


Project 1 – A2/M2 Connected Corridor Infrastructure Feasibility Study

Deliverable D4 and D5 – Final Report and Pilot Study Recommendations

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Disclaimer

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Contents

1 Introduction

1.1 Background

Developments in communications technologies are enabling opportunities to improve transport networks through the use of emerging services based on connectivity. These improvements will be seen in the areas of safety, efficiency, and environmental performance. They have implications for the design, construction, operation and management of transport infrastructure. This project is undertaking research to understand the requirements which need to be met to enable the emerging services to be realised.

The government's Road Investment Strategy[1] set out an objective to improve safety levels, smooth traffic flow, and increase capacity on the busiest parts of the network by 2040. This included a commitment to implement a connected corridor which can provide connected services to meet this objective.

1.2 Purpose

The purpose of this project was to provide advice on the technological feasibility of implementing a connected corridor along the A2 and M2 from the Blackwall tunnel in central London to Dover. A parallel project investigating possible services for the corridor was also undertaken within the same timeframe as this project.

This corridor covers urban roads in London, the Strategic Road Network, and local roads in Kent. Thus the services which may be appropriate include services for private motorists, fleets (particularly freight), urban roads and inter-urban roads.

This report presents the methodology for the project, a brief summary of what was undertaken, recommendations arising from the feasibility study and recommendations for the pilot project.

[1] Published December 2014, updated March 2015: https://www.gov.uk/government/collections/road-investment-strategy

2 Methodology

The Partners in this project, the Department for Transport (DfT), Highways England (HE), Transport for London (TfL) and Kent County Council (KCC) had a set of specific objectives for this project, namely to:

- Identify and assess the technology capabilities for delivering connected vehicles for the corridor
- Develop technological options for the corridor that support an open platform for encouraging the development of interoperable Cooperative-ITS (C-ITS)
- Ensure that the technology capabilities, identified within this study, are sufficient to meet the requirements of the corridor services
- Undertake an assessment of the security requirements for the communication technologies identified and the privacy of data, as required by national and international laws
- Validate the potential technologies by undertaking bench tests across a range of equipment types to establish likely performance in a highway environment
- Meet the aspirations of the wide-range of potential users
- Identify the appropriate technology and roadside installation requirements
- Provide a design specification for the corridor scheme
- Deliver a robust and data-led conclusion

To achieve these objectives the following activities were undertaken:

- A review the current literature and ongoing international projects to ensure that the project was fully aware of recent developments and standards in this area
- Engagement with the market to establish the scope and scale of services likely to be wanted by users, and which in turn will be enabled by this technology
- Identification of suitable technological solutions and providers
- Development of a shortlist of providers who were in a position to supply suitable equipment for the corridor
- Bench tests of the identified equipment at the supplier premises
- A track trial to validate the performance of roadside Wi-Fi solutions
- Development of recommendations for the feasibility of roadside Wi-Fi generally and for the pilot study.

Each of the stages is described in more detail in the following sections.

3 Results and Conclusions

The results in this section should be read in conjunction with the findings from the parallel project investigating the services and data which the corridor will need to support.

In particular, a number of "core" services were identified which the corridor should support and implement. These services were:

- Floating Vehicle Data (FVD) – gathering road traffic data directly from vehicles using the road network.
- Road Works Transit time (RWT) – measuring the time taken for vehicles to transit roadworks; used for RWW (see below).
- Green Light Optimisation with speed assistance (GLOSA) – drivers approaching traffic lights are given an optimal speed at which to drive to go through the traffic lights at green.
- In Vehicle Signage (IVS) – roadside static and variable messages signs are transmitted into the vehicle and displayed to the driver on an in-vehicle display.
- Road Works Warning (RWW) – warnings to drivers about upcoming road works. Can be long-range (allowing drivers to select an alternative route) and short range (allowing drivers to take more care).
- Freight Lorry Parking (FLP) – provides freight drivers with information about parking and upcoming parking facilities. Can be combined with a parking booking system.
- Freight Slot Availability (FSA) – allocated freight vehicle a time slot to sign into a port facility without queuing.
- eCall automatic crash notification (eCall) – automatic emergency call in the event of a crash.

