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Integrating Connected and Autonomous Mobility into the UK transport system

How can we achieve an enabling digital infrastructure?

March 2025

Introduction

The techUK Self-Driving Vehicles Working Group brings together individuals and organisations across the CAM sector, to provide thought leadership and steering to Government and industry on the roll-out of Connected and Autonomous Mobility (CAM) technology and policy in the UK.

The Automated Vehicles Act (2024) aims to place the UK as leaders in regulation of self-driving technology, targeting Autonomous Vehicles (AVs) on UK roads by late 2027 (1). This short report presents the Working Group's vision for necessary progress and actions to enable the integration of CAM into the UK's transport system, from a point of view of digital infrastructure. Zenzic reported that the UK can take advantage of strong competitiveness in digital infrastructure, however the UK currently lacks this capability (2).

Frazer-Nash Consultancy, in partnership with techUK, have produced this report to outline digital infrastructure requirements to successfully integrate CAM into multi-modal transport systems. In this report, we will focus on the themes of standardisation, using data to gain the most valuable insights, and what successful connectivity might look like, with the aim of providing direction to the UK CAM sector on important steps from now to 2035 to develop digital infrastructure as a CAM enabler.

The key areas of focus for digital infrastructure recommended by the techUK Self-Driving Vehicles Working Group are summarised as:

- Gaining industry consensus on best practices and potential standards for sharing data to enable enhanced connected AV services as part of MaaS.
- Driving standardisation and best practice with the requirements for the right data, at the right time, for the right reasons, to maximise valuable insights gained, and build in adaptability to changing technology whilst enabling rather than stifling technology roll-out across developers and regions.
- Measure the success of connectivity on the meeting of service needs, rather than coverage across the country.

Vision to 2035

For enablement of integrated CAM services, we consider data collected and shared across transport modes, such as timetabling, ticketing, service availability and location, to improve choice for users and allow seamless operation in a transport system, commonly termed as Mobility as a Service (MaaS) (3) (4). Data of these types requires wide sharing between operators and users and is likely to be subject to less standardisation than safety data. However, best practice including standardisation where appropriate should be defined to realise integrated services, and a digital infrastructure that enables such services. Safety data, such as hazard perception and decision-making required for proving that a vehicle can operate equivalent to a careful and competent human driver, will need to be standardised and able to be shared with only specific entities, such as regulatory authorities. In this

report, safety data and MaaS data are considered separate under current AV technology development.

Frazer-Nash conducted research with techUK members via a workshop, focused on digital infrastructure themes of telecommunications, data sharing and management, and cybersecurity.

This graphic (Figure 1) presents brief visioning outputs, considering the current state and how the infrastructure should look in 2035. The following sections explore these themes in more detail.

