

Roadmap bids to connect the diverse strands of mobility

Report calls for a coordinated approach to the pursuit of connected and automated mobility, reports **David Fowler**

Driverless cars are coming to Britain's roads, according to many in Government circles. The big question is when. Here, opinions are numerous and diverse (see also page 30: Do AVs really hold the key to future travel?).

The Department for Transport (DfT) wants to see driverless cars being tested on UK roads by 2021. But when connected and automated vehicles (CAVs), to give them their full title, will be on the roads in significant numbers, is more difficult to pin down.

According to Government/industry-backed connected mobility organisation Zenic (formerly Meridian), 30 roadmaps and other forward-looking studies have been published in the past three years alone.

And, as Zenic points out, each organisation working in this area has been defining its own objectives and path to the future.

As a result, these visions "lack alignment"; they do not push towards the same goal.

Zenic believes what is needed is "a single vision - combined with a common understanding of how we get there".

That was the premise of its *UK Connected and Automated Mobility Roadmap to 2030*, published in September.

It attempts to set out "a single, agreed view of the future", with all the steps needed to allow automated cars to operate in their thousands on UK roads a decade from now.

The roadmap is designed, Zenic says, to provide insights into connected and automated mobility (CAM) for a range of organi-

sations. It aims to answer questions such as, for businesses, "should I invest?", or "what relationships do I need to be successful?"; for consumers, "will CAM be safe?", or "how will CAM make travel easier?"

For governments it seeks to respond to such questions as "how does this fit with the rest of transport policy?", "when do we need changes in legislation?" and "how can the Government support CAM?"

Moreover, in what Zenic believes is a first, it has set out to identify how the various steps are connected and interdependent. It says collaboration, across industry and with the Government, will be critical.

The data from the workshops Zenic conducted suggests that, without any parallel activity, it would be 2079 before the goal was achieved. A review and analysis process to examine where activities could happen concurrently brings the date back to 2030.

In addition, there appears to be a tipping point in 2025. "When you take a macro view of the milestones across the next 10 years, there is a clear changeover point," says Mark Cracknell, Zenic head of technology.

"The majority of the milestones in the first five years deal primarily with the enabling environment in setting up the processes, legislation, defining infrastructure and so on. From [around] 2025 the milestones take on a much keener focus on deployment."

THE BENEFITS

Why is connected and automated mobility needed? "The potential benefits of CAM are

staggering," says Cracknell in the report's introduction.

First: safety. More than 85% of road accidents are attributable to human error, according to DfT statistics.

"By replacing human drivers with automation, we will harness the ability to vastly reduce the number of serious incidents," Cracknell says.

Second: connectivity. Connectivity between vehicles, drivers and cities will increase the efficiency with which the road network operates.

Third: accessibility. CAM will offer improved access to transport across society.

Fourth: productivity. Driverless cars will give up to 225 hours back to drivers annually, according to the DfT.

THE 2030 VISION

"To work together on the journey... the destination must first be defined," says the report. The 2030 Vision sets out "an aspiration of where the ecosystem aims to be and the benefits to be realised by 2030".

It says:

By 2030, the UK is benefiting from proven connected and automated mobility, with an increasingly safe and secure road network, improved productivity and greater access to transport for all. Next-generation services and technology are designed and developed in the UK, powered by high-value skills and a strong supply chain and driven by public demand. We are a world leader.

The vision itself is a product of two core elements: societal benefits and industrial productivity. For the societal benefits, the nine core principles of the DfT's recent *Future of Mobility: Urban Strategy* document (Smart Transport issue 2) form the foundations of the vision.

These were 'distilled' through the three core priorities of the Centre for Connected and Autonomous Vehicles (CCAV, the cross-government agency that works to support the market for connected and automated vehicles) of safety and security, productivity and access to transport.

The report identifies 10 key deliverables (outcomes) by 2030, to provide a clearer picture of what the roadmap seeks to achieve. These are listed right.

