InterCor Partners

TESTFEST EVALUATION PLAN

Intercor UK Interoperability

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ABBREVIATIONS

CU	Central Unit
DENM	Decentralized Environmental Notification Messages
DfT	Department for Transport
ETSI	European Telecommunications Standards Institute
FESTA	Methodology for European Field Operational Tests
GLOSA	Green Light Optimal Speed Advisory
ICMP	Internet Control Message Protocol
IVI	In-Vehicle Infotainment
IVS	In Vehicle Signage
KCC	Kent County Council
KPI	Key Performance Indicator
MDR	Message Delivery Ratio
NAR	Neighbourhood Awareness Ratio
OBU	Onboard Units
PDR	Packet delivery ratio
PVD	Probe Vehicle Data
R-ITS-S	Roadside ITS Station
RQ	Research Question
RSU	Roadside Units
RSSNR	Received Signal, Signal to Noise Ratio
RWW	Road Works Warning
SPAT	Signal Phase & Timing
TFL	Transport for London
TMC	Traffic Management Centre
UIN	Unified Interchange Node

SCOPE OF DOCUMENT

This document will provide the Evaluation Plan for the InterCor Hybrid Testfest to be held in Kent, England between 8th – 12th October.

The Evaluation Plan will define the facilities designed for the collection and evaluation of data up to, during and immediately following InterCor Hybrid Testfest. The Evaluation Plan will define the evaluation data and describe how it will be collected. It will also describe some details of the operational requirement where it adds to the overall operational plan for Testfest. For example, manual collection of data from Onboard Units (OBUs) at the end of each day.

The Evaluation Consultant will carry out the evaluation in accordance with the Evaluation Plan. The facilities are described by the Operational Plan and participate facing Plan of Action. Detailed Requirements for participant technology is described by the Baseline Specification.

The Evaluation Plan will include requirements for specific provisions to be made to acquire the right data, and of the right quality.

Figure 1 illustrates where this Evaluation Plan sits in relation to documentation supporting the InterCor Hybrid Testfest.

The focus of the evaluation for the UK Testfest will be to contribute to the development of the Hybrid and Cross Border interoperability specifications.

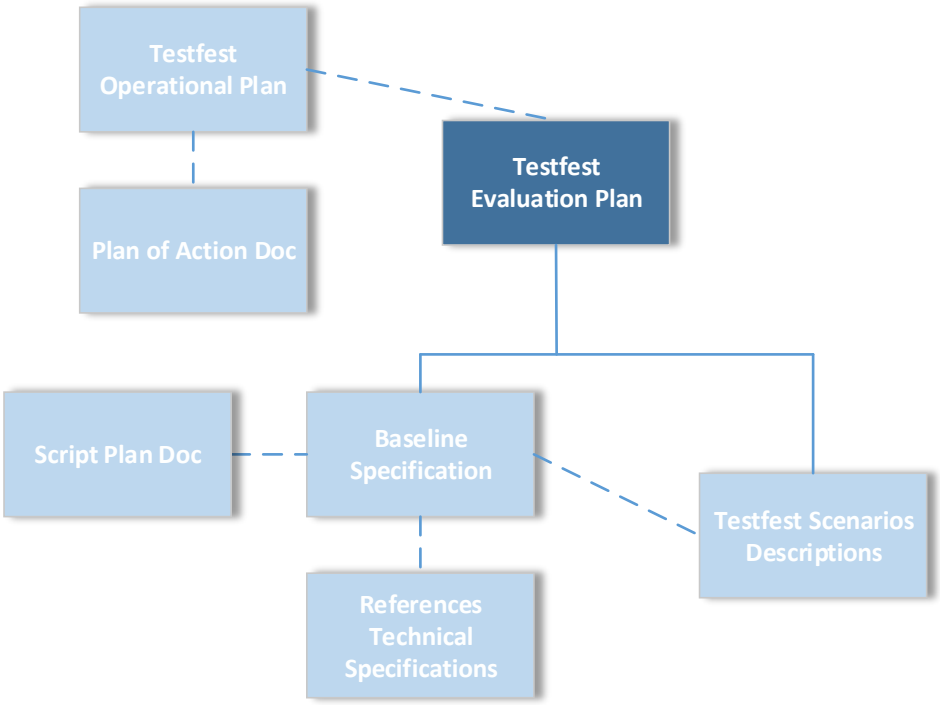

Figure 1 - Document Structure

1 INTRODUCTION

1.1 BACKGROUND

The UK Department for Transport (DfT) and its UK partners Highways England (HE), Transport for London(TfL), and Kent County Council (KCC); have made a commitment to the EU to deliver a UK based Connected Intelligent Transport Systems (C-ITS) technical testing event, in October 2018. The event forms part of the InterCor (Interoperable Corridors) project, co-financed by the EU. InterCor consists of a number of C-ITS corridor initiatives in the Netherlands, France, the United Kingdom and Belgium. InterCor's aim is to achieve a sustainable network of continuous C-ITS corridors that serve as a testbed for Day-One C-ITS service development and beyond.

