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Deliverable

Activity 4

Sub Activity 4.2

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Contributors:

Hasnaâ Aniss, IFSTTAR

Saleh Bensator, PSA

Farah Braiteh, Renault

José Fernandez, CTAG

Hacene Fouchal, URCA

Lara Mouna, Brisa

Jorge Ribeiro, A-to-B

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Acronym Table

App-Serv	Application Server
CAM	Cooperative Aware Message
C-ITSS	Central-ITSS
DENM	Decentralized Environmental Notification
DSMIP	Dual Stack Mobile IP
ITS	Intelligent Transport System
ITS-G5	Adaptation of the IEEE 802.11p (wifi)
ITSS	Intelligent Transport System Station
R-ITS-S	ITSS-Roadside
IVI	In Vehicle Information
LTE	Long Term Evolution
Nfr-ITS-S	French National Central ITSS
NPt-ITS-S	Portuguese National Central ITS-S
NSp-ITS-S	Spanish National Central ITS-S
OEM	Original Equipment Manufacturer
MCTO	Multi-Cargo Transport Optimisation
PFro	Road Operator's Platform
PFcm	Car Manufacturer's Platform
POI	Point of Interest
R-ITS-S	Road Side ITS-S
TMS	Traffic Management System
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	V2V and/or V2I
V-ITS-S	ITS-S Vehicle (user or road operator)
Vro-ITS-S-	ITS-S-V Road Operator
Vru-ITS-S-	ITS-S-V User

List of standards

DENM	ETSI EN 302 637-3 v1.2.2 (2014-11)
IVI	ISO/TS 19321:2015 (2015-04-15)
BTP	ETSI EN 302 636-5-1 V1.2.1 (2014-08)
Geonetworking	ETSI EN 302 636-4-1 V1.2.0 (2013-10)
Security	ETSI TS 103 097 V1.2.1 (2015-06)
AMQP 0.9	

1 Introduction

This second series of cross-tests, held in Spain/Portugal in July 2019, within the project SCOOP@F represents the ambition of partners (France, Spain and Portugal) to evaluate the overall C-ITS system interoperability in a cross-border environment.
The cross-border tests aim at:

- Evaluating the C-ITS system in open-road environment involving several European countries
- Experimenting C-ITS continuity of services when vehicles are roaming from one country to another
- Experimenting in real conditions the hybrid communication solution; which implies on one hand the long-range communications (3G/4G) and short-range communication (ITS-G5)
- Contributing to the identification of the key aspects to be considered for a successful deployment of C-ITS among the European members states

2 Functional Architecture in Spain, Portugal and France for hybrid communications

2.1 France

2.1.1 General Overview

SCOOP is a pilot project for the deployment of cooperative intelligent transport systems, i.e. systems based on the exchange of information between vehicles and between vehicles and roads. Vehicles are equipped with sensors to detect events such as a slippery road, an emergency brake, etc. and with on-board units to transmit the information to vehicles behind (V2V) and to the road operator (V2I) through road side units. The road operator can also transmit information (roadworks, etc.) to the vehicles through their on board units (I2V).

SCOOP federates numerous public and private partners around the Ministry of Environment, Energy and the Sea Ministry of Ecological and Solidarity Transition (MTES Ministère de la Transition Ecologique et Solidaire), who acts as as coordinator : local authorities, road operators, car manufacturers PSA and Renault, universities and research institutes. Since January 2016, a telecom operator, a trust services provider and Austrian, Spanish and Portuguese partners have joined the project.

The exchange of information between the vehicles and the infrastructure are based on ITS G5 (Figure 1), a short-range communication technology designed for cooperative ITS.

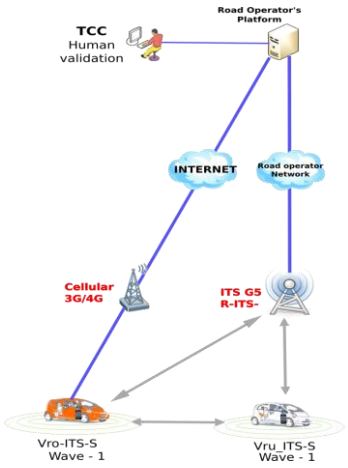


Figure 1: ITSG5 based architecture

In a second phase, new services were specified and a hybrid ITS G5/cellular technology was developed (Figure 2). All specifications can be found in 2.4.1.Common set of functional and technical specifications for SCOOP for ITS-G5 and Day1 services.

For Hybrid communication, specifications can be found in 2.4.1.H. Functional and technical hybrid architecture – Common specifications.

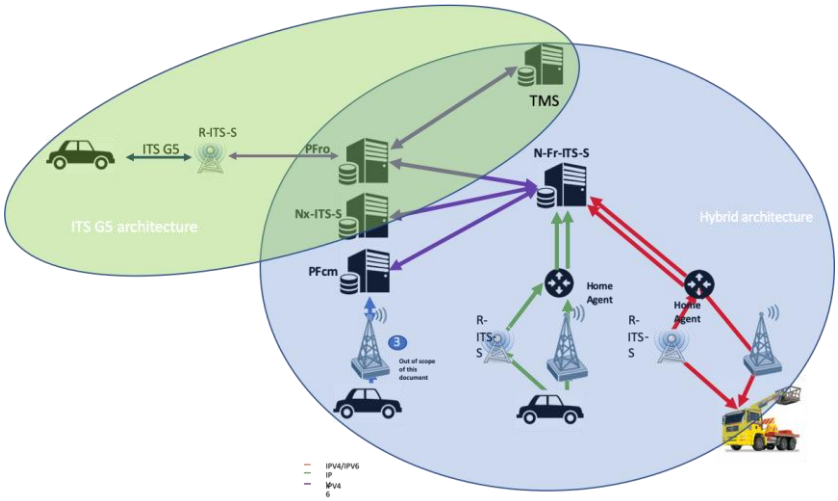


Figure 2: General SCOOP Architecture

2.1.2Use Cases

Several use cases were specified, implemented and evaluated in this project. Table 1 presents the complete list of SCOOP use cases.

List of SCOOP use cases
Traffic data collection (CAM aggregation)
Traffic data collection (automatic denm aggregation)
Traffic data collection (manual denm aggregation)
Alert neutralization of part of a lane, whole lane or several lanes
Alert planned closure of a road or a carriageway
Alert planned road works – mobile
Road operator's intervention
Alert end of queue by a road operator vehicle
Winter maintenance
Temporary slippery road
Animal or people on the road
Obstacle on the road
Stationary vehicle, breakdown
Unprotected accident area
Reduced visibility
Unmanaged blockage of a road
Emergency brake
Enf of queue
Extreme weather conditions
Wrong-way driving
Temporary lane blockage or closure

Table 1: SCOOP use cases

List of use case can be found in COCSIC- 2.2_H Catalogue of French use cases.

2.2 Spain

2.2.1General overview

Aiming to check interoperability of SCOOP@F system with other C-ITS implementations deployed in other countries, as indicated previously, SCOOP@F Part 2 involved partners from Spain, Portugal and Austria and included cross-tests with test sites in these countries.

These cross-tests were firstly focused on the priority services specified in SCOOP@F Part 1, using ITS-G5 communication technology and without considering fully implemented security processes and lastly, with a second series of cross-tests, on the hybrid communication technology (ITS-G5 / 3G-4G) deployed in the participant pilots.

For the SCOOP Xtest activity, tests in Spain were carried out in 10 Kilometers included in the permanent C-ITS corridor SISCOGA that leads from CTAG facilities to the Spain-Portugal border. SISCOGA cooperative corridor comprehends more than 100 km of interurban (A52, A55 and AP9) and urban (different parts of Vigo City) roads equipped with 50 ITS G5 RSU connected to the North West DGT Traffic Management Centre and sending cooperative messages related to the I2V based DAY 1 services defined by the EC C-ITS platform.

SISCOGA corridor has been used for testing cooperative services since 2010, being the main Test Site of the Project SISCOGA National FOT. This Project dealt with cooperative systems analyzing the impact of Car to Infrastructure and Car to Car communications-based applications on safety, efficiency, mobility and driver behaviour. This Project set the basis for the participation within the European FOT DRIVE C2X as one of the seven Test Sites of the project, running both naturalistic and controlled tests in this corridor. Also, in the urban part of the corridor (Vigo City) important European Pilots were run as COMPASS4D and CO-GISTICS.

SISCOGA corridor was enlarged within SCOOP Part 2 project framework creating a second testing area, 40 km of the A6 motorway near Madrid, by deploying 30 ITS G5 RSUs following an analogue architecture to the previous existing one and depicted in the following diagram.

