

Written evidence submitted by the Department for Transport (SDV0052)

1. This evidence sets out the government's position on self-driving vehicles in relation to the specific areas of interest to this inquiry. Further information on government's work on self-driving vehicles can be found in the recently published '[Connected & Automated Mobility 2025: Realising the benefits of self-driving vehicles in the UK](#)'.

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3. A note on language

- a. The term 'Connected and Automated Mobility' is used here to refer to the sector and broad set of vehicle technologies that can be used in wheeled (non-rail), ground-based vehicles as opposed to any other definitions.
- b. Self-driving capability is a specific application of Connected and Automated Mobility technologies. A self-driving vehicle is one that has at least one self-driving feature, delivering sufficiently high levels of automation that it meets a legally defined threshold and is capable of safely driving itself with no human input. Such features could provide self-driving capability for all or part of a journey. The term automated can refer to a wider range of automation, including technologies which are not capable of self-driving. Although often used interchangeably,

the terms self-driving and automated are therefore used in distinct ways in this document.

- c. The clear and accurate use of language is important because of the need to build public understanding of Connected and Automated Mobility technologies and ensure clarity of associated responsibilities.
- d. Many of the terms used relating to the proposed new legislative framework are derived from those used in the Law Commissions' published report, for example the planned new legal entities, and may be subject to change as they are turned into legislative proposals.

Section 1 - Introduction and summary

1. A global transport revolution is happening that will transform the future, improving people's lives and the country's productivity. The UK is reaching a transition point in the emergence of the sector and application of the technologies to solve transport problems. Driven forward by an ambitious, clear and comprehensive Future of Transport strategy, government is developing regulation, investing in innovation and skills, and engaging the public to harness the potential of self-driving vehicle technology and create a thriving automotive sector.
2. Self-driving vehicles are fast approaching commercialisation in markets across the world. By 2035, 40% of new cars in the UK could have self-driving capabilities: the UK market alone could be worth as much as £42 billion by 2035, creating as many as 38,000 jobs in the sector; and the technologies could increase UK productivity by allowing drivers to benefit from optimised route planning, improved traffic flow and by giving them more productive time in their vehicles. Importantly, these vehicles could also make the roads safer, reducing the number of collisions involving human error – which is currently a factor in over 80% of collisions that result in personal injury.
3. This will be the future of road travel, but this is the beginning of this journey, and human drivers will share the roads with self-driving vehicles for many years to come. It is therefore vital for us to manage the changes that they will bring by introducing the right rules, training and support at the right time.
4. Government's Centre for Connected and Autonomous Vehicles was established in 2015. It is a UK government policy team which reports jointly to the Department for Transport and the Department for Business, Energy and Industrial Strategy, and aims to secure the UK's position at the forefront of the safe development, production and use of connected and automated mobility technologies. Since 2015, the UK has significantly improved its international ranking from a lagging position to being amongst the world leaders. This has been achieved through the government's focus

on an enabling regulatory environment, research & development, testing infrastructure and public engagement.

5. The Government welcomes the potential for self-driving technologies to contribute to key government objectives such as: securing economic growth, safer roads, improved access to transport and transport decarbonisation. To capitalise on this potential, ‘*Connected & Automated Mobility 2025: Realising the benefits of self-driving vehicles in the UK*’ was published in August 2022 (referred to as “Connected and Automated Mobility 2025”). It sets out government’s approach to secure the UK’s long-term position as a leading market to safely develop and deploy connected & automated technologies.

6. ‘Connected and Automated Mobility 2025’ establishes the government’s vision: “By 2025, the UK will begin to see deployments of self-driving vehicles, improving ways in which people and goods are moved around the nation and creating an early commercial market for the technologies. This market will be enabled by a comprehensive regulatory, legislative and safety framework, served by a strong British supply chain and skills base, and used confidently by businesses and the public alike.”

7. Government’s vision will be delivered in collaboration with industry, academia, and alongside central, regional, and local government partners via three pillars of activity as depicted below.



Activities	Pillar 1: Ensuring safety and security of CAM	Pillar 2: Securing the industrial and economic benefits of CAM	Pillar 3: Delivering the societal benefits of CAM
	<ul style="list-style-type: none"> Establishing a new safety ambition for self-driving vehicles that will shape safety assurance and legislation. Introducing legislation to clarify responsibilities and create the safety framework, including responding to Law Commissions' recommendations. Developing and implementing new safety and cyber security assurance processes including new safety requirements and test processes both before vehicles are in use and for their whole lifetime. Enabling safe trials and early deployment of self-driving vehicles through close collaboration with developers and manufacturers. Shaping the safety and security programme to address public concerns to build trust and willingness to use self-driving technologies. 	<ul style="list-style-type: none"> Allocating over £60m of new government R&D funding to leverage private sector investment that will drive the sector's transition into commercialisation, with £40m targeted at the deployment of CAM services and £20m towards supply chain capabilities. Encouraging the training and skills that enable a successful CAM sector. Coordinating work across government and its arms-length bodies, Zenzic and CAM Testbed UK, and industry bodies such as the UK Automotive Council and Logistics UK to drive innovation and help businesses address challenges through CAM technologies. Driving international engagement, inward investment, and trade opportunities for the UK CAM ecosystem by collaborating with partners across Whitehall and in industry. 	<ul style="list-style-type: none"> Promoting CAM deployment in alignment with Future of Transport principles. Developing CAM with the public through activities including engagement and research on public priorities for the technologies. Working with stakeholders to communicate with vehicle and road users about how to use and interact with self-driving vehicles. Working with partners on the integration of CAM into wider networks, including road networks, mass transit systems and wireless networks. Further consideration of research into CAM's role in delivering our environmental commitments.

