



French C-ITS Deployment Coordination committee

Functional and technical hybrid architecture – Common specifications

Deliverable 2.4.1_H

Activity 2: Studies

Sub Activity 2.4 > Specifications

Version 4.00

Publication Date : 14/11/2019



Co-financed by the Connecting Europe
Facility of the European Union

The contents of this publication are the sole responsibility of the SCOOP@F project consortium, C-ROADS France project consortium and InterCor project consortium (French beneficiaries only) and do not necessarily reflect the opinion of the European Union.

Information on the document

Document: Function and technical hybrid architecture – common specifications

Date of publication: 14/11/2019

Responsible, Entity: Hasnaâ ANISS, IFSTTAR

Status: Version 4.00 – Release 4

Publication history

| Date | Version | Author(s) | Updates & changes | Diffusion |
|------------|---------|-----------|------------------------------------|-----------|
| 14/11/2019 | V4.00 | H. ANISS | Consolidated version for release 4 | Release 4 |

Reference to the version administration

Version number to be composed of 3 digits > vR.XY

- **R** corresponds to the release number: it is upgraded each time SC Studies validates the diffusion of a new release,
- **X** is the major version number: it is upgraded each time SC Studies validates the deliverable,
- **Y** is the minor version number: it is upgraded each time a contributor changes anything.

Once the deliverable is approved, its version number is upgraded from vR.XY to vR.(X+1)0

Once the deliverable is release, its version number is upgraded from vR.XY to v(R+1).00

As illustration:

- 0.03 > Work in progress version
- 0.10 > Del. Approved by SC Studies but not released
- 2.00 > Del. approved & released (in release 2)
- 2.05 > Del. Updated - in progress version

Table of Contents

| | |
|--|----|
| Table of Contents | 3 |
| List of figures | 5 |
| List of tables | 5 |
| 1 Presentation of the document | 7 |
| 2 Functional architecture overview | 9 |
| 3 Dataflows | 12 |
| 3.1 Nfr-ITS-S links | 12 |
| 3.2 Vru-ITS-S architecture | 14 |
| 3.2.1 Architecture using a Car Manufacturer's Platform | 15 |
| 3.2.2 Architecture using a Home Agent | 16 |
| 3.2.3 V2V communication through cellular link | 17 |
| 3.3 Vro-ITS-S architecture | 18 |
| 3.3.1 uplink flows | 19 |
| 3.3.2 Downlink flows | 19 |
| 4 GLOSA Functional Architecture | 21 |
| 4.1 For local traffic light | 21 |
| 4.2 For centralized traffic light | 22 |
| 5 Functions of main components of the architecture | 24 |
| 5.1 Nfr-ITS-S station functions | 24 |
| 5.2 Applications server Functions | 28 |
| 5.3 V-ITS-S Functions | 29 |
| 5.3.1 Function #1: message sending | 29 |
| 5.3.2 Function #2: V2V via cellular link | 30 |
| 5.3.3 Function #3: Security | 30 |
| 5.3.4 Function #4: MAPEM | 30 |
| 5.4 Vro-ITS-S function | 31 |
| 5.5 Car Manufacturer's Platform functions | 31 |
| 5.6 Functionalities of the Home Agent functions | 32 |
| 5.7 R-ITS-S functions | 32 |
| 5.8 PFro Functionalities | 34 |
| 6 Technical architecture | 36 |
| 6.1 Communication profiles | 36 |
| 6.2 Network architecture | 37 |
| 6.3 Interconnection | 38 |

| | | |
|-------|---|----|
| 6.3.1 | For interfaces 1, 2, 6, 7 | 39 |
| 6.3.2 | For interfaces 4, 5, 8, 9 and 10 | 40 |
| 6.3.3 | For interface 11 | 40 |
| 7 | Interface description | 42 |
| 7.1 | General description | 42 |
| 7.2 | Message format..... | 43 |
| 7.2.1 | For Interface 1, 2, 6 and 7 | 43 |
| 7.2.2 | For Interface 4, 5, 8, 9 and 10 | 43 |
| 8 | Access and Network layers | 45 |
| 8.1 | Full IPv6 access network..... | 45 |
| 8.2 | Transition Mechanisms for IPv4 road operator core networks..... | 46 |
| 9 | Mobility Management (Home Agent and Mobile Node stack)..... | 47 |
| 9.1 | Home agent function hosting..... | 47 |
| 9.2 | Common Mobility Stack..... | 48 |
| 9.3 | Mobility security | 49 |
| 9.4 | DS-MIP based solution..... | 49 |
| 9.5 | Architecture Using a Home Agent Entity | 51 |
| 9.5.1 | Interface 1 and 7- Technical requirements: | 52 |
| 9.5.2 | Interface 2 and 6 – Technical requirements: | 54 |
| 9.5.3 | Interface two - IPv6 communication flow with Internet Core Network entities | 58 |
| 10 | Implementation Choices..... | 66 |
| 11 | ANNEX: GeoNet structure..... | 69 |

