in the CAV ecosystem.

We are, thus, witnessing a convergence towards a risk-based approach to managing cyber security in CAVs – based on identification, categorisation and prioritisation of risk – which borrows heavily from the performance-based regulation in safety, and adding lifecycle support requirements specific to cyber security, such as incident response. This strategy has clear benefits, ensuring that regulatory frameworks stay flexible, without prescribing techniques and processes, as long as hazard thresholds are established. However, this approach relies heavily on the seamless integration of technical specifications and standards for information and communication technologies, data management and functional safety.

There is a clear need for standards organisations which operate at domestic and international level to more closely align their standards developing activities across technical committees that have historically dealt with these issues in siloes. Early movements in this direction can be seen in the British Standards Institution (BSI), which is developing a UK standards strategy for CAVs aimed at integrating functional safety, vehicle communications, cyber resilience, data governance, vehicle security and road network management. Similarly, in the International Organization for Standardization (ISO), there have been several advancements in standardising intelligent transport systems, as well as in developing a methodology for trustworthy Internet of Things (IoT) systems and services, that encompasses security, safety, reliability, resilience and privacy standards.

Future options and approaches
The emergence of this guidance indicates the development of a risk-based approach to managing cyber-physical risks in CAVs. In these instances, data protection, cyber security and safety are integral components to system safety, and to the roadworthiness and trustworthiness of the vehicles of the future. However, developing such a complex governance framework – that relies on risk-based regulations, supplemented by standards that integrate technical specifications across safety, security, data protection, reliability and resilience – will take considerable time and effort, and requires a continuous dialogue between vehicle manufacturers, suppliers, service providers and regulators.

Liability – and how we frame and apportion it – remains a missing piece of this puzzle. Locating liability with product manufacturers and/or importers is unlikely to be a proportionate response to the business dynamics that CAVs will operate in, especially if we consider the relatively long lifecycle of automotive vehicles and the increasing number of services relied upon after purchase.

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At the moment, in almost every jurisdiction, if a vehicle is involved in an accident the liability will lie with the driver who can be shown to have fallen short of expected driving standards. Autonomous vehicles will mean that this approach is at best an incomplete solution to the potential causes of accidents. Efforts to arrive at new frameworks to govern who should be held responsible for damage caused by autonomous vehicles has been under debate for some time but remains a work in progress.

The more autonomous the car, the less scope there is for negligence liability to be placed on the driver within existing legal frameworks. If the car is truly driverless then those sitting in it are (all things being equal) likely to be much more minimally involved in decisions contributing to an accident. Factual causation is more likely to be an issue of product safety, capability and interaction such that it will, in many cases, more obviously raise questions for the manufacturer or the developer of various software, subsystems or sensors.

Presently the person injured in an accident can rely on the fact that both parties should be insured and that normally issues of liability will be determined by relatively simple evidence around lack of driving care. However, as the vehicle increasingly becomes driverless, the person in control of the vehicle is likely to be substantially or wholly reliant on the performance of the vehicle in avoiding collisions. If this were followed to its logical conclusion, an injured party would be faced with bringing complex product liability claims against the vehicle manufacturer or the producer of the control mechanisms or assembly in order to establish liability. The very complexity of vehicles raises the concern about whether injured parties would have unnecessary obstacles placed in their path to compensation.

Recent developments
In 2017, various developments in this debate took place. BMW and Allianz Worldwide Partners issued a joint statement under which they advocated that even with autonomous vehicles, in the first instance, the owner of the vehicle should continue to be strictly liable for any damage caused, whilst the ultimate settlement of damages would then be resolved between the relevant insurer and the manufacturer.

As mentioned earlier, the German federal legislator has approved a Bill changing the country’s Road Traffic Act to allow the use of automated vehicles on public roads. The Bill defines what constitutes a highly- or fully-automated vehicle.

Under the new rules, drivers must only operate automated vehicle functionality within the manufacturer’s instructions on the “intended use” of such function and the vehicle must itself be able to inform the driver if they are using it outside the limits of its “intended use”. It remains to be seen whether this “intended use” concept works out as it leaves it to the manufacturers to define under which circumstances the vehicle actually may be operated in automated mode. It is a flexible and technology neutral approach which gives manufacturers freedom to design and define the level of automation considering what their car can and what it can’t handle, but some argue that it also opens the door for extensive disclaimer language in the original equipment manufacturer’s (OEM’s) system description for the purpose of limiting their liability.

Over in the UK a bright start was made in 2017 as the UK government was keen to ensure a country wide framework in order to embrace the coming driverless car revolution. It proposed a limited set of adjustments to the existing insurance regime through the Vehicle Technology and Aviation Bill which was introduced in the first part of the year.

The Bill provided for the Government to maintain a list of vehicles which are capable of driving themselves in at least some circumstances without being monitored. Where such a vehicle caused injury or damage to any person whilst driving itself the proposal was that the insurer of the vehicle would be liable for the loss. Damage to the vehicle itself, and property being carried by, or in the custody of, the insured or the person in charge of the vehicle were not required to be covered.

Exceptions also existed for modifications to the vehicle’s operating system which might be made by the insured in contravention of the insurance policy. Likewise, if updates to the system were not installed by the insured contrary to the policy damage to the insured which was the direct result of such action or...
failure could be excluded by the policy and the insurer could also recover from the insured money paid to third parties.

Beyond this, the insurer was to be able to reclaim some or all of the losses it was responsible for from other parties responsible in whole or part for the accident. This was to include others involved in the accident, manufacturers or software houses in the normal way and based on existing approaches in legislation (e.g. the Consumer Protection Act, contributory negligence etc), contract and wider common law.

Unfortunately, the Vehicle Technology and Aviation Bill was lost due to the 2017 UK general election. However very similar provisions were reintroduced in the form of a bill titled the Autonomous and Electric Vehicle Bill. This has achieved a third reading in the House of Commons and at the time of writing (April 2018) is currently awaiting the committee stage in the House of Lords.

The legislation is designed to enable the testing of driverless vehicles on UK roads by 2019.

Meanwhile the UK government announced in March 2018 a Law Commission review to examine how the current driving laws might be amended to address the challenges of the coming generation of vehicles. In particular issues such as:

- who should be treated as the driver or responsible person;
- allocating criminal responsibility where there is a sharing of human / machine control;
- the role of automated vehicles for on demand transport / car sharing and mobility as a service; and
- any need for new offences to deal with novel areas of conduct.

Also, in January 2018 the European Parliament exercised powers under Article 225 of The Lisbon Treaty to invite the European Commission to consider making proposals for European regulations revising the EU framework for liability and insurance for CAVs.

The European Commission does not have to respond with legislation, but if it chooses not to it must provide detailed reasons. The European Parliament considered that revisions to the rules would ensure legal coherence and better safeguarding of consumers rights across the European Union and would aid the adoption of the technology and so be likely to generate economic added value. It put the added value at €148 billion as a result of an acceleration by five years of the adoption of driverless/ autonomous vehicles and the removal of costs and uncertainties related to differing local legal approaches.

The European Parliament identified what it regarded as the main gaps under the current Product Liability Directive. It suggested that in its view the existing regime would tend to shift liability from manufacturers to consumers as autonomous vehicles come to be adopted.

Its argument rested on the suggestion that software failures, network failures, risks relating to hacking and cyber crime and risks/factors relating to programming choices were not sufficiently catered for under the Product Liability Directive and the Motor Insurance Directive. It felt that in the absence of new legislation it was likely that the cost of scientifically unknown risks particularly would, to an increased degree, be shifted to the consumer. This would happen by reason of the ability of manufacturers to rely on requirements that:

- the product must be shown by the consumer to have been defective from the moment that it left the factory; and
- scientifically unknown risks within the compliance risk and development risk defences can prevent consumers being compensated.

The European Parliament felt that with increasingly complex vehicles the opportunity to seek defence from these sources was much increased. There was also concern that the European Court of Justice would find the technological complexity of automated vehicles difficult to adjudicate within the existing Directive.

The European Parliament also favoured the adoption of a no-fault insurance regime to compensate injured consumers.

**Material risks for manufacturers**

The spate of incidents with autonomous cars under test and in use recently has clearly shown how important the reputational risk to manufacturers associated with road accidents, injuries or fatalities is. The knee jerk reactions to the Uber and Tesla incidents underline the danger posed to the developing industry that can be raised by perceptions, right or wrong, of a flawed technology. The potential for a consumer or regulatory backlash is obvious.
Motor manufacturers already under scrutiny from the diesel emissions scandal need to be very cautious about accepting risks to safety in the course of pushing new vehicles to market despite the competitive pressure.

The accessibility of data in partially or wholly autonomous vehicles will make it much easier to establish the cause of accidents. If safety corners have been cut it will be easier to identify the fault and for the authorities to seek to delve deep into organisations to establish whether risks were appreciated but accepted. Such calculating behaviour is likely to be severely punished.

This kind of behaviour can carry serious criminal sanctions such as corporate manslaughter or homicide offences in some jurisdictions.

Under the new traffic laws in Germany, automated vehicle manufacturers will be required to install a ‘black box’ that can identify whether the human driver had control of the car at the time of any accident, to identify liability. There are a number of issues to be discussed further, such as the question which third parties will actually be entitled to request access to the data in order to ‘assert, satisfy or defend’ legal claims, as well as questions around data protection, data ownership and access to the data generated in automated vehicles in general.

The Act was heavily criticised for not providing for a new liability regime for automated vehicles that included direct liability of manufacturers. Instead, lawmakers kept up the principle that the driver and registered owner of the vehicle are primarily and directly liable instead of providing for a new direct route through to the manufacturer when incidents have occurred during automated mode.

Under this framework, drivers in Germany will not be automatically exempt from liability if the vehicle is in automated driving mode but will be able to take recourse if their use of that mode is lawful. Liability of the driver or registered owner of the vehicle is now limited to an amount of up to €10 million for death or injury stemming from accidents caused by automated vehicles, which is an increase by 100% compared to prior legislation. The maximum aggregate amount of liability for damage to property has been set at €2m. The liability caps are to be understood as a limit for the aggregate liability resulting from a specific incident, which means that where claims raised by a number of claimants affected exceed the aggregate amount of the cap, the individual claimant will only be able to claim a respectively reduced amount.

Key to the control of liability exposure for manufacturers will be absolute clarity about maintenance and servicing and software updating requirements. The increasing level of connectedness makes delivery of warnings and even disablement of vehicles not complying with warnings viable modes of incentivising appropriate safety conscious behaviour as well as liability control.

Adequate explanatory guidance is a requirement to render products safe under existing laws in some jurisdictions (including the European Union). Again, the level of digital embedding in new vehicles may enable training to be delivered to each new user via video “walk throughs” and even driver comprehension testing.

Civil liability - risks and opportunities
Even where liability is initially accepted by or placed upon insurers, the inevitable pass down of responsibility where the vehicle is at fault has the potential to raise complex issues of showing causation between the manufacturer and its various sensor/ hardware and software suppliers. Achieving a viable sharing of liability in a way that avoids a legal jamboree is a challenge worth addressing. A combined insurance scheme would be potentially superior to the present lottery which often depends on market power and contractual cleverness.

While product liability rules will almost certainly continue to provide nearly strict liability compensation to consumers, the opportunity for manufacturers lies with the opportunity to use big data harvested from the field preventatively to promptly identify and resolve issues as they emerge from field use.

This offers both the chance to drive repair and spares sales while driving down risk. If manufacturers avoid the temptation to run the ‘Facebook risk’ of being too ambitious about the data taken many owners would contentedly opt in to schemes which enable their vehicle to be managed for safety and faults by collation of non-personal data.

Liability and driving rules still in flux
It is clear from the spate of legal initiatives and discussion programmes that much remains to be settled. The speed with which manufacturers are promising to introduce autonomous and semi-autonomous vehicles raises the question of whether the regulatory frameworks will keep pace.

