


Project 3 - A2/M2 Connected Corridor Data and Services Feasibility Study

Deliverable D5 – Final Report and Pilot Study Recommendations

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1 Introduction

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 and 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 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 contribute to this objective.

An important input to the project is the work of the Amsterdam Group, a forum considering the future of connected transport, particularly the list of "Day 1" I2V applications identified by the group.

1.1 Purpose

The purpose of this project is to provide advice on the technologies which are appropriate for communications to support connected vehicle services along the A2 and M2 from the Blackwall tunnel in central London to Dover. A parallel project investigating possible infrastructure for the corridor has also been 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.

The project included a number of workstreams that contributed to a bid for funding from Europe; these are detailed in following sections.

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 had a set of specific objectives for this project, namely to:

- Determine the selection of Day One C-ITS services/applications and future service development
- Investigate commercial offerings that deliver additional services
- Review systems for vehicle communications
- Review relevant data types and management tools for the selected services
- Review data access availability and security and determine what data sources are required to deliver the identified services
- Determine the security requirements for the privacy of this data
- Determine the type, quantity and mix of vehicles for the pilot – based upon the recommended services
- Determine the programme for installing/creating the services both at roadside and in-vehicle
- Establish the framework for assessment of impacts of the services, costs and likely benefits, and identify outline business cases for the roadside technologies, in-vehicle services and data management
- Detail monitoring proposals
- Develop a specification for a test bed for services development and validation
- Deliver a robust and data-led conclusion

To fulfil these objectives the following tasks were undertaken:

- Review of the current literature and market to understand the current situation and identify who to contact in later tasks
- 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
- Engagement with freight operators and freight service providers to understand the specific industry needs of this major freight corridor
- Defining the technological requirements of data and services in terms of data prioritisation, package size etc. and matching these to the services
- Outlining a business case for the highest priority services as identified by the market and freight services engagement exercises
- Developing a methodology to assess the likely impact of the services identified so that the services with the most beneficial impact can be prioritised and supported
- Creating a test bed specification
- Producing a written report which includes recommended services for the next stage of the Programme

Each of these tasks is described in more detail in the following sections.

3 Summary of project findings

3.1 Review of the current literature and market to understand the current situation - Deliverable D1: Market Engagement Report

A literature review was undertaken using standard literature search techniques to identify published material on the technologies used in vehicular communications. As a number of national and international projects have undertaken similar reviews within last few years, this review concentrated on recently published material.

The literature review was then extended to survey the connected vehicle market to establish what is currently being offered (or mandated), or is likely to become available in the near future. An example of a connected vehicle service which is already widely available is real time adaptive route guidance, while an example of a mandated service is Pan-European eCall which will become mandatory in new vehicles in Europe during 2018.

Deliverable D1: Market Engagement Report provides the results of the review of literature to understand the current 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.

3.2 Engagement with the market to establish the scope and scale of services likely to be wanted by users

As part of parallel Project 1: A2/M2 Connected Corridor Infrastructure Feasibility Study, discussions were held with the Department for Transport (DfT), Highways England (HE), Transport for London (TfL) and Kent County Council (KCC) 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 were identified 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 (particularly for 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, 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 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 beyond the extent of the corridor 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 around 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 are 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 the data that is 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; OEMs, for example, 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, its use and future services.

3.3 Engagement with freight operators and freight service providers to understand the specific industry needs of this major freight corridor

Specific engagement was undertaken with freight stakeholders as the freight industry is considered a key potential user of connected services. This included meetings with the Dover port authority and a workshop, facilitated by Kent County Council, with stakeholders from industry, local authorities, emergency services and road authorities.

A number of meetings were held with other freight stakeholders including TfL, Beijer and Dynniq. The findings of the meetings helped drive the list of services which was included in the European bid.

3.4 Defining the technological requirements of data and services – Deliverable D2: Deployment requirements and Identification of Data Formats for Transmission

The findings from the work undertaken in sections 3.2 and 3.3 formed the basis for project deliverable D2. Details in the report were derived from information gained from various stakeholders and industry experts in cooperative ITS and communications systems.

Starting with a previously identified set of services identified in D1 and an analysis of the possible communication channel implementations (ITS G5 or cellular), a set of priority services were identified:

- 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.

FVD, GLOSA, IVS and RWW in the priority services list above are also to be found in the Amsterdam Group's list of day-1 services. RWT was chosen as it can provide the data required for RWW. The freight services were chosen following consultation with the freight industry, while eCall was added as the corridor provides a useful pilot environment for the mandated roll-out of eCall.

Table 1 shows the communication channel implementations chosen for each service.

Table 1: Communications channels for priority services

Service		Communication implementation
FVD	Floating Vehicle Data	G5 only
RWT	Road Works Transit time	G5 only
GLOSA	Green Light Optimisation, speed assistance	G5 only
IVS	In Vehicle Signage	Separate G5 and cellular services
RWW	Road Works Warning	Separate G5 and cellular services
FLP	Freight Lorry Parking	Cellular only
FSA	Freight Slot Availability	Cellular only
eCall	eCall automatic crash notification	Cellular only

Note that two of the services use both cellular and G5 – this is because there are separate short and long range use cases for these services which have different communications requirements.

Additional services and their outline requirements were also considered to future proof the recommendations, these being:

- Infotainment
- Route guidance and optimisation
- Parking management and availability
- Road user charging/tolling
- Integrated transport, particularly multi-modal travel choices
- Other congestion reduction measures

The D2 report covers the deployment requirements, and supporting data formats for the connected corridor, for the services which were identified in earlier parts of this project and also discusses potential additional services and technical requirements.

The report is intended to provide a basis for future work to develop a detailed specification and design for the connected corridor and the services supported.

