Milestone 9 – Start of Pilot Operation in the four MS

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CONTROL SHEET

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Terms and abbreviations

Term / Abbreviation	Definition
AC	Advisory Committee
AL	Activity Leader
AMQP	Advanced Message Queuing Protocol
AT	Authority (for PKI)
ASR	Action Status Report
CAM	Cooperative Awareness Message
CMT	Core Management Team
CRW	Collision Risk Warning
DENM	Decentralized Environmental Notification Message
EC	European Commission
ETA	Estimated Time of Arrival
GA	Grant Agreement
GLOSA	Green Light Optimised Speed Advice
HMI	Human Machine Interface
HSM	Hardware Security Module
INEA	Innovation and Networks Executive Agency
IVI	In Vehicle Information
IVS	In Vehicle Signage
IPR	Intellectual Property Right
MAP	Map Data
MCTO	Multimodal Cargo Transport Optimisation
ML	Milestone Leader
MQTT	Message Queuing Telemetry Transport
MS	Member State
OBU	On Board Unit
PC	Project Coordinator
PKI	Personal Key Infrastructure
PVD	Probe Vehicle Data
RSU	Road Side Unit
RWW	Road Works Warning

SCOOT UTC	Transport for London’s Urban Traffic Control (UTC) system which controls and coordinates approximately 4,500 of London's 6000 sets of traffic signals, etc.
SE	Service Editor
SPAT	Signal Phase And Timing
TCC	Traffic Control Centre
TIC	Technical & Interoperability Coordinator
TMS	Traffic Management System
UC	Use Case
UIN	Unified Interchange Node
VMS	Variable Message Signs

1 Executive summary

1.1 General

Activity 3 Pilot Operation consists of the deployment of the actual pilot operations in the four Member States (MS). The present deliverable describes the four pilot sites in the MS.

Typically the following information is provided per MS:

- Location of pilot site(s)
- Services deployed
    - Use cases (UC) deployed
    - Communication technology (ITS-G5 and/or cellular)
    - Date of deployment per service/UC
    - Location of deployment per service/UC
- Vehicle fleet
    - Number of vehicles
    - Vehicle specifications

1.2 Belgium

The Flemish InterCor pilot operations started with RWW, IVS and PVD services over ITS-G5 at the end of 2018. IP-based communication, the inclusion of detected/declared events in the PVD Service and also a limited GLOSA service were realised by March 2019.

All together 25 ITS-G5 roadside units have been installed near Antwerp on the E313 (10 km full coverage) and E34 motorway (13 km with partial coverage), and on the N12 road – covering 2 intersections (during the TESTFEST). The IP-based channel covers the Antwerp area, but will be expanded to cover all Flemish motorways by the end of May 2019.

The IVS service ensuring a digital twin of the dynamic lane signalling is available on the E313, E34, R1 and E19 motorway sections around Antwerp, whereas the RWW service aims at improving real-time (in-vehicle) provision of information and warnings on mobile road works activities in the area. The IVS service will be expanded to include the Ghent and Brussels-Leuven areas by the end of May.

1.3 France

The French InterCor pilot operations cover 6 services: RWW, IVS, PVD, GLOSA, Multimodal Cargo Transport Optimization and Truck Parking. These services are delivered partly in ITS-G5, in cellular and via both technologies. The final validation of the prototypes took place during the final TESTFEST of March 2019, enabling the start of pilot operations –

as initially planned – on the 1st of April (except for GLOSA due to technical problems currently being solved);

- For ITS-G5 services, the French pilot extends the SCOOP@F coverage from Paris towards the North. Roadside units have been installed along the A1 and A22 motorways. The A25 and A16 from Lille towards Dunkirk and Calais, as well as a portion of the Paris outer ring will be also equipped in order to extend the network;
- For the purposes of logistics services, two logistics terminals (Dunkirk and Dourges) as well as 12 truck parking areas in the southern part of motorway A1 are involved. A fleet of 30 trucks of the transport company Bogaert is equipped with a cellular application including logistics services MCTO and TP.

1.4 The Netherlands

In the Netherlands an incremental approach was chosen for the InterCor pilots, building on work already carried out in the Cooperative ITS Corridor project and other (national) projects such as Talking Traffic. The pilot activities can be seen as a process growing from first trials with ITS-G5 communication in 2016 to full pilot operation with all services with cellular and ITS-G5 communication in 2018/2019. In this process not only extra services were gradually added over time, this approach also allowed to work in a 'learning by doing' way and to adapt in a flexible way to the alignment of specifications during the InterCor project.

After gradually building the pilot since 2016, the services RWW, IVS, GLOSA, Truck Parking, MCTO and Tunnel Logistics are all fully operational now, in 2019. RWW, IVS and Truck Parking are operational in the total pilot area using cellular communication. In addition ITS-G5 is in use for RWW and IVS on the A16 motorway between Dordrecht and Rotterdam. GLOSA is operational on several intersections in the city of Helmond (both ITS-G5 and cellular), while MCTO and Tunnel Logistics function near the harbour of Rotterdam and north of the Leidsche Rijn tunnel near Utrecht, respectively. In order to evaluate the services, a wide range of vehicles is in use, such as 15 vehicles specially equipped by Rijkswaterstaat (ITS-G5 and cellular) to evaluate IVS/RWW and vehicles from a number of transport companies for MCTO and Tunnel Logistics. In addition a co-operation with existing popular commercial apps was established for the pilot (RWW/IVS and Truck Parking).

1.5 UK

The A2M2 Connected Vehicle Corridor has been established by the Department of Transport in partnership with Highways England, Transport for London and Kent County Council. It pilots the infrastructure, data management and service delivery necessary for connected vehicle services. This Corridor was chosen as it offers a variety of operating environments that make it attractive and unique as a pilot site. Commencing in inner London near to

Blackwall Tunnel with potential links to urban ITS applications; it provides the interface between the trunk road (A2), motorway network (M25 and M2) and Kent local roads (A229/A249).

The Corridor is a pathfinder for future investment and the blueprint for the wider roll-out of connectivity across the UK road network. It will also aim to provide an open test bed where the UK motor manufacturing sector and after-market companies can develop new interactive customer services for C-ITS applications in addition to the core traffic and safety services which are market-ready. It will demonstrate how Connected Vehicle (CV) technology can help highway and roads authorities to manage their urban and inter-urban road network more effectively with the aim of achieving substantial benefits, shown in other trials (i.e. halving incident related delays, reducing rear-end collisions by up to 12% and lowering fuel consumption /emissions by up to 25%).

The UK recognises the need for interoperability and the need to be able to operate across boundaries, which is why the UK part of the InterCor. This close collaboration between the InterCor partners ensures the interoperability of services and contributes to the wider harmonisation effort. The functional and technical specifications that will be delivered through this project will help to ensure that future UK deployment of these services will be able to be compatible and interoperable with European deployment of the four services (RWW, IVS, PVD and GLOSA).

2 Introduction

2.1 InterCor project

InterCor (Interoperable Corridors) is a European project that links the C-ITS corridor initiatives of the Netherlands (C-ITS Corridor Netherlands-Germany-Austria) and France (SCOOP@F), and the United Kingdom and Belgian C-ITS initiatives.

2.2 Purpose of this document

The purpose of the present document is the presentation of the four pilot sites and the pilot operation in the Member States:

- Belgium/Flanders
- France
- The Netherlands
- United Kingdom

While this document for Milestone 9 (M9) focusses on the start of the pilot operation, the document for M10 describes roll out guidelines and best practices of pilot operation. Thereafter, the document for M11 provides an overview on how the pilot operations were finalised and the M13 document provides the results of the pilot evaluations, carried out in accordance with the evaluation framework described in the M12 document.

The description of member state pilot operations in this document vary in length. The clause on The Netherlands is significantly larger, since there is a relatively long history of gradually developing the pilot activities that are relevant for this deliverable.

2.3 InterCor Contractual References

InterCor is an action co-financed by the European Union under the Grant Agreement number INEA/CEF/TRAN/M2015/1143833. The Project duration is 36 months, effective from the 1st of September 2016 until the 31st of August 2019. It is a contract with the Innovation and Networks Executive Agency (INEA), under the powers delegated by the European Commission.

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3 Pilot operation in Belgium/Flanders

3.1 Pilot Start overview

The Flemish InterCor pilot operations kicked off with ITS-G5 roadside and on-board units trials during the French PKI TESTFEST in April 2018. Following further developments, RSUs were effectively rolled out on the E313 motorway as from September 2018. The central C-ITS server was set up in parallel and has been connected to data sources in October 2018, whereas the Flemish PKI was integrated in November 2018.

Due to contractual issues (relocation of our main contractor's application development team out of the UK in summer 2018) the start of pilot operations was slightly delayed – resulting in an effective start of RWW, IVS and PVD services over ITS-G5 at the end of 2018. Cellular/Wi-Fi-P based communication, the inclusion of detected/declared events in the PVD Service and also a limited GLOSA service were realised by March 2019.

All together 25 ITS-G5 roadside units have been installed near Antwerp on the E313 (10 km full coverage) and E34 motorway (13 km with partial coverage), and on the N12 road – covering 2 intersections (during the TESTFEST). The IP-based channel covers the Antwerp area, but will be expanded to cover all Flemish motorways by the end of May 2019.

The IVS service ensuring a digital twin of the dynamic lane signalling is available on the E313, E34, R1 and E19 motorway sections around Antwerp, whereas the RWW service aims at improving real-time (in-vehicle) provision of information and warnings on mobile road works activities in the area. The IVS service will be expanded to include the Ghent and Brussels-Leuven areas by the end of May.

3.2 Location of pilot site(s)

3.2.1 ETSI ITS-G5 pilot site location

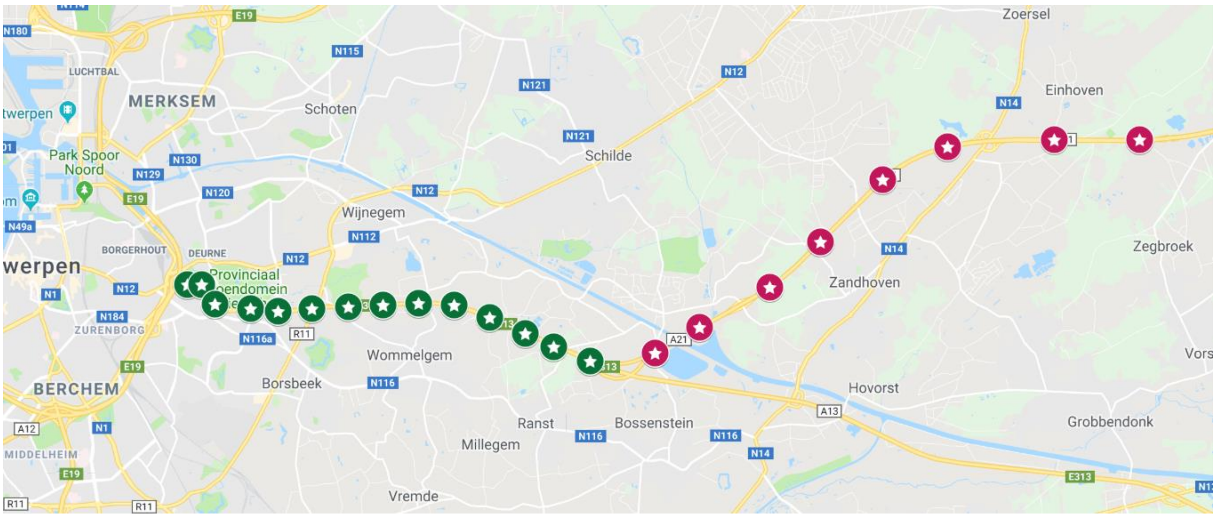

Figure 1: BE/Flanders ITS-G5 pilot site near Antwerp

26 Dynniq ITS-G5 RSU's on the E313-E34 motorways

- E313 between Antwerp and Ranst: 10km of continuous coverage. Motorway equipped with dynamic lane signalling, peak lane and bus lane. Traffic volume: 64-83.000 vehicles/working day
- E34 between Vorselaar and Ranst: 13km of intermittent coverage. Traffic volume: 25-29.000 vehicles/working day

3.2.2 Cellular pilot site location

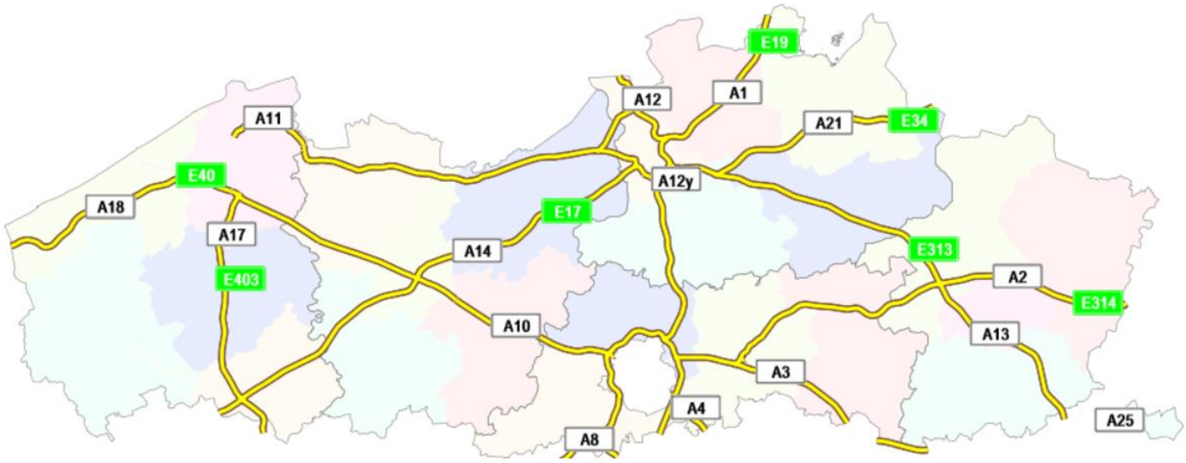

Figure 2: BE/Flanders cellular service coverage

Coverage of the IF2 IP-based channel started with coverage of the Antwerp region, being the ITS-G5 site, expanded with the R1 ring road and adjacent motorways.

Coverage of cellular service will be expanded to all Flemish motorways at the end of May 2019, following the TESTFEST.

3.2.3 GLOSA site location during TESTFEST

2 signalised intersections on the N12 in Schilde (North of E313/E34).

- N12-Turnhoutsebaan intersection with Liersebaan
- N12-Turnhoutsebaan intersection with Waterstraat

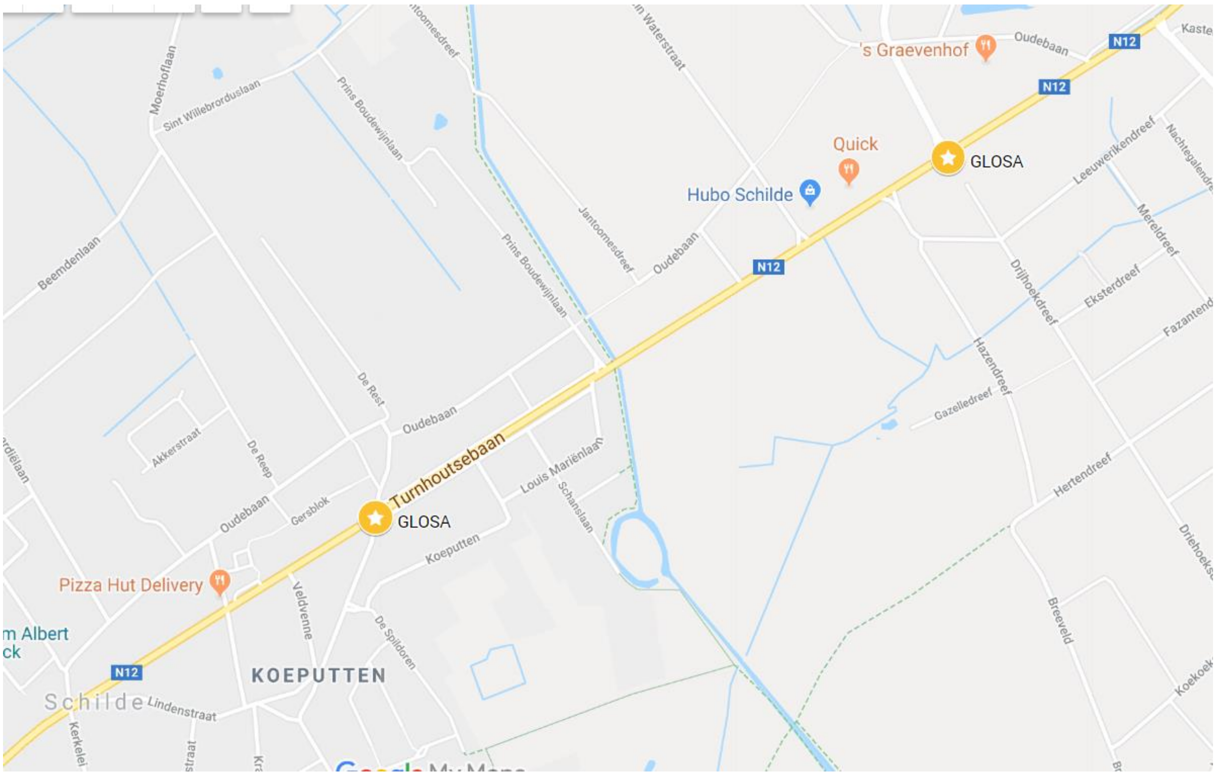

Figure 3: GLOSA site location

3.3 Network Topology

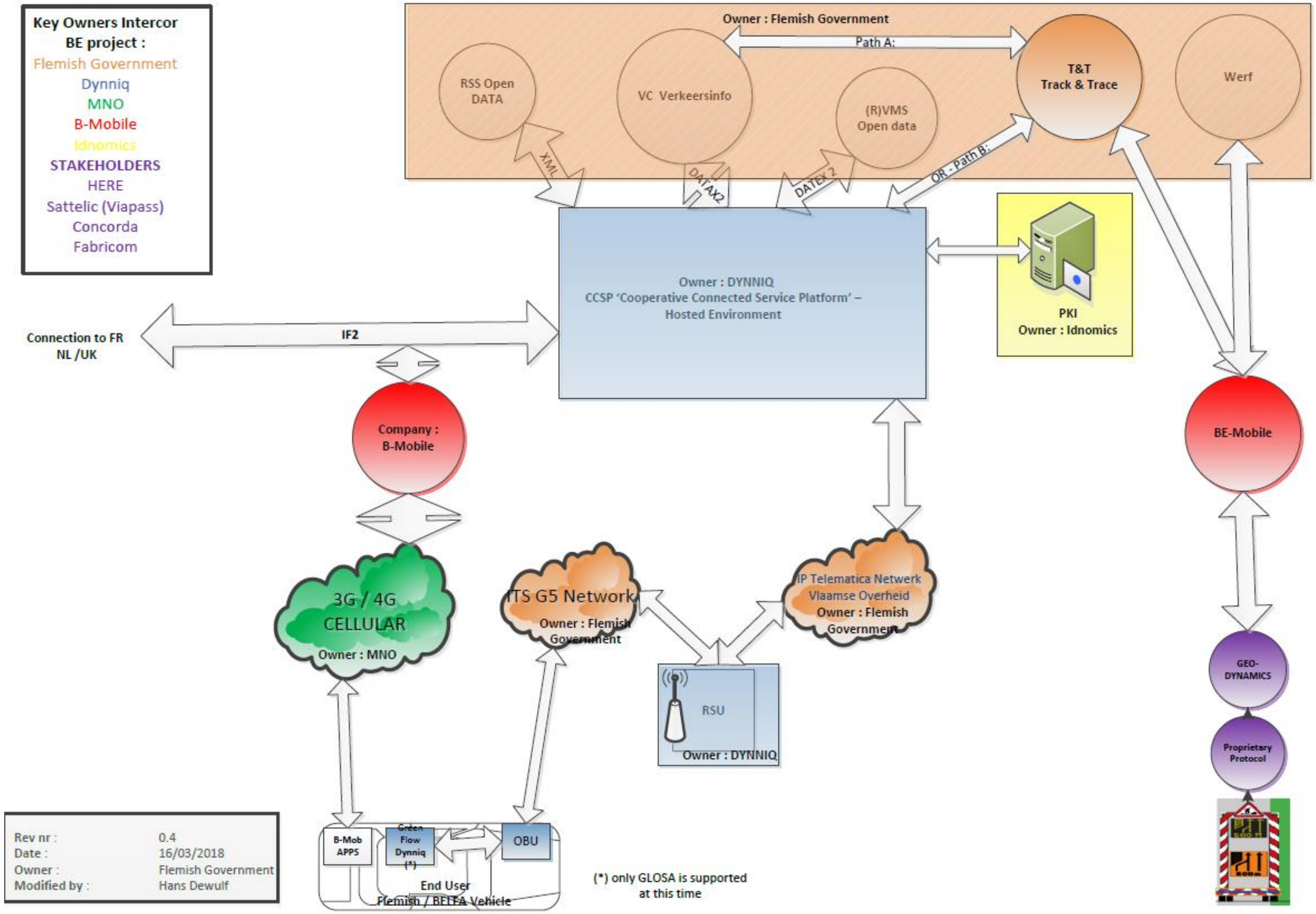

Figure 4: BE/Flanders network topology

3.4 Services deployed

3.4.1 Services deployment overview

Supported UCs, date/location of deployments, communication type (ITS-G5 and/or cellular) per UC/location

Table 1: BE/FL use case table

Service	Use Case	Belgium	actual start date (pilot implementation plans)	Comments / Issues
RWW	Lane closure or other restrictions	ITS-G5 & cellular	ITS-G5: 19/12/2018 Cellular: 19/12/2018 Cellular client: 18/3/2019	7/2/2019: Update/Improvement of service was deployed 20/3/2019: Logging according to InterCor Common Log Format added
	Alert planned road works – mobile	ITS-G5 & cellular	ITS-G5: 7/2/2019 Cellular: 7/2/2019 Cellular client: 18/3/2019	
IVS	In-vehicle signage dynamic speed limit information	ITS-G5 & cellular	ITS-G5: 19/12/2018 Cellular: 19/12/2018 Cellular client: 18/3/2019	20/3/2019: Logging according to InterCor Common Log Format added
	Dynamic Lane Management - Lane Status information	ITS-G5 & cellular	ITS-G5: 19/12/2018 Cellular: 19/12/2018 Cellular client: 18/3/2019	
PVD	Traffic data collection	ITS-G5 only	ITS-G5: 19/12/2018 Cellular: no	
	Probe vehicle data on detected/declared events	ITS-G5 & cellular	ITS-G5: 14/2/2019 Cellular: 25/3/2019	Simulated declared events coming from test vehicle(s) only.
GLOSA	Time-to-green information and speed advice	cellular ITS-G5	ITS-G5: 25/3/2019 Cellular: 14/3/2019, TTR/TTG, no server-side speed advice, currently TESTFEST Flanders only	
	Time-to-red information and speed advice	cellular ITS-G5	ITS-G5: 25/3/2019 Cellular: 14/3/2019, TTR/TTG, no server-side speed advice, currently TESTFEST Flanders only	

3.4.2 Service details

3.4.2.1 RWW details

Initial deployment will not provide information about which lane is closed. The static road works information is based on the public traffic information stream by our Traffic Control centre.

