Centre for Connected
& Autonomous Vehicles

UK Testing Ecosystem for Connected and Autonomous Vehicles

Government response to the call for evidence

March 2017

Contents

1. Executive summary

1.1 What we consulted on

The UK has an opportunity to assert a global leadership position in the demonstration and deployment of connected and autonomous vehicle (CAV) technologies, capitalising on our competitive advantage of being able to test anywhere in the UK today (as set out in the Code of Practice), supporting our industrial strategy and building on the strength in depth of our world-leading centres of excellence and wider business environment.

In 2015, the Council for Science and Technology wrote to the then Prime Minister about the importance of CAV technologies; a "real-world lab" for testing was its top recommendation. The Centre for Connected and Autonomous Vehicles (CCAV) conducted an initial assessment in consultation with industry.

A call for evidence on the UK testing ecosystem for connected and autonomous vehicles was issued on 26 May 2016.

The call's purpose was to build the evidence base for how the UK might integrate and strengthen the national testing offer and to consider the case for a new flagship test bed to provide a focus for this activity. It would also inform development of powerful and tangible investment signals to global corporates of the UK's leadership ambition and position.

1.2 What we proposed

The UK has world leading, regionally distributed centres of excellence in the existing test environment. To strengthen the UK's position as a world leader in test environments, government initiated this Call for Evidence to seek opinions on the wider ecosystem as well as the viability of a flagship, live urban test bed. The call for evidence set out a refined list of ideal technical requirements for such a test bed, seeking to

- Test, refine, and prioritise the ideal characteristics identified by the Centre's study,
- Identify gaps in the current UK testing ecosystem,
- Identify opportunities to secure future competitive advantage,
- Consider the case for a flagship, large-scale, live urban test facility,
- Ask industry and academia to articulate what they want and need from the testing and demonstration landscape to attract and de-risk investment and ensure viability,
- Foster opportunities for collaboration across sectors, academia, local government, network operators and inform development of compelling, industry-led propositions,
- Gather views on what government's role could be in removing barriers, enabling, and accelerating the development of these technologies (without creating an expectation of government funding)

1.3 Responses received

The call opened on 26 May 2016 and closed nine weeks later on 31 July 2016.

The call received 53 responses from industry, academia, local government, industry groups, trade associations, stakeholder groups, and school children (see Annex).

1.4 Government decision

There is broad support for doing something genuinely unique in the UK by coordinating our existing world class assets more effectively into a coherent national ecosystem.
This ecosystem will provide an exemplar of the UK's industrial strategy, exhibiting the best of our world class science, research, and innovation in the vanguard of disruptive new business models. It will encompass UK excellence in automotive, software, communications, infrastructure, and business services such as insurance, law, and finance. It embodies a strong regional story, fusing the Midlands Engine with Europe's only mega-city to underpin a globally significant national offer, illustrating how the UK can secure sustainable, long-term economic growth with high quality jobs and a competitive global trade and investment offer while also maintaining strong international influence.

Integrating and strengthening existing centres of excellence across a range of sectors and testing environments to form a national ecosystem was a recurring theme in responses. The consensus view favours a hub and spoke model with an independent, impartial hub.

Respondents consistently warn against spreading capabilities too thinly across many projects or too widely across the country. There is strong support some presence for a national testing ecosystem in London, reflecting its global standing and associated benefits. There is also support for strengthening the established centres of excellence in the West Midlands and in the corridor in between the two.

Removing barriers to entry for SMEs and providing them routes to market was repeatedly cited as essential to securing UK competitive advantage. The ecosystem should accessible to all for reasonable cost (facilitating use by start-ups and SMEs) and provide advice, kit, and training for optimising use of the facilities.

The general view is that new purpose-built facilities garner media attention but would duplicate existing facilities, risk immediate obsolescence and – most importantly – are unlikely to meet the real requirement of complex, "live" urban environments.

Unlocking and securing social benefits that compete with commercial priorities was seen as central to the argument of additionality of government involvement in this sector. There were persistent calls for investment to support large scale connectivity demonstration and deployment with greatest return on investment for systems of vehicles and fastest impacts.

