# Milestone 6 – Common set of upgraded specifications for Services

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|---|---|
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# CONTROL SHEET

| Version history | | | |
|---|---|---|---|
| **Version** | **Date** | **Main author** | **Summary of changes** |
| V0.1 | 31/12/2016 | Peter Schmitting (ERTICO) | First interim version |
| V0.2 | 17/02/2017 | Peter Schmitting (ERTICO) | Second draft with inputs from NL, UK and text snippets from FR excel sheet |
| V0.3 | 07/03/2017 | Peter Schmitting (ERTICO) | Third draft |
| V0.4 | 26/02/2018 | Peter Schmitting (ERTICO) | Aligned UC version for discussion |
| V0.5 | 08/03/2018 | Peter Schmitting (ERTICO) | Added agreed-upon UCs and line for profiles |
| V0.6 | 09/07/2018 | Peter Schmitting (ERTICO) | IVS and GLOSA inputs included<br>New clause 3 |
| V0.7 | 12/07/2018 | Peter Schmitting (ERTICO) | Version for service editor review/completion |
| V0.8 | 20/08/2018 | Peter Schmitting (ERTICO) | IVS from Marcel van Sambeek and RWS from Marie-Christine Esposito included. |
| V0.9 | 27/08/2018 | Peter Schmitting (ERTICO) | Truck parking and Tunnel Logistics from Patrick Hoffman added, RWS comments from Marie-Christine Esposito addressed. |

 

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| V0.10 | 05/09/2018 | Peter Schmitting (ERTICO) | New version of Truck parking from Patrick Hoffman added. |
| V0.11 | 10/09/2018 | Peter Schmitting (ERTICO) | New versions of MCTO and Tunnel Logistics added. |
| V0.12 | 25/09/2018 | Peter Schmitting (ERTICO) | New version with UK, BE, FR comments incorporated. |
| V1.0 | 09/10/2018 | Iuliia Skorykova, Giacomo Somma (ERTICO) | Final quality check |

| | Name | Date |
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# TABLE OF CONTENTS

# LIST OF FIGURES



 

## Terms and abbreviations

| Term / Abbreviation | Definition |
|---|---|
| AC | Advisory Committee |
| AL | Activity Leader |
| ASR | Action Status Report |
| CMT | Core Management Team |
| EC | European Commission |
| ETA | Estimated Time of Arrival |
| GA | Grant Agreement |
| GLOSA | Green Light Optimised Speed Advice |
| INEA | Innovation and Networks Executive Agency |
| IVS | In Vehicle Signage |
| IPR | Intellectual Property Right |
| MCTO | Multimodal Cargo Transport Optimisation |
| ML | Milestone Leader |
| MS | Member State |
| PC | Project Coordinator |
| PVD | Probe Vehicle Data |
| RWW | Road Works Warning |
| SE | Service Editor |
| TCC | Traffic Control Centre |
| TIC | Technical & Interoperability Coordinator |
| TMS | Traffic Management System |
| UC | Use Case |

 

# 1 Executive summary

Sub-Activity2.1d C-ITS Services develops functional specifications for innovative services and reviews previously deployed services and contributes to the InterCor Activities 3 and 4.

This Activity starts with a review of existing C-ITS services implemented in the Netherlands and France and aims for the development of a common set of specifications for additional C-ITS services on freight and logistics and traffic management based on the hybrid and PKI approach developed in Sub-Activities 2.1b and 2.1c. Special attention is paid to the logistic process (particularly for HGV vehicles) around tunnels avoiding congestion/stops in tunnels to increase safety (Dutch tunnel law).

The final version of the present document is the report to Milestone 6 due on 31st of August 2018. Indicator for its acceptance is the successful application of the developed set of specifications at the C-ITS service TESTFEST event under Sub-Activity 2.2. Criterion for verification is the presence of documentation of common service specifications upgraded for logistics services related to traffic management.

 

# 2 Introduction

## *2.1 Purpose of this document*

The purpose of the present document is the description of the following C-ITS services:

- Road Works Warning (RWW)
- In Vehicle Signage (IVS)
- Probe Vehicle Data (PVD)
- Green Light Optimised Speed Advice (GLOSA)
- Multimodal Cargo Transport Optimisation (MCTO)
- Truck Parking
- Tunnel Logistics

In the following sections the services are described. Each description starts with a high level description of the overall service. This is followed by explanations of the uses case(s) for the service. The use case descriptions are split into two parts. There is a functional description and a high level technical description. Details on the technical description may be found in the documents produced by the InterCor Sub-Activities 2.1a, b and c, i.e. the reports of Milestones 3, 4 and 5.

## *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:**

Any communication addressed to the Agency by post or e-mail shall be sent to the following address:

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

 

# 3 Architectural considerations

During the elaboration of the subsequent sections, discussions between the Member States (MSs) led to the conclusion that the .deployment of C-ITS services may use different architectural approaches, especially when using a hybrid communications. The descriptions currently found in the field "Reference architecture" in the high level technical description of each use case lay out the deployment plan in one or several MS in an exemplary way. In a future version of the present Milestone report, reference architecture options from further MS may be added.

Some general considerations have been made on the use of interface IF2 as developed by InterCor Sub-Activity 2.1b. The interface specification for IF2 does not prescribe a specific deployment model for the usage of the interface specifications. For the pilot operation phase, it is however necessary for each MS to select a specific deployment model (possibly different per InterCor MS). The choice for a specific deployment model may be influenced also by what deployment model is foreseen in the long term, extending after the completion of the InterCor project.

The figure below provides a simplified view of the usage of IF2, as described in [1]. In this view, other interfaces are deliberately left out, and the situation that a vehicle from country 1 is visiting country 2 is shown. This and all other figures apply also for multiple countries, but for simplicity, only 2 countries and 2 vehicles are always presented to ease understanding.

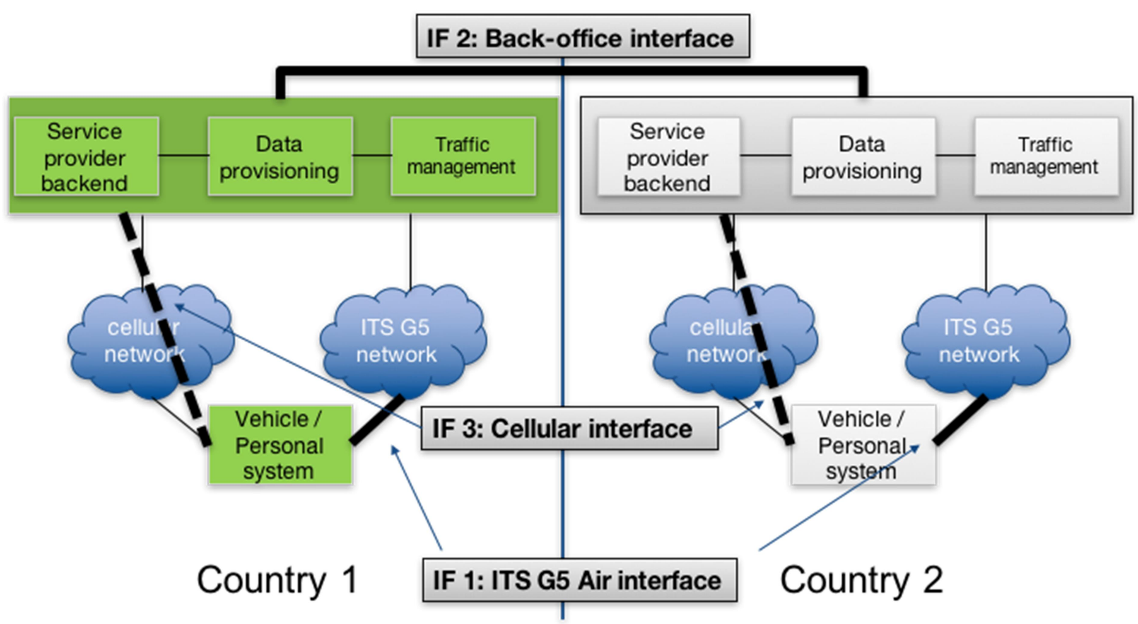


**Figure 1: General system overview for the usage of IF2**

Three deployment models can be derived from this overall architecture:

1 Model based on national nodes service national data only

In this model every country has a national node that services only national data. Service providers from other countries all have to connect directly to that broker in this national node. Every national node will have to serve all service providers with vehicles in their country, and service providers will need to connect to brokers in all countries where it has customers.

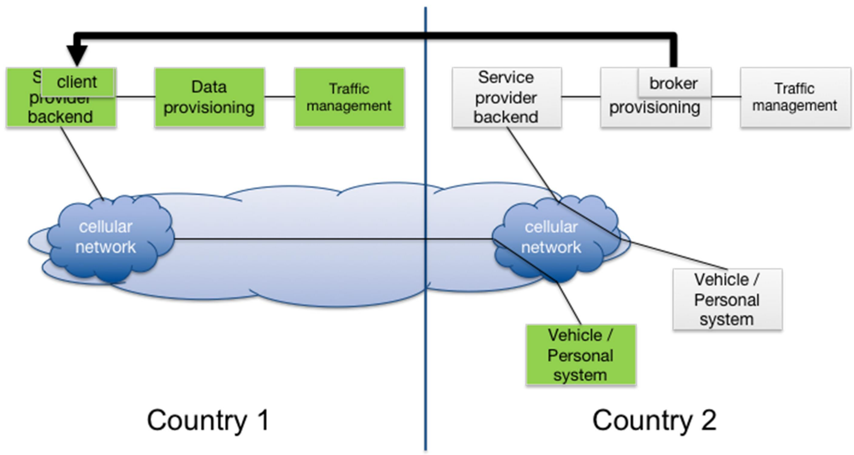


**Figure 2: Model based on national nodes service national data only**

2 Model based on national nodes exchanging data

In this model, all national nodes are interconnected with each other, and the service providers will only connect to their national node. Every national node will have to connect to every other national node and has to process all data from all other national nodes to be able to serve it to their own national service providers.

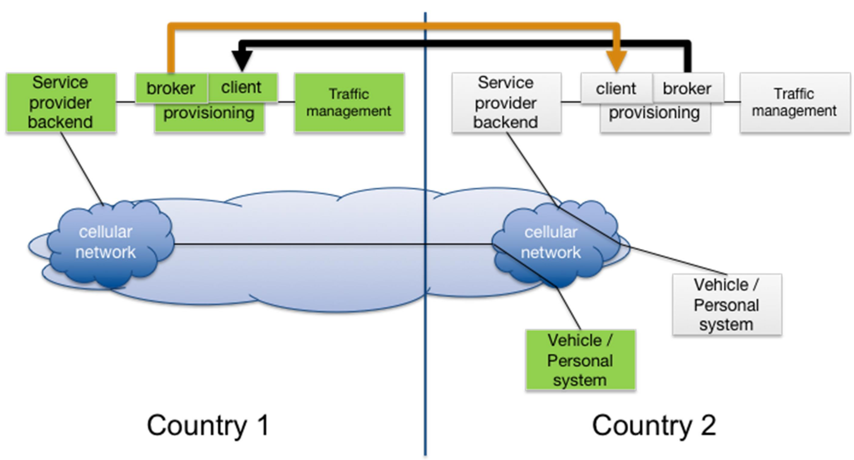


**Figure 3: Model based on national nodes exchanging data**

Model based on a central EU node

In this model, all the national nodes forward their data to a central EU node, and all service providers connect only to that central EU node. The central EU node can connect as a client to all brokers in all national nodes, and the service providers can connect as client to the broker in the EU central node. This model is currently considered as node out of scope of InterCor.

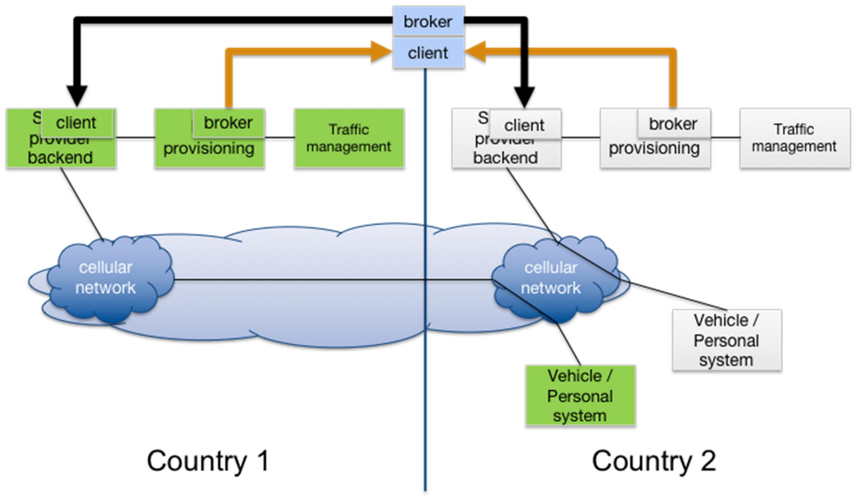


**Figure 4: Model based on a central EU node**

# 4 RWW

## *4.1 RWW High Level Description*

| Service introduction | |
|---|---|
| **Summary** | The service is to provide warnings to road users about road works, which can be mobile or static. Possibly, when a dangerous vehicle approaches a road works, a warning can be sent to the driver of the dangerous vehicle and to workers. |
| **Background** | Road works normally result in changes to the road layout and driving behaviour. Despite dedicated signing in advance of the road work zones, such changes to road conditions can frequently come as a surprise to many drivers, leading to an unsafe situation for both drivers and road operator. |
| **Objective** | To encourage drivers to be more attentive when approaching and passing a road work zone, thereby reducing incidents and accidents. This is achieved by giving real-time in-vehicle information well in advance about road works, changes to the road layout and applicable driving regulations. |
| **Expected benefits** | Expected benefits include: attentive driving behaviour while approaching and passing a work zone; helping to avoid sudden braking or steering / swerving manoeuvres; helping to improve road safety.<br>RWW will aim at reducing the number of collisions with traffic management measures associated with road works. RWW will alert the driver when approaching such measures by providing relevant information on steps to take to avoid any conflict. |
| **Use Cases** | 1. Lane closure or other restrictions<br>2. Alert planned closure of a road or a carriageway<br>3. Alert planned road works – mobile (e.g. cutting the grass or renewing the lane markings)<br>4. Winter maintenance – Salting in progress |

Note: For the different use cases the following sources were used:

The Netherlands:

- Dutch C-ITS Corridor (https://itscorridor.mett.nl)
- Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)

France:

- French catalogue of services related to connected vehicle

## *4.2 RWW Use Cases (UC)*

### 4.2.1 Lane closure or other restrictions

#### *4.2.1.1 Functional description*

| Lane closure or other restrictions | |
|---|---|
| **Use case introduction** | |
| **Summary** | • The road user (driver) receives information about the closure of part of a lane, a whole lane or several lanes (including hard shoulder), but without the |

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| | road closure.<br>• The closure is due to a static road works site.<br>• In this use case, alternate mode and total road closure are excluded |
| **Background / added values** | • Currently, many road users enter the road works sites or hit the protection equipment of the site, sometimes causing injury. An alert sufficiently in advance may prevent this type of situation by adapting the behaviour of the driver.<br>• The same risks exist in incident sites, even when they are secured with warning beacons. |
| **Objective** | • The objective is to allow drivers to anticipate the reduction in lane availability or other restrictions (such as temporary speed limits or width restrictions) and to adapt their speed and position on the road.<br>• The objective is not to signal a road closure; therefore no alternative route will be transmitted.<br>• The objective is not to signal to the user that they are likely to have to stop. |
| **Desired behaviour** | • Increased vigilance<br>• Adaptation of vehicle speed<br>• Change of lane, if required |
| **Expected benefits** | • Reduce the risk of accidents (for users, road agents, or emergency services in case of an incident)<br>• Alleviating discomfort by providing timely information on road works ahead thus allowing the driver to slow down and take appropriate actions to avoid a hazard<br>• Improved traffic management |
| **Use case description** | |
| **Situation** | • Road works equipped with warning beacons / temporary road signs, safety trailers, on a road with separate carriageways or on a dual carriageway.<br>• Accidents that do not require a full road closure, or diversion route. The area has been equipped by road operators with warning beacons / temporary road signs.<br>• Carriageway crossover. |
| **Logic of transmission** | I2V Logic Broadcast |
| **Actors and relations** | • **The Road operator** is the sender of the message**.**<br>• **The vehicle driver** approaching the area is the end-user of this service (receives the message).<br>• **Information provider:**<br>o In case of road works: the road works planner of the road operator, a management system, or the safety trailer (driver).<br>o In case of accidents: can be the emergency services, the road operator through its cameras, etc.<br>o Service provider: disseminates RWW information, warnings and/or guidance from traffic / road operator to vehicle drivers. |
| **Scenario** | 1. The road manager programs a static and planned road works and reports it in his Traffic Management System (TMS).<br>The information contains all the elements that can be used to describe the work site (start / end position of the work-site, duration) precisely. Additional information can be added, such as the speed limit of each affected section.<br>Some data could be provided to the TCC by the trailers or road operator (vehicle) of the roadwork.<br>2. The message is then broadcasted to the road users.<br>3. The road user receives the information and processes it. |
| **Display / Alert logic** | • When planning a journey, the user is informed of road portions with lane |

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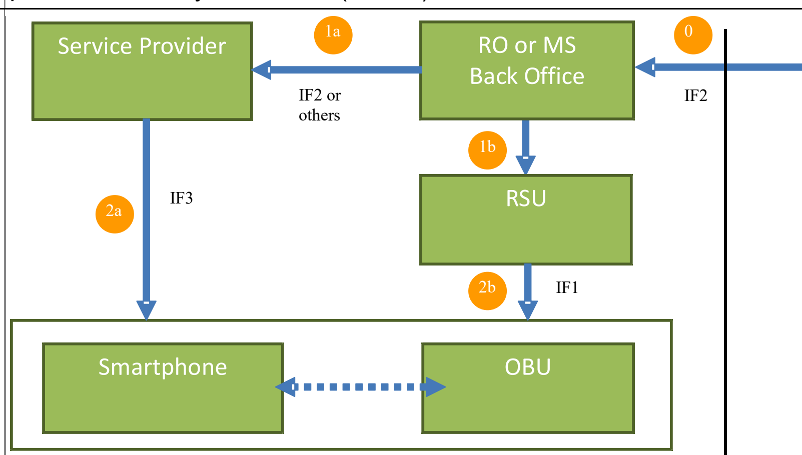
| | availability changes.<br>• When the road user arrives near the work zone site, he/she receives information allowing adjustment of speed and position on the road to prevent dangerous situations. The information needs to be displayed on the HMI early enough, and is moderately intrusive |
| **Functional Constraints / Dependencies** | • The road works information must be available in near-real time.<br>• The location information needs to be accurate on road, and related to the physical location of the actual roads works. Lane level accuracy is optional.<br>• All information of the road works needs to be available in the data elements of the RWW messages.<br>• It must be assured that information generated via different messages/ information networks can be linked by the receiver to the same road works event.<br>• The validation process of transmitted information (quality) against the physical layout of a RWW site needs to be taken care of. |

#### *4.2.1.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | In Cooperative-ITS (C-ITS), presenting information related to the traffic situation or traffic regulation to the driver of a vehicle is an important component of road operations. The road authorities are responsible for road setup, the operation and maintenance of their network to support traffic management and road safety.<br>When the HMI within the vehicle that is approaching the road works informs the driver about the event, the on-board vehicle (ITSS-V) advises an itinerary (using the DENM RoadWorksContainerExtended-recommendedPath or if the vehicle is equipped with a navigation system it can compute an alternative route) and lanes closed to the driver based on the DENM messages. This information will either be received from the infrastructure using G5 communications or it will be provided centrally via cellular (3G/4G). |
| **Reference architecture** | <br>The process for this service contains several steps:<br>0. The DENM message is sent through interface IF2 from another MS when a vehicle from the ego MS knows that one of its connected vehicle is in the said MS.<br>1. The road operator declares the event on the traffic management system or equivalent (aka back-office) |

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| | 2. The back-office sends information about the roadwork event to the RSU or the service provider (1a or 1b).<br>3. On the ITS-G5 link (2b), the RSU uses the information to generate a DENM message in the facilities layer and broadcasts the DENM. On the hybrid link, the service provider forwards the information to the vehicle.<br>4. The message received by the OBU will be analysed in order to display the warning event to the driver. |
| **Relation to InterCor profiles** | The DENM message for RWW is profiled in the 2.1a document (chapter 4.2.1).<br>For this UC (lane closure or other restrictions): The DE eventType will be (causeCode/subCauseCode) 3/0 or 3/4.<br>The DENM messages need to be signed and to contain the appropriate certificate that helped sign the message (still under discussions whether the DENM message is signed over the hybrid link.) |
| **Functional and non-functional requirements** | |
| **Sources of information** | TMS |
| **Standards** | • ETSI TS 103 301 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>• ETSI EN 302 637-3 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.<br>• ETSI TS 102 894-2 - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary |
| **Technical Constraints / Dependencies** | None |