For mobile road works, the location of the Impact Protection Vehicle is obtained through a Track & Trace module in the vehicle. Its position is sent to the central server and updated each couple of minutes. The central C-ITS server generates the RWW message. The service stops generating RWW when the IPV position/speed either is not updated for 10 minutes, or when the speed exceeds 30 km/h. In case multiple Impact Protection Vehicles are used for the same road work, the event location will correspond to the location of the second IPV (see Figure 5). This is the vehicle closest to traffic on the closed lane, not the warning vehicle 500m upstream. The length of the road works zone itself cannot be provided yet.

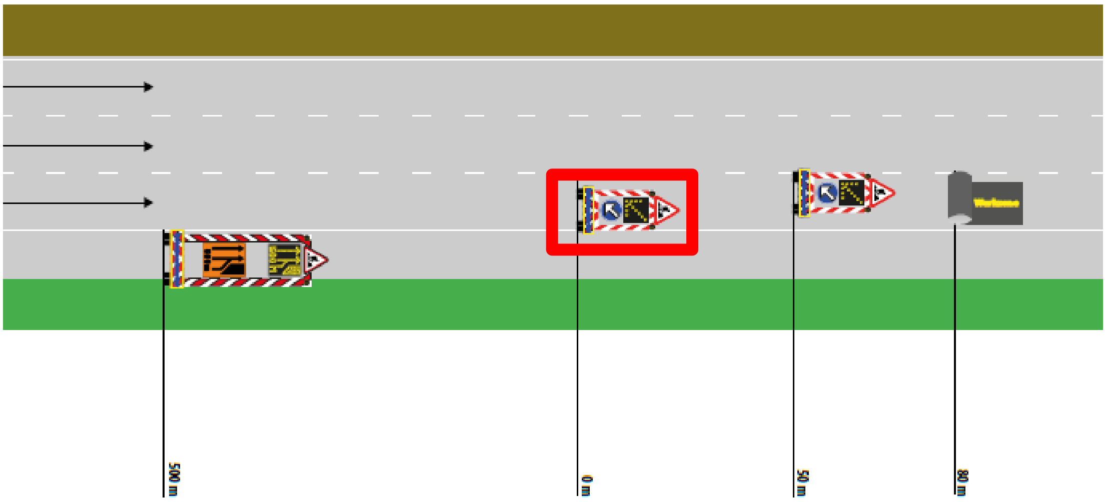

Figure 5: Example mobile road works in BE / Flanders

Figure 6: Usage of Impact Protection Vehicles in BE \ Flanders

3.4.2.2 IVS details

The IVS dynamic speed limit and lane status information is based on the actual dynamic lane signalling on the motorways. Information from the gantries is sent out in near real time. The actual delay is still to be determined, but could be several seconds.

Table 2: Mapping of signs to ISO 14823:2017

Description	ISO 14823:2017 CategoryCode	ISO 14823:2017 pictogram CategoryCode	Attributes
Green arrow	13	660	
Red cross	13	659	
Yellow arrow to the left	13	661	
Yellow arrow to the right	13	662	
C43 speed limit 50 km/h	12	557	50 kmperh
C43 speed limit 70 km/h	12	557	70 kmperh
C43 speed limit 90 km/h	12	557	90 kmperh
C43 speed limit 100 km/h	12	557	100 kmperh
C43 speed limit 110 km/h	12	557	110 kmperh

During the TESTFEST an extra simulation layer was added to be able to insert simulated scenarios on certain gantries. The BUS+TAXI lane information is not provided as C-ITS information yet.

Figure 7: Dynamic lane signalling gantry, information also provided by the IVS service

The IVS service is currently provided around Antwerp. The IP-based IVS service will be expanded to the Ghent and Brussels-Leuven areas at the end of May 2019.

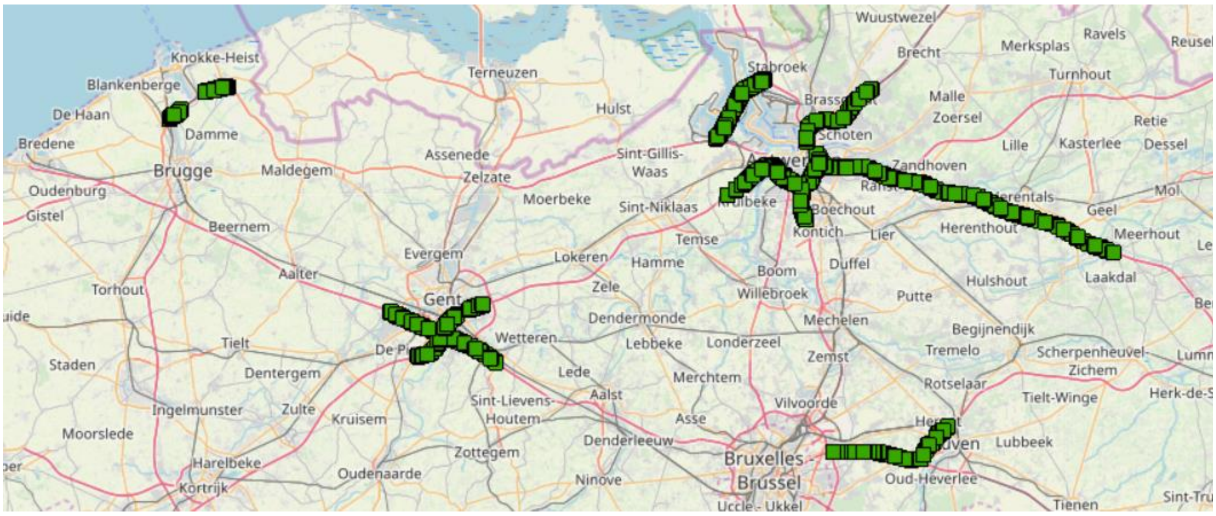

Figure 8: Locations of the IVS service in BE \ Flanders

3.4.2.3 PVD details

CAM messages received over ITS-G5 are stored / logged centrally.

DENM messages received over ITS-G5 are received and sent out again over IF2 and repeated over ITS-G5. DENM messages received over the read-write IF2 are stored / logged centrally.

The ITS-G5 client application is able to simulate manual warnings for accidents, traffic jam ahead, broken down and stationary vehicles. For testing purposes, the OBU can generate a stationary vehicle warning after 30s without movement.

3.4.2.4 GLOSA details

The two intersections for GLOSA testing were operational during the TESTFEST 25-28/3/2019. Whether they will be kept operational afterwards is to be decided. During the

TESTFEST the intersection phasing and timing were adapted during testing hours to obtain a rigid and predictable timing. Without rigid timing, the prediction is only possible for the last 4 to 5 seconds of a phase. The local intersection controller sends the SPAT information over 4G to a central MQTT server. Both the Flanders IF2 server and the local RSUs connect to the MQTT server to obtain the SPAT and MAP messages. The RSUs are (also) connected over 4G and mounted onto one of the traffic light poles. There is no speed advice added in the SPAT. Only maximum speeds are provided.

Figure 9: GLOSA site – N12 Waterstraat, with HMI

Figure 10: ITS-G5 Road Side Unit attached to traffic light.

3.5 Vehicle fleet

Table 3: BE/FL Vehicle fleet

Number of vehicles	Start	Full regime
Dynniq ITS-G5 OBU	2	4
Cellular Touring-Mobilis app (Be-Mobile)	1	4

Figure 11: Fleet will mainly consist of vehicles of the Agency of Roads and Traffic.

3.6 IF2 details

The read only IF2 is operational since 19/12/2018 on ccsp-be-tools.westeurope.cloudapp.azure.com: 5671 on the virtual host production_fg. It is serving messages on the exchanges IVI, DENM, SPAT and MAP.

Since 25/3/2019, an additional read/write IF2 is operated on the virtual host production_fg_ext, receiving messages on the DENM exchange.

3.7 OBU and application details

The OBU and applications used are single channel only, either ITS-G5, either IP-based. Currently no fully hybrid OBUs or clients are planned.

Figure 12: HMI of the application using the ITS-G5 channel + OBU

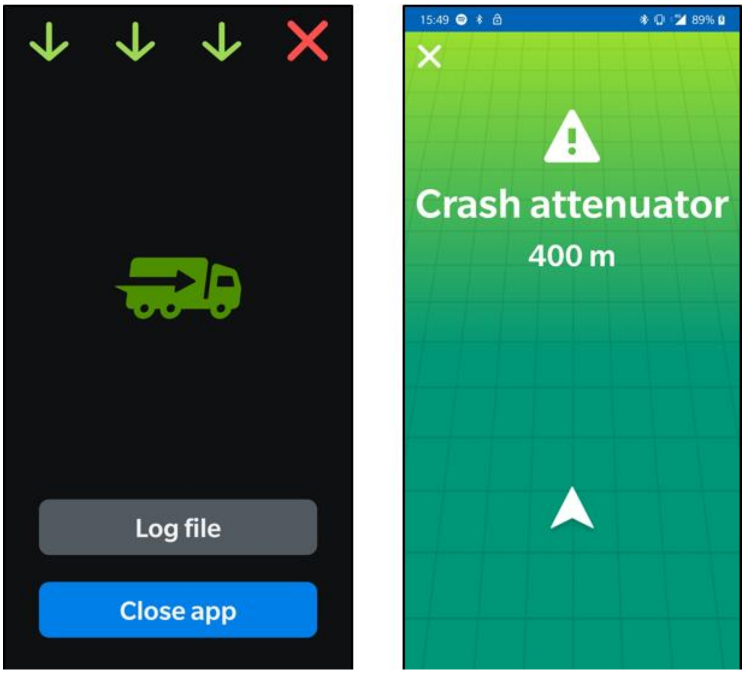

Figure 13: HMI of the application using the IP-based channel + service provider

3.8 PKI deployment

In October 2018, BE/Flanders created a preproduction RCA, EA, AA *BE-FLANDERS TEST* for the duration of the InterCor project. As specified in the M5 document, the certificates use the TS 102 940, 1.2.1 version. Migration path to 1.3.1 – delegated act version is still to be decided.

Currently supported ITS-AID's in EA and AA:

- CAM (36)
- DENM (37)
- SPAT (137)
- MAP (138)
- IVI (139)

AT certificates will have a validity of 1 year.

BE/FL plans to use HSM in the ITS-G5 OBU, with rotating AT's. This is still to be developed and to be tested.

No signing (PKI) is used on IF2.

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4 Pilot operation in France

4.1 Location of pilot site(s)

The French pilot extends the SCOOP@F coverage from Paris towards the North. It is entirely included in the TEN-T Core Network. It includes the A1 motorway up to Lille and the A22 motorway between Lille and the Belgian border. An extension is made from Lille towards Dunkirk and Calais through the A25 and A16. This region has dense and high volume traffic hotspots especially for transports of goods. Most of these hotspots are directly on the TEN-T North Sea-Mediterranean Corridor, some on the extension (Dunkirk) and most on the E40/A16 motorway. In addition, to ensure the continuity of services between A1 and the roads equipped within SCOOP@F, additional sections ‘’la Francilienne’’ of the Paris outer ring road will be equipped in this project. As the main crossing point from the continent to the UK and on the North Sea range, the region is a very important international road transit and will be ideal for a testing cross-border C-ITS interoperability.

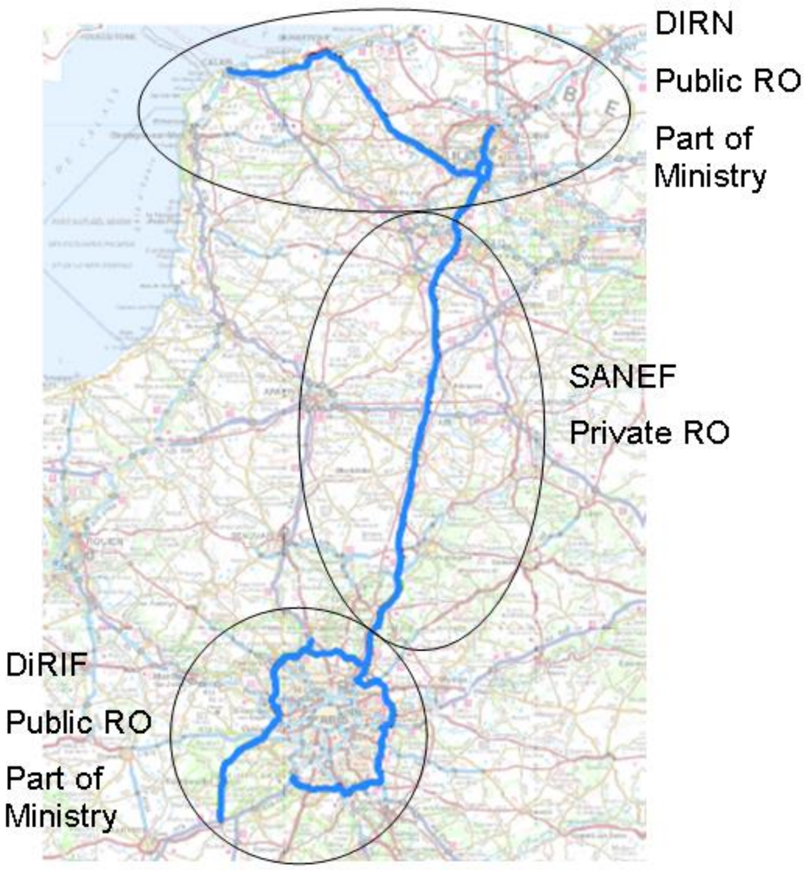

Figure 14: Total pilot area in France, with the 3 road operators involved

For the purposes of the Multimodal Cargo Transport Optimization service, two logistics terminals are involved in the pilot:

1. one sea port terminal, Terminal des Flandres, in Dunkirk

2. one inland multimodal terminal, Delta3, in Dourges.

For the purposes of the Truck Parking service, information on availability is sent from 12 truck parking areas in the southern part of motorway A1, that are equipped with counting devices.

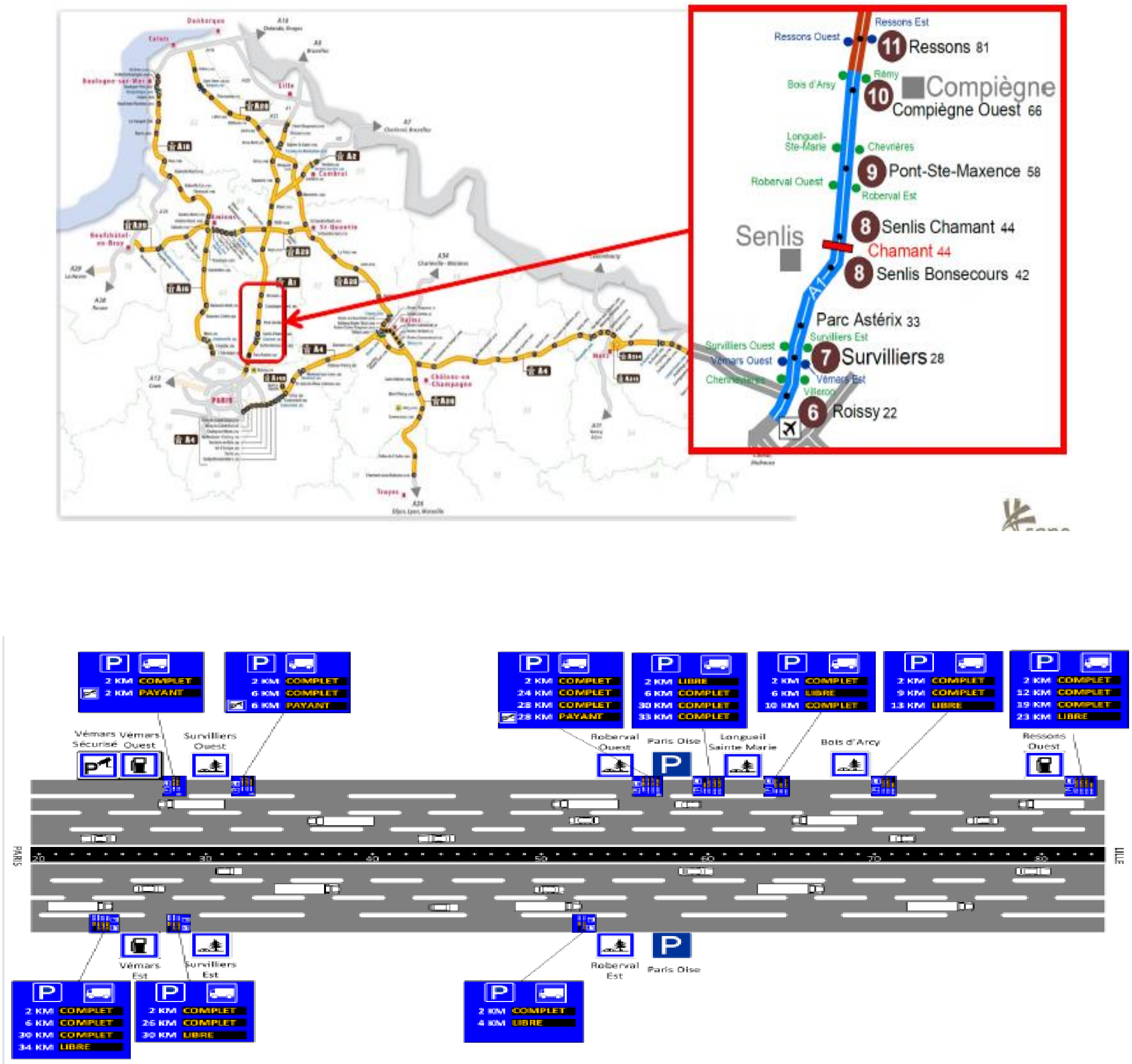

Figure 15: Truck parking areas involved in the TP service

4.2 Services deployed

The French pilot covers 6 services, in accordance with the Grant Agreement: Road Works Warning, In-Vehicle Signage, Probe Vehicle Data, Green Light Optimal Speed Advisory, Multimodal Cargo Transport Optimization, and Truck Parking. Some are delivered in ITS-G5, others in cellular, some with both technologies.

To limit the costs incurred and resources required, French partners have waited for sufficiently stable specifications (also in relation to the alignment with the C-Roads Platform), before launching the calls for tenders. They have built a schedule in which TESTFESTs are used to refine the specifications and enhance the prototypes, and the final TESTFEST of March 2019, along with a national validation event organized just before, is used as a final validation before start of pilot operation scheduled April 1st, 2019. This validation has been successful, so that pilot operation can start on April 1st, 2019 as scheduled, except for GLOSA which is experiencing a small delay due to technical problems currently being solved.

Table 4: Services deployed on the French pilot

Service	Use Case	Tech. and start date
RWW	Lane closure or other restrictions	ITS-G5 & cellular 01/04/19
	Alert planned closure of a road or a carriageway	ITS-G5 & cellular 01/04/19
	Alert planned road works – mobile	ITS-G5 & cellular 01/04/19
IVS	Embedded VMS	ITS-G5 & cellular 01/04/19
PVD	Traffic data collection	ITS G5 01/04/19
	Probe vehicle data on detected/declared events	ITS G5 01/04/19
GLOSA	Time-to-green information and speed advice	Cellular 01/05/19
MCTO	Multimodal ETA for cargo optimization	Cellular 01/04/19
	Dock reservation	Cellular 01/04/19
TP	Information on parking lots location and availability	ITS G5 & Cellular 01/04/19

4.3 Vehicle fleet

A fleet of 30 trucks of the transport company Bogaert is equipped with a cellular application including logistics services MCTO and TP. 30 additional trucks of the same company are not equipped but will be used as a baseline for evaluation.

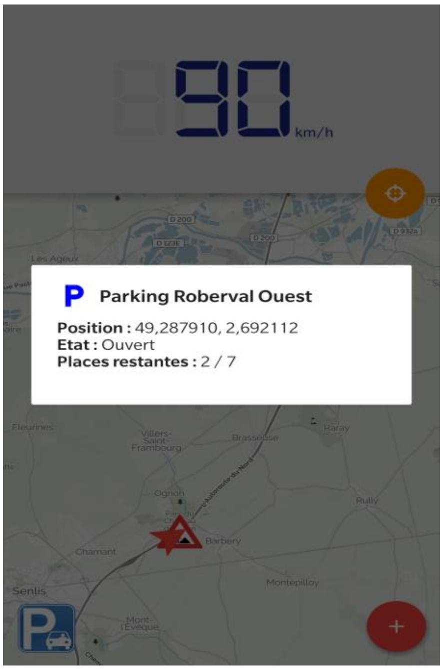

Figure 16: View of the HMI with truck parking information

For ITS-G5 services, InterCor specifications are also backwards compatible with the SCOOP@F specifications, allowing for the PSA and Renault vehicles deployed in SCOOP@F to receive services on InterCor roads.

5 Pilot operation in The Netherlands

5.1 Location of pilot site(s)

In the Netherlands, the pilot area is situated in the southern part of the country and near the town of Utrecht (see Figure 17). The area consists of the motorways A15-A16 Europoort Rotterdam–Breda-Belgian border, the motorways A58-A2 Breda-Eindhoven, motorway A67 Belgian border-Eindhoven-Venlo, motorway A2 and the N201 near Utrecht, as well as a number of urban roads in the town of Helmond. The description of the pilots per use case (see section 5.3) gives a more detailed explanation of the specific pilot areas.

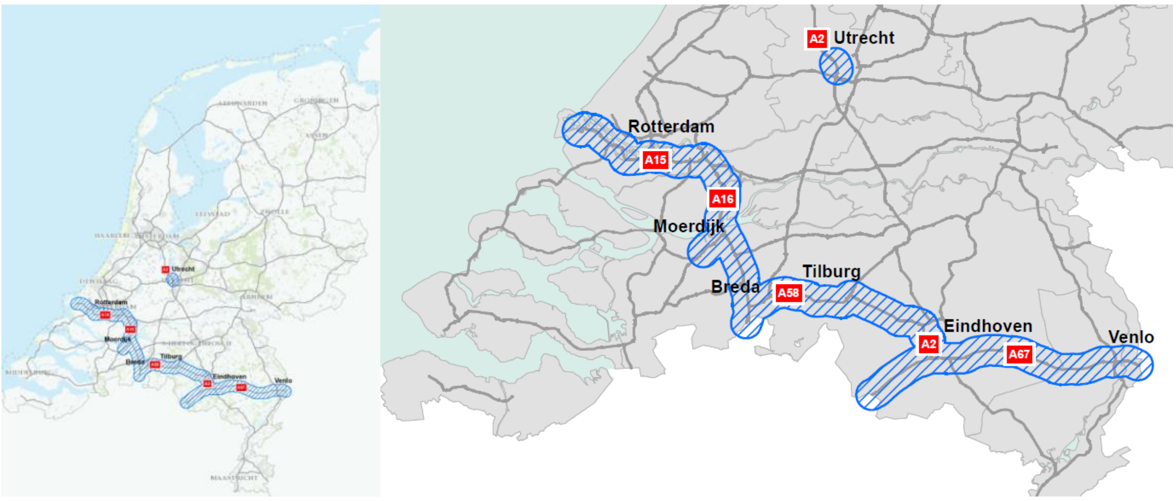

Figure 17: Total pilot area in the Netherlands

5.2 Incremental Approach

In the Netherlands an incremental approach was chosen for the InterCor pilots, building on work already carried out in the Cooperative ITS Corridor project and other (national) projects such as Talking Traffic. The pilot activities can be seen as a process growing from first trials with ITS-G5 communication in 2016 to full pilot operation with all services with cellular and ITS-G5 communication in 2018/2019. In this incremental approach not only extra services were gradually added over time, this approach also allowed to adapt to changes of the (international) specifications of systems during the first years of the InterCor project and to work in a 'learning by doing' way.