To enable practical rollout of interoperable C-ITS services, technical specifications have to be validated in broader contexts. For this reason, InterCor partners have each been tasked with implementing specific technical testing events, called "Testfests". Testfests will contribute to the harmonised deployment of specifications of C-ITS services and connected corridors.

For its part, the UK InterCor Testfest requires UK partners to validate a set of specifications for hybrid communications for C-ITS services, utilising a combination of cellular and ITS-G5 communication. The event will also provide the basic infrastructure and selected Amsterdam Day One services to enable C-ITS vendors to test and verify the interoperability of their products, across borders.

1.2 INTERCOR OBJECTIVES

As part of the InterCor project a variety of C-ITS are being tested across corridor projects the Netherlands, Belgium, France and the United Kingdom. Common objectives for all participating Member States can be summarised below:

1. Demonstrating large-scale interoperable deployment of C-ITS;

2. Demonstrating cross border interoperability;

3. Providing C-ITS services on a broader scale by hybrid communication;

4. Extending the strategic cooperation between C-ITS front running countries and assisting other Member states to step-in;

5. Evaluating the life benefits of C-ITS applications by reports on technical evaluation, impact assessment and user acceptance;

These objectives provide the focus for pilot preparation, pilot design and evaluation, from top level to the formulation of scenarios, research questions, hypotheses and pilot design.

1.3 CRITICAL SUCCESS FACTORS

The InterCor Hybrid Testfest has ten objectives that contribute to the InterCor project and partnership working between Kent, DfT, TFL and Highways England.

Output to meet these objectives is required during the Testfest event or soon after by 22nd November 2018

- Test Vehicle-to-Infrastructure ITS-G5 and Cellular communications, by providing a UK "Hybrid Testfest".
- Test four different services Green Light Optimal Speed Advisory (GLOSA), In Vehicle Signage (IVS), Road Works Warning (RWW) and Probe Vehicle Data (PVD) using ITS-G5 communications.
- Test three different services (GLOSA, IVS and RWW) using cellular communications and the InterCor IF2 protocol.

Use both real and simulated service information distributed directly into vehicles and collected from participating fleet vehicles (i.e. Cooperative Awareness Message (CAM) and PVD).

- Investigate and assess the performance of the communication technologies.
- Investigate and assess interoperability issues between different InterCor member states.
- Utilise the findings of the evaluation to input into the redevelopment of the service profiles and technical specifications.
- Inform the main A2M2 pilot and other / subsequent Testfests.
- Support the European harmonisation of C-ITS technology.
- Promote the UK as market leader in Connected and Autonomous Vehicles (CAV) and C-ITS technology and services

1.4 OBJECTIVES OF THE EVALUATION

The InterCor Hybrid Testfest will investigate the technical aspects of hybrid interoperability. Hybrid includes interoperability between ITS-G5 and cellular communications. It also includes interoperability across country borders. This means that the evaluation plan, data collection and reporting for InterCor Hybrid Testfest will be focussed on technology.

The Evaluation Plan focusses on findings from the critical success factors that provide input into the redevelopment of the service profiles and technical specifications particularly the use of IF2 for interoperability (see section 4.5).

The evaluation will include tests that align with a subset of the technical Research Questions (RQ's) defined in "Detailed Evaluation Methodology[i]"

The evaluation will also collect data from the components of the system to provide a log of the Testfest event assisting with identifying how well the system worked. The logging format[ii] is strictly defined to allow Testfests and pilots from the partner states to be compared and evaluated together.

1.5 RESEARCH QUESTIONS

Research questions are in the process of being defined for User Perception, Traffic Impact and Technology. The Technology research question have been used as a guide to develop the tests to be performed on the Testfest facility. The current (July 2018) list of Technology RQs is listed below. Reference is made to the source of the tests requirement in this Evaluation Plan.

Figure 2 - Testfest Research Questions

The tests and data to be collected in the InterCor Hybrid Testfest are explained in section 2 and tabulated in appendix A.

2 INTERCOR HYBRID TESTFEST FACILITIES

2.1 INTRODUCTION

The facilities created for the InterCor Hybrid Testfest are outlined in the table below. The detail of the facilities is contained in various related documents.