### Alert planned closure of a road or a carriageway

#### *4.2.1.3 Functional description*

| **Alert planned closure of a road or a carriageway** | |
|---|---|
| **Use case introduction** | |
| **Summary** | The driver receives information about a road closure due to planned static road works. |
| **Background / added values** | When road users are not presented with up-to-date information about the condition of the road network, they can often become anxious and make inappropriate manoeuvers leading to an unsafe situation. Keeping the drivers well informed can help towards improving driver behaviour and road safety for all road users. There is an added value in this use case if the information is accurately linked with re-routing information. |
| **Objective** | To allow the driver to anticipate the closure of a road, so he/she can plan the journey accordingly and possibly choose an alternate route. This anticipation can be geographical or temporal. |
| **Desired behaviour** | The driver is able to make an informed decision about his/her route choice. |

 

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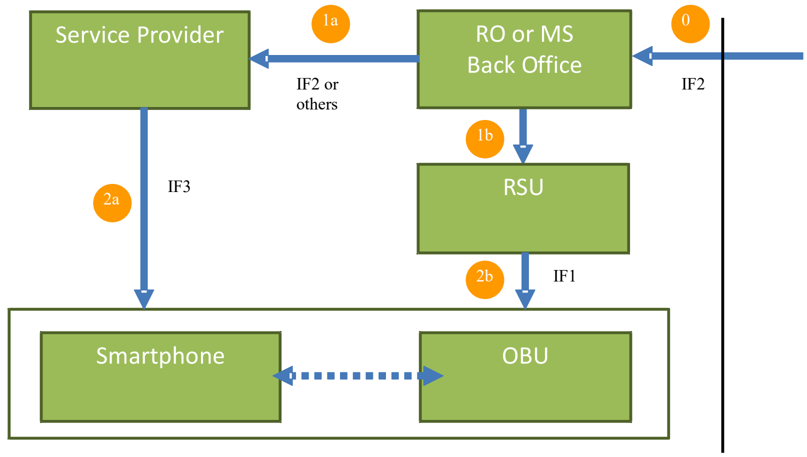
| **Expected benefits** | • Improved safety (avoid dangerous behaviour, e.g. U-turns)<br>• Improved traffic management<br>• Improved comfort for road users |
| **Use case description** | |
| **Situation** | • On a dual carriageway: one direction is closed, without carriageway crossover. A diversion is indicated near the closure.<br>• On a two-way carriageway: the whole road is closed (therefore without alternate), resulting in multiple diversions (at least two). |
| **Logic of transmission** | I2V Logic Broadcast |
| **Actors and relations** | • **The Road operator** is the sender of the message. It can be in contact with the other road managers in order to implement a smart deviation itinerary.<br>• **The Vehicle driver** is the end-user of the service.<br>• **The information provider** is normally the road operator.<br>• **Other**: In some countries, the authorization of the road works is given following the issuance of a decree. |
| **Scenario** | 1 The road manager programs a static and planned road works and reports it in his Traffic Management System (TMS) or equivalent.<br>2 This information contains all the elements that can be used to precisely describe the work-site (start / end position of the closure, duration) and potential alternative routes (may be different by type of road user or destination).<br>3 The message is then broadcasted to the road users sufficiently in advance, in time (for example one week) as well as geographically (e.g. one or two previous exchangers) so that users can adapt their itinerary. If the road closure occurs during the trip, information is updated.<br>4 The vehicle receives the information and displays it to the driver. |
| **Display / Alert logic** | • When planning his journey, the user is informed of road closures.<br>• An initial less intrusive alert when the travel time to the road works is reasonably significant. Progressively more intrusive alerts as the travel time shortens.<br>• The display of alternate routes is to be considered. |
| **Functional Constraints / Dependencies** | • Management of planned events to be sent to road users.<br>• Prior the standards decision, some checks would be necessary:<br>• Update of the Message Set and Triggering Conditions for Road Works Warning Service which now also includes LT-RWW (all based on DENM only)<br>• Work plan proposal, including IVI, MAP and several stakeholder perspectives. |

#### 4.2.1.4 High level technical description

| | |
|---|---|
| **Use case implementation** | |
| **Model implementation** | In Cooperative-ITS (C-ITS), presenting information related to the traffic situation or regulation of a road to the driver of a vehicle is an important component of road operations. The road operators are responsible for road setup, operation, signage and maintenance to support traffic management and road safety.<br>When the vehicles approaching the event inform the driver in advance about the event, the vehicle (ITSS-V) will advise an itinerary and an optimal speed to the driver based on the DENM and IVI messages. This |

<table>
<tr><td></td><td>information will either be received from the infrastructure using G5 communications or it will be provided centrally via cellular (3G/4G).</td></tr>
<tr><td>Reference architecture</td><td>




The process for this service contains several steps:

0. A DENM or an IVI message is sent through interface IF2 from another MS when a vehicle from the ego MS knows that one of its connected vehicle is in the said MS.

1. The road operator declares the event on the traffic management system or equivalent (aka back-office)

2. The back-office sends information about the roadwork event to the RSU or the service provider (1a or 1b).

3. On the ITS-G5 link (2b), the RSU uses the information to generate an IVI indicating the closing date (ISO14823Attributes) of the road with a deviation pictogram (e.g. the TCC can send the message one week before the planned date) the ReferencePosition of the IVI corresponds to the point of deviation and its relevanceZone Corresponds to the road or carriageway which will be closed. On the hybrid link, the service provider forwards the corresponding information to the vehicle.

4. The day of the event the RSU installed near the area generates a DENM message in the facilities layer

5. These messages are transmitted to the OBU in order to inform vehicle on the event.

6. The messages received by the OBU will be analysed in order to display the warning event to the driver via a HMI.

</td></tr>
<tr><td>Relation to InterCor profiles</td><td>The DENM message for RWW is profiled in the 2.1a document (chapter 4.2.1). The IVI message is profiled in chapter 4.3.1.<br>For this use-case (lane closure or other restrictions): The DE eventType of the DENM will be (causeCode/subCauseCode) 3/0, 3/1 or 3/4.<br>The DENM and IVI messages need to be signed and to contain the appropriate certificate that helped sign the message (still under discussions whether the DENM/IVI message are signed over the hybrid link).</td></tr>
<tr><td colspan="2">Functional and non-functional requirements</td></tr>
<tr><td>Sources of information</td><td>TMS</td></tr>
</table>

| | |
|---|---|
| **Standards** | • ETSI TS 103 301 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>• ETSI EN 302 637-3 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.<br>• ETSI TS 102 894-2 - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary<br>• ISO TS 19321:2015 – Dictionary of in-vehicle information (IVI) data structures.<br>• ISO/TS 14823:2008(en) - Traffic and travel information; Messages via media independent stationary dissemination systems; Graphic data dictionary for pre-trip and in-trip information dissemination systems |
| **Technical Constraints / Dependencies** | None |

### 4.2.2 Alert planned road works – mobile

#### *4.2.2.1 Functional description*

| **Alert planned road works – mobile** | |
|---|---|
| **Use case introduction** | |
| **Summary** | The driver approaching a planned mobile lane closure receives information about which lane is closed well in advance of the road works. |
| **Background / added values** | Currently there are a number of cases where drivers come into conflict with the traffic management equipment at mobile road works, such as traffic cones, barriers and cushions. This can also lead to injury. An alert sufficiently in advance of the road works would prevent this type of situation from happening by informing the driver about changes to road conditions and suitable driving behaviour to adopt. There is a higher risk of rear shunt type collisions at mobile road works with impact protection vehicles and it is therefore essential to warn the driver well in advance about the impending danger. The risk is even more important with mobile work site that are “lighter” in terms of protection and signalling. |
| **Objective** | The objective of this use case is to inform a road user of a mobile work zone where he may encounter traffic management equipment and operatives working in the area. This use case does not cover mobile bottleneck operations. |
| **Desired behaviour** | • Increased driver vigilance<br>• Appropriate speed adaptation<br>• Change of lanes (if needed) |
| **Expected benefits** | • Reducing conflict and risk of personal injury for all road users<br>• Alleviating discomfort by providing timely information on road works ahead, thus allowing the driver to slow down and take appropriate actions.<br>• Improved traffic management and road safety |
| **Use case description** | |
| **Situation** | • Mowing<br>• Application of road markings<br>• fixing restraint systems<br>• phyto-sanitary treatments<br>• sweeping, road cleaning, |

| | |
|---|---|
| | • etc. |
| **Logic of transmission** | I2V / Vro2V (mobile road works vehicles may also be used to broadcast DENM messages either to the RSU or to vehicles), Broadcast. |
| **Actors and relations** | • **The Road operator** is the sender of the message.<br>• **The vehicle driver** approaching the area is the end-user of this service (receives the message).<br>• **Information provider:** the road works planner of the road operator. |
| **Scenario** | 1 The road manager programs mobile and planned road works and reports it in the TMS.<br>2 The information contains all the elements that can be used to precisely describe the work zone (start / end position of the work zone, duration). This zone will not be entirely used by the operating agents; they will set markings around the actual work site within this zone.<br>3 Additional information can be added, such as the speed limit of each neutralized portion.<br>4 The message is then broadcasted to the road users.<br>5 The vehicle receives the information, processes it, and displays it to the driver. |
| **Display / Alert logic** | When the driver arrives near the possible work zone, he receives an alert to allow him to adjust his speed and position on the carriageway. The alert needs to be displayed on the HMI early enough, and is moderately intrusive (at the manufacturer's discretion). |
| **Functional Constraints / Dependencies** | • Prior the standards decision, some checks would be necessary:<br>o Update of the Message Set and Triggering Conditions for RWW service which now also includes LT-RWW (all based on DENM only).<br>o Work plan proposal, including IVI, MAP and several stakeholder perspectives.<br>• The road operator vehicle on site, if equipped, might broadcast a message signalling a mobile work-site as well. The HMI might need to handle those two messages. The priority shall be given to the information received from the vehicle on site. |

#### *4.2.2.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | In Cooperative-ITS (C-ITS), presenting information related to the traffic situation or regulation of a road to the driver of a vehicle is an important component of road operations. The road operators are responsible for road setup, operation, and maintenance to support traffic management and road safety.<br>When the vehicle approaches the roadwork area or is driving into it, the driver receives a warning about the presence of road worker.<br>This information will either be received from the infrastructure using G5 communications or it will be provided centrally via cellular (3G/4G). |

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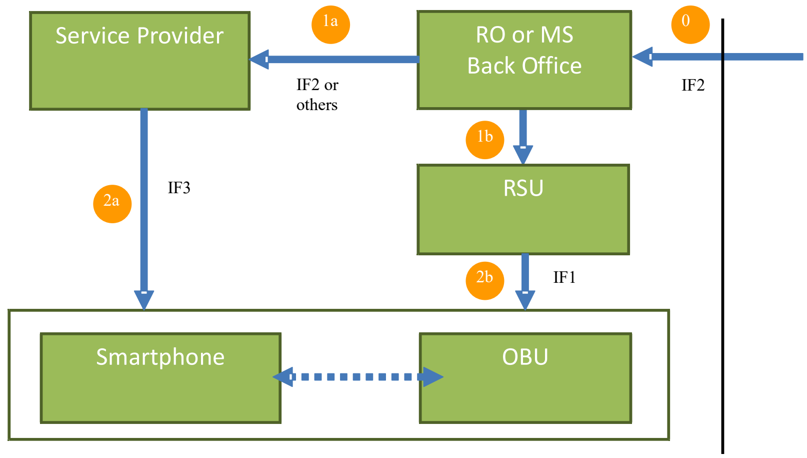
| **Reference architecture** | <br>The process for this service contains several steps:<br>0. The DENM message is sent through interface IF2 from another MS when a vehicle from the ego MS knows that one of its connected vehicle is in the said MS.<br>1. The road operator declares the event on the traffic management system or equivalent (aka back-office).<br>2. The back-office sends information about the roadwork event to the RSU or the service provider (1a or 1b).<br>3. On the ITS-G5 link (2b), the RSU uses the information to generate a DENM message in the facilities layer and broadcasts the DENM. On the hybrid link, the service provider forwards the information to the vehicle.<br><br>The message received by the OBU will be analysed in order to display the warning event to the driver.<br>Note:<br>- if a road operator vehicle on site is starting the mobile road works, the service starts at step 3 on the ITS-G5 link, where the road operator creates the DENM ; for the hybrid, the road operator vehicle may send the DENM message to its MS/RO back-office to be forwarded through IF2 to other MS. |
| **Relation to InterCor profiles** | The DENM message for RWW is profiled in the 2.1a document (chapter 4.2.1).<br>For this use-case (lane closure or other restrictions): The DE eventType will be (causeCode/subCauseCode) 3/3.<br>The DENM messages need to be signed and to contain the appropriate certificate that helped sign the message (still under discussions whether the DENM message is signed over the hybrid link). |
| **Functional and non-functional requirements** | |
| **Sources of information** | TMS |
| **Standards** | • ETSI TS 103 301 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>• ETSI EN 302 637-3 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.<br>• ETSI TS 102 894-2 - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer |

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| | common data dictionary |
| **Technical Constraints / Dependencies** | None |

### 4.2.3 Winter maintenance – Salting in progress

#### *4.2.3.1 Functional description*

| **Winter maintenance – Salting in progress** | |
|---|---|
| **Use case introduction** | |
| **Summary** | Operating agents (or one, depending on the road operator) are in a winter maintenance vehicle currently salting the road and sending a message signalling their activity. If the TCC knows that an operating agent is on site, the event can be sent from the TMS. |
| **Background / added values** | Salt spreading vehicles are much slower and cannot be overtaken. Even if the road might not be easily used because of the snow, and the vehicles might not go very fast, they usually don't know exactly where the winter maintenance activities are happening. This use-case can then prevent collisions between winter maintenance vehicles and other vehicles. It can also help sending information about a possible spill for vehicles circulating on the other side of the road (bi-directional roads). |
| **Objective** | The objective of this use-case is to alert a road user that he will encounter a winter maintenance vehicle salting spreading on the road, so that he can adapt his driving behaviour. |
| **Desired behaviour** | • Increased vigilance<br>• Alert of an imminent hazard<br>• Adaptation of speed |
| **Expected benefits** | • Reducing the risk of incidents (for users, road agents) during a winter maintenance intervention<br>• Improved winter maintenance interventions efficiency |
| **Use case description** | |
| **Situation** | • A vehicle arrives behind a salt spreading vehicle in progress and either cannot overtake or may overtake with caution.<br>• The salting can only be on a few lanes on a dual carriage-way. |
| **Logic of transmission** | Vro2V or I2V Logic Broadcast |
| **Actors and relations** | • Sender is the operator in his vehicle or the vehicle automatically (if connected to the salt spreading equipment), or the TMS<br>• End-receivers are drivers<br>• The source of information is the road operator. |
| **Scenario** | 1 The operating agent(s) start salt spreading the road while circulating on the road.<br>2 If connected directly to the salt spreading equipment, the salt spreading vehicle's OBU sends a message to inform users of the salt spreading; otherwise, the signalling can be made manually on an HMI if the vehicle is equipped with such a winter maintenance tool.<br>If the TCC also knows that winter maintenance is on site, it also sends a message to inform users.<br>3 The road user vehicles around the winter maintenance vehicle receive the |

 

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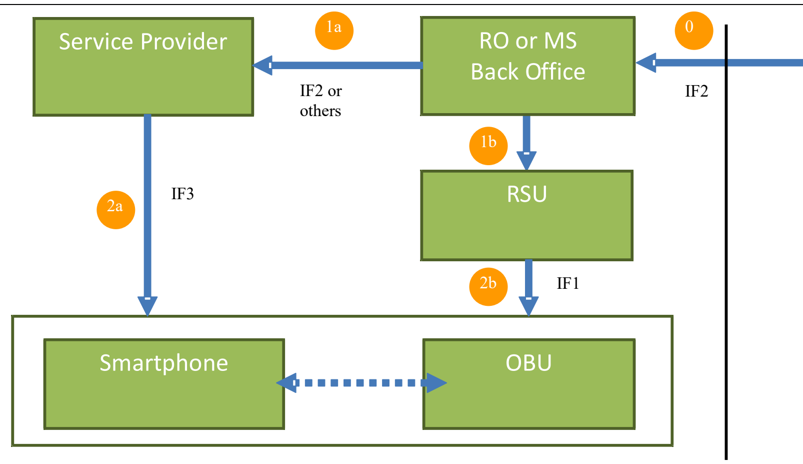
| | message and display it to the drivers. |
| **Display / Alert logic** | The display logic should be different if the message is received by a vehicle behind the winter maintenance vehicle (maybe a reminder that it cannot overtake?) or a vehicle on the other side of the road. |
| **Functional Constraints / Dependencies** | This message could be also accompanied by a message sent by the TCC signalling a zone of winter maintenance (using VMS for example). The receiving vehicle will have to deal with the priority or redundancy of both messages. |

### *4.2.3.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | In Cooperative-ITS (C-ITS), presenting information related to the traffic situation or regulation of a road to the driver of a vehicle is an important component of road operations. The road operators are responsible for road setup, operation, and maintenance to support traffic management and road safety.<br>This information will either be received from the infrastructure using G5 communications or it will be provided centrally via cellular (3G/4G). |
| **Reference architecture** | <br>The process for this service contains several steps:<br>0. The DENM message is sent through interface IF2 from another MS when a vehicle from the ego MS knows that one of its connected vehicle is in the said MS.<br>1. The road operator declares the event on the traffic management system or equivalent (aka back-office)<br>2. The back-office sends information about the winter maintenance event to the RSU or the service provider (1a or 1b).<br>3. On the ITS-G5 link (2b), the RSU uses the information to generate a DENM message in the facilities layer and broadcasts the DENM. On the hybrid link, the service provider forwards the information to the vehicle.<br>4. The message received by the OBU will be analysed in order to display the warning event to the driver.<br><u>Note:</u><br>- If a road operator vehicle on site is starting the winter maintenance, the |

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| | service starts at step 3 on the ITS-G5 link, where the road operating agent creates the DENM ; for the hybrid link, the road operator vehicle may send the DENM message to its MS/RO back-office to be forwarded through IF2 to other MS. |
| **Relation to InterCor profiles** | The DENM message for RWW is profiled in the 2.1a document (chapter 4.2.1).<br>For this use-case (winter maintenance), the DE eventType will be (causeCode/subCauseCode) 26/8.<br>The relevanceDirection is set to allTrafficDirection.<br>For the message sent from the road operating vehicle, as the event is moving, the validityDuration is set to a short value. The event position and detectionTime are updated every few seconds or when the vehicle position moves more than a threshold. The event is a punctual event (no event history), and the message should have the DE eventSpeed filled in.<br>The DENM messages need to be signed and to contain the appropriate certificate that helped sign the message (still under discussions whether the DENM message is signed over the hybrid link). |
| **Functional and non-functional requirements** | |
| **Sources of information** | OBU in the winter maintenance vehicle, RSU, winter maintenance planning |
| **Standards** | • ETSI TS 103 301 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>• ETSI EN 302 637-3 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.<br>• ETSI TS 102 894-2 - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary |
| **Technical Constraints / Dependencies** | None |

 

# 5 IVS

## *5.1 IVS High Level Description*

| **Service introduction** | |
|---|---|
| **Summary** | In-Vehicle Signage (IVS) is an information service to inform drivers on actual, static or dynamic (virtual) road signs via in-car systems. The road signs can be mandatory or advisory. |
| **Background** | The IVS service provides drivers with information via in-car information systems on static and dynamic road signs. The information is similar to physical road signs erected on the carriageway including any additional virtual information (virtual VMS or free text). IVS can be used to target information to specific vehicle types or to individual vehicles part of the communication network. IVS is a subset of the broader scope of In-Vehicle Information service. The IVS information is retrieved by means of Infrastructure-to-Vehicle (I2V) communication. Variable Message Sign (VMS) are currently used by road operators to send operational, tactical or strategic information to road users. Different types of VMS are used to display:<br>• Variable Message Signs (VMS)<br>• Variable Text Panels (VTP)<br>• Variable Direction Signs (VDS) |
| **Objective** | To provide up to date real-time information about traffic signs and condition of the road **network**. |
| **Expected benefits** | The expected benefit include more attentive driving behaviours, improved road safety, better traffic management and contextualised information to specific vehicle types, e.g. restrictions for trucks. |
| **Use Cases** | IVS consists of several use cases where VMS, VTP or VDS are used:<br>1. Dynamic speed limit information<br>2. Embedded VMS<br>3. Dynamic lane management - Lane Status information |

Note: For the different use cases the following sources were used:
The Netherlands:

- NL - ITS Corridor: [Dutch C-ITS Corridor Profile, Rijkswaterstaat, 28-10-2016, version 3.0]
- NL – Nationale Databank Wegverkeersgegevens (NDW): see ndw.nu and [Trafficmanagementinfo interfaces Interface Design Description (IDD), Rijkswaterstaat, version 1.1.0-1.0, date 2015-03-31]

France:

- French Use Cases Catalogs C-ROADS FRANCE, INTERCOR (work-in-progress)
- SCOOP@F project: [SCOOP@F D2.4.1 V3.0 Common set of functional and technical specifications for SCOOP]

Other resources:

- Amsterdam Group: [Draft Functional Description of Day One Application [In-Vehicle Information] from the point of view of the Amsterdam Group, version 3.1, 2016-04-15]
- C2C CC: [Car2Car Communication Consortium, C2C-CC Basic System

Standards Profile, R1.1.0, 21-12-2015]