In 2016 first activities on the road started, regarding RWW (trailer based portable solution) and PVD with ITS-G5 communication. In March 2017 this was followed by first trials with RWW and IVS (fixed roadside units) on motorway A16 south of Rotterdam. Later on, PKI was added as well as the hybrid approach including cellular communication.

Taking into account the experience from the first activities, the A16 test site was extended, in order to be able to organize the first interoperability TESTFEST on services, using ITS-G5 communication (RWW, IVS and PVD), in July 2017. After the TESTFEST, when the results of the interoperability testing and the common InterCor specifications were available (Milestone 3 report) the site could be adapted to these revised specifications. The participation in the TESTFESTs on security in France and hybrid communications in the UK led to further adaptions of the test site, so that it became fully compatible with the agreed common InterCor specifications and ready for piloting with an up scaled fleet for longer periods, with regular users and under normal traffic conditions. The enhancements include further automation allowing messages to be generated fully automatically and without manual intervention as well as full time monitoring and support.

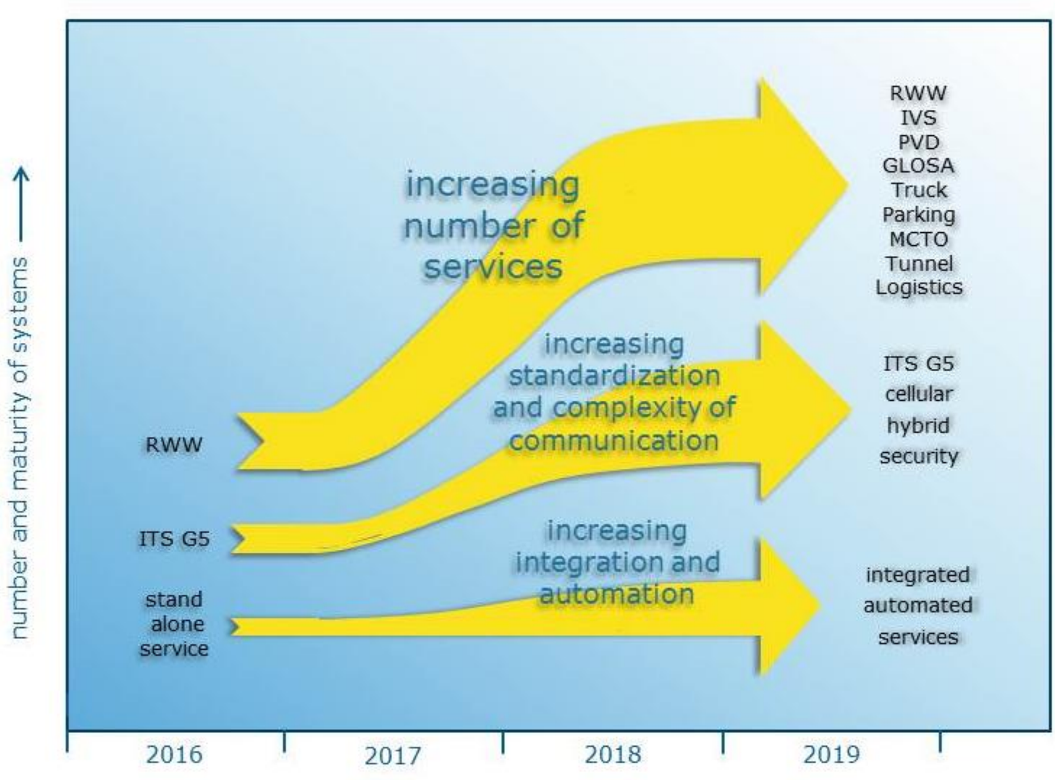

Figure 18: Illustration of the incremental approach in the Netherlands

The GLOSA test site in Helmond was operational in a first phase from the beginning of 2018. During this stage, GLOSA Helmond has been used by 50 trucks and emergency vehicles using ETSI messages that were broadcasted by 24 intelligent intersection controllers. In January 2019 the roll out started of a new baseline to ensure interoperability with the InterCor Profile standard for SPaT and MAP and realising compatibility with the Dutch Talking Traffic iVRI specifications. In addition to the ETSI messages, the GLOSA service is delivered fully hybrid (according to the InterCor IF2 specifications) over an operational IF2 cloud data server and cellular wireless channels.

Table 5: Overview of the increments within Pilot Operations

Increments	Service	ITS-G5 / Cellular	Location	Date
Gaining first experience with ITS-G5 on the InterCor test site by testing the trailer based portable solution in real traffic and with real roadworks	RWW	ITS-G5	A16	Nov 2016
Demonstrating the technical feasibility of PVD and the potential added value for traffic management.	PVD	ITS-G5 + Cellular	A58	Dec 2016
Testing gantry based RWW and IVI, using specifications aligned with Germany and Austria	RWW IVS	ITS-G5	A16	Mar 2017
Updating the ITS-G5 services on the test site in accordance with the harmonised InterCor specifications issued after the TESTFEST ITS-G5	RWW IVS PVD	ITS-G5	A16	Jul 2017
GLOSA operational in Helmond	GLOSA	ITS-G5	Helmond	Jan 2018
Adding PKI for the ITS-G5 services in conjunction with the participation in the TESTFEST PKI in France	RWW IVS	ITS-G5	A16	Apr 2018
Adding cellular services on RWW and IVI, provided by a private service provider (Flitsmeister)	RWW IVS	cellular	total test site	Aug 2018
Adding MCTO, provided by the Mainport Traffic Monitor initiative	MCTO	cellular	A15	Sep 2018
Adding the IF2 interface in conjunction with the participation in the TESTFEST on hybrid communication in the UK	RWW IVS	ITS-G5 + cellular	A16	Oct 2018
Starting regular pilot-drives for technical evaluation of the RWW and IVI services	RWW IVS	ITS-G5	A16	Nov 2018
Rolling out a new baseline for GLOSA, hybrid communication, interoperable with InterCor specs	GLOSA	ITS-G5 / cellular	Helmond	Jan 2019
The cellular Truck Parking service becomes operational	Truck Parking	Cellular	total test site	Feb 2019
The cellular service Tunnel logistics becomes operational	Tunnel Logistics	Cellular	A2 / N201	Feb 2019
Adding a fully automatic connection to the backend systems for the ITS-G5 services	RWW IVS PVD	ITS-G5	A16	Mar 2019
Up-scaled vehicle fleet for pilot-drives	RWW IVS PVD	ITS-G5	A16	Mar 2019

Several cellular services were added to the pilot activities in 2018 and at the start of 2019. The cellular service on RWW and IVS in the summer of 2018, the MCTO service in September 2018, Truck Parking and Tunnel logistics in February 2019.

Table 5 gives an overview of important increments regarding the pilot in the Netherlands, while Figure 18 gives an illustration of it.

5.3 Services deployed

5.3.1 Trailer based Road Work Warning

In November 2016, during road works on the A16 motorway south of Rotterdam, a trailer based portable implementation of the RWW service was tested. The portable trailer based implementation is particularly suitable for motorways and other roads without variable message displays. It is similar to the solution being developed in e.g. Germany.

Figure 19: Road safety trailer on the A16 sending a RWW message

A road works trailer was fitted with a roadside unit, including a Wi-Fi-P beacon, for this test. The roadside unit used a secure Wi-Fi___33-P link to send detailed information about the upcoming road works to passing test vehicles. The roadside unit was connected to a central unit via the Rijkswaterstaat wireless communication network NNV. The test included three test vehicles equipped with on-board units. The messages used in this test were DENM messages and complied with the specifications of the Dutch profile.

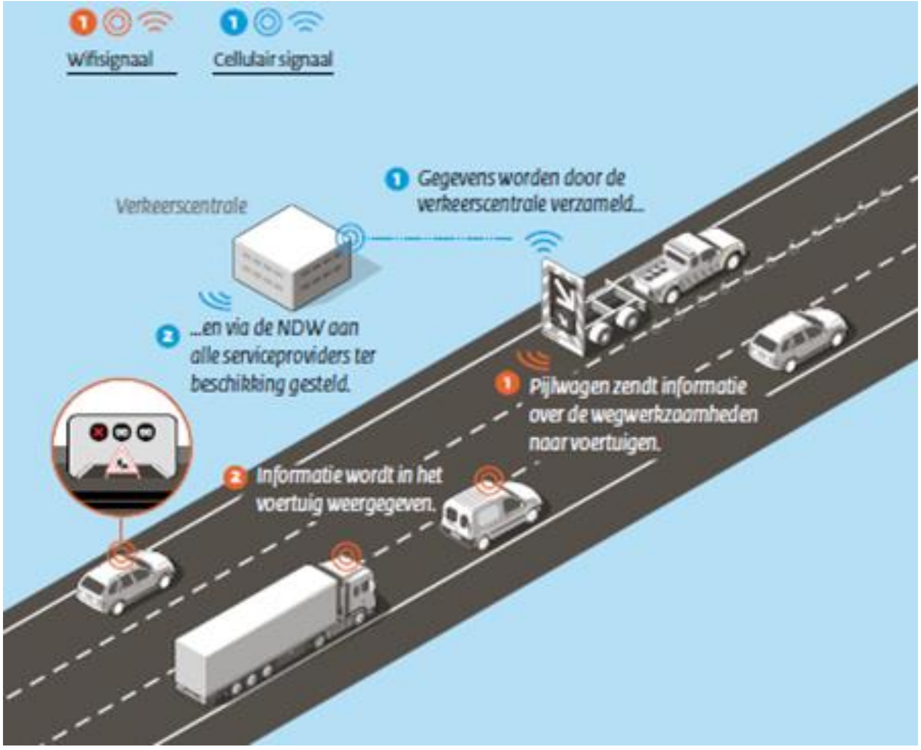

Figure 20: Trailer based RWW

The test was performed during real life traffic and real life road works. The road works involved work on variable message signs and entailed closure of the rightmost lane as well as the hard shoulder. The test was held on 14, 15 and 16 November 2016 on the A16 southbound near Ridderkerk on km 26.960Re, involving a complicated road layout with fly-overs and parallel carriageways.

The test runs were performed between 10:00 and 15:00, totally 46 test runs back and forth. Figure 22 gives an overview of the runs (green = routes travelled, red = locations where DENM messages were received).

The short range communication between the roadside unit on the trailer and the on-board units in the test vehicles performed effectively. The test primarily focused on the radio reception range of the beacon and correct reception of the DENM message by the on-board units in the test vehicles, even in heavy traffic. Almost 75% of the messages sent out by the roadside unit were received by the on-board units. It was concluded that the communication range was about 500-700 m.

Figure 21: Test track on the A16 for the trailer based RWW test

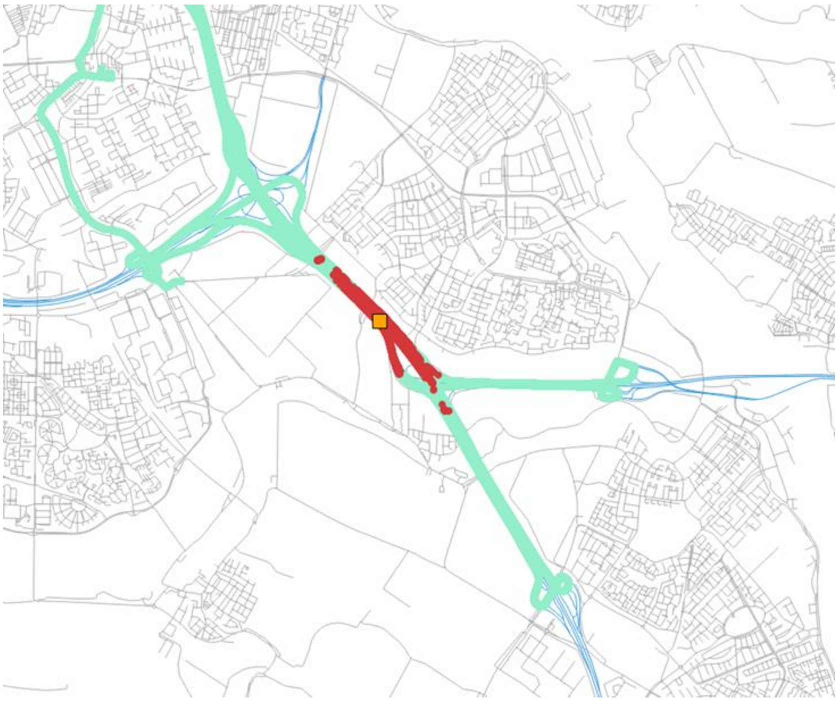

Figure 22: Routes travelled and messages received

Figure 23: Number of messages received as a function of the distance to the trailer (results from three different vehicles)

5.3.2 Probe Vehicle Data

A test of the cooperative Probe Vehicle Data (PVD) service of collecting sensor data from vehicles was performed on 14 December 2017 on the Dutch A58 motorway. It was coordinated from the Innovation Traffic Control Centre in Helmond ('Innovatiecentrale').

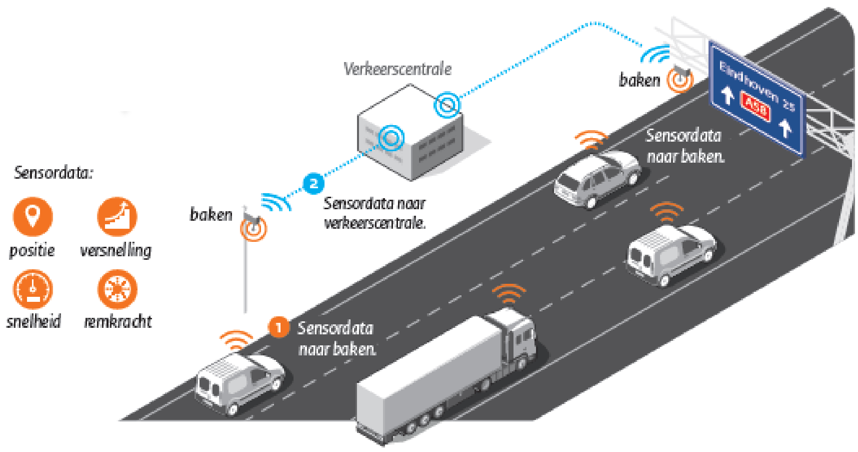

Figure 24: Probe Vehicle Data, data collected from vehicles on motorway A58

The objective was twofold[1]:

- demonstrate the technical feasibility of the PVD use case on Dutch motorways, by collecting, visualizing, and aggregating CAM from On-board Units (V-ITS-Ss);
- demonstrate the potential added value of PVD for traffic management.

[1] Ref: Praktijktest A58 Probe Vehicle Data / B. Netten (TNO), I. Yperman and S. Logghe (Be-Mobile), W. Vossebelt (V-tron) / 26-01-2017 / Version 0.1.

The tests were carried out on a section of the A58 motorway in the Netherlands between the cities of Tilburg and Eindhoven. This route had a length of 22 kilometres with an optimal travel time of 11 minutes. Traffic situation is characterized by heavy congestion during both morning and evening period. Rush hour jams are typical shock wave traffic jams.

The route was previously developed for the Dutch 'A58 Shockwave Traffic Jam' project and was equipped with roadside units (R-ITS-Ss). Several vehicles equipped with on-board units (V-ITS-Ss) were passing the route daily. The route was also equipped with variable message signs and loop detectors as well as data feeds with Floating Car Data (FCD). The route allowed demonstration of PVD in real life and real traffic jam conditions, allowed comparison of PVD with loop detector data, and allowed demonstration of the potential of PVD by scaling the input data to the penetration rate of existing FCD feeds.

Figure 25: The A58 site

The route included:

- 37 Roadside Units on gantries
- CAM messages from ITS-G5 On-board Units in test vehicles.
- Variable Message Signs on gantries.
- Loop detectors on every lane near every gantry.
- Floating Car Data (FCD) feeds from vehicles passing the route daily from connected car services, e.g. from smartphone applications and other mobile devices.

The figure below gives an overview of the various data feeds on the A58 that are relevant to PVD. The first column identifies the various data sources and detectors that are available on the A58 infrastructure as mentioned above. These sources provide 'raw' data as potential input for a PVD service or to compare with the input for PVD. The aggregated data was compared to the output of the PVD service. The A58 shockwave damping services fuse various data feeds in order to generate more reliable and plausible information.

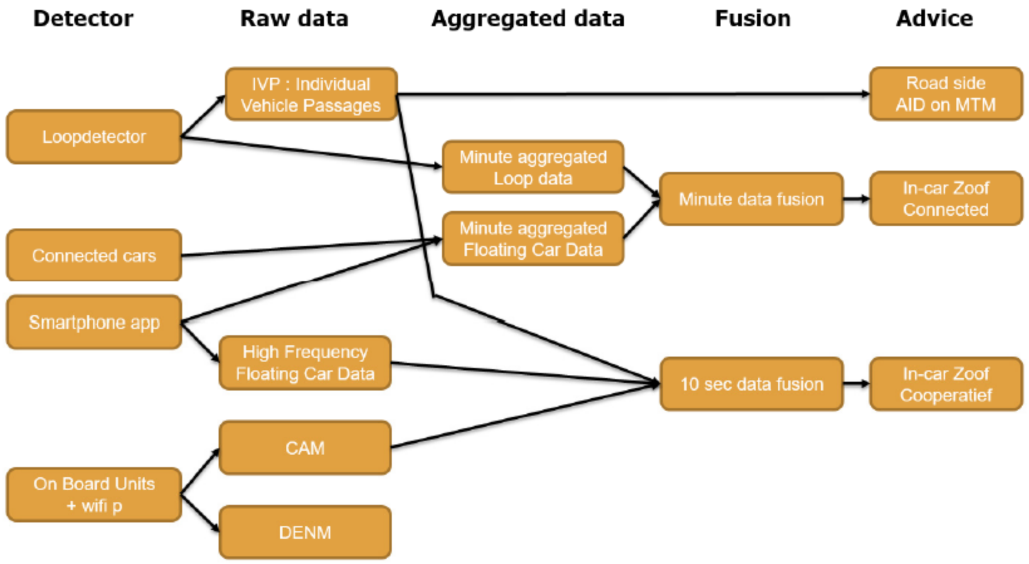

Figure 26: Overview of data feeds

The tests demonstrated the possibilities for the Probe Vehicle Data (PVD) service on the A58 motorway in the Netherlands. The technical feasibility of the basic Probe Vehicle Data use case was demonstrated live on the A58 motorway for various data feeds. Historical data from the A58 project was used to motivate the technical feasibility.

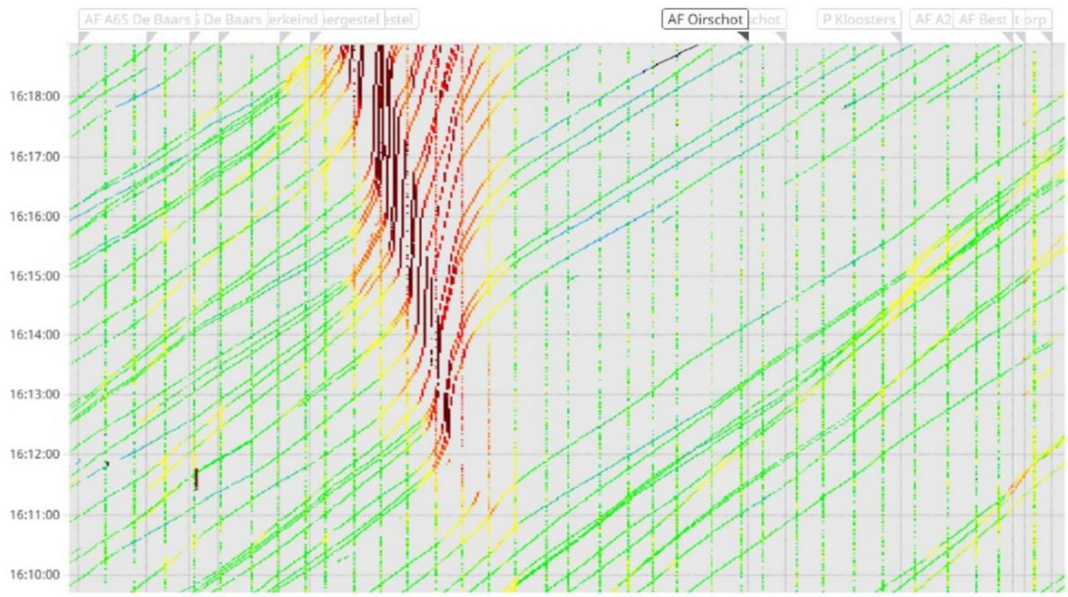

Figure 27: Detection of onset of congestion with both in-car data and loop detectors

The main objective of the PVD service is to aggregate CAM data from cooperative On-board Units (V- ITS-Ss) into average speeds. From the PVD pre-deployment combined with historic data on the A58 it was concluded that:

- Technically, aggregating CAMs is possible at road level. Sampling rate, timestamps, location and speed are sufficient to aggregate the data into an average spot speed at any location within a few hundred meters of the Roadside Unit, or as an average speed in the area.
- The positioning accuracy of the On-board Unit is insufficient to map the On-board Unit on a specific lane. Lane mapping would require more accurate positioning capabilities on the On-board Unit.
- It is estimated that with a penetration rate of On-board Units of 5-8% during working hours the average speed can be calculated to values similar to those of existing data sources.

5.3.3 Gantry based Road works Warning and In-Vehicle Signage

First tests with gantry based Road works Warning and In-Vehicle Signage (RWW/IVS) were carried out from 20 to 22 March 2017 during road works on the A16 near Dordrecht, on a stretch equipped with gantries with variable message signs. The roadside units on gantries transmitted detailed information on road works up ahead, including the location of the road works as well as the information displayed on the signs, to passing vehicles. The tests were performed during normal traffic from about 10.00 till 14.00 during which the leftmost lane was closed for road works and the signs were activated.

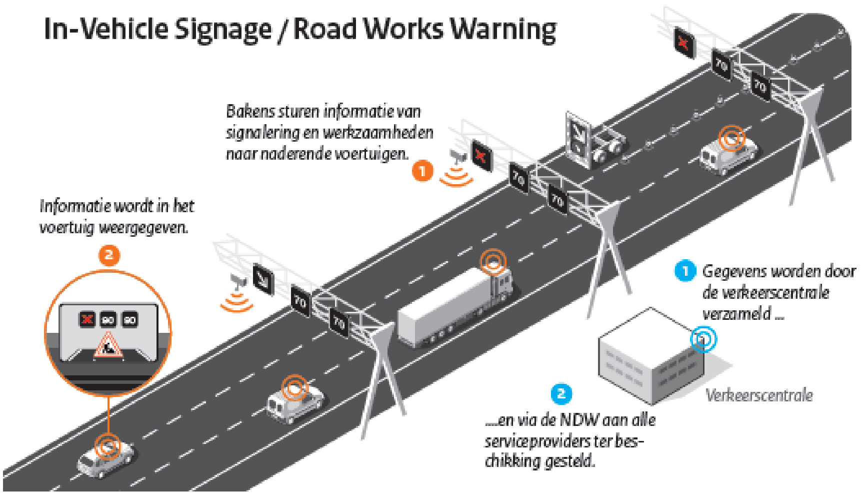

Figure 28: RWW and IVS with gantry based RSUs

Having learned from previous tests the gantry based RWW/IVS tests focussed on transmitting not only DENM messages but also IVI messages from Roadside Units (RSUs) to passing test vehicles On-board Units. The DENM messages contained the exact position of the road works whereas the IVI messages the information presented on the displays over the road.