Although this consultation specifically indicated that it did not create an expectation of new government funding, the evidence gathered through this process informed a compelling business case that **resulted in the announcement at Autumn Statement 2016 of "£100 million for new connected and autonomous vehicle (CAV) testing infrastructure" in November 2016 as part of a four-year programme requiring match-funding from industry**.

1.5 Next steps

To achieve this programme, government and industry are working together to create the world's most effective connected and autonomous vehicle testing ecosystem, integrating existing proving grounds and public road test sites across the UK's existing automotive and technology heartlands, strengthening existing capabilities and creating new ones.

Government will, in partnership with industry, shortly set out its strategy for delivering the vision for this £100 million, four-year programme through a robust mechanism that maximises speed, impact, openness, and value for money. It will have a strong focus on the economic benefits from projects as well as high additionality.

This investment programme is part of a wide-ranging strategy to bring the best of the UK's industrial and academic talent to bear on these challenges, from all over the country. Most of the government support for this area is (and will continue to be) open to developers in all parts of the UK, as evidenced by current, government-funded R&D projects.

For controlled and real world testing infrastructure, there is a strong case to have more of a geographical focus, both to draw on the UK's existing centres of expertise, and to cluster testing activity in a way which is fruitful for innovation and provides a world-class, "one stop shop". These points were made strongly in the call for evidence which indicated that what the country is lacking is a test environment with a comprehensive range of capabilities that is open to everyone, but particularly SMEs and universities.

Government has therefore decided to focus the test bed programme funding on a small number of projects within the strong cluster defined by the environs of Birmingham and London, and the corridor between them broadly bound by the M40 and M1, encompassing most of the UK's current physical testing for connected and autonomous vehicle projects, both government-funded and independent (see Figure 1 in section 4, below).

This ecosystem approach will support businesses across the UK where the research and technologies will be developed but will be proved at the real world, physical testing facilities of the test bed "core". It addresses a current market failure identified through the Call for Evidence, namely the barriers to entry for SMEs who develop technologies but lack the facilities for proving them or the funding to access existing facilities. A key feature of this programme will be to provide fair and open access to all businesses at fair market rates. Companies from anywhere in the UK will be will be able to bid for test bed programme funding in partnership with existing centres of excellence within the "core".

Companies and research entities will still be able to test anywhere in the UK – an integral part of the UK's competitive advantage – but, in addition, this ecosystem will provide them access to a "one-stop shop", including facilities and world-class capabilities not previously available in the UK nor in close proximity to each other and open to users on a transparent and non-discriminatory basis.

1.6 Further detail

The remainder of this document sets out the formal government response to the consultation, together with a summary of the responses we received, and the rationale for the government's decision.

2. Background – what we consulted on and proposed

The government recognises the significant benefits that connected and autonomous vehicle (CAV) technologies will bring and has acted quickly to make the UK a world leader. In 2014 the government announced £19 million to fund the demonstration of driverless vehicles in four UK cities, and in 2015 the Chancellor announced a further £100 million for an Intelligent Mobility research and development fund to be matched by industry. This funding is unlocking and attracting significant industry investment to the UK, exemplified in the first, £20 million collaborative research and development funding competition (CAV1). Alongside this, the UK has also secured a global reputation as one of the most welcoming environments for testing connected and autonomous vehicle technologies through the government's regulatory review, The Pathway to Driverless Cars (2015), and the subsequent Code of Practice for testing (2016).

The Centre for Connected and Autonomous Vehicles (CCAV) was announced in July 2015. It is a joint team, with members from both the Department for Business, Energy, and Industrial Strategy and the Department for Transport.

CCAV is helping to ensure that the UK remains a world leader in the research, development, demonstration, and deployment of connected and autonomous vehicle technologies. It is working with industry and academia to realise the significant potential benefits of these technologies for UK society and the economy. It will provide a single point of contact for industry and academia in the UK and around the world, as well as ensuring that:

- The UK has a vibrant, world-leading connected and autonomous vehicles industry.
- The UK remains one of the best places in the world to develop and use connected and autonomous vehicles.
- Research on connected and autonomous vehicles is effective, and targeted at delivering value for the UK.
- Connected and autonomous vehicles are safe and secure by design, and handle data appropriately.