- ECo-AT: [SWP 2.1 Use Cases In-Vehicle Information, WP 2 – System Definition Version: 03.60 (2016-07-29)]

## *5.2 IVS Use Cases*

### 5.2.1 Dynamic speed limit information

#### *5.2.1.1 Functional description*

| **Dynamic speed limit information** | |
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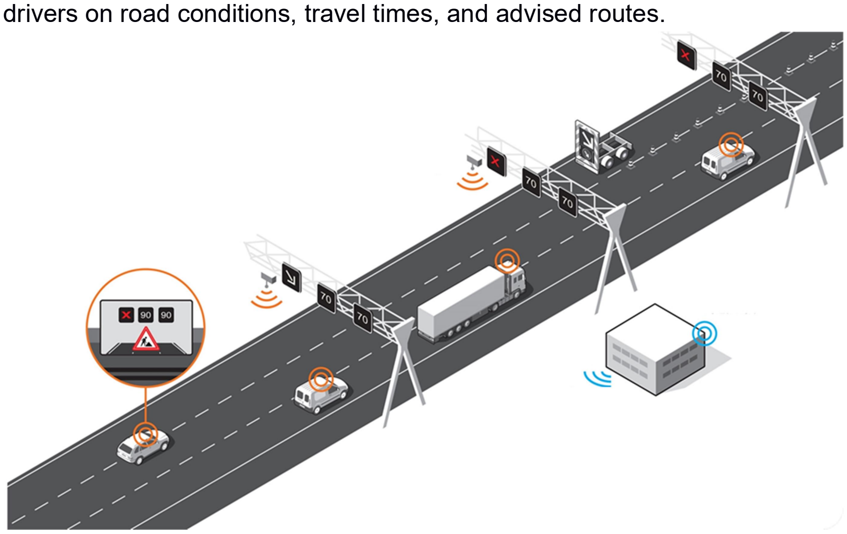
| **Use case introduction** | |
| **Summary** | The driver receives speed limit notifications. The message subject is the dynamic speed limit given by the road manager. |
| **Background / added values** | The aim is to alert the driver about the speed limit in a particular location, helping them to avoid exceeding the speed limit. |
| **Objective** | The aim is to inform the drivers what speed they should adopt to avoid a potentially dangerous situation. |
| **Desired behaviour** | The drivers adapt their driving behaviour compliant to the applicable driving speed limit. In the future the information may be used by Advanced Driver Assisted Systems for automated driving. |
| **Expected benefits** | Comfort and safety. |
| **Use case description** | |
| **Situation** | IVS shows both static and dynamic information of road signs. In the European countries different Variable or Dynamic Message Signs (VMS) systems are deployed on parts of the highway. The VMS systems can be used to inform drivers on road conditions, travel times, and advised routes.<br><br><br>**Figure 5: In-vehicle information: status information of dynamic speed limit signs on a variable message system is also sent as IVS service**<br><br>The IVS service contains actual and continuous information on speed limits, i.e. in-car information on actual speed limit<br>• Static contextual speed limit (incl. time-of-the-day windows, weather |

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| | conditions)<br>• Dynamic speed limit during incidents, traffic jams, etc.<br>• Temporary speed limits during road works (temporary signs) |
| **Logic of transmission** | I2V |
| **Actors and relations** | • Traffic manager / road operator: The original source or sender is the **road operator** from the Traffic Control Centre (TCC). The sender is expected to have validated by his own means the content of the message before sending the message into the system.<br>• Vehicle driver: The end-receiver that should benefit from this specific information is the **road user in his vehicle**. The vehicle driver receives IVS information, warnings and/or guidance on the in-vehicle display.<br>• Service provider: disseminates IVS information, warnings and/or guidance from traffic / road operator to vehicle drivers. The traffic / road operator may also act as service provider to convey selective messages to end road users over the HMI. The OEMs may also communicate information to drivers.<br>• Vulnerable road user: n/a |
| **Scenario** | 1 The Traffic Control Centre (TCC) sends a message with the dynamic speed limit. The speed limit can be targeted to a specific vehicle type (for e.g. Heavy Goods Vehicles).<br>2 Vehicles receive the message, and display it on the HMI if relevant.<br>3 Drivers adopt their speed accordingly. |
| **Display / alert principle** | IVS information shall be displayed to the driver and shall be consistent with the actual dynamic traffic signs. |
| **Functional constraints / dependencies** | • The presentation of information on the HMI is <u>not part</u> of the service description. It is left to the provider of the in-vehicle information system with the HMI how information is presented. Information might e.g. be translated to the preferred language of the driver.<br>• The information presented by means of I2V is not legally binding: Information should be treated as advisory and presented accordingly to the driver, as currently done within navigation systems. Before the system is activated, the driver of the vehicle should be informed about the legally binding status of the road signs. This takes into consideration any possible errors in translations of messages and signs. |

#### *5.2.1.2 High level technical description*

| **Use Case Implementation** | |
|---|---|
| **Model Implementation** | Cooperative-ITS (C-ITS) present information related to the condition of the road network and traffic signs regulation to the driver of a vehicle. Real-time traffic and travel information is an important component of efficient network operation. The road operators are responsible for the management, operation, maintenance of the road network to ensure efficient operation and road safety Road operators are responsible for the information distributed to drivers via many dissemination channels, such as IVS. This use case supports mandatory and advisory road signage. IVS can either be sent via ITS-G5 via networks of RSUs or hybrid communication (mobile Internet). The corresponding messages for ITS-G5 for IVS (IVI message) will be sent by a Roadside ITS-S. The information is presented |

 

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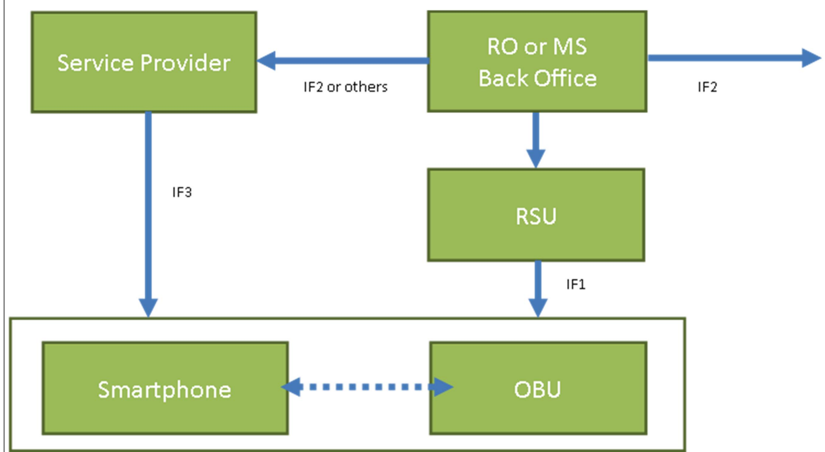
| | to the driver via an HMI. |
| **Reference architecture** | <br>The figure above is an example how the IVS service can be offered: i.e. how a (public) road operator can enclose IVS information directly via IF1 (RSU-OBU) and indirectly via IF2 (back-office interface to service provider or to other Member States). The actual implementation of IF2 is not universal to all InterCor Member States.<br>The process for the IVS application as foreseen contains several steps:<br>• The RO back-office system is triggered by an external trigger (not shown) that dynamic signalling is activated. The dynamic signalling system along the highway is used to show information of closed lanes and reduced speed limits dynamically on road signs.<br>• The RO back-office triggers RSUs to send ITS messages (IVI) via IF1 to an OBU.<br>• The RO back-office also forwards the ITS messages (IVI) via IF2 to service providers.<br>The service provider determines whether an IVS message is required for the individual user, and sends the appropriate information to the smart phone or any other connected in-vehicle system via IF3. The smartphone or any other connected in-vehicle system determines based on the input from IF1 and IF3 what to put on the HMI, and shows the IVS information, if required. |
| **Relation to InterCor profiles** | The IVS Use Case Dynamic Speed Limit information is based on the exchange of IVI messages towards vehicles (I2V) as specified in the InterCor profiles for the interfaces IF1 (ITS-G5 network, RSU to OBU) and IF2 (back-office, for distribution via cellular networks):<br>• IF1: InterCor Milestone 3 – Common set of upgraded specifications for ITS-G5 (version 1.1, 20/10/2017) [REF: IF1] – definition of IVI message<br>• IF2: InterCor - Specifications for IF2 for hybrid communication (v1.0, 17/12/2017) [REF: IF2]<br>The IF1 document is aligned in the C-ROADS Platform via the latest version: C-ROADS C-ITS Infrastructure Functions and Specifications (release 1.1, version 6.0, 21/03/2018).<br>The specification for the Network & Transport layer (GeoNetworking and BTP) and the Radio Access layer (IEEE 802.11p and G5 radio channels in the 5.9 GHz ITS band) is still work-in-progress. For IVS the C-ROADS Platform profile “Roadside ITS G5 System Profile” will be applicable.<br>IVI messages (IVIM) are used for this service and can be sent via both IF1 and |

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| | IF2. The profile as specified in section 4.3 of [IF1] is applicable. For this specific use case the following additional remarks are applicable:<br>1) Road Sign Codes: the road-sign codes according to ISO14823:2017 are applicable<br>2) For dynamic speed limit the `pictogramcode` for the traffic sign for speed limit is used with<br>a. `countryCode`: : ISO 3166-1 code (alpha-2) for countries, BE for Belgium, FR for France, GB for United Kingdom, NL for Netherlands,<br>b. `serviceCategorycode`: 12 (1: Traffic Sign, 2: Regulatory)<br>c. `pictogramCategoryCode`: 557 (Maximum speed limit to the figure indicated), `nature` = 5, `serialNumber` =57<br>d. Attribute: `International Sign-speedLimits (spe)` with<br>i. `speedLimitMax (spm)`<br>ii. `unit (unit)`<br>Attributes spm=50 and unit = kmperh are used to indicate a dynamic speed limit of e.g. 50 km/h<br>3) End-of-speed limit: the end of a dynamic speed limit is indicated via the `pictogramcode` for the traffic sign for “End of speed limit” is used with<br>a. `countryCode`: ISO 3166-2 code for countries, BE for Belgium, FR for France, NL for Netherlands,<br>b. `serviceCategorycode`: 12 (1: Traffic Sign, 2: regulatory)<br>c. `pictogramCategoryCode`: 614 (End of speed limit)<br>d. No attributes |
| **Functional and non-functional requirements** | |
| **Sources of information** | The information provider can either be:<br>• the road operator himself<br>• another service provider<br>Information from the point of detection to dissemination can be fully automated for the use case.<br>The information can be based on:<br>• Database with location and type of all static road signs on speed limits;<br>• (Virtual) variable message sign systems for dynamic speed limits<br>• Data concerning the implementation of planned temporary speed limits |
| **Standards** | The following standards apply to IVS:<br>• ETSI TS 103 301 v1.1.1 (2016-11) - Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services;<br>• CEN/ISO TS 19321:2015 - Intelligent transport systems - Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures;<br>• CEN/ISO TS 14823:2017 – Intelligent transport systems - Graphic data dictionary. Also see http://standards.iso.org/ISO TS/14823/ for the latest version (work in progress);<br>• CEN/ISO TS 17426:2016 Intelligent transport systems — Cooperative systems — Contextual speeds (Note: this TS refers to message format of ISO TS 19321);<br>• CEN/ISO TS 17425:2016 Intelligent transport systems -- Cooperative systems -- Data exchange specification for in-vehicle presentation of external road and traffic related data; |

 

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| | • CEN/ISO TS 17423:2014 Intelligent transport systems -- Cooperative systems -- ITS application requirements and objectives for selection of communication profiles;<br>• CEN/ISO TS 17429:2017 Intelligent transport systems -- Cooperative ITS - ITS station facilities for the transfer of information between ITS stations.<br>The following standards apply specifically to dynamic speed limits:<br>There is a "contextual speed" standard (ISO TS17426) regarding:<br>• the static speed limits,<br>• the dynamic speed limits,<br>• the recommended maximum speed.<br>This use case deals with the section "Dynamic speed limit" of the CEN/ISO TS 17426 standard that addresses the speed regulation. This applies to all cases where there is a modulation of the static speed: thanks to pollution, rain, traffic, incidents and road works.<br>The CEN/ISO TS 17426 refers to the message template defined in the CEN/ISO TS 19321. |
| **Technical Constraints / Dependencies** | • The information from the VMS systems has to be made available by road operators.<br>• For traffic signs a standardised catalogue (e.g. ISO 14823) for traffic signs needs to be used, including dynamic signs.<br>• The VMS information on regulatory signs must be consistent with the actual information displayed on the VMS and must be available in near-real time.<br>• The location information needs to be accurate on road and lane level, and related to the physical location of the actual roads signs.<br>• All information of the road signs needs to be available in the data elements of the IVS messages.<br>• All roles in the above functional architecture have to be fulfilled. |

## 5.2.2 Embedded VMS

### *5.2.2.1 Functional description*

| **Embedded VMS** | |
|---|---|
| **Use case introduction** | |
| **Summary** | The service is to display to the user information of type "free text". The information to display can be similar to the information on a physical VMS (Variable Text Panel) or be other messages (virtual VMS). |
| **Background / added values** | • The aim is not to provide new information but to convey potentially relevant information to road users continuously with enhanced quality. Indeed, it is a well-known fact that the inability to have read the whole content of the message displayed on the VMS can cause anxiety among the drivers.<br>• Another added value would be to enable the information to be displayed in the driver's own language.<br>• Relative to traffic signs, it is possible to display free contents (text, images)<br>• Relative to physical VMS: besides extended coverage of communication relative to view by user, the embedded VMS is shown directly on the HMI display inside the vehicle, allowing the driver or the passenger to have enough time to read the message |
| **Objective** | • Transmit to road users information in "free text" that is not provided by other IVS use cases. |

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| | • Add details to an already transmitted message (e.g. DENM or IVI) in order to provide a more precise and readable information to the road users to achieve the expected behaviour.<br>The information may already be displayed on a physical VMS or other means of signalling on the road. |
| **Desired behaviour** | The desired behaviour depends of the message. |
| **Expected benefits** | • Traffic management: this use case allows improvement of traffic management (regulation, smart routing, etc.), because information is broadcast on the scale of the complete network, beyond the limited cover of the physical VMS.<br>• Comfort: this use case allows VMS information to be displayed within the vehicle after the vehicle has passed the roadside VMS, thereby reducing driver stress.<br>• Optimization of the management costs of the road infrastructure<br>• In case of regulation information, the virtual VMS displays a message exactly in the zone of application, which should increase compliance with regulations. |
| **Use case description** | |
| **Situation** | • Traffic management plan<br>• Pollution<br>• Kidnap alert<br>• Special events (sports, demonstration, etc.)<br>• Travel time<br>• Speed advice<br>• Information on services available on highway parking areas<br>• etc. |
| **Logic of transmission** | I2V |
| **Actors and relations** | • The sender is the road operator from the traffic control centre (TCC). The sender is expected to have validated by his own means the content of the message before sending it into the system.<br>• The end-receiver that should benefit from this information is the road user in his vehicle. |
| **Scenario** | 1 The road manager wants to send information to road users. The virtual VMS is a possible means, as well as physical VMS, radio, the internet, etc.<br>2 The road manager sends the information via all or selected information channels.<br>3 Vehicles receive the information, and display it to the drivers, in real time and in the location defined by the road manager. The priority of the messages to display may be defined by the road manager. |
| **Display / Alert logic** | The display principles on the Human Machine Interface (HMI) of the in-vehicle ITS station cannot be the same according to the content of the message and corresponds to the 5 different message categories defined in the 2 priority levels as written in the CEN/ISO TS 17425 standard:<br>• “higher priority messages” are displayed to warn the driver and prevent accidents.<br>• “lower priority messages” are displayed to inform the driver without causing distraction.<br>In SCOOP, the 5 different types of messages are used. There are two main logics:<br>• Copy the contents of the message to be displayed as it is.<br>• Other displays may be envisaged, such as a drop-down text, etc. Information may e.g. also be translated to the preferred language of the |

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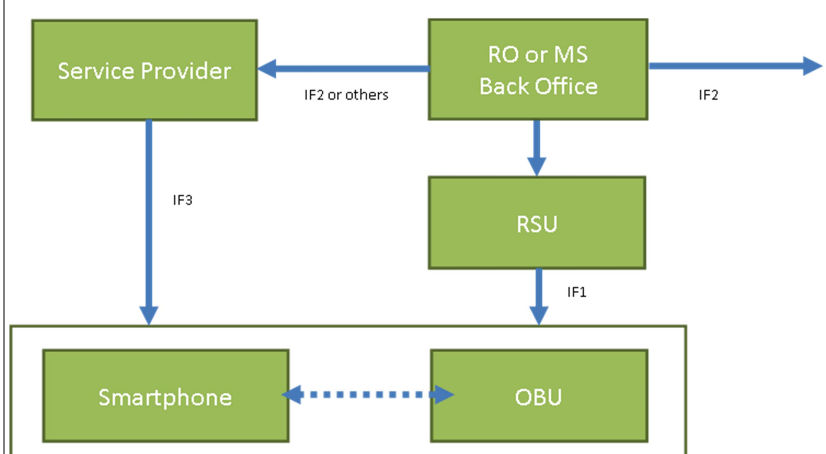
| | driver. |
| **Functional Constraints / Dependencies** | The presentation of information on the HMI is <u>not part</u> of the service description. It is left to the provider of the in-vehicle information system with HMI how information is presented. Information might e.g. be translated to the preferred language of the driver.<br>The information presented by means of I2V is not legally binding: Information should be handled as 'convenience information' and presented accordingly to the driver, as currently done within navigation systems. Before using the system/service the driver should be asked to confirm that he is aware that the road signs on the road are legally binding, whatever the in-car system says. This applies also for possible errors in translations of messages and signs. |

#### *5.2.2.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | In Cooperative-ITS (C-ITS), presenting information related to the traffic situation or regulation of a road to the driver of a vehicle is an important component of road operations. The road operators are responsible for road setup, operation, signage and maintenance to support traffic management and road safety, and in some countries, also for the enforcement of road laws. Road operators contribute to how road information is properly distributed to drivers via IVS. This use case supports mandatory and advisory road signage. IVS information can either be sent via ITS-G5 based networks of RSUs or via (mobile) Internet. The corresponding messages for ITS-G5 for IVS (IVI message) will be sent by a Roadside ITS-S. The information is presented to the driver via an HMI. |
| **Reference architecture** | <br>The figure above is an example how the IVS service can be offered: i.e. how a (public) road operator can enclose IVS information directly via IF1 (RSU-OBU) and indirectly via IF2 (back-office interface to service provider or to other Member States). The actual implementation of IF2 is not universal to all InterCor Member States.<br>The process for the IVS application as foreseen contains several steps:<br>• The RO back-office system is triggered by an external trigger (not shown) that dynamic signalling is activated. The dynamic signalling system along the highway is used to show information of closed lanes and reduced speed limits dynamically on road signs. |

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| | • The RO back-office triggers RSUs to send ITS messages (IVI) via IF1 to an OBU.<br>• The RO back-office also forwards the ITS messages (IVI) via IF2 to service providers.<br>• The service provider determines whether an IVS message is required for the individual user, and sends the appropriate information to the smart phone or any other connected in-vehicle system via IF3. The smartphone or any other connected in-vehicle system determines based on the input from IF1 and IF3 what to put on the HMI, and shows the IVS information, if required. |
| **Relation to InterCor profiles** | The IVS Embedded VMS use cases is used to display “free text” and is based on the exchange of IVI messages towards vehicles (I2V) as specified in the InterCor profiles for the interfaces IF1 (ITS-G5 network, RSU to OBU) and IF2 (back-office, for distribution via cellular networks):<br>1) IF1: InterCor Milestone 3 – Common set of upgraded specifications for ITS-G5 (version 1.1, 20/10/2017) [REF: IF1] – definition of IVI message<br>2) IF2: InterCor - Specifications for IF2 for hybrid communication (v1.0, 17/12/2017) [REF: IF2]<br>The IF1 document is aligned in the C-ROADS Platform via the latest version: C-ROADS C-ITS Infrastructure Functions and Specifications (release 1.1, version 6.0, 21/03/2018).<br>The specification for the Network & Transport layer (GeoNetworking and BTP) and the Radio Access layer (IEEE 802.11p and G5 radio channels in the 5.9 GHz ITS band) is still work-in-progress. For IVS the C-ROADS Platform profile “Roadside ITS G5 System Profile” will be applicable.<br>IVI messages (IVIM) are used for this service and can be sent via both IF1 and IF2. The profile as specified in section 4.3 of [IF1] is applicable. For this specific use case the following additional remarks are applicable:<br>1) Road Sign Codes: the road-sign codes according to ISO14823:2017 are applicable<br>2) The specific pictogram as applicable for eVMS service will be used, e.g. `pictogramCategoryCode` 421 - No entry for goods vehicles<br><br><br>3) extraText: for the specific “free text” the field extraText is used with<br>a. `language:` ISO 639-1 language code, e.g. fr for French, en for English and nl for Dutch<br>b. `textContent:` the text itself<br>The text may be sent in multiple languages. |
| **Functional and non-functional requirements** | |
| **Sources of information** | • The road manager for information concerning traffic management, events, etc.<br>• Other road managers during coordinated traffic management<br>• Public or transport authorities for all information concerning pollution, |