The roadmap also makes several underlying assumptions. A period of unprecedented technological change is taking place worldwide and is beginning to disrupt existing systems and services. Users are increasingly expecting to be able to plan, book and pay for transport through mobile applications, the report says.

These changes are not taking place in isolation or uniformly, and new, unexpected business models are being created from the convergence of emerging and existing technologies, particularly arising from vast amounts of data.

An open discussion about the trade-offs

10 KEY DELIVERABLES

- 1 The UK legal and regulatory framework is world-class and mature, promoting and enabling CAM to be deployed at scale.
- 2 An enviable and robust safety record has been established in the UK and replicated around the world.
- 3 A significant number of highly automated vehicles are delivering mobility in the UK.
- 4 Society understands, accepts and is adopting CAM.
- 5 Infrastructure is ready for increased deployment of CAM and has areas with highly connected roads.
- 6 UK-based high-value jobs with (a) rich skills pipeline (are) in place.
- 7 Capabilities and benefits are delivered by the UK throughout the CAM supply chain.
- 8 [There is] greater certainty in emerging business models.
- 9 Road networks are managed using new methods, delivering more efficient use of road space.
- 10 The UK is recognised as a leader in innovation in this developing ecosystem.



▲ **The Zenic UK Connected and Automated Mobility Roadmap is available now**

between technologies is needed. "Public trust and acceptance of the potential benefits of technology-driven innovation are key, meaning implications for safety, inclusivity, and employment are crucial," says the report.

The UK has a growing, ageing and urbanising population, which is experiencing increasing health-related issues.

Society is increasingly digitally integrated, but this does not guarantee fairness. By using technology intelligently, there is an opportunity to help reduce digital divides and social inequity; conversely, misuse of technology could lead to greater inequality.

Some trends give concern. Climate change is increasing the frequency and severity of extreme weather events, while fears about congestion and air quality are heightening.

Meanwhile, "the UK is a leader among a dozen leading countries in CAM across the globe", the report asserts. As a leader in cybersecurity, which underpins much of the roadmap, it has an opportunity to exploit its competitive advantage in this field too.

Not mentioned explicitly in the roadmap is that it envisages the introduction of road user charging in 2025, something that has, hitherto, proved politically impossible.

225
number of hours drivers will get back annually as a result of CAM

FOUR KEY THEMES

The roadmap identifies four key themes: society and people, vehicles, infrastructure and services.

Each theme is subdivided into sub-topics or streams, such as vehicle approvals, ►



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connectivity, intelligent network management and inclusive transport.

In addition, the report places a great deal of emphasis on 'golden threads' (see terminology panel overleaf), a series of milestones which connect across themes.

Zenic highlights six golden threads, but users can explore and identify their own using the interactive online version of the roadmap (www.zenic.io/roadmap/), starting by highlighting a milestone and its connections.

THEMES: SOCIETY AND PEOPLE

The society and people theme is the primary driving force behind the roadmap. It covers streams that deal with societal mechanisms such as vehicle approvals, and licensing and use, as well as skills and public desirability.

The roadmap envisages the creation of a legal and regulatory framework for vehicle approval and licensing, together with national standards, which "create a culture where innovation can flourish".

"Insurance and investment are "enablers" that will "create an environment to unlock deployment at scale". Competitive invest-

ment platforms will be needed to ensure the UK is positioned at the forefront of the global market.

It recognises there are economy-wide skills shortages in emerging technology sectors and that cross-industry collaboration is critical to creating a "skills pipeline". This will start with encouraging Stem (science, technology, engineering and mathematics) subjects in school, through to PhD level.

The vehicle approvals and licensing and use streams explore how the UK is building on existing foundations, including the code of practice for automated vehicle trialling and continuing work by the Law Commission (see later in article).

In the near future, it says, the emphasis will be on developing an initial framework for advanced trial approvals that will support international processes and regulations. It is expected a national approval scheme will need to be in place by the end of 2027.

