



CONNECTED VEHICLES – WHAT CAN THEY DO FOR A UK LOCAL AUTHORITY?

CONNECTED VEHICLES – HELP FOR A UK LOCAL AUTHORITY

1 Why this guide?

DfT's recent survey of Local Authorities (LAs) highlighted a widespread lack of understanding of connected vehicles. Connected vehicles rarely feature on LAs' action lists but there is a real need for LAs to understand the opportunities and potential effects, so that investments can be informed and planned.

Connected vehicles are an immediate reality. It is important that they have a place in LAs' short as well as long-term planning. The ways in which they are used and adopted by drivers and network operators is important, not least because the longer-term deployment of autonomous vehicles may rely on connected but self-driven vehicle technology and experiences.

DfT is now investing in pilots and trials of co-operative ITS with UK LAs. It is important that the knowledge of these and the results are spread, and this guide introduces these.

2 What are connected vehicles?

A connected vehicle can be, for example, an existing vehicle with a sat nav, a fleet management system, an insurance black box, a navigation app or simply a mobile phone on board. It is not necessarily a new vehicle with new technology. 'Connected' can equally apply to a bicycle, motorbike, bus passenger or even a freight container – as long as it can report data or receive information.

In the UK we already have:

- Well over 1 million vehicles currently reporting their locations in real time (source: INRIX plus Tomtom) – smart phone apps, sat navs, fleet management and other devices already provide a wealth of location data and more data is becoming available;
- New vehicles connected for online navigation and 'infotainment', with services such as parking space finding and payment being added by Original Equipment Makers (OEMs) such as MINI;
- Data direct from vehicles such as road/weather conditions, airbag deployments and engine statuses;
- Data from 'dongles' in existing older vehicles on fleet movements, road asset condition, engine condition and hence emissions, and data used for smart parking;
- OEMs such as Vauxhall with the new Viva offering services in mass-market models which, allied to low-cost leasing, means accelerated penetration of the UK vehicle fleet;
- Rapid expansion of both the number and capability of smartphones/devices inside older vehicles;
- The increasing use of transport/navigation apps such as Waze and other services, such as parking;
- Images from vehicles for asset management such as potholes and incident detection;
- Initiatives underway promoting connectivity, such as the A2/M2 pilot and the UK CITE and Compass4D projects and forthcoming C-ITS projects;

The EU ITS platform is promoting 'Day One' services via connectivity. These will emerge from the EU auto industry as the UK is the second-largest market for many EU vehicle makers. And autonomous vehicles will need to be connected to co-operate with others, so helping connected vehicles to become established will help the future delivery of autonomous vehicles.

3 What are the potential benefits and costs for a UK Local Authority?

3.1 Benefits

Potential quick wins for LAs include:

- Making data available for parking and driver information services, e.g. supporting smart parking services that combine finding a space, payment and navigation;
- Using Big Data from vehicles and the devices in them to plan and value-engineer future investment and maintenance via smarter asset management;
- Looking at new tools like Signal Phase and Timing to reduce emissions and smooth traffic;
- Safety benefits for vulnerable road users;
- Using data direct from vehicles to improve signal timings to reduce congestion.

Larger benefits from slower-burn deployments include:

- Mobility as a Service, which moves away from people owning cars to paying for travel by many means;
- Removing/reducing roadside infrastructure.

These benefits are gained by an LA being actively involved with connected vehicles – they are not benefits simply from the existence of connected vehicles. For example:

- Congestion may be improved by sat nav without LA intervention but further improved with LA data and aligned with polices, especially for freight movement;
- Pay-as-you-go data may be used by an insurance company to improve driver safety without LA intervention or support. However, driver benefits may be enhanced with LA help in, for example, providing data to parking providers.

Some benefits are likely to be more immediate than others. For example, removing physical infrastructure may take time to give cashable benefits but improving signals using new data might give more immediate benefits in emissions. This is an area where there are fewer tools currently available but a significant policy push and increasing political awareness.

But most of the proposed outcomes are not yet well evidenced and indeed there is also a great deal of hype. Information we now show here is:

- Evident from previous research where possibilities ‘in the future’ are already here;
- From simulation, for example of signal junction delays or emissions reductions;
- Now being trialled in the UK, with results emerging from early projects, such as Compass 4D, and from other projects now starting, like UK CITE and the DfT’s C-ITS programme;
- About to be tested in the DfT’s 19 C-ITS projects (see Appendix A)
- From tests abroad which may not map to UK conditions but nevertheless show potential;
- Subject to ongoing research such as the T-TRIG programme.