Of the abover, FVD, RWT, GLOSA, IVS and RWW are considered "day 1" services which should be part of the corridor specification.

3.1 Review the current literature and ongoing international projects - Deliverable D1: Market Requirements and Technology Match Report

A literature review was undertaken in October 2015 and the report updated and presented in February 2016. The deliverable was 'D1 Market requirements and technology match report'.

The report reviewed current literature to understand the situation in wireless data connectivity, requirements for data connectivity and the technical requirements of systems to provide connectivity in order to deploy services on the corridor. These requirements varied depending on the nature of the C-ITS service they are supporting, so the requirements were identified on the basis of services identified in the parallel project as being appropriate to consider for deployment on the connected vehicle corridor.

The initial draft of the report was prepared in advance of an Information Event which informed the process of service selection; this service selection in turn determined the detailed technical requirements for connectivity on the corridor.

The deliverable D1 supported a decision on the feasibility of moving on to subsequent stages of the project, namely a bench testing exercise to gain confidence in the ability of current equipment, a track test to ensure that claimed critical performance needs can be met, and finally a robust, evidence led recommendation for the most appropriate technology to be used in the connected corridor pilot.

3.2 Engage with the market – Information Event Summary

Discussions were held with the partners and a number of suppliers, and a list developed of potential stakeholders who were invited to an Information Event held at TRL on 18th November 2015.

The information event was designed to engage a wide range of stakeholders in considering the selection of services, stakeholder requirements, the issues involved and benefits arising from providing services on the corridor and the role which stakeholders might wish to play in offering services on the corridor.

The services which it was considered essential for the corridor to be able to support were:

- Safety (including safety critical information, maximum speed advice, actual speed limit implemented in vehicles, brake lights ahead warning, providing a safety bubble around novice drivers and fleet safety – such as tyre condition monitoring)
- Hazard warning
- Automatic breakdown call (B-Call)
- Road works warning
- Reducing congestion (including close coupling of vehicles and providing incentives for non-essential users to take a break during congested periods)
- Journey time information
- Journey time reliability predictor
- Accurate and reliable delay information (particularly for freight)
- Real time route planning/optimisation information (including height restrictions)
- Real time information e.g. real time traffic and incidents, real time information for breakdown services
- In-vehicle signage
- Incident management information
- Infotainment (seen as important by vehicle manufacturers)
- Personalised information
- Destination data including ferry and tunnel information
- Tolling/ road user charging either by paying for road use, or paying for faster journeys or peak use
- Preventative maintenance/ asset management
- Identifying and notifying vehicles that will run out of fuel in the Blackwall Tunnel (congestion reduction measure)
- Identifying and notifying vehicles that are too high to use the Blackwall Tunnel (congestion reduction measure)
- Pothole/ road surface condition detection/ monitoring and reporting
- Availability of parking spaces (for urban areas)

- Integrated transport – services which integrate the corridor with other forms of transport. For example for people travelling into London, information to promote multi-modal journeys when it would be beneficial to switch from car to public transport
- Probe vehicle data based on the vehicle as a sensor.

Views were also provided on the fundamental requirements of a connected corridor which were about the technology: interoperability (including global solutions), integration with legacy systems, based on open standards (for future proofing), ability to support any new (and possibly unforeseen) services or communications technologies that come along in future, using agreed communications standards, having service level agreements for communications (for example with guaranteed connectivity), with flexibility to respond to peaks in demand.

There were also requirements identified for the data, including that it is relevant, accurate, reliable, timely, consistent, has a high level of integrity, is authenticated and contextual. Making data available as open data was seen as important for encouraging new services. The availability of data after the end of the corridor project was also mentioned.