Certainly, there appears to be a political will and a perception of economic benefit, however progress to date has been limited and there must be concerns that the vehicles will be delivered before the regulation.

The current flux does allow manufacturers a significant opportunity to be closely involved with the moulding of new regulations so that as far as possible solutions meet new regulations from an early point.
Connected vehicles and, especially fully autonomous vehicles, are going to profoundly change the nature of car insurance. Given that more than 90% of car accidents result from human error, the optimistic scenario is that the number of accidents will decrease dramatically reducing risk all round.

At the moment the personal traits and behaviours of customers are critical factors when companies set premiums. They use a wide range of data, such as the customer’s age, where they live and their history of accidents. Increasingly, insurers are also able to use information about individual usage gained through telematics or “black box” technology. This provides insurers with a more accurate assessment of the risk although it requires that they have systems and processes in place that are able to analyse and manage high volumes of data as well as ensuring compliance with the GDPR which will be enforced from 25 May 2018. As a result of this, insurers have to develop their understanding of the legal implications around data ownership and data privacy in relation to the information they gain from telematics systems.

New ways of assessing risk are needed

It is expected that the use of autonomous vehicles on public roads will force insurers to change the way they assess risk and how they set premiums. If we move to fully autonomous vehicles the fundamental question is likely to become whether a driver who has no control over the vehicle will need insurance at all. It will be possible to argue that all the liability will transfer to the manufacturer if an accident is caused by, for example, failures in the design of the vehicle.

However, whilst some manufacturers are now saying they will take full liability for any accidents caused by their autonomous vehicles, at this stage, the emphasis in pending legislation is that the compensation route for injury/damage caused by an automated vehicle will fall within the motor insurance settlement framework.

The shift in liability for damages being directly recoverable from manufacturers is more likely to take place once technology advances to the stage of fully automated vehicles. If the risk of accidents is significantly lower for autonomous vehicles, and some calculations suggest it could be 50 times lower than for conventional cars, manufacturers would only have to make a very modest increase in the purchase price to cover the cost of the risk they are taking on.

The German insurance model already includes protection for the traffic accident victim if damage is caused by partly- and fully-automated vehicles. In Germany, the position is that the car owner is liable towards the party that incurred damage regardless of whether the accident happened because of a driver error or because of a vehicle fault (strict liability). The driver is liable unless he can prove that he did not cause the resulting damage (presumed fault).

In July 2017, Germany amended its Road Traffic Act permitting the use of automated vehicles on public roads. The Bill defined what constitutes a highly or fully automated vehicle. The system must, amongst other things, be able to comply with traffic rules, recognise situations that require human input, and allow override by the driver at any time. It does not cover automated vehicles that do not need any driver or that do not have a steering wheel and pedals. Drivers must only operate automated vehicles within manufacturers’ instructions on the “intended use” if such function and the vehicle itself must be able to inform the driver if they are using it outside the limits of its intended use.

The new laws do not require drivers to remain focused on the road at all times, but they must be able to react “without undue delay” if the system prompts them to do so, or they themselves realise it is needed.

Under the new laws, automated vehicle manufacturers will be required to install a ‘black box’ that can identify liability.

The amendment to the Road Traffic Act was heavily criticised for not providing for a new liability regime for automated vehicles that included direct liability of manufacturers. Instead, lawmakers kept up the principle that the driver and registered owner of the vehicle are primarily and directly liable instead of providing for a new direct route through to the manufacturer when incidents have occurred during automated mode.

The compensation route for injury/damage caused by an automated vehicle will fall within the motor insurance settlement framework.

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Horizon Scanning

The new Automated and Electric Vehicles Bill (the "Bill") is now at an advanced stage through Parliament with the Committee stage due to be scheduled imminently. The Bill gives a good indication of how the law is likely to address insurers’ liability for accidents caused by automated vehicles. As drafted, the Bill prescribes compulsory insurance for automated vehicles via a single insurer model. Following an accident, insurers of an automated vehicle will be liable for damage caused to the insured/any other person when the vehicle was driving itself. Where the vehicle was driving itself and is not insured, the owner will be liable for the damage caused by the accident. The insurer or owner of the automated vehicle will not be liable to the person in charge of that vehicle where the accident caused was wholly due to the person’s negligence in allowing the vehicle to drive itself when it was not appropriate to do so.

An insurer may exclude/limit its liability for damage suffered by an insured where the accident occurs directly as a result of software alterations that are prohibited under the policy or a failure to install software updates which are known/ought to be known are ‘safety-critical’.

Where the manufacturer of the vehicle/other third party is responsible for the damage or injury, the insurer/vehicle owner will still have a liability to the injured party, but it will be entitled to recover against that manufacturer under relevant existing laws (e.g. product liability laws).

The government considered making changes to product liability law, but concluded that this was not a proportionate response at this stage as there would only be a small number of automated vehicles in the near future on the roads. This may of course change in future when automated vehicles become a common feature on public roads.

In March of this year, the government announced that the Law Commission of England and Wales and the Scottish Law Commission will together “examine any legal obstacles to the widespread introduction of self-driving vehicles and highlight the need for regulatory reforms” during their three-year project. The Roads Minister in England, Jesse Norman, said: “With driving technology advancing at an unprecedented rate, it is important that our laws and regulations keep pace so that the UK can remain one of the world leaders in this field.”

This of course supplements the existing compulsory insurance regime that covers motor claims and the Association of British Insurers (ABI) is feeding in on all developments which may be relevant to the insurance of CAVs. It appears likely that we will see changes to this too as the government grapples with how best to integrate new technology with the needs of road users. It will therefore be important for insurers to keep a watching brief over the evolution of the Bill to understand what their exposures are likely to be.
Traditionally most vehicle manufacturers have had very limited information about their customers and managing customer data has not been a key priority. This is all changing with the development of connected vehicles, which depend on the collection and use of a wide range of data. This brings significant new challenges and obligations relating to the collection, use and protection of such data.

Legislation is developing that stands to have a major bearing on the way car manufacturers develop connected cars. The General Data Protection Regulation (GDPR) and the European Commission’s planned new Privacy and Electronic Communications (e-Privacy) Regulation is one area of reform that businesses involved in developing connected cars (and applications for it) should track closely.

In 99 Articles and 173 Recitals, the GDPR imposes detailed obligations on those that are processing personal data. Therefore, e-Privacy proposals, together with reforms delivered under the GDPR, require vehicle manufacturers to make the management of customer data a more central part of their business.

Developing connected cars with rules on third party data sharing in mind

The e-Privacy reforms, as drafted, could affect the way connected cars are built and sold, and restrict manufacturers’ scope for sharing data from those vehicles with third parties.

Under the proposed e-Privacy Regulation, which would be directly applicable in each European Union member state, manufacturers and retail distributors of vehicles would have to ensure that the systems in vehicles being “placed on the market” are configured in a way that prevents third parties from processing data generated by those vehicles, unless they have the user’s consent to enable third party access to that data.

This requirement can be read as building upon the privacy-by-design and privacy-by-default requirements of the GDPR. The e-Privacy provisions could effectively prohibit the sale of connected cars in the EU which do not meet this requirement. Car manufacturers could look to raise awareness of the benefits of data sharing to customers and obtain consent from connected car buyers to third party data sharing through sales contracts or associated documentation to meet the obligations.

Like with breaches under the GDPR, sanctions for non-compliance could be severe. Fines of up to €10 million, or 2% of a car manufacturers’ total worldwide annual turnover, whichever is higher, are envisaged for a breach of the provisions on default third party data sharing settings under the proposed e-Privacy Regulation.

After MEPs having submitted their proposal it is now for law makers at the EU’s Council of Ministers to review and amend the e-Privacy proposals, so car manufacturers should monitor developments in the legislation.

New obligations on confidentiality

The European Commission also intends for the e-Privacy Regulation to apply to machine-to-machine communications, such as the communications that are envisaged between connected cars and other vehicles or road infrastructure.

This means that, for the first time, connected car manufacturers could find themselves subject to rules designed to ensure the confidentiality of communications and the data flowing over communication networks. It would mean they would be responsible for ensuring that there is no interference with electronic communications data through listening, tapping, storing, monitoring, scanning or other kinds of interception, surveillance or processing of such data. This would negatively affect all the data flowing between ‘Internet-of-Things’ devices, but the proposal makes no distinction between machine-to-machine transmissions that contain human communications, and those that do not, like connectivity between sensors of automated vehicles. For example, the e-privacy Regulation proposal would require drivers using live traffic information services to consent to data processing each time their car enters the range of a new sensor network and tries to exchange data with road sensors – this is not practical.
Even the Article 29 Working Party recognises that "still, there is an interest in processing this data allowing objects such as self-driving cars and devices to warn each other about their vicinity or other risks. The question then is what exception would apply in this case. Consent from end-users is not a feasible exception because it may become necessary to always be able to process this data. Providers should therefore be able to rely on a specific exception, allowing objects such as self-driving cars and devices to warn each other about their vicinity or other risks." It is now for the Council of Ministers to firm up their position on this.

Some European Union countries have already taken steps to bolster the powers that law enforcement agencies and intelligence and security services have to access data for the purpose of preventing, detecting and investigating acts of terrorism or serious crime.

The connectivity of the car, therefore, could see car manufacturers drawn into a scenario where law enforcement agencies could demand access to a vehicle's data to help them track a terrorist's location. Connected cars mean everyone's location and journey history is potentially available to a third party. This places the vehicle manufacturer at the centre of far reaching questions about civil liberties and the role of the state.

**Data protection**

In most jurisdictions, data protection regulations have not been developed to deal with the specific implications of connected and autonomous cars.

CNIL, the French data protection authority, has taken particular interest in privacy issues concerning the connected car. In March 2016, the watchdog launched a connected car compliance package in consultation with the automotive industry, some innovative companies in the insurance and telecoms sector and public authorities. The final package was published in October 2017 and proposes a sectorial reference framework, a toolbox for the responsible use of personal data under GDPR in the connected car context.

CNIL uses compliance packages to promote good practices among actors in a particular sector, as well as to introduce legal obligations in an operational manner and simplify administrative formalities. The connected car compliance package provides guidelines in order to ensure the most responsible use of data in the next generations of cars and is likely to look to boost transparency and give people more control over how their data is collected and processed. It further promotes the protection of personal data throughout the product life-cycle, starting from the conception of the products, in line with the principle of ‘privacy by design’.

The current divergent approach to data protection taken by countries inside and outside of the European Union raises the question of what happens when the vehicle crosses a border. Can collected data be sent across borders e.g. in order to establish a centralised connected car data centre, and if so, under what restrictions?

The GDPR will provide some comfort by providing a common set of laws for all the European Union member states. However, challenges remain with regard to data transfers to recipients outside the European Union. Non-European car manufacturers or service providers will be subject to the GDPR as it applies to the processing of personal data of data subjects who are in the European Union by a controller or processor not established in the European Union in many cases. This will, however, be difficult to enforce.

Apart from mandatory data protection impact assessments, the use of privacy by design and privacy by default, and the question around data portability, a further significant change coming with the GDPR, will be the threat of fines for non-compliance of up to 4% of the total worldwide annual turnover.

**Data ownership**

In the context of the connected car, a whole range of data could be gathered, ranging from infotainment systems, event data recorders and diagnostic systems, the cameras and the safety sensors on the car and embedded SIM cards. Increasing connectivity and power of data analytics means that the data generated by connected cars is likely to qualify as ‘personal data’, and therefore fall subject to the GDPR and e-Privacy Regulation.

Indeed, a data protection declaration issued in 2014 by global data privacy watchdogs on the subject of data generated by devices, or ‘internet of things’ (IoT) sensor data, said businesses should treat that sensor data as personal data.

The European Commission confirmed that the approach applies to connected cars in a new connected cars strategy published in November 2016. It said that all data broadcast by connected cars "will, in principle, qualify as personal data”, and that the processing of that data would need to adhere to the GDPR when becoming effective.