8. Connected & Automated Mobility 2025 provides further detail on this programme of work. The following sections of this document respond to each of the subjects identified in the inquiry, linking to the Government's plan.

Section 2 - Likely uses, including private cars, public transport and commercial vehicles, and levels of automation

9. Self-driving vehicles could lead to a broad range of potential uses and services, from logistics and freight vehicles, to shared public transport options and privately owned vehicles. Government has already set out nine principles that help define the vision for future transport and guide how government can harness the opportunities and mitigate the unintended consequences of profound changes in the way people travel (see section 8

for more detail). The approach to self-driving vehicles has been developed with these principles in mind.

10. The government-led social behavioural research programme, the 'Great Self Driving Exploration' included work to understand the public's views on how the technology should be deployed and what needs to be put in place to ensure it meets the needs of end users. As part of this, 1073 members of the public took a ride in a self-driving vehicle and there were over 90 hours of deliberation with members of the public, including representation from a range of demographic groups, such as those living with long term health conditions, older adults and young people. Analysis is currently underway, but early insights suggest ways in which self-driving vehicles could address current transport challenges, particularly in rural areas, and improve current transport provision.

11. There are several initial uses under development by industry including:
 - a. vehicles with Automated Lane Keeping Systems, which is a technology designed to control a vehicle while on motorway-type roads without a human monitoring the driving task. This could give people with motorway commutes the ability to reduce the stress of their journey whilst using the time more productively.
 - b. vehicles that could offer the provision of passenger and freight services on specific routes or a specific area using purpose-built novel vehicles, for example:
 - i. grocery delivery allowing for pinpoint accuracy of location, increasing efficiency and reducing waiting times for the people receiving it.
 - ii. passenger shuttle services could be introduced between small villages and nearby cities, potentially utilising old railway lines and stations, giving people access to more jobs, reducing isolation and loneliness of those unable to drive, and encouraging development in the village in light of improved transport links.
 - iii. self-driving car clubs, allowing families that have short term increased demands on their transport to travel to two different places at once, e.g. one to work and one to a train station, without the addition expense of a second vehicle and station parking costs.
 - c. off-road use cases, such as:

- i. airside automated luggage dollies allowing for a more effective and efficient use of aircraft, reducing wait times and allowing staff to focus more on safety and customer service.
- ii. mining applications, improving safety by allowing people to be removed from the inherent risks associated with operating heavy trucks in mining operations while improving productivity within the complexes.

12. The level of automation that a system can deliver is particularly important in relation to determining accountability for the driving performance of the vehicle. The Society of Automobile Engineers' levels of driving automation (SAE J3016) defines six levels of driving automation, levels zero to five. However, the recent multi-year review from the Law Commission of England & Wales and the Law Commission of Scotland (the Law Commissions) found these are not useful in determining liabilities. Instead, government will either identify a vehicle as 'self-driving' or not. If a vehicle is self-driving, government will make a further distinction:

- a. The vehicle has the functionality to both be driven or drive itself for some or all of the journey. When the vehicle is driving itself, the driver is not responsible for how the vehicle drives, though they retain other responsibilities such as insurance and vehicle roadworthiness. When the vehicle is *not* driving itself, it is treated as a conventional vehicle.
- b. The vehicle drives itself for the whole journey (e.g. a fixed-route shuttle). No occupant is a driver during the journey and, in some cases, it may not be possible for the vehicle to be traditionally driven (e.g. it may not have a steering wheel or other conventional controls). A licensed operator will provide oversight of the vehicle and ensure it is properly insured and maintained.

13. As of August 2022, there are no self-driving vehicles commercially available in the UK.

14. Both driver assistance technologies and self-driving vehicle technologies are likely to play a key role in road transport, alongside drivers of conventional vehicles, for years to come. Driver assistance technologies are designed to undertake some elements of the dynamic driving task, such as braking or steering. They require a human driver to monitor the road

environment at all times and the human driver remains responsible for the behaviour of the vehicle at all times. Self-driving technologies are designed to undertake all elements of the dynamic driving task and must be sufficiently capable that a human driver is not needed in order for the vehicle to behave safely and legally on the road when the technology is active under agreed conditions. If this bar is met, under the government's legislative proposals, the human driver would no longer be responsible for the vehicle's behaviour whilst it is driving itself.

15. During the transition to self-driving vehicles it is vital that people in the driving seat understand the capabilities and limits of the vehicles they are operating and recognise their responsibilities. In line with the Law Commissions' recommendations, government proposes a clear legal distinction between driver assistance technologies and self-driving technologies to ensure safe use and fair allocation of responsibilities.