Facility	Detail
A Test Centre at which to hold meetings, park vehicles, obtain refreshments and communicate test instructions.	Testfest Action Plan
A similar physical Test Centre in London to help facilitate the Urban test scenarios hosted by TfL (Transport for London).	Testfest Action Plan
An organised event for InterCor partners and other parties including six UK provided OBUs offering the opportunity to collect up to 17 hours of data in controlled conditions.	Testfest Action Plan
A deployed C-ITS system meeting defined specifications providing European Telecommunications Standards Institute (ETSI) messages to simulate C-ITS services.	Baseline Specifications
Four test areas each with a different focus within the Evaluation.	Scenario Plans
A fifth test area within the Test Centre for establishing communications before entering the public road system	Scenario Plans
Four Use Cases for C-ITS services taken as a subset from the UKs InterCor Pilot Operations set of use cases.	Scenario Plans
A set of Scenarios designed to provide a platform for the four use cases.	Scenario Plans
A repository for collected logs in the common logging format.	Baseline Specification
Visualisation tools to help understand the success of use cases during Testfest week.	To Be Defined

Table 1 - Testfest Facilities

2.2 TEST AREAS

For clarity the five test areas are:

1. Hybrid served motorway area (ITS-G5 and Cellular),
2. Cellular served GLOSA Junctions, urban IVS and RWW area (TfL),
3. Cellular served Cross Border route,
4. ITS-G5 GLOSA site,
5. ITS-G5 RSU located at the Test Centre for establishing communications.

2.3 USE CASES

The following table shows the Use Cases to be evaluated during Testfest.

Service	Use Case	Communications
RWW	Lane closure or other restrictions.	ITS-G5 & Cellular
IVS	In-vehicle signs Dynamic speed limit information. Embedded VMS	ITS-G5 & Cellular
PVD	OBU generated data only over ITS-G5	ITS-G5
GLOSA	Time to Green information Speed advice. Time to Red (ITS-G5 only)	ITS-G5 & Cellular at separate sites.

Table 2 - Services for Evaluation (ITS-G5 & Cellular)

SCENARIOS

The six sites will offer a wide range of opportunities to test technical aspects of interoperability and hybrid as follows:

- Bench test - Local test (Test Centre) to establish communications,
- Baseline test - Basic ITS-G5 and cellular operation on live roads,
- GLOSA test - functional test of the London cellular GLOSA service,
- Interoperability tests - Testing of cross border operability,
- Hybrid tests - Testing of cross media operability on the M2 test site (Cell ITS-G5),
- GLOSA test - functional test of the Kent ITS-G5 GLOSA service,

The scenarios are designed to offer the full range of testing and measurement opportunities.

MESSAGING PROFILES

Message profiles are defined in the baseline specification to provide the above use cases integrated with the road locations defined by the Scenario Definition document.

3 APPROACH TO TESTING

3.1 TELECOMMUNICATIONS PERFORMANCE

The effect of the telecommunications layer is of interest in Testfest as it is fundamental to InterCor objectives for Hybrid interoperability. The Telecommunications layer is part of the core infrastructure and will be assessed at the time of commissioning and at least once during Testfest. Fundamental radio measurements of signal strength and noise measurements are proposed.

The absolute method of measuring telecommunications paths includes readings of transmitted power, received signal power and signal to noise ratio in each available channel. Readings are then taken along the route at 100-metre intervals.

For the purpose of Testfest, it suffices to make reference readings of Received Signal strength and Signal to Noise Ratio and make use of those readings in a relative capacity to help diagnose potential issues with poor performance. The method of calculation will differ between different C-ITS media however the result will be a few relatively easily obtained signal and noise metrics for cellular and 802.11p quality along the route. Both sets of measurement will entail a receiver (mobile phone or lap top) being driven through the test route and taking readings at intervals.

3.2 NETWORK PERFORMANCE

Any delay in delivery of messages is likely to be caused by re-tries in the network layer due to congestion or poor radio signal quality. The network layer can be considered part of the infrastructure and will be assessed at the time of commissioning and at least once during Testfest. For Testfest a relative measurement of the network delay is proposed by “pinging” an OBU at regular points on the test route from the location of the interchange node.

It is expected that the cellular solution will have an IP connection between the C-ITS service application and the OBU. A ping measurement will be made between these points to get an indication of packet loss providing a relative measurement of PDR (Packet Delivery Ratio).

Network delay cannot easily be measured for ITS-G5 which does not have an IP address structure and broadcasts messages without expectation of any response. It is expected that OBUs will respond to Internet Control Message Protocol (ICMP) requests as a supplement to the ITS-G5 protocols. This could provide an indication of network performance by measuring packet loss and a round trip delay time for a ping request.

3.3 APPLICATION PERFORMANCE

Application Message Performance

For the Testfest evaluation of Message Delivery Ratio (MDR) we will interrogate the message sent logs of the ITS-G5 system and the message received logs of a sample of vehicle systems.

The expectation is that messages will be re-transmitted by the ITS-G5 network to ensure that all vehicles entering the dissemination area will receive at least one message. It is therefore expected that the message delivery ratio will be 100%.

In this measurement all C-ITS messages will be extracted from logs from the back office, RSU and vehicle systems and treated as the same. (ie. Not categorised by message type.)