Alongside these objectives, the Centre is examining the testing ecosystem for connected and autonomous vehicle technologies. As part of this work it is considering the case for an ambitious UK flagship test bed to provide both a focus for testing connected and autonomous vehicles at large scale in complex urban environments, a key recommendation from the Prime Minister's Council of Science and Technology.

Successful development of connected and autonomous vehicles will require the expansion of the classic automotive testing environment to allow for the validation of new technologies coming together in new ways. Much of this will be enabled by advanced software. It is vital for the UK to be able to provide the capability for the testing of the full range of technologies necessary to succeed in this market.

The audience for this call for evidence included potential partners from industry (not just from automotive but from all sectors), academia, centres of excellence, local government

and network operators, as well as innovative companies not currently investing in the UK. Companies could come from the gaming, telecoms, Formula 1, rail, marine, aerospace, and other sectors, as well as from the UK's world-leading insurance, financial, and legal centres. A submission was received from a group of school students as part of the Pupils4Parliament initiative.

2.1 Proposed characteristics of an ambitious connected and autonomous vehicle technology testing landscape

Analysis by the Centre for Connected and Autonomous Vehicles suggested that a varied and distributed offer will make the UK a more investable and competitive proposition and spread the risk across a number of projects that should be big enough to scale, but small enough to fail.

The Centre asserted that key components of a flagship test bed to support development from initial concept to market deployment are likely to include, but are not limited to:

- **Strong local political support**.
- An activist **skills and training infrastructure** to help users get the most out of the ecosystem's components and their own projects as well as on-site support on cyber-security, user behaviour, insurance, law, finance, standards, IP, software and so on.
- **Virtual validation and verification capabilities** to address the unsustainable time and cost of physical testing requirements of increasingly complex, software driven systems.
- A comprehensive **physical infrastructure** (roads, signs, signals, intersections, weather conditions, etc), a library of general purpose vehicles and off-the-shelf kit, and a Fab Lab for the design, (additive) manufacture, repair, and modification of components.
- **Cyber and security standards expertise** for testing and certifying the resilience and interoperability of technologies against cyber-attack.
- A **data catalyser** to release the value of real-time data, while protecting the IP of the data owner, and the privacy of the data source.
- **A comprehensive and flexible mix of connectivity options** to reflect current and future connectivity scenarios to support (or interfere with) vehicles and/or infrastructure - a minimum level of ubiquitous connectivity is a priority.
- **High precision, real-time, dynamic mapping**.
- A horizon scanning function to keep the test bed at the cutting edge of the latest technological, regulatory, and consumer requirements in this fast-changing sector.
- A business model accelerator, bringing together different skills and ideas to create the conditions for new CAV products and services from which UK will obtain long-term, sustainable economic value, as well as operationalising new business cases.
- Innovative procurement tools, support and advice, such as the Small Business Research Initiative (SBRI), challenge prizes, and pre-competitive procurement to stimulate achievable, bespoke solutions to challenges as they arise.

3. Government decision – what we heard

Note: the following provides an illustrative summary of responses received. It is not exhaustive. There will be omissions and information has deliberately been anonymised or omitted where permission for publication has not been received.

This summary does not create an expectation that government will enact any proposal.

3.1 What we heard through the Call for Evidence

This is summarised at 1.4, above.

3.2 Characteristics of a national testing ecosystem

The range of responses overwhelmingly supported and validated the proposed characteristics set out in the call for evidence.