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| | kidnap alert, etc.<br>• Other partners for all information concerning demonstrations, sport events, etc. |
| **Standards** | • CEN/ISO TS 17425<br>• CEN/ISO TS 19321<br>• CEN/ISO TS 14823 (Graphic data dictionary) |
| **Technical Constraints / Dependencies** | • France: The French regulations (IISR part 9) do not specify the number of lines or characters and follows the recommendations of Geneva's agreements (RES2) of 7 words at most. In the SCOOP project, we will not limit ourselves to the IISR part 9 guideline, we choose to use a non-regulatory technical French guideline (*Panneaux à messages variables – La composition des messages – Collection Références CEREMA – 2014* issued by the CEREMA) recommends that the VMS have at most 4 lines of 21 characters each.<br>• It is possible that some duplicates occur between DENM messages (or other messages) and embedded VMS messages. Therefore, SCOOP bias is to consider that it is up to the road operator to deal with that redundancy (between DENM or IVI messages) of information by having his own I2V broadcast policy, so that the information broadcasted is in coherence with the sources of information available in the TCC and is the more likely to be accurate.<br>• Service providers including car manufacturers might have limited control over the display options on HMI as they do not know the content of the message. This can lead to driver distraction if road managers do not implement an optimized management policy for these messages.<br>• A prioritization between the different C-ITS messages is needed.<br>• Next step: In the technical specifications: work on zone definitions; establishing a correspondence between the signs used in the VMS and the graphic data dictionary. |

### 5.2.3 Dynamic Lane Management - Lane Status information

#### *5.2.3.1 Functional description*

| **Dynamic Lane Management - Lane Status information** | |
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| **Use case introduction** | |
| **Summary** | The service is to inform drivers of the status of any lane (open/closed, normal or rush hour) of a road. |
| **Background / added values** | Dynamic lanes support sustainable mobility. This service enables the road manager to optimize the management of the lane knowing the real-time traffic characteristics.<br>Currently, dynamic lanes need to be clearly identified in the field by signalization, for instance, lane control signs located gantries. With this service, it would be possible to implement easier dynamic lane on the networks. |
| **Objective** | Inform the user of a dynamic lane opening, and notify the driver whether vehicle is allowed or not to use it. |
| **Desired behaviour** | Only authorized vehicles use the reserved lane. |
| **Expected benefits** | Better awareness and improved safety |
| **Use case description** | |

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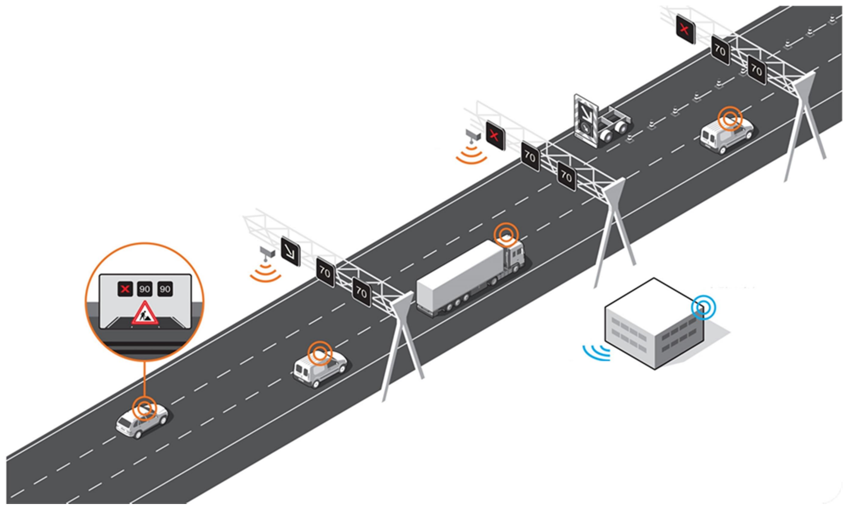
| **Situation** | IVS shows both static and dynamic information of road signs. In the European countries different Variable or Dynamic Message Sign (VMS) systems are deployed on parts of the highway. The VMS systems can be used to inform drivers on road conditions, travel times, and advised routes.<br><br>**Figure 6: In-vehicle information: status information of lanes on a variable message system also sent as IVS service** |
| **Logic of transmission** | I2V, broadcast |
| **Actors and relations** | • Vehicle driver: receives IVS information, warnings and/or guidance on the in-vehicle display.<br>• Road operator: provides info on dynamic road signage.<br>• Service provider: disseminates IVS information, warnings and/or guidance from road operators to vehicle drivers.<br>• End user: trip planners may use IVS information, and expected delays caused by these, to optimise their trip planning.<br>• Vulnerable road user: n/a |
| **Scenario** | While driving on a highway, vehicle drivers receive actual IVS related information, warnings and/or guidance on the in-vehicle display. Instructions may include to reduce the driving velocity, to change lanes, to prepare for a steering manoeuvre, etc. |
| **Display / Alert logic** | IVS information shall be displayed to the driver and shall be consistent with the actual dynamic lane control traffic signs. |
| **Functional Constraints / Dependencies** | The presentation of information on the HMI is not part of the service description. It is left to providers of the In-Vehicle information system with HMI how information is presented. Information might be translated to the preferred language of the driver.<br>The information presented by means of I2V is not legally binding: Information should be handled as ‘convenience information’ and presented accordingly to the driver, as currently done within navigation systems. Before using the system/service the driver should be asked to confirm that he is aware that the road signs on the road are legally binding, whatever the in-car system says. This applies also for possible errors in translations of messages and signs. |

### *5.2.3.2 High level technical description*

| **Use case implementation** | |
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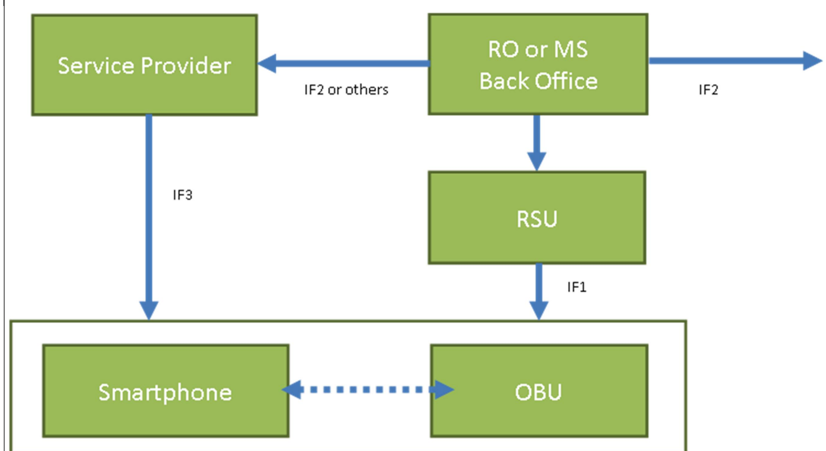
| **Model implementation** | In Cooperative-ITS (C-ITS), presenting information related to the traffic situation or regulation of a road to the driver of a vehicle is an important component of road operations. The road operators are responsible for road setup, operation, signage and maintenance to support traffic management and road safety, and in some countries, also for the enforcement of road laws. Road operators contribute to how road information is properly distributed to drivers via IVS. This use case supports mandatory and advisory road signage such as contextual speeds around road works. IVS information can either be sent via ITS-G5 based networks of RSUs or via (mobile) Internet. The corresponding messages for ITS-G5 for IVS (IVI message) will be sent by a Roadside ITS-S. The information is presented to the driver via a HMI. |
| **Reference architecture** | <br>The figure above is an example how the IVS service can be offered: i.e. how a (public) road operator can enclose IVS information directly via IF1 (RSU-OBU) and indirectly via IF2 (back-office interface to service provider or to other Member States). The actual implementation of IF2 is not universal to all InterCor Member States.<br>The process for the IVS application as foreseen contains several steps:<br>• The RO back-office system is triggered by an external trigger (not shown) that dynamic signalling is activated. The dynamic signalling system along the highway is used to show information of closed lanes and reduced speed limits dynamically on road signs.<br>• The RO back-office triggers RSUs to send ITS messages (IVI) via IF1 to an OBU.<br>• The RO back-office also forwards the ITS messages (IVI) via IF2 to service providers.<br>The service provider determines whether an IVS message is required for the individual user, and sends the appropriate information to the smart phone or any other connected in-vehicle system via IF3. The smartphone or any other connected in-vehicle system determines based on the input from IF1 and IF3 what to put on the HMI, and shows the IVS information, if required. |
| **Relation to InterCor profiles** | The IVS Use Case Dynamic Lane Management is based on the exchange of IVI messages (VIM) towards vehicles (I2V) as specified in the InterCor profiles for the interfaces IF1 (ITS-G5 network, RSU to OBU) and IF2 |

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| | (back-office, for distribution via cellular networks):<br>1) IF1: InterCor Milestone 3 – Common set of upgraded specifications for ITS-G5 (version 1.1, 20/10/2017) [REF: IF1] – definition of IVI message<br>2) IF2: InterCor - Specifications for IF2 for hybrid communication (v1.0, 17/12/2017) [REF: IF2]<br>The IF1 document is aligned in the C-ROADS Platform via the latest version: C-ROADS C-ITS Infrastructure Functions and Specifications (release 1.1, version 6.0, 21/03/2018).<br>The specification for the Network & Transport layer (GeoNetworking and BTP) and the Radio Access layer (IEEE 802.11p and G5 radio channels in the 5.9 GHz ITS band) is still work-in-progress. For IVS the C-ROADS Platform profile “Roadside ITS G5 System Profile” will be applicable.<br>IVI messages (IVIM) are used for this service and can be sent via both IF1 and IF2. The profile as specified in section 4.3 of [IF1] is applicable. For this specific use case the following additional remarks are applicable:<br>1) Road Sign Codes: the road-sign codes according to ISO14823:2017 are applicable<br>2) For dynamic lane management several `pictogramcode` for the traffic sign are used with:<br>a. `countryCode`: : ISO 3166-1 code for countries, e.g. BE for Belgium,<br>b. `serviceCategorycode`: 13 (1: Traffic Sign, 3: Informative)<br>c. `pictogramCategoryCode`:<br>i. 659 - Lane closed<br>ii. 660 - Lane free<br>iii. 661 - Clear lane to left<br>iv. 662 - Clear lane to right<br>v. 663 - End of all restrictions by electronic signs<br>d. No attributes<br>Note: other electronic signs may be used in specific countries. The corresponding pictogramcode of ISO 14823:2017 will be used, if available. For this use case which is lane specific, the description of all lanes is needed. |
| **Functional and non-functional requirements** | |
| **Sources of information** | • Database with location and type of all static road signs;<br>• (Virtual) variable message sign systems for other dynamic traffic signs, e.g. for overtaking prohibition. |
| **Standards** | • ETSI TS 103 301 v1.1.1 (2016-11) - Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services;<br>• CEN/ISO TS 19321:2015 - Intelligent transport systems - Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures;<br>• CEN/ISO TS 14823:2017 - Traffic and travel information -- Messages via media independent stationary dissemination systems -- Graphic data dictionary for pre-trip and in-trip information dissemination systems;<br>• CEN/ISO TS 17426:2016 Intelligent transport systems — Cooperative systems — Contextual speeds (Note: this TS refers to |

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| | message format of ISO TS 19321);<br>• CEN/ISO TS 17425:2016 Intelligent transport systems -- Cooperative systems -- Data exchange specification for in-vehicle presentation of external road and traffic related data;<br>• CEN/ISO TS 17423:2014 Intelligent transport systems -- Cooperative systems -- ITS application requirements and objectives for selection of communication profiles<br>• CEN/ISO TS 17429:2017 Intelligent transport systems -- Cooperative ITS - ITS station facilities for the transfer of information between ITS stations. |
| **Technical Constraints / Dependencies** | • The information from the VMS systems has to be made available by road operators.<br>• For traffic signs a standardised catalogue (e.g. ISO 14823) for traffic signs needs to be used, including dynamic signs.<br>• The VMS information on regulatory signs must be consistent with the actual info displayed on the VMS and must be available in near-real time.<br>• The location information needs to be accurate on road and lane level, and related to the physical location of the actual roads signs.<br>• All information of the road signs needs to be available in the data elements of the IVS messages.<br>• All roles in the above functional architecture have to be fulfilled. |

 

# 6 PVD

## *6.1 PVD High Level Description*

| Service introduction | |
|---|---|
| **Summary** | The Probe Vehicle Data (PVD) is a service enabling vehicles to send data to the road operator. |
| **Background** | • Modern vehicles know at any time their own position, speed and direction<br>• Moreover, thanks to their sensors / embedded technologies, they also know specific events affecting the driving experience (windscreen wiper status, ABS, ESP, collision sensors, etc.).<br>• This data could be used by the road operator to get a more comprehensive knowledge of its network (especially in areas not equipped with counting loops).<br>• This data could also be used to enhance the road operator's knowledge of events, complementing cameras, patrol and other existing sources. |
| **Objective** | The objective of the service is to collect data from vehicles. |
| **Expected benefits** | • The collected data permits to enhance the road operator knowledge of its network:<br>  ○ Characterize in a finer way the impact of events on traffic (development of congestion, end of queue evolution, etc.)<br>  ○ Identify more precisely the critical points of the network<br>• Assist in the development and evaluation of traffic management strategies and measures<br>• The collected data proves as a basis for other I2V applications which are improved or possibly otherwise impossible. Impact of such applications include:<br>  ○ Safer road conditions (e.g. warning on a slippery road)<br>  ○ Lower $CO_2$ emissions (resulting from a more stable traffic flow)<br>  ○ Faster travel times (because of more optimal rerouting of traffic).<br>  ○ More reliable journey times |
| **Use Cases** | 1. Traffic data collection<br>2. Probe vehicle data on detected/declared events |

Note: For the different use cases the following sources were used:

The Netherlands:

- Dutch C-ITS Corridor (https://itscorridor.mett.nl)
- Praktijkproef Amsterdam (http://www.praktijkproefamsterdam.nl/default.aspx)

France:

- French catalogue of services related to connected vehicle

 

## 6.2 PVD Use Cases

### 6.2.1 Traffic data collection

#### 6.2.1.1 Functional description

| **Traffic data collection** | |
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| **Use case introduction** | |
| **Summary** | The service is the automatic reporting of traffic data from the vehicle to the road manager. |
| **Background / added values** | • Modern vehicles know at any time their own position, speed and direction.<br>• This data could be used by the road operator to get a more comprehensive knowledge of its network (especially in areas not equipped with counting loops). |
| **Objective** | The objective of the service is to collect data from vehicles. |
| **Desired behaviour** | • No specific behaviour is expected from road users for whom the operation of the service is totally invisible.<br>• Data can be used by the road manager as input for monitoring and evaluation, as well as for I2V use cases. |
| **Expected benefits** | • Allow the road manager to know especially the average speed at each point of its network.<br>• Characterize in a finer way the impact of events on traffic (development of congestion, end of queue evolution, etc.).<br>• Identify more precisely the congestion/pinch points of the network.<br>• Assist in the development and evaluation of traffic management strategies and measures. |
| **Use case description** | |
| **Situation** | A driver is driving his vehicle along the road. The vehicle automatically sends messages, with a given frequency, related to the vehicle's traffic data (position, direction, speed). |
| **Logic of transmission** | V2I Broadcast |
| **Actors and relations** | • **The vehicle** is the source of the information, through its sensors.<br>• **The vehicle driver**, possibly, needs to give its consent regarding automatic sharing of his vehicle's data.<br>• **The road operator** collects the data from vehicles.<br>• **The end-users** of the data are road operators and possibly service providers.<br>• **Service provider:** uses the information derived from the data to provide warnings and advice.<br>• **Others**: OEMs can act as a service provider, but also as an intermediate between the service providers and the end users. |
| **Scenario** | 1. The vehicle regularly generates messages indicating its speed, position and direction.<br>2. Messages from the vehicles are received, and transmitted to the (ITSS-C platform).<br>3. The data is collected, anonymised, aggregated and consolidated within road side units or back-offices according to a parameter defined by the road manager.<br>4. Data is accessible in the Traffic Management System (TMS) of the road |

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| | manager. |
| **Display principle / Alert logic** | This use case is totally invisible for the road user. There are no alerts / information displayed on the vehicle's HMI. |
| **Functional Constraints / Dependencies** | • **Technology of communication**:<br>o If the technology of communication used is the ITS-G5, data will be received by the road operator only if a RSU is within range of the vehicle sending messages.<br>o A solution to handle this problem would be to equip vehicles with a function which stores the messages or the information they contain as long as it doesn't cross a RSU. RSU could send requests to vehicles when in communication range. Vehicles receiving this request could then send the stored messages/information ("extended Probe Vehicle Data"). Note: This is (currently) out of scope for interoperability within InterCor, because BE/FLA can currently not agree on any usage/support for an implementation of extended PVD because of privacy concerns.<br>• **Readiness of OEMs to broadcast data:**<br>o Road authorities are dependent on what information will be broadcasted from the C-ITS equipped cars.<br>o To a certain extent, it is up to OEMs what data will be broadcasted.<br>• **Privacy** plays an important role. It is expected that car owners must answer a question whether they allow their data to be used for purposes as thought out by the road authorities (i.e. traffic jam detection, policy making, etc.).<br>• **Standardization:** The CAM standard has limitations in terms of data types. It would be particularly useful to extend it, for example to integrate the occupancy rate of the vehicle. |

#### *6.2.1.2 High level technical description*

| **Use case implementation** | |
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| **Model implementation** | The source of the data is the vehicle which sends its speed, position and direction at a high frequency. This data is recovered by RSUs installed on the roads or back-offices over cellular networks. This data alone is not sufficient and must be transformed in order to be useful for the end user. This transformation is done by the ITSS-C (also possible on the RSU) so that the result is of interest to the end-user. |
| **Reference architecture** | The process for this service contains several steps:<br>1. The vehicle regularly generates cooperative awareness messages (CAM) indicating its speed, length position and direction (1a or 1b).<br>2. Messages from the vehicles are received by RSU using IF1 (ITS-G5 link - 1b) or the service provider (1a) using IF3. |

 

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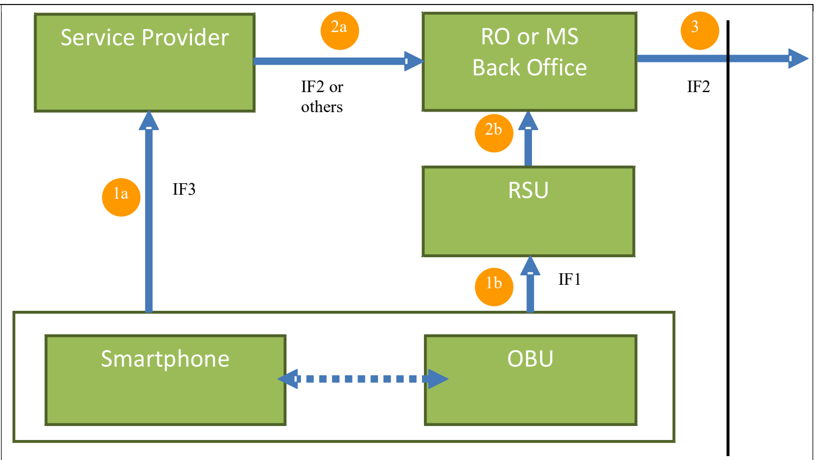
| | <br>3. The data is collected, crossed, aggregated and consolidated within the road side units/service providers or the back-office according to a parameter defined by the road manager.<br>4. Data is accessible in the Traffic Management System (TMS) of the road manager (2a or 2b).<br>5. If requested and available, the CAM (and not the aggregated data) is sent through IF2 to other Member States. |
| **Relation to InterCor profiles** | The CAM message is profiled in the report of Milestone 3 (clause 4.5).<br>Note:<br>Only one CAM message every second sent over ITS-G5 contains the PKI certificate that can help decode the signature. The RSU will only be able to decode one CAM message every second then, unless they keep the certificate from the first CAM message that contains it. Still under discussions whether the CAM message is signed over the hybrid link. |
| **Functional and non-functional requirements** | |
| **Sources of information** | - Sensors/configuration of the vehicle<br>- GNSS information from the vehicle |
| **Standards** | • ETSI TS 103 301 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>• ETSI EN 302 637-2 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service<br>• TSI TS 101 539-1 - Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification<br>• ETSI TS 102 894-2 - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary |
| **Technical Constraints / Dependencies** | None |