CELLULAR SERVICE

The cellular service will be developed as an end-to-end service. It can be assumed that messages from the Unified Interchange Node (UIN) will be guaranteed delivery. The method of achieving subscription to messages relevant to an OBU will vary depending on the service. Delays and mis-interpretation could occur due to:

- Method of calculating Area of Interest,
- Method and frequency of subscription/re-subscription,
- Granularity of location mapping,
- Method if any of dead reckoning future location,
- Interpretation of the ETSI message.

There are risks that differences in interpretation of data exchanged over Interface 2 (IF2) will result in different experiences of the use cases by vehicle drivers. The causes of such differences will form the basis of the test to be carried out during Testfest.

The Cellular service will send messages to vehicle systems based on their subscription and location. It is therefore expected that all subscribed vehicles will receive one message and possibly only one. Re-transmissions will occur if messages are not received. Therefore, there can be expected to be a PDR of one unless the subscription fails completely.

Failure could occur because of incorrectly locating the vehicle or communications failure caused by physical or atmospheric conditions.

Two location references will be relevant. GPS location and the Quadtree reference.

ITS-G5 SERVICE

ITS-G5 is an established application platform. Much of the interpretation requirement for the vehicle station is defined by the ETSI message content.

Delays and mis-interpretation could occur due to:

- Miss-interpretation of the ETSI message profile.

By taking measurements on the three main layers of the service, a picture for the relative performance of Hybrid services can be established.

There is no specific requirement to take detailed measurements of performance of the two media and much academic work has been done previously to compare the potential performance issues. It should be noted that there are more variables with the cellular service as it is a public service, however all radio systems are subject to performance variations. For the purposes of Testfest some simple metrics to be used in relative comparisons will suffice in any investigations into service performance issues.

There are more opportunities for the cellular service application to misinterpret the intention of a use case than there is with ITS-G5.

It is more complex to identify network delay issues such as packet loss with ITS-G5 due to its broadcast nature. Given the coverage provided at the Testfest Hybrid test site packet loss will only be investigated in the event that excessive ETSI message delay is encountered. An indication of network performance will be obtained by taking sample ping measurements.

PDR measures the radio network performance by lost packets. It is an underlying network performance measure useful as a measure of the quality of the C-ITS infrastructure but does not have direct bearing on the performance of the services unless it is so poor that the service fails. It will be measured as a post commissioning test. It will not be routinely measured in all vehicles taking part in Testfest.

It could be optionally recorded by Testfest participants interested in testing elements of their design such as antenna design.

RESULT LOGGING

The InterCor partners have agreed to log service activity using a common log format. Systems provided as part of the Testfest facility will log activity automatically. Where logs are not in the common log format they will be converted after Testfest.

Data logs for the delivery of an evaluation in compliance with InterCor data logging and communication requirements are:

1. for CAM, DENM and IVI in encoded (binary, xml) or decoded (csv, sql) formats.
2. The baseline specification will define example logs for the above messages.

InterCor partners attending the event with an OBU receiving messages from the system are required to contribute OBU logs in the common log format.

Each day a briefing will be held to communicate and agree any requested changes to the scheduled scenarios.

At the end of each day logs will be collected from each participating OBU either by transmission to a central file repository or by manual collection of free USB sticks.

At the end of each day a de-briefing will provide an opportunity to identify success and failures. This will be more successful if logs are available from previous tests so that effects can be shared and discussed. The success and failures may be used to influence the scripted scenarios for following tests periods. The experiences of the participants are essential to the overall success of the event because they will provide a diverse range of interpretations of the use cases. This will be the case especially where Interface 2 is being used for the first time to distribute services over multiple telecommunications networks and via multiple country service providers.

The following Test periods will be available for logging and results collection.

Monday am	IVI messages sent continuously over ITS-G5 and cellular located at the Test Centre for the purpose of establishing communications. Receipt and PVD data.
Monday pm	ITS-G5 and cellular IVI and RWW available on the Hybrid test area
Tuesday	As above with the addition of dynamic sign settings as described in the test scenario definitions
Tuesday	Embedded VMS and speed limits at the Cross-Border test area
Wednesday	Urban GLOSA, IVS and RWW scenarios in the London test area.
Thursday am	Rural GLOSA at the ITS-G5 GLOSA site.
Thursday pm	As Tuesday

Table 3 - Outline Programme of Testing

More detailed and up to date programming is contained in the Action Plan Document. Full details of the Scenarios are contained in the Scenario Definitions document.

4 EXPLANATION OF TESTS DURING UK INTERCOR TESTFEST

4.1 TELECOMMUNICATION TESTS.

ITS-G5 RADIO PERFORMANCE.