Another set of requirements were about security and privacy, with cyber security seen as being crucial to the success of any service. Designing services taking account of possible malicious uses of the data was recommended. Ownership of data and governance structures need to be established. Issues of access to data, who has it and who has the right to share it were also raised.

Requirements for the services themselves were that they should be mature, affordable, safe, deal with driver distraction, secure, resilient, reliably available, with a human-centred approach and integrate with existing products and services (such as satnav systems).

Discussions also took place around security issues; covering the risks of hacking into vehicles and infrastructure and denial of service attacks. It was felt that it is vital that any data exchanged is accurate and valid. Building trusted pathways is the key to security, although with crowd sourced data it may be necessary to validate data. The importance of having an architecture which separates systems with different levels of vulnerability was emphasised. For example, Original Equipment Manufacturers (OEMs) deal with these risks by installing separate SIMs for safety and other services. Service providers emphasised the importance of focusing on authentication. Others said that designing services with the worst case risks in mind is the approach to take. One suggestion was to start by offering services that have low levels of vulnerability and develop those with more security issues at a later stage.

The impact of security breaches would be expected to vary between different types of service, with some having safety implications, others causing disruption and some causing inconvenience. The risks of threats to personal or sensitive data were seen as less crucial than the risk from malicious falsification or corruption of network data.

It was noted that current standards on security may not be appropriate for connected vehicle services, which could be a challenge for certification.

Privacy concerns would vary between businesses, fleets and private users. A key decision will be whether or not users have the option to provide data (for example by signing up in advance, thereby engaging the user in the service), and whether users are asked to opt in or opt out. Anonymising data at source before it leaves the vehicle was also suggested as a solution. EU legislation will need to be considered.

Other discussions covered business models, benefits of a connected corridor, how it is used and future services.

3.3 Identify suitable technological solutions and providers and provide a shortlist of providers who are in a position to supply suitable equipment for the corridor

From the connectivity requirements for the connected corridor, as identified in D1 of this project and confirmed at the Information Event, three companies were identified which had the potential to demonstrate the ability of suppliers to meet these requirements. In addition, three companies which could supply innovative communication infrastructure solutions, though not necessarily compliant with the core requirements, were also identified. These six companies were invited to take part in bench tests where they were going to be asked to demonstrate certain performance characteristics of their solutions.

Of the six companies, two suppliers from each of the groups agreed to take part. These were:

- Dynniq (previously Imtech Traffic and Infra) from the Netherlands
- Siemens traffic, also from the Netherlands
- Bouygues, a supplier of innovative solutions, and their technology partner Horsebridge Networks in the UK
- McLaren electronics, a supplier of specialist solutions, including communication systems

Dynniq and Siemens both supply ITS G5 systems to existing connected vehicle projects and demonstrators.

Bouygues (through Horsebridge) and McLaren both have a track record in supplying innovative communications' solutions, although not involving ITS G5.

Each of the suppliers was sent a method statement of what they would be expected to demonstrate during the bench tests.

3.4 Undertake bench tests of the identified equipment at the supplier premises – Deliverable D2: Equipment Analysis and Suitability Report (Bench test report)

In the bench tests, evidence was sought on the level of performance that current generation equipment can achieve. Suppliers were expected to provide evidence of achievable performance in the following areas:

- Maximum data rate achievable between the Road Side Unit (RSU) and the On-Board Unit (OBU), with an indication of the performance degradation as signal strength varies
- Range – can be simulated, and change in data rate with reduced signal strength. Note that range limitations can be signal-strength related (the system loses connectivity when the received signal gets too small) and design limited (the systems expects a response within a maximum time which cannot be achieved beyond a certain range)
- Latency experienced by messages exchanged between the RSU and OBU
- Hand-over as the OBU moves from one RSU to the next, identifying any hand-over time lags.
- Immunity to co-channel (other signals using the same frequency band) and adjacent channel (other signals using frequency bands adjacent or close to the band used by the equipment under test) interference
- Support for ETSI basic message sets (CAM and DENM) where appropriate