However, it is less clear who owns data generated by connected cars. Germany’s civil law code, for example, does not recognise ownership of personal data, only the ownership of data carriers. The concept of ownership of personal data is not clearly recognised under English law either.
If manufacturers are not able to achieve the contractual ownership of certain data carriers, the rightful ownership of the vehicle as a data carrier would entitle the owner to prevent third party access to vehicle data and to demand access to technically locked data memories in the vehicle. Because of this, external access is usually subject to a contract or declaration of consent.

Clarity is required around the data that may be generated, stored, and used and where required consents are secured from owners, drivers and even passengers. This is even more complicated where the vehicle is shared amongst various users or when it is sold. Users of connected data may need to set up procedures to establish contact and obtain consent to the use of the new owner/users’ data.

Manufacturers and service providers must manage risks posed by any third-party IT suppliers who process data on their behalf. If they collaborate with a technology company to provide connected services and that partner breaches data protection rules, then manufacturers and service providers themselves may also be liable. Due diligence and contractual assurances will be ever more important.

Questions of ownership may be addressed in future regulations. In January 2017, the European Commission set out its plans to build the European Union’s ‘data economy’. Its paper set out a wide range of options that it could pursue to liberate data held in “silos” and help businesses put it to use to boost economic growth.

One of the options under consideration is the creation of a new licensing regime for anonymised ‘machine-generated data’. The European Commission said such a framework could require manufacturers – such as connected car manufacturers – to provide access to the data they hold on fair, reasonable and non-discriminatory (FRAND) terms. A new “data producer’s right” could also be introduced, it said, giving the owner or long-term user of a device a right to use and authorise the use of non-personal data. For the moment, however, one of the most important tasks is the issue of precisely determining access to data generated by moving vehicles and access to ‘third-party’ data. This is precisely what OEMs and suppliers are battling over after the TRL had issued its “Access to In-Vehicle Data and Resources” noting that the OEM solution of an OEM controlled “Extended Vehicle” Server for data sharing raises concerns with regard to non-discrimination requirements.

In February 2018, MEPs in the European Parliament’s Transport Committee voted overwhelmingly in favour of the European Commission developing binding legislation on connected car data. The recommendation of the Committee specifically calls on the Commission to come forward with a regulatory proposal on access to car data by no later than the end of 2018.

**Cybersecurity will be critical**

The most recent industry initiative related to ownership of connected car data is MOBI — the Mobility Open Blockchain Initiative — launched with over 30 founding members that also include BMW, Renault, GM, Bosch, Blockchain at Berkeley, Hyperledger, Fetch.ai, IBM and IOTA. The group has a fairly broad goal of using blockchain technology for a more open platform where users, owners, mobility service companies, and infrastructure providers can better control and monetize their assets, including their data but also making transportation safer, more affordable, and more widely accessible. The distributed ledger component and smart contracts, in particular, could reshape the way organizations and products use and consume data. Along those lines, MOBI said its scope of focus varies from payments, data tracking, and supply management, to consumer finance and pricing, and more futuristic areas like autonomous vehicles and ride-sharing systems. Whilst it will need to be reviewed further which legal implications may arise from this, one of the main issues from a privacy point of view may be the fact that personal data (e.g. vehicle identity and usage information) stored on the blockchain cannot be removed and is widely accessible which arguably could be contrary to core principles of GDPR.

Data security, including cybersecurity, is a critical issue. Whether the data is stored in the car or in a cloud database, effective security measures will need to be in place to protect the data.

Manufacturers of connected cars will also have to plan for data loss incidents, including implementing appropriate crisis management procedures to ensure the cause of the data loss can be analysed without undue delay, to minimise the impact of a data breach and to comply with reporting obligations to the authorities and affected individuals.
The GDPR provides for the possibility for stiff financial penalties to be imposed where businesses fail in their duties to implement reasonable measures to protect personal data. The proposed e-Privacy Regulation could also put the onus on connected car manufacturers to share knowledge of security risks directly with customers.

Regulatory authorities are expected to pay particular attention to vehicle IT, and the role of encryption, program code signatures, hacking tests as well as the practical implementation of principles of data protection law, including data economy, privacy by design and privacy by default.

It seems vital that existing European regulations are extended to cover the field of automation. The European Commission has recently submitted a proposal on cyber-security which includes the task of creating a new European certification system to ensure that digital products and services can be used safely.

Managing data effectively is a critical business issue. Significant potential revenue streams and manufacturer and customer benefits risk being lost if the data from connected cars cannot be widely used. More information about the use and operation of vehicles can improve customer satisfaction, allow for predictive maintenance, enable more personalised insurance products, make more effective use of road space and improve safety.

The use of data is going to be a complex issue for the developers of CAVs. It will require careful management and a detailed understanding of the different approaches in different countries and their changing requirements. Manufacturers need to consider the concept of ‘privacy by design’ from the very beginning. If data regulation is not considered from the start of the design phase for a new vehicle, car makers may not be able to use the vehicles in particular countries without unplanned adjustments which are costly and have a potential to disturb any uniform sales as well as maintenance processes.

Wherever the applicable regulation is unclear, manufacturers would be well advised to consider the potential for deactivation of certain features in order to avoid, in a worst case, product recalls if the car does not comply with privacy laws in a particular jurisdiction.

On the other hand, where any car data qualifies as personal data and if, in many cases, the users have a right to opt out of sharing location data, for example, this will undermine connected and autonomous car safety features.

Careful assessment will therefore be needed to determine in which instances a public good, like avoiding collisions, can override privacy concerns. For example, should a driver be able to opt-out of the use of personal data for a feature that warns drivers of slippery roads or obstacles lying ahead? At the moment, there is no obligation that drivers keep their radios on to listen for traffic and road hazard warnings, so it would represent a change of approach to use more advanced technology to favour health and safety potentially at the cost of privacy.

In this context, some argue that European privacy concerns could potentially stand in the path of connected and autonomous car collision avoidance strategies, making it clear that these complex and profound issues will need to be addressed by policy makers.
Increasingly, the deliberations of urban planning and city authorities are going far beyond ‘how can we best get from A to B?’ and is evolving to encompass a more sophisticated understanding of what it means to operate transport services in a city. This question may now be better characterised as trying to determine how the requirement to get from A to B (if necessary) can be achieved most effectively for society, considering the needs of the widest spectrum of the population and given overarching imperatives that include climate change, quality of life, ethical concerns, social equity and aesthetic value.

In this context, the use of vehicles is being re-evaluated. There can be no doubt that personal motor vehicles have brought independence and prosperity to people, businesses and nations around the world. However, in becoming established as the pre-eminent transportation mode in developed countries over more than a century, it can be easy to overlook that these benefits are also associated with a range of different inter-related adaptations to infrastructure, livelihoods and business models.

In terms of infrastructure, online map services with satellite imagery make it very easy to see the impact that motor transport has had on urban environments, with roads providing their connective tissue. In some cities, this is relatively convoluted and organic (e.g. London, Rome, Amsterdam). Although primary routes in such cities often pre-date the existence of motor vehicles, it is still apparent that roads and parking infrastructure are hugely significant to the fabric of the city. In other cities, typically those that underwent significant growth in the 20th century, roads are arranged in grid-like patterns (e.g. Chicago, Toronto, Barcelona), with the symmetry of city ‘blocks’ only challenged by geographical features such as rivers and coastlines. For such cities, it is even more apparent how consideration for motor vehicles has shaped thinking about urban design.

Easy access to motor transport has had a revolutionary impact on livelihoods. Children from faraway villages could access education services; traders could access new and larger markets with their goods; workers could access a wider range of employment opportunities; and families could more easily maintain social contact and access healthcare despite being distributed over a wider area. To maximise these benefits, road systems and infrastructure were adapted to support more and better mobility by motor vehicles. This includes the development of long distance highway networks but also roundabouts (to improve traffic flow at complex intersections) and signalised junctions (to improve traffic management and to help pedestrians cross busy streets).

The growth of motor vehicle use has also seen the emergence of directly and indirectly associated business models. Marketing of cars has evolved to pitch the vehicle as an extension of self; a reflection of position and status in the world, a statement of self-expression. Parking (e.g. airport car parks) and access (e.g. Dartford crossing, London congestion charge zone) become opportunities to generate revenue and manage road use. In addition to new car sales, the wider motor trade encompasses significant sales through the second-hand car market and all of the associated sectors including driver training, vehicle maintenance, insurance, and aftermarket accessories.

However, many challenging aspects of motor vehicle use are tolerated in exchange for all the perceived benefits that motor vehicles provide; perhaps none more so than road collisions. Whilst huge improvements in safety have been achieved by enhancing vehicles, infrastructure, driver training, enforcement and emergency responses, crashes remain a tragic concern associated with vehicle use. Fatalities and life-changing injuries resulting from road collisions, whilst recognised as unacceptable, are seen as an unfortunate but unavoidable consequence of road transport.

Automated vehicles: going beyond A to B

Professor Nick Reed, Bosch

The growth of motor vehicle use has also seen the emergence of directly and indirectly associated business models
Congestion results when demand to use a road exceeds its capacity to meet that demand. The resultant delay can be seen as a self-limiting factor on road use: as congestion increases, the acceptability of the delay may cause road users to reconsider their journey route and transport mode. Meanwhile, roads authorities try to find ways to meet the demand using a range of different mitigations. One option is to build new roads. However, relatively lower cost measures such as implementing smart motorway technology, enabling in-vehicle connectivity and improving safety can also help to reduce congestion.

A further consequence of embracing motor vehicles is that when they are not being used, they must be stored somewhere. Despite being a relatively expensive asset, vehicles tend to be used for only a small fraction of their lifespan, spending the remainder parked. Whether on street or off-street, the infrastructure needed for vehicle storage represents a significant adaptation of our society to accommodate the benefits that the vehicles bring.

The automotive sector has continually adapted and embraced technology. Vehicles today are safer, cleaner, more efficient and more comfortable than they have ever been. However, the anticipated revolution in mobility foreseen in a world of connected and automated vehicles represents a potential step change in the way we use motor vehicles that some imagine to be as dramatic as the shift from horses to cars. Furthermore, ever tighter emissions regulations and a shift to zero tailpipe emission powertrains also herald dramatic changes in the way mobility is to be delivered.

It is possible that all of the factors associated with motor vehicle use can be enhanced to some extent by the use of connected and automated vehicles. Safer vehicles that do not get distracted or fatigued; vehicles that avoid congestion (or at least allow us to reclaim the time spent in traffic jams for productive use); vehicles that achieve much higher levels of utilisation by being shared and as a result spend less of their time being parked. However, this discontinuity in the steady evolution of motor vehicles provides an opportunity to reimagine more expansively how mobility can be achieved. Technology provides us with a wider variety of options from which we can choose how we wish to live our lives. This might mean a transportation system that places a greater emphasis on societal wellbeing, safety and efficiency. This could include encouraging walking and cycling as part of the journey to support wider health objectives, providing a more inclusive transport system that better caters to the needs of rural communities, the elderly and disabled travellers and supporting efficient transport by encouraging shared mobility wherever possible.

Ultimately, the development of automated vehicle technologies, the new business models that they enable and our understanding of mobility needs is associated with a massive growth in our ability to collect and use objective data about our environment in intelligent ways. This includes data collected from smartphones, cameras, sensor systems and vehicles. Analysis of the data these systems collect is providing fascinating insights into how and why A to B journeys are being undertaken and how these journeys can be completed in ways that are safe, efficient and equitable. Ensuring that this data is collected and used in ways that are ethical, secure and transparent is vital. The laws and regulations that surround this topic must enable organisations to innovate safety but also provide the public and businesses with real confidence that their interests are being protected.
Patent strategy needed for developing connected and autonomous cars

Businesses looking to develop connected and autonomous cars must consider how they will access patented technology central to the way those vehicles will operate.

The importance of having a robust patent strategy stems from the fact that innovative products in the CAVs market will be unable to operate effectively unless they are developed using standardised technology.