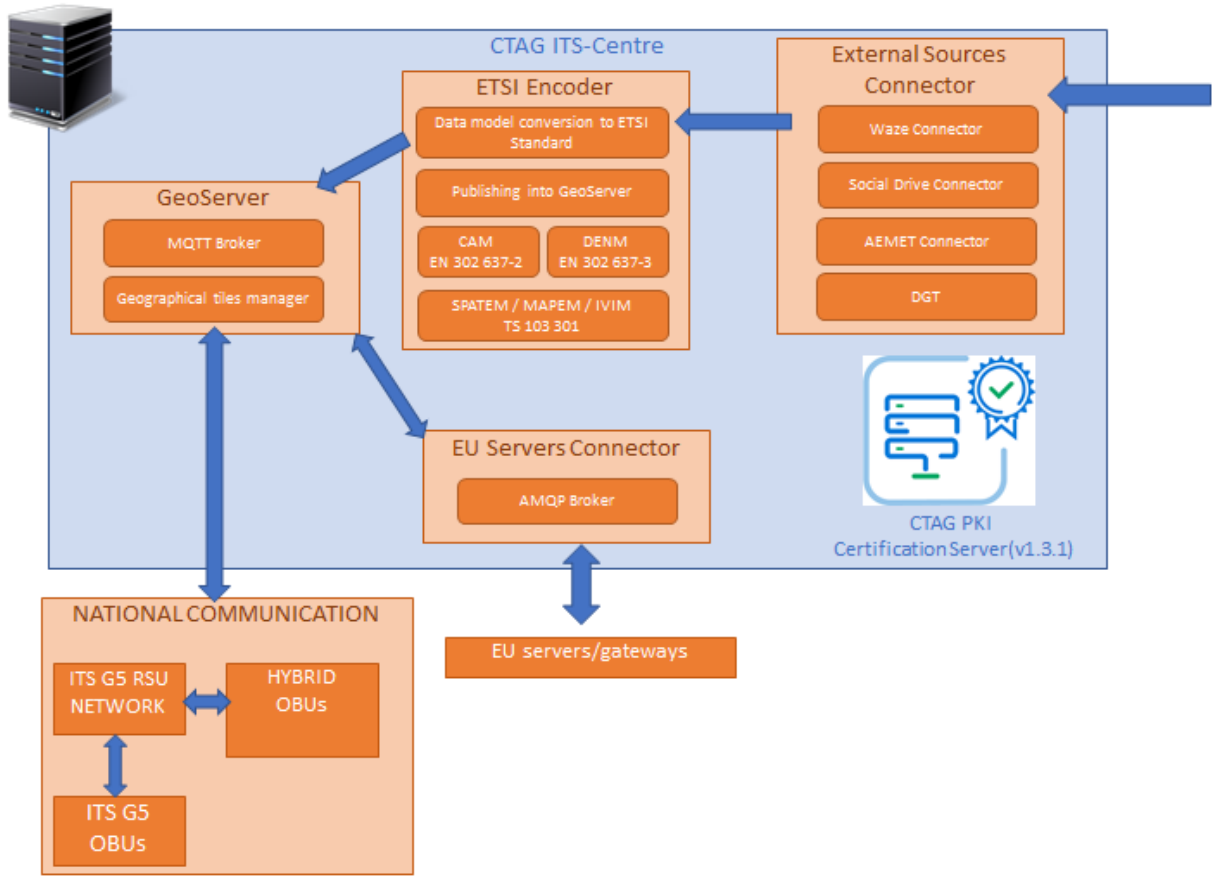


Figure 3:Spain Architecture

As it can be checked, relevant traffic information obtained from different sources is processed in the CITS to be encoded according to the defined ETSI standards for C-ITS messages. Such messages are distributed via the Geoserver both to a national part (ITS G5 RSU network - which broadcast information to ITS G5 OBUs under its coverage- ; and national hybrid OBUs) and to the external servers/gateways connected according to the communication interface defined for the Xtest activity (please see later sections for further explanation on this interface).

As indicated in the schema, certificates used for C-ITS communication in the national deployment are currently under v 1.3.1 of the standard. This circumstance, different version of standard for C-ITS messages, challenged to use some intermediate gateways able to make the convenient adaptations to create an interoperable communication framework (please see later sections to go further on gateways usage).

Both for the national communication as for the communication with EU servers/gateways, it is worth to say that sending all available infrastructure data through the existing communication network and selecting the relevant information once it has been received in the final users was not an option due to the huge amount of data to be processed. To solve this potential bottleneck geographic filtering was applied to provide the information.

A geographic filter can be built by splitting the world map into tiles, like Internet map providers do. Each tile where data should be 'in range' provides that data. The geographical location (latitude, longitude) of a vehicle is used to find the corresponding tile. If data is related to this tile it is forwarded to the vehicle. In the other direction, the location of the vehicle can be provided inside the tile, if a service requires this. All data outside the tile is ignored. The size of a tile is determined by the zoom level. At zoom level zero there is only one tile that encompasses the whole world. Each additional zoom level splits the tile into four new tiles.

There are various ways to identify tiles and zoom levels.The method used here is the quadtree. The advantage of the quadtree is that the identification largely stays the same when the zoom level changes. A tile in a quadtree is represented by a string of numbers, where each number identifies one quarter of a tile split into four new ones.

Out of the scope of the activity, as interoperability is obtained via backend communication, just remark that at national level, MQTT protocol is used to obtain information from tiles. MQTT is a publish/subscribe, extremely simple and lightweight messaging protocol designed to minimize network bandwidth and device resource requirements whilst also attempting to ensure reliability and some degree of assurance of delivery. Multiple clients (e.g. RSUs, hybrid OBUs) can connect to a broker (e.g. information source in Geoserver) and subscribe to topics (e.g. DENMs, IVIs, ...) that they are interested in. Clients can also connect to the broker and publish messages to topics.

2.3 Portugal

The Portuguese partners integrated the project "*SCOOP@F Part 2*" with a diversified spectrum of competences coordinated by a public administration (Institute for Mobility and Transport – IMT) and including: a public road operator (Infraestruturas de Portugal – IP); a private road operator (Auto-Estradas Norte Litoral – AENL); and a technological company (A-to-Be).

A-to-Be

Brisa is a Portugal-based international transportation company that manages approximately 1600 kilometers of road infrastructure. The company vision is centered on the client, focused on mobility and accessibility solutions following the development of new tendencies, technologies and behaviour changes.

Recently, Brisa adopted a new brand for its technology company - A-to-Be® - that expresses the developments made together with clients, from tolling to parking, from traffic management to monitoring, on what it can be referred as human seamless mobility experiences.

A-to-Be has joined the project to continue its work on developing cooperative intelligent transportation systems (C-ITS), namely, an end-to-end framework, ranging from the radio transmission hardware to the back-office software for managing the road infrastructure.

Throughout the project a C-ITS Central Platform (MOBICS) has been developed that arises from the need to implement the use cases and quickly manage the network of cooperative ITS systems. It is responsible for handling all traffic event information and sharing it with hardware and software from different manufacturers. Through an a priori defined rule engine, it automatically manages and routes events by forwarding them to RSUs in a given zone or alerting the traffic management centre operator whenever necessary (without human intervention).

Infraestruturas de Portugal

Infraestruturas de Portugal, S.A. is the public company that results from the merger between REFER (Rede Ferroviária Nacional - Railway Manager) and EP (Estradas de Portugal - Roadway manager), companies that manage and administer the rail and road infrastructures in Portugal. The merger was established on June 1, 2015, following the Decree-Law no. 91/2015 of May 29.

In practice, road and railway infrastructures are managed by a single company in accordance with a joint, integrated and complementary strategy.

The purpose of the IP, S.A. is to design, design, construct, finance, conserve, operate, re-qualify, extend and modernize national road and rail networks, including command and control of railway traffic. IP, whose sole shareholder is the Portuguese State, is subject to the tutelage of the Ministry of Planning and Infrastructures and Ministry of Finance The mission of Department Telematics, Accessibility and ITS is to ensure the development and operation of Accessibility, Telematics and ITS systems and telecommunications networks to support Infrastructures de Portugal core activities (Road and Rail), developing new projects to innovative road-rail mobility solutions. IP participate in the SCOOP project, with the objective of accompanying and participating in the development of I2V communication and C-ITS platform, as well as conducting an analysis of the necessary changes to existing communications infrastructures and systems, inter-state interoperability modes, etc...

IP participation was based on the installation of 4 RSU on Road N13 in the north of Portugal, near the border with Spain and 1 C-ITS centrally installed, thus ensuring knowledge of these new technologies in order to design an architecture at the national level. Infraestruturas de Portugal possesses a vast experience in managing and maintain the railway and road infrastructure (2562 km of rail network and 17,874 km of road network). In the core activities are the rail traffic management, the road traffic surveillance including ITS, the safety of the traffic in both modes. Complementary we possess very strong competencies in Mobile and Fixed Network Planning, Deployment and Operation.

IP also brings to the project the experience on developing and operating mission critical Networks to support safety related services. Large experience one evaluation and tuning of key performance parameters. As the National Road Infrastructure Manager, IP brings knowledge related to traffic management requirements definition and the experience on other V2X tests, which will improve the applicability of the use cases and C-ITS services integration to support CCAM.

General Overview

The range of vehicular radio communications is limited to distances not higher than 1000 meters (with line of sight between the parties), which is a restrictive factor for the widespread of connected vehicle technologies. To address this, it was intended to use cellular communications by increasing service coverage in use cases where low latencies are not a requirement (on 3rd and 4th generation, cellular networks can easily have latencies of 100 milliseconds).

Until then, C-ITS services would be implemented by the road operator and the communications would be done in its premises. By adding cellular communications to the on-board units, vehicles are now connected directly with the internet and with C-ITS service provider configured by the manufacturer, as such a good infrastructure should be put in place that constantly shares events between operators, service providers and other countries.

The project consortium agreed on using a protocol for event sharing between national servers, the Advanced Message Queueing Protocol (AMQP), responsible reliably route communications messages. This protocol is commonly used for managing and sharing messages on Internet of Things (IoT) devices because it contains features such as real-time messaging from multiple sources to multiple destinations, message filtering by type, validity temporal or geographical location.

To simplify the implementation and lower the network latencies, the Portuguese consortium decided to use the same protocol and infrastructure deployed on the national node to share information with the vehicles and all the local road operators.
Just for the sake of this demonstrator, only one message exchange server was considered for the whole Portugal (shown on Figure 4). Later it can be extended to a multi-layer architecture where multiple servers can be maintained by road operators, services providers and manufactures and centralized in the existing national node.

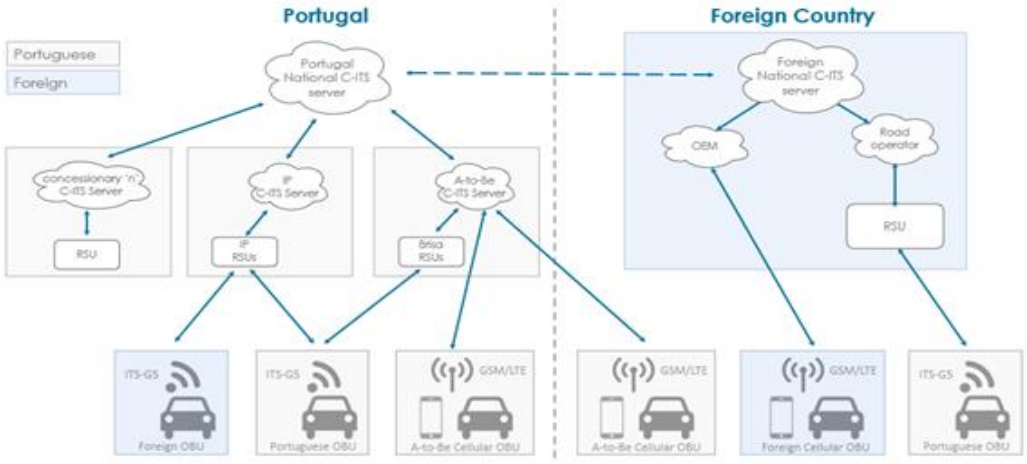


Figure 4: functional architecture in Portugal

A-to-Be had the dual role of being road operator and an OBU manufacturer, exchanging not only the ITS-G5 events (like Infraestruturas de Portugal) but also reported events through the cellular network by the hybrid OBUs deployed.