The information transmitted during the test was provided by Rijkswaterstaat systems and generated automatically by a Central Unit (CU). The messages generated complied with the specifications of the Dutch profile and the international profile agreed with Germany and Austria. This pre-deployment for the first time included transmission of IVI messages based on information from the back-end systems. In this the Netherlands was the first European country to demonstrate this service during real road works.

Many motorways in the Netherlands are equipped with the signalling system (MTM) which allows overhead variable message signs to dynamically display traffic signs. This system is specifically used during road works to display arrows, red crosses and maximum speeds. It is essential that the digital information received by the road user corresponds to the physical information provided at the roadside. The road works information was therefore split into a RWW DENM message warning the road user of the upcoming road works event and IVI messages providing accompanying information as displayed on the overhead variable message signs. Both message sets were subsequently combined in the On-board Unit and integrally displayed on the HMI.

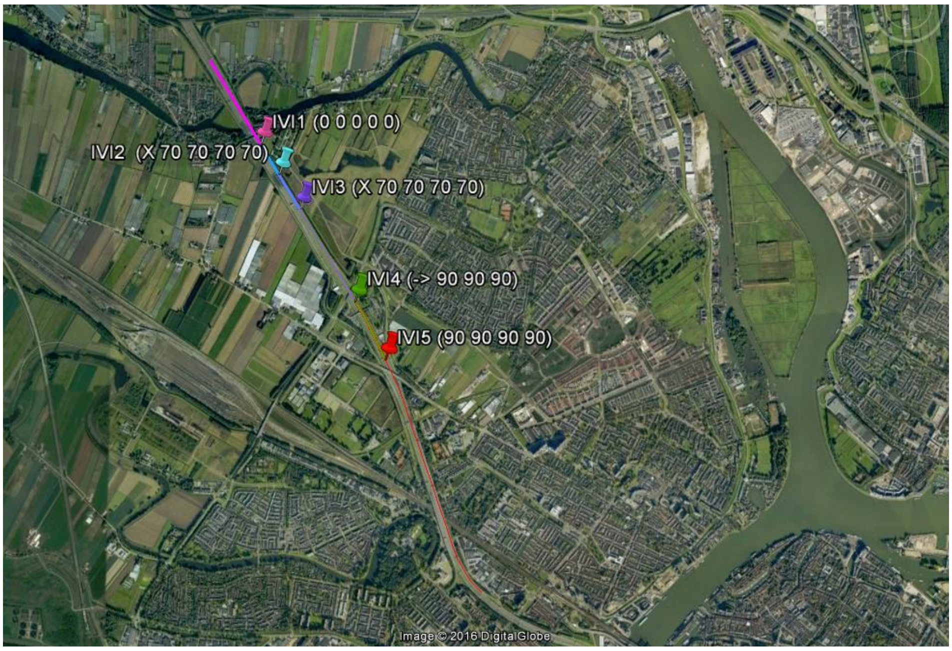

Figure 29: Overview of scenario with consecutive IVI messages

The gantry based RWW/IVS tests in March 2017 included:

- a Central Unit (CU) enabling manual input of images on variable message signs as well as event positions of road works.
- Roadside Units (RSUs, ITS-G5) connected to the CU, transmitting DENM en IVI messages and receiving CAM messages.

- Strategically placed RSU in accordance with the ‘RSU Placement Guidelines’.
- 3 On-board Units (OBUs) from 2 different suppliers transmitting CAM messages and receiving DENM and IVI messages. The OBUs also log its coordinates as well as the IVI, DENM and CAM messages.
- 21 trips north bound along the road works (and 23 trips south bound in opposite direction).

The DENM messages defined the trace to the road works vehicle in the leftmost lane. This trace started several kilometres upstream of the event. An IVI message was defined for each gantry. The detection zone of the first IVI message at position HM 30,7 started with the DENM message several kilometres in front of the gantry. For the subsequent gantries each IVI message defined the reference position at the gantry, the detection zone starting from the previous upstream gantry and the relevance zone ending at the next downstream gantry.

Figure 30 below illustrates the HMI display between two consecutive gantries approaching the event. The picture shows screenshots from the dashcam video taken during one of the demonstration tours. In each zone, the road signs at the next gantry were shown on the top of the screen and the passed gantry in the middle of the screen. The RWW event warning was shown when approaching the road works until passing the trailer, as defined in the DENM message.

Figure 30: HMI display showing IVS as well as RWW

From the gantry based RWW/IVS tests it was concluded that:

- The definitions of traces and zones in DENM and IVI messages caused confusion. It became apparent that there is a firm needed for explicit profiles in order to avoid confusion which will harm interoperability.
- The accuracy of line segments in traces and zones can be insufficient. This may cause erroneous decisions in the On-board Unit, e.g. as to whether the vehicle is on a parallel road or not.

- Logically linked IVI and/or DENM messages which are sent separately may cause display problems in the On-board Unit.
- The standards do not allow distinction as to whether a lane change occurs at the right or at the left side of the road. This hinders correct display of the road layout on the HMI.
- A high frequency of DENM and IVI messages causes performance problems in the On-board Unit.
- The communication range proved to be in the range of 380 to 930 meters.

5.3.4 RWW, IVS and PVD - ITS-G5, updating the services

Since March 2017 the test site on motorway A16 was updated several times in conjunction with the InterCor TESTFESTs on ITS-G5, PKI, hybrid communication and service interoperability.

TESTFEST ITS-G5

From 3 to 6 July 2017 the Netherlands hosted the first InterCor TESTFEST, which focussed on ITS-G5 services and functionality. The TESTFEST ITS-G5 included the services Road Works Warning (RWW), In-Vehicle Signage (IVS) and Probe Vehicle Data (PVD).

The TESTFEST included real live road works with temporary traffic management measures on the A16 on a busy stretch with complicated road layout with fly-overs and parallel carriageways. One or more lanes were closed for the purpose of placing machines and executing road works. During these traffic management measures it was possible to drive past the road works in order to execute real live tests.

Figure 31: Test vehicles from several EU member states at the TESTFEST ITS-G5

The RWW service was implemented by sending one DENM message for every subsequent closed lane with information about the road works from fixed Roadside Units (RSUs). Additionally the IVS service was implemented by sending one or more IVI messages containing the information on the centrally controlled variable message signs on overhead gantry from fixed RSUs. The IVI messages might contain information supporting the DENM message but might also contain standalone traffic information (such as speed advice for traffic jam ahead). The RSU that was sending the IVI message was not necessarily the same one as the one sending the DENM message. This depended on the specific situation. The IVI messages were automatically generated based on the actual images on the variable message signs. The RSUs were also receiving CAM messages from the test vehicles.

The Central Unit (CU) composed the content of the DENM and IVI message, based on information from various sources. Next this message was being transferred to a Roadside Unit (RSU), or multiple if applicable, at the roadside, upstream from the road works. Road works can differ per situation and are often dynamic. Therefore the specific situation at a given moment was not always known at the traffic centre. In this case the message was generated tailor made especially for the given situation, conform the relevant Profile. CAM messages received from the On-board Units and transferred via the Roadside Units were stored by the CU.

The TESTFEST ITS-G5 included:

- Stretch of 17 kilometres on the A16.
- 13 fixed RSUs mounted on existing gantries.
- Test Roadside Unit at the test centre location.
- RSUs strategically placed compliant with the Dutch ‘RSU Placement Guidelines’.
- Central Unit (CU) automatically connected to the Dutch signalling system (MTM).
- Roadside Units (RSUs) connected to a Central Unit (CU) based on a 3G network connection.
- Infrastructure suited to test the services/use cases in both driving directions simultaneously.
- Test DENM and IVI messages on the A16 and at the test centre for known and unknown as well as real and virtual events.
- Collection of CAM data sent by passing OBUs.
- Photo scripts for known virtual events.
- 3 test vehicles from Rijkswaterstaat equipped with validation/demonstration On-board Units.
- Coordinated logging of log data.

TESTFEST PKI

A further update of the test site took place in conjunction with the participation in the security TESTFEST in France in April 2018. Before taking part in the TESTFEST in France "security" was added to the Dutch test site. Then, in France it was checked whether the Dutch implementation was interoperable with the French implementation and whether still adaptation of the Dutch site would be necessary.

The Dutch test site was extended with PKI functionality, including a rudimentary Root Certificate Authority (RCA) as well as Enrolment Authorities (EA) and Authorisation Authorities (AA) for Roadside Units (RSUs) as well as On-board Units (OBUs) for the Netherlands. These Certificate Authorities were capable of generating Enrolment Credentials and Authorisation Tickets for RSUs as well as OBUs. The certificates and lists were generated manually and distributed manually to the RSUs as well as the OBUs as well as to the French partner coordinating the TESTFEST PKI. The common lists (CTL, CRL) generated by the French partner were distributed by hand to the RSUs and OBUs. Figure 32 below gives an overview.

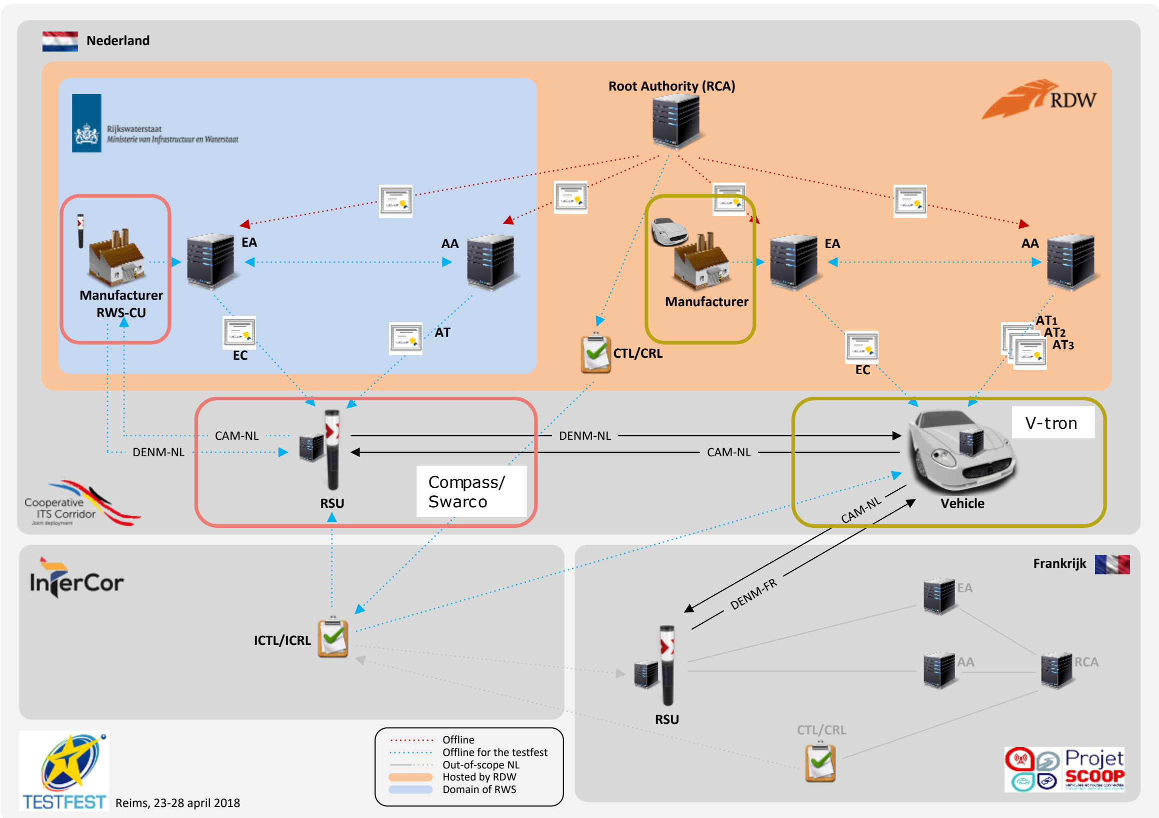

Figure 32: Dutch PKI infrastructure in preparation of the TESTFEST PKI

TESTFEST Hybrid

A next update of the test site took place in conjunction with the participation in the TESTFEST on hybrid communication in the UK in October 2018. In the same way as was done for the security TESTFEST, at first hybrid communication was added to the Dutch test site. Then, in the UK it was checked whether the Dutch implementation was interoperable.

The Dutch test site was extended with an additional cellular infrastructure. This infrastructure consisted of a Data Provider and a Service Provider as well a Cellular App. The Data Provider function was implemented by means of extending the existing TLEX entity. TLEX is the hub within the Dutch TalkingTraffic architecture. The Service Provider function was implemented by the same supplier which also provided the validation OBUs. This company furthermore also extended the OBU with a cellular App. The resulting OBU could be switched to either full hybrid, ITS-G5 only or cellular only. Figure 33 below gives an overview.

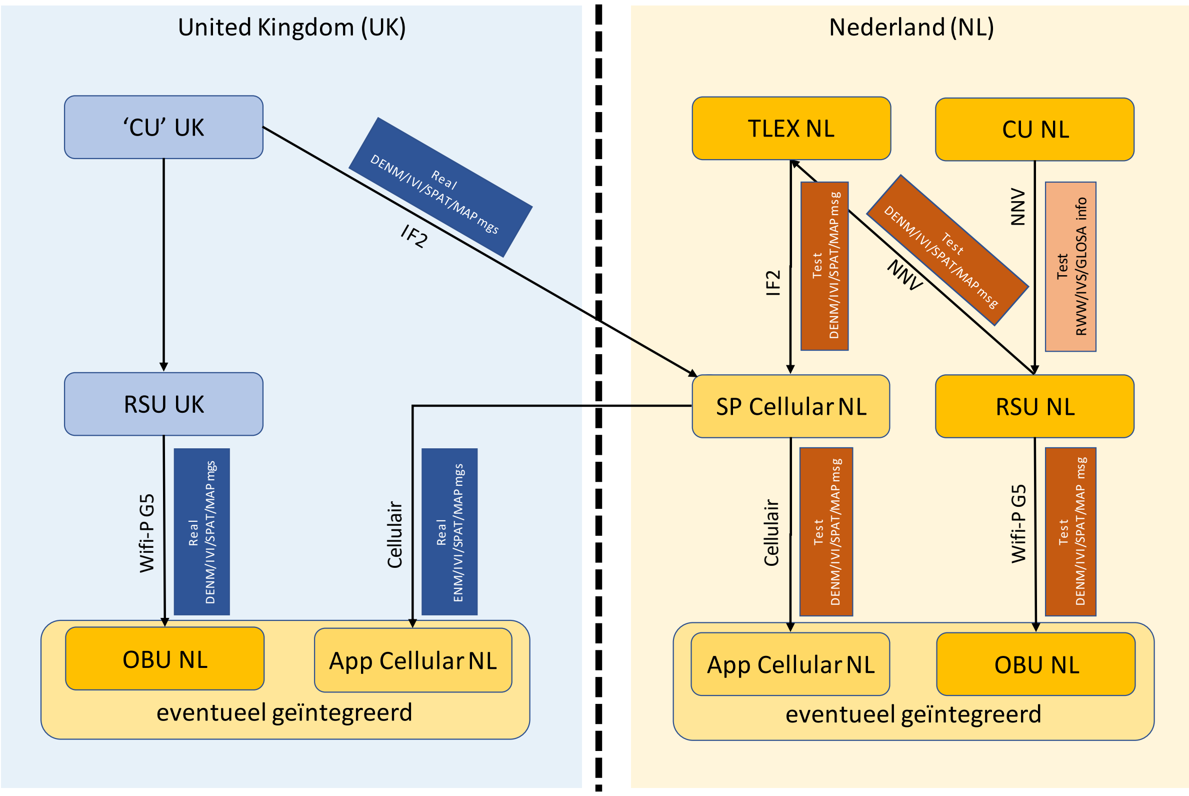

Figure 33: Dutch hybrid infrastructure in preparation of the TESTFEST Hybrid

Final TESTFEST on service interoperability

In preparation of the final TESTFEST Services (or Cross-border Interoperability), organized by the Belgian colleagues, the test site was reorganized and ruggedized. The hardware hosting the Central Unit (CU) was upgraded, the connection with the signalling system (MTM) via the Enterprise Service Bus (ESB) of Rijkswaterstaat was re-established, all Roadside Units (RSUs) were reconnected, the validation OBU was extended, a new set of certificates was generated and the trajectory was filled with nine virtual scenarios. Figure 34 below shows the scenarios.

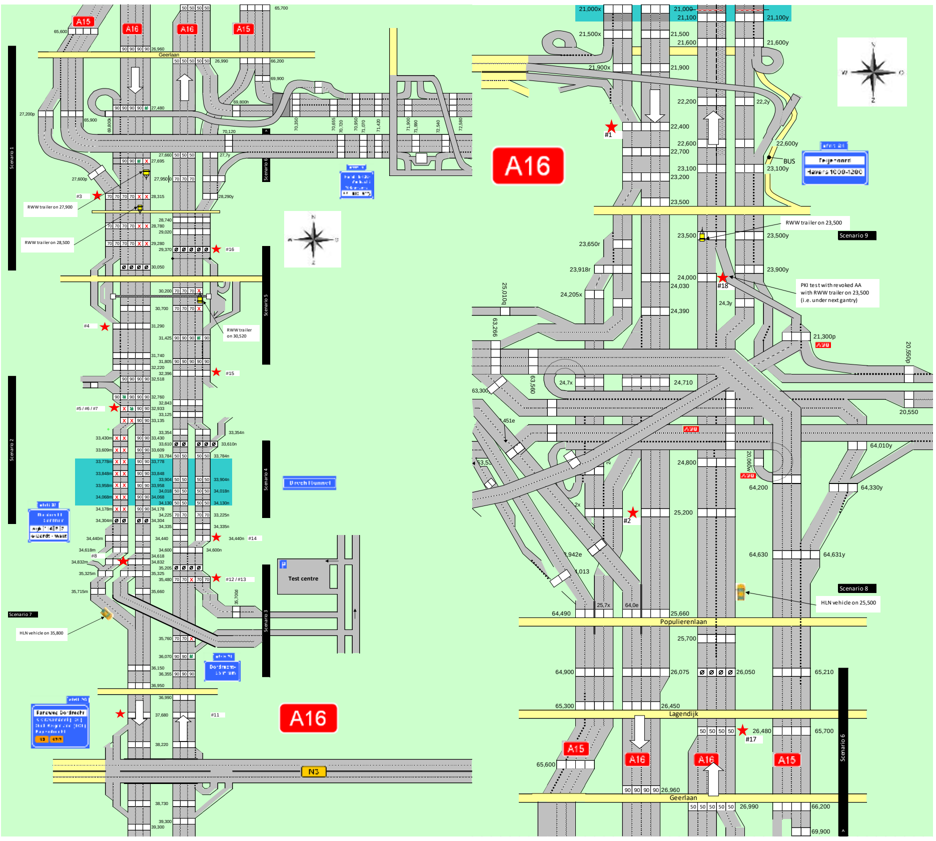

Figure 34: Scenarios on behalf of the TESTFEST Services

Final stage of delivering the services

In the final stage of delivering the services in the InterCor project the test site on the A16 covers a stretch of 19 kilometres, from Dordrecht to Rotterdam and vice versa. The test site is now (partly) automated, robust, fully hybrid, providing PKI and covers the services RWW, IVS, HLN (CRW) as well as PVD.

In order to deliver the services the Central Unit (CU) is connected to the Dutch signalling system (MTM) of Rijkswaterstaat. This system manages the overhead variable message signs on gantries on motorways. PKI is managed by the Dutch vehicle registration authority RDW. Certificates and lists are generated by hand and distributed to Roadside and On-board Units manually. The Roadside Units (RSUs) are connected to the CU via the Rijkswaterstaat owned dedicated communication network NNV, either wired or wireless. The test system/ infrastructure also includes own On-board Units, specifically designed for validation purposes.

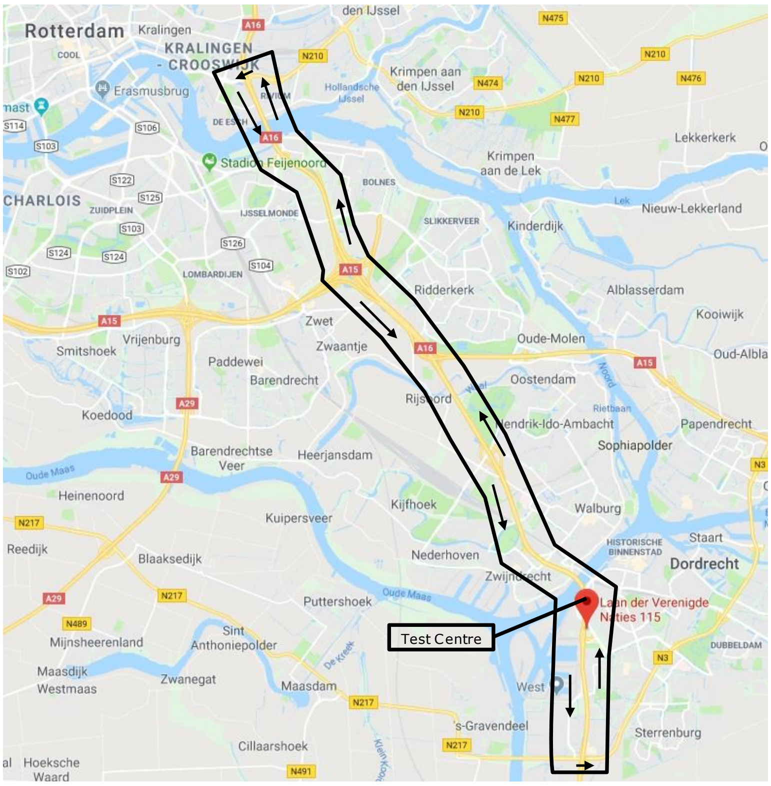

Figure 35: Overview of the A16 test site

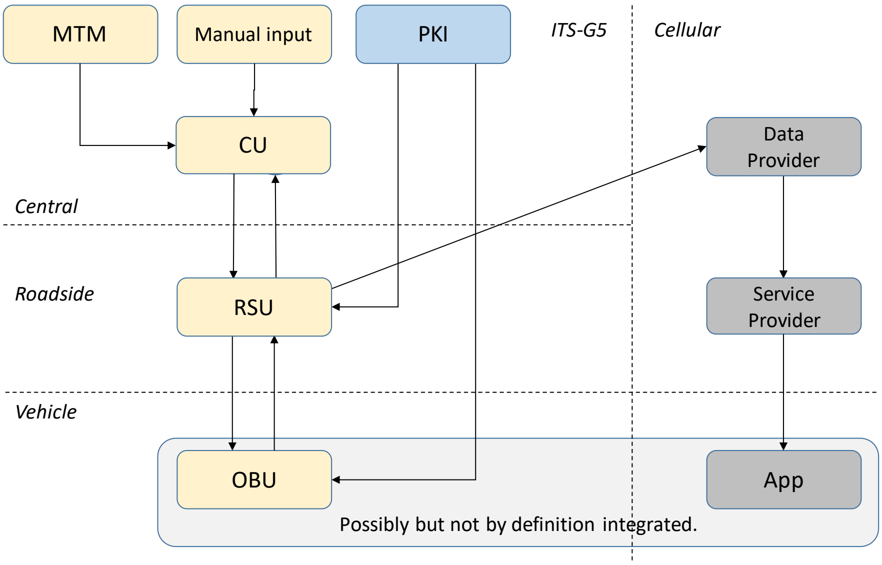

Figure 36: System overview

The data sent by the ITS-G5 services is also made available for the cellular path. The cellular path uses the Dutch TLEX system as Data Provider. The Roadside Units (RSUs) are connected to TLEX in order to provide this system with the relevant data. TLEX distributes the data via an InterCor IF2 interface to Service Providers which again distribute the data to their Apps in vehicles.