Wireless communication technologies allow these vehicles to link to their surroundings and, for example, identify potential risks in real time. These technologies are, on the whole, standardised. Standardisation ensures that the vast number of devices and systems supporting the operation of CAVs produced by a range of entities are interoperable. Without interoperability, the cars of the future will not be able to interact properly with their surrounding environment, from underlying road and traffic infrastructure to other vehicles.

There are opportunities for businesses in the automotive sector to secure a strong position in this emerging market by adopting an appropriate patent strategy.

CAVs technologies

A connected car is a car equipped with internet access, and usually a connection to a wireless local area network. Connected cars are therefore able to communicate both with the car’s external environment and with the passengers’ handheld devices inside the car. This technological shift provides tremendous opportunities for automotive companies that embrace this step change.

The cars of the future promise to operate much in the same way as a smartphone does today – they will themselves be devices capable of transmitting and receiving data.

Communications technologies are at the heart of this information exchange and will operate in conjunction with the vehicle’s hardware, cloud-based software solutions, sensors and other ‘internet of things’ (IoT) technologies.

New technologies and use cases will develop over time. However, existing technical standards used in mobile communications are relevant and indeed critical to the smooth operation of today’s CAVs. This includes, for example, technical standards providing for ‘handover’ between ‘cells’ – a core principle in ensuring that connections are not dropped as a mobile handset user moves between different areas.

The role of standard-essential patents

Standards are typically developed by standardisation organisations (SOs), whose members consist of market participants in the respective industry sector. During the course of developing a particular technical standard, SO members put forward proposals for specific functionalities that the standard should have, typically based on their research and development which they have patented or seeking to patent. If a patented technology becomes part of a standard and it is mandatory to implement the particular feature as part of the requisite standard, such patents are designated as standard-essential patents (SEPs).

However, just because technology is standardised doesn’t mean it is free. The SEP holder can ask implementers to pay a royalty for using that technology. However, the technology included in the standard should be available to any potential implementer of the standard and the holder of an SEP must license on fair, reasonable and non-discriminatory (FRAND) terms.

Where the implementer of a standard-compliant product does not have a license to the SEP, or is unwilling to license, then the patent holder may raise claims against them for infringement based on ‘essentiality’ to the technical standard.

Demands from a SEP holder must be managed carefully in order to balance concerns related to competition law and businesses accessing existing standardised technologies must also be mindful of the interface of the FRAND licensing rules for SEPs with competition law.

Any connected device, including CAVs, will involve a multitude of SEPs declared to various technical specifications. The sheer number of patents that may need to be licensed to use some technologies means that it is no longer possible to rely on individually assessing patents in freedom to operate exercises.

Patent strategy options

Despite their expertise in designing and manufacturing cars, automotive businesses will be unable to deliver CAVs without accessing standardised technology predominantly in the wireless space. Conversely, technology companies sitting on patent portfolios and eager to exploit the opportunities presented by CAVs, lack many of the skills, networks and infrastructure to manufacture the vehicles themselves.
This is why many businesses across the automotive and technology sectors in recent times have moved to collaborate. We have seen automotive businesses acquire technology companies, enter into joint venture arrangements and otherwise engage in new models of contracting to underpin bilateral or multilateral partnerships.

Outside of collaboration arrangements, it is also open to businesses to acquire existing portfolios of SEPs or agree licenses with patent rights holders for their use. Even established businesses in the automotive market may find it useful to develop their own patent portfolio for leverage in negotiations over cross-licensing.

There are also opportunities for businesses in the automotive sector, not previously involved in standard setting, to innovate and look to get the solutions they come up with adopted as part of new technical standards from which they can derive future benefits.

A cultural challenge for the automotive sector will be considering these patents more as an income generator rather than as a cost centre. SEPs require an initial investment in terms of R&D, and then getting the technology covered by the SEP adopted into the standard takes time and energy. The potential advantage of this investment, however, is huge as that SEP becomes a potential revenue stream of its own.
Risk of litigation
The adoption of new and existing wireless technologies in cars, together with new players entering the market, is likely to contribute to a more litigious climate in the future. There are a number of reasons for this. Competitors may look to patent litigation to preserve or even increase their market share. There is another risk, however, not previously known to the automotive sector.

A number of non-practicing entities (NPEs) have already acquired patents that may be relevant to CAVs. The diverse technologies that make up the IoT provide NPEs with many points of attack, and given that established companies in the automotive and technology sectors have been investing significantly in developing new IoT technologies tensions over patent rights are likely to develop. The story so far with NPEs in the mobile phone world has been to target well-funded new entrants to the market and, preferably, the seller of the end product, as opposed to component suppliers.

We have also seen well-known patent licensing companies express an interest in acquiring patents for technology relevant to electric and autonomous vehicles. However, NPEs will already have patents in their portfolios that cover technologies implemented by CAVs. Currently, it is communications technologies that are the main patent risks for businesses in the automotive sector. There are vast numbers of patents applicable to the Wi-Fi, 2G, 3G, and 4G (LTE) standards. Cars developed with ‘wireless’ connectivity capabilities and sold as “standards-compliant” will be susceptible to these patents.

With many of these existing communications technologies relevant to CAVs, a new front is opening in the smartphone patent wars as we see more litigation in the CAVs market.
CAVs of the future will rely on strong and stable telecoms networks to allow data to flow between in-car systems and other networks and devices, such as smartphones.

In building those vehicles, manufacturers therefore must understand how telecoms regulations might apply to them and manage relationships with telecoms providers. The past year has seen some significant developments in the industry in this respect.

Collaboration and partnerships
Both manufacturers and telecoms service providers are busy developing a wide range of products, from entertainment to navigation systems, many of which are already available, and which present significant opportunities to develop new revenue streams. The efforts reflect the fact that a wide range of new technology is needed to enable new services for the connected car.

While manufacturers are conducting their own research and development programmes, there is an acknowledgement that, to access the technology they need, they also need to work with many new suppliers from sectors they have not traditionally worked with before. The most significant of the new relationships car manufacturers are likely to have is with telecoms providers.

Industry has recognised the importance of such collaboration. In September 2016, two new industry bodies were set up to bring together expertise from across the automotive and telecoms sectors and focus on issues relevant to the development of connected cars.

The 5G Automotive Association (5GAA) and the European Automotive and Telecom Alliance (EATA) signed a memorandum of understanding, reflecting their commitment to collaboration on issues such as automated driving, road safety, traffic efficiency, and the digitalisation of transport and logistics.

Major car brands such as Audi, BMW, Renault and Jaguar Land Rover, and automotive suppliers, together with telecoms companies such as Ericsson, Nokia, Vodafone and Orange, are among the businesses participating in the partnership.

Recently agreed collaborations between car manufacturers and telecoms providers can help manufacturers overcome complex telecoms issues they face in developing new connected cars.

The tie-up may be the beginning of a more consistent approach to telecoms in the connected car space. Up until now, many businesses looking to enjoy a future in the connected cars market have bolstered their own expertise and offerings either by acquiring other businesses in the market, or by entering into individual collaborations.

For example, Intel, in a $15.3 billion deal bought Israeli technology business Mobileye in 2017, which develops technology that helps advanced driver assistance systems to ‘see’, while in November 2016, Samsung Electronics announced that it had agreed to buy in-vehicle technology supplier Harman International Industries in an $8 billion deal. Orange, Ericsson and PSA Group along with Qualcomm, have worked together to carry out connected-vehicle field trials in France using 5G technology.

Managing new relationships
Connected car manufacturers entering into new relationships with telecoms providers must address a number of technical issues to ensure systems in their vehicles are compatible with the mobile network they rely upon. The particular challenge is that, unlike a mobile phone, it may not be possible or cost-effective to upgrade an in-built telecoms system later in the car’s life to take advantage of advances in the technology or service.

One way manufacturers can address this is to enable connections between in-car systems and users’ smartphones. However, that potentially creates a complex set of arrangements and contracts between the smartphone service provider, the smartphone owner, and the vehicle manufacturer.

As they develop more connected services, manufacturers will also need to manage a number of legal issues. These start with the different ways they may procure services from telecoms providers, whether that is through licensing models, joint ventures or other types of contracts.
At the moment these tend to be service contracts but are likely to develop into more complex arrangements as the range of services car manufacturers wish to provide increases. The challenge is that these arrangements are likely to be very different to those car makers have traditionally had with their suppliers, so they will need to ensure these agreements are clear and enforceable.

**Manufacturers need to understand telecoms regulations**

In developing connected cars, manufacturers could themselves become subject to obligations under telecoms regulations. Special rules on consumer contracts, as well as rules on lawful interception of communications, ‘know your customer’ obligations, automated regulatory reporting duties, and a requirement to set up a local entity in each country where they are providing telecom services could all apply to manufacturers for the first time.

In Europe, connected car manufacturers might be also classed as providers of electronic communication services. Legislation in this area is extensive but has not been designed to deal with the particular services which will be provided by connected cars, so there is a lack of clarity about the exact obligations and requirements manufacturers would face. However, broadly, such a classification could bring additional burdens on notification, data protection and retention, as well as certain limitations on end-user contract terms, and obligations to collect end-user data for the purpose of making it available to security authorities, potentially through specific interfaces that allow automatic and direct access to the data.

The latter obligation would trigger practical issues where manufacturers do not have a direct relationship with the customers. They would, for example, need to implement a process with their car dealerships to collect the required data. Reforms to the EU’s e-Privacy laws were proposed by the European Commission in January 2017 and should be watched carefully by businesses in the connected cars market. The draft legislation proposes that the updated framework apply to both traditional telecoms operators and OTT service providers.

To best respond to these new obligations, manufacturers could seek agreements with the telecom service providers they use to procure connectivity so that such operators have to help satisfy, to the extent possible, any regulatory requirements the law imposes on manufacturers in this context.

Regulators need to start to look at the specific implications of connected vehicles and work to develop streamlined and convergent telecoms regulation in this area. This will be difficult, given the pace of development in a whole range of emerging technologies, particularly in the context of increased wireless connectivity envisaged in the age of the ‘internet of things’ (IoT).

It is therefore essential for manufacturers to engage in early dialogue with regulators to ensure they understand the technological developments and the need for clarity and certainty about how they are to be regulated.

Another issue that will need to be addressed is that of spectrum availability. Spectrum is allotted to different uses, such as for TV broadcasting, radio services and mobile data services. Some spectrum will need to be set aside for connected vehicles in future. This is not expected to be a barrier to the development of connected vehicles in the near term, but it is likely that regulatory changes will be needed to help facilitate the increase in network traffic. In March 2018, the European Parliament, the EU Council and the European Commission agreed to set a 20 year time span on the awarding of 5G spectrum licences. Telecoms lobbying group ETNO had lobbied for 25 years.

In the UK, UK telecoms regulator Ofcom has started to look towards the future of ‘5G’ connectivity and has already identified spectrum it thinks will be ripe for services that will rely on 5G, including connected cars. It also recognises that demand for spectrum may come from a wider range of service providers and that other wireless technologies will also be vital.

Telecoms providers are at the early stages of 5G testing. 5G multi-vendor interoperability trials are taking place globally with input from both telecoms and automotive sectors; for instance, in Japan and Germany. In the UK, a testbed project for CAV was one of six pilot schemes to receive part of £25m of public funding from the DCMS. Announced in March 2018, the AutoAir project will focus on the 5G technologies available for the validation and development of CAV and investigate how 5G connectivity solutions could be transferable to both road and rail transport. The Ordnance Survey and Met Office are also involved in ongoing projects with the 5G Innovation Centre and have highlighted the importance of 5G for data connectivity and CAV.

In France, manufacturers need to obtain a licence to use spectrum or to contract with a telecom operator to use its licence, unless manufacturers use free frequencies. However, free frequencies are very limited, and do not offer any protection against signal jamming. So, it is likely that measures will be needed to make more spectrum available. This includes the liberalisation of the use of ‘white space’, such as is already happening in the UK, which harnesses the potential of unused gaps in the radio spectrum.
New responsibilities and liabilities
As well as the need to meet the requirements of telecoms legislation and of data regulation, the increased role of telecoms in connected cars brings new questions of liability.