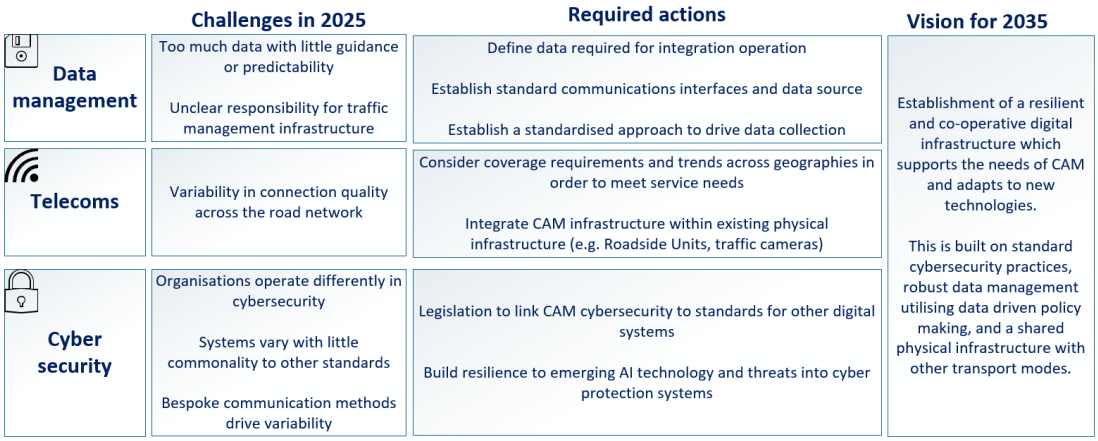

Figure 1: Digital Infrastructure vision for 2035

Focusing on enabling UK CAM through standardisation and maximising data insights

Collecting copious amounts of data for MaaS, in diverse ways and for varied reasons across operators, leads to inconsistency in how data is used and can be shared to enable integrated and connected operation of AVs in a multi-operator system. Predictability can be improved by central guidance, which need not be CAM-specific in the first instance. Associated data standardisation or best practice should be focused on only the most beneficial data, and only as far as effective, such that the right data is collected, at the right time, for the right reasons, avoiding vast sets of unnecessary or unusable data. Consensus across the industry needs to be achieved to guide this. If we can specify what data is required and the benefits brought, and insights and methods are led by those developing AV technology, we can sustainably manage the quantity and purpose of data for enabling services. Not gaining consensus risks the creation of a system in which disparate methods for data use are employed in the absence of standardisation, and the quantity of data collected and transferred surpasses the capacity of the infrastructure, posing further barriers to integration across operators and technical solutions. However, standardising all data collection and sharing risks stifling technology development, considering that technological possibility will inevitably move on or beyond the latest level of standardisation. Standards and best practices should be developed, where possible, with adaptability to changing modes and evolving technology.

On cybersecurity; system misbehaviour, response to threats, and digital certificates should be defined uniformly to allow consistent operation across the network, and learning from evolving threats (5). Digital certificates used in the Vehicle-to-

Infrastructure (V2I) message verification process, for example in Roadside Units (RSUs), should be managed by a security credential management system hosted by the infrastructure. Alerts and notifications should be standardised to allow sharing of threat information and should be included in the standardisation of safety data. On resilience to emerging threats, a potential ‘gold standard’ approach is for protection to be placed at the control system level in the platform and the vehicle, which could present a rapid cascade route for a threat, with safety-critical final systems being isolated from connected systems to reduce risks of or eliminate the most dangerous scenarios from cybercrime.

Measuring success of connectivity

Connectivity is fundamental to remote oversight of No User-in-Charge (NUiC) AVs (where a human driver does not take control for any part of a journey), though is not essential for standard AV operation. Rather, it plays an important role in enhancing AV operation as part of a MaaS system, where vehicles can receive and use additional information to allow them to operate in a system of integrated services (2). However, the infrastructure which enables this is often modally siloed (6), with distinct technologies used across the highways, rail, and urban transit sectors. Local authorities tend to manage datasets independently (6), which leads to inconsistent standards and practices in the data that is collected and shared. Present lack of agreement on data provision and use appears to be a significant barrier, which if removed could unlock £14bn in annual value for the UK transport network (6). Under current models, consistent exchange of specific data, driven by operational needs, is not achievable. The DfT’s transport data strategy aims to support development of unified data-sharing standards across modes, further promoting sustainability and consistency.

5G networks increasingly enable high-speed, low-latency data transfer across Vehicle-to-Everything (V2X) communications (7). 60% of UK roads currently have 4G in-vehicle coverage from all four Mobile Network Operators (MNOs), whilst 96% are covered by at least one (8). Invariably, AVs will not benefit from the best possible connectivity all the time. Variability in MNO and satellite coverage, and competition for bandwidth against other load sources on the network in urban areas at specific times (mixed load-sharing) will impact availability. Whilst fast speed, low latency and high capacity are the hallmark of successful 5G networks, CAM success should not be measured on coverage. 5G connection is a helpful addition to AV connected operation, though is not a pre-requisite to an AV’s ability to maintain a remote status indicator. Significant government and private investment would be required to achieve consistent levels of coverage and connectivity across the country, which from a CAM enablement perspective may not achieve desired results for regional operation. Rather, success should be measured on whether service needs are met locally, which may consider the minimum or optimal service required in a specific location, affected by the local infrastructure, and the enhanced operation gained through MaaS.