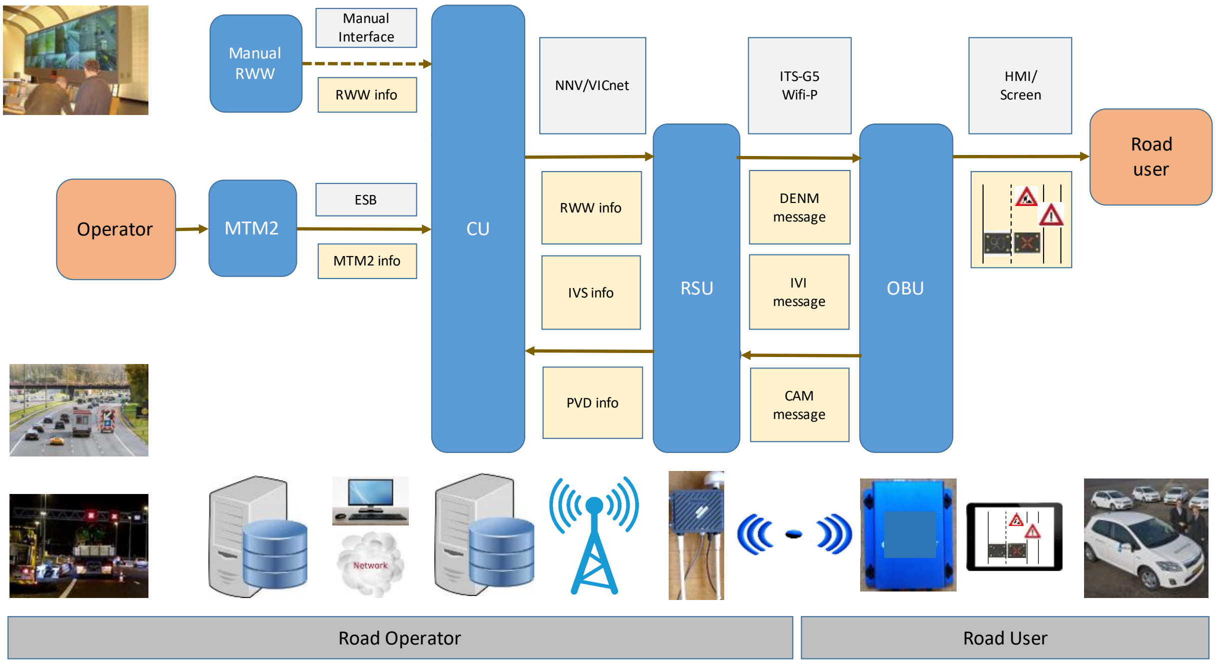

Figure 37: System overview for ITS-G5 (not including PKI)

The test system on the A16 includes 13 physical Roadside Units (RSUs). The RSUs are located a strategic point on the trajectory, according to the Placement Guidelines as drawn up by Rijkswaterstaat. Figure 38 below gives an overview of the RSUs and their locations (the numbers denote the 'logical' RSUs).

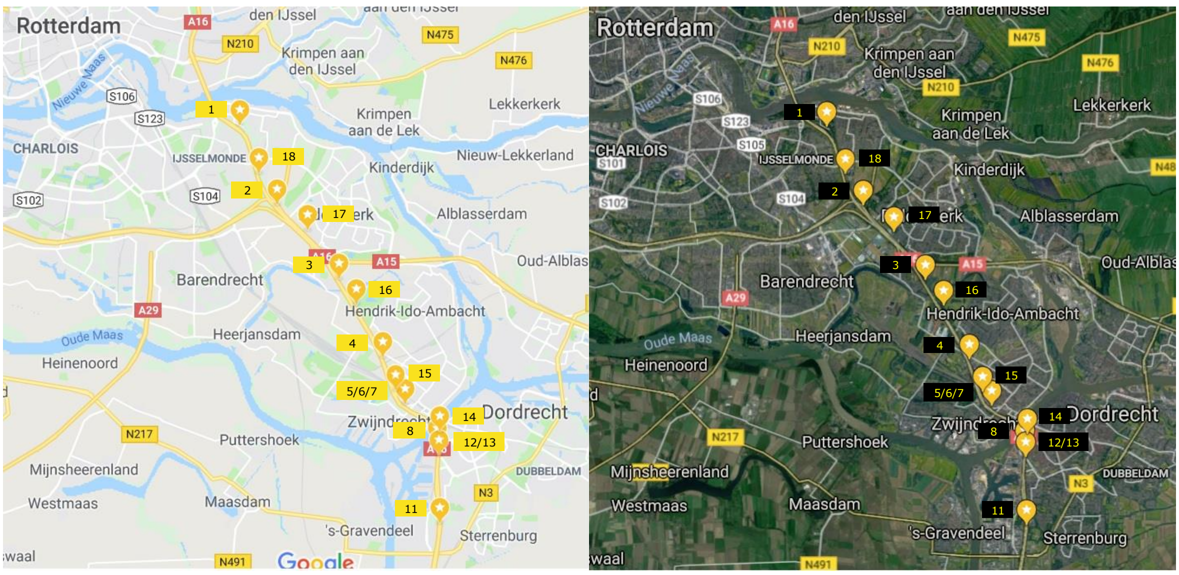

Figure 38: Overview of the RSUs on the A16 test site

The Roadside Units (RSUs) are placed in regular roadside cabinets ('wegkantstations', WKSs) of the signalling system MTM. The beacons are mounted on the overhead gantries.

Additional to the fixed RSUs the test system also includes a portable RSU, allowing dedicated testing in a controlled environment. The RSUs are connected to the Central Unit (CU) via the Rijkswaterstaat network NNV via a dedicated VPN. Twelve RSUs have a wireless connection; one is connected via optical fibre (wired).

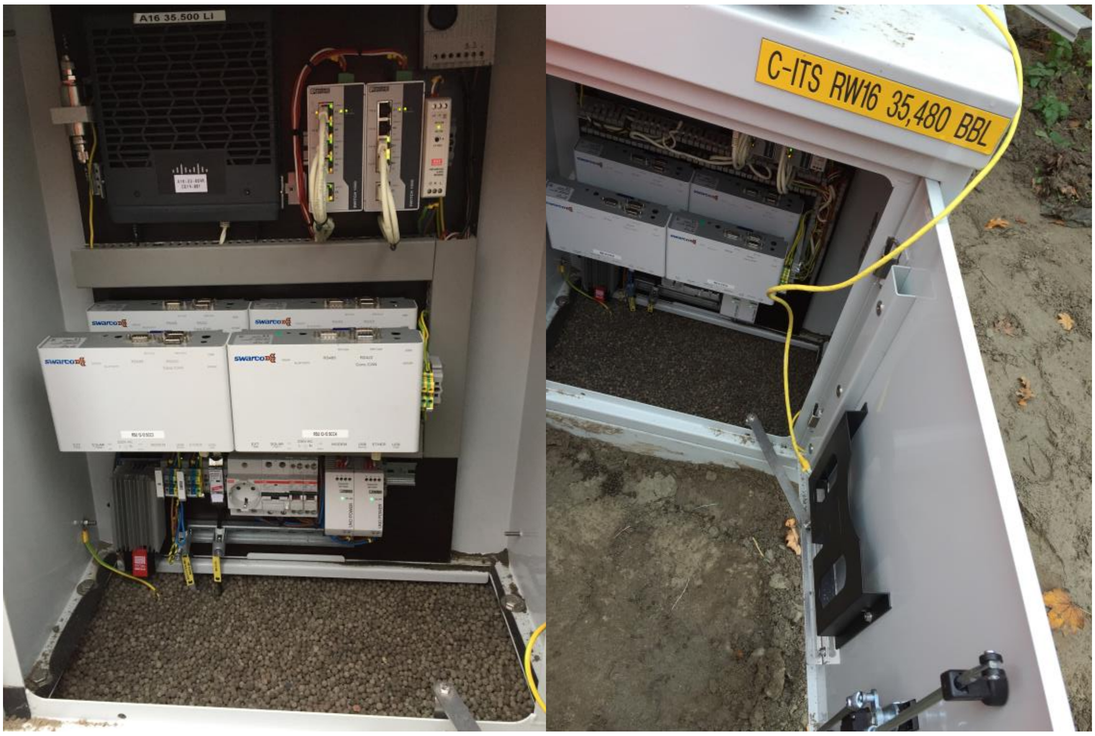

Figure 39: Roadside cabinet with additional RSU hardware (white boxes)

Figure 40: Gantry with beacon

Figure 41: Portable RSU and the Rijkswaterstaat test vehicle

The test site provides full PKI support, based on the security standard ETSI TS 103 097 'Security header and certificate profile'; V1.2.1. Certificates and lists such as CTLs are generated manually and distributed manually to Roadside Units (RSUs) and On-board Units (OBUs).

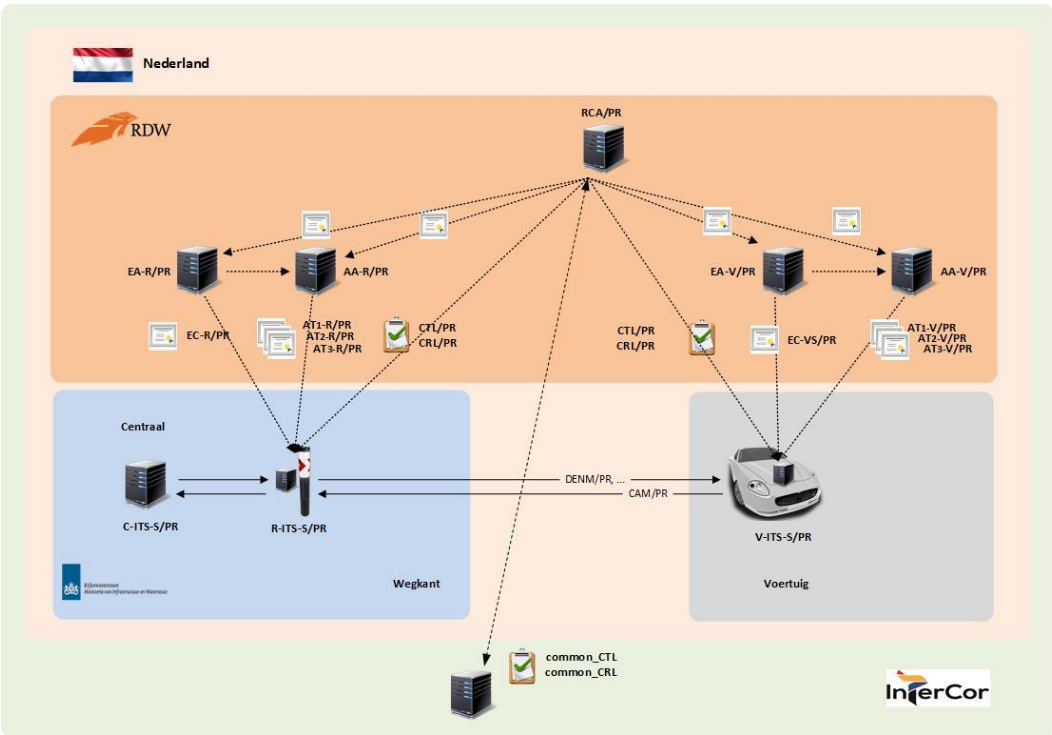

Figure 42: Test site PKI infrastructure

The Central Unit (CU) is now hosted on a dedicated server which can be monitored professionally - locally as well as remotely and managed by means of web-based human-machine interfaces. The Central Unit is capable of generating any virtual RWW, IVS as well as HLN scenario's (DENM as well as IVI messages) on request. The Central Unit (CU) can additionally generate real life IVI messages based on a live feed from the signalling system (MTM), The live feed can be activated per individual Roadside Unit (RSU). Figure 43 below gives an example of a virtual scenario combining RWW and IVS.

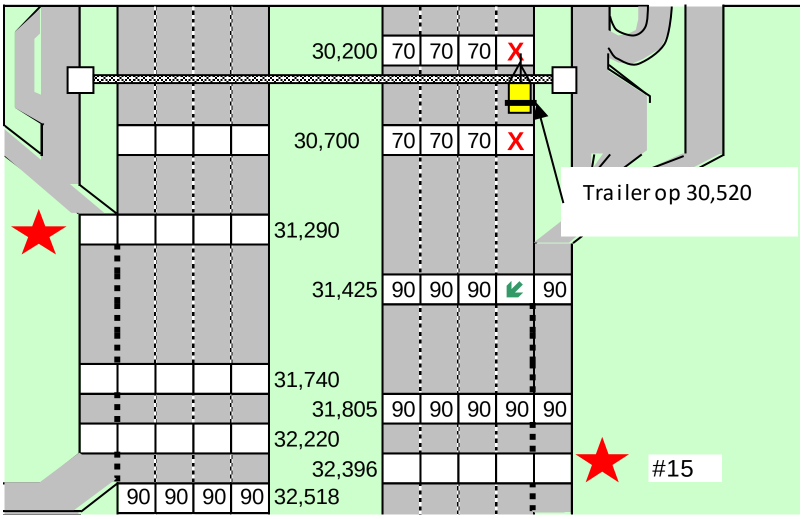

Figure 43: Example of a virtual scenario on the A16 test site

Last but not least, the test system includes several 'validation OBUs'. These On-board Units (OBUs) are specifically designed to allow validation of the end-to-end chain. The OBUs are fully hybrid but can be switched to either ITS-G5 only or cellular only. The OBUs for RWW/IVS/HLN and GLOSA are not yet integrated.

Figure 44: Validation OBU

Pilot drives

Using the final commonly agreed InterCor specifications, in August 2018 data collection started on the test site regarding the ITS-G5 services RWW and IVS. From 2018 to March

2019 up-scaling from one vehicle with ITS-G5 communication, collecting data on the technical performance of the systems to 15 vehicles equipped in such a way that it is possible to fulfil the requirements for evaluation

Considering the requirements for a useful evaluation, the driving of the vehicles will be partly organized and partly fully naturalistic:

- One Rijkswaterstaat test vehicle;

  This is a standard company car of Rijkswaterstaat, a Renault Clio (see Figure 41), equipped with an OBU and HMI, which became exclusively available for testing and piloting in 2016. Rijkswaterstaat also used this car when updating the test site to the commonly agreed InterCor specifications, while since November 2018 this car is in use for more regular technical data collection on the test site.

- Two Rijkswaterstaat road inspector vehicles;

  These are two cars of road inspectors based closely to the test site. These road inspectors work on incident management and maintenance inspections and are often active on the test site. The cars were equipped in March 2019 and will be available for data collection until August 2019.

- Two vehicles from a Rijkswaterstaat subcontractor;

  Two cars of subcontractor Compass are equipped. Compass works on the maintenance of the roads in the test site area and has its office just north of the test site. Co-workers of Compass will also use these cars for commuting from the area south of the test site to this office. These cars were also equipped in March 2019 and available for data collection until August 2019.

- Ten Rijkswaterstaat vehicles;

  For the pilot, ten company cars of Rijkswaterstaat are taken out of the normal company car fleet. After January 2019 these ten cars became available to be equipped with an OBU and HMI and for data collection until August 2019.

  During three nights or weekends with road works on the test site, Rijkswaterstaat will organise pilot drives: 10 vehicles x 3 persons every night/weekend, driving with and without the active in-car service. In addition these ten cars are used for fully naturalistic driving with and without in-car information, mainly by commuting Rijkswaterstaat personnel to and from the Rijkswaterstaat offices in and around Rotterdam.

5.3.5 RWW and IVS - cellular

In August 2018, the operation of the cellular RWW and IVS services started. The functionality of a popular existing app with traffic information, 'Flitsmeister', was extended for this purpose - in partnership with the company Be-Mobile. It concerns a publicly available app, so that all road users are able to benefit from it.

As explained before, the Netherlands chose an incremental approach for InterCor, building on work already carried out in other projects. The cellular RWW and IVS services in The Netherlands build on the work of the Talking Traffic project. In this national project, government and businesses are jointly taking responsibility to improve the flow of traffic using smart new technologies. Companies work on traffic light data, cloud services and end user services.

Figure 45: Display of speed and lane information in Flitsmeister

The Talking Traffic project aims to deploy a range of services including road works information and in-vehicle signage. Flitsmeister started the extension of in-vehicle display of maximum speeds in August 2018. Their research showed that quite some road users are not aware that VMS speeds are mandatory maximum speeds, and feel uncertain about maximum speeds when hard shoulder running is active. Static information was already part of the app, and now dynamic speed information including information from VMS on gantries is being deployed (indicating dynamic speeds and closed lanes).

Pilot operation started in August 2018 – the service is being evaluated continuously to be able to further improve the performance.

Information on road works is already part of the standard functionality of Flitsmeister. The Talking Traffic project will contribute to even more accurate information in the app.

Figure 46: Display of road works information in Flitsmeister

This cellular RWW and IVS service will be active during the whole remaining lifetime of the InterCor project. The services are available all over The Netherlands including the InterCor pilot areas.

Because of the many users (number of downloads: 1.3 million) and long period of operation it would not be possible to analyse all data that could be generated with this app. Therefore the collection of data will be limited to specific periods.

5.3.6 GLOSA

Pilot site

The InterCor GLOSA Brabant pilot site is based in the city of Helmond. The city of Helmond (90.000 inhabitants) has a major road dividing the city into two halves, going right through the city centre, being both a physical barrier as well as a cause for congestion, noise, pollution, etc. On this west-east corridor about 30,000 vehicles pass every day, of which approximately 2,000 trucks. Due to this huge amount of trucks on this main road in Helmond, and the impact of these trucks on traffic efficiency, quality of life for citizens and air quality, GLOSA will be piloted in Helmond as one of the ways to mitigate the impact of freight traffic.

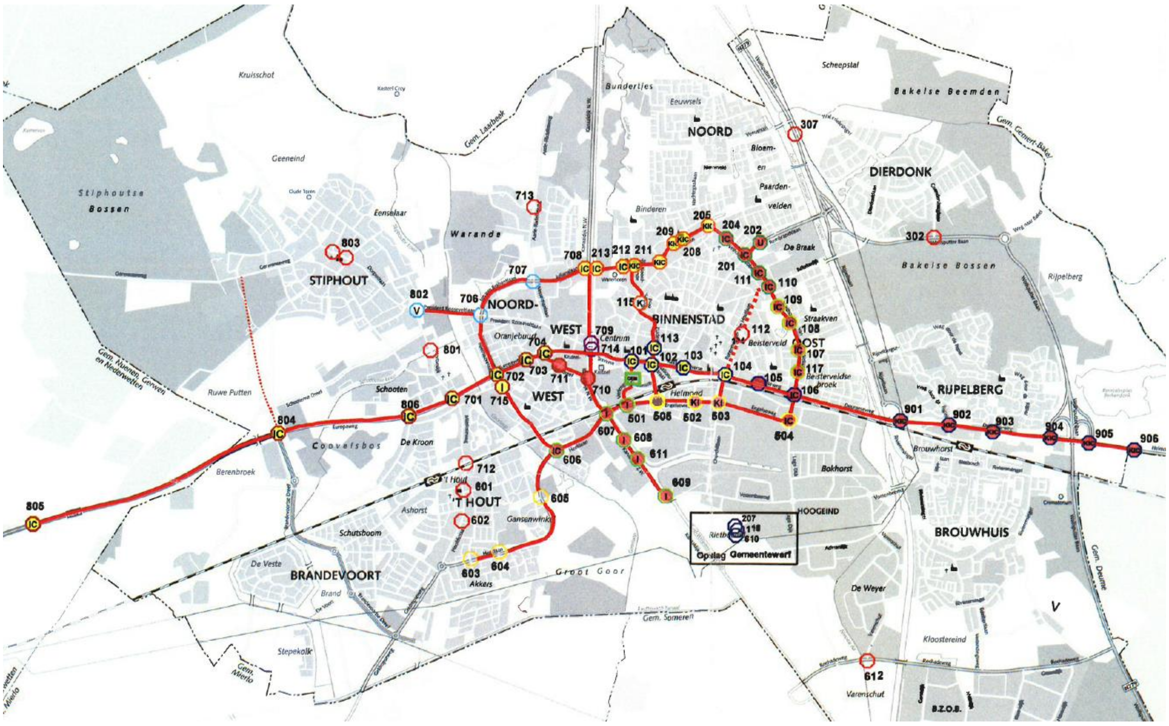

Figure 47: Various ITS project beacons rolled out in Helmond

Since 2009 the City of Helmond has been involved in various cooperative ITS projects which gradually led to a true living lab on smart mobility. The Helmond test site is situated along the main road that runs through Helmond which is equipped with 24 road side units. In addition the motorway between Helmond and Eindhoven (A270) is used as a Field Operational Test site for both cooperative and automated vehicles.

The InterCor pilot site consists of urban roads and is executed under normal traffic conditions. The InterCor pilot consists of two phases. The first phase till September 2018 focused on GLOSA for ITS-G5 and the extension of the test site to 29 intersections. The second phase in 2019 will focus on hybrid GLOSA. Helmond will migrate all its intelligent intersection controllers to the new ETSI standard and InterCor GLOSA profile standards. For purposes of the GLOSA Pre-TESTFEST and the Final TESTFEST, Helmond first brought these new standards in production along a smaller trajectory as illustrated below.

Figure 48: New ETSI and InterCor standards rolled out in June 2018

Legend:

Hybrid operational
ITF approval in process, possibly hybrid operational
Not operational

- *603, 604, 605 operational Wi-Fi-P and data availability over InterCor IF2 cloud data interface*
- *505, 503 en 607 operational and data-availability over InterCor IF2 cloud-data interface*
- *501 en 504 operational with the intersection topology ITF-files in process of approval - and data availability through cloud data interface*
- *502 not operational*

Following the Final TESTFEST, all intelligent intersection controllers in Helmond (as illustrated in Figure 48) will be migrated to the new ETSI and InterCor GLOSA standards.