It is possible to envisage a scenario where an autonomous vehicle crashes as a result of the interruption of data to the car where the reason for that interruption was a defect in the mobile network operator’s system. It may be unclear where any claim for liability could be directed.

In this context, however, the UK government has confirmed plans to ensure that every driverless vehicle is insured and that insurers initially cover the cost of claims before having the right to pursue the cost of those claims from vehicle manufacturers. This ‘single insurer model’ avoids leaving it to the consumer to pursue claims against the manufacturer or the telecoms provider, or any other supplier whose fault an accident was, directly.

The forthcoming change in UK law will make it important for manufacturers to have robust contracts in place with telecoms providers and other technology suppliers to ensure that they can recoup any costs of claims stemming from accidents involving their vehicles that are not their fault. The Law Commission’s joint project launched in March 2018 will examine difficult areas of law in order to develop a regulatory framework that is ready for self-driving vehicles.

The allocation of responsibility and any resulting sanctions will vary in different jurisdictions, however.

Under current German telecoms laws, the liability of a mobile network operator is limited to €12,500 per end-user and to an aggregate sum of €10m in cases where there is damage incurred by multiple end-users. This makes sense for mobile telephone services, since it is unlikely that much damage can be caused by an outage that affects a simple telephone conversation. However, that provision may not be adequate for the much greater damage that could potentially be caused by a failure of connectivity in a car. In July 2017 the German federal government approved a Bill changing the country’s Road Traffic Act to allow the use of automated vehicles on public roads. This was criticised for not providing for a new liability regime for automated vehicles that included direct liability of manufacturers.

MEPs have called for the European Union to adopt similar laws on insurance and liability for robots, which includes driverless cars, as those that are planned in the UK.

The challenges of managing different regulatory regimes
Divergences in national telecoms regulatory regimes, even within the European Union, might complicate compliance for connected car manufacturers. They will have to study the applicable regulation in each country its vehicles are to be sold in. In addition, manufacturers will need to check that they are compliant with telecoms rules in each country in which their vehicles may travel to or be sold into in the second-hand market.

Some countries require telecoms service providers to be situated in the country, so a car manufacturer who was providing these services would, under certain circumstances, need to establish a separate entity in order to provide connectivity in that local market. As a result, manufacturers will need a clear understanding of which components of a connected car are governed by which elements of telecoms regulations, bearing in mind this may vary in different jurisdictions.

They will also need to ensure that any agreements with service providers or with customers meet the requirements of the telecoms legislation in the relevant country and that the service providers undertake to deliver any support needed in order to fulfil local telecom law regulatory requirements that the manufacturer may be subject to.
One of the most significant benefits of connected technology is the way it is enabling new products and services to be developed that solve some of the most long standing and intractable business problems.

The founders of Starship Technologies recognised that new technology presented a real opportunity to tackle this ‘last mile’ problem. The company has created an autonomous robot that can deliver to an individual door, reducing costs, increasing efficiency and making truly on-demand ordering an affordable reality. It will be used in urban areas covering a two to three mile radius, and with clear potential to be used across parcel, grocery and food delivery.

The robot, equipped with GPS and computer vision, can travel along pavements at 6km/h to autonomously deliver parcels weighing up to 10kg. As Henry Harris-Burland, Starship’s marketing manager, says: “The advantage of the robot is that it uses currently available technology, proprietary mapping software and its sensors have the ability to integrate with pedestrians to make it a safe and efficient option. And because we have built in the ability for a human operator to intervene at any point in the journey, we can deal with any problems quickly.”

The way the service will work is that the customer will place an order online and choose a Starship delivery as an option, along with a time slot for the delivery. The order can then be tracked through a mobile phone and when it arrives 15-30 minutes later the parcel can be removed from the robot using an access code sent to the mobile phone.

Starship has now completed over 150,000km in 20 countries and is operating daily in 8 cities across 5 countries including USA, UK, Germany, Switzerland and Estonia. Starship is working with partners across the food, grocery and parcel industry.

As with all new technology that interacts with the public, there needs to be both social acceptance and compliance with a wide variety of regulatory requirements in different jurisdictions, be it traffic law regulations or data protection laws, for example. These can vary across countries and also within them, making it potentially complex to secure blanket approval for testing and use of the robots.

However, in a sign of how authorities are increasingly seeing the potential of autonomous delivery, five states across the USA and multiple cities across the world have recently passed legislation specifically authorising the use of delivery robots on the pavement.

Another advantage of this technology and the use of the delivery robot is that it is safe and does not bring new risks to the public. Its low speed reduces the potential for problems and the ability for a remote operator to intervene means this technology can be implemented quickly without needing major changes in regulation or legislation.

All of this means that Starship robots provide a very clear example of the potential of connected technology to disrupt traditional ways of doing things and solve business problems, in ways which will bring improvements in cost and convenience for the end customer.
The effect of connected and autonomous vehicles will be felt across the supply chain

It is clear that the move to CAVs has the potential to bring significant changes to business models across automotive supply chains, and in the contracts that govern the relationships within those supply chains. These changes will require the development of new thinking on where liability lies and how it might be enforced.

They will also potentially change the balance of power in contracts, as well as raising a whole range of challenges around managing intellectual property and protecting data. In addition, the sector may need to develop new relationships with its customers and, if it moves towards a servitisation based business model, it will need to adapt to very new types of contractual arrangements. The question of liability is clearly critical to the development and public acceptance of CAVs. Even if manufacturers say they will accept strict liability for failures in CAVs this will only solve the liability issue at the front end. The causes of accidents and defects in CAVs may result from faulty design, manufacture, software, telecommunications and/or faulty maintenance. This means that manufacturers will need to ensure that their contractual arrangements with all elements in their supply chain are clear and robust enough to allow for liability to be passed back in the event of these failures.

A shift in the balance of power in the supply chain

Another key development we may see will be a shift in the negotiating power of manufacturers and their supply chains. Traditionally, vehicle manufacturers, by virtue of their size and dominance in the market, have held the power and have largely been able to dictate the terms of contracts to their suppliers. Suppliers have had little scope to change those terms, leading to relationships that can be adversarial and which have little flexibility. In a world of CAVs, those relationships may be very different. It is possible that the automotive sector will follow a similar pattern to that seen in the development of smartphones, where power switched dramatically from handset manufacturers to software providers. In a world where consumers are demanding infotainment and connectivity systems in their vehicles, manufacturers will be dependent on specialist hardware and software providers to ensure that they are competitive in that market. This creates a very different kind of relationship to the one manufacturers may have had with their traditional suppliers who provided a particular part to the manufacturers’ specification. Manufacturers also have to accept that the more IT and software is being used in the car, the more their legacy concept of not being able to change components after the start of production will be challenged. This is because IT
and software suppliers typically work with regular updates and patches in order to deliver constant improvements and bug fixing. Similarly, the product life cycles of cars with development lead times of up to seven years and the fast paced ones for IT products need be aligned in order to ensure that a new vehicle is not already outdated in terms of IT when coming to market.

**Challenges for technology companies**

The challenges of a new connected world do not just apply to vehicle manufacturers. The suppliers of technology will also face their own challenges, particularly around protecting their intellectual property. They will need to ensure that they have the appropriate protections in their contractual documents to safeguard their ownership of their hardware and software and their right to derive revenue from such technology. Manufacturers and businesses higher up the supply chain will need to ensure that appropriate licences or rights are obtained to use any intellectual property that they do not own. All of this adds to a more complex set of contractual relationships and the need to secure the expertise to deal with unfamiliar legal arrangements.

A further area of contractual complexity is that it may lead to entirely new business models for vehicle manufacturers. At the moment, most manufacturers have limited interaction with the end consumer as their arrangements are principally with dealers. However, CAVs open up a whole set of new business models where manufacturers could find themselves selling services directly to consumers which range from insurance to servicing and from infotainment to leasing. We can also foresee scenarios where the whole nature of car ownership could change. We are already seeing some evidence of this with the growth of urban car clubs where people simply hire a car to use for limited periods of time. The emergence of CAVs will enable that further, with users able to call on pools of cars which could be ordered by phone and arrive at your door. This means that car makers could see their business developing into one which no longer sells cars but provides mobility as a service.

**New ways of doing business**

These developments offer potentially significant new income streams but represent very different ways of doing business. As a result, manufacturers will need to ensure that their contractual arrangements reflect this new approach and manage risk effectively. As with mobility as a service, a move towards servitisation will also change business models further as it brings in income over an extended period of time as opposed to a one off payment. In addition, it may bring manufacturers within the remit of consumer protection legislation which governs transactions with individuals and which can have more onerous requirements than those applying to business-to-business contracts. Servitisation models have worked well in some sectors for a number of years, most notably in Rolls Royce’s approach to aircraft engines, where the engines are leased and Rolls Royce maintains them.

There is a great deal of uncertainty about how the CAVs market will develop and how fast. However, it is clear that CAVs will have implications for the whole automotive supply chain and will potentially lead to the emergence of different kinds of relationships in a more complex environment, involving a wider range of parties. These changes could be very beneficial to all those involved but it will be vital to manage them carefully to ensure that the arrangements put in place are as dynamic as the technology they are designed to cover.
Discussion of CAVs tends to focus on the challenges in making them a reality, especially with recent high profile incidents gaining extensive media coverage. While these are undoubtedly important, it can mean the extent of the benefits these developments could bring can sometimes be overlooked.

By transforming mobility, autonomous vehicles have the potential to deliver solutions to some of the critical social, economic and environmental problems we face. This starts with dealing with traffic congestion which is a growing drag on economic development in many cities around the world. Reduced congestion will, in turn, lower emissions and could enable the use of more electric and cleaner vehicles. Autonomous vehicles could also deal with the ‘last mile’ problem, where people are less likely to use public transport because they have to get from the station or bus stop to their home. A fleet of on-demand autonomous shuttles could solve that problem.

Another significant benefit of a move to driverless cars comes from the potential improvements in safety. Most of the 25,000 serious accidents every year in the UK are caused by driver error, so removing driver control could dramatically improve road safety. Equally, as we spend the equivalent of six working weeks a year driving, the widespread use of fully autonomous cars could free up significant amounts of time. There is also the advantage that they would increase mobility for a large number of people who cannot currently drive, perhaps through disability. While this might mean that the number of journeys would increase, if road space is better managed it would not increase congestion, and would transform lives.

These will all be in addition to new business opportunities. Research for the UK Society of Manufacturers and Traders suggests that the development of CAVs will help generate 320,000 jobs in the UK and create a market worth £51 billion.

A wide range of challenges
However, to reach this point will require a number of issues to be addressed. The first is that we tend to treat cars and driving in a different way to other products we buy. Buying a car is likely to be the most expensive purchase we make, apart from our houses, and for many people, buying a car is a very different kind of transaction to buying a washing machine or a computer. For them, driving is not simply a way of moving from place to place; it can be an inherently enjoyable experience in which they have an emotional investment. Driverless cars will potentially disrupt the whole nature of the driving experience. Manufacturers will need to consider the impact of people willing to give up car ownership and moving to a leasing or hiring model for individual journeys, possibly sharing with others, and how they make a driverless pod attractive to users.

It is these broader and softer issues, as much as the technical ones, that will need to be resolved before manufacturers, or future operators, can be sure that autonomous vehicles will be commercially viable. This means that the success of manufacturers in maximising these new business opportunities will depend on their understanding that creating a market for autonomous vehicles is not just an engineering problem but a psychology, communications and marketing challenge as well. In particular, they will have to get the experience and the price right. As we have seen with the slow take up of electric vehicles, buyers need to be sure of the advantages of a new form of driving and confident that the new car will be as safe, reliable, affordable and enjoyable to drive as traditional vehicles.