Ref RQ 1 - Test 1

For Testfest, the test area between Junction 2 and Junction 3 of the M2 has been equipped with ITS-G5 radio coverage. It has been designed for reliability of communications at the roadside within the constraints of physical construction processes. (environmental, geotechnical, special, structural communications and power supply constraints). The expectation is that full coverage is available over the test area. This means that measurement of radio performance is measured as a post commissioning baseline exercise rather than a variable within the Testfest activity. Measurement of the radio performance will also help inform future ITS-G5 designs.

One of the UK test fleet vehicles equipped with a Cohda OBU will be driven through the test area and the received signal strength as measured by the OBU logged and related to geographic location. This test will produce an easily repeatable test for evaluating potential signal issues throughout the service life of the test area. Measurements will also be made in the approach to the Kent ITS-G5 GLOSA site.

Signal strength and signal to noise measurements are recommended for the purpose of proving the design and providing a record of the baseline conditions for Testfest. These tests require specialist test equipment and 15-minute stops on the hard shoulder.

The output of these tests will be presented on a geographic map creating a visualisation of the quality of the G5 coverage.

CELLULAR RADIO PERFORMANCE

Ref RQ 1 - Test 2 &3

Clearly cellular coverage is not limited to the 4km Testfest hybrid test area 4km Hybrid test or a single radio path. In summary, cellular radio performance will be measured:

Along the A2 Junction 2 to Junction 3 hybrid test area,

Along the X-boundary test area,

Along the entire London GLOSA, IVS and RWW test area.

The inbuilt phone handset measurements used to manage cell handover will be used to collect radio coverage data. 4G communication performance will be measured using two basic parameters Reference Signal Received Power(RSRP) and Received Signal, Signal to Noise Ratio (RSSNR). These will be measured at 100m intervals (where possible using marker posts as a locator) as part of post commissioning baseline tests for the Testfest route and at least once during Testfest week. Each of the four main 4G providers signals will be measured.

- Vodaphone
- Three
- Telephonica
- EE

The measurements will be taken from four phones equipped with relevant sim cards. Measurements will be taken at 100m intervals along the cellular test areas.

The output of these tests will be presented on a geographic map creating a visualisation of the quality of the 4G coverage.

CELLULAR RELIABILITY

Ref RQ1 - Test 4 & 5

Cellular reliability will be measured as a function of location and of time of day. The assumption is that cellular messages may be delayed by cellular congestion depending on time of day. In urban areas congestion may also be related to location.

Although this is a telecommunications constraint it will be indicated by measuring relative ETSI message delay along the test routes at 1km intervals throughout an 8-hour day from 09:00 to 17:00.

Results will be tabulated and combined with results taken for each of the four main cellular providers.

X BOUNDARY TELECOMMUNICATIONS PERFORMANCE

Ref RQ 1 - Test 6 Test 7

A feature of the UK X Border test site is that there is no telecommunications border that coincides with the test border for C-ITS services. The telecoms performance will therefore not be affected by the border crossing.

4.2 NETWORK PERFORMANCE

ITS-G5 NETWORK PERFORMANCE

Reg RQ 1 - Test 8 & Test 9

The InterCor indicators for network performance are NAR (Neighbourhood Awareness Ratio) and PDR. NAR will not be measured during the InterCor Hybrid Testfest because it is a measure of the effect of data congestion in the 802.11p channels. Since the InterCor Hybrid Testfest has a high density of RSU and relatively few equipped vehicles, it is unlikely there will be any useful benefit from measuring NAR.

Packet loss and delay measurements will be taken during the event to inform the results of Testfest. PDR will be measured at the level of ICMP packet level (Internet Control Message Protocol). It should be noted that Testfest is using the public or private cellular network for backhaul between RSU and C-ITS Central Station. This may not be indicative of the design for Pilot Operations. The measurement of Packet loss will also provide a network delay measurement using ping over ICMP. The IP packet loss and delay will be used as an indication of ITS-G5 packet loss and delay.

A vehicle equipped with an OBU will be stopped at 100m intervals (each marker post) long enough for an IP connection to be established to the nearest RSU. Ping measurements (round trip delay and %age packet loss) will then be taken from IP addresses of the RSU and the Central Unit.

Measurements will be made along the length of the hybrid test area and the approach to the Kent GLOSA test site. Results will be presented on a geographic map creating a visualisation of the quality of the ITS-G5 network.

CELLULAR NETWORK PERFORMANCE BASELINE

Ref RQ1

Test 10

A measurement of network delay and packet loss will be taken at a time of low congestion across the IP connection between OBU and Central Unit. The cellular reliability data described above will be used as an indicator of where and when congestion may occur so that an indication of baseline network performance can be established.

Packet loss and delay will be measured using ping over ICMP (round trip delay and %age packet loss). A vehicle equipped with an OBU will be stopped at 100m intervals (each marker post) long enough for an IP connection to be established to the Central Unit.