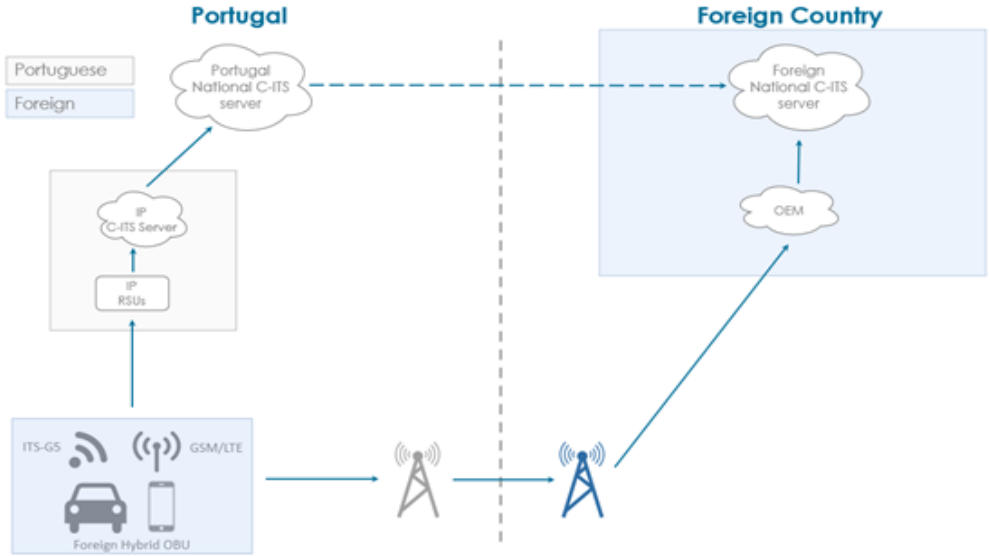


Figure 5: Example of a foreign vehicle with hybrid communications capabilities reporting an event on a Portuguese road.

The above figure depicts an example of a foreign vehicle with hybrid

communications capabilities reporting an event on a Portuguese road. The message is routed both by the ITS-G5 network and over the cellular network. It shows the vehicle communicating directly with its original provider through the cellular towers, and the country where it travels through roadside units, in this case exemplified by IP's infrastructure.

The Portuguese national node was configured with a rabbitMQ agent that supports several messaging protocols, that connects to: Spain using an intermediary server implemented by the University de Reims Champagne-Ardenne (URCA); and France with a server inside the French Ministry premises.

3 Methodology for the experimentation

3.1 LOGISTICS

3.1.1MEETING PLACE

Address: Avenida Principal, 2, 36475 O Porriño, Pontevedra, Espanha

Point: https://goo.gl/maps/oPcCry5aRntWwQqF8

Date: 9-11 July 2019

Figure 6: Ctag facilities

3.1.2Test run in Portugal/Spain

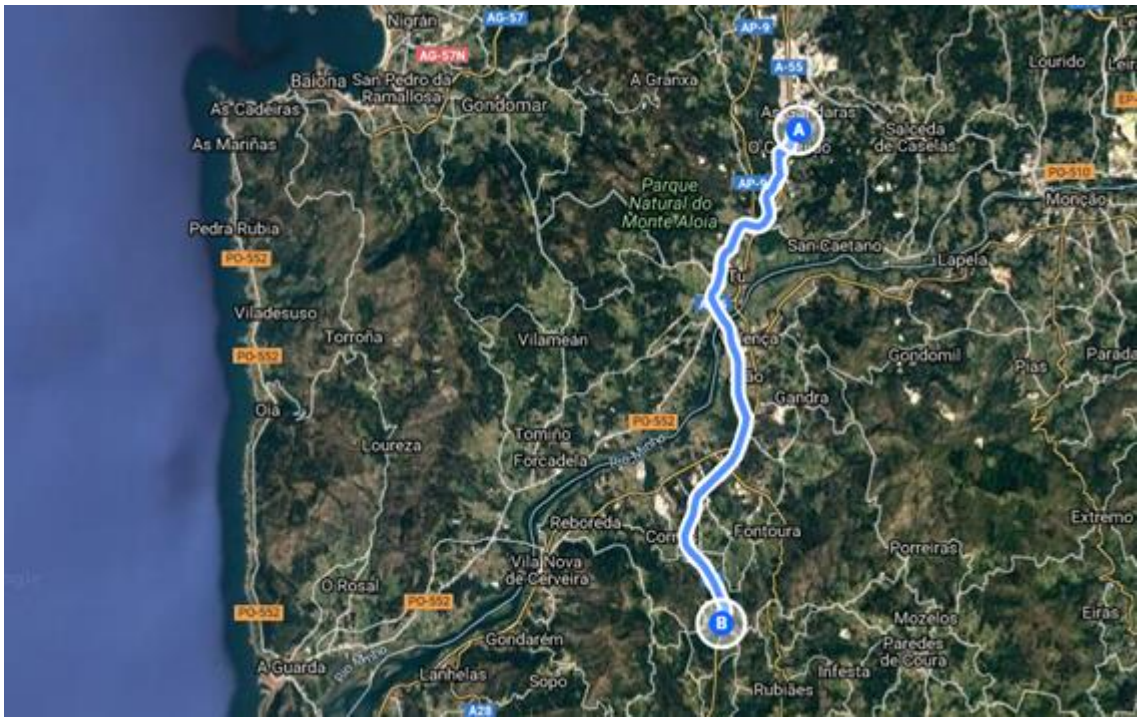


Figure 7: Test run in Portugal/Spain

Figure 7 depicts the 35 km test run that was planned for starting on CTAG's facilities (A) in Spain to Aldeia - Vila Nova de Cerveira in Portugal (B).

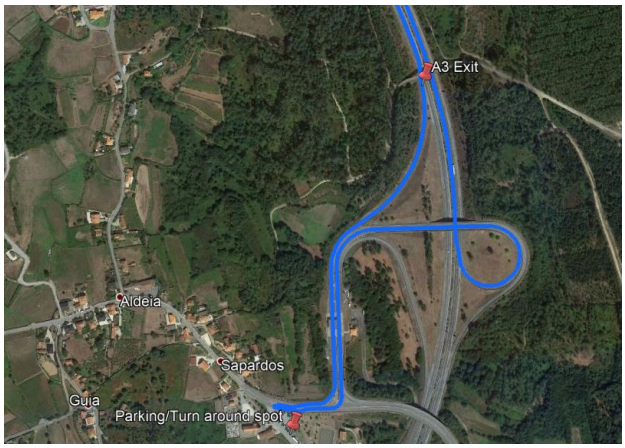


Figure 8: Aerial view depicting A3 highway exit

After exiting the A3 highway there is a parking lot where it is possible to comfortably stop before continuing the run.

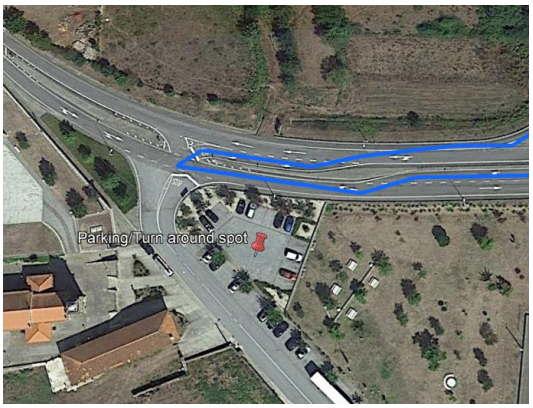


Figure 9: Turn around or parking spot

3.1.3Test track scenario

As done for the Xtest session carried out within W1, previous to on road tests, it was taken advantage of CTAG test track facilities to allow participants to perform some initial tests to validate their vehicle setups and configurations.

Figure 10: Test track at CTAG facilities

These tests were devoted to assure that all equipment in vehicles were correctly up and running and that every participant was visible to all others (both directly – ETSI ITS G5- and cellular-communication with corresponding National Node-).

By verifying STATION ID parameter included in emitted CAMs by the different C-ITS equipment, the above commented goal was met. It could be also checked that the other information that can be included in these messages, as they were correctly encoded, was proper for PVD based services.

C-ITS equipment	STATION ID
CTAG Test Track RSU 1	30000
CTAG Test Track RSU 2	30001
CTAG Test Track RSU 3	30020
URCA NN	42
CTAG NN	12345
CTAG OBU	567
Portuguese NN	576176022
A-to-Be OBU	605414176
PSA OBU	4142493406
Renault OBU	450356753

Table 2: STATION IDs used for XTESTs W2

3.1.4PARTICIPANTS

- CTAG (Spain): 1 Vehicle equipped with a Hybrid OBU (cellular + ITS G5 – security v1.3.1) and 2 RSUs (security v1.3.1)
- A-to-Be (Portugal): 1 Vehicle equipped with a Hybrid OBU (cellular + ITS G5 – security v1.2.1) and 4 RSUs (security v1.2.1)
- Infraestruturas de Portugal (Portugal): 1 Vehicle equipped with a Hybrid OBU (cellular + ITS G5 – Security v1.2.1) and 4 RSUs (Security v1.2.1)
- Renault (France): 1 Megane equipped with a Hybrid OBU (cellular + ITS G5 – security v1.2.1)
- PSA (France): 1 C4 equipped with a Hybrid OBU (cellular + ITS G5 – security v1.2.1)

3.1.5Road Side Unit (R-ITS-S)

Number	Location	Provider
1	42.0819º, -8.6295º	CTAG
2	42.0469º, -8.6568º	CTAG
3	42.0317°, -8.6525°	IP
4	41.9196°, -8.7631°	IP
5	41.6500°, -8.7751°	IP
6	41.8039°, -8.8563°	IP
7	41.9852º, -8.6475º	A-to-Be
8	41.9598º, -8.6709º	A-to-Be
9	41.9446º, -8.6637º	A-to-Be
10	41.9264º, -8.6521º	A-to-Be

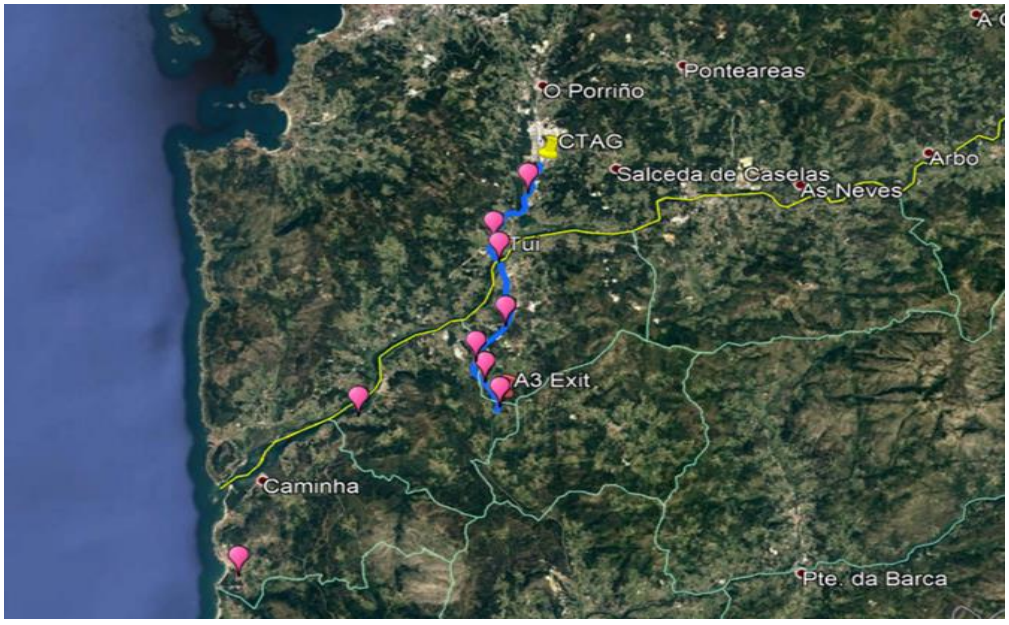


Figure 11: Road Side Units Location

ITSG5 on road test (V2V and V2I) were done in Portugal as in Spain is currently active ETSI TS 103 097 1.3.1 for security. Nevertheless, some ITS G5 test with configuration check purposes could be done at CTAG test track as far as security level could be deactivated in the RSUs there installed.