Transforming mobility through autonomous vehicles

Autonomous vehicles have the potential to deliver solutions to some of the critical social, economic and environmental problems we face.
In meeting those challenges, manufacturers will need to consider how to get from where we are now to driverless vehicles. That transition will be complex and the debate has tended to assume that there will be incremental change that will pass through different levels of autonomy until we get to fully driverless vehicles e.g. the levels 0-5 as specified by the SAE. That is a potentially slow and expensive process, given the length of time and cost involved in developing and launching new car models.

An alternative scenario might be to develop and sell fully autonomous cars as soon as they are technically viable but allow the driver to be able to switch that facility on and off. So we could envisage that the driverless car function could be used on a motorway lane where all the vehicles were operating in the same way. However, in a congested urban area, the driver would still be in charge but, over time, the number of roads where the fully autonomous function could be used would grow. This would allow manufacturers to navigate through the transition phase without constantly having to upgrade vehicles and give legal and regulatory authorities the time to develop new regimes. It also avoids the problematic challenges of handover between driver and vehicle at SAE level 3.

### Building public trust

For this to happen, there will need to be public trust in the technology. Surveys suggest that there is currently some public concern about the safety of driverless cars and that, at the moment, people are happier getting a taxi with a driver whose skills they know nothing about rather than an autonomous car.

Testing and early deployment will play a critical role in building that trust and addressing those concerns but that will be a complex process. Testing will need to understand the response of the vehicle to every variable: a child in the road; a plastic bag; different weather conditions; and other vehicles. Successful testing will not be about the number of miles driven, but about the scenarios encountered on the way. It will be hard to replicate each of the huge range of specific individual scenarios to test the consistency of the response of the vehicle, meaning testing will be very expensive, and yet still not comprehensive. So while much of the focus has been on the need for on-road testing, it will be necessary to use simulators which allow for the vehicles to be tested in a wide variety of conditions and to repeat those tests consistently, and to test in the purely digital world too.

All this underlines that the development of connected and autonomous vehicles requires a very different process to that used in many other products because it requires such a multidisciplinary approach. It needs to bring together engineers, software developers, philosophers, marketers, behavioural insight researchers, city planners, experts in standards and systems, and legal specialists. However, that combination of expertise is a very powerful one and if they can make driverless cars a reality then they will be making a significant improvement to both the quality of many people’s lives and to our wider environment.

While much of the focus has been on the need for on-road testing, it will be necessary to use simulators which allow for the vehicles to be tested in a wide variety of conditions.
The move to electric vehicles from those powered by fossil fuels offers energy and automotive businesses an opportunity to develop innovative new business models and power management solutions to meet the demands of this developing market.

Companies are already re-shaping the economics of vehicle power, investigating distributed models of electricity storage and distribution, and offering users of electric vehicles flexibility in when and where they get power and how much they pay for it.

Resolving the challenges relating to the cost and practicalities of electric vehicle power is pressing: the UK government announced in 2017 that the sale of new petrol and diesel cars will be banned in the UK from 2040.

New business models and collaborations are emerging as businesses respond to the question of how power for the predicted proliferation of electric vehicles will be generated and distributed. Incumbents in the energy and automotive sectors are adapting their business models and collaborating in new joint venture partnerships, combining their expertise. Entirely new players are also emerging. These ‘disrupters’ offer new products or services that challenge our existing perceptions of both the energy and automotive sectors.

**Generation**
The UK’s capacity to generate electricity will need to grow to meet the extra demand from electric vehicles.

Further improvements in the capacity of electric vehicle batteries, and the development of faster electric vehicle charging points, such as the ‘ultra-rapid’ 350kW chargers that cater for long-distance electric vehicle travel, will place further strain on generation, distribution and supply.

The UK government is aware of the issue. It has estimated that an extra 60 GW of electrical output (GWe) will need to be added to the UK’s electricity generation capacity by 2025. Due to the UK’s climate change obligations, the new capacity will need to be provided through a combination of nuclear and renewable sources of power.

It is predicted that 35 GWe will come from renewables by 2025 and a significant proportion of the remaining 25 GWe is set to come from nuclear, although only 16 GWe is expected to come online by 2030.

Relying on renewable sources of electricity, however, has inherent risks due to the intermittent nature of its generation. On its own, renewables cannot provide a 24/7 reliable base load of electricity.

This demand offers opportunities for innovation, such as the development of electric vehicle charging points that incorporate on-site generation, typically by way of solar photovoltaics and battery storage capabilities. This can range from small-scale batteries for individual charging points or large, grid-scale batteries designed to serve a bank of charging points at a motorway service station, for example.

These solar and storage solutions give charging point operators greater flexibility and resilience, through a varying degree of self-sufficiency, and also provide them with the option to manage users’ demand, and thereby their own revenues. They can do this by, for instance, charging a large battery during off-peak hours in the middle of the day, when solar power is at its most efficient and most people are at work, and discharging it at peak hours in the evening when users seek to charge their electric vehicles when back at home and electricity prices are at their highest. This model enables operators to minimise their costs of electricity supply too, with a view to maximising profits or passing savings on to customers.

There are also increasing opportunities for electric vehicle charging point operators to enter into power purchase agreements (PPAs) with electricity generators, such as local solar generators. PPAs provide the generator – or seller – a guaranteed price for its electricity and the charging point operator a secure supply of electricity. This arrangement can also be provided by way of a ‘private wire’ solution if the generator and the charging station are co-located.

**The potential of ‘vehicle-to-grid’ and other developments in distribution and supply**

Grid constraints and the cost of connection to the electricity grid can be major challenges for electric vehicle charging point developers and operators.

Charging points by nature need to be widely distributed, and may need to be installed in locations, such as petrol and service stations, which are not well-served by the grid. Other charging points will need to be installed in densely populated areas where the grid is frequently already at capacity, and cannot accommodate additional loads.
Either scenario can lead to high costs attached to planning, design and installation, as well as lengthy delays, for the charging point developer. This issue will become particularly acute as the case for installing increasingly high-powered charging points grows.

On-site generation and storage can play an important role here, providing charging operators a means of reducing their impact, and reliance, on the grid, and managing users’ demand, for example through charging a large-scale battery during off-peak hours and discharging it during hours of high demand.

As well as conventional, ‘stand-alone’ batteries, the concept of a ‘vehicle to grid’ (V2G) solution is also being explored by the industry through so called V2G bidirectional charging stations. This revolves around using the battery in the electric vehicle itself as a storage device to help balance the grid while the vehicle is not in use. Operators could incentivise electric vehicle users to charge their vehicles at off-peak times through cheaper rates, and apply higher rates at peak times. This would help to balance demand as well as lower customers’ electricity bills.

Another option is to pay electric vehicle owners for allowing an energy company or a third party aggregator to take over the management of the vehicle’s battery, charging it during off-peak periods and selling it at peak times by way of a specialised charger installed at the user’s home. Users would likely wish to specify a minimum amount of charge for driving the next day. Such schemes are currently in their infancy, but will no doubt become more widespread as electric vehicles become commonplace and providing users’ concerns over energy companies accessing their vehicle remotely are allayed.

Taken together with a home electricity generation and battery solution, the V2G model could enable demand for electricity to be managed and the grid to be effectively balanced while providing consumers with a greater degree of control over how they use energy in their home.

Business model innovation

Incumbents in the energy and automotive sectors are responding to the new opportunities and challenges with innovative new products and cross-sectoral collaborations: energy companies are developing new product lines around electric vehicle charging, and car companies are using their electric vehicle battery expertise to branch into home energy storage. For example, both Nissan and Mercedes have home battery offerings which use ‘second life’ car batteries which are still serviceable as home storage solutions.

This commercial model makes a lot of sense for vehicle manufacturers. As the market for electric vehicles grows, increasing numbers of batteries that are no longer suitable for use in cars will be gathered by automotive businesses – those batteries could, however, still have a useful life for powering applications in the home, since the cycle and efficiency requirements are lower. Via this model, manufacturers would also have access to valuable data on how customers use their electric vehicles as well as how they use energy in their homes.

Car companies and energy companies are also collaborating to provide electric vehicle and home storage solutions: Nissan’s ‘XStorage’ is available as a home storage system to homeowners with solar panels in collaboration with Ovo, for example. Ionity, a joint venture between BMW Group, Daimler AG, Ford Motor Company and the Volkswagen Group with Audi and Porsche, is also collaborating with Shell to install a network of high-powered charging points at Shell petrol stations across Europe.

Car companies are also in some cases offering electric cars for sale with free or discounted charging for a period of time at certain brands of charging stations. Battery storage operators and developers, relatively new to the energy market, are also able to offer their expertise to electric vehicle charging point developers and car companies by developing, operating and maintaining electricity storage systems for the charging stations, helping to maximise revenue and provide security of supply.

In future, we could also see vehicle manufacturers offer electric vehicles at a discount to customers if customers enable the manufacturer to aggregate the capacity of their vehicles when not in use. This could create a ‘virtual power plant’ which the aggregators could access to sell energy at times of peak demand. A more advanced model of this nature could even see consumers earn money from the sale of electricity obtained from their vehicles, or use the value of their asset to the aggregator as a battery to offset the cost of buying their vehicle.

Some car manufacturers are already changing the basis on which they sell electric vehicles to customers, offering end-user services as opposed to the cars themselves. This reflects the fact that electric vehicles are less complex to maintain than traditional internal combustion engine cars due to there being fewer moving parts.

As a result, we may see manufacturers become more comfortable offering consumers a ‘one price’ model which covers all maintenance. This would leave consumers only liable for further costs of charging the vehicle, insurance and tax. Polestar is already offering its inaugural electric vehicle, after its spin-off from Volvo, on a subscription model, where a monthly payment covers all maintenance and servicing.
Infrastructure must be built with connected and autonomous vehicles in mind

The mainstream adoption of new CAVs will depend on infrastructure being updated with CAVs technologies in mind: in this respect, collaboration between the infrastructure and technology sectors is essential.

The future of CAVs promises a world where vehicles transmit and receive data constantly, with a myriad of associated possibilities, from enabling the safe, automated, or semi-automated, and efficient flow of traffic along motorways or within cities, and directing occupied or unoccupied vehicles to available parking or storage spaces, to the sharing of weather or accident warnings, and facilitating the exchange of information digitally between vehicles themselves.

Car manufacturers and their parts and software suppliers cannot deliver this vision alone. There are pivotal roles for telecoms operators as well as those funding, developing and operating underlying infrastructure, such as roads, traffic management systems and communications networks.

Some of the infrastructure-related challenges ahead are obvious: there will be a need to retrofit existing highways and roads with technology to enable CAVs, and it is equally imperative that new highways and roads are designed with CAVs in mind. However, it is also important that the future of CAVs is considered in relation to infrastructure beyond the road networks.

The modernisation of other transportation systems such as rail networks and airports should factor in how vehicles of the future will change the way we travel. This is especially important for projects with long time lags between project initiation and commencement of use – for example, thought should be given to the need for extensive parking at stations being built or regenerated as part of the HS2 project, or perhaps the use of compact, multi-level storage facilities for CAVs instead of open parking lots for human-driven cars.

We can also anticipate that the vast majority of CAVs over time will be electric vehicles. A whole raft of infrastructure will be needed to support their use. This includes the installation of new charging stations at motorway service stations and at the home, while underlying electricity networks will also need to be upgraded – this could support ‘vehicle-to-grid’ or ‘vehicle-to-everything’ solutions based on the potential to make use of the battery power in those vehicles.

New communications infrastructure will be a central enabler of CAVs, including wireless technologies such as 5G sensor technologies, and fibre networks.

5G technologies promise not only ultra-high capacity and speed broadband; it offers the potential for communications networks to operate more efficiently through ‘network slicing’, which is where multiple virtual networks for the transmission and receipt of data can operate over common communications infrastructure. 5G will mean vehicle-to-everything communications are more effective due to low latency and higher reliability – this should dramatically improve the reliability of data services for CAVs and reduce the number of network ‘drop-outs’.