GLOSA service in the Brabant pilot

Vehicles approaching a traffic light will inform the driver in advance about the traffic signal status for crossing the conflict area of an intersection. This function reduces stop times, number of stops and unnecessary acceleration in urban traffic situations to save fuel and reduce emissions. The provided speed advice helps to find the optimal speed to pass the next traffic light during a green phase. When the traffic light is green and the distance to the traffic light is less than 50 meters no speed advice is displayed. This is for safety reasons, as a queue may still be in place.

Road side units broadcast MAP and SPaT messages. Approaching vehicles map-match their own position onto the topology of the MAP messages. A match produces the signals that are relevant for the vehicle, and the accompanying data can be retrieved from the SPaT message. Next, a speed advice can be retrieved from the SPaT message (if it has been calculated by the road side unit), or it can be calculated based on the distance to the stop line and the data from the SPaT message. The signal state and timing information is shown to the driver, and the speed advice is shown if it contains a safe driving speed (below the speed limit, and not too slow). Complementary to the 2018 pilot phase, in 2019 the service operates in hybrid mode.

Characteristics of the GLOSA pilot site of Provincie Noord-Brabant are:

- ETSI G5 RSUs (fixed solutions) – multi-vendor;
- Based on standards ETSI for Wi-Fi-P based and open Talking Traffic iVRI (intelligent Traffic Light Controller) specifications;
- iVRI capable R-ITS-S sending SPaT, MAP;
- Central Unit for generating and/or processing required DENM, CAM, IVI messages according to iVRI Talking Traffic architecture;
- Central cloud data unit according to InterCor IF2 specifications operational since 2nd half 2018;
- Interfaces with several existing subsystems (data collections);
- > 50 Vehicles equipped with OBU (trucks, emergency vehicles);
- Test and validation/verification tooling.

Figure 49: GLOSA on an intersection in Helmond

5.3.7 Truck Parking

The Truck Parking Service indicates free parking spaces at truck parking lots across the whole Dutch corridor area. The Truck Parking pilot will answer research questions concerning functionality, technology and user acceptance of the Truck Parking Service. This pilot leads to recommendations and guidelines for a successful implementation of a truck parking service which allow truck drivers to manage and optimize their driving time according to the availability of parking lots.

InterCor focusses on ITS-G5 and hybrid communication. The truck parking pilot developed in the Netherlands uses only the InterCor hybrid communication standard, limited to the cellular network.

Figure 50: Trucks parked next to the motorway – Situation to be prevented

The dynamic data will be collected by a service provider. This service provider will provide the information for the truck driver by an app on his smartphone. This app already exists and provides mainly static data to 800.000 users. The focus during this pilot will be to add the dynamic data. The service provider will also configure a proprietary interface as the national single point for data exchange. This data exchange is based on the European standard Datex II specifications for truck parking data including both static and dynamic data (number of available spaces).

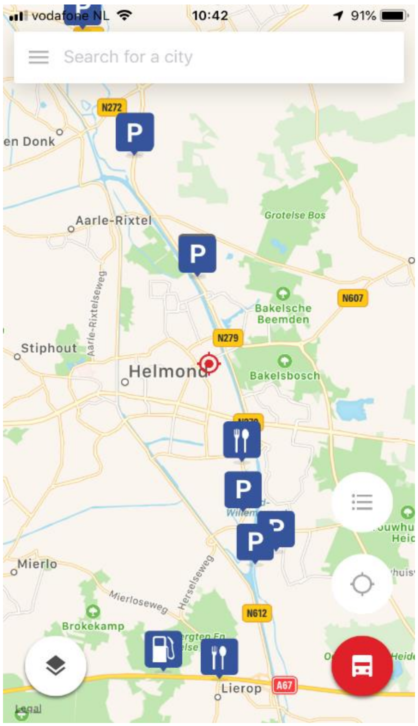

Figure 51: Truck Parking App showing several parking places

5.3.8 Multimodal Cargo Transport Optimization (MCTO)

The Dutch incremental approach also applies to the Multimodal Cargo Transport Optimization (MCTO). MCTO is a service helping the truck driver when transporting containers to a terminal or logistic hub. Often truck drivers have to wait for some time when they arrive on a logistic hub / terminal. This service is meant to provide a more accurate estimated time of arrival and to optimize the planning for (un)loading trucks at logistic hubs. By reducing the time trucks stand idle, transport companies are able to use this time more cost efficiently. In most logistic hubs several modes of transport are available, such as trains, barges and trucks. In the near future, MCTO is able support all those modes.

MCTO derived from several pilots done in 2015 and 2016 in the Netherlands. ETA services have been tested at the European Container Terminal in the harbour of Rotterdam and as a Control Tower service for the biggest supermarket chain of the Netherlands. In order to align lessons learned with the opportunity to further harmonise services via InterCor the MCTO pilot has been developed together with stakeholders such as TLN (Dutch Association for Transport and Logistics) and companies who were involved in the previous tests.

The MCTO pilot has been aligned with the Mainport Traffic Monitor initiative. This initiative is taken by the Port of Rotterdam, TLN, Ministry of Infrastructure and Water Management and the Top sector Logistics. The Traffic Monitor provides logistic stakeholders with better information about the traffic situation in the Port of Rotterdam and the situation at container terminals and empty depots. The collection of information aims to better predict the best routes, arrival times of trucks and speed up container handling. At the start of 2018 both the Port of Rotterdam and Simacan started the development of the Traffic Monitor. Simacan is a Dutch company who will act as MCTO service provider. The MCTO service in InterCor is delivered by the Mainport Traffic Monitor. The pilot started in September 2018 and is alive until the end of the InterCor project.

In the Mainport Traffic Monitor, the Multimodal ETA for Cargo Optimization use case is implemented. The ETA use case was implemented in September 2018. Five transport companies, who together hold over more than 100 heavy trucks joined the program. They share a minimal set of data which includes their Location, Vehicle ID, Trip, Route and Shipment. This set of data is derived from the on-board units of the trucks via a cellular network to Simacan. Simacan combines this set and calculates the expected time of arrival of the trucks. In order to provide a reliable ETA, Simacan uses various data sources on traffic state and events to predict any delays on route. It is up to Simacan to decide which data needs to be acquired in order to provide a reliable ETA. Finally, the calculated ETA, together with the linked vehicle ID is sent to the terminal / logistics hub, where it's presented on an online dashboard. The same dashboard functionality is also present at the planning department of the participating truck companies. Filters are used to make sure that only relevant trucks for each stakeholder are displayed. The data collection for the MCTO pilot applies to the trucks in the pilot area, consisting of the main roads through the Port of Rotterdam, which is the A15 (between Knooppunt Ridderkerk and Oostvoorne) and N15 (Oostvoorne and Tweede Maasvlakte). They are highlighted on the map below.

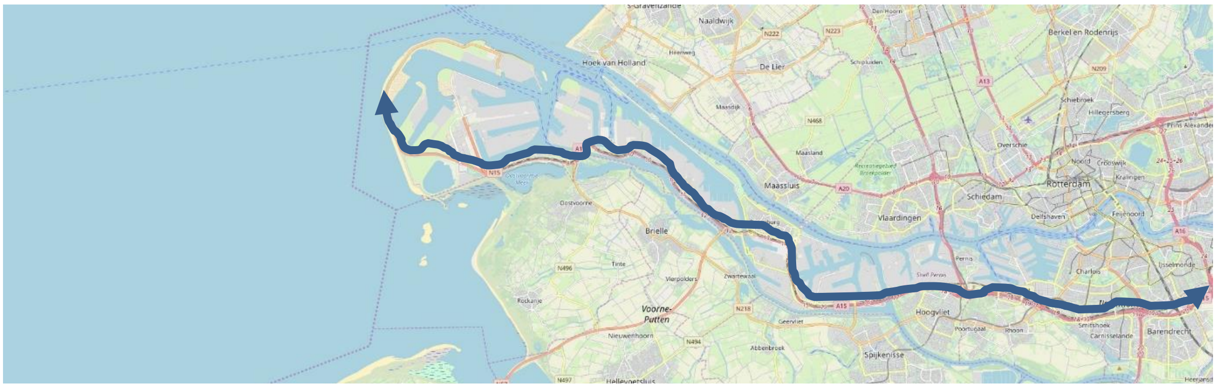

Figure 52: Pilot area for MCTO in the Netherlands

5.3.9 Tunnel Logistics

The pilot on Tunnel Logistics in the province of Utrecht concerns two use cases which are operational since February 2019: optimal route advice for heavy vehicles and balanced priority for dedicated vehicles. Both use cases take into account the traffic flow towards the

Leidsche Rijn tunnel in motorway A2, west of the town of Utrecht and contribute to the objective of optimizing road usage for logistic companies.

Geographical scope

The N201 is a common route for heavy vehicles heading for or coming from the region of SchipholRijk/FloraHolland. SchipholRijk/FloraHolland is located in a short distance of Schiphol at the east side of motorway A9. Most heavy vehicles leaving this region, go south to motorway A2 via regional road N201 or motorway A9 and pass the Leidsche Rijn tunnel in motorway A2 near Utrecht. For safety reasons in this tunnel traffic jams are not allowed. If there is a risk that there will be a traffic jam in the tunnel (e.g. caused by an accident downstream the tunnel) tunnel operators will close a lane, so that fewer vehicles can drive into the tunnel. This measure causes traffic jams at the A2 in the direction of the tunnel. Often these traffic jams grow until the junction N201-A2 (or even further), also causing traffic jams on the N201. This area is very suitable to pilot a service with the objective to optimize road usage for logistic companies.

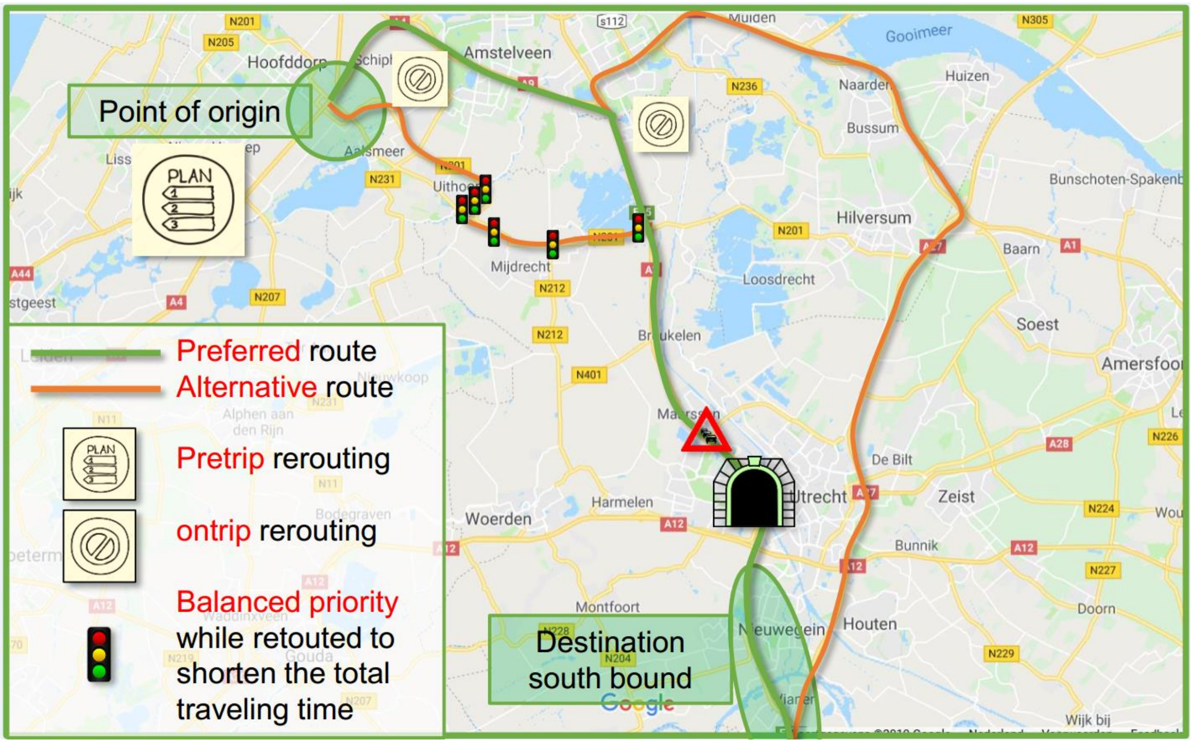

Figure 53: Pilot area for Tunnel Logistics

Optimal route advice for trucks

The first use case, optimal route advice for trucks, aims to provide optimal routes (with the least delays) to drivers of heavy vehicles, resulting in a reduction of the loss of time, caused by traffic jams. Specifically for the N201 area, in case of a traffic jam at the A2 from N201-A2 junction towards the Leidsche Rijn tunnel and the availability of another faster route, drivers of heavy vehicles will be advised via in-car information to take another, faster route to get to the other side of the tunnel.

Alternatively, if the common routes via regional road N201 are available and faster than other routes (e.g. due to traffic jams located elsewhere), drivers of heavy vehicles will be advised via in-car information to take the N201 to the south. This is when the second use case, balanced priority for dedicated vehicles, comes into the picture.

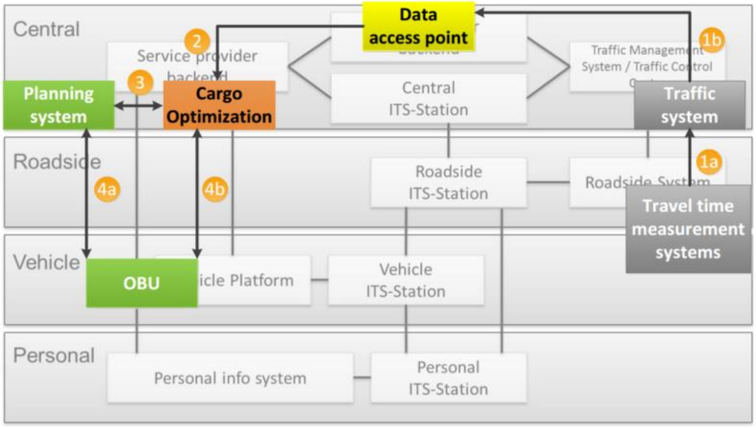

Figure 54: System architecture use case optimal route advice for trucks

Balanced priority for dedicated vehicles

Six traffic lights on the N201 (FloraHolland – A2) are upgraded to intelligent traffic lights (iTLC) in 2018. These upgraded traffic lights enable to provide priority for dedicated vehicles. In case the fastest route is advised via the N201 (due to traffic jams on other routes), heavy vehicles will get priority at these intelligent traffic lights to limit the hindrance of the extra heavy vehicles breaking and accelerating at the N201.

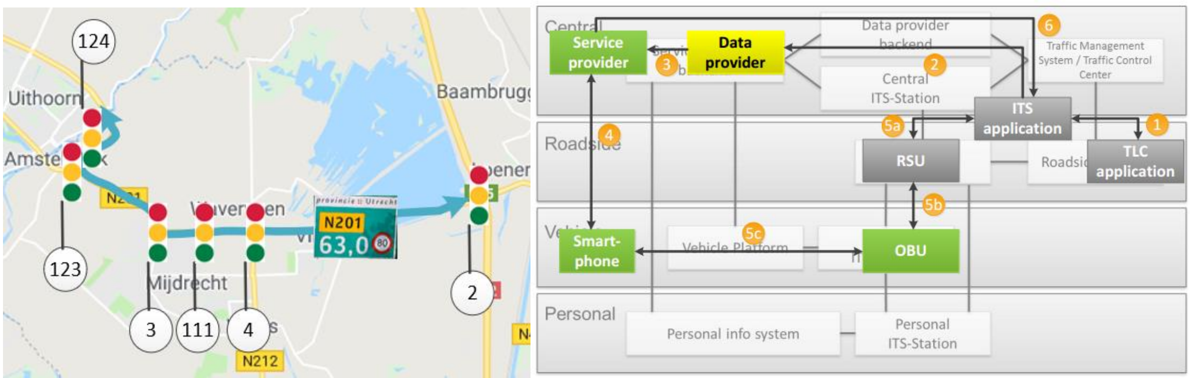

Figure 55: System architecture use case balanced priority for dedicated vehicles

5.4 Vehicle fleet

The following table gives an overview of the vehicle fleet in the pilots in the Netherlands.

Table 6: Overview of the vehicle fleet in the Netherlands

Use case	Communication technology	# vehicles	Comments
RWW	ITS-G5	15	11 Rijkswaterstaat company cars 2 Rijkswaterstaat road inspector cars 2 cars from a Rijkswaterstaat subcontractor
	Cellular	15 + # downloads > 1 mln	11 Rijkswaterstaat company cars # downloads of the publicly available app > 1 million
IVS	ITS-G5	15	11 Rijkswaterstaat company cars 2 Rijkswaterstaat road inspector cars 2 cars from a Rijkswaterstaat subcontractor
	Cellular	15 + # downloads > 1 mln	11 Rijkswaterstaat company cars # downloads of the publicly available app > 1 million
PVD	ITS-G5	15	11 Rijkswaterstaat company cars 2 Rijkswaterstaat road inspector cars 2 cars from a Rijkswaterstaat subcontractor
GLOSA	ITS-G5 Cellular	50	50 heavy vehicles and emergency vehicles
Truck Parking	Cellular	~800.000 heavy vehicles	publicly available app
MCTO	Cellular	>100 heavy vehicles	5 transport companies involved, together holding more than 100 heavy vehicles
Tunnel logistics	Cellular	20	1200 movements during the evaluation period

6 Pilot operation in the United Kingdom

6.1 Location of pilot site(s)

Geographical site descriptions

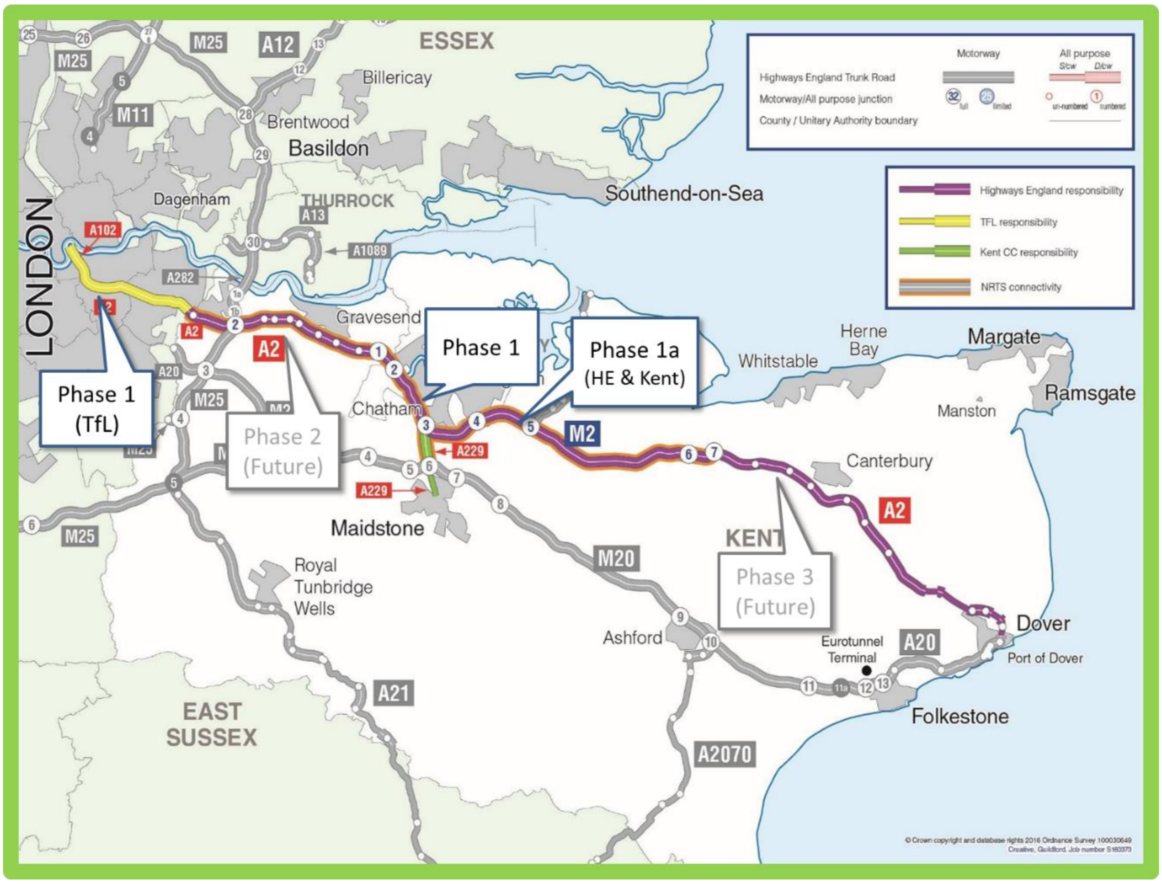

Figure 56: Overview of UK pilot site

The active sites are being deployed in phases between October 2018 and June 2019 and are split between short range (ITS-G5), long range (Cellular) and a combination of both (Hybrid).

The UK will pilot four services:

- In-Vehicle Signage
- Road Works Warning
- Green Light Optimised Speed Advice
- Probe Vehicle Data.

Where applicable the service will be displayed to the driver using suitable on-board units with dashboard mounted HMI displays.