3.2 HYBRID CONFIGURATIONS

3.2.1INTERFACES

The interface being used to communicate between National Servers is described in the document "*InterCor_2.1b_IF2_specs*", from the InterCor project and document "DRAFT_SCOOP2_Livrable_2.4.1_H_Functional and technical description", depicted in the following by the interfaces 4 and 5.

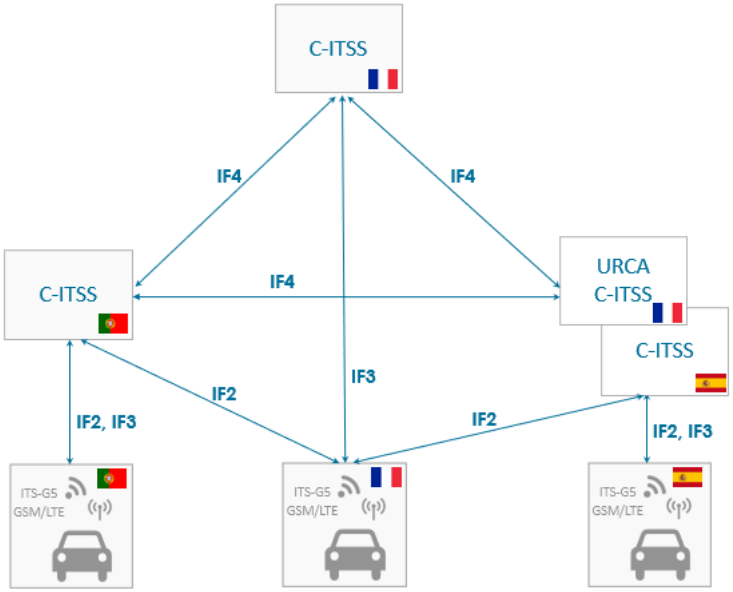


Figure 12: Message flow example

Interface list

Interface 3:

- Downlink: DENM IVI (ASN1 upper)/BTP/Geonet/TCP/IPV4/cellular (security at Geonet level)
- Uplink: CAM et DENM (ASN1 upper)/BTP/Geonet/TCP/IPV4/cellular (security at Geonet level)
- Implementation of DSMIP tunnel

Interface 2:

- Downlink: DENM IVI (ASN1 upper)/BTP/Geonet/TCP/IPV6/ITS-G5 (security at Geonet level)
- Uplink: CAM and DENM (ASN1 upper)/BTP/Geonet/TCP/IPV6/ ITS-G5 (security at Geonet level)

Interface 4

- Uplink: IF2 from InterCor/ DENM (ASN1 UPPER)/ AMQP 0.9 /TCP/IPV4/ (security at Geonet level)
- Downlink: IF2 from InterCor / DENM IVI (ASN1 UPPER)/ AMQP 0.9 /TCP/IPV4/ (security at Geonet level)

3.2.2 PUBLISHING AND SUBSCRIBING MESSAGES (INTERFACE 4)

- All DENM and IVI messages sent to ITSS-R should be routed to its corresponding National Node;
- All National Nodes relay DENM messages coming from 3G/4G vehicles to all its subscribers;
- All National Nodes should republish active DENM events every 5 minutes;
- All countries shall route DENM messages coming from ITS-G5 vehicles to its corresponding National Node;
- The default quadtree path zoom level for publishing is 18;
- The messages shall contain security (ETSI TS 103 097 v1.2.1) and geonet headers as if they were sent through the ITSS-R.

3.3 TEST PROGRAM

This test aims to validate the hybrid communications solution by sending events from the infrastructure to the vehicles.

All the following I2V events will be made available on both on the RSU (ITS-G5) and AMQP server at 9am WEST.

3.3.1 EVENT DESCRIPTION

N° event	Message type	Main message attributes	Use Case	Provider	Location
1	DENM	Upstream 10/0 With Trace and EventHistory	D3 - Obstacle on the road	A-to-Be	Portugal
2	DENM	AllTrafficDirection 18/1 With Trace	D6 - Adverse weather conditions - Fog	A-to-Be	Portugal

3	DENM	Upstream 3/3 With Trace and EventHistory	B1 – Planned road works	A-to-Be	Portugal
4	DENM	AllTrafficDirection 11/0 With Trace	D2a - Animal on the road	IP	Portugal
5	DENM	Upstream 3/0 With Trace and EventHistory	B1 – Planned road works	CTAG	Spain
6	DENM	AllTrafficDirection 11/0 With Trace	D2a - Animal on the road	CTAG	Spain
7	DENM	AllTrafficDirection 10/0 With Two traces	D3 - Obstacle on the road	CTAG	Spain
8	IVIM	INIT SPANISH XTEST PATH Nature 9 SerialNumber 99	eVMS	CTAG	Spain
9	IVIM	END SPANISH XTEST PATH Nature 9 SerialNumber 99	eVMS	CTAG	Spain
10	DENM	Upstream	B1 – slowMovingRo	URCA	Portugal

		3/3 With Trace and EventHistory	adMaintenance		
11	DENM	Upstream 3/3 With Trace and EventHistory	B1 – PslowMovingRoadMaintenance	URCA	Spain
12	DENM	Upstream 3/0 With Trace and EventHistory	B1 – Planned road works	URCA	Spain
13	DENM	Upstream 17/0 With Trace and EventHistory	B1 – adverseWeatherCondition-ExtremeWeatherCondition	URCA	Portugal

Table 3: event description

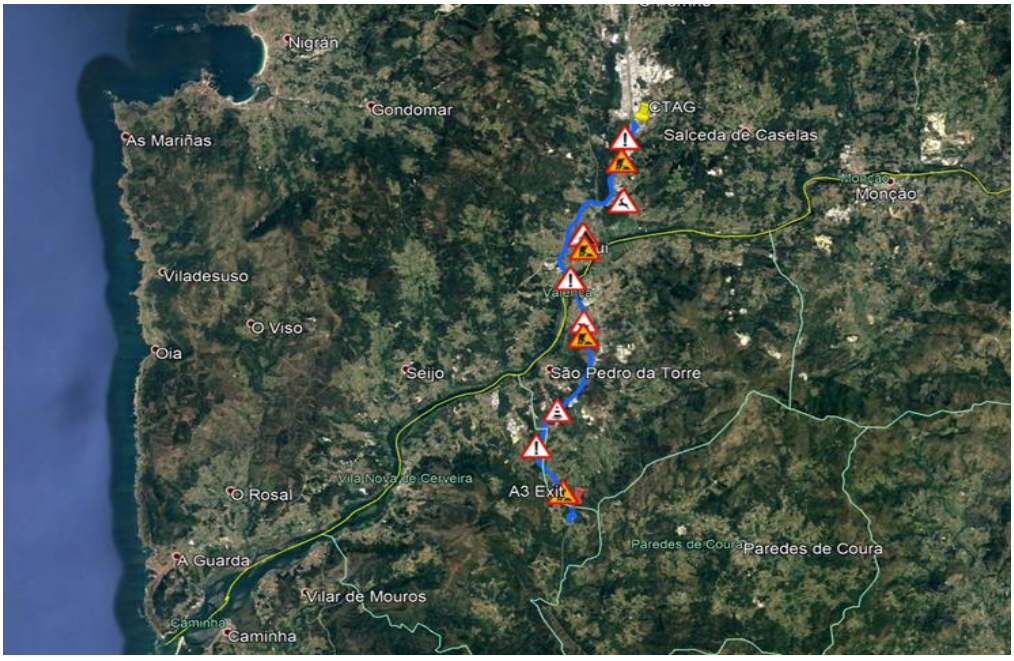
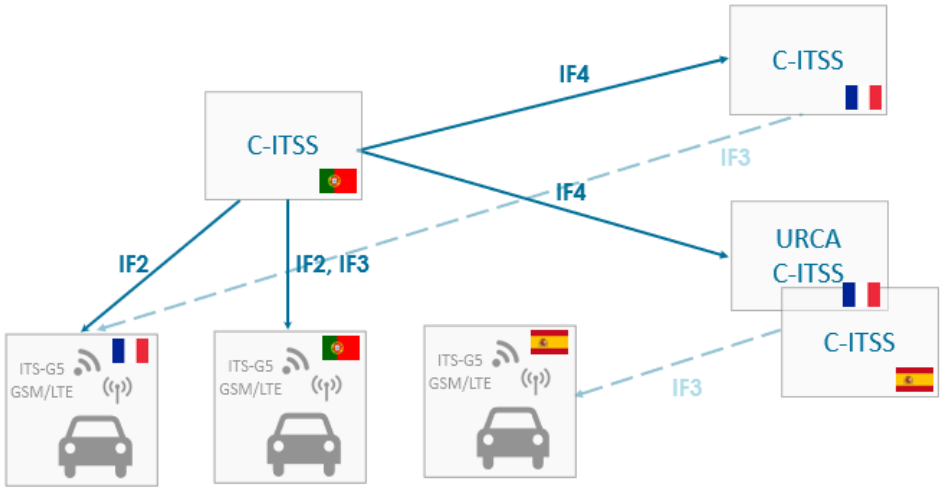


Figure 13: Map of I2V event locations

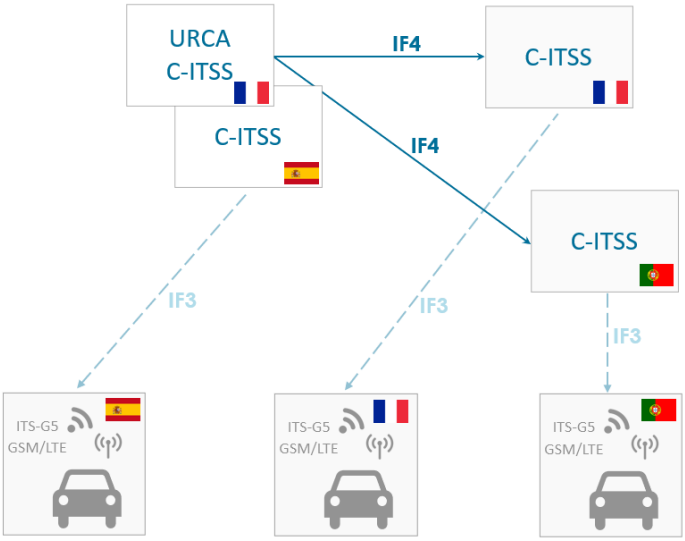
Events 1-4 pretend to validate the communications when an event originates on the Portuguese infrastructure represented by the following diagram:



Functional steps:
1. Foreign servers subscribe to PT exchange (DENM)
2. PT TMC publishes on PT exchange (DENM)
3. Foreign servers receive through PT exchange (DENM)
4. Foreign vehicles receive information through its own Nxx-ITS-S

To ensure interoperability between Spain and the other countries, all messages from or to Spain N-ITS-S are routing towards URCA ITS-S in order to be converted according to the standard ETSI TS 103 097 v1.2.1.

