GLOSA TESTFEST Specifications

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Terms and abbreviations

Term / Abbreviation	Definition
AC	Advisory Committee
AL	Activity Leader
ASR	Action Status Report
CMT	Core Management Team
EC	European Commission
GA	Grant Agreement
GLOSA	Green Light Optimal Speed Advisory
INEA	Innovation and Networks Executive Agency
IPR	Intellectual Property Right
CMT	Core Management Team
ML	Milestone Leader
MS	Member State
PC	Project Coordinator
TIC	Technical & Interoperability Coordinator
TLC	Traffic Light Controller
VRU	Vulnerable Road User

1 Executive summary

The InterCor pre-TESTFEST for Green Light Optimised Speed Advisory (GLOSA) services will be held on 13 and 14 June 2018 in Helmond, the Netherlands.

This document defines the InterCor reference specifications to be validated in this TESTFEST, and also specifies the test and validation criteria, test environment and setup.

2 Introduction

InterCor [1] stands for Interoperable Corridors, linking the C-ITS corridor initiatives of the Netherlands C-ITS Corridor NL-DE-AT, the French SCOOP@F and extending to United Kingdom and Belgium C-ITS initiatives to achieve a sustainable network of corridors providing continuity of C-ITS services and offering a testbed for beyond Day-One C-ITS service development.

InterCor is a 3 year study that seeks to enable vehicles and the related road infrastructure to communicate data through cellular, ITS G5 or a combination of cellular and ITS-G5 (hybrid) networks on a road corridor through the Netherlands, Belgium/Flanders, UK and France to achieve safer, more efficient and more convenient mobility of people and goods.

The main objective of InterCor is to harmonise the specifications, deployments and evaluations for seamless and interoperable C-ITS services across Europe. An important step prior to deployment is to test, verify and validate the compliance and cross-border interoperability of the specifications in TESTFESTs.

The first TESTFEST was held in July 2017 [1] on the A16 motorway in the Netherlands. More than 20 participants from across Europe participated to test Road Works Warning (RWW), In-Vehicle Signage (IVS) and Probe Vehicle Data (PVD) services using ITS-G5 communication. Three more TESTFESTs are planned in 2018.

This document specifies the pre-TESTFEST for Green Light Optimised Speed Advisory (GLOSA) services to be held on 13 and 14 June 2018 in Helmond, the Netherlands.

2.1 Purpose of this document

This section sets the objectives for the TESTFEST. The following sections specify the reference specifications, criteria for testing and validation during the TESTFEST, the set up and scenarios for testing.

Objective is to test and validate the compliance and cross-border interoperability of the InterCor specifications for GLOSA services and several use cases. Cross-border interoperability is validated in the broader sense that devices and services are both compliant to the InterCor specifications, and interoperable between road operators, service providers, on-board unit and in-vehicle device suppliers, and communication networks.

The scope for this pre-TESTFEST is defined by the (draft) specifications from InterCor on GLOSA services, ITS-G5 communication, and hybrid communication and services. The scope for testing is also defined by the capabilities of the systems deployed at the test site.

- Several intersections in Helmond will be used that are equipped with road side units broadcasting SPATEM and MAPEM messages via ITS-G5 short range communication.

- A first implementation of the InterCor specifications for hybrid communication [4] will be available for testing the data provisioning of the same SPATEM and MAPEM messages to service providers. As these specifications are still in draft, testing will be experimental and will be refined in future TESTFESTs.
- Alternative architectures and services for hybrid communication are being developed and deployed, for example in the Talking Traffic project [12]. Hybrid services from Talking Traffic, and possibly other projects, will also be invited in this pre-TESTFEST, albeit that compliance and cross-border interoperability will only be tested and validated at the level of services provided by in-vehicle devices to the driver. Back-office and data-provisioning services will be out of scope in this pre-TESTFEST.

Evaluations and assessment of the expected benefits, such as the impacts on traffic efficiency, safety and the environment, and on driver behaviour and acceptance, are not the primary scope of the pre-TESTFEST. TESTFESTs however are also used to validate the InterCor approach and tools for data logging and analyses, evaluation and assessment.

2.2 InterCor Contractual References

InterCor (Interoperable Corridors) links the C-ITS corridor initiatives of the Netherlands C-ITS Corridor Netherlands-Germany-Austria and the French one defined in SCOOP@F, and extending to the United Kingdom and Belgium C-ITS initiatives.

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.