### 6.2.2 Probe vehicle data on detected or declared events

#### *6.2.2.1 Functional description*

| **Probe vehicle data on detected or declared events** | |
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| **Use case introduction** | |
| **Summary** | The service provides the reporting of specific event information from the vehicles to the road manager.<br>Probe Vehicle Data will improve information on traffic conditions, the condition of the road and possibly its surroundings, enabling the road operator to improve traffic conditions, safety, and the environment (CO2 reduction). |
| **Background / added values** | • Thanks to their sensors / embedded technologies, vehicles know specific events affecting the driving experience (windscreen wiper status, ABS, ESP, collision sensors, etc.).<br>• But some events cannot be detected automatically by the vehicle itself (e.g. Animal on the road, unmanaged blockage of a road, etc.). For such events, the driver himself could be a source of information to detect some specific events and to warn the road operator.<br>• This data could be used to enhance the road operator's knowledge of events, complementing cameras, patrol and other existing sources. |
| **Objective** | The objective of the service is to collect data about traffic conditions, road surface conditions and the environment. |
| **Desired behaviour** | • No specific behaviour is expected from road users for whom the operation of the service is totally invisible in case of vehicle detected events. For driver detected events, the ability of the driver to pull up information quickly, without putting himself in danger is necessary.<br>• For the road operator, the collected data gives insight in the traffic situation and surroundings. These are used as input for monitoring & evaluation (e.g. for policy making) and other I2V use cases such as traffic condition warning, hazardous location notification and adverse weather condition. |
| **Expected benefits** | For the road manager, the service permits to detect and to qualify more precisely and more efficiently road events on its network. The collected data proves as a basis for other I2V applications which are improved or possibly otherwise impossible. |
| **Use case description** | |
| **Situation** | A vehicle is driving along the road, detects a specific event, and transmits a message automatically. Specific event are:<br>• Stationary vehicle<br>• Vehicle in accident<br>• Emergency braking<br>• Traffic jam ahead/Warning – dangerous end of queue |
| **Logic of transmission** | V2I Logic, Broadcast |
| **Actors and relations** | • **The vehicle** is the source of the information, through its sensors.<br>• **The vehicle driver**, possibly, needs to give its consent regarding automatic sharing of his vehicle's data.<br>• **The road operator** collects the data from vehicles.<br>• **The end-users** of the data are road operators and possibly service providers.<br>• **Service provider:** uses the information derived from the data to provide warnings and advice.<br>• **Others**: OEMs can act as a service provider, but also as an intermediate between the service providers and the end users. |

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| **Scenario** | 1 Two possibilities:<br>• Vehicle detected event:<br>The vehicle automatically detects an event, the OBU sends a message in broadcast.<br>• Driver detected event:<br>The driver observes an event and informs the OBU via the HMI. The OBU sends a message in broadcast.<br>2 The message is received and transmitted to the back-office.<br>3 The data is collected, cross-checked, aggregated and consolidated within the road manager back-office.<br>4 The data is then made available to the road manager on a dedicated database; He can access it from his TMS to assist in the operation of the network and / or generate automatic alerts directly to the occurrence of certain events.<br>5 This will allow it, in return, to send this information back down to the vehicles (I2V). |
| **Display / Alert logic** | This use case is totally invisible for the road user for vehicle detected events. There are no alerts / information displayed on the vehicle's HMI. |
| **Functional Constraints / Dependencies** | • **Technology of communication**:<br>o If the technology of communication used is the ITS-G5, data will be received by the road operator only if a RSU is within range of the vehicle sending messages.<br>o A solution to handle this problem would be to equip vehicles with a function which stores the messages or the information they contain when the vehicle is not covered by an RSU around. RSU could send requests to vehicles when in communication range. Vehicles receiving this request could then send the stored messages/information ("extended Probe Vehicle Data").<br>• **Readiness of OEMs to broadcast data:**<br>o Road authorities are dependent on what information will be broadcasted from the C-ITS equipped cars.<br>o To a certain extent, it is up to OEMs what data will be broadcasted.<br>• **Privacy** plays an important role. It is expected that car owners must answer a question whether they allow their data to be used for purposes as thought out by the road authorities (i.e. traffic jam detection, policy making, etc.).<br>• **The driver** can be distracted when he reports the event on the HMI. |

#### *6.2.2.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | The source of the data is the vehicle which sends events automatically or triggered by the driver. This data is recovered by RSUs installed on the roads. This data alone could not be understandable and must be transformed in order to be useful for the end user. This transformation is done by the ITSS-C (also possible on the RSU) so that the result is of interest to the end-user. |

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<tr>
<td>Reference architecture</td>
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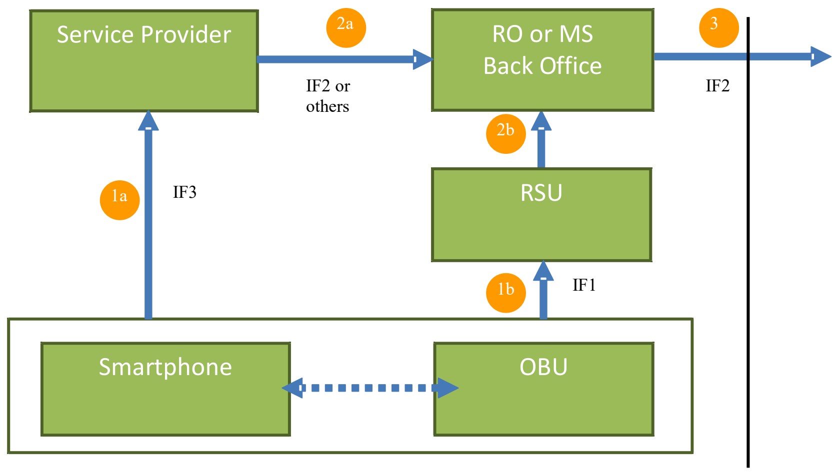

The process for this service contains several steps:<br>
1 The vehicle automatically detects an event or the driver observes an event and informs the OBU manually via the HMI.<br>
2 The vehicle sends a DENM message through IF3 (1a) or IF1 (1b)<br>
3 The message is received by a road side unit and transmitted to the back-office of the road manager (2b) or the service provider (and transmitted to the MS or RO back-office (2a).<br>
4 The data is collected, crossed, aggregated and consolidated within the back-office of the road operator according to a parameter defined by the road manager.<br>
5 If requested and available, the DENM (and not the aggregated data) are sent through IF2 to other Member States.
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<tr>
<td>Relation to InterCor profiles`</td>
<td>
The DENM profiles for those 4 use-cases (Stationary vehicle, Vehicle in accident, emergency braking, traffic jam ahead/Warning – dangerous end of queue) are not available in the Milestone 3 report.<br>
However, one can use the RWW DENM profile (clause 4.2.1) and change the DE eventType (causeCode/subCauseCode) depending on the use-case:<br>
Stationary vehicle : 94/0 (stationary vehicle) – 94/2 (broken down vehicle)<br>
Vehicle in accident : 94/3 (post-crash vehicle) – 2/0 (accident)<br>
Emergency braking : 99/1<br>
Traffic jam ahead/Warning – dangerous end of queue: 27/0<br>
<u>Note :</u><br>
- Only the following DE will be used by the road operator for PVD: actionID, detectionTime (to identify uniqueness of the event), termination (to check if ended), eventposition, eventHistory (if any), validityDuration (to check if ended), informationQuality (this is where the difference might be made between detected or declared events), eventType, eventSpeed, eventPositionHeading, traces (to identify the direction of the event).<br>
- The DENM messages need to be signed and to contain the appropriate certificate that helped sign the message (still under discussion whether the DENM message is signed over the hybrid link).
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<tr>
<td colspan="2">Functional and non-functional requirements</td>
</tr>
<tr>
<td>Sources of information</td>
<td>Sensors or driver of the vehicle</td>
</tr>
<tr>
<td>Standards</td>
<td>
• ETSI TS 103 301 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>
• ETSI EN 302 637-3 – Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.
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| | • ETSI TS 101 539-1 - Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification<br>• ETSI TS 102 894-2 - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary |
| **Technical Constraints / Dependencies** | None |

# 7 GLOSA

## 7.1 GLOSA High Level Description

| Service introduction | |
|---|---|
| **Summary** | This document described requirements for the GLOSA use case and it represents the collective input from France, Netherlands and the UK.<br>Vehicles approaching traffic signal controlled intersections inform the driver in advance about the status of the traffic signals, and also advise them of an optimum approach speed that should minimise delay and ensure a smooth transition through the conflict area of an intersection. |
| **Background** | The GLOSA service provides drivers (via an in-car information system), or vehicle control systems, with advisory speed information. The advisory speed information is derived from a combination of traffic signal phasing and timing information (SPAT) that is relevant to the position and direction of travel of the vehicle, and the topology of the intersection (MAP). |
| **Objective** | To calculate advisory speeds for vehicles that will enable a vehicle or platoon of vehicles to pass through a signalised intersection in the most efficient manner, with minimal delay. |
| **Expected benefits** | The primary expected benefit is smoother vehicle flow through signalised intersection, reduced start/stop delay and reduced desire to chase green signals or the need to rapidly decelerate. With knowledge of the likely duration of the red signal, the driver or vehicle control system can also determine whether or not to stop the vehicle's engine.<br>This should result in reduced energy consumption, reduced vehicle emissions (including CO2), reduced vehicle wear and tear, increased safety, improved driver and passenger comfort, reduced stress and better average speeds, particularly in urban environments where there is generally a higher density of traffic signals.<br>Where a vehicle is stationary at a red light and where the provision of 'countdown to green' information is permitted, the start delay is expected to decrease as the start of the green phase is known in advance.<br>Secondary benefits may result from interaction with other use cases like 'Traffic Signal Optimisation', e.g. driving speeds and the signal phases and timing could be optimised synchronously to reduce delay. |
| **Use Cases** | There are two primary use cases:<br>UC 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.<br>UC 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. |

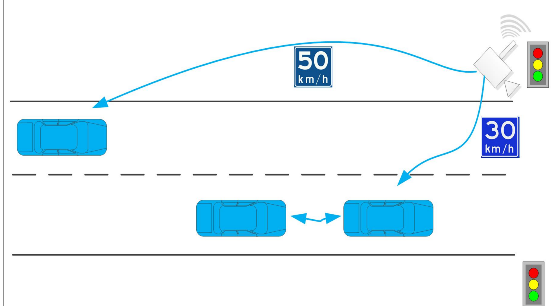
 

## 7.2 GLOSA Use Cases

### 7.2.1 Time-to-green information and speed advice

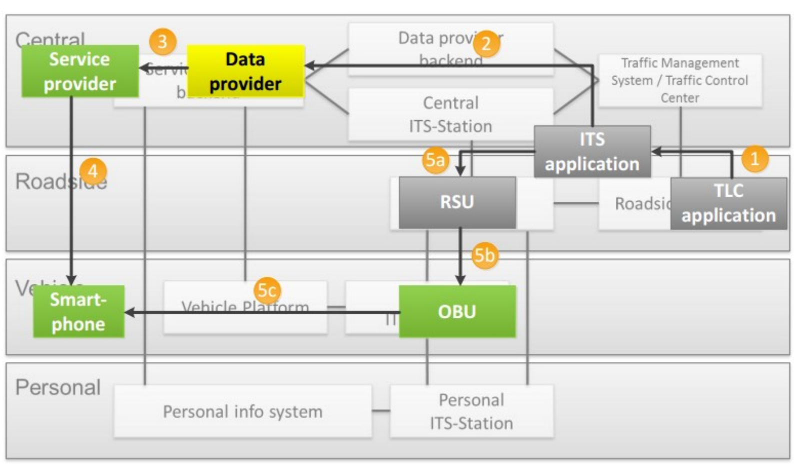
#### 7.2.1.1 Functional description

| Time-to-green information and speed advice | |
|---|---|
| **Use case introduction** | |
| **Summary** | While approaching a signalised intersection information is broadcast 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), or via a central system via cellular 3G/4G.<br>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). Vehicle drivers receive the speed advice information via the display (HMI) of the vehicle's OBU.<br>Where legally permitted, when stationary at a red traffic signal, road users may also be advised of the time to green. |
| **Background / added values** | The information can be displayed in the driver's own language.<br>Reduced driver anxiety and improve compliance with traffic signals. |
| **Objective** | The aim is to display an alert to the user that they are approaching a signalised intersection and to provide an advisory speed, or to notify the driver (where permitted) of the likely 'time to green'. |
| **Desired behaviour** | The vehicle driver or the vehicle controls will adjust the speed of the vehicle to comply with the speed change advice, and will maintain that speed while approaching or passing the signalised intersection. Or, they will be prepared to decelerate smoothly if they arrive at the intersection when it is displaying a red traffic signal. |
| **Expected benefits** | Comfort, safety and reduced fuel consumption and emissions. |
| **Use case description** | |
| **Situation** | 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. |
| **Logic of transmission** | I2V via G5 beacon located at the traffic signal intersection, or cellular 3G/4G. |
| **Actors and relations** | • Vehicle driver: receives speed advisory information on the in-vehicle display (OBU HMI).<br>• Road Operator or Highway Authority: provides signal phasing and timing (SPAT) and map information, either locally from the traffic signal controller, or centrally from their traffic signal control system.<br>• Service provider: disseminates the speed advisory information to vehicle drivers.<br>• Vulnerable road user: speed advisory information may be offered to cyclists too. Crossing vulnerable road users may affect the validity of the speed advisory information.<br>• Other: n/a. |
| **Scenario** | There are three possible scenarios: |

| | |
|---|---|
| | 1. As indicated by the speed advice a vehicle maintains the current speed and arrives at the intersection during a green phase.<br>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.<br>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. |
| **Display / alert principle** | GLOSA speed advice information and 'time to green' information shall be displayed to the driver via the HMI.<br><br><br>**Figure 7: Green light optimal speed advisory**<br>The SPAT / MAP information that is broadcast from the R-ITS-S/ G5 or via cellular communication reflects the real-time signal phase & timing status for each lane. Based on the SPAT / MAP information the vehicle (V-ITS-S) may advise an optimal speed to the driver for smoothly approaching the intersection (in case of red).<br>The potential display/ alert scenarios are as follows:<br>• When the light is red and the driver has to stop, the advice is to stop. The time to green (TTG) can be given only if permitted.<br>• When the light is red but about to turn green, the driver receives speed advice. The advice may either be to continue, or to reduce their speed in order to arrive at the intersection on a green signal phase. |
| **Functional constraints / dependencies** | • The speed advice has to be equal to or lower than the legal speed limit.<br>• The presentation of information on the HMI is <u>not</u> part of the service description. It is left to the provider of the in-vehicle information system how the information is presented. Information might e.g. be translated to the preferred language of the driver.<br>• The information presented by means of I2V is advisory information and may not take into consideration variables such as road conditions including weather or traffic density/ congestion. |

### *7.2.1.2 High level technical description*

| **Use Case Implementation** | |
|---|---|
| **Model Implementation** | Vehicles approaching a traffic light will inform the driver in advance about the traffic signal status for crossing the conflict area of an intersection. The vehicle (V-ITS-S) may advise an optimal speed to the driver for smoothly approaching the intersection (in case of red) or for safely passing the conflict area of the intersection based on the signal phase and timing (SPAT) and intersection |

<table>
<tr><td></td><td>
topology (MAP) information. This information will either be received from the local infrastructure (R-ITS-S / G5), or it will be provided centrally via cellular (3G/4G) communication.<br><br>
The Signal Phase and Timing message (SPAT) and the corresponding intersection layout message MAP as specified in SAE-J2735 are messages designed for infrastructure-to-vehicle communication. Their purpose is to transmit either the current and/or the future status of signalling on the entire intersection in an electronic, machine readable way to vehicles.<br><br>
The SPAT / MAP information that is broadcast, together with other information, reflects the real-time signal phase & timing status for each lane. Therefore, a vehicle may be able to calculate or derive the optimal speed advice for each lane.<br><br>
Fast (low latency) communication and suitable HMI to communicate to the driver are needed. The GLOSA application communicates information to the driver about which speed he should adopt to keep in continuous flow with no need to stop. The millisecond timing is less important than the fact that a correct forecast-message is available before reaching the intersection.<br><br>
A digitised map of the area is also pre-requisite for SPAT, which might include road topography and road attributes, such as number of lanes on each approach to the intersection and the manoeuvres possible between them. SPAT messages relate to these relations in the MAP.<br><br>
Once the SPAT with forecast and a MAP is implemented, this enables Green Light Optimal Speed Advisory (GLOSA) to be given to the drivers via the same interface.<br><br>
Drivers travelling at or close to the advised speed are likely to clear the intersections, creating what is commonly referred to as the “Green Wave” - minimising erratic stop/start behaviour.
</td></tr>
<tr><td>Reference architecture</td><td>
NL: In the Netherlands, the GLOSA service is implemented following the architecture of the ‘intelligent Traffic Light Controller’ (iTLC). The architecture allows for integration of the C-ITS domain with the TLC domain by allowing ITS Applications to use facilities from both the Traffic Light Controllers (TLC) and Roadside ITS stations (RIS) and therefore enables the implementation of various ITS use-cases related to TLC’s. The ‘TLC-Facilities’ and ‘RIS-Facilities’ describe the functionality of respectively TLC and RIS. The goal of the architecture is to provide the TLC Facilities and RIS Facilities functionality to ITS Application by defining open interfaces.<br><br>
The figure below shows the functional architecture of the GLOSA service.<br><br>


Every colour could indicate another stakeholder<br><br>
The process for this application contains several steps:
<ul><li>The ITS application receives TLC-information from TLC applications (1).</li></ul>
</td></tr>
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<tr><td></td><td><ul><li>The ITS application sends messages containing SPAT / MAP information towards data providers (2) and towards RSUs (5a) to broadcast the message during the requested duration time with a specific repetition rate to OBUs (5b). In the vehicle the message of the OBU is forwarded to an application on a smartphone (5c).</li><li>Data providers collect the data of ITS applications and provide that to service providers (3).</li><li>Service providers determine whether SPAT / MAP information is required for individual users and send the appropriate information to smartphones (4).</li></ul>UK: The above reference architecture is fully applicable to the KCC pilot and items 1 – 4 are applicable to TfL.</td></tr>
<tr><td>Relation to InterCor profiles</td><td>The GLOSA Use Case uses SPAT and MAP messages towards vehicles (I2V) are as specified in the InterCor profiles for the interfaces IF1 (ITS-G5 network, RSU to OBU) and IF2 (back-office, for distribution via cellular networks):<ul><li>IF1: InterCor Milestone 3 – Common set of upgraded specifications for ITS-G5 (version 1.1, 20/10/2017) [REF: section 4.4] – definition of GLOSA</li><li>IF2: InterCor - Specifications for IF2 for hybrid communication (v1.0, 17/12/2017) [REF: IF2]</li></ul>SPAT and MAP messages are used for this service and can be sent via both IF1 and IF2. The profile as specified in section 4.4 of [IF1] is applicable.</td></tr>
<tr><td colspan="2">Functional and non-functional requirements</td></tr>
<tr><td>Sources of information</td><td>The following information will be provided locally at each junction via the infrastructure, i.e. Traffic Light Controllers (TLC) and Roadside ITS stations (RIS) through IF1, and/or it will be provided centrally via cellular communication (3/4G) through IF2 (AMQP):<ul><li>Signal Phase and Timing message (SPaT)</li><li>Intersection topology message (MAP)</li></ul>For any communication over ITS G5 the service will use PKI.</td></tr>
<tr><td>Standards</td><td>The following standards apply to GLOSA:<ul><li>ETSI TS 103 301<br>Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services</li><li>SAE J2735<br>Dedicated Short Range Communications (DSRC), Message Set Dictionary.</li><li>CEN ISO/TS 19091<br>Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections.</li></ul></td></tr>
<tr><td>Technical Constraints / dependencies</td><td><ul><li>The highly dynamic nature of some traffic control systems, which are able to make late signal phasing decisions, combined with other adaptive systems (e.g. selective vehicle detection bus priority), could limit the viability of GLOSA in some applications.</li><li>For GLOSA via G5: The TLC is connected to R-ITS-S and can provide information on the current and next signal phase or phases.</li><li>For GLOSA via 3G/4G cellular: back-office systems and interfaces exist or are established to enable the outputting of current and next signal phase information to the cloud.</li></ul></td></tr>
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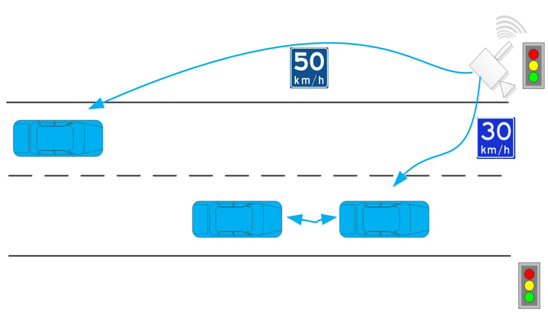
| | • GPS accuracy could potentially be a constraint at signal controlled intersections that employ multiple traffic phases on an approach (e.g. left turn and/or right turn traffic phases that are on a different phase to the ahead movement). OBUs will need to be able to identify a vehicle's position and intended direction, or route, with sufficient accuracy in order to identify the correct traffic phase.<br>• R-ITS-S is able to send information on the static topology of the signalised intersection. Optionally this static information is provided to V-ITS-S by other methods.<br>• R-ITS-S supports I2V services and can send information on signal phase and timing.<br>• V-ITS-S supports I2V services and can receive information on signal phase and timing.<br>• If there is a traffic queue/ congestion in front of a traffic light, GLOSA becomes useless, but could be adapted if it is possible to integrate this information into the algorithm.<br>• GLOSA depends on the data provided by the Traffic light controller or centrally. The information that is provided may not be adapted to GLOSA, especially if the phases are adaptive.<br>• Information received by the OBU via 3G/4G cellular should be consistent with information received via G5. |