Events 5-9 pretend to validate the communications when an event originates on the Spanish infrastructure represented by the following diagram:



Functional steps:
1. Foreign servers subscribe to URCA gateway to get SP exchange (DENM, IVI)
2. SP TMC publishes on SP exchange (DENM, IVI)
3. Foreign servers receive through URCA gateway to get SP exchange (DENM, IVI)

4. Foreign vehicles receive information through its own Nxx-ITS-S.

3.4 TEST PROGRAM – V2V/V2I

This test aims to validate the hybrid communications solution by generating simulated events on one vehicle to the infrastructure and surrounding vehicles.

All the events should be triggered by the vehicles closer to the agreed location and broadcast both on the ITS-G5 and Cellular.

3.4.1EVENT DESCRIPTION

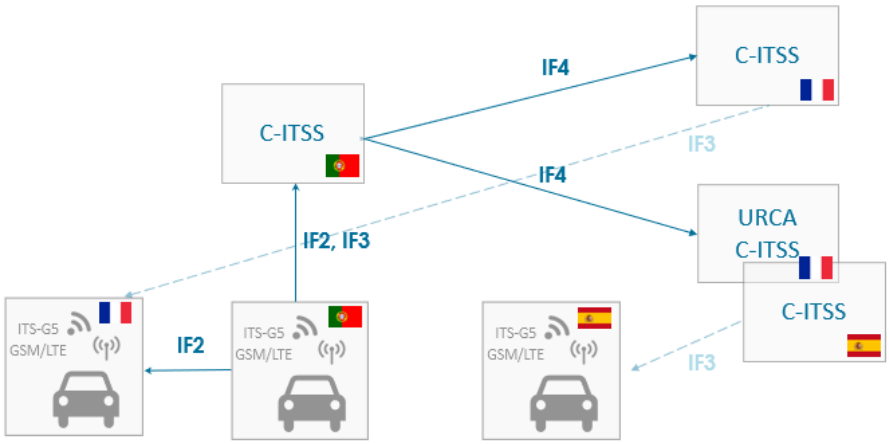
N°event	Message Type	Main message attributes	Use Case	Publisher	Listener	Channel	Location
14	DENM	AllTrafficDirection 12/0	D2b People on the road	A-to-Be	All	ITS-G5 + Cellular	Portugal
15	DENM	AllTrafficDirection 12/0	D2b People on the road	A-to-Be	All	ITS-G5 + Cellular	Portugal
16	DENM	AllTrafficDirection 12/0	D2b People on the road	A-to-Be	All	ITS-G5 + Cellular	Spain
17	DENM	AllTrafficDirection 12/0	D2b People on the road	CTAG	All	Cellular	Spain
18	DENM	AllTrafficDirection 12/0	D2b People on the road	CTAG	All	Cellular	Spain
19	DENM	AllTrafficDirection 12/0	D2b People on the road	CTAG	All	Cellular	Portugal

20	DENM	AllTrafficDirection 12/0	D2b People on the road	CTAG	All	Cellular	Portugal
21	DENM	AllTrafficDirection 94/0	Stationary vehicle	CTAG	All	Cellular	Portugal
22	DENM	AllTrafficDirection 11/0	D2a - Animal on the road	PSA	All	ITS-G5 + Cellular	Portugal
23	DENM	94/0	Accident	Renault	All	Cellular	Spain

Table 4: event location

3.4.2Test description

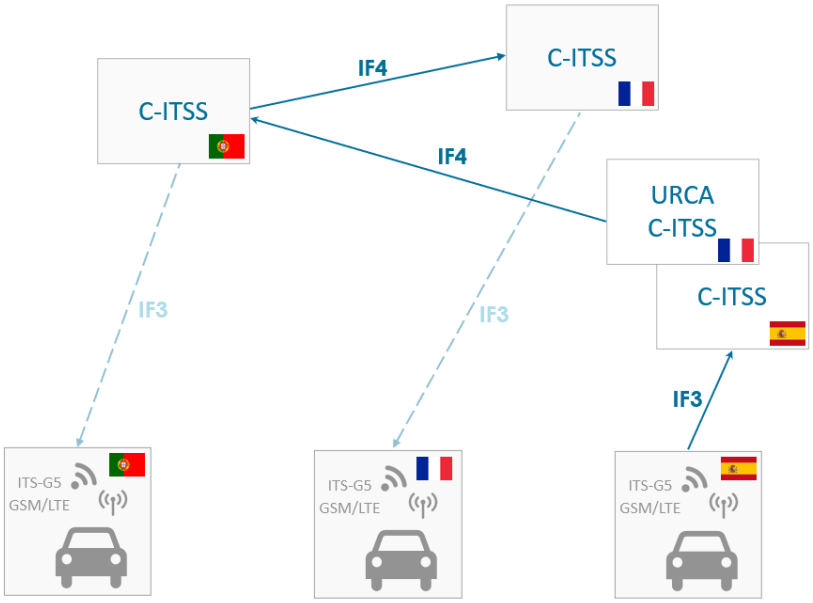
Events 11-13 pretend to validate the communications of a Portuguese vehicle emitting an event on a Portuguese road, like described in the following diagram:



Functional steps:

1. Foreign servers subscribe to PT exchange (DENM)
2. PT vehicle sends message to PT Npt-ITS-S
3. PT TMC publishes on PT exchange (DENM)
4. Foreign servers receive through PT exchange (DENM)
5. Foreign vehicles receive information through its own Nxx-ITS-S

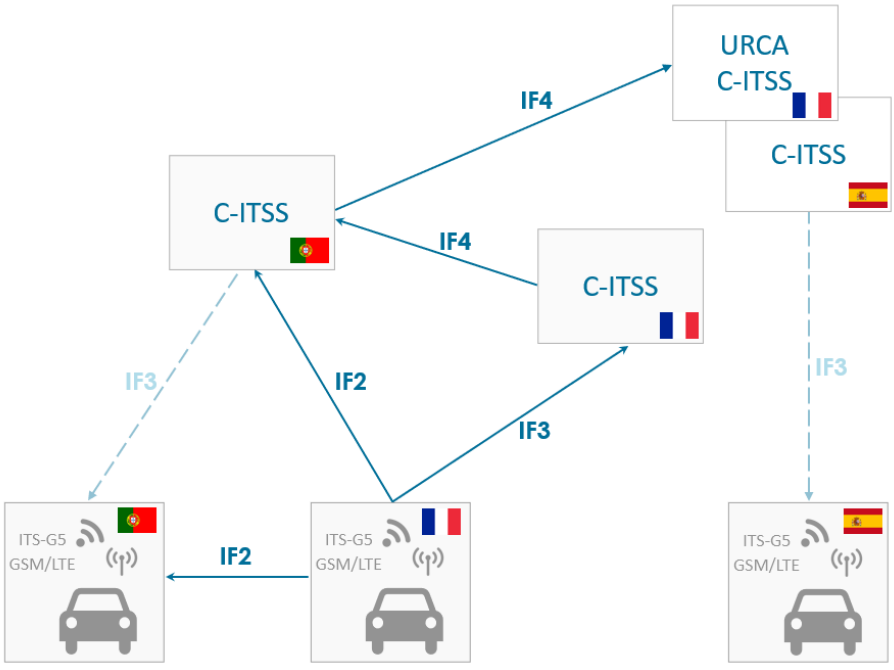
Events 14-15 pretend to validate the communications of a Spanish vehicle emitting an event like described in the following diagram:



Functional steps:

1. Foreign servers subscribe to URCA gateway to get SP exchange (DENM)
2. SP vehicle sends message to NSp-ITS-S
3. SP TMC publishes on SP exchange (DENM)
4. Foreign servers receive through URCA gateway to get SP exchange (DENM)
5. Foreign vehicles receive information through its own Nxx-ITS-S

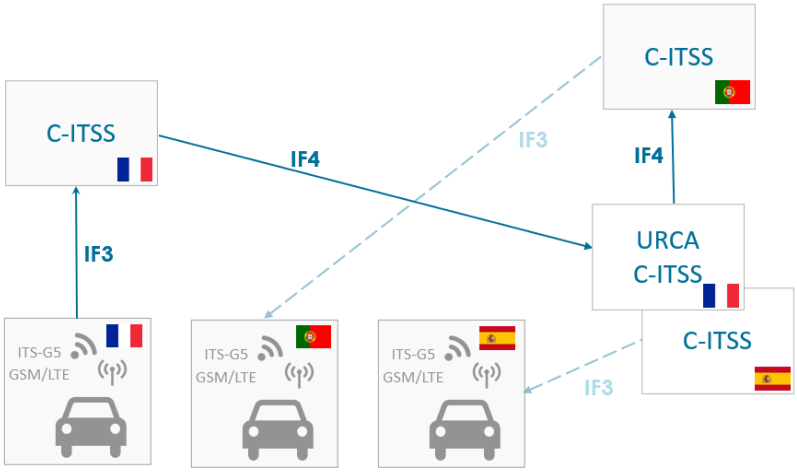
Events 16-17 pretend to validate the communications of a French vehicle emitting an event on a Portuguese road, like described in the following diagram:



Functional steps:

1. Foreign servers subscribe to FR exchange (DENM)
2. FR vehicle sends message to Nfr-ITS-S
3. FR TMC publishes on FR exchange (DENM)
4. Foreign servers receive through FR exchange (DENM)
5. Foreign vehicles receive information through its own Nxx-ITS-S