Communication details of the Agency:

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https://webgate.ec.europa.eu/tentec/

All communication with the INEA or the European Commission shall be done via the Project Coordinator, Mr. Fred Verweij.

3 Reference Specifications

The basis for the TESTFEST and test scenarios are the following specifications for GLOSA services and communication.

3.1 GLOSA services and use cases

The GLOSA services to be used in InterCor are specified in [1] at a functional and technical level. [1] describes requirements for the GLOSA use case and it represents the collective input from France, Netherlands and the UK.

It should be noted that [1] is:

- Still in draft and will be finalised after the Pre-TESTFEST (planned June 2018).
- Being aligned with C-ROADS functional and technical specifications [9].

The test environment determines the capabilities for the participants‘ services to be tested. The test environment is described in more detail in section 5, and provides more information to participants than specified in [1]:

- Time to Green and Time to Red information is provided to support a GLOSA service in [1] and the Time to Green / Time to Red use case in [9].
- Speed advice will not be provided on the test environment to support a GLOSA use case in [9].

Vehicles approaching controlled intersections inform the driver in advance about the status of the traffic signals, and also advise an optimum approach speed that should minimise delay and ensure a smooth transition through the conflict area of the intersection. The advisory speed information is derived from a combination of traffic signal phase and timing information (SPAT or SPATEM) that is relevant for the position and direction of travel of the vehicle, and topology information relating to the intersection (MAP or MAPEM). Additional advice information on the estimated queue length and advisory speed will not be added in the SPAT in the specific situations of the test environment.

While approaching a signalised intersection information is sent to approaching vehicles informing them of the traffic light phase schedule. This is either sent from the traffic signal controller via a roadside unit (R-ITS-S / G5), via the data provisioning service (IF.2) or via a service provider via 3G/4G cellular communication.

This information, combined with information on the position of the vehicle, the speed of the vehicle and the distance to the traffic light, will enable an algorithm in the vehicle to calculate an optimal speed of approach (under the mandatory speed limit), or a time to green or red. Vehicle drivers receive the speed or time advice information via the display (HMI) of the vehicle's OBU or in-vehicle device.

There are two primary use cases:

Situation 1: Time-to-green information and speed advice: a vehicle approaches a signalised intersection while the traffic light is red or will arrive at the stop line during the red phase.

This use case identifies three possible scenarios:

1.1. As indicated by the speed advice a vehicle maintains the current speed and arrives at the intersection during a green phase.

1.2. As indicated by the speed advice a vehicle decreases its current speed and arrives at the intersection at the start of a green signal phase.

1.3. As indicated by the speed advice a vehicle gradually decreases speed and stops to wait for the next green phase. In some member states, where legally permitted, the vehicle may then receive speed (acceleration) advice as soon as the signal turns to green, in order to minimise the start delay.

Situation 2: Time-to-red information and speed advice: a vehicle approaches a signalised intersection while the traffic light is green or will arrive at the stop line during the green phase.

This use case identifies two possible scenarios:

1.1. As indicated by the speed advice a vehicle maintains the current speed and arrives at the intersection during a green phase.

1.2. As indicated by the speed advice a vehicle increases the current speed (never beyond the legal speed limit) and arrives at the intersection before the end of a green phase.

3.1.1 Use cases not in scope

The GLOSA specifications in [1] also identify use cases for Vulnerable Road Users (VRU) such as cyclists as actors to receive advices from GLOSA services. VRUs will not be included or tested as participants using GLOSA services. Obviously equipped and unequipped VRUs may directly or indirectly affect the TLC.

The GLOSA use case in [9] also specifies situations for fast pre-emption and red light violation. These are not validated in this pre-TESTFEST.

Emergency vehicle scenarios will not be evaluated in this pre-TESFEST.

3.2 C-ITS messages

3.2.1 MAP or MAPEM

The terms MAP and MAPEM are used in this document as synonyms to denote the European version of the topology message standard. The version is specified in [4].

The message includes the road and lane topology of the intersection and the allowed manoeuvres.

Table 2 gives the options that can be used at the test site for specific message fields (data elements) from [4] section 2. Note that all profiled fields are also considered as mandatory.