### 7.2.2 Time-to-red information and speed advice

#### *7.2.2.1 Functional description*

| **Time-to-red information and speed advice** | |
|---|---|
| **Use case introduction** | |
| **Summary** | While approaching a signalised intersection information is broadcast 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), or via a central system via cellular 3G/4G.<br>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). Vehicle drivers receive the speed advice information via the display (HMI) of the vehicle's OBU. |
| **Background / added values** | The information can be displayed in the driver's own language. Reduced driver anxiety and improve compliance with traffic signals. |
| **Objective** | The aim is to display an alert to the user that they are approaching a signalised intersection and to provide an advisory speed, or to notify the driver to be prepared to stop. |
| **Desired behaviour** | The vehicle driver or the vehicle controls will adjust the speed of the vehicle to comply with the speed change advice, and will maintain that speed while approaching or passing the signalised intersection. Or, they will be prepared to decelerate smoothly if they are likely to arrive at the intersection when it is displaying a red traffic signal. |
| **Expected benefits** | • Smoother vehicle flow through signalised intersection, reduced start/stop delay and reduced desire to chase green signals or the need to rapidly decelerate.<br>• Improved driver and passenger comfort.<br>• Increased safety.<br>• This should result in reduced energy consumption, reduced vehicle |

| | |
|---|---|
| | emissions (including CO2), reduced vehicle wear and tear.<br>• Reduced stress and better average speeds, particularly in urban environments where there is generally a higher density of traffic signals. |
| **Use case description** | |
| **Situation** | 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. |
| **Logic of transmission** | I2V via G5 beacon located at the traffic signal intersection, or 3G/4G. |
| **Actors and relations** | • Vehicle driver: receives speed advisory information on the in-vehicle display (OBU HMI).<br>• Road Operator or Highway Authority: provides signal phasing and timing (SPAT) and map information, either locally from the traffic signal controller, or centrally from their traffic signal control system.<br>• Service provider: disseminates the speed advisory information to vehicle drivers.<br>• Vulnerable road user: speed advisory information may be offered to cyclists too. Crossing vulnerable road users may affect the validity of the speed advisory information.<br>• Other: n/a. |
| **Scenario** | There are two possible scenarios:<br>1 As indicated by the speed advice a vehicle maintains the current speed and arrives at the intersection during a green phase.<br>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. This facility may not be implemented in all Member States. |
| **Display / Alert logic** | GLOSA speed advice information and 'time to red' information shall be displayed to the driver via the HMI.<br>GLOSA speed advice information and 'time to green' information shall be displayed to the driver via the HMI.<br><br>**Figure 8: Green light optimal speed advisory**<br>The SPAT / MAP information, broadcasted from the R-ITS-S/ G5 or via cellular communication, reflects the real-time signal phase & timing status for each lane. Based on the SPAT / MAP information the vehicle (V-ITS-S) may advise an optimal speed to the driver for approaching the intersection.<br>The potential display/ alert scenarios are as follows:<br>• When the light is green (and the driver can pass it without exceeding the speed limit), the driver receives a speed advice to continue and pass the green light.<br>• When the light is green but the driver cannot pass it without exceeding the speed limit, no speed advice is given. The driver receives the advice to |

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| | prepare to stop. |
| **Functional Constraints / Dependencies** | • The speed advice has to be lower than the speed limit.<br>• The presentation of information on the HMI is not part of the service description. It is left to the provider of the in-vehicle information system how the information is presented. Information might e.g. be translated to the preferred language of the driver.<br>• The information presented by means of I2V is advisory information only and may not take into consideration variables such as road conditions including weather or traffic density/ congestion. |

### *7.2.2.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | Vehicles approaching a traffic light will inform the driver in advance about the traffic signal status for crossing the conflict area of an intersection. The vehicle (V-ITS-S) may advise an optimal speed to the driver for smoothly approaching the intersection (in case of red) or for safely passing the conflict area of the intersection based on the signal phase and timing (SPAT) and intersection topology (MAP) information. This information will either be received from the local infrastructure (R-ITS-S / G5), or it will be provided centrally via cellular (3G/4G) communication. The Signal Phase and Timing message (SPAT) and the corresponding intersection layout message MAP as specified in SAE-J2735 are messages designed for infrastructure-to-vehicle communication. Their purpose is to transmit either the current and/or the future status of signalling on the entire intersection in an electronic, machine readable way to vehicles.<br>The SPAT / MAP information that is broadcast, together with other information, reflects the real-time signal phase & timing status for each lane. Therefore, a vehicle may be able to calculate or derive the optimal speed advice for each lane.<br>Fast (low latency) communication and suitable HMI to communicate to the driver are needed. The GLOSA application communicates information to the driver about which speed he/she should adopt to keep in continuous flow with no need to stop. The millisecond timing is less important than the fact that a correct forecast-message is available before reaching the intersection.<br>A digitised map of the area is also pre-requisite for SPAT, which might include road topography and road attributes, such as number of lanes on each approach to the intersection and the manoeuvres possible between them. SPAT messages relate to these relations in the MAP.<br>Once the SPAT with forecast and a MAP is implemented, this enables Green Light Optimal Speed Advisory (GLOSA) to be given to the drivers via the same interface.<br>Drivers travelling at or close to the advised speed are likely to clear the intersections, creating what is commonly referred to as the “Green Wave” -minimising erratic stop/start behaviour. |
| **Reference architecture** | The figure below shows the functional architecture of the GLOSA service. |

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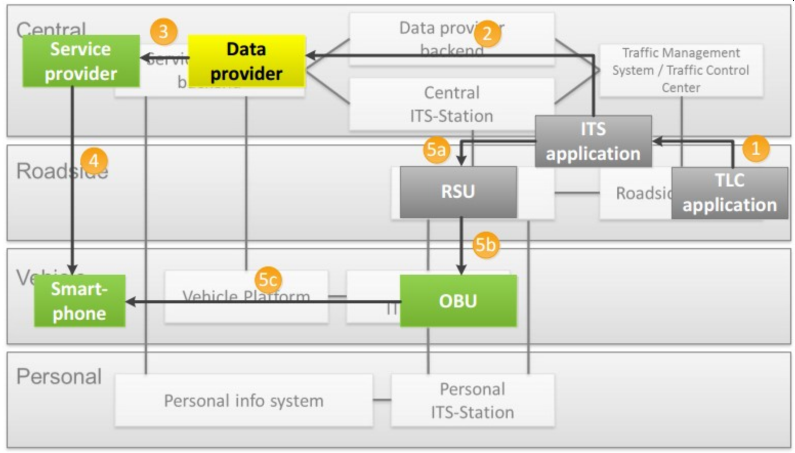


Every colour could indicate another stakeholder<br><br>
The process for this application contains several steps:
<ul>
<li>The ITS application receives TLC-information from TLC applications (1).</li>
<li>The ITS application sends messages containing SPAT / MAP information towards data providers (2) and towards RSUs (5a) to broadcast the message during the requested duration time with a specific repetition rate to OBUs (5b). In the vehicle the message of the OBU is forwarded to an application on a smartphone (5c).</li>
<li>Data providers collect the data of ITS applications and provide that to service providers (3).</li>
<li>Service providers determines whether SPAT / MAP information is required for individual users and send the appropriate information to smartphones (4).</li>
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The above reference architecture is fully applicable to the KCC pilot and items 1 – 4 are applicable to TfL.
</td></tr>
<tr><td>Relation to InterCor profiles</td><td>
The GLOSA Use Case uses SPAT and MAP messages towards vehicles (I2V) are as specified in the InterCor profiles for the interfaces IF1 (ITS-G5 network, RSU to OBU) and IF2 (back-office, for distribution via cellular networks):
<ul>
<li>IF1: InterCor Milestone 3 – Common set of upgraded specifications for ITS-G5 (version 1.1, 20/10/2017) [REF: section 4.4] – definition of GLOSA</li>
<li>IF2: InterCor - Specifications for IF2 for hybrid communication (v1.0, 17/12/2017) [REF: IF2]</li>
</ul>
SPAT and MAP messages are used for this service and can be sent via both IF1 and IF2. The profile as specified in section 4.4 of [IF1] is applicable.
</td></tr>
<tr><td colspan="2">Functional and non-functional requirements</td></tr>
<tr><td>Sources of information</td><td>
The following information will be provided locally at each junction via the infrastructure, i.e. Traffic Light Controllers (TLC) and Roadside ITS stations (RIS) through IF1 (ITS-G5), and/or it will be provided centrally via cellular (3/4G communication through IF2 (AMQP).
<ul>
<li>Signal Phase and Timing message (SPaT)</li>
<li>Intersection topology message (MAP)</li>
</ul>
For any communication over ITS G5 the service will use PKI.
</td></tr>
</table>

| | |
|---|---|
| **Standards** | • ETSI TS 103 301: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services<br>• SAE J2735:Dedicated Short Range Communications (DSRC), Message Set Dictionary.<br>• CEN ISO/TS 19091: Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections.<br>• ETSI TS 102 894-2: Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary. |
| **Technical Constraints / Dependencies** | • The highly dynamic nature of some traffic control systems, which are able to make late signal phasing decisions, combined with other adaptive systems (e.g. selective vehicle detection bus priority), could limit the viability of GLOSA in some applications.<br>• For GLOSA via G5: The TLC is connected to R-ITS-S and can provide information on the current and next signal phase.<br>• For GLOSA via 3G/4G cellular: back-office systems and interfaces exist or are established to enable the outputting of current and next signal phase information to the cloud.<br>• GPS accuracy could potentially be a constraint at signal controlled intersections that employ multiple traffic phases on an approach (e.g. left turn and/or right turn traffic phases that are on a different phase to the movement ahead). OBUs will need to be able to identify a vehicle’s position and intended direction or route, with sufficient accuracy in order to identify the correct traffic phase.<br>• R-ITS-S is able to send information on the static topology of the signalised intersection. Optionally this static information is provided to V-ITS-S by other methods.<br>• R-ITS-S supports I2V services and can send information on signal phase and timing.<br>• V-ITS-S supports I2V services and can receive information on signal phase and timing.<br>• If there is a traffic queue/ congestion in front of a traffic light, GLOSA becomes useless, but could be adapted if it is possible to integrate this information into the algorithm.<br>• GLOSA depends on the data provided by the Traffic light controller or centrally. The information that is provided may not be adapted to GLOSA, especially if the phases are adaptive.<br>• Information received by HMI via 3G/4G cellular should be consistent with information received via G5. |

# 8 MCTO

## *8.1 MCTO High Level Description*

| Service introduction | |
|---|---|
| **Summary** | The Multimodal Cargo Transport Optimisation (MCTO) is a service helping the truck driver when transporting containers to a terminal and crossing the channel. |
| **Background** | 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 terminals. |
| **Objective** | Optimizing the predictability of travel times for cargo transport, decreasing waiting times at logistics hubs / terminals, simplifying access to the port and terminals. |
| **Expected benefits** | For the driver: Simplification of terminal access, gain of time, less stress, problem anticipation.<br>For Terminal operator: Optimized truck flow management around the port.<br>For Port authorities, reduction of the traffic volume of trucks at the entrance of the port and reduction of risks of accidents and congestion. |
| **Use Cases** | 1. Multimodal ETA for cargo optimization<br>2. Dock reservation<br>3. Assigning a slot to a given vehicle for cross-channel traffic<br>4. Information on the site's access conditions<br>5. Guide the truck in the port (terminal or truck parking) |

## *8.2 MCTO Use Cases*

### 8.2.1 Multimodal ETA for cargo optimization

#### *8.2.1.1 Functional description*

| **Multimodal ETA for cargo optimization** | |
|---|---|
| **Use case introduction** | |
| **Summary** | Optimization of cargo transport to logistic hubs by providing ETA in a single point of visualization (dashboard) of all the transport modes related to the transport. This includes truck, train, vessel/barge and ship. |
| **Background** | Often truck drivers have to wait for some time when they arrive on a logistic hub. This service is meant to provide to terminal operators at logistic hubs a more accurate estimated time of arrival. When terminal operators know the ETA of the trucks, then it is possible to optimize the planning for (un)loading trucks. In the same way if a truck driver knows the ETA of the transport mode on which he will (un)load his goods then he can better adapt his delivery and reduce waiting time. |
| **Objective** | Optimize the (un)loading of goods in a logistic hub for truck companies and terminal operators and decreasing waiting time. |

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| | Optimize the shift of containers from one transport mode to another by providing necessary information for logistics anticipation. |
| **Desired behaviour** | The terminal operator optimizes the (un)loading of goods by anticipating the preparation.<br>Truck drivers optimize their arrival at the logistics hub by taking into account the logistics information provided. |
| **Expected benefits** | The expected impact is a reduction in loss of time (less waiting time) for truck drivers at logistic hubs and better management of resource utilization for the logistics hubs.<br>Optimization of the number of containers on a train thanks to the fact of knowing if a truck will arrive on time or not. |
| **Use case description** | |
| **Situation** | A container must be (un)loaded in a logistics hub from one transport mode to another.<br>One situation is that a transport mode unloads a container to the logistics hub. This can be done by truck, train, vessel/barge or ship.<br>Another situation is that a container is loaded on a transport mode at the logistics hub. This can be done by truck, train, vessel/barge or ship.<br>The global situation is that a container changes transport mode in a logistics hub. |
| **Logic of transmission** | Will be provided at technical description phase. |
| **Actors and relations** | • Truck transport company<br>Provides the necessary information concerning the transport (Departure, steps, destination, reference)<br>Consignee (Multimodal operator), id of the transport in terminal<br>• Truck driver<br>Provides vehicle GPS positions through an OBU, a beacon or a smartphone HMI<br>• Terminal operator<br>Visualizes the ETAs of the transport modes and optimizes the organization of the (un)loading of the goods<br>Provides provisional time of arrival of the train concerned by the transport<br>Provides updated time of arrival of the train if delayed<br>Provides provisional time of arrival of the ship concerned by the transport<br>• Vessel/barge<br>Provides its position through a smartphone<br>• Dashboard Service provider:<br>Receives location and destination of trucks and vessels/barges<br>Calculates ETA for trucks<br>Calculates ETA for vessels/barges<br>Visualizes the ETAs on the dashboard (trucks, vessels/barges, trains, ships) |
| **Scenario** | <u>Basic truck driver scenario</u><br>1. Truck driver provides vehicle destination via his OBU or smartphone to service providers<br>2. Truck driver starts his trip<br>3. Truck driver sends his location at regular intervals via his smartphone, OBU or beacon<br>4. This service receives this information, calculates an ETA and makes it available to Terminal operators |

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|---|---|
| | 5. Terminal operators use this service to plan (un)loading trucks at logistic hubs<br><u>Complete truck driver scenario</u><br>1. Truck driver provides vehicle destination via his OBU or smartphone to service providers<br>2. Truck driver chooses the operator for which he comes in a list of multimodal operators<br>3. Truck driver starts his trip<br>4. Truck driver sends his location at regular intervals via his smartphone, OBU or beacon<br>5. This service receives this information, calculates an ETA and makes it available to Terminal operators.<br>6. Terminal operators use this service to plan (un)loading trucks at logistic hubs<br>7. This service sends to Truck driver ETA for the transport mode of the chosen operator (train, vessel/barge, ship)<br>8. Truck drivers use this service to optimize their arrival at the logistics hub<br><u>Barge scenario</u><br>1. Barge driver chooses a travel on his smartphone<br>2. Barge driver starts his trip<br>3. This service receives this information, calculates an initial ETA and makes it available to the end user (Terminal operator, Truck drivers, etc.)<br>4. Barge driver sends location at regular intervals via his smartphone<br>5. The barge passes through geofenced areas<br>6. This service receives new positions and detects the crossing of geofence zones<br>7. It updates the ETA and makes it available to Terminal operators and Truck drivers<br>8. Terminal operators use this service to plan (un)loading trucks at logistic hubs<br>9. Truck drivers use this service to optimize their arrival at the logistics hub<br><u>Terminal operator scenario</u><br>1. Terminal operator provides provisional time of arrival of trains<br>2. Terminal operator provides provisional time of arrival of ships<br>3. This service receives this information and makes it available to truck drivers<br>4. Terminal operator provides updated time of arrival of trains if delayed<br>5. Terminal operator provides updated time of arrival of ships if delayed<br>6. This service receives this information and makes it available to truck drivers |
| **Display / alert principle** | The ETA dashboard displays information on the ETA of each transport mode related to the delivery or pick-up of goods. This information is completed with additional interesting data concerning the transport. |
| **Functional Constraints / dependencies** | The final destination (port or terminal) of the truck must be available / declared.<br>The port destination of the barge must be available / declared.<br>The use of push notifications should be reduced to an absolute minimum. How this is being implemented in the service is not part of the use case.<br>FR: Vehicle drivers or Barge drivers must accept to be tracked if they want to use InterCor services because, for example, the position of the vehicle is important information for the operation of the services. |

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| | NL: Desirably this use case should be implemented only when there is an existing HMI in the trucks. In the NL it is not preferred to use any other devices as HMI, although the cellular communication allows this. |

### *8.2.1.2 High level technical description*

| **Use case implementation** | |
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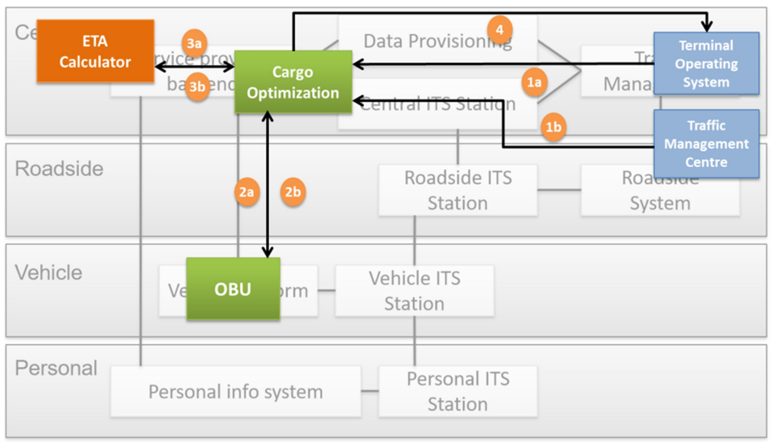
| **Model implementation** | The terminal operators will have access to an HMI displaying the ETA of each transport modes arriving at their terminal and will plan (un)loading of trucks.<br>The truck driver visualizes on an HMI an update in real time of own ETA and ETA for the transport mode of the chosen operator (train, vessel / barge, ship). |
| **Reference architecture** | <br>The process for this service contains several steps:<br>1. The service Cargo optimization gets information about waiting time at port entrance (1a) from the TOS - Terminal Operating System. This information is updated regularly on the TOS.<br>2. The service Cargo optimization gets information about provisional time of arrival of trains and ships.<br>3. The service Cargo Optimization gets information about traffic conditions and travel time measurement (1b) from the TMC - Traffic Management Centre/ Data Access Point. This information is updated in real time on the TMC.<br>4. The service Cargo optimization receives the location and destination of truck drivers (2a) and barge driver.<br>5. The service Cargo Optimization combines the data feed from TMC, TOS and OBU and provides it to the service ETA calculator (3a)<br>6. The service ETA calculator sends the ETA information to the service Cargo Optimization (3b).<br>7. The service Cargo optimization provides the ETA of all trucks with a specific terminal set as destination to terminal operators (4).<br>8. The service Cargo optimization provides the ETA of all barges with a specific terminal set as destination to terminal operators (4).<br>9. The service Cargo optimization provides the ETA for the transport mode of the chosen operator (train, vessel/barge, ship) to OBU (4).<br>10. The service Cargo optimization provides the ETA of all trucks to the corresponding Transport Company. |
| **Relation to InterCor profiles** | The terminal operators will have access to an HMI displaying the ETA of each transport modes arriving at their terminal and will plan (un)loading of trucks.<br>The truck driver visualizes on an HMI an update in real time of own ETA |

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| | and ETA for the transport mode of the chosen operator (train, vessel/barge, ship). |
| **Functional and non-functional requirements** | |
| **Sources of information** | The different sources of information are:<br>- The driver who entered information on the HMI like:<br>  o vehicle destination (port, terminal)<br>  o the multimodal operator<br>- The Logistics Service Provider which provides:<br>  o the destination (port, terminal)<br>  o the multimodal operator<br>- The OBU which<br>  o sends the GPS position of the truck or barge at regular intervals.<br>  o displays information on ETA.<br>- The TMC (Traffic Management Centre), Traffic system or National Data Warehouse which broadcasts traffic conditions and travel time measurement.<br>- The Terminal operator who sends information about the entrance to the port. |
| **Standards** | • 3G/4G communication<br>• GPS positioning (System Geofence)<br>• Security standards<br>• DATEX II: Datex II is an extensive standard for exchanging traffic-related data. Datex II codes are interoperable with the OpenTripModel. https://www.datex2.eu/<br>• OpenLR: is a dynamic location reference standard and is used to position the trucks and traffic events. http://www.openlr.org/<br>• OpenTripModel is a simple, free, lightweight and easy-to-use data model, used to exchange real-time logistic trip data on the web https://www.opentripmodel.org/ |
| **Technical Constraints / Dependencies** | OBU must be active:<br>- To provide positions in real time.<br>- To receive information and notifications in real time.<br>The 3G/4G communication must be active and the driver must be in an area with 3G/4G coverage.<br>The GPS positioning must be active.<br>Information about waiting time at entrance of port must be available.<br>All information systems used in the different scenarios shall ensure and provide API for connection with the service Cargo Optimization to send or publish data.<br>Interfaces shall be intuitive for the end user and shall be available in the local language. |