CAVs will also rely on short-range sensors, radar and image recognition technologies, as well as mesh networks and existing standard mobile networks.

Wireless technologies require backhaul – for CAVs this means fibred-up highways and city roads with dense fibre feeding wireless transmitters. Highways England’s National Roads Telecommunications Service (NRTS2) project is an example of work in this regard.

Delivering the telecoms infrastructure needed for CAVs comes with regulatory challenges, including access to infrastructure sites and to spectrum. However, legislative reforms, such as the newly revised Electronic Communications Code in the UK, should make it easier for telecoms infrastructure to be installed and maintained, while regulators, including Ofcom, are already making some of the key frequency bands of spectrum available for the provision of 5G services that will be used for CAVs.

The private sector interest in CAVs is strong and significant spend has been allocated to research and development globally. However, without a well-defined business case for CAV infrastructure, government has an important role in supporting the testing of CAV technology and to further define the infrastructure requirements for a CAV future. In the UK, the government’s 5G testbed and trials programme may be significant in this respect.
Rolling out new infrastructure fit for CAVs is not a simple exercise – it requires collaboration across a diverse supply chain that includes traditional infrastructure providers and technology providers. With the importance of technology and adaptability in these projects, there is a need to re-consider where the technology companies and experts sit in the supply chain for testing, procuring, designing, building and operating transport infrastructure assets. They are unlikely to remain as sub-contractors at the base of a layered supply chain.

Pinsent Masons’ report on ‘infratech’ provided views from businesses surveyed across the infrastructure and technology sectors. It highlighted an increasing appetite for closer collaboration.

The survey revealed that most infrastructure developers expect to enter into joint venture agreements with technology companies by 2020 as a way to gain long-term access to technology. Public private partnerships are other likely forms of collaboration, while the report also indicated the potential for new “alliance models” to emerge in the longer term as the preferred model for collaboration in future.

Alliance models work by eliminating the need for separate contracts with each entity involved in a project. Instead, a single contract covers all participating parties. Objectives, risks and benefits are shared.

In light of closer collaboration, and the huge value of data that CAVs will generate, traditional business models for delivering transport infrastructure need to be re-considered.

There will be opportunities, for example, to target new and innovative services at a captive audience – passengers travelling in autonomous vehicles will not be driving and instead are likely to be connected to wireless internet services. Authorities could look to secure the involvement of private sector partners to fund infrastructure in return for concessions to monetise the route. Might we see the technology giants building and operating road networks in the future?

Contractual models will need to change to incentivise the necessary investment in new infrastructure and to recognise the value of infrastructure assets will change over the life of those assets.

Outcomes-based contracts have the potential to enable the infrastructure needed for CAVs. For instance, the focus of an outcomes-based contract might be on delivering a road that can accommodate X thousand cars per hour at an average speed of Y, rather than on delivering static requirements and outputs.

There are further challenges ahead in relation to traffic and data management.

Legacy traffic management systems often aren’t optimised and fully integrated. This results in data from sensors and other deployed technologies, such as at junctions or in tunnels, not being fully fused or correlated, and therefore less useful for predicting future conditions. It is important in CAV procurement programmes to address these kinds of issues by sourcing solutions that improve the quality, speed and integration of data. This will allow faster detection and response to incidents (including predictive response) and will provide a single view of systems for better decision making informed by multiple data sources. This is likely to include data from private sources, such as Google’s Waze application which is used as an additional source of traffic information by Transport for London.

Standard and interoperability of data and devices is another barrier to enabling infrastructure assets to communicate with vehicles and vehicles to communicate with other vehicles. Several local councils are looking at standards and interoperability, including as part of ‘smart city’ initiatives, and infrastructure providers are increasingly offering connected products that can interact with the entire ecosystem for intelligent transport.

Connecting ‘systems of systems’ opens up security vulnerabilities. Cybersecurity is a critical risk, particularly for traditional construction and engineering companies working on infrastructure for which managing and utilising data has only recently become an imperative. It will be important for the infrastructure sector to understand and guard against cybersecurity risks.

Businesses that embrace collaboration and sensibly manage risks will be at the forefront of developments in infrastructure for the vehicles of the future.
Connected Cars are a major factor in a bull market for automotive technology M&A

In a world where vehicles are becoming moving carriers of ICT-technologies rather than engine driven modes of transportation, traditional players are investing billions in order to catch up with the new kids on the block. The development of the hardware and services allowing drivers and fleet owners to enjoy wondrous new functionality unseen before, brings with it even more joint ventures and mergers & acquisitions than we anticipated in previous editions of this paper.

In order to meet the pace of innovation and regulation, automotive OEMs and suppliers are acquiring businesses that have track records for delivering next-generation technology. This fuels not only automotive M&A activity but also activities in the technology sector.

According to advisory firm Hampleton Partners15, the three most active acquirers over the last couple of years were Continental with four deals, including the purchase of Argus Cyber Security, Delphi with three deals, including nuTonomy, makers of a self-driving vehicle software, and Reynolds & Reynolds with three deals, including ReverseRisk, an automotive dealership analytics SaaS. As for the largest deals of 2017, Hampleton Partners reports that Intel acquired MobileEye for US$15.3 billion, Ford invested US$1.0 billion into Argo AI and Delphi spent US$400 million on nuTonomy, equal in deal-size with Dassault Systems’ acquisition of Exa Corporation.

Still, automotive suppliers seem to find it difficult to keep up with the rapid changes in automotive technology. OEMs are pushing to improve engine technology, electrification, connectivity in vehicles and infotainment equipment.

First successes
But successes for early movers can be found in the market already and should be very encouraging to others. While at the time it seemed that this was just a merger about scale and with a certain element of hope for automotive technology, ZF’s $12.6 billion acquisition of TRW was essentially about purchasing fundamental radar and vision systems and advanced electronic control units. The gamble has paid off and has given ZF what it hoped: to become a global leader in autonomous vehicle technology.

Continuing challenges
Still, the ZF/TRW transaction was very much an automotive deal. The challenges we addressed in our last report have not ceased to exist. The biggest of these is that technology M&A is very competitive, more so than the traditional automotive sector.

So in seeking to buy a technology firm, vehicle manufacturers and suppliers face competition from private equity and software companies, as well as from other suppliers and OEMs, and they may have to cope with higher valuation multiples than they are used to.

A further challenge lies in the way that company boards have to make tough decisions about the cost and risk of any acquisition when they are dealing with emerging and potentially disruptive technology where it is still fairly unclear exactly how the connected and autonomous vehicle market will develop. It is clear that driver assistance systems in the autonomous driving space are part of the general up-market offering nowadays. Whether truly autonomous driving will ever become part of our lives, and if it does, just when this will happen and automotive companies will earn the fruits of their investments, is unknown.

“The next big thing has yet to become the next big business”.

The view expressed in the last edition of this whitepaper is supported by others. According to The Boston Consulting Group (BCG)16, the market for in-vehicle connectivity is expected to reach EUR 120 billion by 2020. But so far, vehicle manufacturers are struggling to turn that potential into significant revenue and profits. As BCG puts it “The next big thing has yet to become the next big business”. This requires market participants to embrace significant changes in their connectivity strategy, organisation, and mind-set. Still the traditional part of the new automotive market does not seem to have understood what it is that makes technology companies successful. Technology companies adopt faster development cycles, approach monetization in new ways, and build platforms that woo partners and customers alike, and are often open for other brands. Whether that works in a market such as mobility where a larger part of the consumer’s discretionary income is involved as in, let’s say, the smartphone market, still seems to be unknown.

What it means for M&A

So far, this has not stopped M&A activity. All this means is that it makes it harder to carry out effective due diligence, to verify business plans, and to come up with valuations. Yet the competitive nature of the sector means that potential buyers will have to react more quickly or risk missing out on opportunities.

Continuing stream of new joint ventures

Many of the challenges faced by car manufacturers and automotive suppliers alike are still being tackled by setting up new joint ventures. Our research has shown that in Q1 2018 alone 24 joint ventures were set up by automotive OEMs and Tier 1 suppliers alone in order to tackle the development and manufacturing of connected vehicle technology.

Along these lines, one project to watch will be a joint venture set up in China in December 2017. The Beijing-based joint venture, temporarily known as China Intelligent and Connected Vehicle Research Institute, brings together 21 Chinese carmakers, telecom operators and tech giants such as FAW Group, Dongfeng Motor Corporation, Chongqing Changan Automobile, China Mobile, China Unicom as well as ride-sharing giant Didi Chuxing’s parent company Beijing Xiaoju Technology. It will be run independently and is to undertake national research and development programs, help its investors develop products and offer consulting services to them. It is the largest venture of its kind China has seen in its smart and internet-connected car efforts. According to China’s automotive development plan, China wants to be a global leader in the smart and internet-connected car space by 2025.

Another good example for the challenges facing the industry and the reaction of major players is the alliance agreed upon by the truck divisions of Toyota and Volkswagen in April 2018 in order to advance their efforts in electric vehicles and self-driving technology jointly. According to the report, 50% Toyota-owned Hino Motors and Volkswagen Truck & Bus, a wholly owned subsidiary of Volkswagen AG, are planning to work together on a wide basis, covering issues ranging as far as procurement, logistics, hybrid engines and connectivity. The move came as a surprise, seeing that both Toyota and Volkswagen have a long history of competing against each other for world domination in the market for passenger vehicles. Both companies, however, felt the urgency driven by rising investment costs, a shortage of truck drivers and the need to develop new technologies. Another reason for the joint venture, and one that the public should be endorsing, are the challenges facing companies around standardisation and joint technological platforms in an environment where commercial vehicles make up an essential backbone of basic social infrastructure.

Rising stars in venture capital

The picture would not be complete without a look at venture capital investments in the automotive world as well. According to CB Insights, venture capital investments in growing automotive companies are experiencing a surge and the bulk of it goes to those working on autonomous driving technologies (in 2017 until November approximately 76 per cent of the nearly US$ 4 billion total venture capital investments went into automotive).

Again, China is the place to watch. For example, Chinese start-up NIO, a company which has ambitions to develop connected autonomous electric vehicles, alone having raised over US$ 1.6 billion in venture capital until November 2017.

Another major player in the new world order of mobility, arising stronger than ever, is Japanese telecoms giant SoftBank which in September 2017 discussed a US$ 1 billion investment into Zoox, a robotics company aiming to develop a fully autonomous electric vehicle and the supporting ecosystem. SoftBank is already invested in new players such as Uber and China’s own Didi Chuxing as well as in Nvidia, Nauto, Mapbox and German start-up Auto1. Its major transaction, however, was the GBP 23.4 billion takeover of UK semiconductor and software design company, ARM.

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18. https://www.ft.com/content/4579a578-3e05-11e8-b7e0-52972418fec4
Still a variable picture

So while the volume and value of the M&A market in automotive technology continues to be very significant (although the ZF-TRW deal volume has a certain influence on figures), there is a wide variation in the amounts the different manufacturers are investing. Deals range from multi-billion dollar transactions or large-scale partnerships, to corporate venture investments in start-up companies. Moreover, the structures for co-operations vary enormously as well. We believe that one of the most significant steps can be found in the development of HERE since its acquisition by the BMW, Daimler and Audi, as an attempt to create an open platform. Such industry platforms are – in our view – the most promising way that the general standards can be created, which are undoubtedly necessary to facilitate automotive connectivity and allow for widespread, higher level autonomous driving.