Section 3 - Progress of research and trials in the UK and abroad

16. The UK's open regulatory regime, world class research base, and industry and government investment in Connected and Automated Mobility technologies have earned the UK a place among global leaders in Connected and Automated Mobility technology research and development, including in self-driving technologies.
17. Since 2015, the Centre for Connected and Autonomous Vehicles has enabled joint public and private investment of over £400 million into connected and self-driving vehicle innovation. The Centre for Connected and Autonomous Vehicles has supported over 90 collaborative projects, involving over 200 organisations. These projects include several world and European first projects, as well as standards development with the British Standards Institute and a globally recognised four-year review of regulation by the Law Commissions.
18. Within the £400m co-investment, government and industry have jointly invested nearly £200m to establish a globally unique testing infrastructure. With six increasingly interoperable core facilities, coordinated by Zenzic, Connected and Automated Mobility Testbed UK offers a comprehensive set of capabilities across virtual, controlled, and public testing environments for the development of connected and automated mobility technologies, all within a 3-hour drive.
19. Over the next 3 years, government will provide a further £100m of funding for Connected and Automated Mobility technology research and innovation, with £66m aimed at progressing from technology development towards commercial deployment, and £34m to support research into connected and self-driving vehicle safety assurance and preparation within the motoring agencies to carry out their new roles.
20. Government is also considering requirements for increasingly advanced trials. The UK Code of Practice for testing automated vehicles on public roads is recognised as one of the most open in the world, and government is working to consider whether updates to the Code of Practice are needed to further support advanced trials. This is part of a dedicated trials

workstream within the CAVPASS (Connected and Automated Vehicles: Process for Assuring Safety and Cyber Security) programme, which was set up in 2019 to work with organisations that wish to trial and provide support to address any challenges they face.

21. Since 2015, trialling in the UK has progressed from early testing of designs and concepts, through proof of concept demonstrations and is now moving towards piloting viable commercial services in moving freight and passengers. This has seen a variety of businesses develop within the Connected and Automated Mobility sector and the wider supply chain, addressing areas such as the design and development of vehicles, software and sensors, experts in the development of safety case assessments, and those bringing forward operational deployments to test the technology.
22. Examples of projects supported with government funding to date in the UK include:
 - a. In 2019, the Nissan-led **HumanDrive** project completed its 230 mile Grand Drive, the UK's longest and most complex automated journey (and one of the most ambitious achieved in Europe), including country lanes with no or minimal road markings, junctions, roundabouts, and motorways.
 - b. Currently being undertaken is the **CAVForth** project, which will be utilising five full-sized single deck buses to operate a 14-mile route between Ferry Toll park and ride in Fife to Edinburgh Park. This will require the bus to navigate complicated road junctions, manoeuvre between lanes, and respond to road closures while achieving up to 10,000 passenger journeys per week. The project is being delivered in partnership with Fusion Processing Ltd, Stagecoach Plc, Alexander Dennis Ltd, Transport Scotland, Napier University and Bristol Robotics Lab.
 - c. The 2021 Oxbotica-led '**Project Endeavour**' focussed on explaining technologies to the public, helping to build understanding. This project worked in collaboration with road safety charity Brake to increase public understanding about self-driving vehicle safety.
23. It is important to note that trialling is not limited to just the physical testing of self-driving vehicles, and that wider research, such as into vehicle

standards, will also play an important role. For example, as part of the CAVPASS programme, government has commissioned a recently completed series of projects to inform development of technical standards for automated driving systems.

24. Government's focus is now on supporting the commercialisation of connected and automated mobility technologies. £66 million of new BEIS funding over three years has been allocated to support research and development in the Commercialising Connected and Automated Mobility programme, comprising:

- i) £40 million "Deployments" competition to support commercial service deployments (freight or passenger) on private land or public roads from March 2025. Currently under independent assessment, the competition was heavily oversubscribed and attracted bids from across the UK. It is intended to deliver "European first" projects that bring investors, UK small and medium-sized enterprises and local authorities together to solve a specific transport challenge.
- ii) £16 million Supply Chain competition which launched on 21 October to strengthen sovereign capabilities, increase the UK elements within the growing connected and automated mobility supply chain, and to support UK small and medium-sized enterprises to innovate.
- iii) £1.5 million Feasibility Studies competition to investigate how segregated connected and automated mobility solutions could offer viable alternatives to traditional mass transit options, e.g., repurposing disused land or railway lines.

International trials

25. The UK continues to be a world-leader in self-driving vehicle research and trialling. With the creation of the Centre for Connected and Autonomous Vehicles in 2015, the UK showed a uniquely integrated approach to self-driving vehicles as demonstrated in the recent Connect and Automated Mobility 2025 policy paper. According to KPMG's Autonomous Vehicle Readiness Index, "The UK has a really healthy ecosystem for early stage work, with a lot of tests and trials"¹.