3.2.1 Gaps and opportunities

Responses emphasised certain, existing components elements and recommended a number of new features. The top ones include:

- Connectivity – a significant number of responses highlighted the central importance of connectivity within the testing environment, particularly mixed technologies, and the ability to test interference. Several commentators stated that Connected Vehicles do not need testing as it has already been done or is being done – wide scale demonstration is what is required.
- Removing barriers to entry for SMEs is a persistent theme. One respondent estimated that it cost around £500,000 to access a vehicle to test new devices and indicated that this is prohibitively expensive for SMEs. Another respondent claimed that most car manufacturers, supply chain companies, and disruptors get involved with SMEs and then control the intellectual property or the outputs through non-disclosure agreements.
- Virtual design and verification – several noted that this was imperative for testing and validating increasingly complex, software driven technologies.
- High definition, dynamic mapping – numerous contributors indicated that high precision (millimetre) tracking was essential to safe navigation of CAVs in public environments.
- Standards and certification/verification – a range of proposals were made including: developing evidence from testing to inform “type approval” (homologation); utilising a form of EuroNCAP scoring to shape demand; a new “CAVA” (CAV Accredited) certification system; a “digital MoT”, especially to guard against tech degradation and to validate updates; or leveraging UKAS (UK accreditation service).
- A controlled environment for motorway testing.

Other recommendations encompassed:

- Enabling cross-pollination with other transport modes and sectors, including freight and HGV platooning, farming and precision agriculture, mining, construction, fire-fighting, and energy.
- Informing public sector transport requirements, such as in the health sector.
- The ability to test "corner cases" and limit handling.
- Creating a data observatory – a mechanism for providing a form of "honest broker" to manage privacy and intellectual property issues while enabling value to be derived from the data.
- A "human factors" testing facility to develop understanding of how people will interact with these technologies.
- Citizen-centric design to promote public acceptance and user requirements through a variety of tools, including a website Q&A, mythbusting, and tracking and reporting health and safety impacts and improvements from the technologies (the IET cited its "Tech Savvy" report, 19 July 2016).
- Cyber-physical security (the Royal Society recommends its report, 12 July 2016).
- Open innovation to catalyse and maximise collaboration across disparate actors and sectors that may not naturally or otherwise benefit from each other's knowledge and experience.
- Forensic capability for accident investigation and reconstruction.
- Storage/repair facilities.
- Infrastructure – including a high speed off-road test facility for motorway assist technologies with junctions.
- A UK-based global conference.

3.2.2 Proposed locations for current or future testing in public, controlled, and virtual environments

Public and controlled environments

- London
    - Greenwich
    - Heathrow
    - London-Dover connected corridor (A2/M2).
    - Stratford – Queen Elizabeth Olympic Park
    - Transport for London
    - Volvo DriveMe London project
- Midlands Engine
    - Bruntingthorpe Proving Ground (Leicestershire)
    - Coventry/Warwick (Warwick Manufacturing Group and Jaguar Land Rover)
    - Cranfield University
    - "Midlands Diamond" (Birmingham – Oxford – London – Cambridge)
    - Midlands Engine Innovation Hub

  - Millbrook Proving Ground
  - Milton Keynes
  - Nissan Technical Centre Europe (at Cranfield)
  - Northampton
  - UK CITE connected roads project
  - Nuneaton – HORIBA MIRA

- Other
  - Blackburn with Darwen unitary authority area
  - Bristol
  - Hurn Proving Ground – Qinetiq
  - Manchester
  - Ministry of Defence - existing or soon to be decommissioned MOD facilities, e.g. FIBUA, IMBA and Copehill Down
  - Oxford / “Culham City” / Didcot Garden Town
  - Stone Hill Park

Virtual environments

- Advanced Propulsion Centre’s Digital Engineering and Test Centre (Stratford)
- Coventry University SVeCLab
- Liverpool University Virtual Engineering Centre
- Met Office (Exeter)
- Nottingham Geospatial Institute
- Ordnance Survey (Southampton)
- Transport Systems Catapult (Milton Keynes)
- TRL (Wokingham)
- University of Southampton
- Vodafone Automotive (Burnley)
- Warwick Manufacturing Group 3xD simulator

3.2.3 Cost and benefit estimates

A number of illustrative cost and benefit estimates were provided in the responses which were extremely helpful to inform the rough order of magnitude of potential investments.