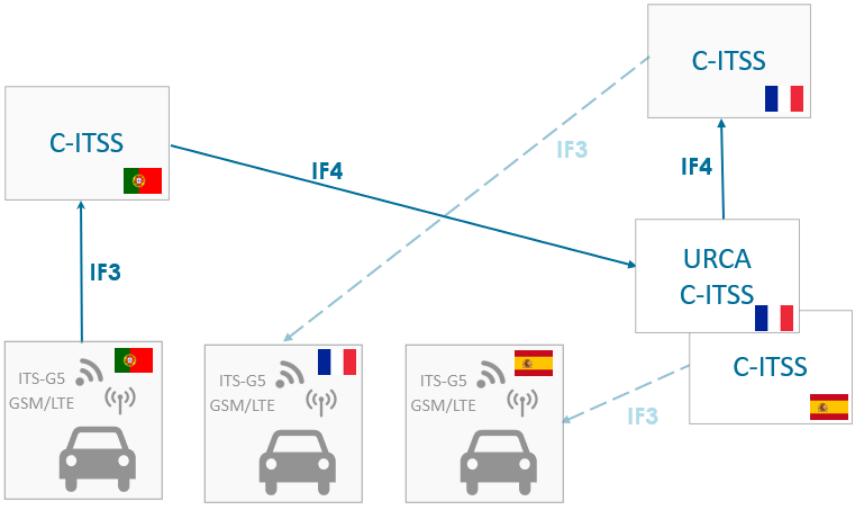
Events 18-19 pretend to validate the communications of a French vehicle emitting an event on a Spanish road, like described in the following diagram:



Functional steps:

1. Foreign servers subscribe to URCA exchange (DENM)
2. FR vehicle sends message to Nfr-ITS-S
3. Nfr-ITS-S publishes on URCA exchange (DENM)
4. URCA publishes on SP exchange (DENM)
5. SP vehicle receives through NSp-ITS-S
6. Foreign servers receive through URCA exchange (DENM)

Events 20 pretend to validate the communications of a Portuguese vehicle emitting an event on a Spanish road, like described in the following diagram:



Functional steps:

1. Foreign servers subscribe to URCA exchange (DENM)
2. PT vehicle sends message to NPt-ITS-S
3. NPt-ITS-S publishes on URCA exchange (DENM)
4. URCA publishes on SP exchange (DENM)
5. SP vehicle receives through NSP-ITS-S
6. Foreign servers receive through URCA exchange (DENM)

4 Results

4.1 Overall result summary

Event description	Channel reception per partner		
	Spain	Portugal	France
Event 1: I2V A-to-Be 10/0 Portugal	Cellular	ITS-G5+Cellular	ITS-G5+Cellular
Event 2: I2V A-to-Be 18/1 Portugal	Cellular	ITS-G5+Cellular	ITS-G5+Cellular
Event 3: I2V A-to-Be 3/3 Portugal	Cellular	ITS-G5+Cellular	ITS-G5+Cellular
Event 4: I2V IP 11/0 Portugal	N/A	ITS-G5	ITS-G5
Event 5: I2V CTAG 3/0 Spain	Cellular	Cellular	cellular
Event 6: I2V CTAG 11/0 Spain	Cellular	Cellular	cellular

Event 7: I2V CTAG 10/0 Spain	Cellular	Cellular	cellular
Event 8: IVI BEGIN Spain	Cellular	Not supported	cellular
Event 9: IVI END Spain	Cellular	Not supported	cellular
Event 10: I2V URCA 3/3 Portugal	Cellular	Cellular	cellular
Event 11: I2V URCA 3/3 Spain	Cellular	Cellular	Cellular
Event 12: I2V URCA 3/0 Spain	Cellular	Cellular	Cellular
Event 13: I2V URCA 17/0 Portugal	Cellular	Cellular	Cellular
Event 14: V2V A-to-Be 12/0 Portugal	Cellular	Cellular	Cellular
Event 15: V2V A-to-Be 12/0 Portugal	Cellular	Cellular	Cellular
Event 16: V2V A-to-Be 12/0 Spain	Cellular	Cellular	Cellular
Event 22: V2V PSA 11/0 Portugal	N/A	ITS-G5	ITS-G5
Event 23: V2V Renault 94/0 Spain	N/A	Not received	ITS-G5

4.2 A-to-Be results

In this section, Portuguese specific results are summarized. The national node server was put in place at A-to-Be's premises and configured to connect to DGITM/DIT and URCA nodes for exchanging I2V and V2V events between all the partners involved in the trial, at the time neither the backend nor the OBU used were not ready for in-vehicle signage services. The events were created and signed at the A-to-Be's traffic management system with the simulated events described on the tables before. They were routed to the physical RSUs and Portuguese national node for testing SCOOP's hybrid solution. On the Infraestruturas de Portugal side it was not possible to get the right permissions to have external connections from within the network, providing in the end just ITS-G5 communications.

After analyzing the log files, it was uncovered that all created events had the same station ID and sequence number, originating message rejections after being validated by the facilities layer at some partner components, therefore not being displayed by the HMIs.

Nevertheless, as the summary and subsequent tables depict, the communications were received and sent through ITS-G5 and cellular (using AMQP).

4.2.1Message receptions by Channel:

Event (Cause Code/ Sub-Cause Code)	Number of different messages	ITS-G5	Cellular
trafficCondition (1/0)	5	5	0
accident (2/0)	2	1	1
roadworks (3/0)	36	12	24
roadworks-slowMovingRoadMaintenance (3/3)	28	0	28
hazardousLocation-ObstacleOnTheRoad (10/0)	17	7	10
hazardousLocation-AnimalOnTheRoad (11/0)	11	3	8
humanPresenceOnTheRoad (12/0)	11	7	4
adverseWeatherCondition-ExtremeWeatherCondition (17/0)	14	0	14
adverseWeatherCondition-Visibility-Fog (18/1)	4	2	2

4.2.2Message receptions on ITS-G5 by country:

Event (Cause Code/ Sub-Cause Code)	Spain	Portugal	France
trafficCondition (1/0)	5	0	0
accident (2/0)	0	0	1
roadworks (3/0)	10	2	0
roadworks-slowMovingRoadMaintenance (3/3)	0	0	0
hazardousLocation-ObstacleOnTheRoad (10/0)	5	2	0
hazardousLocation-AnimalOnTheRoad (11/0)	1	1	1
humanPresenceOnTheRoad (12/0)	5	2	0
adverseWeatherCondition-ExtremeWeatherCondition (17/0)	0	0	0
adverseWeatherCondition-Visibility-Fog (18/1)	0	2	0

4.2.3 Message receptions on cellular by AMQP routing key provider:

Event (Cause Code/ Sub-Cause Code)	A-to-Be	URCA	DGITM/DIT
trafficCondition (1/0)	0	0	0
accident (2/0)	0	0	1
roadworks (3/0)	2	20	2
roadworks-slowMovingRoadMaintenance (3/3)	0	28	0
hazardousLocation-ObstacleOnTheRoad (10/0)	2	6	2
hazardousLocation-AnimalOnTheRoad (11/0)	0	6	2
humanPresenceOnTheRoad (12/0)	4	0	0
adverseWeatherCondition-ExtremeWeatherCondition (17/0)	0	14	0
adverseWeatherCondition-Visibility-Fog (18/1)	2	0	0

Check the Annex 2 (Portuguese receptions) for a detailed list of the message receptions with originating times and providers.

4.3 Spain results

In this section results from Spain are summarized. As commented in previous sections, due to the differences existing between the different individual participants in terms of C-ITS security standard version and message content used (ETSI TS 103 097 v1.3.1 and not inclusion of Geonetworking headers for cellular communications respectively for Spain implementation), this Xtest session for Spain was focused on testing interoperability among the different implementations for cellular communication and, following INTERCOR approach, URCA node was used as an intermediate gateway where both security headers as defined by ETSI TS 103 097 v1.2.1 and Geonetworking headers were included/extracted for message transmission/reception with other participants.

Table 5: Spain result per event

Event (Cause Code/ Sub-Cause Code)	Number of events expected	Received	Processed	Discarded
roadworks (3/0)	3	3	2	1

roadworks-slowMovingRoadMaintenance (3/3)	2	2	2	
hazardousLocation-ObstacleOnTheRoad (10/0)	2	2	2	
hazardousLocation-AnimalOnTheRoad (11/0)	3	1	1	
Stationary vehicle (v2v) (94/0)	1			
humanPresenceOnTheRoad (v2v) (12/0)	3	3	3	
adverseWeatherCondition-ExtremeWeatherCondition (17/0)	1	1	1	
adverseWeatherCondition-Visibility-Fog (18/0)	1	1		1
IVI	2	2	2	

From the Table 5, it can be checked that all expected in vehicle information was received except the AnimalOnTheRoad event information provided by IP (I2V) and PSA (V2V) and Stationary Vehicle (V2V) emitted by Renault (V2V)). Reasons for these no receptions were found in the technical problems detected in IP node (no message triggered) and in the roaming issue affecting PSA equipment when the test trip was performed (no coverage).

Focusing on information in vehicle received, to be noted that two events were discarded at facilities level. These events coming from A2B node (roadworks and adverseWeatherCondition-Visibility-Fog) were discarded due to their corresponding DENMs were considered the same as their stationId and seqNumber were the same and previously received for other DENM (ObstacleOnTheRoad).

Not included in the table, but checkable in Annex 1, V2V events sent by Spanish vehicle were received but not showed at HMI level due to being self-originated.

For further information on this analysis, logs from Spain side can be checked in Annex 1.

4.4 France results

This section focuses on France vehicles result. Table below summarizes events received and processed or not by vehicles.

Table 6: France results per event

Event (Cause Code/ Sub-Cause Code)	Number of events expected	Received	Processed	Discarded	Comment
roadworks (3/0)	7	7	0	1	
roadworks-slowMovingRoadMaintenance (3/3)	3	1	1	1	The originator is not registered in the French PKI. Thus, the messages are considered untrustworthy in one vehicle. The security module was indicating that certificates included in the incoming messages were not valid.
hazardousLocation-ObstacleOnTheRoad (10/0)	4	4	4	1	
hazardousLocation-AnimalOnTheRoad (11/0)	6	5	5	1	
Stationary vehicle (v2v) (94/0)	2	2	2	0	
humanPresenceOnTheRoad (v2v) (12/0)	4	4	4	1	DENM send twice but with a new action ID.
adverseWeatherCondition-ExtremeWeatherCondition (17/0)	2	1	1	1	
adverseWeatherCondition-Visibility-Fog (18/0)	2	1	1	1	
IVI	5	4	0	5	Roaming issues observed when driving

					from Portugal to Spain.

All messages have been received by French vehicles at lower layers. To be noticed not all messages were displayed due to some technical issue on security or messages data element like stationID. But they were all received at lower layer. Sometimes they haven't been processed due security issue linked to the registration of stations in the French PKI. This problem has been solved.

5 Conclusion

The purpose of this second series of cross-Test was to evaluate cross-border interoperability of hybrid communications and interoperability of new use cases like eVMS.

The test site allows French, Spanish and Portuguese vehicles to receive Spanish and Portuguese messages in each country but also when crossing border between Spain and Portugal.

Main conclusion is that all messages were received at lower layer. Issue on security or dataelement were solved.