There will be a "profound" impact on the insurance industry. Emphasis will shift from the insurance of an individual to the insurance and liability of a vehicle or service.

To make this possible, greater collaboration will be needed to ensure appropriate data sharing. Safety-critical data will require

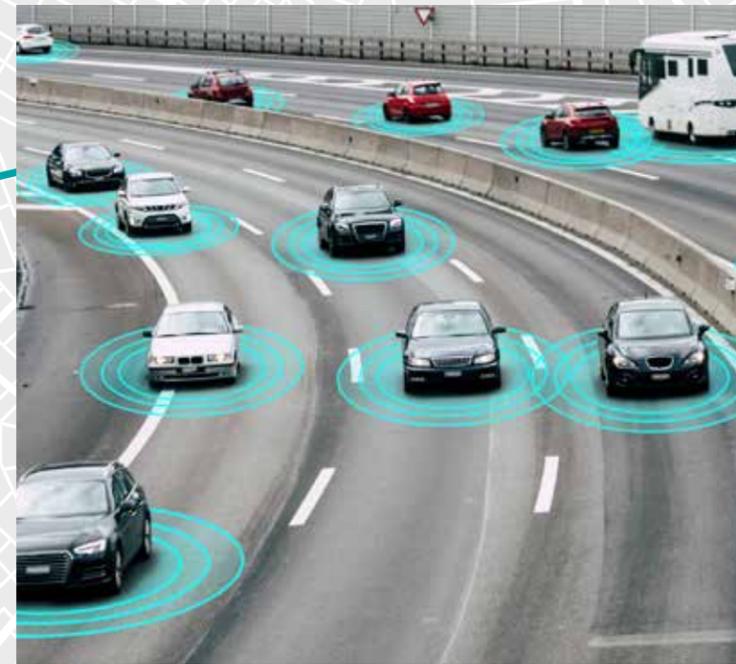
Methodology

Zenic led development of the roadmap but sought input from a variety of stakeholders throughout the process. A comprehensive literature review of existing reports in the field was undertaken, followed by collaborative cross-sector stakeholder workshops, held over six months.

A comprehensive data analysis process was then undertaken, aggregating and grouping the data across the four roadmap themes. Interdependencies were identified, helping to inform the dates for milestones.

A draft of the roadmap was distributed to allow to stakeholders to give feedback. Two steering group sessions reviewed and finalised the roadmap.

To download the full report as a PDF, or see the interactive version, go to www.zenic.io/roadmap/



covering aspects such as the automated driving system and sensors, as well as the components of vehicle design that are affected by changes in use.

Central to the vehicles theme is the automated driving systems stream. "Much research and development is required to move from small-scale controlled trials into broad deployment", the report says, but it also stresses that there is "a danger" that self-driving technology "could be seen as the end goal itself", and it seeks to put this in the context of the other three themes.

The Society of Motor Manufacturers and Traders (SMMT) predicts that by 2026, all cars produced in the UK will be connected. "Connectivity will unlock many of the 2030 vision deliverables – particularly when considering desirable mobility services and integration into towns and cities to enhance efficiency and productivity," says the report.

In addition, vehicles of the future will not look the same as they do today and many changes to the ergonomics and design of passenger vehicles will be needed.

INFRASTRUCTURE

Is the second of the technology themes. It covers communications and intelligent network management, as well as tradi-

tional roads infrastructure and new digital infrastructure. In other words, the environment in which connected and self-driving vehicles will operate, including the technologies which underpin the safety of the vehicle and integrate it into society and the wider transport system.

SERVICES

The culmination of the three other themes, says the report. This theme is concerned with how vehicles and infrastructure contribute to achieving the vision of improving the mobility of people and goods. However, the report warns, "it should not be seen as the final element of the roadmap, to be delivered once all other aspects are complete".

The theme is sub-divided into three streams: personal mobility, freight and logistics, and inclusive transport.