- The Automotive Council[1] and IM-pact group[2] endorsed a proposal to accelerate development of these technologies and global differentiation of the UK offer through

[1] Made up of senior figures from across industry, the Automotive Council enhances dialogue and strengthens co-operation between UK government and the automotive sector. Its long term strategy aims to address the cross-cutting objectives of improving access to finance, support for emerging and disruptive technologies (including intelligent mobility), skills development, and improving the competitiveness of the UK supply chain.
[2] The Intelligent Mobility Planning, Action and Coordination Team (IM-PACT) is a government industry body set up to identify strategic issues, recommend future activities, and coordinate ICT, telecommunications, data and infrastructure in order to facilitate their application on UK roads in support of connected and autonomous vehicles.

a hub and spoke model. The model would seek to deliver the full range of testing requirements across public, controlled, and virtual testing environments.

- TRL's Smart Mobility Living Lab also made a proposal totalling, comprising infrastructure (data storage, communications, cutting edge physical infrastructure), simulation and customer experience, international influence, commercial development, cyber security, and specialist recruitment.
- The Transport Technology Forum suggested that these technologies "have the potential to improve efficiencies in delivering the £4bn-£5bn per annum congestion and safety benefits which already result from traffic management systems and can unlock a further £4bn per annum in travel, emissions and highway asset ownership costs".
- Transport for West Midlands cites a number of industry projections and estimates,
    - "ON-VEHICLE: Vehicle connectivity is an essential and competitive feature and is estimated to be worth $113bn by 2020, with the advanced driver assistance and safety segments growing to $49bn and $33bn respectively."
    - "SERVICES: The global value of entertainment and wellbeing services in non-commercial vehicles is forecast to grow at 25% Compound Annual Growth Rate to $18bn by 2020. Greater connectivity is an opportunity for mobile network (LTE) and WiFi network operators to increase the productivity of their asset base with a new customer segment. "
    - "AXA (2015) estimated the 10 year benefits to the UK haulage industry for Intelligent Transport Services and safety services at >£20bn."
    - "The impact of road congestion costs the metropolitan area economy some £2.3bn per year in higher costs, lost business, and reduced productivity. Within this figure of £2.3bn, despite representing just 6% of all trips, congestion to road freight movements costs the economy some £600M per year, almost a quarter of the annualised cost." (West Midlands, "Gridlock or Growth?": Congestion Management Study, 2007)
- Other sample costs cited include,
    - Sweden's AstaZero facility cost SEK 0.5bn (£40-£50m) to build from scratch
    - America's MCity cost US$10m start-up costs as well as having 15 founding members of the Leadership Circle ($1m each) and nearly 40 affiliate members who have each pledged $150,000 over three years.
    - To develop an off-road motorway testing facility on a green field site would cost an estimated £100m.
    - a unique electromagnetic compatibility (EMC) chamber could cost 5m-6m Euros.
    - Hardware-in-Loop (HiL) for Automotive RADAR, infotainment, and camera would each cost in the region of £500k.
    - "SMEs have a substantial barrier to entry to overcome before being able to develop a product for the CAV market. They require a CAV of SAE 1-5 to verify and validate their product. This requires investment of £500k+ realistically [and needs provision of fair access plug-and-play vehicles and kit to lower it] to £10k-£20k or someone's time"

3.2.4 Funding models for public proposals

A number of proposals for funding models were received and are summarised below but this summary does not comment on their viability nor create an expectation that government will enact any proposal.