MESSAGE DELIVERY ASSURANCE

Ref RQ1 - Test 11

To deliver C-ITS services, there is an assumption that network quality is sufficient to expect that every unique message (new trigger, update and cancelation) is received at least once in every vehicle in time to be displayed correctly to the driver. This will be measured by investigation of the logged messages along with time stamps and location to determine the delivery position of each message. The test is combined with a measure of application delivery performance to provide an overall assessment of the ability of the system to deliver every message via cellular.

ITS-G5 AND 4G COMPARISON

Test 12

Comparative performance between the two delivery technologies will be measured by the effect on the application messages. Both can be expected to deliver every message as described above but with variations in delay and retries. Relative delay will be measured from the logs as they step through the system. If a very broad assumption is made that the network overhead is similar for the two networks, bandwidth requirements will be similar for the two networks on the basis that the application data is the same. The Cellular path will have a higher overhead due to higher level communications systems and protocols used. It also requires more overhead to manage subscriptions at various stages of the system operation. Bandwidth is likely to be used on both systems where signal strength, congestion and noise create the need for transmission re-tries.

CELLULAR IN-FILL

Test 13

The expectation is that cellular communications will fill gaps in coverage where there is no coverage from ITS-G5. Variation in performance between areas served by Hybrid communications (both ITS-G5 and cellular) and areas covered only by cellular will be measured by comparing message delivery in the Hybrid test area and the Country B test area. It may also be possible to compare delivery with the hybrid area and the test area in London. There are no gaps in the ITS-G5 coverage within the Hybrid test area. For Test fest there is no facility to remotely switch off an RSU to artificially create a scenario where Cellular fills an ITS-G5 gap.

NETWORK AVAILABILITY

Test 14

The availability figure is calculated from network monitoring software between CU and RSU. It is possible that measurement software may not be continuously available at the InterCor Hybrid Testfest due to constraints on the available development time. During Testfest availability will be closely monitored by an on-site team to ensure that the test areas are available according to the published timetable. Availability may not therefore be indicative of real conditions.

HYBRID NETWORK COVERAGE

Test 15

Using data collected from previous tests a “heat map” will be created that shows the Hybrid coverage of all the test areas. It is expected that it will reveal that the hybrid area with both ITS-G5 and cellular coverage will show better coverage than areas with only one or the other.

Test 16

The heat map will reveal where congestion or geographic restrictions limit performance the alternative communication path improved the availability.

4.3 APPLICATION PERFORMANCE

SERVICE INTERPRETATION

Test 17 & Test 18

This test investigates any failure of Participants to receive the service as a result of differences in interpretation of messages, failure of service subscriptions or failure of IF2 between service providers. Failure will be indicated by an OBU of one design failing to receive a service where others of a different design or subscribed to a different service provider do receive the service. It may also be indicated where all OBUs fail to receive the service and there are no underlying network or telecommunications performance reasons.

Failure could also be indicated by part loss of service such as incorrect information in detection, awareness or relevance areas.

MESSAGE REPETITION

Test 19

The repetition rate of messages received via cellular and via ITS-G5 will be measured and compared with the design expectations. This will create statistics on communication frequency between CU and RSU taken from Script logs, OBU Logs, RSU logs.

MESSAGE DELAY

Test 20

Communication delays, transmission frequencies, network access, etc. result in communication delays, that affect updating of information to end user devices, and performance (delays) in the applications or HMI.

The delay (latency) for messages received via cellular and via ITS-G5 will be measured and compared with the design expectations. This will create statistics on application message delay between CU and RSU taken from Script logs, OBU Logs, RSU logs.

IF2 MESSAGE DELAY

Test 21

Similar to Test 18, but extended to measure delay from the script log to other service providers via Unified Interchange Node. End points will exist in, Country B; Country C and possibly other country users OBUs.

PKI SECURITY

Test 22

This will be limited to gathering information from Participants from Registration by a declaration of the state of their security implementation.

TIME SYNCHRONISATION STANDARDS

Test 23

This will be limited to gathering information from Participants from Registration by a declaration of the method of time synchronisation and how they have interpreted the log format requirement for time.

4.4 COUNTRY A / COUNTRY B/ COUNTRY C

The A2M2 Testfest location will split into two virtual countries, using defined lat / long coordinates. Using IF2, each Service Provider will route data from the relevant C-ITS service (UK or Country B) depending upon the subscriber's geographical location at the roadside, achieved by using GPS data obtained from the OBU. This meets the requirement for C-ITS services to be provided using your nation's Service Provider, wherever you are. Note this is an effective way of replicating the visionary requirement to use IF2 from Centre to Centre (be that Traffic Management Centre (TMC) to TMC, Data Provisioning to Data Provisioning, or Service Provider to Service Provider).