An important issue was the roaming delay for cellular connection when vehicles crossed the border. Latency can reach 5 min (IP switching from a country operator to another). Some events nearby the border were too delayed to be displayed. On the contrary, ITS-G5 was always available thanks to R-ITS-S placed nearby the border and V2V communications.

It’s important to notice that CA messages sent are received by both vehicles and national ITS-S. This implies that road operator has the capability to perform data aggregation for road information calculation like traffic density.

Annex 1 (Spain logs)

Messages received from France partners:

New message arrived (DENM) 01010000002a8300000015003c0e419937bc8390664def24eaec0a6662263640000 00e11dbba1f2a300003818180 àDENM originatinStationID: 42 àDENM sequenceNumber: 120 àCauseCode: 3 (roadworks) àSubCauseCode : 3 -slowMovingRoadMaintenance (Event from URCA)
New message arrived (DENM) 01010000002a830000001500380e41991a6c439066469b14eaec0a666226364000 000e11dbba1f2a300003818180 àDENM originatinStationID: 42 àDENM sequenceNumber: 112 àCauseCode: 3 (roadworks) àSubCauseCode : 3-slowMovingRoadMaintenance (Event from URCA)

New message arrived (DENM)

01010000002a830000001500350e4198fd1e4390663f4794eb1c4c26621d3ea0000
00e11dbba1f2a300003888000

àDENM originatinStationID: 42

àDENM sequenceNumber: 106

àCauseCode: 17 (adverseWeatherCondition-ExtremeWeatherCondition)

àSubCauseCode : 0

(Event from URCA)

New message arrived (DENM)

01010000002a8300000015003e0e419937bdc390664def74eb4d18066227d72000
000e11dbba1f2a300003818000

àDENM originatinStationID: 42

àDENM sequenceNumber: 124

àCauseCode: 3 (roadworks)

àSubCauseCode : 0

(Event from URCA)

Messages received from Portuguese partners:

New message arrived (DENM)

01012257bf96c7912bdfcb00008e413d75a803904f5d6a04ea9a3b466203fb2ffffffe111c2c868d46000f90f34280057b7ade5efc7380000b7b0a1e1adc7380000b798e1d835c7380000a408c1007853361e82c7380000c3bc715aee39c00006227b8bb8b1ce00000

àDENM originatinStationID: 576176022

àDENM sequenceNumber: 1

àCauseCode: 10 (hazardousLocation-ObstacleOnTheRoad)

àSubCauseCode : 0

(Event from A2B)

New message arrived (DENM)

01012257bf96c7912bdfcb00008e413d75a803904f5d6a04ea724ae661e8974ffffffe111c2c868546000f90f344805383596006dc7380000b836d5ff7dc7380000b83635fe83c7380000b83595fd89c7380000b83595fca3c7380000b83365fb8bc7380000b835bdfa9bc7380000b8365dfa0fc7380000b835e5f9c9c7380000b835bdf9c9c7380000a408c1007830de059bc7380000c3917089ce39c000062172865cb1ce00000

àDENM originatinStationID: 576176022

àDENM sequenceNumber: 1

àCauseCode: 18 (adverseWeatherCondition-Visibility)

àSubCauseCode : 0

Exception processing DENM: DenmBasicService: The denm is the same (stationId 576176022, seqNumber 1)

(Event from A2B)

New message arrived (DENM)

01012257bf96c7912bdfcb00008e413d75a803904f5d6a04ea3f6ee6620b4c4ffffffe111c2c868d46000f90f340c00574e7220f8c7380000b73cde15cbc7380000b79f2e08c6c7380000a408c10058ebe9cde7c7380000c89a2e324e39c000000

àDENM originatinStationID: 576176022

àDENM sequenceNumber: 1

àCauseCode: 3 (roadworks)

àSubCauseCode : 0

Exception processing DENM: DenmBasicService: The denm is the same (stationId 576176022, seqNumber 1)

(Event from A2B)

New message arrived (DENM)

01012415e320c7920af19000008e41988d7f439066235fd4ea69d96661e7b64ffffffe1118c3294000f03e7052430001fffffffffc73800002001fffffffffe39c000000

àDENM originatinStationID: 605414176

àDENM sequenceNumber: 1

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

(Event from A2B V2V)

New message arrived (DENM)

01012415e320c7920af19000010e41988eb463906623ad1cea6afe2661e7b11ffffffe1118c0c94000f03e7052430001fffffffffc73800002001fffffffffe39c000000

àDENM originatinStationID: 605414176

àDENM sequenceNumber: 2

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

(Event from A2B V2V)

New message arrived (DENM)

01012415e320c7920af19000018e4198fa5e8390663e97a4eac8d1e6622e310ffffffe11186fb94000f03e7052430001fffffffffc73800002001fffffffffe39c000000

àDENM originatinStationID: 605414176

àDENM sequenceNumber: 3

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

((Event from A2B V2V)

Messages received from Spanish partners:

New message arrived (IVI)

010600003038bba1c0e40010720c939efd1c8324e7bf47211b9fafd02013af1a8319897396c190
190000668a3c010001affd9c01430477c166b0700425d705a942053048ac198d0654c25190596
42007081ec2eb50654c240d05f5415bf03cc40b5105a940e3907d240af10929c0c82204a020000
840f0a000463091e040002e929c92a840a6a0829c92a69040b0a88aa6a840a082a890

àIVI issuerIdentifier: 12345

àIVI identificationNumber: 5

àCategoryCode: 11

àNature: 9

àSerialNumber: 99

(TrafficSignPictogram)

àText: “INIT SPANISH XTEST PATH”

(Event from Spain)

New message arrived (DENM)

010100003039e78000181c80018e41927c9f0390649f27c4ebad36566258409ffffffe11dbba1fad
46003e70f3c0c01c7ff65ffffc7380fdc3bffff8e701f51f8012f1ce03ed38ffaee39c07d181fd0ec7380f
9253f1798e701ea187bd671ce03df82f971e39c07ae55ef88c7380f676be1d38e701efc17ce3b1c
e03e90cfb19e39c07d349f807c7380f9bdbecc78e701fd057f4af1ce00041ffff7fe818ce206d97fd9
d8ce213117f7358ce213f67f5918ce219a07f9498ce22ac37f0f18ce22e567ef018ce22b5b7f0f18c
e0440028

àDENM originatinStationID: 12345

àDENM sequenceNumber: 3

àCauseCode: 3 (roadworks)

àSubCauseCode : 0

(Event from Spain)

New message arrived (DENM)

010100003039e78000181c80010e41927d252390649f494ceb8b1dd6624b742ffffffe11dbba1fad46003e70f1c2c000227fffe001263387ce86026163387ca5a00ed63387c9c1fdec63387c7f9fbca633884485f58863387bad9f240633877225dd2b633877d75e15763387c0d1f00e63387b4e5ea3563387ca59e13163387d8a9dbc063387f1b1cde563387ed85ce90633881a35e275633880e49f00e633811000a0

àDENM originatinStationID: 12345

àDENM sequenceNumber: 2

àCauseCode: 11 (hazardousLocation-AnimalOnTheRoad)

àSubCauseCode : 0

(Event from Spain)

New message arrived (DENM)

010100003039e78000181c80020e41931006839064c401a4eb65c9f662167deffffffe11dbba1fad46003e70f1c280009880559feeb633881efa09de6338829b60e1d63388346e13aa633884d7a1d2063388507217b063388405a10896338833d60a7663388320e072663388291e050663388376a0447633882326033c633861fea880a698ce1f7267de798ce1f7817e08d8ce1f3557d9658ce1eedd7d9658ce1ee447de798ce1ed857e6398ce1e5c67e3618ce1eb497f3798ce1ef037f3798ce1ef757fe358ce1f650800e18ce0440028

àDENM originatinStationID: 12345

àDENM sequenceNumber: 4

àCauseCode: 10 (hazardousLocation-ObstacleOnTheRoad)

àSubCauseCode : 0

(Event from Spain)

New message arrived (IVI)

01060000303cbba1c0e40014720c983196160af04900092f3973c0004013acacdf598854ce8190
190000668a3c01000190012bfde906ed3e6710cf63d09d10d63c55d0b65bd9671076bc55d09af
3df4b0e013cbff0fb83c47905bc3ebe3062ebef3d0831befaf062ebf308013acacdf598854ce81901
90000668a3c21000190012bfde906ed3e6710cf63d09d10d63c55d0b65bd9671076bc55d09af3
df4b0e013cbff0fb83c47905bc3ebe3062ebef3d0831befaf062ebf308104014ff8dbff66fa8fc1120f
aa2c1560f54542944ef03438fcf32f4272ef42741c86eb95c2328f7f4406b2f7e0c05e0fa43400ce2
05a020000202102c2800118c40002c8a9c8840a6a0829c92a69040b0a88aa6a840a082a8900

àIVI issuerIdentifier: 12345

àIVI identificationNumber: 6

àCategoryCode: 11

àNature: 9

àSerialNumber: 99

(TrafficSignPictogram)

àText: “END SPANISH XTEST PATH”

(Event from Spain)

New message arrived (DENM)

010100000237E78000011B80028E4197CB2AC39065F2CAB4EA1DEE06621000AFFFFFFE1
1DBBA1FAD46003E70F1D780000011000A

àDENM originatinStationID: 567

àDENM sequenceNumber: 5

àCauseCode: 94 (stationaryVehicle)

àSubCauseCode : 0

(Event from Spain V2V)

New message arrived (DENM)

010100000237E78000011B80030E41985628C39066158A34EA35202662116EEFFFFFFE11DBBA1FAD46003E70F1C300000E77BA61B6B633877A3E1B2F63387788615CB6338777E6100D6338758CE0E90633876CA607896338762F602ED633811000A0

àDENM originatinStationID: 567

àDENM sequenceNumber: 6

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

(Event from Spain V2V)

New message arrived (DENM)

010100000237E78000011B80038E419858A7E390661629FCEA380CE6620FE34FFFFFFE11DBBA1FAD46003E70F1C300000E7708E1841633877BA61B6B633877A3E1B2F63387788615CB6338777E6100D6338758CE0E90633876CA60789633811000A0

àDENM originatinStationID: 567

àDENM sequenceNumber: 7

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

(Event from Spain V2V)

New message arrived (DENM)

010100000237E78000011B80040E4198F4648390663D1924EAC7B3E6622D8B2FFFFFFE11DBBA1FAD46003E70F1C300000E75DF5EF5B633875B4DEE8063387609DEF3D63387604DEE7F633876345EC9563387672DEA3D633876641E73B633811000A0

àDENM originatinStationID: 567

àDENM sequenceNumber: 8

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

(Event from Spain V2V)

New message arrived (DENM)