- Raising R&D Tax credits, increasing the patent box rate, reinstating the Industrial Buildings Allowance.
- Private funding "represents a high risk on a purely commercial basis … infrastructure investment is long-term and costs would not be recouped in a short term action to develop regulations. The main role of government is to de-risk the investment" – directly part-funding, co-owning, and/or flexibly financing.
- Take "2-5%" of the second Road investment strategy (RIS2)" (£300m-£750m) to drive innovation rather than more tarmac and infrastructure
- Use the model of Catapults or UK Collaboratorium for Research in Infrastructure and Cities (UKCRIC), £138m with 14 specialist nodes including a transport systems model.
- Distributed match-funding: 1/3 government; 1/3 car manufacturer/supplier; 1/3 industrial/engineering companies (including. telecoms)
- Procurement/investment using projected social benefits
- Could model on MOD/dstl/BAE Systems' NiTEWorks collaboration
- Sharing cost model among beneficiaries along the lines of the Apprenticeship Levy.
- Access to private equity
- Means-tested access to subsidised aspects of the test bed ecosystem (plug and play); large businesses should be charged according to use and SMEs should accrue loans that are repaid as the product develops. Could also use grants/vouchers for SMEs/start-ups
- MCity has 15 companies in its Leadership Circle ($1m each) and 33 Affiliate Members.

3.2.5 Additionality of public proposals

A key function of government involvement is to ensure that the UK unlocks the significant potential social benefits of these technologies, such as safer, cleaner, more inclusive, and more enjoyable journeys. However, securing sustainable economic value to the UK economy is the main priority of this work. Responses reinforced this requirement, seeing the development of a world-leading testing ecosystem as a catalyser of investment, leading to a value adding proposition and productivity gains through research spillovers, supply chain development, and cluster effects.

There were calls for significant investment to support large scale connectivity demonstration and deployment with greatest return on investment for systems of vehicles and fastest impacts.

The removal of barriers to entry for SMEs and provision of routes to market was the most striking and consistent theme in the responses to the call,

i. "SMEs have a substantial barrier to entry to overcome before being able to develop a product for the CAV market. They require a CAV of SAE 1-5 to verify and validate their product. This requires investment of £500k+ realistically [which needs access to plug-and-play, all-purpose kit to lower it] to £10k-£20k or someone's time …No matter how much we push the virtues of simulation, investors, engineers, managers, etc. are always sceptical up until they experience it in the real world … when it becomes substantially easier to attract funding to complete the R&D phase"

ii. (Thatcham Research), the ecosystem requires "open access such that innovators without the financial muscle to create their own facilities can participate in developments at reasonable costs."

iii. (IET - Institution of Engineering and Technology) "There is a real danger of stop/start with funding provided for small trials and corridors that are then not sustained"

3.2.6 International case studies

How have other countries responded to similar challenges and priorities? Are there any lessons to be learned and applied in the UK? (The following list reflects initiatives cited in responses).

i. **Portugal**: Virgin Media public transport connectivity trial (Porto).

ii. **Sweden**: Volvo DriveMe, Volvo "Communities", and Volvo Holisec (Gothenburg); VTI; VICTA lab; AstaZero proving ground.

iii. **Germany**: A9 (Aachen); CARISSMA (University of Ingolstadt); Moovel (Daimler); BMW ReachNow

iv. **Netherlands**: Smart Mobility Living Lab and DITCM (Helmond); DAVI/WE-pods (Wageningen)

v. **USA**: MCity test facility (UoM University of Michigan Transportation Research Institute); GoMentum proving ground (California), IIHS Vehicle Research Centre (Virginia), Daimler "Freightliner" HGV trials (Nevada),

vi. **Singapore**: SAVI/OneNorth

vii. **France**: CityMobil2 (La Rochelle), Transdev (Ladoux), and a project in Civaux

viii. **EU**: SARTRE, PETRAS, ESPRESSO

ix. **Australia**: Australian Driverless Vehicle Initiative

x. **Finland**: VTT technical research centre

4. Conclusions and next steps – what we will do

The UK has an opportunity to be one of the world's premier development locations for innovative future vehicle technology, supporting our industrial strategy, and making vehicles that are safer, cleaner and more enjoyable.

Although this consultation specifically indicated that it did not create an expectation of new government funding, the evidence gathered through this process provided a compelling case resulting in the Chancellor's announcement of "£100 million for new connected and autonomous vehicle (CAV) testing infrastructure" in November 2016 as part of a four-year programme requiring match-funding from industry.