Table 1: Options in MAP messages used at the test site

Level	Field	Available options
0.3	**layerType**	Not Used or set to intersectionData
0.4	**layerId**	Not used
0.5	**intersections**	Used for intersections, typically contains 1 IntersectionGeometry object (although multiple intersections are allowed).
0.6	**roadSegments**	Not used
0.8	**restrictionList**	Not used
1.1	**Name**	Used
1.5	**LaneWidth**	Not used
1.6	**speedLimits**	Used
5.4	**egressApproach**	May be available
5.5	**sharedWith**	Following values can be used: otherNonMotorizedTrafficTypes (2) individualMotorizedVehicleTraffic (3) busVehicleTraffic (4) taxiVehicleTraffic (5) pedestriansTraffic (6) cyclistVehicleTraffic (7)

Level	Field	Available options
		trackedVehicleTraffic (8) Following values are not used: overlappingLaneDescriptionProvided (0) multipleLanesTreatedAsOne(1)
5.8	**connectsTo**	Used to indicate the signal group for the SPAT
5.10	**Regional**	Not used
6.1	**vehicle**	Generally no values are used, resulting in an all-zero bit string.
6.2	**crosswalk**	Not used.
6.3	**bikeLane**	Not used.
6.7	**trackedVehicle**	Not used.
7.2	**localNode**	Not used.
7.2	**disabled**	Not used.
7.2	**enabled**	Not used
7.2	**data**	Not used
7.2	**dWidth**	Not used
7.2	**dElevation**	Not used
12.4	**regional**	Not available

3.2.2 SPAT or SPATEM

The terms SPAT and SPATEM are used in this document as synonyms to denote the European version of the signal phase and timing message standard. The version is specified in [6] and [7].

The message contains the traffic light signal phase and timing information for each allowed manoeuvre. The message may include a speed advice for the main traffic route or other allowed manoeuvres.

Table 2 gives the options that can be used at the test site for specific message fields (data elements) from [6] section 2. Note that all profiled fields are also considered as mandatory.

Table 2: Options in SPAT messages used at the test site

Level	Field	Available options
1.4	**status [Intersection-StatusObject**	Following values can be used: • failureFlash (2), • trafficDependentOperation (6), • off (9), • noValidSPATisAvailableAtThisTime (13)

Level	Field	Available options
		Following values are not used by Dynniq: • manualControlIsEnabled (0), • stopTimeIsActivated (1), • preemptIsActive (3), • signalPriorityIsActive (4), • fixedTimeOperation (5), • standbyOperation (7), • failureMode (8), • recentMAPmessageUpdate (10), • recentChangeInMAPassignedLanesIDsUsed (11), • noValidMAPisAvailableAtThisTime (12),
1.7	**enabledLanes**	Not used
2.4	**maneuverAssistList**	Not available
3.1	**eventState**	Unlit (dark): 0. unavailable, e.g. power outage 1. dark, e.g. outside of operating hours Reds: 2. stop-Then-Proceed 3. stop-And-Remain Greens: 4. Pre-Movement 5. permissive-Movement-Allowed 6. protected-Movement-Allowed Yellows / Ambers: 7. permissive-clearance 8. protected-clearance 9. caution-Conflicting-Traffic, e.g. outside of operating hours
4.1	**startTime**	Not available
4.3	**maxEndTime**	Not available
4.4	**likelyTime**	If this is used, then it is advised not to use the mandatory minEndTime
4.5	**confidence**	Used with likelyTime as specified in [7]
4.6	**nextTime**	Not available
5.2	**speed**	Conditions for usage are not present near the intersections of section 5
5.4	**distance**	Conditions for usage are not present near the intersections of section 5
6.2	**queueLength**	Not available

3.3 ITS-G5 communication

For ITS-G5 communication, all specifications and references to standards are specified in [3], which gives an overview in [3] Annex A, including the SPAT and MAP messages ([4][6][7]).

3.4 Hybrid communication and services

InterCor specifications for hybrid communication [4] will be available for testing the data provisioning of the same SPATEM and MAPEM messages via InterCor interface IF2 to service providers. The test specifications will be adapted in a next release.

The implementation of IF2 to be used in the pre-TESTFEST is specified in [13].

3.5 ITS-G5 Security

ITS-G5 security is out of scope for the Pre-TESTFEST in June 2018.

4 Test criteria

The main criteria to be tested in the TESTFEST can be grouped into:

- Verification of compliance to the specifications of section 3.
- Differences in legislation, traffic rules, interpretation and implementation of specifications, and validation of the effects on the quality of service provided to drivers
- Measurement of communication performance of ITS-G5 and 4G cellular communication, and validation of the effects on the quality of service provided to drivers
- Validation of the interoperability between hybrid and ITS-G5 services, and the effects on the quality of service provided to drivers

The pre-TESTFEST is not set up as a full compliance test and verification of the specifications as in other TESTFESTs:

- Specifications and profiles for the SPATEM and MAPEM will be verified as far as used in the test environment.
- Specifications and profiles for ITS-G5 communication at and below the facilities layer will not be verified explicitly in this pre-TESTFEST (section 3.3).
- Security will not be verified (section 3.5).