The level of support for building a business case will vary. Moreover, not all the benefits are delivered in the same way, there may be hard cash savings, economic benefits, or measurable gains in policy terms.

3.2 Costs

In terms of costs to local authorities:

- For the most part, the in-vehicle devices are paid for by the driver or vehicle operator (e.g. smartphone/device, onboard unit for fleet management or vehicle leasing);
- Some services, notably navigation and parking, require data feeds from LAs for spaces and to integrate with enforcement systems, but little further investment. The user will provide the communications via his/her smartphone and use an app (and if parking availability can be reported by the vehicle itself, this is another cost saving over installing sensors);
- The key unknown cost is for dedicated roadside infrastructure, such as beacons to communicate with connected vehicles (this is discussed in the next section);
- The data feeds from vehicles and devices are currently a commercial service from suppliers like tomtom, here, Google and INRIX. Mobile phone suppliers are also selling data. It is not known the extent to which data collected by vehicle makers will compete with this, or be available openly. Companies like Ford and Tesla are starting to provide open access, but even a large manufacturer may not by itself have enough data for, say, journey time measurement. It provides enough of a sample for asset management, though (one or two vehicles per day reporting a pothole may be enough, for example).

This suggests that the key dimensions are:

- The cost of data services – and the market for data is still finding a sustainable level;
- The possible need for dedicated roadside equipment.

Driving down the cost of roadside communications and affordable pricing or even free data will be key enablers.

4 Technologies

The technology needed for connection will have a clear effect on the business case.

4.1 Current connectivity

Data such as vehicle locations is collected from devices like connected sat navs, fleet management systems and other GPS/GNSS-enabled devices such as smart phones. It is communicated to service providers via mobile telephone/data networks, processed and turned into congestion/routing, parking availability and weather warning messages, and sent back to in-vehicle devices. This can be over the internet using mobile data networks, via Digital Audio Broadcasting or (as it is still used to communicate with many sat nav systems) FM radio. More detailed data such as vehicle acceleration is connected by “black boxes”.

As vehicles become more connected, data which provides more than simple location updates can be sent. For example, status updates on road temperatures, steering angles, harsh braking, traction control, windscreen wiper use (which can be used to discern rain) and so on will all be possible. Much of this information is taken from the vehicle’s CAN bus data network and a direct connection to the vehicle maker or its service provider. Some is already accessed by connecting to the vehicle’s On-Board Diagnostic (OBD) port, with aftermarket devices called ‘dongles’ sending data back over mobile data networks via smartphones.

There is as yet no direct communication between vehicles in mainstream use in the UK.

4.2 Future connection to and from vehicles

Here we need to think about two aspects for future connected vehicle services:

- What we send; and
- How we send it.

In terms of *what we send*, standards are being developed that offer two-way messaging between vehicles/devices and infrastructure to warn of hazards, request priority at signals, warn of wrong-way drivers, support co-operative cruise control, etc. There is a wide range of messages being developed for co-operation between vehicles and infrastructure (V2V and V2I). Specific examples are:

- Messages that inform any other device (vehicles, equipped roadside units and some smartphones) about a vehicle’s location and speed (often called “Here I am”);
- Warnings from infrastructure to vehicles (e.g. “Queue ahead”) that can be ‘daisy-chained’ between vehicles to increase the geographic range of communication;
- Signal Phase and Timing (SPAT) – messages from devices connected to traffic signals on current and future phase settings.

In theory, all of the above messages are not tied to a particular way of *how we send it*. There is much debate as to whether this could be done via current mobile data communications (4G/LTE), next-generation 5G mobile data services, or via a Wi-Fi-based standard tailored for connected vehicles, confusingly called ITS G5.

4.3 5G, ITS G5 or LTE?

ITS G5 is a dedicated channel which gives a very fast service and high-speed delivery. But it requires dedicated beacons at the roadside to talk to vehicles, whereas 5G or LTE can use devices akin to mobile phones with no dedicated investment. 5G is being designed for high-capacity mobile data (e.g. video streaming) but there is debate over whether even this will have enough capacity and be quick enough to send data at peak times – consider a major traffic jam with all vehicles telling each other their statuses.