Significant work continues to develop infrastructural solutions to connectivity. The Digital Connectivity Infrastructure Accelerator (DCIA) is running 8 pilots in urban and rural areas, using public assets like streetlights and bus shelters to accelerate deployment of 5G coverage (7). The Department for Science, Innovation and Technology (DSIT) are running the Rural Connectivity Accelerator programme, focusing on the most isolated rural environments (9). Motorways can use RSUs for traffic updates and hazard alerts, though they are currently not used more widely on

the network. IoT-enabled traffic signals and congestion management systems exist in cities, however are modally siloed (6), limiting integration between highways and rail. Cooperative Intelligent Transport Systems (CITS), which enable V2V communication, can be used in dense areas with high network capacity, though do not provide a universal solution due to their cost and complexity to implement, and variability in network availability (10). This further strengthens the case for requirements of a specific region and the benefits that CAM can bring being used to measure the success of services, rather than focusing effort on achieving high-quality coverage on a wide scale, which would be costly and complex to implement. This allows infrastructural development projects and initiatives to be locally led, delivered, and managed.

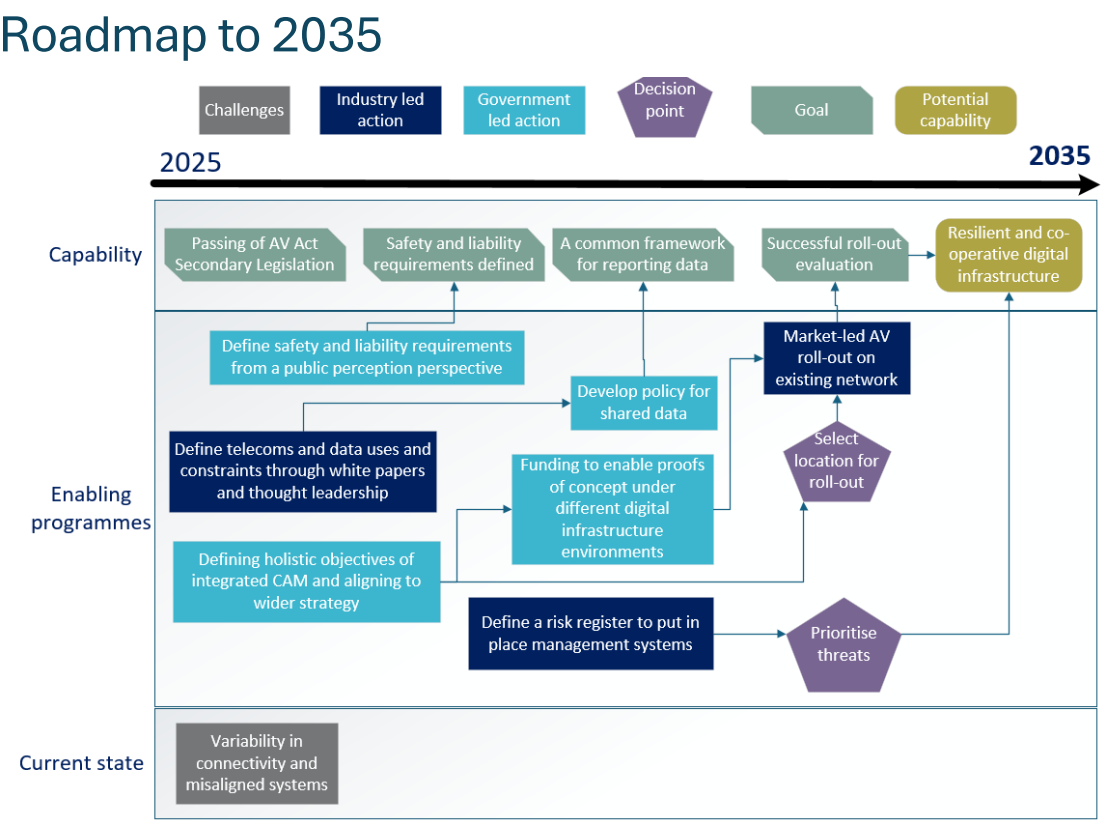

Figure 2: Roadmap of key Government and industry actions to 2035

CCAV's secondary legislation work package on the Statement of Safety Principles starts with the initial call for evidence in Q2 of this year, with publication targeted for January 2027. The in-use regulation aspect, to enable continued safe operation of vehicles following initial certification, pertains to ongoing in-service monitoring, which falls in-line with the forthcoming UN Automated Driving System (ADS) Regulation. This requires manufacturers to monitor vehicular operation post-deployment and notify of incidents. The content of these regulations could form an important driver for operators collecting the right safety data, at the right time, for the right reasons, guided by a national or international standard. For MaaS or open data, industry input is required to define data uses, and government input to holistically define CAM objectives. A collaborative and comprehensive approach will help us towards the goal of a common framework for using and reporting data in a comparable way to the rail sector.