In-vehicle signage

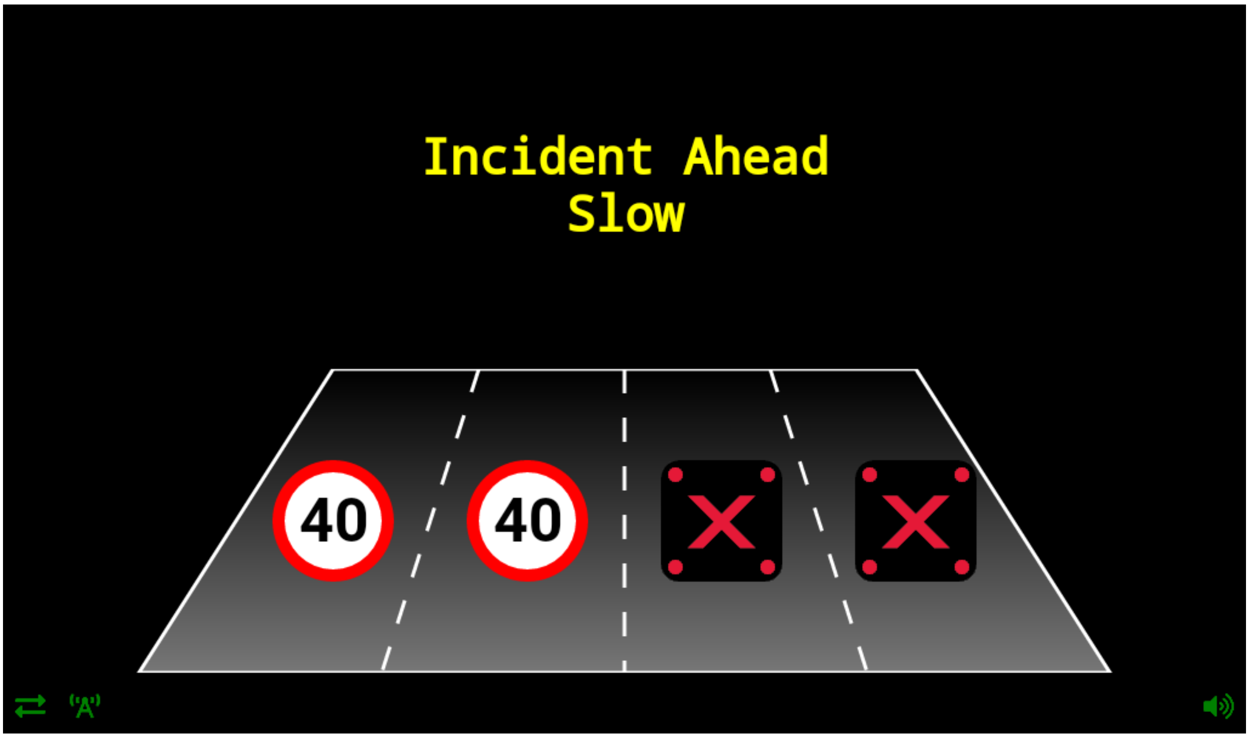

Figure 57: IVS – UK HMI driver display example

Road Works Warning

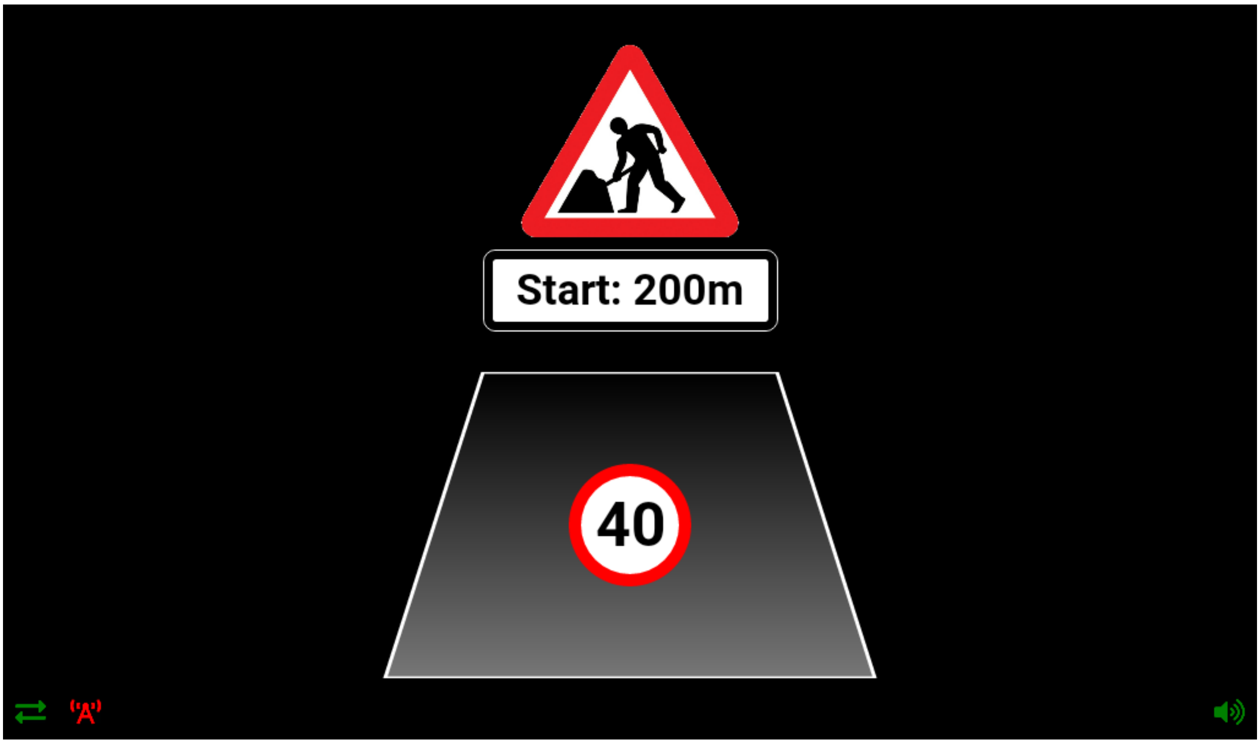

Figure 58: RWW – UK HMI driver display example

Green Light Optimised Speed Advice

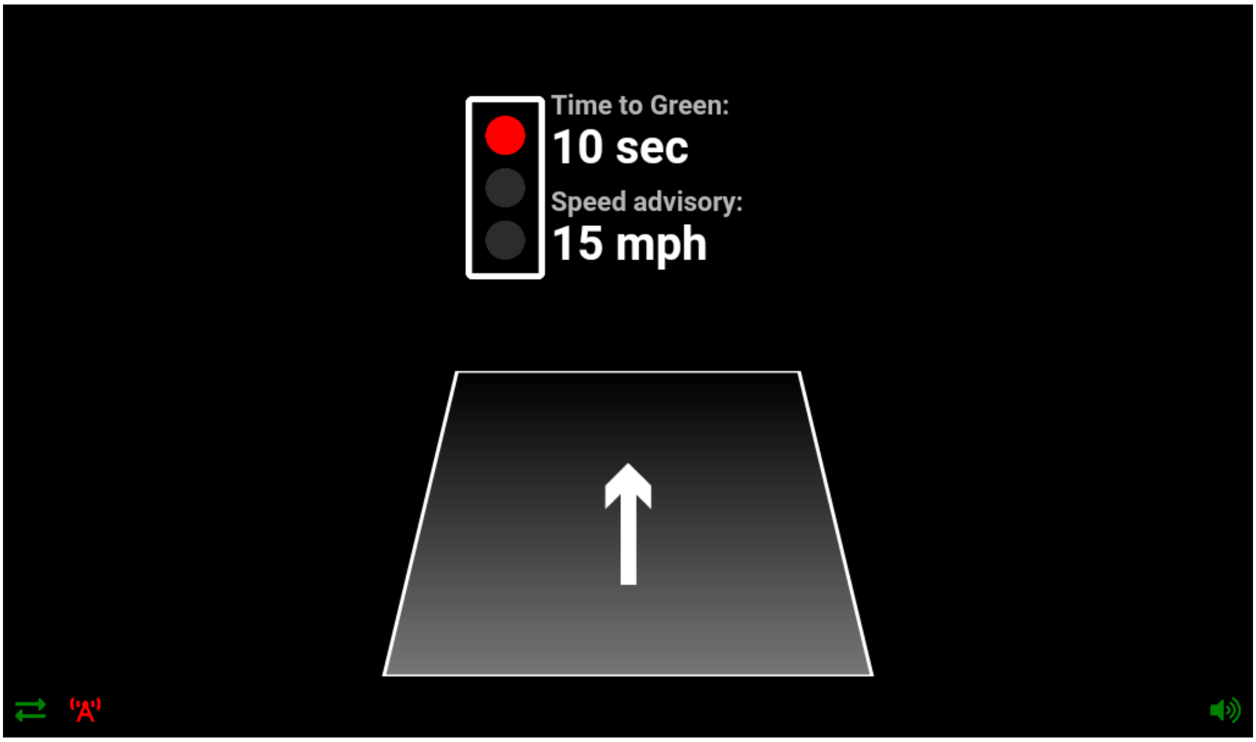

Figure 59: GLOSA – UK HMI driver display example

6.1.1 ITS-G5 sites

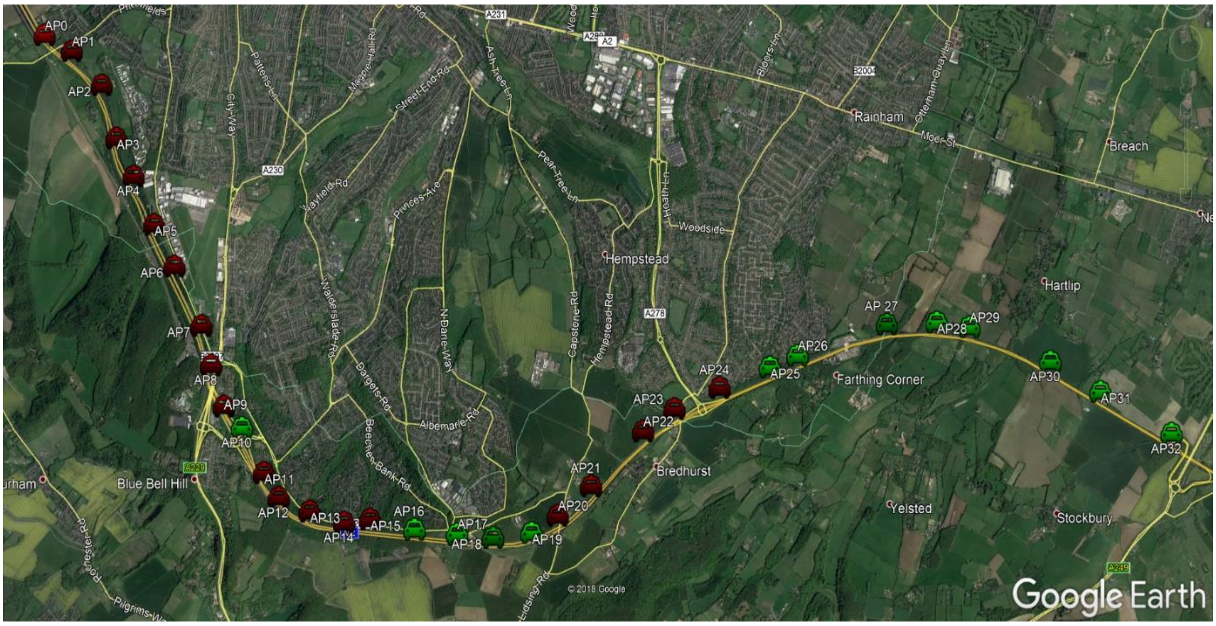

Figure 60: Short range deployment A2 M2 (Key: Green RSU = with Maintenance Access Area, Red RSU = no Maintenance Access Area)

Figure 61: Short Range Deployment on A2 M2 of 32 ITS-G5 Roadside Units

6.1.2 ITS-G5 rural GLOSA site

The rural test site is located at Junction 6 of the M20 which connects the M20 to the A229.

Figure 62: Short range deployment A229 – Kent GLOSA site

6.1.3 Hybrid Deployment

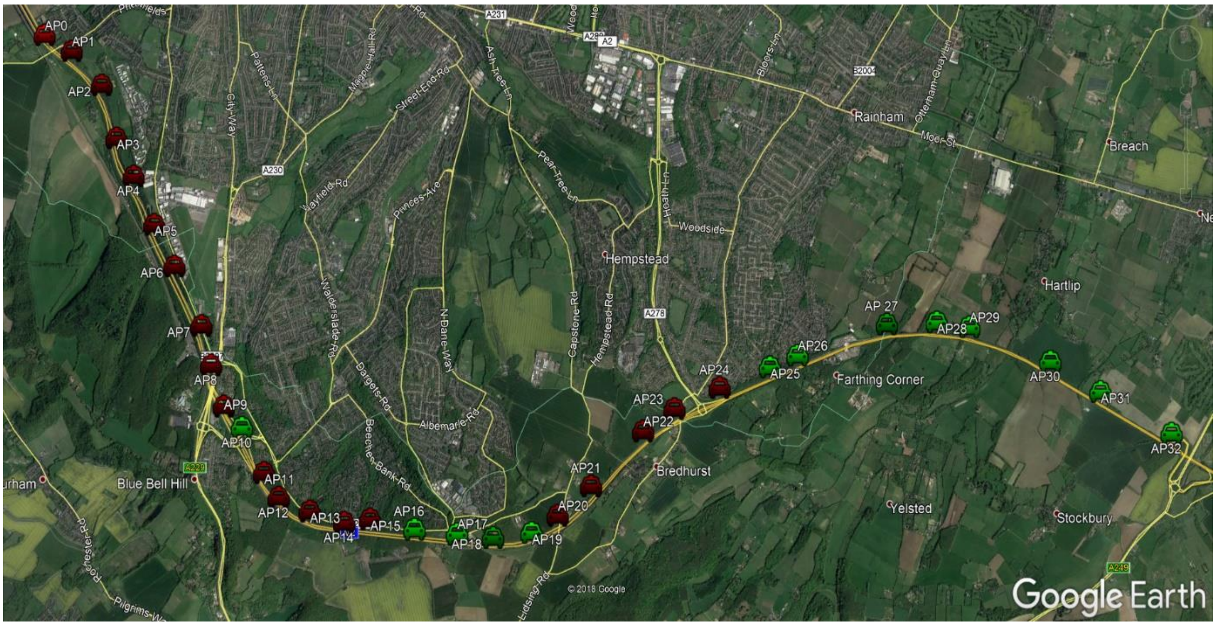

Figure 63: Hybrid Deployment (ITS-G5 and Cellular) - A2 M2 Corridor

Hybrid coverage (both cellular and ITSG5) will be at the same locations along the M2 (cellular coverage matches roadside unit ITSG5 coverage as above) so that comparison and evaluation between cellular and ITS-G5 can take place.

6.1.4 Urban Cellular Deployment (A2 and A102)

Transport for London (TfL) is deploying cellular only services for GLOSA, IVS and RWW. No additional road-side infrastructure has been installed for the pilot. Figure 11 below indicates the area of coverage of each service.

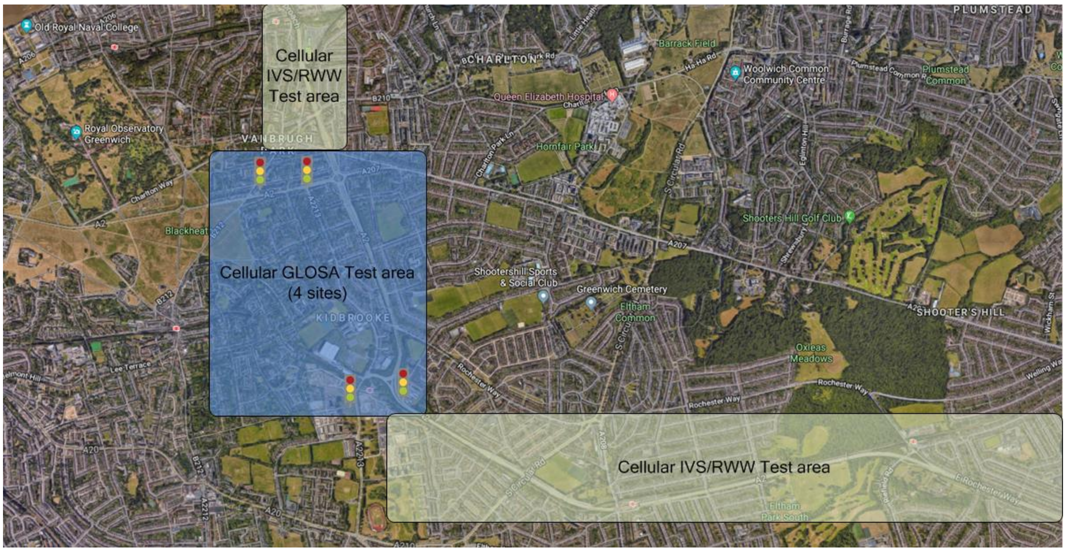

Figure 64: Urban Cellular Deployment overview - A2 and A102 Transport for London area

The area of coverage of each service is determined by the location of the on-street assets that are associated with the service. For instance, GLOSA will operate at four signal controlled junctions: one on the A2 Rochester Relief Road / Kidbrooke Park Road junction and three on the A2 Shooters Hill (see figure below).

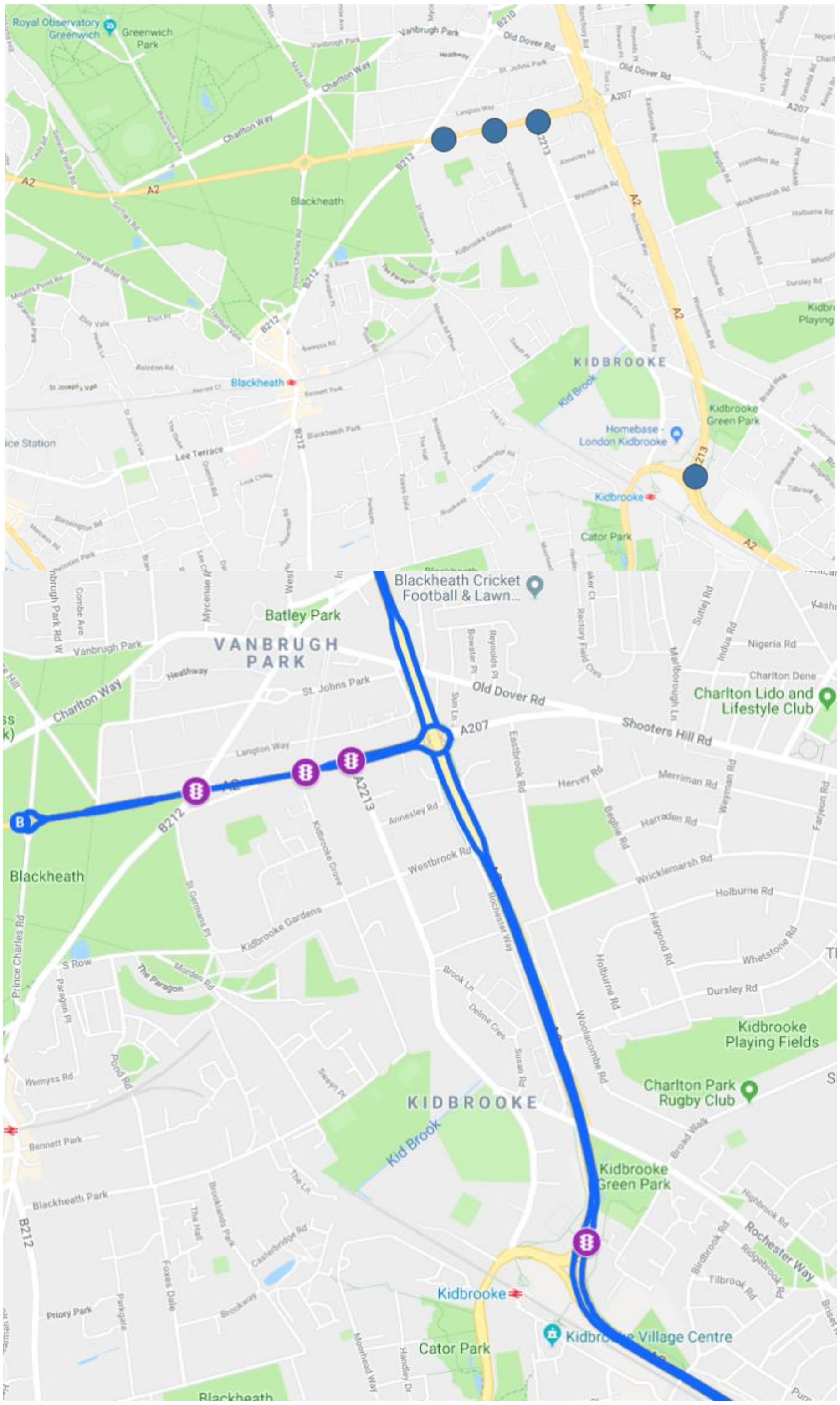

Figure 65: Urban Cellular Deployment – A2 specific GLOSA test sites

The blue dots on the map indicate the location of the GLOSA sites.

The IVS and RWW services will operational at locations where there are variable message signs and lane control gantry signs on the A2 and A102. The lane control gantry signs are used for general lane control including lane closures and temporary speed restrictions, and they are also used to manage traffic approaching the Eltham Tunnel on the A2, and on the A102 northbound carriageway to manage traffic that is approaching the Blackwall Tunnel from the south.

IVS and RWW service information will be derived from TfL's back-office VMS and tunnel control systems. SPAT messages for TfL's cellular GLOSA service will be derived from TfL's Urban Traffic Control System (UTC), which controls and coordinates approximately 4,500 of London's 6,000 sets of traffic signals.

The figure below provides the location of each on-street asset that is associated with the GLOSA, IVS and RWW services, and it indicates the current extent of TfL's C-ITS test bed.