Personal mobility: "defines new solutions for the movement of people", working towards a future of mobility shifting away from modal transport choices to integrated and seamless multi-modal journeys. The roadmap explores how to bring together CAM and traditional services in integrated mobility-as-a-service (MaaS) platforms.

Freight and logistics: deals with the more efficient movement of goods, looking at both inter-hub transport and first-and last-mile solutions.

Inclusive mobility: recognises "mobility solutions today do not equitably provide access to transport for all". The use of new

technology will plug gaps in mobility, which will be "vitaly important in the smooth running and inclusive future the 2030 Vision sets out to achieve".

GOLDEN THREADS

Golden threads are used to highlight interdependencies which are not restricted by the theme structure. For each of six threads, the report sets out the contribution from individual themes, and identifies enablers (starting points), deliverables (end points) and waypoints (milestones which stand in the middle of long strands, often pinch-points with many other milestones preceding them and many deliverables unlocked by them).

The roadmap explores six Golden Threads: Legislation and Regulation, Safety, CAM Services, Public Acceptability, Infrastructure and Cyber Resilience. In each case, it lists all the associated milestones and includes "deep dives" into the importance of selected ones.

LEGISLATION AND REGULATION

Regulations, standards and legislation are the most critical enablers in the roadmap. The workshops that informed the development of the roadmap demonstrated that building a legislative and regulatory framework to allow the testing, development and deployment of connected and self-driving vehicles and services was crucial.

Legislation and regulation was consistently voted the most critical aspect in mak-

ing possible a connected and automated future.

This Golden Thread takes the UK aspiration further – to ensure the UK has a world-class and mature legal and regulatory framework that enables CAM to be used at scale, the report explains.

Most of the milestones in this thread originate from the licensing and use and vehicle approvals streams. But there are also key relationships with insurance, testing, development, infrastructure and different types of vehicles.

Deliverables under this thread include legislation for clearing road space for automated vehicles and the establishment of a harmonised vehicle approval scheme.

Enablers or starting points include: Baseline policy and standards established and the United Nations Economic Commission for Europe (UNECE) cybersecurity regulations development (see below).

Three milestones are considered critical waypoints:

- 1) Trials of CAM in multiple environments and differing economic models.
- 2) Establishment of a CAM service licensing framework.
- 3) The start of development of MaaS regulations.

SAFETY

Connected and self-driving vehicles represent an opportunity to significantly improve road safety by removing the opportunity for human error, the roadmap says.

Research has shown that evidence of a robust safety record and widespread belief in the safety benefits of connected and self-driving vehicles are necessary antecedents to widespread public acceptance of self-driving vehicles.

To arrive at a point where there is clear evidence of improved safety will also require credible data security.

The critical waypoints for safety are: development of safety protocols for CAM services; stable standards and regulations in place; and legislation for mandatory sharing of safety-critical data.

CAM SERVICES

The CAM services golden thread is particularly complex as it is a culmina-

Zenic

Launched in 2017 under the name Meridian Mobility UK, Zenic was set up by the Government and industry to coordinate a national platform for testing and developing connected and self-driving vehicles in the UK, focusing on key areas of UK capability). It was rebranded in May. Government and industry are committed to investing £200 million through Zenic. The first £102m was announced in October 2017 and the latest competition was completed in 2018.

2026

the year by which all cars produced in the UK will be connected, the Society of Motor Manufacturers and Traders predicts

particular focus to reach the goal of a reduction in premiums for connected and self-driving vehicles and services.

The report admits the vision of CAM being widely accepted in the UK by 2030 is ambitious. A focused and defined effort to understand how the UK public feels about connected and self-driving vehicles will be key. PR and educational activities will be needed, starting next year, respectively to educate the public about connected and self-driving vehicles.

"Increasing exposure to CAM will allow them to be ready for commercial vehicle deployment by 2022", the report contends.

VEHICLES

One of two technology-related themes,

85%
expected acceptance of CAM by 2028

tion of many individual strands, and “in many senses is the end goal of the roadmap itself”, the report says. Many aspects, across all streams, must come together at the right time to make possible a significant number of CAM services.