- Support for hybrid communications, i.e. seamless movement to longer range communications infrastructure (e.g. cellular) when moving out of range of the shorter range communications being demonstrated

The bench tests took place between January and March 2016 as follows:

- Dynniq's bench test took place on 15th January in Amersfoort, in the Netherlands
- Siemens' bench test took place on 3rd March in Zoetermeer, in the Netherlands
- Mclaren's bench test took place on 7th March in Woking, UK
- Bouygues' bench test took place on 10th March in Cheltenham, UK

The bench tests showed that solutions exist which are able to meet the core requirements to support the proposed connected corridor core ITS-G5 based services. In addition, innovative technology solutions can be found.

The full results of the bench tests are contained within 'Deliverable D2 – Equipment Analysis and Suitability Report (Bench test report)'.

3.5 Design a track trial to validate the performance of roadside Wi-Fi solutions and implement track trials for up to three solutions – Deliverable D3: Track Trials Report

Previous work packages and the experience of other connected vehicle projects indicated that the most suitable communications technologies for connected ITS services are ETSI ITS G5 for short-range, low latency connections, and cellular (3G and 4G/LTE) connections for connected services which do not require guaranteed low latencies. It is expected that, in time, connected ITS will use a hybrid of ITS G5 and cellular, selecting the most appropriate connection at the time of use.

Cellular communications are very well established and understood, to the extent that running a track trial for this technology would deliver little if any value.

ITS G5 is also well-established with a range of ETSI standards supporting it, although it is much less widely implemented, all current installations being in trials or demonstration phase projects. While the performance is well characterised, practical experience of the technology is not widespread, and there are still some performance issues which are not fully understood. It was therefore decided that ITS G5 would be trialled to gain a fuller understanding of its capabilities and limitations.

This stage also looked at alternative technologies which may be appropriate to investigate. One technology which stood out was the use of LTE in unlicensed spectrum.

LTE (the technology used in 4G cellular data communications) is designed as a licensed communications medium where the use of the spectrum in which it operates is licensed to a cellular operator. The operator is responsible for ensuring that its users get a reasonable quality of service, which means that access to the network is centrally controlled. Unlicensed LTE is similar to commercial LTE, but operates in an unlicensed part of the spectrum. This allows services to be provided by anyone with the means to set up a network, while the mobile terminals would be based on standard telephony devices as the protocols used are based on LTE. This would for example be an alternative to network-owned Wi-Fi hotspots. Unlicensed LTE is not widely used, but could be a means for an organisation like Highways England to provide enhanced communications to its customers.

It was therefore decided that unlicensed LTE would be the second technology to be trialled.

Following the bench tests, three suppliers were invited to take part in track trials which were set for 9th – 11th May 2016. The three suppliers were Siemens, Dynniq and Bouygues.

Siemens and Dynniq were unable to take part in the trial as they could not make their equipment available for the dates of the trial. Bouygues took part in the track trial, the results of which are detailed in Deliverable D3: Track Trials Report.

4 Discussion

Project deliverable D1 described the market requirements for the communications' infrastructure, based on the services likely to be implemented on the corridor. A survey of the market identified that current suppliers are likely to be able to meet the technology requirements.

The technical requirements for the communications' infrastructure are such that a single technology will not be able to meet all the requirements, and hence a multi-technology approach is recommended. Two communications infrastructure technologies are currently available which will meet the core communications requirements for the core services:

- A short-range, low latency network designed for safety-related services, namely ETSI ITS G5
- The cellular data network for longer range, lower speed and latency communications.

These two will fulfil the requirements for the core services envisaged, but both have limitations when future services with more stringent communications requirements are considered. The two recommended technologies, as well as alternatives for future consideration, are discussed in more detail below.

In addition, we also make recommendations regarding the use of hybrid communications technologies and possible future alternative technologies.