### 8.2.2 Dock reservation

#### *8.2.2.1 Functional description*

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| **Dock reservation** | |
| **Use case introduction** | |
| **Summary** | Optimization of cargo transport to logistic hubs by improving predictability of dock availability in time. |
| **Background /** | Often truck drivers have to wait for some time when they arrive on a logistic hub. |

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| **added values** | This service is meant to optimize the planning for (un)loading trucks at logistic hubs. |
| **Objective** | Decreasing waiting times at logistics hubs. |
| **Desired behaviour** | Terminal operators define timeslots enabling better dock management. Drivers adapt their behaviour by arriving at the reserved time slot. |
| **Expected benefits** | The expected impact is a reduction in loss of time (less waiting time) for truck drivers at logistic hubs. |
| **Use case description** | |
| **Situation** | Terminal operators at logistic hubs provide timeslots for (un)loading trucks at docks. Transport planners make a reservation for a specific timeslot and plan a truck arriving in that timeslot. Transport planners provide this information to truck drivers. |
| **Logic of transmission** | Will be provided at technical description phase. |
| **Actors and relations** | • Vehicle driver / truck driver:<br>Receives a reservation for a timeslot at the terminal.<br>Has the possibility to make dock reservations on-trip.<br>• Transport planners:<br>Receive available timeslots for (un)loading docks, plan cargo transport and make timeslot reservations.<br>• Terminal operators (at logistic hubs):<br>Receive timeslot-reservations of transport planners and provide to a data access point available timeslots for (un)loading trucks at docks.<br>• Traffic system operators:<br>Provide real-time traffic information.<br>• Data provider:<br>Collects information from terminal operators and aggregates them into a single data source which can be accessed at a data access point. |
| **Scenario** | 1. Terminal operators at logistic hubs provide available docks and timeslots for (un)loading trucks<br>2. This service receives this information and provides it to transport planners.<br>3. Transport planners use this service to assign docks and timeslots to trucks.<br>4. Transport planners reserve docks and timeslot for (un)loading trucks.<br>5. Truck drivers receive the reserved docks and timeslot on their HMI. |
| **Display / Alert logic** | The end user (truck driver) receives dock and timeslot reservations at logistic hubs on his HMI. |
| **Functional Constraints / Dependencies** | • Available docks and timeslots should be counted in a correct manner.<br>• Reserved docks should be available at the reserved timeslot. |

#### *8.2.2.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | Transport planners assign docks and timeslots to trucks and reserve docks and timeslots for their trucks.<br>Truck drivers receive the reserved docks and timeslot on their HMI.<br>Terminal operators at logistic hubs provide an update of current and future (based on reservations made) available docks and timeslots to this service.<br>This service provides to transporters (transport planners and truck drivers) an overview of available docks and timeslots. |

 

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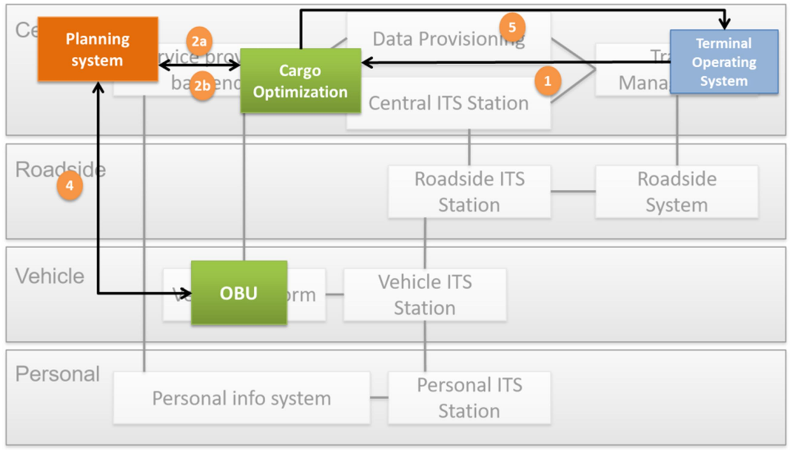
| **Reference architecture** | <br>*Every colour could indicate another stakeholder*<br>The process for this service contains several steps:<br>1. Terminal operators define information on available loading docks and timeslots and provide this information (1) to the service Cargo optimization. It is possible to have more than one terminal operator.<br>2. The service Cargo optimization provides available docks and timeslots as a service to its customers, transport companies:<br>- Planning systems (2a)<br>3. Planning systems use this information to make a planning for (a fleet of) trucks and<br>- Requests to reserve an available dock and timeslot (2b);<br>- Send these routes to the trucks (4) and reserved dock/timeslot information.<br>4. The service Cargo optimization reserves the available dock and timeslot at the logistic hub requested (5). |
| **Relation to InterCor profiles** | Transport planners assign docks and timeslots to trucks and reserve docks and timeslots for their trucks.<br>Truck drivers receive the reserved docks and timeslot on their HMI.<br>Terminal operators at logistic hubs provide an update of current and future (based on reservations made) available docks and timeslots to this service.<br>This service provides to transporters (transport planners and truck drivers) an overview of available docks and timeslots. |
| **Functional and non-functional requirements** | |
| **Sources of information** | Terminal operator at logistic hubs.<br>Data on destination, route, cargo and planned ETA are derived from the planning systems of the Logistics Service Provider. |
| **Standards** | • 3G/4G communication<br>• Security standards<br>• DATEX II: Datex II is an extensive standard for exchanging traffic-related data. Datex II codes are interoperable with the OpenTripModel. https://www.datex2.eu/<br>• OpenLR: is a dynamic location reference standard and is used to position the trucks and traffic events. http://www.openlr.org/<br>• OpenTripModel is a simple, free, lightweight and easy-to-use data model, used to exchange real-time logistic trip data on the web https://www.opentripmodel.org/ |
| **Technical Constraints / Dependencies** | All information systems used in the different scenarios shall ensure and provide API for connection with the service Cargo Optimization to send or |

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| | publish data.<br>Interfaces shall be intuitive for the end user and shall be available in the local language. |

### 8.2.3 Assigning a slot for multimodal terminal access management

#### *8.2.3.1 Functional description*

| **Assigning a slot for multimodal terminal access management** | |
|---|---|
| **Use case introduction** | |
| **Summary** | Optimization of cargo transport to logistic hubs by dynamic status slot verification or slot reservation. |
| **Background / added values** | During a transport by truck, the container/trailer must be programmed on another transport mode. This is done with a slot at a terminal, the loading date and time. Reservation before departure is optimal but must be done at the latest before arrival at the terminal. If this isn't done then the container/trailer arrives without any preparation which perturbs the port activities. |
| **Objective** | Decreasing waiting time at logistics hubs and simplifying access to the port terminal. |
| **Desired behaviour** | A slot reservation must be made for accessing a multimodal terminal The driver requests a slot. The infrastructure provides the available slots and the vehicle driver selects the most appropriate slot. The infrastructure receives confirmation of booking. |
| **Expected benefits** | The expected impact is the transparency for terminal operators about the "compliance" status of approaching trucks, a reduction in loss of time (less waiting time) for truck drivers at logistic hubs and better management of resource utilization. |
| **Use case description** | |
| **Situation** | A truck has for destination a terminal and the container has no slot registration.<br>A truck has for destination a terminal and the container/trailer has no slot registration. |
| **Logic of transmission** | Will be provided at technical description phase. |
| **Actors and relations** | • Vehicle driver (sender and receiver): The truck driver interacts with an HMI to:<br>o Indicate his destination<br>o Ask for a slot to access a multimodal hub and visualize results<br>• Road operator (receiver)<br>• Terminal operators at logistic hubs (sender and receiver): Provide available timeslots for (un)loading trucks at docks and receive information about reserved slots by truck.<br>• Port authorities (receiver): Receives information about reserved slots by truck.<br>• Truck companies (receiver): Receives information about reserved slots by truck.<br>• Terminal operated carrier (sender) like Eurotunnel, Ferry lines or Overseas Shipping lines provide a slot or a slot validity status. |
| **Scenario** | **Initial**: An ETA has been calculated for a truck for a slot managed terminal.<br>1. The truck driver can enter a slot reference.<br>2. The service asks for validity of the slot reference with the terminal, or the terminal operated carrier (Eurotunnel, Ferry lines or Overseas Shipping lines).<br>3. Terminal or terminal operated carrier provides slot reference validity status.<br>4. The service displays validity status to terminal operator or terminal operated |

 

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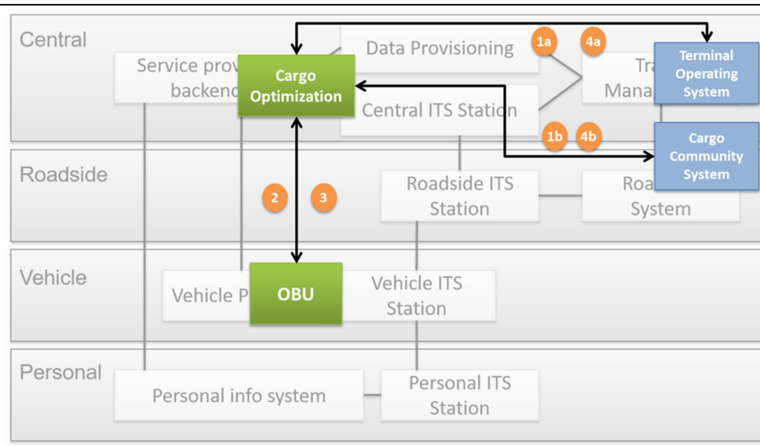
| | carriers.<br>5. The service displays validity status to truck drivers.<br>6. If validity status is not correct the truck driver can submit another reference and restart the process at step 1.<br>**Secondary**:<br>1. The truck driver does not have a slot reference.<br>2. The service asks for a slot reference with the terminal, or with the terminal operated carrier (Eurotunnel, Ferry lines or Overseas Shipping lines).<br>3. The service displays the list of slots to truck driver on his HMI.<br>4. Truck driver chooses and reserves a slot.<br>5. The service sends reserved slot to the terminal.<br>6. The service displays slot reference and validity status to truck driver.<br>7. The service displays slot reference and validity status to terminal operator or terminal operated carriers.<br>8. The slot reference presence is checked at each crossing of a geofence zone. |
| **Display / Alert logic** | The truck driver visualizes the reserved slot and its status. |
| **Functional Constraints / Dependencies** | Available docks should be counted in a correct manner.<br>Reserved docks should be available at the reserved timeslot.<br>The final destination (port or terminal) of the truck must be available / declared.<br>Privacy:<br>• Vehicle driver must accept to be tracked if he wants to use InterCor services because, for example, the position of the vehicle is important information for the operation of the services. |

### *8.2.3.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | A truck driver wants to access a multimodal hub. He selects a terminal and provides a slot reference. The slot reference is checked and confirmed by terminal operator and or terminal operated carrier. |
| **Reference architecture** | <br>The process for this service contains several steps:<br>1. The service Cargo optimization gets information about available slots from the different TOS - Terminal Operating Systems (1a) and CCS - Cargo Community System (1b).<br>2. The service Cargo optimization combines the data feed from TOS and CCS and provides that to the truck driver (2) through the OBU which consists of an application on a smartphone.<br>3. Truck driver chooses a slot (3) on the application and this information is sent to the service Cargo optimization.<br>4. The service Cargo optimization books the slot on the TOS (4a) or the |

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| | CCS (4b) depending on the driver's choice. |
| **Relation to InterCor profiles** | n/a. |
| **Functional and non-functional requirements** | |
| **Sources of information** | The different sources of information are:<br>• The driver who:<br>  ○ enters desired destination (port, terminal),<br>  ○ enters container/trailer number, slot reference, if it is a loading/unloading,<br>  ○ chooses slot.<br>• The OBU which displays available slots.<br>• The Terminal operator who provides slot reference or slot validity status and an occupancy measurement system for docks at logistic hubs.<br>• Multimodal operators, ferry or shipping lines who can assign slot reference either by Electronic Data Interchange or by real time request to their information systems. |
| **Standards** | • 3G/4G communication<br>• GPS positioning (System Geofence)<br>• Security standards |
| **Technical Constraints / Dependencies** | The OBU must be active:<br>- To provide positions in real time.<br>- To receive information and notifications in real time.<br>The 3G/4G communication must be active and the driver must be in an area with 3G/4G coverage.<br>The GPS positioning must be active.<br>All information systems used in the different scenarios shall ensure and provide API for connection with the service Cargo Optimization to send or publish data.<br>Interfaces shall be intuitive for the end user and shall be available in the local language. |

### 8.2.4 Information on the site's access conditions

#### *8.2.4.1 Functional description*

| **Information on the site's access conditions** | |
|---|---|
| **Use case introduction** | |
| **Summary** | Give information to the driver on the site's access conditions upstream from the port like road events, parking slot information and waiting time at port entrance. |
| **Background / added values** | A truck driver has to (un)load goods in a terminal and during its approach is not aware of access conditions. Provide real-time information including road events, parking information, waiting time. |
| **Objective** | Allowing the driver to better manage arrival at the port.<br>Optimizing the flow of trucks around the port (thereby reducing congestions or traffic jams).<br>Improving safety around the port (decreasing risk of accidents).<br>Allowing terminal operators to broadcast information on port entrance. |
| **Desired behaviour** | Drivers adapt their behaviour by optimizing their itinerary to the terminal. |
| **Expected benefits** | Information on the site's access conditions permits: |

 

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| | - For the driver: Simplification of terminal access, gain of time, less stress, problem anticipation<br>- For the Terminal operator: Optimized truck flow management around the port<br>- For port authorities: reduction of the traffic volume of trucks at the entrance of the port and reduction of risks of accidents and congestion. |
| **Use case description** | |
| **Situation** | Information collection and displaying about destination terminal access state (Traffic jam, Busy access lane, Gate congestion, Accident) and real time updating according to truck progression via Geofence zone crossing. |
| **Logic of transmission** | Will be provided at technical description phase. |
| **Actors and relations** | • Vehicle driver<br>The truck driver interacts with an HMI to:<br>o Indicate his destination<br>o Visualize information about terminal access<br>• Traffic system operators<br>Provide real-time traffic information.<br>• Terminal operators at logistic hubs<br>Send information about entrance to the port to service provider.<br>• TMC (Traffic Management Centre)<br>Broadcasts traffic conditions.<br>• Parking operator<br>Provides information on the parking lot. |
| **Scenario** | 1. The service detects the crossing of a geofence zone by a truck driver for which the terminal of destination is identified.<br>2. The service requests information from different providers about terminal access.<br>3. The service sends the information to the driver.<br>4. This process is done at each geofence zone crossing. |
| **Display / Alert logic** | The HMI presents a map with information about access conditions: Traffic and road events, location of parking lots, waiting time at entrance of port. |
| **Functional Constraints / Dependencies** | The final destination (port or terminal) of the truck must be available / declared.<br>Vehicle drivers must accept to be tracked if they want to use InterCor services because, for example, the position of the vehicle is important information for the operation of the services.<br>For the publication of static and dynamic parking information, it would be interesting to standardize the data format / exchange and use for example the Datex II standard.<br>Also, information about waiting time at the entrance of port should be published using a common format. |

#### *8.2.4.2 High level technical description*

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| **Use case implementation** | |
| **Model implementation** | A truck driver crosses a geofence zone in direction of a cross channel terminal. The service displays the latest situation of terminal access surroundings. |

 

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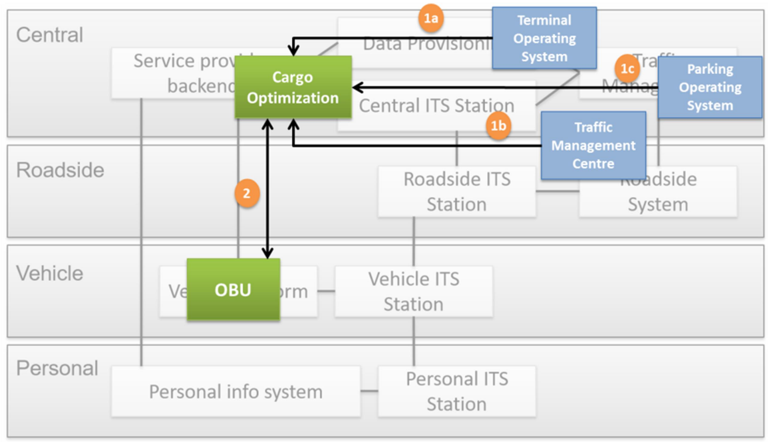
| **Reference architecture** | <br>The process for this service contains several steps:<br>1. The service Cargo optimization gets information about waiting time at port entrance (1a) from the TOS (Terminal Operating System). This information is updated regularly on the TOS.<br>2. The service Cargo Optimization gets information about traffic conditions and travel time measurement (1b) from the TMC (Traffic Management Centre). This information is updated in real time on the TMC.<br>3. The service Cargo Optimization gets information on the parking lot (1c) from the POS – Parking Operating System. This information is updated in real time on the POS.<br>4. The service Cargo optimization combines the data feed from TOS, TMC and POS and provides that to the truck driver (2). |
| **Relation to InterCor profiles** | n/a. |
| **Functional and non-functional requirements** | |
| **Sources of information** | The different sources of information are :<br>- The driver who entered information on the HMI (his destination (port , terminal)).<br>- The OBU which sends the GPS position of the truck to the service at regular intervals.<br>- The TMC (Traffic Management Centre) which broadcasts traffic conditions and travel time measurement.<br>- The parking operator who provides information on the parking lot.<br>- The Terminal operator who sends information about the entrance to the port. |
| **Standards** | • 3G/4G communication<br>• GPS positioning (System Geofence)<br>• Security standards |
| **Technical Constraints / Dependencies** | The OBU must be active:<br>- To provide positions in real time.<br>- To receive information and notifications in real time.<br>The 3G/4G communication must be active and the driver must be in an area with 3G/4G coverage.<br>The GPS positioning must be active.<br>Static and dynamic parking information must be available.<br>Information about waiting time at entrance of port must be available.<br>All information systems used in the different scenarios shall ensure and provide API for connection with the service Cargo Optimization to send or publish data.<br>Interfaces shall be intuitive for the end user and shall be available in the |

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| | local language. |

### 8.2.5 Guide the truck in the port (terminal or truck parking)

#### *8.2.5.1 Functional description*

| **Guide the truck in the port (terminal or truck parking)** | |
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| **Use case introduction** | |
| **Summary** | Guide the trucks in the port to access a terminal or truck parking using a predefined path. If the terminal is ready, the truck will be guided directly otherwise it will first be guided to a parking and then to the terminal when possible. |
| **Background / added values** | To manage and secure truck traffic inside terminals. |
| **Objective** | Simplifying access to the port terminal for the driver.<br>Reducing the time of the truck's presence in the port.<br>Optimizing the flow of trucks in the port (thereby reducing congestion or traffic jams).<br>Improving safety in the port (decreasing risk of accidents). |
| **Desired behaviour** | Drivers adapt their behaviour by optimizing its itinerary in the terminal. |
| **Expected benefits** | The guidance in the port permits:<br>- For the driver: Simplification to access terminal, gain of time, reduce early arrivals (with additional waiting time) and reduce stress.<br>- For the Terminal operator: Truck flow and management on the terminal / in the port, knowing truck's position in the port.<br>- For the port: Better manage traffic flows by having the possibility to guide the truck via several paths and to several destinations (terminal, parking). |
| **Use case description** | |
| **Situation** | In the terminal, drivers are routing for better reliability and security of traffic inside terminals. |
| **Logic of transmission** | Will be provided at technical description phase. |
| **Actors and relations** | • Vehicle driver<br>The truck driver interacts with an HMI to:<br>o Indicate desired destination<br>o Follow an itinerary to access a terminal or truck parking in a port<br>• Service provider<br>Map Repository Platform provides circuits to access different terminals.<br>• Port<br>Sends terminal or parking destination. |
| **Scenario** | 1. A driver enters a port.<br>2. The service detects the entry of the truck in the port via a geofence.<br>3. The service requests from the port manager the terminal or the parking where the driver must go.<br>4. The service requests the itinerary from the Map repository platform.<br>5. The service detects the movement of the truck via a geofence.<br>6. The driver HMI displays instructions in real time at each critical point of the driver's itinerary.<br>7. The service closes action at arrival. |
| **Display / Alert logic** | On the HMI, a map is displayed with graphical directions (left, right, straight, etc.) |

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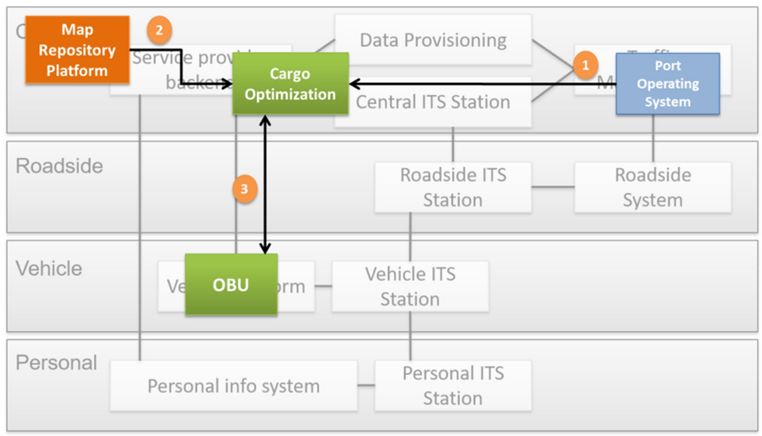
| | on the way to take. |
| **Functional Constraints / Dependencies** | A mapping of the port must exist.<br>Vehicle driver must accept to be tracked if he wants to use InterCor services because, for example, the position of the vehicle is important information for the operation of the services. |