When each Service Provider recognises that the virtual border has been crossed it publishes data from the relevant C-ITS Service. For example, the Southern half of the A2M2, would be defined as 'Country B', the North as the UK. A UK subscriber in the North will receive UK C-ITS Services from the UK service provider. As the UK Subscriber crosses the border' he/she receives Country B C-ITS Services from the same UK service provider. The converse applies for a Country B Subscriber in the South. This meets the requirement for Interoperability, where geographically relevant C-ITS services are published from the relevant country, received by any subscriber.

To indicate that the 'border' has been crossed, UK subscribers will receive a 'Welcome to' IVS message from Country B C-ITS service via the UK Service Provider; Country B subscribers will receive an IVS message from the UK C-ITS service via the Country B Provider. This provides a simple visual indication that the source of the data has changed, even if the service provider has not. This supports the notion of testing the effectiveness of international data roaming and inter-country interoperability.

4.5 INTEROPERABILITY INTERFACE 2

The interchange node provides for the exchange of messages between C-ITS systems, 3rd party information providers and cellular delivery partners. As per InterCor specifications for IF2 communication v1.0, all data to and from the interchange node will be in IF2 format.

Subscribers will receive filtered messages based upon on geographical attribute and message type attributes, using a quad tree algorithm implemented as a routing key. Publishers and subscribers will be authorised to access the interchange node via the authentication, authorization, and accounting service (Microsoft Active Directory). Upon start-up/recovery, the node will not keep any data from its previous cycle; all publishers will update the interchange node with the latest situational data.

InterCor specifications for hybrid communication will be available for testing the data provisioning of the same SPATEM and MAPEM messages via InterCor interface IF2 to service providers.

Figure 3, taken from the InterCor Hybrid Communications Presentation, shows the link between the ITS-G5 (IF1) and cellular (IF3) interface with the Back Office (IF2 interface.