010100000237E78000011B80048E41999347C3906664D1F4EB6FEC46622016CFFFFFFE11DBBA1FAD46003E70F1

C300000E75FFDEB2D63387776DE001633878D4DD737633878D75D7E16338777E5DEE9633876051E92F633877385

F57D633811000A0

àDENM originatinStationID: 567

àDENM sequenceNumber: 9

àCauseCode: 12 (humanPresenceOnTheRoad)

àSubCauseCode : 0

(Event from Spain V2V)

Annex 2 - Portuguese receptions

Events received through ITS-G5 channel

Event 1 First reception: 2019-07-10 11:45:19 Provider: A-to-Be C-ITS (stationID: 576176022) Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad) Sub-cause Code: 0
Event 2 First reception: 2019-07-10 11:45:20 Provider: A-to-Be C-ITS (stationID: 576176022) Cause Code: 18 (adverseWeatherCondition-Visibility) Sub-cause Code: 1 (fog)
Event 3 First reception: 2019-07-10 11:45:20 Provider: A-to-Be C-ITS (stationID: 576176022) Cause Code: 3 (roadworks) Sub-cause Code: 0
Event 4 First reception: 2019-07-10 11:48:03 Provider: A-to-Be OBU (stationID: 605414176) Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0
Event 5 First reception: 2019-07-10 11:48:12 Provider: A-to-Be OBU (stationID: 605414176) Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0

Event 6 First reception: 2019-07-10 11:50:43 Provider: CTAG C-ITS (stationID: 12333) Cause Code: 3 (roadworks) Sub-cause Code: 0
Event 7 First reception: 2019-07-10 11:52:33 Provider: Renault OBU (stationID: 450356753) Cause Code: 11 (hazardousLocation-AnimalOnTheRoad) Sub-cause Code: 0
Event 8 First reception: 2019-07-10 11:54:16 Provider: IP RSU (stationID: 576176022) Cause Code: 11 (hazardousLocation-AnimalOnTheRoad) Sub-cause Code: 0
Event 9 First reception: 2019-07-10 11:55:35 Provider: CTAG RSU (stationID: 30000) Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad) Sub-cause Code: 0
Event 10 First reception: 2019-07-10 11:55:36 Provider: CTAG RSU (stationID: 30000) Cause Code: 1 (trafficCondition) Sub-cause Code: 0
Event 11 First reception: 2019-07-10 11:55:36

Provider: CTAG RSU (stationID: 30000) Cause Code: 3 (roadworks) Sub-cause Code: 0
Event 12 First reception: 2019-07-10 11:55:37 Provider: CTAG RSU (stationID: 30000) Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0
Event 13 First reception: 2019-07-10 11:59:10 Provider: CTAG RSU (stationID: 30001) Cause Code: 1 (trafficCondition) Sub-cause Code: 0
Event 14 First reception: 2019-07-10 11:59:15 Provider: CTAG RSU (stationID: 30001) Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad) Sub-cause Code: 0
Event 15 First reception: 2019-07-10 11:59:17 Provider: CTAG RSU (stationID: 30001) Cause Code: 3 (roadworks) Sub-cause Code: 0
Event 16 First reception: 2019-07-10 11:59:17 Provider: CTAG RSU (stationID: 30001) Cause Code: 12 (humanPresenceOnTheRoad)

Sub-cause Code: 0

Event 17

First reception: 2019-07-10 11:59:18

Provider: CTAG RSU (stationID: 30001)

Cause Code: 3 (roadworks)

Sub-cause Code: 0

Events received through cellular (AMQP) channel

Event 1

First reception: 2019-07-10 11:45:17

Provider: URCA

Cause Code: 11 (hazardousLocation-AnimalOnTheRoad)

Sub-cause Code: 0

Detection Time: 489840316392

Event 2

First reception: 2019-07-10 11:45:17

Provider: URCA

Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad)

Sub-cause Code: 0

Detection Time: 489840316463

Event 3

First reception: 2019-07-10 11:45:17

Provider: URCA

Cause Code: 3 (roadworks)

Sub-cause Code: 0

Detection Time: 489840316535

Event 4 First reception: 2019-07-10 11:45:31 Provider: A-to-Be Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad) Sub-cause Code: 0 Detection Time: 489792712000
Event 5 First reception: 2019-07-10 11:45:31 Provider: A-to-Be Cause Code: 18 (adverseWeatherCondition-Visibility) Sub-cause Code: 1 (fog) Detection Time: 489792712000
Event 6 First reception: 2019-07-10 11:45:31 Provider: A-to-Be Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489792712000
Event 7 First reception: 2019-07-10 11:45:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840339484
Event 8 First reception: 2019-07-10 11:45:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition)

Sub-cause Code: 0 Detection Time: 489840339487
Event 9 First reception: 2019-07-10 11:45:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840339490
Event 10 First reception: 2019-07-10 11:45:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840339492
Event 11 First reception: 2019-07-10 11:46:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840399507
Event 12 First reception: 2019-07-10 11:46:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840399521
Event 13

First reception: 2019-07-10 11:46:39

Provider: URCA

Cause Code: 3 (roadworks)

Sub-cause Code: 0

Detection Time: 489840399529

Event 14

First reception: 2019-07-10 11:46:39

Provider: URCA

Cause Code: 3 (roadworks)

Sub-cause Code: 3 (slowMovingRoadMaintenance)

Detection Time: 489840399541

Event 15

First reception: 2019-07-10 11:47:39

Provider: URCA

Cause Code: 3 (roadworks)

Sub-cause Code: 3 (slowMovingRoadMaintenance)

Detection Time: 489840459545

Event 16

First reception: 2019-07-10 11:47:39

Provider: URCA

Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition)

Sub-cause Code: 0

Detection Time: 489840459548

Event 17

First reception: 2019-07-10 11:47:39

Provider: URCA

Cause Code: 3 (roadworks)

Sub-cause Code: 0

Detection Time: 489840459559
Event 18 First reception: 2019-07-10 11:47:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840459569
Event 19 First reception: 2019-07-10 11:47:46 Provider: A_to_Be Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0 Detection Time: 489840471034
Event 20 First reception: 2019-07-10 11:47:48 Provider: A_to_Be Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0 Detection Time: 489840473507
Event 21 First reception: 2019-07-10 11:48:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840519571

Event 22 First reception: 2019-07-10 11:48:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840519575
Event 23 First reception: 2019-07-10 11:48:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840519578
Event 24 First reception: 2019-07-10 11:48:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840519582
Event 25 First reception: 2019-07-10 11:49:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840579609
Event 26 First reception: 2019-07-10 11:49:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition)

Sub-cause Code: 0 Detection Time: 489840579612
Event 27 First reception: 2019-07-10 11:49:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840579614
Event 28 First reception: 2019-07-10 11:49:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840579616
Event 29 First reception: 2019-07-10 11:50:17 Provider: URCA Cause Code: 11 (hazardousLocation-AnimalOnTheRoad) Sub-cause Code: 0 Detection Time: 489840617130
Event 30 First reception: 2019-07-10 11:50:17 Provider: URCA Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad) Sub-cause Code: 0 Detection Time: 489840617197

Event 31 First reception: 2019-07-10 11:50:17 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840617300
Event 32 First reception: 2019-07-10 11:50:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840639619
Event 33 First reception: 2019-07-10 11:50:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840639621
Event 34 First reception: 2019-07-10 11:50:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840639625
Event 35 First reception: 2019-07-10 11:50:39 Provider: URCA Cause Code: 3 (roadworks)

Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840639628
Event 36 First reception: 2019-07-10 11:51:29 Provider: A_to_Be Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0 Detection Time: 489840694004
Event 37 First reception: 2019-07-10 11:51:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840699631
Event 38 First reception: 2019-07-10 11:51:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840699634
Event 39 First reception: 2019-07-10 11:51:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840699636

Event 40 First reception: 2019-07-10 11:51:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840699645
Event 41 First reception: 2019-07-10 11:52:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840759650
Event 42 First reception: 2019-07-10 11:52:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840759654
Event 43 First reception: 2019-07-10 11:52:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840759659
Event 44 First reception: 2019-07-10 11:52:39 Provider: URCA Cause Code: 3 (roadworks)

Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840759667
Event 45 First reception: 2019-07-10 11:53:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840819684
Event 46 First reception: 2019-07-10 11:53:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840819693
Event 47 First reception: 2019-07-10 11:53:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840819694
Event 48 First reception: 2019-07-10 11:53:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840819717
Event 49

First reception: 2019-07-10 11:54:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840879726
Event 50 First reception: 2019-07-10 11:54:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840879729
Event 51 First reception: 2019-07-10 11:54:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840879730
Event 52 First reception: 2019-07-10 11:54:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840879732
Event 53 First reception: 2019-07-10 11:55:30 Provider: URCA Cause Code: 10 (hazardousLocation-ObstacleOnTheRoad) Sub-cause Code: 0

Detection Time: 489840918455
Event 54 First reception: 2019-07-10 11:55:30 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840918488
Event 55 First reception: 2019-07-10 11:55:30 Provider: URCA Cause Code: 11 (hazardousLocation-AnimalOnTheRoad) Sub-cause Code: 0 Detection Time: 489840918444
Event 56 First reception: 2019-07-10 11:55:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840939734
Event 57 First reception: 2019-07-10 11:55:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840939736

Event 58 First reception: 2019-07-10 11:55:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489840939745
Event 59 First reception: 2019-07-10 11:55:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840939747
Event 60 First reception: 2019-07-10 11:56:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840999750
Event 61 First reception: 2019-07-10 11:56:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489840999752
Event 62 First reception: 2019-07-10 11:56:39 Provider: URCA Cause Code: 3 (roadworks)

Sub-cause Code: 0 Detection Time: 489840999754
Event 63 First reception: 2019-07-10 11:56:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489840999756
Event 64 First reception: 2019-07-10 11:57:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489841059765
Event 65 First reception: 2019-07-10 11:57:39 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489841059770
Event 66 First reception: 2019-07-10 11:57:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489841059775

Event 67 First reception: 2019-07-10 11:57:39 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489841059779
Event 68 First reception: 2019-07-10 11:58:40 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489841119784
Event 69 First reception: 2019-07-10 11:58:40 Provider: URCA Cause Code: 17 (adverseWeatherCondition-ExtremeWeatherCondition) Sub-cause Code: 0 Detection Time: 489841119786
Event 70 First reception: 2019-07-10 11:58:40 Provider: URCA Cause Code: 3 (roadworks) Sub-cause Code: 0 Detection Time: 489841119788
Event 71 First reception: 2019-07-10 11:58:40 Provider: URCA Cause Code: 3 (roadworks)

Sub-cause Code: 3 (slowMovingRoadMaintenance) Detection Time: 489841119789
Event 72 First reception: 2019-07-10 11:58:52 Provider: A_to_Be Cause Code: 12 (humanPresenceOnTheRoad) Sub-cause Code: 0 Detection Time: 489841124589