26. United States of America

- a. In the USA, a number of states are enabling trialling of self-driving technologies. According to the National Highway Traffic Safety Administration AV TEST Initiative², there are 103 active self-driving trials across the United States, with the majority focused on shuttle and car vehicle types. For example:
 - i. Currently, Arizona has self-driving vehicles that are operated by more than a 12 developers.
 - ii. Waymo and GM Cruise are carrying passengers in their self-driving robotaxis in San Francisco.

27. Europe

- a. The EU's Horizon Europe includes up to €600m over seven years (€122m already made available for the first two years) for ERTRAC's Connected Collaborative and Automated Mobility partnership. The Horizon 2020 project has funded 17 projects so far ranging from in-vehicle technologies, to and demonstrating activities towards larger scales. For example:
 - i. AVENUE, a four-city deployment of self-driving mini-buses which started in 2018.
 - ii. ENSEMBLE, the development of self-driving trucks.

28. Germany

- b. Germany is expecting deployments from 2022. For example:
 - i. The German automotive company ZF has announced that they will operate its battery electric fully self-driving shuttles as an alternative to buses in the German state of Baden-Württemberg, with trials starting by the end of 2023.

29. France

- a. France has offered a €200m fund (2021-2023) for "Automated, connected, and low carbon road" projects including "digitization and decarbonization of mobility". For example:
 - i. French manufacturers EasyMile and Navya are self-driving innovators and several French operators are working toward integrated public transport solutions.

30.Singapore

- a. There have been various public trials in Singapore since 2015, and since 2019 the self- driving testing area has been extended to the western half of the country to over 600 miles of public roads. For example:
 - i. Since December 2020, the National Parks Board has operated an 11-seater self-driving shuttle service in Singapore's newest national garden.
 - ii. Singapore's Land Transport Authority will pilot the deployment of 100 autonomous buses and self-driving on-demand shuttles from 2022.

Section 4 - Potential implications for infrastructure, both physical and digital

31. Self-driving vehicles will need to be able to safely operate using existing infrastructure and therefore immediate changes to infrastructure are not anticipated. However, some advanced functionality may depend on infrastructure changes in future to maximise the benefits of these technologies (e.g. to maximise efficiency and provide advanced warning of hazards).

32. Widespread digital connectivity and 'Vehicle to Infrastructure' communications can be key enabling technologies for maximising the future benefits of Connected and Automated Mobility. The benefits V2I infrastructure could provide are:

- a. improving management of the road network by enabling real time communication between vehicles and transport infrastructure, such as green light optimisation which could significantly reduce energy usage on journeys.
- b. improving and reducing the costs of infrastructure maintenance by using vehicles to monitor the wear and tear of roads, reducing impact on the wear and tear on vehicles.
- c. enabling more effective monitoring, predicting, and controlling of route demand, enabling the better design and use of public transport and space, and making the UK's communities more attractive places to live.

33. Wireless connectivity and infrastructure can help to maximise the benefits of self-driving vehicles. 4G coverage across major roads in the UK is currently at 66%, with urban coverage at 84% and rural coverage at 57%, which the £1 billion Shared Rural Network Programme will help to address. In addition, government launched the £200 million 5G Testbeds and Trials (5GTT) Programme in March 2017, which funded the 5G-Cal trial, which saw connected and self-driving 40-tonne trucks driving around the Nissan Plant in Sunderland.

34. Government will work with road authorities and other stakeholders to prepare the UK's road network and infrastructure and drive innovation through the development and promotion of standards, targeted research

and engagement with education providers to provide road authorities with the guidance and skills they require.

35. National Highways is exploring the operational impact of self-driving vehicles on the Strategic Road Network. This will include the impact of vehicles with Automated Lane Keeping Systems and other emerging forms of self-driving technologies on operational procedures, such as the traffic management of incidents. They will also be researching road layout, lane markings and roadwork design, digitisation and implementation standardisation to support other use cases of self-driving vehicles.

36. The National Highways Digital Roads Programme tackles the digital infrastructure implications, through three digital-by-default ambitions: digitally enabled design, modularised and standardised approaches, and automated construction.

37. Government is exploring potential research on creating a 'national architecture' to bring together the work on the SRN and the local road networks through managed system integration.

38. It is also recognised that for communities to capitalise on the benefits of these technologies, particularly where they become increasingly integrated into existing local and national digital networks, efforts will need to be made to ensure that security is protected. Government has committed to implementing new cyber security assurance processes, building on the Connected Places Cyber Security Principles developed by the National Cyber Security Centre (NCSC), to ensure that transport applications such as Connected and Automated Mobility can be safely integrated.