4.1 ETSI ITS G5 Short Range Network

ETSI ITS G5[2], called G5 from here on, is a short-range, low latency data communications standard designed specifically to support safety related services on the road network. It is designed as both a V2V and V2I network. While it is based on the IEEE 802.11 protocols, it should not be seen as an implementation of Wi-Fi, rather as network designed to support specific services.

G5 is designed as a broadcast system, in which a terminal (mobile or fixed) broadcasts information which can be used by all recipients to implement ITS services. Pre-defined messages are specified in the G5 standards and support for these is normally expected to be built into the beacons and mobile terminals.

G5 is based on the IEEE 802.11p standards which forms part of the IEEE 802.11 suite of standards and as such it can, in principle, support generic IP-based communications. However the frequency band designated to G5 in Europe 5.875 GHz – 5.905 GHz only allows safety related applications. Further spectrum has been identified in the ETSI ES 202 663 standard for non-safety related ITS services using G5, namely 5.47 GHZ – 5.725 GHz (which is a shared access band where other services like 802.11ac Wi-Fi), and 5.855 GHz -5.875 GHz (identified in the standard as a European ITS frequency bands dedicated to ITS non- safety applications). Note, however, that the last band is not

[2] G5 is based on the IEEE 802.11p standard, and is virtually identical to the WAVE (Wireless Access in the Vehicular Environment) standard used in North America. It is also sometimes referred to as DSRC, though this term has a specific meaning in Europe and hence is avoided in this report.

designated to ITS in the UK. Ofcom is currently consulting on the designation of spectrum in the 5.8 GHz band, so no assumptions can be made about this.

As G5 is based on standard 802.11 protocols, it is possible that is can be used in the shared access bands for general purpose data transfer and some suppliers are starting to experiment with implementing this functionality in their OBUs.

4.2 Cellular Long Range Network

The cellular network provides data communications capability to mobile devices using the cellular phone network. The infrastructure is available to road users at no cost to the road operator, with the costs of installation and operation being funded by user fees.

Cellular terminals (e.g. mobile phones) are in widespread use and are relatively inexpensive due to the economies of scale inherent in their manufacture. This means that any service delivered over a cellular network can in principle make use of the mobile phones as the OBU, with the service implemented as an app on the phone. In the future these services could then make use of the vehicle's in-dash display as the HMI for the application via technologies like Apple Carplay, Android Auto and MirrorLink.

Cellular networks tend to provide very good coverage in densely populated areas, but have less good coverage on roads and rural areas. There are a number of issues regarding the use of cellular networks for road transport applications:

- Coverage is uncertain, with individual network operators prioritising according to their own business needs. With four operators in the UK, this means that users on different networks will experience different levels of service depending on which network they are on.
- Networks are a mixture of 2G, 3G and 4G technologies, so data rates are highly variable.
- Latencies are not deterministic, depending on which type of network is currently in use, network traffic and the prioritising strategies of the network operator.

All the above mean that current cellular networks are not suitable for safety related services as these typically depend on low-latency communications. However, it is recognised that cellular standards constantly evolve, and already technology updates (for example LTE-V) are being trialled to overcome the limitations of cellular networks in delivering direct point-to-point communications suitable for safety related services. It is expected that these technologies will be part of the LTE standards used in future 5G networks.

Non-safety related services, for example the freight services expected to be implemented in this programme, may be well suited to making use of cellular networks.

4.3 Hybrid Network

Hybrid communications, sometimes referred to as ubiquitous communications, is making use of multiple communications technologies to ensure the best possible chance of achieving a successful connection. In the case of connected ITS, it generally refers to an OBU using either a G5 or a cellular connection to communicate. This maximises the chance of a successful connection being made.

The two different approaches are shown in Figure 1.