Although it might be assumed that the milestones required for delivery would only be found in the services theme, this is far from the case. Establishing CAM services relies on items such as vehicle approvals, licensing and use and public desirability.

A number of early enablers are critical, including a first code of practice for CAM services; UNECE cyber security regulations development; establishment of an Independent body to handle data; large-scale public demonstrations of CAM solutions (as many as 50 to 100); and a public education programme.

PUBLIC ACCEPTABILITY

Public acceptability also depends on a range of milestones from different strands.

Critical milestones include the establishment of a cybersecurity centre of excellence, the trial and development of inclusive city services and collaboration between transport service providers. Collaboration and synchronisation of multiple work-streams across different sectors will be required, as will engaging and involving the public through trials, pilots and deployments, as well as designing services which meet true customer needs.

INFRASTRUCTURE

“The UK road network is one of the world’s oldest, yet it has suffered a chronic lack of funding over many years,” says the report. “The introduction of CAM unlocks the potential to radically change how we consider and invest in this infrastructure.”

The 2030 Vision sets out the ambition of infrastructure that is ready for increased deployment of CAM, focused on areas with highly-instrumented roads. This ambition is critical in making possible high levels of CAM uptake.

Among the deliverables is the development of new city planning methods to enable more efficient CAM travel. Enablers mainly relate to establishing baseline policy,



cybersecurity regulations and communications standards. Data will be fundamental in achieving CAM-ready infrastructure.

CYBERSECURITY

Cybersecurity and resilience will add value and boost consumer confidence, the report says. Cyber resilience is perhaps the most pervasive topic in the roadmap. Cybersecure, digitally-resilient services and systems influence a total of 249 milestones.

The roadmap provides a set of dates over the coming decade intended to unlock an effective and legally-sustainable system of engineering practice, regulations and insurance. This will support the growth of the overall system, says the report, allowing development “in directions that are currently unforeseen”.

Cyber resilience is not just about defending against malicious actions; it also considers how day-to-day operational problems can affect the provision of safe and efficient services. The interactions between vehicles, infrastructure and third-party services across rapidly-evolving applications and diverse supply chains could make managing risk in this emerging critical national infrastructure complex.

However, the UK is regularly ranked in the top three in global league tables for cybersecurity; early investment from Government and industry “will not only ensure resilient and trusted services are built, but could also be a significant export strength for the UK in years to come”.

KEY MILESTONES

Some milestones play a critical role, either influencing and forming the basis for progress in many of the themes and threads, or being the culmination of long chains of earlier milestones.

The roadmap document explores some of these in “deep dives”. We look in more detail at a few of them below.

LAW COMMISSION FINAL REPORT

The CCAV commissioned a far-reaching Law Commission review into automated vehicles, including their use as part of public transport networks and on-demand passenger services.

Launched in 2018, the review has published its interim findings. The final report is expected early in 2022. It is the single largest enabler in the roadmap, opening up the way to 110 milestones, according to the report.

Establishing a CAM service licensing framework by early 2024 will unlock trials of CAM in multiple environments and differing economic models.

These trials will go on to inform the design of future CAM services as part of MaaS. The CAM licensing framework also unlocks city planning methods that enable more efficient CAM travel.

Self-driving insurance, cheaper than the human-driven equivalent, will be available by 2030, the roadmap predicts. Public acceptability will be unlocked through the active participation of passengers who experience the benefits of CAM, leading to public acceptance at 85% from 2028.

◀ **The UK road network is one of the world’s oldest and has suffered “a chronic lack of funding over the years”**

CYBERSECURITY REGULATIONS

UNECE has begun to produce guidance to address all identified cyber threats and vulnerabilities. Ultimately, this will safeguard vehicle safety should cyber-attacks occur. UNECE guidance published in 2018 details cybersecurity threats and suggests high-level counter-measures. It also includes a draft UN regulation for the approval of in-vehicle cybersecurity.