Section 5 - The regulatory framework, including legal status, approval and authorisation processes and insurance

39. The existing safety framework for roads and road vehicles is extensive, covering a wide range of issues that have implications for drivers and other road users, such as: vehicle standards that enable a car to be registered and approved for use in the UK, obtaining a driving license, the rules of the road and enforcement of motoring offences. But it has been developed with the human driver at its heart.
40. New and innovative self-driving technologies are pushing the boundaries of existing legislation and safety assurance processes. In addition, self-driving vehicle technologies and services will not be successful in the UK without a robust regulatory framework that provides certainty for innovators and investors, as well as confidence for the public that the technologies are safe, secure, equitable and work in the interests of society. Government therefore intends to introduce legislation to create a new safety framework which will enable a new era of safe self-driving road vehicles.
41. This framework will be based on the multi-year review of legislation by the Law Commissions to prepare for the safe introduction of self-driving vehicles on GB roads. This world-leading, government-funded review concluded in January 2022 with the publication of a report with 75 recommendations to government. Taken together, these set out a new regulatory framework for self-driving vehicles. The review involved extensive consultation across the self-driving vehicle landscape, including manufacturers, insurers, academics, and civil society, generating a wealth of evidence. It has provided international thought leadership on the way in which self-driving vehicles should be regulated. The recommendations underpin government's plans, set out in the 'Connected and Automated Mobility 2025' paper, to establish a comprehensive safety and regulatory framework for self-driving vehicles.
42. The new safety and regulatory framework will need to meet the needs of society and industry in ensuring the safety of self-driving vehicles, with some of the most significant changes being to how the safety of the self-driving system is assured. Critical to setting out the extent of the framework will be establishing how safe self-driving vehicles need to be.

43. A high-level safety ambition for self-driving vehicles was the subject of a recent public consultation, which sought views on government's proposal that self-driving vehicles would be expected to achieve an equivalent level of safety to that of a competent and careful human driver. The consultation closed on 14 October and responses are being considered. The safety ambition will be expanded upon in a set of the National Safety Principles, setting out expectations for self-driving vehicles.
44. Guided by the safety ambition and National Safety Principles, vehicles and their developers and/or operators will be subject to a cycle of approval, authorisation, operator licensing, in-use regulation and incident investigation which aim to answer the following questions:
- a. Approval – is the vehicle technically safe?
 - b. Authorisation – should the vehicle be permitted to drive itself?
 - c. Operator licensing - where the vehicle needs no driver at all, is there a responsible operator behind it?
 - d. In-use regulation – are vehicles safe when used on GB roads?
 - e. Incident investigation – how can real-world evidence be used to continuously improve and update assessment requirements?
45. Automated driving systems would be assessed against safety requirements, most often through approval to either national or international technical standards.
46. Vehicles with these systems could then be put forward for authorisation to determine whether they should be permitted to drive themselves in at least some circumstances or situations. This will include identifying the organisation responsible for the vehicle when it is driving itself.
47. Where the vehicle requires no driver at all, government intends to identify a responsible operator which must be licensed to oversee the vehicle's operation. These operators would then take over remaining driver roles such as ensuring roadworthiness and appropriate insurance for the life of the vehicle.

48. Government intends to establish a new regulatory regime to monitor the ongoing safety of self-driving vehicles, enhancing existing processes for checking conventional vehicles. This in-use regulation would be able to respond dynamically to unforeseen issues. It would also be able to issue sanctions to the responsible organisation(s) if standards fall below those set out in the National Safety Principles or in wider regulation. The ability for a vehicle to 'explain' its actions is likely to be a fundamental component of in-use regulation, as highlighted by the Centre for Data Ethics and Innovation's (CDEI) report "Responsible Innovation in Self-Driving Vehicles", published alongside the 'Connected and Automated Mobility 2025' paper. Understanding what happened following an incident, and to what extent it was caused by a failure of due diligence by the responsible organisation or something that could not have been predicted, will make for a more intelligent regulatory framework.

49. If a specific incident of concern occurs, or a significant negative trend is identified, the proposed Road Safety Investigation Branch (RSIB) may also investigate and identify learnings, which will be fed back into the approval, authorisation, licensing or in-use regulation processes.

50. The intention is that the framework as a whole creates a safety feedback loop which provides for continuous learning throughout the life of a self-driving vehicle.

51. Government intends to create new legal entities to ensure clear and fair responsibility for self-driving vehicles. For self-driving vehicles where the self-driving systems can only drive the vehicles for part of the journey, government will consider the human driver to be a User-in-Charge (UIC) when the vehicle is driving itself and therefore no longer responsible for the behaviour of the vehicle. They will remain responsible for other legal requirements however, such as vehicle insurance, loading and roadworthiness. It is the intention that responsibility for the vehicle's behaviour will pass to its Authorised Self-Driving Entity (ASDE).

52. An Authorised Self-Driving Entity is likely to be a vehicle manufacturer or software developer, or a partnership between the two. If a self-driving vehicle breaks a traffic law while it is driving itself, for example by driving in

a bus lane, the human occupants will not be responsible, instead the Authorised Self-Driving Entity will be responsible and could be subject to regulatory sanctions.