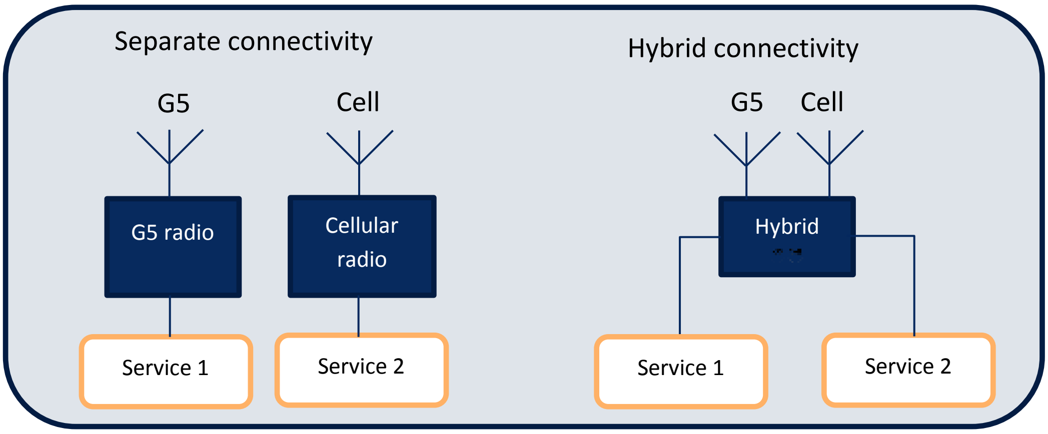

Figure 1: Hybrid vs separate connectivity

The hybrid approach has the distinct advantage that the probability of a successful connection is increased as in principle any service can use any available connectivity solution. Other connected corridor projects in Europe envisage eventually implementing hybrid solutions.

There are however significant unresolved issues regarding the implementation of hybrid solutions. These primarily centre on the differing requirements for different services. For example, if a safety related message needs to be received within a minimum time, this can only be guaranteed by a G5 type of network, so this type of safety service should not use a cellular connection. Further the short-range, non-cellular broadcast nature of G5 networks means that messages are automatically geographically limited. So a message displayed on a VMS could be broadcast via G5 from the VMS location and this message will then only be received by vehicles within 500m of the sign. To achieve the same geographic limiting on a cellular system requires complex geolocation rules at both the back-office and OBU to ensure drivers are only presented with relevant information.

Using cellular for V2V is also not feasible at this time, although this is not relevant to V2I based services as envisaged on the corridor.

4.4 Alternative and upcoming technologies

Both the recommended communications solutions are compromised in that they do not provide a comprehensive solution of high-bandwidth, low latency continuous communications for all road users.

G5 provides the low latency required for safety applications, but cannot provide a continuous data stream as it is does not include a handover mechanism. It is also not possible to use without a dedicated OBU. The radio technology involved is unlikely to be included in consumer mobile devices in the near future, a;though in the longer term it is likely that it will be installed in new vehicles.

Current cellular solutions (2G, 3G, 4G) provide a low cost route directly to road users' devices through their smartphones, but they do not provide the direct device-to-device (V2V, V2I) capabilities required to guarantee low latency communications. It is expected that updates to the LTE standards in the near future may provide this capability, and it is certainly expected to be included in the future 5G standards, but this is still several years away.

A further issue with cellular technologies is that being licensed, it is up to the mobile license holders to provide the infrastructure. There are four mobile network operators in the UK, and all four would need to provide the necessary system upgrades if services are to be available to all road users (or at least those who have a mobile contract).

There are some alternative technologies which may be considered for use on the connected corridor.

Unlicensed LTE (i.e. making use of cellular LTE technologies, but operating in unlicensed bands) has the potential to provide high bandwidth services into the vehicle and the track trials undertaken in this project show that this is possible. More work is needed however on gaining an understanding of how this technology can co-exist with other users of unlicensed bands (for example, 5.8 GHz Wi-Fi). Ofcom is also still addressing final usages of the 5.8GHz, so any decisions to use this band will require a deeper understanding of the full implications.