A key driver will be that ITS G5 is a transport-only solution but 5G is a mobile data solution for many 'Internet of Things' applications, too. Time will tell if the cost drivers of making billions of new 5G devices will sway the market. Technical and customer tests are needed to determine the right solution for LAs and for customers.

Early services that are not safety- or time-critical can already be delivered using smartphones in existing vehicles and 4G-connected vehicles like the new Vauxhall Astra. Examples are parking, navigation or even SPAT, although this needs testing. This focus on using existing technology removes the 'chicken and egg' of waiting for more advanced systems, where supporting new services with investment in beacons will need high penetration to be justified, but this penetration will not occur unless there are beacons able to support the services.

Hence there is a real need for evidence from the UK pilots about not just the technical aspects but also about what customers want.

4.4 Implications for a UK local authority considering connections

This all means that waiting for more evidence (or better still, actively helping collect it) about connected vehicles and infrastructure is the best solution for an LA today. Nevertheless, until the benefits are proven and the technology matures there is still a case for using available connected vehicle data as shown above, and for making data available to be used by other services/ service providers. TTF has written a guide on policy implications of choice of communications which gives more details.

4.5 Areas to consider

In terms of helping drivers make the most of signal timings, work by the Forum has shown that SPAT may not have any benefit at VA or MOVA-equipped junctions. This is because by their very nature they are dynamic. It may work better on fixed-time plans due to their predictable timings. This is because SCOOT's adaptive nature may affect how well SPAT works for the customer in terms of prediction quality for when lights will go green. So there is a clear tension between the investment of many cities in SCOOT for congestion reduction versus fixed-time-plus-SPAT for smoothing traffic. This is an area in need of more UK research via the C-ITS pilots. It highlights that we may need to consider the effects of change on some of our tried and tested approaches to work with connected vehicles, and the effects on non-connected ones.

Work is now underway to see how to apply connected vehicles to signalised junctions to improve performance. Probe data, even at low penetration rates, can be used to update fixed-time plans. This would overcome some of the ageing issues of this approach.

So there is a real need to look at how UK signals and connected vehicles can work well together across a wide variety of use cases – mirroring the testing of MOVA when first developed.

The CITS projects funded by DfT will inform these areas – see Appendix 1.

Other Forum work has shown that the beacons used to connect traffic signal controllers to vehicles may require further thinking for use in a UK context. This is because they have been envisaged by the Amsterdam Group (an organisation of European stakeholders looking at cooperative infrastructure deployment) as a single combined unit. This contrasts with the situation with UTMC, the plug-and-play nature of which would allow separate suppliers to combine together. Again, more work is needed to assess this but this highlights the need to consider the wider effects of new technology on existing LA traffic assets. DfT has already funded research in the CROCS project to investigate this area and produce outline solutions.

5 Getting involved

The discussion above shows a twin timescale approach for an LA:

- Quick wins – use of already-available connected vehicle data, shared LA data, smart phones and current mobile comms to improve services and potentially reduce costs;
- Longer term – preparing for connections for future co-operation using new technologies, once market-ready solutions are in place and benefits are clear.

Longer-term developments will firstly need:

- LAs acting as testbeds and working with service providers and OEMs for the key use cases like SPAT and use of probe data to improve junction performance (DfT has now funded 19 projects in this area, and further Innovate UK funds are a vehicle to support this);
- Sharing of cost-benefit assessment data and a ‘So what?’ learning capture approach aided by the Forum;
- Involvement in standards development and testing to ensure standards developed outside the UK do not have adverse effects;
- LAs to ‘think connected’ in their current facilities design to ensure future-proofing – e.g. something as simple as a CAT6 cable and power to the top of every new signal pole, as used in York. Installing these in a new junction costs a few pounds, adding them later will cost thousands;
- LAs and industry to think about the road user as a customer with choice – unlike traffic lights and signs, apps and services like SPAT are a choice for the customer and if they do not work well they will be discarded and the benefits not gained. This is critical and not well understood;
- LAs to consider how they will procure future services so that connected and co-operative deployments are not off the agenda due to long-term commitments, and to think about the extra skills they will need to support this move.

6 Next steps

The above shows that:

- Connected vehicles have a range of benefits and costs for an LA, albeit over different timescales and in different volumes;
- Some early services are in place now, and LAs can help these mature by making data available (e.g. that on parking and roadworks). Later, there may be cash savings from connected vehicles;
- LAs are in the best position, with government help and industry support, to capture and measure these benefits, and to ensure no unintended effects on current operations;
- A wide range of pilots and tests will demonstrate benefits and co-ordination of their results will create an evidence base for the UK. The learning needs to be shared.