53. For self-driving vehicles where the self-driving system can drive for the entire journey, any human in the vehicle would be merely a passenger. The vehicle would not require a User-in-Charge and is therefore referred to as a No User-in-Charge vehicle under the planned framework. Responsibility for the behaviour of these vehicles would remain with the Authorised Self-Driving Entity. However, they would also need to have a licensed operator, a 'No User-in-Charge Operator', which would be responsible for overseeing the wider operation of the vehicle and taking on the non-dynamic driving task responsibilities, such as ensuring the vehicle has appropriate insurance, that would otherwise remain with the User-in-Charge. This is similar to a bus operator who purchases buses from a manufacturer but is responsible for their operation.
54. Vehicles run by a No User-in-Charge Operator could be offered in a public transport capacity, but it would also be possible for these vehicles to be leased to individual owners, operated as part of a car club or operated by delivery companies as self-driving freight vehicles. It is therefore believed that the new framework could open up a whole new market with the potential for many different business models.
55. To support the development of new, updated and/or revised safety assurance processes for self-driving vehicles, the Centre for Connected and Autonomous Vehicles has instigated a programme that seeks to identify, assess and develop solutions for the issues and challenges that self-driving vehicles bring. This programme, CAVPASS (Connected and Automated Vehicles: Process for Assuring Safety and Security), was launched in 2019 and brings together expertise from across the Department for Transport (DfT) and its motoring agencies as well as from other government departments. The programme also draws on wider expertise from the CAVPASS Expert Advisory Panel (EAP), which includes members from outside government with a range of relevant expertise.

56. The aim of CAVPASS is to put in place the processes, systems and capabilities necessary for government assurance of the safety and cyber resilience of connected and self-driving vehicles by 2025 and is split into six workstreams:

- a. Workstream 1 – Automated vehicle approval and in-service compliance
- b. Workstream 2 – Self-driving vehicle authorisation & legislative elements
- c. Workstream 3 – Safe use of connected and self-driving vehicles
- d. Workstream 4 – Enablers and implementation: government skills, capabilities & assets
- e. Workstream 5 – Safety of self-driving vehicle trials
- f. Workstream 6 – Cyber security and data

57. Alongside regulatory processes, government is supporting the development of industry standards to support safe early development and deployment. The British Standards Institute (BSI), funded by the Centre for Connected and Autonomous Vehicles, has been working with industry partners, local authorities and academia to develop a number of publicly accessible specifications (PASs) – a type of fast-tracked standard – related to self-driving vehicles. These specifications will set out good practice and are reviewed over time to ensure they remain fit for purpose.

58. The UK has already introduced and implemented world-leading legislation on insurance for automated vehicles through the Automated and Electric Vehicles Act 2018, to support quick access to compensation for victims of an incident involving an automated vehicle. The provisions in this Act extend compulsory motor vehicle insurance to cover the use of automated vehicles, so that the insurer will be initially liable to pay compensation to any victim, including to a driver who had legitimately handed control to the vehicle. The insurer then would have the right to recover costs from the liable party under existing common and product law.

Section 6 - Safety and perceptions of safety, including the relationship with other road users such as pedestrians, cyclists and conventionally driven vehicles

59. The UK has some of the safest roads in the world. However, even in 2020 – when travel was severely disrupted – more than 1,460 people were killed on UK roads. Because human error is a significant factor in many road collisions, self-driving technologies have the potential to further improve safety. The Institute for Engineering and Technology (IET) claim that for every 10,000 errors made by drivers, a self-driving vehicle will commit just one.
60. Government seeks to realise the safety benefits from self-driving vehicles as soon as possible to prevent needless injuries and deaths. To achieve this, the safety requirements must not be set at a level that stifles innovation or sacrifices near-term safety improvements. Equally, requirements should be high enough to avoid the safety benefits being very low or non-existent. The aim is to balance safety, innovation and public expectations.
61. A public consultation asking for views on the government’s proposed safety ambition - that self-driving vehicles would be expected to achieve an equivalent level of safety to that of a competent and careful human driver - opened in August 22 and closed on 14 October 2022. The standard of a competent and careful driver is higher than that of the average human driver. This is because the concept of an average driver encompasses a large range of human performance which includes, for example, drivers who are fatigued, distracted or under the influence of drink or drugs.
62. Technology is not infallible, and new technologies bring new risks and challenges which must be managed and met, for the benefit of all. The proposed safety assurance framework will set out the means by which the safety ambition will be achieved, including through a proposed set of National Safety Principles for self-driving vehicles. It will not be acceptable for self-driving vehicles to improve safety for vehicle users at the expense of more vulnerable road users, including pedestrians, cyclists, motorcyclists or horse-riders.

63. At a more detailed level, government intends to require any organisation seeking authorisation of their vehicle as self-driving to submit an assessment of fair outcomes, including considerations of data bias, which must include how they avoid their vehicles unfairly discriminating against certain people. They will also need to consider the importance of accessibility for people with different disabilities.
64. Road safety is also not the result of vehicle technology alone and can only be achieved by addressing and aligning the many factors that contribute towards it – adopting a ‘safe system’ approach. As well as ensuring new technology is designed with safety at the forefront, users and operators must know how to use the vehicles safely, and other road users must understand the technology and how to interact with it.
65. One of the challenges that will be presented by the introduction of self-driving vehicles is that of how other road users interact with and around them, as their introduction presents a possible change in the dynamic for how people understand the relationship between a driver and themselves works. To build an understanding of how this may manifest, a programme of Social Behavioural Research is underway that is examining these issues, while also more broadly working to raise awareness of self-driving vehicles.
66. Areas that the research is addressing includes:
- a. Understanding the factors influencing current travel behaviour
 - b. Understanding perceptions and attitudes towards new modes of transport
 - c. Understanding the concern, barriers and requirements of the public and where these may differ between different groups
 - d. Embedding these findings into the design on new technologies and services
 - e. Identifying relevant policy levers, and designing and implementing behavioural change interventions
 - f. Improving public awareness, building an accurate understanding and increasing willingness to use new technologies to drive uptake and ensure safe use
 - g. Monitor changes in perception, knowledge and behaviour