Commercial Wi-Fi is another technology which is capable of providing high bandwidth services to users via their mobile devices. Being unlicensed, there are no barriers to entry or costs for usage. It is however unproven whether commercial Wi-Fi will operate to specification into fast moving vehicles. There appears to be little research into this subject. Wi-Fi is also subject to delays when moving from base-station to base station as there is no built-in handover mechanism.

4.5 Fixed infrastructure and Backhaul

The backhaul (i.e. the connection to the fixed telecommunications infrastructure) should be defined during the detailed design phase of this programme. If capacity is available on the NRTS network, then it is preferable that this is used. However, alternatives, including point-to-point microwave systems, are available. It is entirely possible that a mixed approach will be preferable, with some RSUs connection directly to NRTS while other use microwave connections.

During the lifetime of this project, the existing NRTS contract will come to an end and a new NRTS2 contract will be put in place. This makes any long term plans to use NRTS as the backhaul somewhat more difficult. As the procurement process for NRTS2 has already started, influencing the requirements will be difficult.

5 Recommendations and Next Steps

5.1 ETSI ITS G5 Short Range Network

G5 is core to some of the services envisaged on the connected corridor, so it is recommended that a G5 network is installed, preferably along the full length of the corridor, but certainly along a substantial length of the corridor. For the length of the road network covered, the coverage should be continuous. This will require a RSU to be installed approximately every 500-1000m, depending on topology and the capabilities of the equipment.

It is further proposed that at least two suppliers are selected to roll out the network, each responsible for a substantial percentage of the coverage. At least one supplier should provide the means to use G5 in a shared access band for general purpose data transfer.

While G5 does not support a seamless handover mechanism, consideration should be given to understanding the potential handover performance of suppliers when streaming data.

Suppliers should be responsible for ensuring the coverage of the implemented network, i.e. they should specify where and how many RSUs are required to achieve full coverage. The positioning of the RSUs should be decided in conjunction with the area teams or authorities responsible for the road in question.

5.2 Cellular Long Range Network

It is recommended that at least one cellular operator is engaged in the programme with a view to rolling out enhanced 4G coverage along the corridor and implementing the latest point-to-point proposed technologies along at least part of the network, providing a testbed environment where the newer technologies can be trialled. It must be recognised that trialling new technologies carries a financial burden as terminals (for example mobile phones) which support the newer technologies do not exist and will need to be supplied, possibly purchased, as part of any trial. It also means that there is no installed base of OBUs which can take part in any trial.

5.3 Hybrid Network

Despite the disadvantages, there are strong reasons why a hybrid solution should be considered. Given the unresolved issues, it is recommended that a hybrid solution is developed in cooperation with the Intercor partners on the A2/M2 corridor and also in consultation with the Rotterdam/Vienna and SCOOP@F corridor projects. This will ensure that a coherent interoperable solution is arrived at.

5.4 Alternative and upcoming technologies

It is recommended that the project keep a watching brief on alternative technologies. None of the available technologies appear to be ready for inclusion in the connected corridor at this stage.

5.5 Fixed infrastructure and Backhaul

It is recommended that the backhaul be defined at the detailed specification stage, working in close consultation with the NRTS team

5.6 Next Steps

The next phase of the programme will be to develop a detailed specification against which infrastructure and services can be procured. It is recommended that, as a first step during the detailed specification phase, the state of play with the supply of communications infrastructure be re-evaluated due to the rapid developments currently taking place in this industry.

The specifications should be developed in close partnership with proposed colleagues on the Intercor project. Should this project for any reason not proceed, partnership should be sought with the existing ITS Corridor and SCOOP@F projects to develop interoperable specifications for infrastructure and services.

6 Pilot Requirements

The A2/M2 corridor pilot is intended to provide an understanding of the benefits and potential dis-benefits of providing C-ITS services and infrastructure on the corridor.