To achieve this, government and industry are working together to create the world's most effective connected and autonomous vehicle testing ecosystem, integrating existing proving grounds and public road test sites across the UK's existing automotive and technology heartlands, strengthening existing capabilities and creating new ones.

Successful industry-led delivery of the ambitious vision for this ecosystem will exploit our ability to test anywhere and enable end-to-end testing across physical, controlled, and virtual environments. These will be open for use by all, facilitating access by UK start-ups and SMEs, providing training and kit to enable best use of the environment, and enabling domestic projects to scale up for final, pre-deployment certification. The ecosystem will also seek to enable development and demonstration of low emission vehicle technologies. It will all be promoted beneath a globally significant brand.

The ecosystem will provide an exemplar of the UK's industrial strategy. Exhibiting the best of our world class science, research, and innovation ecosystem, these technologies are in the vanguard of disruptive new business models across sectors – encompassing UK excellence in automotive (including ultra-low emissions technologies), software, communications, infrastructure, and business services such as insurance, law, and finance, among others. They also embody a strong regional story, particularly fusing the Midlands Engine with Europe's only mega-city but increasingly expanding across other regions, suggesting how the country can secure sustainable, long-term economic growth with high quality jobs and a competitive global trade and investment offer while maintaining strong international influence.

The hub will provide a thin management layer that aims to,

1. Co-ordinate global industry needs for UK development and deployment,
2. Create the ecosystem, enabling dissimilar entities to work together effectively,
3. Establish business principles and protocols across the network,
4. Provide an impartial 'one stop shop' for those wishing to engage with the ecosystem (from UK SMEs to global corporates),
5. Create a globally recognised brand, signpost and promote UK activity,
6. Develop close relationships to government to inform policy and help to direct future funding,

7. Help industry de-risk business cases for investment in the UK for facilities and capabilities that would otherwise be created elsewhere.
8. Ensure the national offer reflects most, if not all, of the ideal characteristics set out in in this Call for Evidence.

4.1 Next steps

Responses to the Call for Evidence suggest broad industry and academic support for the UK doing something that would be genuinely unique by coordinating our existing world class assets more effectively. Government and industry is currently working together at pace to develop the strategy to deliver the ambitious vision for this four-year programme. In the coming weeks, government will set out its plans for delivering the funding through a robust mechanism that maximises speed, impact, openness, and value for money. It will have a strong focus on the economic benefits from projects as well as high additionality.