67. As part of the government-led research, findings from our Future of Transport deliberative research³ explored the factors that influenced perceptions of safety and the minimum safety requirements that would be required for participants to consider self-driving vehicles as safe enough. Two of the commonly identified factors were: evidence of safety; and regulation and oversight.
68. The Department for Transport's long-running "Transport and transport technology public attitudes tracker survey"⁴ has shown that the public see self-driving vehicles as providing several safety benefits, but they also continue to have concerns. A government-led group of industry experts (AV-DRiVE) is looking to improve safety by improving accuracy of understanding, in particular what the technology is able to do and unable to do.
69. One of the key findings emerging from the range of research that has been undertaken to date has been the need to differentiate between road safety and personal safety when discussing the safety impacts of self-driving vehicles, as well as the potential tension between the two. Thinking about the removal of the human driver on public or shared transport led to the perceived risks to personal safety feeling more pronounced, while specific risks around accessibility or an increase in the likelihood of antisocial or criminal behaviour were also highlighted.
70. Personal safety will be a key consideration in the development of self-driving vehicles, services and regulation. This is consistent with the Department for Transport's commitment to ensuring the transport network is safe for all. One element mentioned throughout the research was that these concerns were particularly prominent for women, older adults and those with mobility impairments.
71. In-use regulation (as part of the proposed National Safety Principles) may include a duty for the Authorised Self-Driving Entity, and other third parties, to report data relating to discriminatory behaviour by their vehicle(s) allowing for continued learning and potential for action to be taken to resolve issues.

72. Making education available for the general public is necessary to ensure that they know whether they are using a self-driving vehicle (as opposed to a driver assistance system), that they know how to use it appropriately and that they understand the responsibilities that they retain when in a self-driving vehicle. It's also important for there to be understanding amongst those not using the vehicles, for example pedestrians, cyclists, public transport users and other road users, such as motorcyclists.
73. As an important step in enabling the education of drivers who may soon use vehicles with self-driving technologies, government has laid an amendment to The Highway Code in Parliament which came into force on the 1 July 2022. This creates a new section to explain driver responsibilities and rules about the use of self-driving vehicles, for example: that a driver must remain able to respond to a transition demand in case the vehicle needs to hand back control; and that some activities will continue to be restricted while others may be possible while a vehicle is safely driving itself in accordance with instructions. In addition, government worked with the Society of Motor Manufacturers and Traders (SMMT) to develop guiding principles for marketing self-driving vehicles, which were published in November 2021.
74. Looking to the future, there will be a need to develop educational materials to ensure that they improve accurate understanding of the technologies and that they are clear and accessible to all. The current focus is on Automated Lane Keeping System (and other user-in-charge self-driving vehicle technologies) including the development of a publicly tested toolkit to support industry and public bodies.

Section 7 - The role of government and other responsible bodies, such as National Highways and local authorities

75. Government's role going forward is to help realise the transport, economic and wider societal benefits that self-driving vehicles could unlock, ensuring safety and security.

76. This position was reinforced by the call for evidence on Connected and Automated Mobility in June 2021, which provided crucial insights into the economic, industrial and societal benefits of Connected and Automated Mobility and how the technologies can support government priorities. Stakeholders were clear that they felt government still has an important role to play in securing the safety and security of UK roads, ensuring societal benefits are received in both urban and rural areas including for disabled people, supporting decarbonisation as well as continuing the UK's reputation as a leading destination to develop and deploy Connected and Automated Mobility.

77. In August 2022, Government published its Connected & Automated Mobility 2025 paper. This sets out a plan for realising the benefits of self-driving vehicles, including the actions to be taken forward, which are detailed in the introductory section to this document. Please also see the response to section 4 on potential implications for infrastructure.

78. In delivering on Government's vision, it will be essential to work with industry, local government, safety organisations and others as a collective to move towards the safe roll out of self-driving technologies. The Centre for Connected and Autonomous Vehicles will continue to bring together all parts of Government with an interest in order to align policies and delivery programmes. This includes building on links with Local Government, which is instrumental in providing direction to projects and deployments so that they integrate with local passenger and goods transport provisions and meet people's needs.

Section 8 - Potential effects on patterns of car ownership, vehicle taxation and decarbonisation in the car market

79. The government's work on self-driving vehicles sits within the wider context of emerging transport technologies and business models, and the Future of Transport programme was created to respond to these radical changes. The programme aims to stimulate innovation, prepare the UK for new technologies, support the transition to zero emission, and create a world-leading future transport system that is safe, secure, and accessible to all. Government has already set out nine principles that help define the vision for future transport and guide how government can harness the opportunities and mitigate the unintended consequences of profound changes in the way people travel. The government's approach to self-driving vehicles has been developed with these principles in mind, as set out below.