This suggests a ‘to do’ list from this paper:

Action	Responsibility
Publish online data to support new and emerging connected services (parking, roadworks...) if not already doing so.	LAs
Consider emerging and available data sources (probes, mobile devices) as infill for gaps and for future use as key sources. Use this data in planning future investment e.g. O-D data.	LAs
Monitor emerging services for connected vehicles versus policy and safety implications.	Government
Capture evidence of benefits from existing and emerging projects (COMPASS 4D, UK CITE, A2/M2, etc. and C-ITS projects) and disseminate.	The Forum
Research use of probe data to improve signal timings in UK.	C-ITS projects and industry
Research benefits of SPAT in UK and how to partner it with SCOOT in a way that works for customers.	C-ITS projects and industry
Look at how connected vehicles can affect emissions for an LA and test pilot ideas to build evidence.	All, C-ITS projects
Ensure developing standards are influenced by UK practitioners and don't have unintended effects.	Government and Industry with LAs
Wide range of coordinated pilots and benefits capture/learning dissemination back to UK LAs.	C-ITS projects and the Forum
Consider how to procure future data services, not just systems.	LAs and Industry
Think 'digital future-proofing' in infrastructure design – what can we add now at low cost that we may need in 2020?	LAs and Industry
Ensure connected technology does not have unintended consequences on LAs' existing technology and practices.	All
Think about the skills sets needed to deploy connected services.	LAs and Industry
Drive down the cost of connection via roadside beacon and ease of connection to UK systems.	Industry
<i>Don't Panic!</i> Connected service pilots can start with smart phones and also test various competing technologies; you don't have to decide today.	All
<i>Think Customer!</i> Services need to be chosen by road users as they work well and give benefit, as opposed to regulatory tools like signals and signs.	All
<i>Take part!</i> Unless UK LAs of all shapes and sizes get involved in pilots and tests, we will have a 'one size fits all' solution. UK Government has funded pilots already and there is hopefully more to come.	All

In the above, 'Industry' means the ITS, ICT and automotive industries working co-operatively.

Appendix A: C-ITS Projects (funded by DfT from 21 Feb 2017)

Blackpool – Traffic congestion and parking Bluetooth management technology (£234,000)

City of York – Connected vehicle data for traffic signalling to improve congestion (£295,200)

Derbyshire – Early-warning system for congestion enabling drivers to communicate with one another and avoid traffic (£237,500)

Dorset – Advanced congestion warnings app (£182,100)

Southampton – Enabling council to deliver real-time travel information to better manage road network (£90,000)

Swindon – Alert system for local authority traffic managers to better disseminate congestion information (£235,000)

Warrington – Using Bluetooth and Smart technology to manage traffic flow and provide real-time information to businesses and the general public (£300,000)

Worcestershire – Information-sharing system so traffic incidents can be dealt with quickly by highway staff and vehicles (£300,000)

Newcastle – Connected bus scheme for Arriva Fleet to equip more buses with vehicle infrastructure technology (£98,200)

Portsmouth – Developing platform for Portsmouth's Traffic Management Centre, enabling communication exchange between vehicles infrastructure and other vehicles (£285,000)

Reading – Improve roadworks warning, parking and traffic information (£250,000)

Coventry – Real-time information on parking bay availability to improve parking services (£150,000)

Somerset – Provide advanced traffic signal phase and timing information for traffic on the M5 – Junction 24, through Bridgewater, to Hinkley Point (£290,000)

West Midlands – Real-time information for HGV drivers to avoid unnecessary stops at traffic signals via hands-free smartphone app (£285,000)

Hounslow, Hammersmith, Fulham and Westminster – Sharing information about electric charge points by deploying parking sensors in electric vehicle bays (£204,000)

Luton – To collect live car park availability data and give straight to drivers to reduce congestion by reducing time looking for spaces (£73,500)

Milton Keynes – Provision of real-time information with cameras/sensors and seven laser sensors at key junctions in Central Milton Keynes enabling monitoring of all available parking (£175,000)

Oxfordshire – Real-time parking information for Blue Badge, Pay and Display and electric vehicle charge points with a particular focus on vulnerable road users (£239,000)

Peterborough – Real-time journey information for the visually impaired with a focus on visitors being able to access the new Royal National Institute for the Blind head offices in Peterborough (£50,000)