This working group recommends that a risk register, or similar tool or database, should be defined jointly between government and industry to understand the biggest threats to and opportunities for success presented by data management, cybersecurity and connectivity. This can be used to drive focus on the greatest impact infrastructural actions and instil confidence in decision-making by virtue of cross-disciplinary input. Such a tool would require careful management by an entity independent of technology development, such as a regulator or government body.

To define objectives and success measures for integrated CAM and for the public and private sectors to benefit from the realisation of UK CAM, we should target a collective holistic mindset, rather than aiming to meet a myriad of disparate targets. This links to our recommendation that success be measured on service delivery, which is locally realised. Holistic definition of objectives across the example areas listed in the roadmap is similar to the US Department of Transport's recognition that a comprehensive digital infrastructure strategy is crucial to realising CAM in the transport network (11).

Concluding remarks

Achieving a well-integrated CAM system in the UK, capable of forming part of a wider transport system that can deliver high-quality services across the country, is clearly a multi-faceted challenge. This report presents key areas of focus for digital infrastructure recommended by the techUK Self-Driving Vehicles Working Group:

- Gaining industry consensus on best practices and potential standards for sharing data to enable enhanced connected AV services as part of MaaS.

- Driving standardisation and best practice with the requirements for the right data, at the right time, for the right reasons, to maximise valuable insights gained, and build in adaptability to changing technology whilst enabling rather than stifling technology roll-out across developers and regions.

- Measure the success of connectivity on the meeting of service needs, rather than coverage across the country.

The roadmap presents the key actions for government and industry to move towards our infrastructure vision for 2035. Further research into the needs and uses of specific data and telecommunications aspects should be performed to dive into the ideas presented in this report, such that policy, best practice, and standard developments are focused on the most beneficial actions to CAM enablement.

References

1. Self-driving vehicles set to be on roads by 2026 as Automated Vehicles Act becomes law. *www.gov.uk.* [Online] 20 May 2024. https://www.gov.uk/government/news/self-driving-vehicles-set-to-be-on-roads-by-2026-as-automated-vehicles-act-becomes-law.
2. Naik, Mili and McKinney, Francis. *UK CAM Roadmap to 2035 - Infrastructure and Data Services.* 2024.
3. Department for Transport. Mobility as a service: code of practice. [Online] 30 August 2023. https://www.gov.uk/government/publications/mobility-as-a-service-maas-code-of-practice/mobility-as-a-service-code-of-practice.
4. Department for Transport and Industrial Strategy. *Future of Mobility: Urban Strategy.* 2019.
5. Kimmel, Shawn, et al. *Physical and Digital Infrastructure for CAV - Code Framework.* 2021.
6. Department for Transport. *Transport Data Strategy.* 2023.

7. UKTIN. *Transport and Logistics: How To Secure 5G Connectivity.* 2023.
8. HM Government. *Connected & Automated Mobility 2025: Realising the benefits of self-driving vehicles in the UK.* 2022.
9. Department for Science, Innovation and Technology. Rural Connectivity Accelerator programme: projects. *www.gov.uk.* [Online] 11 November 2024. https://www.gov.uk/government/publications/rural-connectivity-accelerator-programme-projects.
10. International Transport Forum. *Preparing Infrastructure for Automated Vehicles.* 2023.
11. Cambridge Consultants and ITS America. *Digital Infrastructure Strategy Report - Shaping the future of transportation in the United States.* 2023.

Other sources

https://www.connectedautomateddriving.eu/thematic-areas/digital-and-physical-infrastructure/

https://www.sciencedirect.com/science/article/pii/S0966692324002515?ref=pdf_download&fr=RR-7&rr=90fb20e038fb6382

https://nationalhighways.co.uk/media/nkal4tzj/digital-roads-2025-interactive-roadmap.pdf

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