80. In facilitating innovation in urban mobility for freight, passengers and services, the Government's approach will be underpinned as far as possible by the following Future of Transport Principles⁵:

1. New modes of transport and new mobility services must be safe and secure by design.
2. The benefits of innovation in mobility must be available to all parts of the UK and all segments of society.
3. Walking, cycling and active travel must remain the best options for short urban journeys.
4. Mass transit must remain fundamental to an efficient transport system.
5. New mobility services must lead the transition to zero emissions.
6. Mobility innovation must help to reduce congestion through more efficient use of limited road space, for example through sharing rides, increasing occupancy or consolidating freight.
7. The marketplace for mobility must be open to stimulate innovation and give the best deal to consumers.

8. New mobility services must be designed to operate as part of an integrated transport system combining public, private and multiple modes for transport users.

9. Data from new mobility services must be shared where appropriate to improve choice and the operation of the transport system.⁶

81. Connected and automated mobility holds huge potential to improve the way people travel and move goods, but different options for how connected and automated mobility is introduced to the UK transport network, as well as different formats and business models, will vary in terms of how they support government policy objectives.

82. Current market trends show a move from private ownership to lease, with over three quarters of all new private cars purchased using finance in 2021. With the increase in car subscription services this trend is seen not just in the automotive industry but across all consumer technological sectors. Self-driving vehicles are expected to accelerate this trend in the automotive arena and bring forth new business models.

83. For example, business models that make it easy to access flexible and high-quality shared and public transport options. This model could help minimise carbon emissions, reduce the amount of parking/road space needed and improve access to jobs, services and education for those less able to own their own vehicle or drive; alongside helping to reduce the number of collisions resulting from human error. However, alternative business models could result in the opposite or more limited impact to these outcomes.

84. Connected and Automated Mobility could also offer a new mass transit option and provide an alternative to rail and bus. Under various types of operation, self-driving mass transit could provide an additional public transport service that is safe, zero-emission, demand responsive, alongside being flexible and cost effective. Unlike self-driving services on public roads, which require legislation changes to maximise their benefits, self-driving services on fully segregated routes could potentially be regulated under existing arrangements for guided transport. To build our understanding of the potential, the recent £1.5 million Feasibility Studies

competition sought suitable projects to explore the likely costs/benefits of such uses for connected & automated technologies (see Section 3 for more detail).

85. The Office for Budget Responsibility estimated that in 2022-23, £7.2 Billion would be raised via Vehicle Excise Duty (VED)⁷. The new business models and patterns of car ownership that self-driving vehicles could facilitate could affect this amount. Like all taxes, the Government keeps VED under review and any changes are considered by the Chancellor.

86. Government is working with industry partners, local and regional government, and transport bodies to understand the potential costs, benefits and best use of the technologies compared to traditional modes.

87. Government will consider how Connected and Automated Mobility can contribute to delivering on the commitments in the Transport Decarbonisation Plan and 25 Year Environment Plan, also drawing on the 'Connected and Automated Vehicle Decarbonisation Paradox Report'⁸. This may include factors such as how self-driving technologies in zero-emission vehicles and connected infrastructure could smooth traffic flow and reduce emissions per mile, improving air quality as a result and helping the UK to build back greener to meet its net zero carbon commitments. Other identified potential benefits include improving safety, easing congestion and reducing emissions.

88. Feedback to the 2021 consultation on the future of transport Rural Strategy identified a wide range of issues in rural and remote communities that new technologies such as Connected and Automated Mobility could help address. This included the potential to lessen the high levels of private car dependency in rural areas by providing more frequent, demand responsive-driven Connected and Automated Mobility services. This would support addressing the 53% of emissions from transport that originate in rural areas despite these areas only containing 17% of the population⁹.

89. Further innovation and research within the Connected and Automated Mobility sector may provide further opportunities from those already identified to achieve the governments net zero target by 2050. Through

engagement with the industry, government will consider the findings of research into Connected and Automated Mobility's role in decarbonisation and whether it could inform any potential future policy levers.

October 2022

Endnotes

¹ <https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/07/2020-autonomous-vehicles-readiness-index.pdf>

² <https://www.nhtsa.gov/automated-vehicle-test-tracking-tool>

³ <https://www.gov.uk/government/publications/future-of-transport-deliberative-research>

⁴ Transport and transport technology: public attitudes tracker – GOV.UK (www.gov.uk)

⁵ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf

⁶ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf

⁷ <https://obr.uk/forecasts-in-depth/tax-by-tax-spend-by-spend/vehicle-excise-duty/>

⁸ <https://cp.catapult.org.uk/news/cav-decarbonisation-paradox-report-launched/>

⁹ Analysis of local authority CO₂ emissions (2019) classified as rural or urban according to DEFRA local authority classification. <https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/uk-local-authority-andregional-carbon-dioxide-emissions-nationalstatistics-2005-to-2019>; <https://www.gov.uk/government/statistics/local-authority-ruralurban-classification>; and Statistical Digest of Rural England, April 2022 Edition, Department for Environment Food & Rural Affairs https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1072780/03_Statistical_Digest_of_Rural_England_2022_April_edition_final1.pdf