The debate about exactly when fully autonomous vehicles will start appearing in the market on a large-scale basis, which will then allow for level 4 and level 5 autonomous driving, does not seem to deter the players in the market for autonomous driving technologies. An incredible amount of activity can be seen, so autonomous technology clearly has an impact on M&A strategies. That means people responsible for strategic development and M&A in automotive businesses and related technology businesses will need to be able to consider M&A options at all times and will need the systems and advice in place to assess opportunities rapidly, allowing them to carry out effective due diligence and ensure an acquisition really can add value.

www.autonews.com/article/20170403/OEM10/304039948/as-trw-deal-pays-off-zf-focus-is-autonomous
www.autonews.com/article/20170306/OEM/170309860/the-gm- PSA-deal-at-a-glance
01 Intel (HERE, Mobileye): BMW, Daimler, Audi, Volkswagen
  - HERE bought by Daimler, BMW and Audi (December 2015)
  - Canadian auto-parts giant Magna International Inc. joined the consortium between Intel, BMW and Mobi. eye. BMW is one of Magna’s largest customers (October 2017)
  - Fujitsu and HERE Technologies announced a plan to link their respective technologies around mobility and a tonomous cars (November 2017)
  - Hyundai joins Intel, BMW and Mobileye in partnership (February 2018)

02 Uber, Otto, Didi Chuxing: GM, Volvo, Daimler, Toyota
  - Toyota buys a small stake in Uber (May 2016)
  - Volvo signs a $300m deal with Uber to provide vehicles for research and for Uber’s semi-autonomous taxi fleet (August 2016)
  - Uber and Daimler partner: Daimler to supply autonomous Mercedes-Benz vehicles to Uber (January 2017)
  - Volv signed a follow up deal with Uber to provide the company with 24,000 cars over three years starting from 2019 (November 2017)
  - Uber Technologies will be a partner in Toyota Motor’s Mobility alliance (January 2018)

03 Lyft: General Motors, Cruise Automation;
  - GM invests $500 million in ride-hailing company Lyft Inc. The companies are developing autonomous electric taxis (January 2016).
  - Lyft drivers can rent electric Chevrolet Bolts in Los Angeles (February 2017)
  - Lyft announced a self-driving vehicle partnership with Waymo - the deal is non-exclusive leaving both parties free to continue with their previous initiatives (May 2017)
  - Lyft secured $25 million investment from InMotion Ventures, the mobility services business of Jaguar Land Rover (June 2017)
  - Lyft struck an alliance with leading car supplier Magna. Magna is investing $200 million into Lyft (March 2018)

04 Google (Waymo): Fiat Chrysler, Honda
  - Alphabet Inc. spins off a self-driving car company Waymo from Google (December 2016)
  - Waymo signed an agreement with Avis Budget Group. Avis will offer fleet support and maintenance services for Waymo’s fleet of autonomous vehicles (June 2017)
  - An insurance start-up Trovhas will team up with Waymo to provide insurance for journeys on Waymo’s car-hailing service. It will cover passengers for medica expenses, lost property and trip interruption (December 2017)

05 Mobileye, Delphi, KT
  - Mobileye announces a partnership with Delphi Automotive to produce a turnkey autonomous driving system designed for rapid adoption by a variety of automakers (November 2016)

06 Nvidia
  - Audi announces a partnership with chip-maker Nvidia to develop autonomous vehicles by 2020, using NVIDIA’s computing platform (January 2017)
  - Volvo and Swedish car safety system manufacturer Autoliv signed a deal with Nvidia Corp to develop new software systems for self driving cars. Volvo and Autoliv’s Zenuity JV will work with Nvidia to develop AI systems (June 2017)
  - Nvidia agreed to supply its hardware Aliaba, Tencent, and Baidu and separately announced it had joined a group of investors in spending US$52 million on China self-driving car start-up Jingchi (September 2017)

07 Ford: Argo AI, Velodyne, SAIPS
  - Acquired ride-sharing start-up Chariot, reportedly for $50 million (September 2016). In November 2017, applied to launch commuter bus network in London using Chariot
  - Addison Lee leads a consortium including Ford to explore the potential for unmanned vehicles and ride sharing services in London with the Merge Greenwicht project backed by funding from Innovate UK (October 2017)
  - Ford invested in Autonomic and is working with the company to develop an information sharing platform - the Transportation Mobility Cloud. (January 2018)

08 Nissan
  - Renault-Nissan Alliance and Microsoft signed a global, multiyear agreement to partner on next generation technologies to advance connected driving experiences. Plans to integrate Cortana into their vehicles (September 2016)
  - Continental will supply technology for a connected system which will appear in 2018 and be used in 90 percent of vehicles built by Nissan, Renault and Mitsubishi (October 2017)

09 General Motors
  - GM sells loss-making Opel/Vauxhall to PSA Groupe in order to free cash flow necessary to invest in autonomous vehicle development (2017) [2]

10ZF
  - ZF buys a 40% stake in doubleSlate, a data and networking supplier which will help ZF make advances the field of vehicle networking (September 2016)
  - ZF announced a partnership with chipmaker Nvidia and Helia - a leading supplier of cameras and radar (June 2017)

11 Autoliv, Volvo
  - Autoliv announces a partnership with Volvo to develop a full self-driving system in a 50-50 joint venture called Zenuity (September 2016)

12 Daimler, BMW
  - Daimler bought a majority stake in Chauffeur Privé, a car-booking start-up that has positioned itself as an alternative to Uber in France, and plans to fully acquire it by 2019. The financial terms of the deal were not disclosed (December 2017)
  - Chinese carmaker Geely took a 9.7% stake in Daimler citing a wish to cooperate on technology (Feb 2018)
  - Daimler and BMW are in discussions to combine their respective mobility services - an array of apps and services that provide transport options for people who may not own cars - into a joint venture in which they will own equal shares. This includes DriveNow and Daimler’s Car2Go

13 Aurora
  - Aurora struck partnership with Volkswagen working together to integrate Aurora’s package of hardware, sensors and software into Vol swagen’s self-driving platform (January 2018)
  - Strategic partnership with Hyundai. Hyundai earlier joined with Cisco Systems Inc. and Baidu Inc. to collaborate on internet-connected cars (January 2018)
  - Deal with Chinese electric vehicle start-up Byton to build a self-driving SUV (February 2018)

14 Jaguar Land Rover
  - Jaguar Land Rover and Qualcomm Technologies working together to use Qualcomm Snapdragon automotive platforms (January 2018)
  - Waymo announces long-term partnership with Jaguar Land Rover. Waymo will buy tens of thousands of vehicles from JLR and collaborate on future technology. The two companies will begin testing a self-driving version of the Jaguar I-Pace, the carmaker’s first electric model and bring it into the Waymo fleet from 2020 (March 2018)

15 Continental
  - Continental signed a strategic cooperation agreement with Baidu (July 2017)
  - Continental and Huawei have been working with a wireless communication technology called the Cellular Vehicle to Everything, or C V2X, for autonomous drive applications (December 2017)
  - Continental AG and Robert Bosch GmbH both buy 5% stakes in digital mapping and location services provider Here Technologies from Audi AG, BMW AG and Daimler AG (January 2018)
  - Continental and NVIDIA have announced that they are partnering to create AI self-driving vehicle systems based on the NVIDIA Drive platform, with a planned market introduction in 2021 for level 3 features (February 2018)
The future of the automotive sector: navigating the skills gap

The future of the automotive industry relies on access to young talent equipped with the right skills. We commissioned Meridian West to carry out new primary research into this important area. Here is a summary of our findings. A full report is being published separately.

Could a skills shortage affect the UK’s ability to compete in the global CAV market?

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Skills shortage or crisis?
Challenges for the automotive sector

A critical challenge for the automotive sector is attracting talent with the right skills and qualifications. As young people become less interested in STEM subjects and Brexit disrupts the labour market, the skills shortage may deepen. How should the automotive sector react and what can the government do to prevent a crisis?

The sector is primarily focused on innovation and growth

The automotive sector faces unprecedented change. Manufacturers are seizing opportunities by focusing on product innovation and increasing sales, however only one in seven companies named investing in skills and training as their number one priority.

Our research methodology

We conducted telephone interviews with 102 UK-based automotive companies to seek their views. We also wanted to know what young people think and surveyed 122 students at school or university.

Most companies feel prepared for the future, but there are areas of concern

Most companies feel well prepared for the technology-driven changes ahead, embracing advances in the manufacturing process, as well as product innovations such as electric vehicles and AI. Most manufacturers feel as well prepared as possible or adequately prepared for talent-related challenges such as the national shortage of STEM skills and negative perceptions of the sector. However, there are some areas of concern. Over a quarter of companies feel unprepared to deal with the lack of relevant skills and qualifications offered by schools and colleges.
The views of young people show there is no room for complacency

Our informal survey of students’ views shows that the automotive sector cannot afford to be complacent about the potential skills crisis ahead. Less than one in five students names a STEM subject as a favourite and there is a clear reticence to enter an apprenticeship or undertake hands-on learning.

The sector is mainly supportive of government policies which promote skills and training

The automotive sector takes a broadly positive view of government policies such as investment in STEM education and the Apprenticeship Levy. However, there is a significant proportion of companies who feel neutral or negative about the government’s actions.

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Diversity and Inclusion is important for young people and it’s on company’s agendas. We asked young people to rate the importance of various Diversity and Inclusion policies such as initiatives to support BAME people and diversity quotas for leaders. Virtually all were regarded as important by young people. Some companies are using these approaches today, but a greater number are planning to introduce them over the next two years.

Conclusion: Does the automotive industry and government need to up its game?

While companies are acting to meet the challenges of the impending skills shortage, the question remains of whether they are doing enough. Automotive manufacturers see a need for appropriate skills training and pursuing Diversity and Inclusion policies, but many of these are yet to be implemented. The views of young people suggest the time for action is now. There is a worrying lack of interest in STEM subjects and apprenticeships, as well as awareness about the sector.

Our survey also suggests the automotive industry believes the government should do more. With Brexit exacerbating these issues, there could be greater investment in education as well as a new approaches to vocational training, taking inspiration from Germany’s successes. A more joined-up and imaginative approach may be needed to stop today’s skills shortage becoming a talent crisis.

Facing up to the challenges ahead

The sector expects Brexit to intensify the skills shortage

Although companies feel prepared for Brexit (80%), many companies expect it to intensify challenges around attracting talent. Very large companies are most concerned with their ability to access key technical skills (63%), a reflection of their reliance on European talent. Medium-sized companies are less concerned, with only 31% worried about attracting talent post-Brexit.

Young people need greater awareness of the automotive sector

Challenges around attracting younger talent are exacerbated by a lack of awareness of the automotive sector. While there were broadly positive views, we also found a significant minority of young people thought that automotive jobs were "dirty and physical", while few felt it made a positive contribution to society.

Does the automotive sector need to change its message to young people?

Young people also gave us suggestions about what the automotive sector needs to do to attract them. Their advice ranged from increasing awareness by creating more work placements using technology and creative approaches to better get the message across. They also thought companies needed to do more to demonstrate social responsibility including proving environmental credentials, and funding STEM scholarships.

Diversity and Inclusion is important for young people and it’s on company’s agendas

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The Automotive Industry has entered the global arena of IT, communication and infotainment and grapples with opportunities and challenges presented by the ever increasing connected world. Companies in this sector are often at the leading edge of international investment in new frontiers in order to find the customers of tomorrow.

Automotive companies, tier suppliers and suppliers of IT and telecom solutions and services that embrace the paradigm shift of connectivity have access to unprecedented opportunities in the 21st century. In a sector which is sensitive to a litany of regulatory frameworks, it can be difficult to navigate the changing business environment. Our focus is on providing pragmatic advice that makes a real difference by providing solutions, not just identifying problems. We help our clients to steer a clear path through the multijurisdictional regulatory and legal minefields that stand between them and success.

Our TMT, Commercial, Supply Chain, IP, Data Protection, Insurance, Regulatory and Corporate teams all have a wealth of experience within the sector and regularly draw upon the complementary and specialist skills each other offer within the field.

Our international Automotive Team has advised clients on the legal solutions required for original equipment and parts manufacturers, IT and telecom suppliers, and infrastructure providers operating in an increasingly global market. The team has extensive expertise advising clients on their contractual arrangements, the procurement of software and hardware solutions, content for applications and on distribution schemes, regulatory issues against the background of telecom and data protection laws as well as giving operational support regarding risk management, compliance and intellectual property.

About the Pinsent Masons Automotive team

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