From the research undertaken in this project, we can derive the following high-level requirements for the pilot:

General requirements:

1. Agree a common set of aims for the pilots between the four project partners (DfT, HE, TfL, KCC).

Communications infrastructure:

2. Implement a robust, ETSI ITS G5 network for the entire length (or at least a substantial portion) of the corridor. The G5 network must support all the facilities defined in the ETSI specifications, specifically CAM, DENM and SPAT/MAP data.
3. Ensure that the backhaul implemented on the corridor has sufficient capacity to support all envisaged services, both those implemented as “day-1” services, and those expected to be implemented in the foreseeable future.
4. Provide a well-defined open access interface to the G5 network where potential service providers can try out new and innovative application ideas.
5. Work with one (or more) cellular network operators to define a method and scope for implementing an enhanced cellular network for the full length (or a substantial portion of the full length) of the corridor. The enhanced network should include:
    a. Continuous 4G coverage along the length of the corridor
    b. Trial implementations of potential future LTE technologies such as LTE-V
6. Work with continental Intercor partners (assuming the Intercor project is progressed), as well as other European corridors, to define a common standard for hybrid G5/cellular networks.
7. Keep a continuous watching brief on alternative communications technologies which may provide tangible benefits on the corridor.

Services and service interfaces:

8. Provide an easy but robust method for potential service providers to register as service providers on the network.
9. Ensure that current best practice cyber-security is implemented on the network, as well as all other ITS aspects of the corridor. All registered service providers must agree to be bound by these requirements and be able to demonstrate best practice.
10. As part of the conditions for using the corridor as a test bed, registered service providers must agree to make relevant results available to the operators of the pilot. Given the diversity of possible applications which may be implemented, these agreements should be negotiated on an ad-hoc basis with each service provider.
11. Ensure real-world live traffic data for the network (such as that derived from the floating car data collected) is made available under open data access conditions to all registered service providers.

Physical infrastructure:

12. Roadside infrastructure should be designed for easy access and upgrading. Specifically, it should be possible to add new communications' devices to roadside poles and gantries with a simple "plug and play" procedure.
13. Space should be made available for those companies which need close physical access to the roadside infrastructure. For example, it is reasonable that some services may be provided from roadside computing devices for speed and reliability reasons.

Trials support:

14. A number of OBUs should be provided to trial participants as part of this trial. A working paper prepared in support for the Connecting Europe Facility (CEF) bid funding has suggested that 3000 would be a reasonable number.
15. A robust trial participant recruitment process should be put in place.
16. Participants should be drawn from a range of user groups, including commercial vehicle, business traveller and private motorists. Participants should be filtered to ensure that they are regular users of the corridor.
17. Support for trials should be sought from haulage and logistics businesses, road operators, local authorities and local user groups.

7 Glossary

3G	Third generation of cellular networks
4G	Fourth generation of cellular networks
CAM	Cooperative Awareness Message
C-ITS	Cooperative Intelligent Transport Systems
DENM	Decentralised Environmental Notification Message
DSRC	Dedicated Short Range Communications
ETSI	European Telecommunications Standardisation Institute
IEEE 802.11	A suite of standards from the IEEE for Wireless LANs (WLAN)
IEEE 802.11p	A specific IEEE WLAN standard for use in C-ITS applications
IP	Internet Protocol
ITS-G5	European standard for communications in the 5GHz band for Intelligent Transport Systems
LTE	Long Term Evolution, a telephone and mobile broadband communication standard
LTE-V	LTE for vehicles, a proposed extension to the LTE standard having similar functionality to ITS-G5 and 802.11p
NRTS	National Roads Telecommunications Services
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
Ofcom	Office of Communications
RSU	Road Side Unit
SIM	Subscriber Identity Module
SPaT	Signal Phase and Timing
V2I	Vehicle to infrastructure communications
V2V	Vehicle to Vehicle communications
VMS	Variable Message Sign
WAVE	Wireless Access in Vehicular Environments
Wi-Fi	Wireless Fidelity, a widely used, trademarked implementation of a WLAN based on IEEE 802.11 standards
WLAN	Wireless Local Area Network