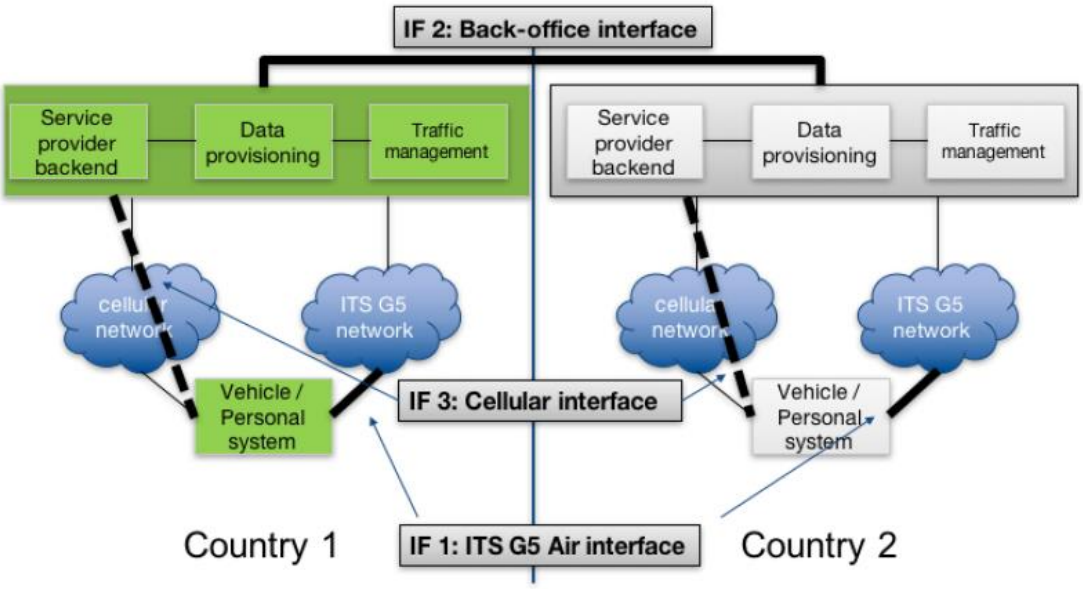

Figure 3 - IF2 (Country 1 / Country 2) Interface

Appendix A

LIST OF EVALUATION TESTS

No	Layer	Sub RQ	Metrics	Source of Data	Notes	Hypothesis
1	Telecommunications	What is the I2V ITS-G5 communication performance?	dBm	Spectrum signal receiver. Or measurement from OBU application.	Requires user story or hire of equipment.	Measure ITS-G5 communication performance for reception of road side information in vehicles.
2	Telecommunications	What is the I2V 4G communication performance?	dBm	Post commissioning tests	requires purchase of sims and phones	
3	Telecommunications	What is the I2V 4G communication performance?	dBm	Post commissioning tests	requires purchase of sims and phones	Measure 4G communication performance for reception of service information in vehicle devices.
4	Telecommunications	What is the 4G communication reliability	time of day - quarter hours & delay in seconds	Time of day delay in seconds		Communication frequency may be reduced by service provider or end user, such that information is lost or delayed
5	Telecommunications	What is the 4G communication reliability	Location in 100m quadtree zones & delay in seconds	Quadtree algorithm, GPS location, message receipt time, delay in seconds		vehicle devices experience reduced communication quality of service, or unavailability of services, over certain time periods or geographic areas, e.g. due to communication network overload, contracted service levels, network access.
6&7	Telecommunications	Can hybrid communication improve reliability of singular communication channels		cellular performance covered elsewhere		Cross-border communication issues in one communication channel can be mitigated via alternative channels.
8	Network	What is the I2V ITS-G5 communication performance?	Packet Delivery Ratio %	Post commissioning tests	In Testfest Telecommunications and Network performance measures no separate measure is made between the I2V and V2I performance. V2V us out of scope.	Measure ITS-G5 communication performance for reception of road side information in vehicles.
9	Network	What is the I2V ITS-G5 communication performance?	Round trip delay in msec.	Post commissioning tests	Test covers V2I and I2V	
10	Network	What is the I2V 4G communication performance?	Packet Delivery Ratio % and msec	Post commissioning tests		Baseline measure of Cellular network performance
11	Network	What is the I2V 4G communication performance?	Pass/Fail. Absolute GPS time.	Script logs, OBU Logs, Pass/Fail for each scripted scenario change.	Requires daily activity to collect logs and purchase of memory sticks.	Communication network and services quality is sufficient to the extent that every unique I2V message (new trigger, update and cancelation) can be received at least once by every vehicle device in or before the detection, awareness and relevance areas, or approach to an intersection.
12	Network	What is the I2V communication performance?	Absolute GPS time.	Script logs, OBU Logs		Compare ITS-G5 and 4G communication performance for reception in vehicle devices.
13	Network	What is the I2V communication performance?	% success rate	Script logs, OBU Logs		4G communication covers all areas between ITS-G5 RSUs.

14	Network	What is the V2I communication performance?	% availability	OBU logs, Back office logs, RSU logs		Compare communication performance for reception of vehicle information at the road side, central unit, service provider and traffic control centre.
15	Network	Can hybrid communication improve reliability of singular communication channels	Quadtree location zones, % coverage.	developed from collected results.		4G communication covers all areas between ITS-G5 RSUs.
16	Network	Can hybrid communication improve reliability of singular communication channels	% availability	developed from collected results.		Congestion problems in one communication channel can be mitigated via alternative communication channel(s).
17	Application	What is the I2V 4G communication performance?	Pass Fail, Scenario, Absolute time.	Script logs, OBU Logs, Delegate questionnaire.		End users, service or telecom providers may adapt communication or application settings causing loss of information in detection, awareness or relevance areas.
18	Application	To what extend is the 4G communication performance affected when crossing borders?	Origin country, Telecom provider, name of service.	Delegate questionnaire.	Ground truth for this is A2M2 OBUs. These will retain the same service and telecom provider throughout.	Communication performance may be affected when crossing the borders of countries or service providers, e.g. by differences in profiles (message contents and trigger conditions) and quality of service (e.g. network access, coverage, delay, data limits).
19	Application	How frequent is information updated?	Messages per second.	Script logs, OBU Logs, RSU logs.		Statistics on communication frequency between CU and RSU
20	Application	How does end-to-end delay vary with communication media?	Milliseconds, system node.	Script logs, OBU Logs, RSU logs.	This test is to identify variation caused by the subscription method of the service provider.	Communication delays, transmission frequencies, network access, etc. result in communication delays, that affect updating of information to end user devices, and performance (delays) in the applications or HMI
21	Application	How frequent is information updated?	Milliseconds, system node.	Script logs, OBU Logs, RSU logs.		Statistics on communication frequency between CU and RSU
22	Application	register which RSUs and OBUs have security enabled	Enumerated from the list, None; PKI security standard 1.2.1; PKI security standard 1.3.1.	Delegate Questionnaire.		Are messages PKI signed
23	Application	Register what time sync method the delegates expect to operate and compliance with the logging format.	Method statement.	Delegate Questionnaire.		End user devices, OBUs, RSU, and other servers / services are time synchronised (within specifications).

25	Physical	What is the I2V ITS-G5 communication performance?	Pass/Fail for each scenario set for each vehicle pass.	Download of OBU logs.	This is a test of RSU coverage. Anecdotal evidence from delegates will add evidence.	RSUs are deployed such that every unique I2V message (new trigger, update and cancelation) can be received at least once by every OBU while in or before the detection, awareness and relevance areas, or approach to intersection.

Appendix B

TBC

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[i] "InterCor Detailed Evaluation Methodology" located
https://service.projectplace.com/#project/1273862723/documents/1416001918

[ii] InterCor logging format for communications and application
CommonApplicationLogFormat.xls
CommonCommunicationLogFormat.xls
Located - https://service.projectplace.com/#project/1273862723/documents/1429661229/842058184