### *8.2.5.2 High level technical description*

<table>
<tr><th colspan="2">Use case implementation</th></tr>
<tr><td>Model implementation</td><td>After exchanging necessary information between truck driver and port, the service guides the driver to the parking or final terminal.</td></tr>
<tr><td>Reference architecture</td><td>



The process for this service contains several steps:
<ol>
<li>The service Cargo optimization gets information about the terminal or the parking where the driver must go (1) from the Port Operating System.</li>
<li>The service Cargo Optimization gets the itinerary to go to the terminal or the parking (2) from the Map Repository Platform.</li>
<li>The service Cargo optimization provides this information to truck driver (3) through the OBU which consists of an application on a smartphone.</li>
</ol></td></tr>
<tr><td>Relation to InterCor profiles</td><td>n/a.</td></tr>
<tr><th colspan="2">Functional and non-functional requirements</th></tr>
<tr><td>Sources of information</td><td>The different sources of information are:
<ul>
<li>The driver who entered on the HMI his destination (port , terminal).</li>
<li>The OBU which:
<ul><li>Sends the GPS position of the truck at regular intervals.</li>
<li>Displays information on guidance in the port, etc.</li></ul></li>
<li>The port who indicates the terminal or the parking where the driver must go when he enters the port.</li>
<li>The map repository platform on which the different paths for each terminal in the port are described.</li>
</ul></td></tr>
<tr><td>Standards</td><td><ul><li>3G/4G communication</li><li>GPS positioning (System Geofence)</li><li>Security standards</li></ul></td></tr>
<tr><td>Technical Constraints / Dependencies</td><td>The OBU must be active:
<ul><li>To provide positions in real time.</li><li>To receive information and notifications in real time.</li></ul></td></tr>
</table>

| | |
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| | The 3G/4G communication must be active and the driver must be in an area with 3G/4G coverage.<br>The GPS positioning must be active.<br>Interfaces shall be intuitive for the end user and shall be available in the local language. |

 

# 9 Truck Parking

## *9.1 Truck Parking High Level Description*

| **Service introduction** | |
|---|---|
| **Summary** | The Truck Parking service is meant to provide to truck drivers information on parking spaces for trucks. |
| **Background** | Information on parking spaces (on and off street) is currently not available. This service will provide information on parking spaces. |
| **Objective** | Allow drivers to manage their driving time according to the availability of parking lots and associated services. |
| **Expected benefits** | Journey planning and comply with driving and resting periods for truck drivers. |
| **Use Cases** | 1. Information on parking availability, location, availability and services |

## *9.2 Truck Parking Use Cases*

### 9.2.1 Information on parking lots location, availability and services via internet

#### *9.2.1.1 Functional description*

| **Information on parking lots location, availability and services via internet** | |
|---|---|
| **Use case introduction** | |
| **Summary** | The service is meant to provide to truck drivers information on parking spaces. Information that can be provided are:<br>• Location of parking lots<br>• Number of spaces available; Information provided can also be just “full” or “free spaces”<br>• Vehicle Types permitted to be parked<br>• Services provided in the parking lot and eventually associated rates<br>• If the parking is secured or not |
| **Background / added values** | The service will inform truck drivers about available spaces and any additional information regarding it. This information will assist truck drivers to make an informed decision about their conditioned driving hours and rest periods helping to reduce stress levels. |
| **Objective** | • To allow truck drivers to manage their driving times and resting periods according to the availability of parking spaces and associated services.<br>• To prevent trucks parking on hard shoulders (or other places that are not suitable parking spaces) when drivers exceed their conditioned hours.<br>• To prevent truck drivers searching for an available parking space, causing unnecessary traffic movements from heavy goods vehicles. |
| **Desired behaviour** | By providing real-time information on trip about availability of truck parking spaces, drivers will be able to make an informed decision regarding their conditioned driving hours and rest periods. |
| **Expected benefits** | • Security<br>• Better traffic management<br>• Better parking lots management<br>• Comfort (information on services at the parking) |

 

| | |
|---|---|
| | • Reduced congestion and the effects of congestion on the environment<br>• Respect of rules on granted parking conditions as well as rules on travel time and driver safety |
| **Use case description** | |
| **Situation** | A truck driver is required to park his/her truck in a suitable truck parking lot to meet the conditioned driving and resting periods. |
| **Logic of transmission** | I2V |
| **Actors and relations** | • Truck driver: Receives information on availability of truck parking spaces and information about the services at a parking lot on the in-vehicle display.<br>• Road operator: n/a.<br>• Service provider: Provides the Truck Parking service to truck drivers.<br>• End user: see truck driver.<br>• Vulnerable road user: n/a.<br>• Other:<br>1 Parking lot operators:<br>Provide information on available truck parking spaces and services at parking lots.<br>2 Data provider:<br>Collects information about truck parking spaces and aggregates it into a single data source which can be accessed via a data access point.<br>Note that it is possible that more than one actor could be part of one party. |
| **Scenario** | 1 The service provider receives the information from their own source or via a third party data provider.<br>2 The information is sent to all relevant vehicles in the area.<br>3 The information is displayed to the drivers of light/heavy goods vehicles using a suitable HMI. If possible, vehicles display the information to drivers, adapted to the vehicle types (e.g. Light Vehicle or Heavy Goods Vehicle).<br>4 Drivers plan their trip accordingly. |
| **Display / Alert logic** | Information on availability of truck parking spaces and services at parking lots are displayed in the vehicle. |
| **Functional Constraints / Dependencies** | Supply chain and the quality of the information presented to the drivers. |

#### *9.2.1.2 High level technical description*

| | |
|---|---|
| **Use case implementation** | |
| **Model implementation** | For further study. |
| **Reference architecture** | For further study. |
| **Relation to InterCor profiles** | For further study. |
| **Functional and non-functional requirements** | |
| **Sources of information** | Parking operators |
| **Standards** | There are no standards available yet. |
| **Technical Constraints / Dependencies** | HMI constraints to display the information properly. |

 

# 10 Tunnel Logistics

## 10.1 Service high level description

| Service introduction | |
|---|---|
| **Summary** | The Tunnel Logistics service is a service providing truck drivers optimal routes when transporting heavy goods taking into account traffic information around tunnels. |
| **Background** | Tunnels are often bottlenecks in the road network. For safety reasons road operators often want to avoid heavy traffic jams in tunnels. If a traffic jam occurs downstream the tunnel, the road operator may decide to limit the access to the tunnel. Often truck drivers are not aware of this kind of traffic information around tunnels, specifically delays caused by tunnel incidents and/or tunnel metering.<br>This service is meant to use traffic information around tunnels and by doing so optimizing the routes of truck drivers. |
| **Objective** | Optimizing the routes of truck drivers taking into account tunnel traffic information. |
| **Expected benefits** | The primary expected impact is an optimal route for truck drivers and therefore less loss of time and less cost for transport companies. The service may also contribute to limit the number of trucks approaching the tunnel in case of congestion. This will contribute to improve the traffic flow, but may also be beneficial for traffic safety (trucks give the highest risks, considering the impacts of accidents in tunnels). |
| **Use Cases** | 1. Optimal route advice for trucks<br>2. Balanced Priority for dedicated vehicles on road sections around tunnels |

## 10.2 Tunnel Logistics use cases

### 10.2.1 Optimal route advice for trucks

#### 10.2.1.1 Functional description

| Optimal route advice for trucks | |
|---|---|
| **Use case introduction** | |
| **Summary** | Optimization of cargo transport from logistic hubs by providing optimal routes taking into account traffic information around tunnels. |
| **Background** | During traffic jams around tunnels, road operators want to reduce the inflow to the tunnels and logistic companies do not want any delays ('time is money'). By providing information on traffic jams, the service can contribute to achieving both goals. |
| **Objective** | Reduction in loss of time for trucks caused by traffic jams and a reduction of traffic jams (in time and distance) around tunnels. |
| **Desired behaviour** | Truck drivers on-trip change their original, delayed routes. |
| **Expected benefits** | The primary expected impact is a more optimal route for the truck driver and therefore less loss of time (and less costs) for the transporter. |

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| | The secondary expected impact is a shorter duration of traffic jams around tunnels. |
| **Use case description** | |
| **Situation** | Truck drivers receive real-time traffic information and information on the availability of tunnels and choose, in case of traffic jams on their route, another available route. |
| **Logic of transmission** | I2V via cellular (3G/4G) |
| **Actors and relations** | • Vehicle driver: Truck drivers receives their route, based on real-time traffic information and information on the predicted availability of tunnels.<br>• Road operator: n/a.<br>• Service provider: n/a.<br>• End user: see vehicle driver.<br>• Vulnerable road user: n/a.<br>• Other:<br>1. Traffic system operators:<br>Provide real-time traffic information and information on the availability of tunnels.<br>2. Data provider:<br>Collects information from traffic system operators and aggregates them into a single data source which can be accessed at a data access point. |
| **Scenario** | 1. Traffic systems provide real-time traffic information and information on the availability of tunnels to a data access point.<br>2. In the data access point information on the availability of tunnels and real-time traffic information is available. This service provides tunnel availability information and real-time traffic information.<br>3. Truck drivers adapt their routes based on real-time traffic information. |
| **Display / alert principle** | The end user (truck driver) receives an optimal route on the HMI. |
| **Functional Constraints / Dependencies** | Truck drivers should be allowed to change their ‘usual’ route. |

### *10.2.1.2 High level technical description*

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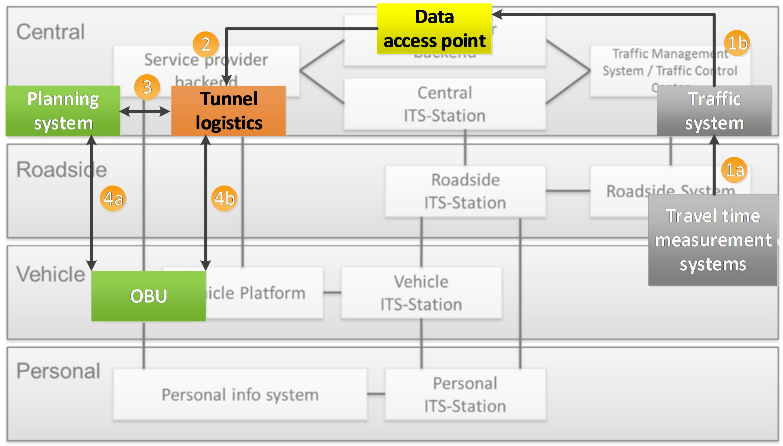
|---|---|
| **Use case implementation** | |
| **Model implementation** | 1. Traffic systems provide information on tunnel availability and real-time traffic information to a data access point.<br>2. This service provides information on tunnel availability, which can be combined with real-time traffic information to calculate optimal routes.<br>3. Truck drivers use this service to find their optimal route to their destination. |

<table>
<tr><td>Reference architecture</td><td>

Every colour could indicate another stakeholder<br>
The process for this service contains several steps:<br>
1. A traffic system gains information on tunnel (e.g. closures) and travel times from travel time measurement systems (1a), gives a prediction of the closure of the tunnel and provides this gained information to a data access point (1b). It is possible to have more than one traffic system.<br>
2. This service gets information on tunnels and real-time traffic information from a data access point (2) and provides this optimal route to its customers, transport companies:<br>
- Planning systems (3),<br>
- OBUs (4b) (= monitoring system in a truck like Fleet Management Systems).<br>
3. Planning systems use the information on tunnels and real-time traffic information to plan the optimal routes for trucks (pre-trip).<br>
4. OBUs in trucks also share their routes with planning systems to help transport planners plan the work that has to be done (4a). It could happen that transport planners change the original routes of their truck fleet because of real-time traffic information (e.g. trucks in a traffic jam caused by a tunnel closure (not planned)).</td></tr>
<tr><td>Relation to InterCor profiles</td><td>n/a.</td></tr>
<tr><td colspan="2">Functional and non-functional requirements</td></tr>
<tr><td>Sources of information</td><td>Travel time measurement systems.</td></tr>
<tr><td>Standards</td><td>n/a.</td></tr>
<tr><td>Technical Constraints / dependencies</td><td>The traffic system gains information in real-time.</td></tr>
</table>

### 10.2.2 Balanced Priority for dedicated vehicles on road sections around tunnels

#### *10.2.2.1 Functional description*

| **Balanced Priority for dedicated vehicles on road sections around tunnels** | |
|---|---|
| **Use case introduction** | |
| **Summary** | Dedicated vehicles like heavy trucks get a limited form of priority at signalised intersections, especially on advised routes, in order to reach a dynamic optimum in the use of the road network with e.g. bottlenecks like tunnels. This priority reduces travel time for this type of traffic on the advised route, saves fuel and emissions, and contributes to the reduction of vehicle and road maintenance. Because the conditional priority makes the advised route more attractive, it also stimulates truck companies to reroute if necessary (e.g. to avoid traffic jams around tunnels). |
| **Background** | Traffic lights interrupt traffic flow and therefore cause delay and emissions. For emergency, safety, environmental, traffic flow efficiency and business reasons it may be advantageous to give priority at traffic lights to dedicated vehicles like heavy trucks. Especially when this can contribute to the willingness of truck companies to reroute their trucks to avoid traffic jams near bottlenecks in the road network such as tunnels. |
| **Objective** | To give priority at traffic lights to specific classes of road users, in order to optimise the use of the road network. |
| **Desired behaviour** | If certain conditions are fulfilled, the traffic signal shows green when the vehicle arrives at the intersection and the vehicle can pass the intersection with no (control) delay. |
| **Expected benefits** | The primary expected impact is a more optimal route for the drivers of dedicated vehicles like heavy trucks and therefore less loss of time (and less costs) for the transporter.<br>The secondary expected impact is that truck companies are more willing to follow the advice of road operators, to optimise the use of the road network (e.g. rerouting their trucks in case of traffic jams around tunnels). |
| **Use case description** | |
| **Situation** | When drivers of dedicated vehicles approach a signalised intersection, especially on an advised route, the drivers get a limited form of priority. |
| **Logic of transmission** | I2V via cellular (3G/4G) |
| **Actors and relations** | • Vehicle driver: receives acknowledgement of priority.<br>• Road operator: defines the policy objectives and priorities.<br>• Service provider: implements the traffic signal priority service.<br>• End user: fleet owners and fleet operators may amend routes based on priority rules.<br>• Vulnerable road user: n/a.<br>• Other: n/a. |
| **Scenario** | A priority vehicle has received a route advice by its service provider. In conjunction with this advice dedicated vehicles get priority at the intersections on the advised route. Now the vehicle approaches a signalised intersection on this route. Vehicle information such as the vehicle class, load properties and punctuality is provided to the signal controller. Subject to the applicable priority policies, the vehicle is given priority green and therefore can pass the intersection |

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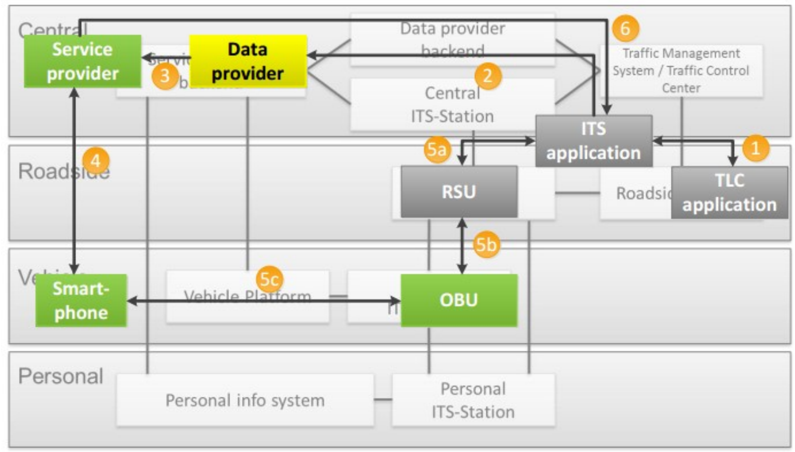
| | unhindered. |
| **Display / alert principle** | A vehicle approaching a TLC sends a priority request to the TLC. The TLC decides if priority will and/or can be given and sends feedback to the vehicle in which way the priority request will be granted. |
| **Functional Constraints / Dependencies** | n/a. |

### *10.2.2.2 High level technical description*

| **Use case implementation** | |
|---|---|
| **Model implementation** | There are two mechanisms for requesting traffic signal priority. The first mechanism detects the approach of a dedicated vehicle by map-matching the received CAM messages onto the topology of the intersection. If an approaching CAM of a dedicated vehicle is detected, a dedicated vehicle priority request is sent to the traffic controller. When the dedicated vehicle has passed the stop line, the request is cancelled. The traffic controller decides if, and how much, priority the dedicated vehicle will get, and it will adapt the traffic lights and their predictions accordingly.<br>The second mechanism is induced by equipped vehicles. For instance, dedicated vehicles will request priority explicitly via a Service Request Message (SRM). A dedicated vehicle detects that it is approaching an intersection by map-matching its own location on the MAP topology received. Next, an SRM message is sent that describes the signal the dedicated vehicle requests priority for. The incoming SRM is combined with the CAM from the dedicated vehicle, and a priority request to the traffic light controller is sent. Feedback from the traffic controller is passed to the dedicated vehicle via a Service Status Message (SSM). When the dedicated vehicle has passed the stop line, the request is cancelled. The traffic controller decides if, and how much, priority the dedicated vehicle will get, and it will adapt the traffic lights and their predictions accordingly. |
| **Reference architecture** | In the Netherlands, the traffic signal priority is used for dedicated vehicles like heavy trucks, emergency vehicles and public transport vehicles. The traffic signal priority for dedicated vehicles service is implemented following the architecture of the ‘intelligent Traffic Light Controller’ (iTLC). The architecture allows for integration of the C-ITS domain with the TLC domain by allowing ITS Applications to use facilities from both the Traffic Light Controllers (TLC) and Roadside units (RIS or RSU) and therefore enable the implementation of various ITS use-cases related to TLCs. The ‘TLC-Facilities’ and ‘RIS-Facilities’ describe the functionality of respectively TLC and RIS. The goal of the architecture is to provide the TLC Facilities and RIS Facilities functionality to ITS Application by defining open interfaces. |

<table>
<tr><td></td><td>


Every colour could indicate another stakeholder<br>
The process for this application contains several steps:
<ol>
<li>Dedicated vehicles (OBU / smartphone) send a priority request to an RSU (5c) or to its service provider (4).</li>
<li>The RSU (5a) or service provider (6) forwards this request to the TLC application via the ITS application (1).</li>
<li>The TLC application decides if, and how much, priority the dedicated vehicle will get, and it will adapt the traffic lights and their predictions accordingly.</li>
<li>The ITS application receives this TLC-information from TLC applications (1).</li>
<li>The ITS application sends messages containing SPAT / MAP information towards data providers (2) and towards RSUs (5a) to broadcast the message during the requested duration time with a specific repetition rate to OBUs (5b). In the vehicle the message of the OBU is forwarded to an application on a smartphone (5c).</li>
<li>Data providers collect the data of ITS applications and provide that to service providers (3).</li>
<li>Service providers determine whether SPAT / MAP information is required for individual users and send the appropriate information to smartphones (4).</li>
</ol>
</td></tr>
<tr><td>Relation to InterCor profiles</td><td>n/a.</td></tr>
<tr><td colspan="2">Functional and non-functional requirements</td></tr>
<tr><td>Sources of information</td><td>Cooperative Awareness Message (CAM)<br>Signal phase and Timing message (SPaT)<br>Intersection topology message (MAP)<br>Service Request Message (SRM)<br>Service Status Message (SSM)</td></tr>
<tr><td>Standards</td><td>
<ul>
<li>ETSI TS 103 301<br>Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services</li>
<li>ETSI EN 302 637-2<br>Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service</li>
<li>ETSI EN 302 637-3<br>Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.</li>
</ul>
</td></tr>
</table>

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|---|---|
| | • ETSI TS 101 539-1<br>Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification<br>• ETSI TS 102 894-2<br>Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities. layer common data dictionary<br>• ISO TS 19321:2015<br>Dictionary of in-vehicle information (IVI) data structures.<br>• ISO/TS 14823:2008(en)<br>Traffic and travel information; Messages via media independent stationary dissemination systems; Graphic data dictionary for pre-trip and in-trip information dissemination systems<br>• SAE J2735<br>Dedicated Short Range Communications (DSRC), Message Set Dictionary.<br>• CEN ISO/TS 19091<br>Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections. |
| **Technical Constraints / dependencies** | • The Traffic application must be made capable to actually give the requested priority.<br>• TLC is connected to RSU and can provide information on the current and next phase.<br>• Special precautions should be taken to connect dynamically timed TLCs.<br>• RSU is able to send information on the static topology of the signalised intersection. Optionally this static information is provided to the HMI by other methods.<br>• RSU supports I2V services and can send information on signal phase and timing.<br>• The HMI supports I2V services and can receive information on signal phase and timing. |

# 11 Bibliography


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