Compliance is validated by means of testing potential non-compliance and interoperability issues, and assessing the potential differences between services and their effects on the quality of services such as the accuracy of driver advices.

4.1 Potential interoperability issues in the interpretation and use of data elements in the messages

In [4] and [6] the MAP and SPAT data elements are profiled to be used as either mandatory, profiled, conditional or optional. The profile is refined in section 3.2 for the specific test environment. The profiled message specifications allow for some alternative approaches that potentially lead to interpretation issues, for example:

- Differences in SPAT and MAP usage and contents by traffic light control applications and road side units of different make and profile versions.
- Intersection configurations in MAP messages
- Timestamping of SPAT messages is different from other C-ITS messages
- Combinations of endTime and likely time advices, in combination with confidences, in SPAT messages, and the calculation of speed advices to drivers.
- Variability of advices over time in the SPAT

4.2 Potential interoperability issues in variations of in-vehicle applications and driver advice

- Trigger conditions for giving an advice to stop, time to red, and time to green.
- Trigger conditions for giving speed advices for green and for red.
- Trigger conditions for giving a maximum speed limit as speed advice, and limiting the speed advices.
- Trigger conditions for giving acceleration or deceleration advices during the approach, at green, and during the egress.
- Filtering, separating or combining lane or signal phase specific information in driver advices.
- Selecting or integrating messages recieved via hybrid communication channels.

Trigger conditions can be:

- Timing relative to the (predicted) crossing of the intersection, stop line or queue
- Distance to the stop line
- Momentary vehicle speed or speed difference to the maximum speed limit

- Traffic conditions such as congestion, slow traffic, emergency or prioritised vehicles.

4.3 Functionality and performance of IF.2

Potentially the data provisioning service via IF.2 to services providers (section 3.4) is also verified and validated, for example on:

- Can a service provider connect to the broker of IF.2?Can a service provider subscribe or request data from the IF.2 for a specific geographical region?
- Communication delay over IF.2

5 Field Test environment

The TESTFEST will be held on the public road and in daily traffic, on the Heeklaan and Engelse weg in Helmond in the Netherlands (Figure 1). The 7 controlled intersections encircled in blue will be used as the test environment. It should be noted that other controlled intersections are also equipped with road side units broadcasting ITSS-G5 messages using different versions and profiles of the specifications. Figure 2 gives an impression on the intersection configurations that can be expected and shows three successive intersections on the Engelse weg from left to right:

1. Engelse weg - Floreffestraat
2. Engelse weg – Montgomerystraat
3. Engelse weg - Churchilllaan

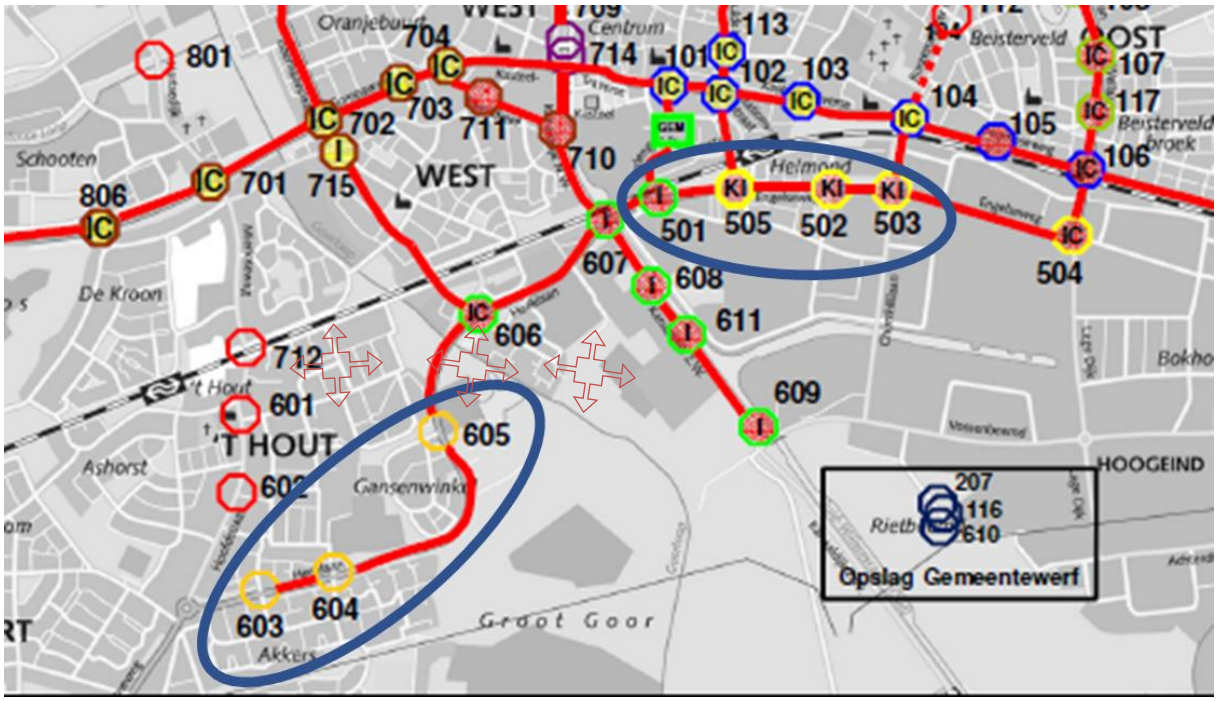

Figure 1: Test site – Engelse weg, Helmond

Figure 2: Test site - Intersections

The complexity of the intersections vary in number of signal groups and lanes per approach, and connections to egress lanes, locations of stop lines, the configuration of pedestrian and cycle crossings.

The traffic light controllers at the intersections are in normal operational mode to control daily traffic.

Participants are expected to behave as normal traffic and respect the traffic rules and traffic lights, independent of the received or processed SPAT and MAP information and independent of the advices given by the systems to be verified in this TESTFEST.

No additional traffic measures will be taken to set (controlled) test scenarios or separate participants from normal traffic.

The road network allows many variations to efficiently drive the corridor along the Heeklaan and Engelse weg, take turns and parallel roads to cross the intersections from all directions.

6 Test sessions

6.1 Test scenarios

The traffic light controllers in the field test environment cannot be adapted or modified to setup specific controlled scenarios. Nevertheless, if participants drive around for some time they will experience may red and green light situation for the use cases defined in section 3.1.

Test scenarios are set up by organisation of test sessions:

- Sessions are organised throughout the day in different traffic conditions, including rush hour periods.
- At the start of sessions participants are organised in platoons to approach and egress the intersections more or less simultaneously and under similar conditions.
- Participants are expected to cross intersections in all combinations of approaches throughout the sessions.

Participants can execute test sessions in different formations:

- Every participant uses and tests his in-vehicle devices in his own test vehicle.
- A single test vehicle will be used in which the in-vehicle devices from multiple participants will be installed and tested in the same session.

Feasibility for the second option depend on the possibilities to install and use participants' systems.

The organisation and schedule for sessions will be decided at the TESTFEST to adapt to traffic situations, progress and capabilities of participants.

6.2 Debriefings

Every test day is concluded with a debriefing in which all participants are expected to share and discuss their experiences and results, e.g. on:

- Incidents and events

- Observations on message contents
- Observations on communication or system behaviour
- Results from participant's data logging and analyses

6.3 Data Logging

To enable quantitative verification and validation of the pre-TESTFEST, log data need to be collected, analysed and evaluated from all road side and in-vehicle devices. To analyse the test criteria in section 4, log data is needed on:

- Sent and received messages on the RSU and in-vehicle devices to measure communication performance, including CAM, SPAT and MAP messages.
    - The contents of SPAT and MAP messages logged on the RSUs will be used as the reference situation on signal phases and timings for verification of the functionality and performance of in-vehicle GLOSA services
- Vehicle traces from CAM messages or otherwise from GPS or a POTI (position and time) component.
- Engine starts and stops
- Application events, decisions and actions from the in-vehicle devices to verify service and message specifications
- Presentation and revocation of information presented on the HMI, such as the aximum and advices speeds, time-to-green and time-to-red, and enginge start/stop advices, to validate interoperability.

InterCor partners are expected to provide logging in one of the agreed data formats after every session. In [8] the formats are defined for communication, application and HMI logging that can be processed automatically and shared through a repository to provide quantitative input for the debriefings and to share results with all participants.

Other partners are encouraged to also provide and share data logging in the debriefings and the repository.

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