3.5 Outlining a business case and developing a methodology to assess the likely impact of the services - Deliverable D3: Impact Assessment Report

Once the list of services had been finalised, an interim Impact Assessment was undertaken in February 2016 to provide evidence for a European bid for CEF funding. The final Impact Assessment under this project was completed in April 2016.

Liaison was undertaken with DfT's Economists to agree the methodology for the Impact Assessment which was in line with the European bid requirements. The overall approach to planning impact assessment was based on the six step process recommended in DfT's guidance on transport evaluations.

The D3 Deliverables contain details of how a trial needs to be designed to ensure that impacts are monitored and assessed robustly, enabling business cases to be developed for the future roll-out of the services trialled in the pilot. To ensure that the proposed trial methodology provides the required information it will be necessary to identify the potential impacts and their potential scale. The approach detailed in the report was therefore to identify potential impacts of the services, making use of external sources and then to use a Cost Benefit Assessment tool developed by TRL (previously developed in the European CEDR project "COBRA") to provide order of magnitude estimates for the largest potential savings that could theoretically be achieved. The output from this defined the overall requirements for any detailed impact assessment methodology to be developed in future trials.

The report covered the approach of mapping interventions to their outcomes and impacts, understanding the expected scale of the impacts and understanding requirements for trial methodology and data analysis. Challenges and assumptions were detailed and different approaches to impact evaluation in Europe discussed.

Full details of the Impact Assessment methodology can be found in deliverable D3.

3.6 Creating a Test Bed Specification – Deliverable D4: Considerations for a Test Bed

At the outset of this project it was anticipated that a specification for the test bed would be developed. However, during the project's execution it was agreed with the Project Board that at this stage specifying a test bed would be premature, and should not be undertaken until the detailed design of the corridor and its interfaces had been completed. It was therefore agreed that deliverable D4 would address the key design issues that will need to be taken into consideration when specifying the test bed.

3.6.1 Description of the connected corridor

Test bed users will need a complete and accurate description of the technical layout and services provided by the corridor. This includes network traffic characteristics, roadside access, corridor details and specifications, and connectivity capability.

3.6.2 Test Bed Offer

As well as the C-ITS technology planned to be installed on the corridor, potential users of the test bed will need to understand how they can install their own technology, or interface with what is already available.

They will need to understand the level of support provided by the corridor operator and the costs that will have to be borne by themselves. This is potentially complex as the road operator will not want undue disturbance on day-to-day traffic operations and will also need to understand the impact on the C-ITS services and any other trials being conducted.

3.6.3 Safety, security and legal issues

The incorporation of innovative technologies within the existing infrastructure and road network along the corridor will need to be demonstrated as inherently safe and to have minimal effect or provide minimal additional hazards to the overall running of the corridor and its ability to operate as a critical part of the UK road network.

It is also expected that any transfer of information using existing or prototype connected technologies would need to demonstrate suitable measures to prevent interception and misuse of information.

Security algorithms and protocols are commonplace in all of today's communication equipment, but detailed considerations and testing for using the V2V and V2I technology on the connected corridor is likely to be a requirement of the test bed testing regime.

3.6.4 Management and administration

All of the above processes will require a comprehensive business and project management structure, if the corridor is to function successfully as a test bed.

A document defining who is in overall control, which particular section of the corridor is under which organisation's remit and the overall structure of the project management team needs to be fully defined before the network is made available to external system developers.

4 Conclusions and Pilot Recommendations

4.1 Achieving Clarity of Objectives

While developing the project's procurement requirements it became clear that the A2/M2 corridor has the potential to address a range of strategic objectives. These objectives are not obviously in conflict, and are, in part overlapping, but understanding their relative importance will greatly assist the allocation of resources during hardware procurement and other activities. In brief, these objectives can be summarised as:

1. Participating in European programmes to benefit from collaborative learning, implementation of standards and to receive European financial support
2. Undertaking technical trials to understand the role and benefits to road operators (and road users) of specific ITS services such as GLOSA and FVD
3. Developing a business case to support future installation of C-ITS roadside communications (e.g. during upgrades or maintenance) throughout the strategic road network
4. Supporting the development of innovative commercial services (that will ultimately benefit road users and operators) by making the corridor available as an open test site

4.2 Development of Detailed Design

The next phase of the corridor programme will be the development of a detailed specification and high-level design for connected corridor. This detailed design can build on the outputs of this project in conjunction with the final Deliverable D5 of the parallel Project 1.

The detailed specification should take into account the priority services which have been identified in this project, while ensuring that a clear path is shown for the future implementation of lower priority services. The support for services is closely bound to the communications architecture and capabilities of the corridor and it is recommended that the infrastructure design should happen in lock-step with the services design.

The specification and design is recommended to take into account the latest learning from the current CITE project, and work closely with EU partners from the Intercor ITS Corridor and SCOOP@F projects. Interoperability will be crucial to the successful implementation of this corridor. This is particularly important for freight operators, which are most likely to be early adopters of services.

5 Glossary

B-Call	Automatic Breakdown Call
CEF	Connecting Europe Facility
C-ITS	Cooperative Intelligent Transport Systems
eCall	Automatic Emergency Call
FLP	Freight Lorry Parking
FSA	Freight Slot Availability
FVD	Floating Vehicle Data
G5	See ITS G5
GLOSA	Green Light Optimisation Speed Advice
I2V	Infrastructure to Vehicle communications
ITS-G5	European standard for communications in the 5GHz band for Intelligent Transport Systems
IVS	In-Vehicle Signage
OEM	Original Equipment Manufacturer
SIM	Subscriber Identity Module
V2I	Vehicle to infrastructure communications
V2V	Vehicle to Vehicle communications