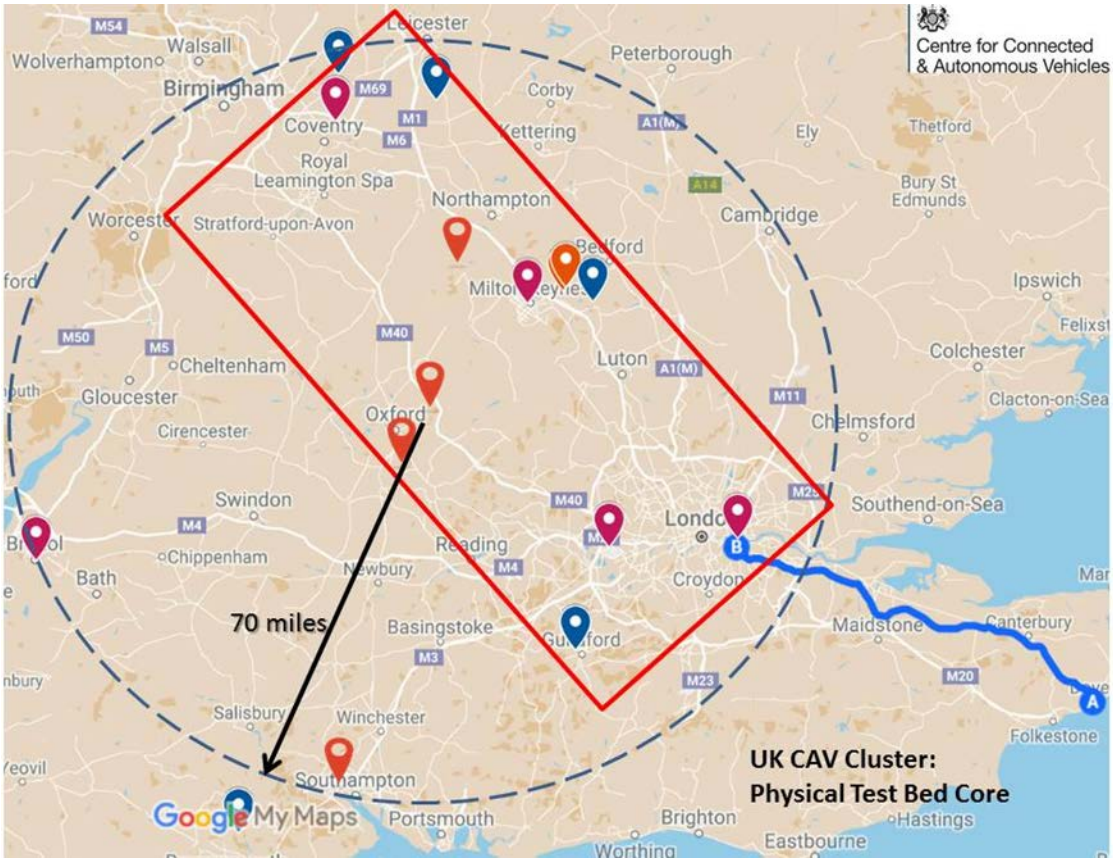
The UK has long-standing capabilities across most, if not all, of the sectors supporting connected and autonomous vehicle technologies. Mapping the key players, project sites, and testing/demonstration locations of existing work reveals an existing cluster of expertise and activities clustered within a 70 mile radius of Oxford and enhanced by, the Midlands Engine of the UK's resurgent auto sector, global centres for law, insurance, and finance; four of the world's top 10 universities; motorsport valley (six of the world's 10 Formula One teams); the Malvern cyber-security cluster; the 5G Innovation Centre; four Catapults (Digital, Transport, Energy, and High Value Manufacturing); the Warwick Manufacturing Group; Tech UK; and London (Europe's only mega-city), among many others.

Furthermore, within this "CAV Cluster" is a core of existing centres of excellence where physical testing and demonstration of these technologies is already taking place (some government-funded; some independently financed). This "CAV Core" (Figure 1, below) is loosely defined by London and Birmingham at each end and by the M1 and M40 on each side. This core comprises the public testing environments of most of the UK's substantial existing research, development, and demonstration projects, the end of the London-Dover Connected Corridor, the 5G Innovation Centre, as well as the autonomous vehicle trials of Nissan (Cranfield), Oxbotica (Culham), as well as the separate 100 vehicle trials of Jaguar Land Rover (Coventry) and Volvo (Drive Me London).

However, a key theme of the evidence provided to this consultation was the risk that the capital intensive nature of infrastructure investment (e.g. building roads and installing telecommunications) risks trying to do too much with the £100 million programme and thereby dissipating the impact. There is strong support in the responses for strengthening the established centres of excellence in the West Midlands, as well as having some presence for the national testing ecosystem in London, reflecting its global standing and associated benefits, and also the corridor joining the two.

In order to optimise the £100 million connected and autonomous vehicle test bed infrastructure fund, we propose to focus the investment on a small number of capital-intensive projects within the "CAV Core" to maximise existing cluster benefits and avoid spreading the funding too thinly. Details about the open funding competition will be published shortly.

Figure 1. Illustrative map of the "CAV Core" of physical test sites (not exhaustive)



5. Help with queries

Questions about the policy issues raised in the document can be addressed to:

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If you wish to comment on the conduct of this call for evidence or make a complaint about the way this call for evidence has been conducted, please write to:

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6. Annex - Call for Evidence respondents

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Will Searle	Founder & Managing Director	Axillium Research
Prof. Paul Newman	Professor of Information Engineering	Oxbotica/University of Oxford
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