The draft regulation lays the groundwork for a requirement to monitor cybersecurity post-production: “Organisations within the automotive industry shall have the capability to identify how threats and vulnerabilities to vehicles or systems change over time and to identify threats that were not identified or accounted for in the development stage.”

Given that hundreds of thousands of new threats could be identified over the average life of a vehicle, this represents a formidable challenge for manufacturers.

The delivery of a cybersecurity centre of excellence in 2024 will provide a focal point for cross-organisational exchange of research and knowledge, the roadmap says. It will also oversee research and development into cyber-reliance, building on the definition of best practice for cyber-secure roadside infrastructure development.

The centre of excellence will provide direction to the government on best practice, so that cybersecurity becomes a central part of vehicle approvals process from 2026.

CLEARING ROAD SPACE

A report by McKinsey in 2018 identified regulatory reform and regulation favourable to automated mobility as essential for developing concepts for vehicle safety assurance. The interim report of the Law Commission review found that a safety assurance scheme for connected and self-driving would need to go beyond the initial safety of the vehicle itself.

Developing a baseline policy and stand-

ards will lead to wider standards and governance by 2022, according to the roadmap.

Producing the first code of practice for CAM services in 2019 is critical to rethinking personal transport and is a key driver for connected and integrated mobility solutions. Building on the experience of the code of practice, it is expected that development of MaaS regulations would begin in 2023, leading to the establishment of a CAM service licensing framework by 2024.

This brings the opportunity to explore trials of CAM in multiple environments and differing economic models by 2026.

Revised highway safety and design standards will be completed by 2029.

MORE EFFICIENT CAM TRAVEL

If more efficient CAM journeys are achieved, in part, through new city planning methods, it is clear that efficient road networks are not just a matter for highways authorities, the report argues.

The path to this objective again begins with the Law Commission review of legislative frameworks. Guidance issued by local authorities on adoption of MaaS will begin to be produced for cities and regions from 2020.

The establishment of baseline policy and standards from 2019, with a strong international engagement plan, will influence wider international standards and governance from 2022.

In 2023 the development of MaaS regulations will begin, setting UK-wide requirements for operators.

By 2024, the CAM service licensing framework will give users and regulators confidence in the safety and security of proposed services. This makes possible large-scale trials of CAM in multiple environments and differing economic models running through to 2026, which refine and inform final regulation. With increasing numbers of CAM services running, CAM travel patterns

Terminology

It can be helpful to keep in mind the terminology used in the roadmap

THEME is the highest level grouping in the document.

STREAM is a sub-topic of a theme.

MILESTONE an individual item in a specific stream.

GOLDEN THREAD a sequence of milestones with connections and interdependencies extending across themes, which allow cross-topic narratives to be found.

STRAND a single interdependent collection of milestones forming part of a Golden Thread.

identify limiting factors of current city design from 2026. New city planning methods build on and enhance initial CAM-ready blueprints – leading to more efficient journeys.

CONCLUSION

The roadmap is an ambitious attempt to set out all the actions that need to take place to allow the introduction of connected and automated mobility, and to give a timescale.

It goes well beyond the introduction of automated vehicles, covering the whole area of MaaS and how automated vehicles could fit into complete, integrated infrastructure mobility services – encompassing the introduction of road user charging.

There are more insights than it is possible to do justice to here, and the roadmap allows potential for the subject to be explored from a range of different viewpoints – particularly using the interactive version, starting from any milestone and its connections.

With more than 500 milestones, it is inevitable, perhaps, that the report includes little detail of those which are not the subject of, or referenced in, the ‘deep dives’.

But perhaps the most striking insight to emerge is the scale of the task at hand, involving industry sectors from carmakers and public transport providers to insurance and cybersecurity.

The level of collaboration required from industry, academia and the Government is formidable. The question now is will they be able to rise to the challenge? **ST**

2022
date the final report from the Law Commission is expected

TURN OVER FOR THE PEER REVIEWS