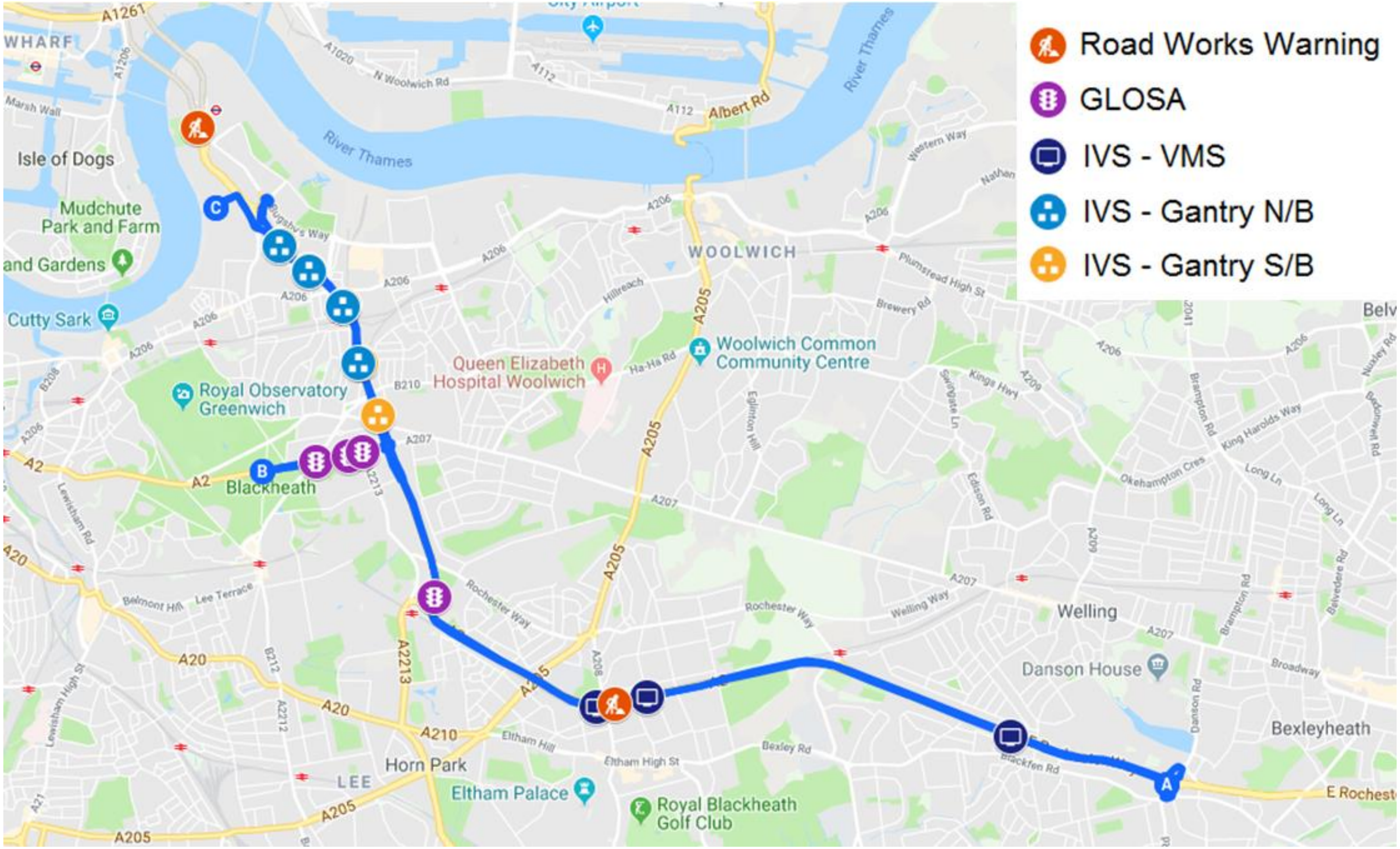

Figure 66: Extent of TfL's C-ITS test bed

<u>TfL GLOSA Service</u>:

TfL's cellular only GLOSA service has been configured to operate at the locations on the A2 as follows below:

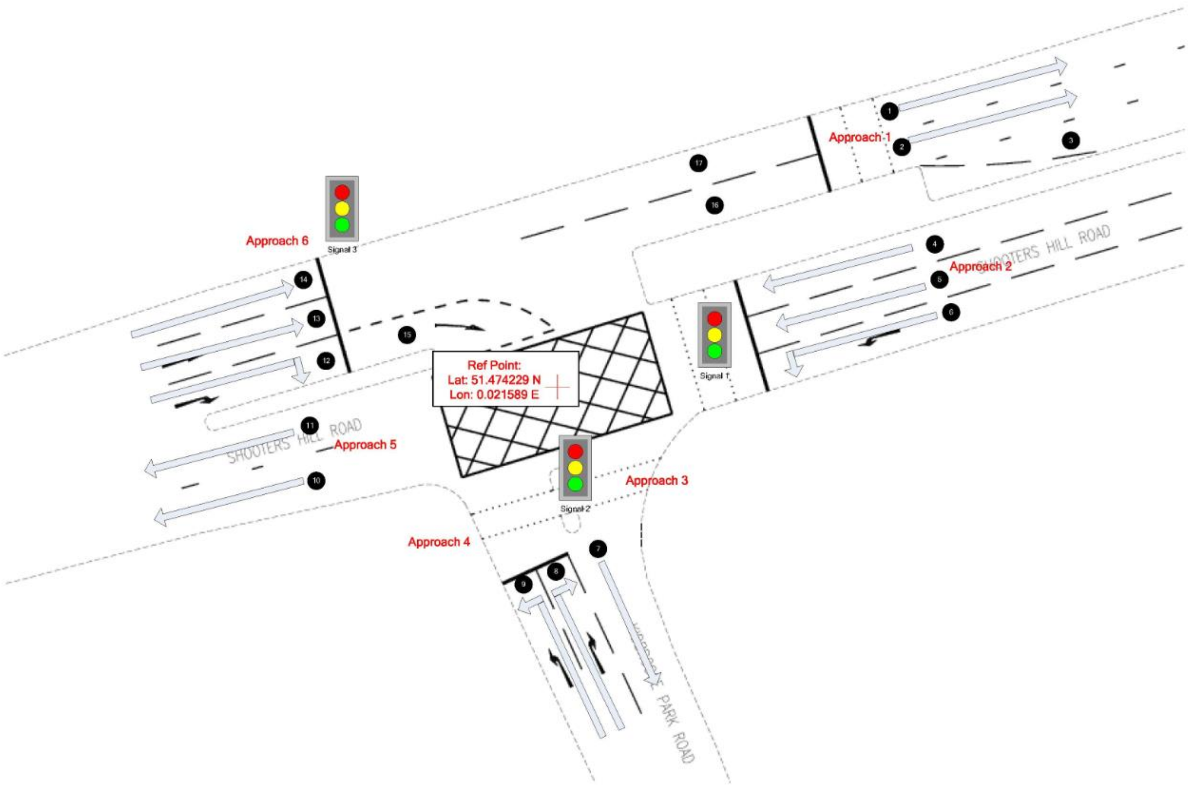

Figure 67: A2 Shooters Hill / Kidbrooke Park Road (site reference 06/021)

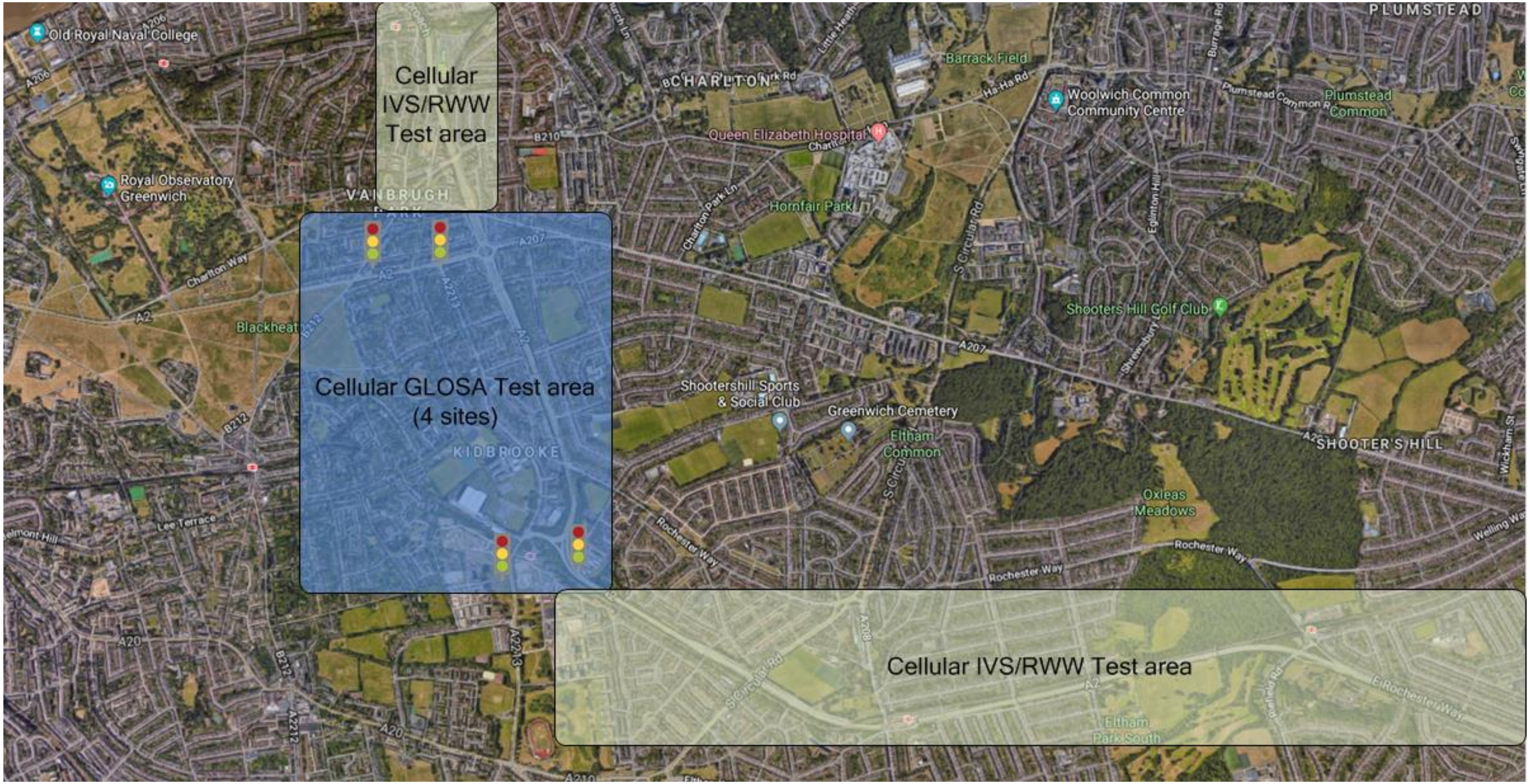

Figure 68: A2 Shooters Hill – Pedestrian Crossing (site reference 06/163)

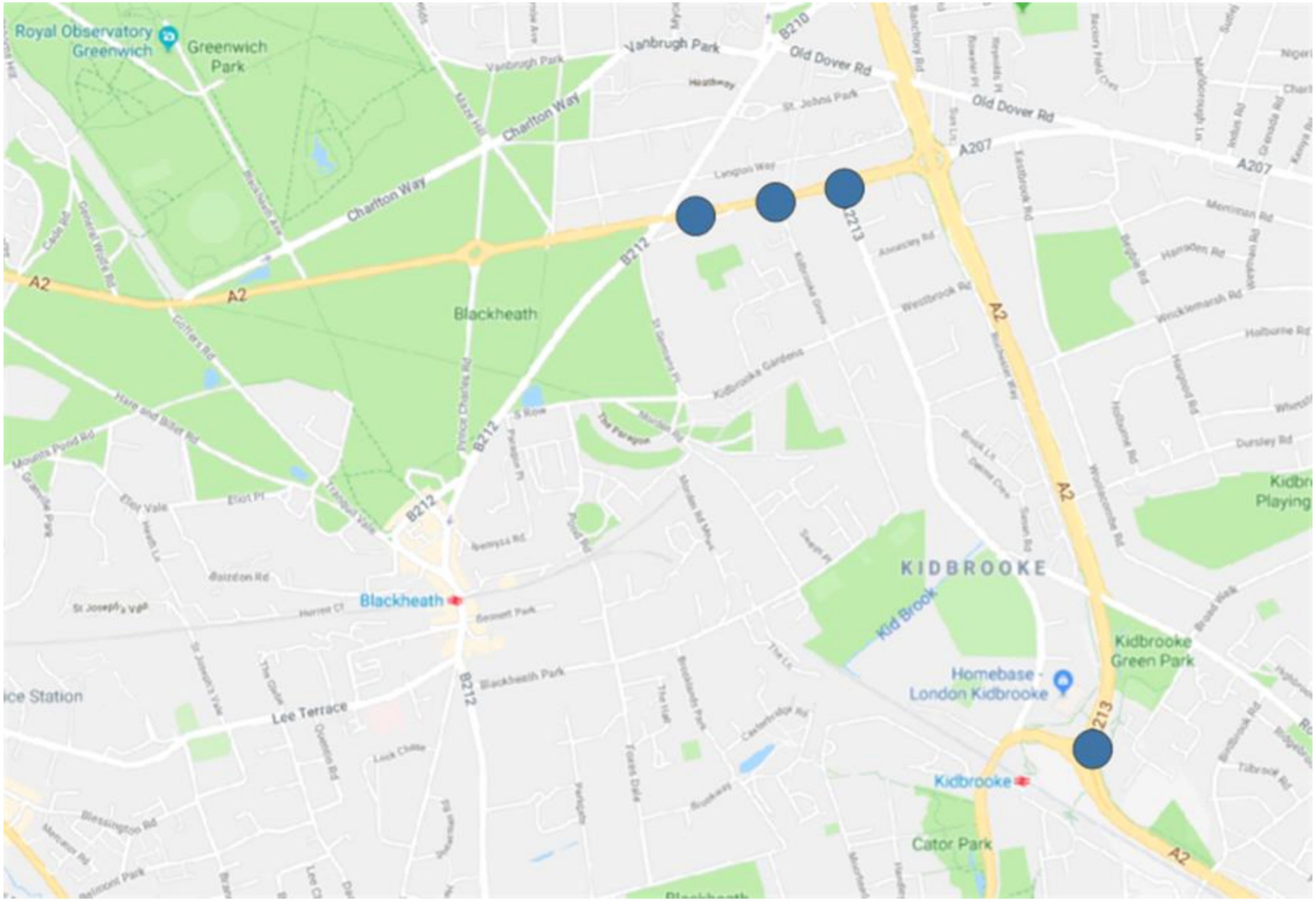

Figure 69: A2 Shooters Hill / Strathenden Road (junction reference 06/001)

TfL’s Urban Traffic Control (UTC) system, which controls and coordinates approximately 4,500 of London's 6000 sets of traffic signals, employs a SCOOT (Split, Cycle Offset, Optimisation Technique) algorithm that dynamically adjusts the signal timings at groups of traffic signals in real-time, according to traffic demand, in order to minimise vehicular stops and delay. This mode of dynamic signal operation is employed at TfL’s four GLOSA test bed sites on the A2, and it should therefore provide an interesting environment in which to test and evaluate GLOSA operation.

Site 06/091 is a simple two stage signal controlled junction on the A2 Rochester Way Relief Road, which is 50mph dual carriageway. This junction will be used for the initial technical evaluation of the GLOSA service under SCOOT UTC control.

Junctions 06/001, 06/021 and 06/263 are located in close proximity to one another on the A2 Shooters Hill Road, on a corridor that is prone to exit blocking during peak periods and where there are more complex traffic movements than 06/091. These junctions therefore offer a more challenging operational environment, where dynamic SCOOT UTC control is also combined with bus priority (BP) is also employed. Under appropriate network conditions, to aid efficient bus movements BP is able to rapidly curtail green signal phases on some approaches and to ’hurry call’ other green phases where there are buses.

This combination of sites and modes of signal control will therefore enable us to better understand the performance and operational limitations of the pilot cellular GLOSA service under a variety of network conditions that are often experienced in congested urban areas of London.

UK System Architecture Diagram

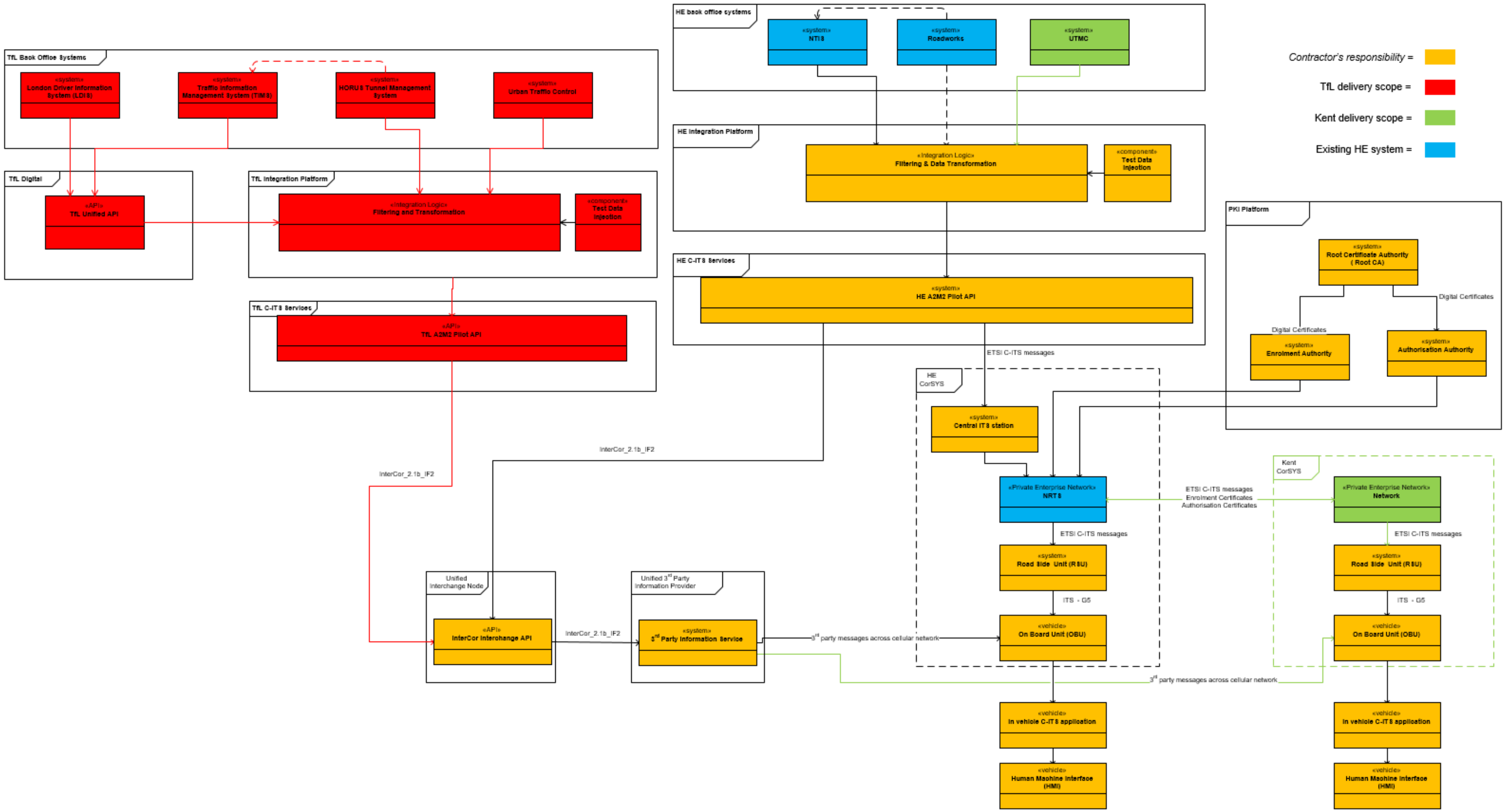

Figure 70: UK System Architecture Diagram

6.2 Services deployed

The table below sets out the services being deployed, supported use cases, expected date of deployments, and the communication type (ITS-G5 and/or cellular) used for service delivery.

Table 7: UK use case table

Service	Use Case	United Kingdom	Expected Start date (Pilot implementation plans)	Comments/Issues
RWW	Lane closure or other restrictions	Yes – ITS-G5 & Cellular	ITS-G5: 3rd June 2019 Cellular: 3rd June 2019	Note: At the time of this report the dates in May and June are programme dates and might be subject to change
	Alert planned closure of a road or carriageway	Yes – ITS-G5 & Cellular	ITS-G5: 3rd June 2019 Cellular: 3rd June 2019	
	Winter maintenance – Salting in Progress	Yes – this information will be provided by the Road Operator's back office, not a vehicle equipped with a beacon	ITS-G5 – 13th May 2019 Cellular – 13th May 2019	
IVS	In-vehicle signage dynamic speed limit information	Yes – ITS-G5 & Cellular	ITS-G5: 3rd June 2019 Cellular: 3rd June 2019	
	In-vehicle signage embedded VMS	Yes – ITS-G5 & Cellular	ITS-G5: 13th May 2019 Cellular: 13th May 2019	
	Dynamic Lane Management – Lane Status Information	Yes – ITS-G5 & Cellular	ITS-G5: 3rd June 2019 Cellular: 3rd June 2019	
PVD	Traffic Data Collection	Yes – ITS-G5 & Cellular	ITS-G5: 13th May 2019 Cellular: 13th May 2019	
GLOSA	Time to green information and speed advice	Yes – ITS-G5 & Cellular	ITS-G5: 18th March 2019 Cellular: 18th March 2019	
	Time to red information and speed advice	Yes – ITS-G5 & Cellular	ITS-G5: 18th March 2019 Cellular: 18th March 2019	

6.3 Vehicle fleet

The main body of the vehicle fleet used for evaluation is made up of Kent County Council works vehicles that use the routes regularly and can also be called upon for randomised controlled testing as per the evaluation detailed methodology. This will start with 6 vehicles and increase to between 30 and 50 vehicles in line with the phasing of the pilot.

6.4 IF2

The UK does not have a national data centre for real-time traffic systems data. Therefore, C-ITS service data from the UK highway authorities that are participating in InterCor (TfL, HE and KCC) will be integrated at a Unified Interchange Node (UIN) which is being developed specifically for the InterCor project (see UK System Architecture diagram above). To enable the C-ITS services to be internationally interoperable and to enable provision of the UK's cellular C-ITS services, the interface between each highway authority's C-ITS Services API and the UIN, and between the UIN and third party service providers will comply with Interface 2 (IF2) as defined (InterCor_2.1b_IF2_specs-v1.0 final) (in document 'InterCor Milestone 4 - Common set of upgraded specification for Hybrid communication' - sub-activity 2.1b). The ITS-G5 interface between vehicles and road side systems will comply with Interface 1 (IF1) as defined by sub-activity 2.1a. In alignment with the requirements of 'InterCor Milestone 4 - Common set of upgraded specification for Hybrid communication', IF2 has been secured such that only authorized users and systems can connect. The security controls and features that have been implemented for IF2 are as follows:

- Data in transit is secured using the TLS protocol.
- IP whitelisting is enabled for all connections to the UIN from the internet. Internal/trusted connections between the UIN and other back office systems are not subject to IP whitelisting.
- AMQP PLAIN authentication (username/password) is required for users and systems to establish a connection with the UIN.

- The UIN InterCor IF2 AMQP broker is payload agnostic
- It is the responsibility of the C-ITS service to publish the payloads in conformance to ETSI message specifications

6.5 PKI

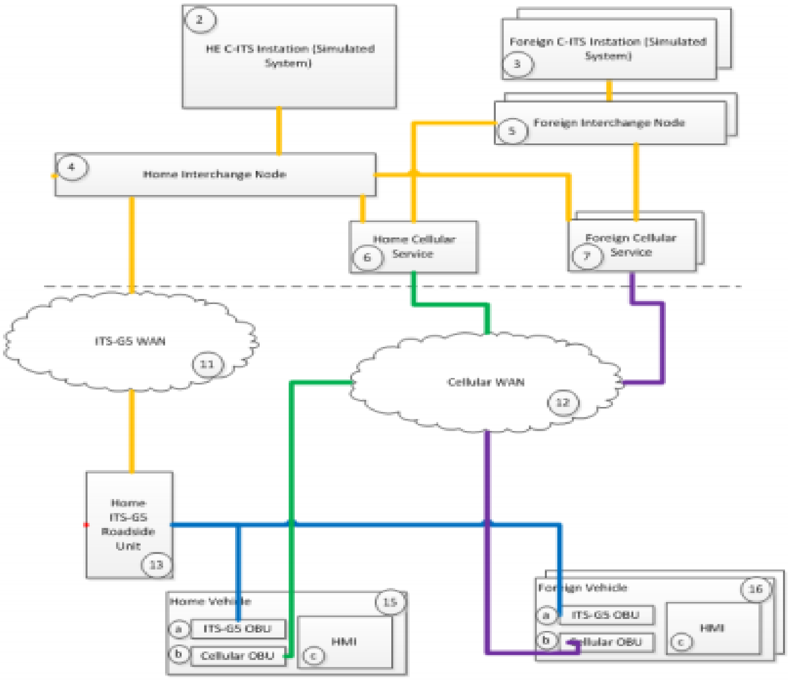

Figure 71: UK PKI architecture

UK has a preference to implement its own ITS-G5 PKI service, contracted out to a PKI service provider.
Certificates will be valid only for the duration of the chosen testing.
The UK will:

- Establish a RootCA – enabling the UK to share the RootCA certificate with the CTL, so that UK messages can be verified by other member states.
- Produce Authorisation Tickets – Certificates (signed by the UK RootCA) will be provided to each UK C-ITS station.
- Certificates will be compliant with ETSI TS 103 097 v1.2.1.
- All certificates will be manually installed.
- The same (static) certificate will be installed.
- Procurement of the PKI service is on-going.
- Feasibility and scoping of the PKI functionality to access the Common CTL is on-going.

7 Bibliography

InterCor Milestone 3 report: “Milestone 3 – Common set of upgraded specifications for ITS-G5”, V1.1, 20/10/2017

InterCor Milestone 4 report: “Milestone 4 – Common set of upgraded specifications for Hybrid communication”, V1.0, 23/03/2018

InterCor Milestone 5 report: “Milestone 5 – Common set of upgraded specifications for PKI and Common Certificate Policy (CP)”, V1.0, 24/09/2018

InterCor Milestone 6 report: “Milestone 6 – Common set of upgraded specifications for Services”, V1.0, 15/10/2018