List of figures

| | |
|--|----|
| Figure 1 : Wave 1 functional architecture..... | 8 |
| Figure 2 : ETSI ITS reference architecture | 8 |
| Figure 3 : Functional architecture..... | 10 |
| Figure 4 : General functional and communication architecture..... | 11 |
| Figure 5: Data flow for the Nfr-ITS-S..... | 14 |
| Figure 6 : Uplink flows Vru-ITS-S architecture with a Car Manufacturer platform | 15 |
| Figure 7: Downlink flows Vru-ITS-s architecture with Car Manufacturer's Platform | 16 |
| Figure 8 : Uplink flows – ITSS-VU architecture with a home agent | 17 |
| Figure 9: Downlink flows – Vru-ITS-S architecture with a home agent..... | 17 |
| Figure 10 : Global flows for V2V communication via cellular. | 18 |
| Figure 11: example of uplink flow for V-Ro-ITS-s | 19 |
| Figure 12: example of downlink flow for V-Ro-ITS-s..... | 20 |
| Figure 13: Glosa Architecture – local traffic light..... | 22 |
| Figure 14: Glosa Architecture – centralized traffic light | 23 |
| Figure 15 : Global ITSS links view | 36 |
| Figure 16: Interconnection architecture..... | 38 |
| Figure 17: Interfaces definition. | 38 |
| Figure 18:Overall view of interfaces | 42 |
| Figure 19 : ITS Stack in V-ITS-S for ITS-G5 and representation of OSI Stack for Hybrid communications..... | 50 |
| Figure 20: Reference architecture for IPv6 related communication flows (one possible implementation) | 51 |
| Figure 21: Interface One End-to-end IPv6 communication flow | 52 |
| Figure 22: Interface 2 End-To-End IPv6 communication flow..... | 54 |
| Figure 23:IPv6 acces by Roadside unit..... | 55 |
| Figure 24:Overall view of interfaces | 66 |

List of tables

| | |
|--|----|
| Table 1: List of C-ITS-S..... | 9 |
| Table 2: Communication profiles..... | 37 |
| Table 3: Communication profiles by messages | 37 |
| Table 4: Communication profiles by interfaces | 43 |
| Table 5: Message format for interface 4 5, 8, 9 and 10 | 44 |

Acronym Table

| | |
|------------|--|
| App-Serv | Application Server |
| CAM | Cooperative Aware Message |
| C-ITSS | Central-ITSS |
| DAD | Duplicate address detection |
| DENM | Decentralized Environmental Notification |
| DSMIP | Dual Stack Mobile IP |
| ETA | Estimated Time of arrival |
| ITS | Intelligent Transport System |
| ITS-G5 | Adaptation of the IEEE 802.11p (wifi) |
| ITSS | Intelligent Transport System Station |
| 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 |
| R-ITS-S | ITSS-Roadside |
| IVI | In Vehicle Information |
| LDM | Local Dynamic Map |
| LTE | Long Term Evolution |
| Nfr-ITS-S | French National Central ITSS |
| ODAD | Optimistic Duplicate Address Detection |
| OEM | Original Equipment Manufacturer |
| MCTO | Multi-Cargo Transport Optimization |
| PFro | Road Operator's Platform |
| PFcm | Car Manufacturer's Platform |
| POI | Point of Interest |
| RDNSS | Recursive DNS Server |
| RSSI | Receiver Strength Signal Indicator |
| TMS | Traffic Management System |
| V2I | Vehicle-to-Infrastructure |
| V2V | Vehicle-to-Vehicle |
| V2X | V2V and/or V2I |

1 Presentation of the document

The present document introduces the common specifications of the connectivity framework based on Cellular/ITS-G5 hybrid architecture to be deployed in SCOOP@F wave 2/InterCor/C-roads.

In SCOOP@F wave 1, communications were only based on ITS-G5. In addition to this communication mode, the wave 2 of the project introduces the possibility to use an additional IP link (over cellular or over 802.11p). Thus, resulting in a “hybrid” architecture mixing cellular (long range) and ITS-G5 (short range) accesses.

Dataflow defined in first wave of the SCOOP@F project are still applicable (cf. [Figure 1](#)). All first wave 1 specifications are described in the deliverable “SCOOP_2.4.1_Common set of functional and technical specifications” and remain applicable.

This document specifies add-ons introduced in SCOOP Wave 2, which deal only on IP communications. The main novelties of SCOOP Wave 2 are the following:

- The interconnection is based on IPv6 (IPv4 remains possible between nodes that mutually agree to use it).
- A mobility management system based on the MobileIPv6 protocol suite provides the application layer with a complete transparency from the various changes of connectivity resulting from the ITSS-V’s mobility (across different access networks and/or different technologies).
- IPoverGeonet is not implemented in SCOOP. Major GeoNet functionalities are to allow multihop and dissemination area control. But this last functionality is already integrated as functionalities of our Nfr-ITS-S at application layer. And multihop is not relevant in a hybrid link thanks to the large cellular coverage. So only IPoverG5 is implemented.

| | |
|------------------------|--|
| Id | 241H-FUNG-001 |
| Component(s) | Vru-ITS-S, Vro-ITS-S, Nfr- ITS Station |
| Requirement | To be able to sign messages, ITSS shall use GeoNet structure. |
| Additional information | Only signature part of the GeoNet structure is used. See deliverable 2.4.4.11_H |

The proposed architecture is compatible with security and privacy requirements of deliverables 2.4.4.11_H. The implementation specifications of the related features (e.g. protocols, key length...) are given in deliverable 2.4.4.8_H.

In the document, V-ITS-S refer to Vro-ITS-S and Vru-ITS-S.

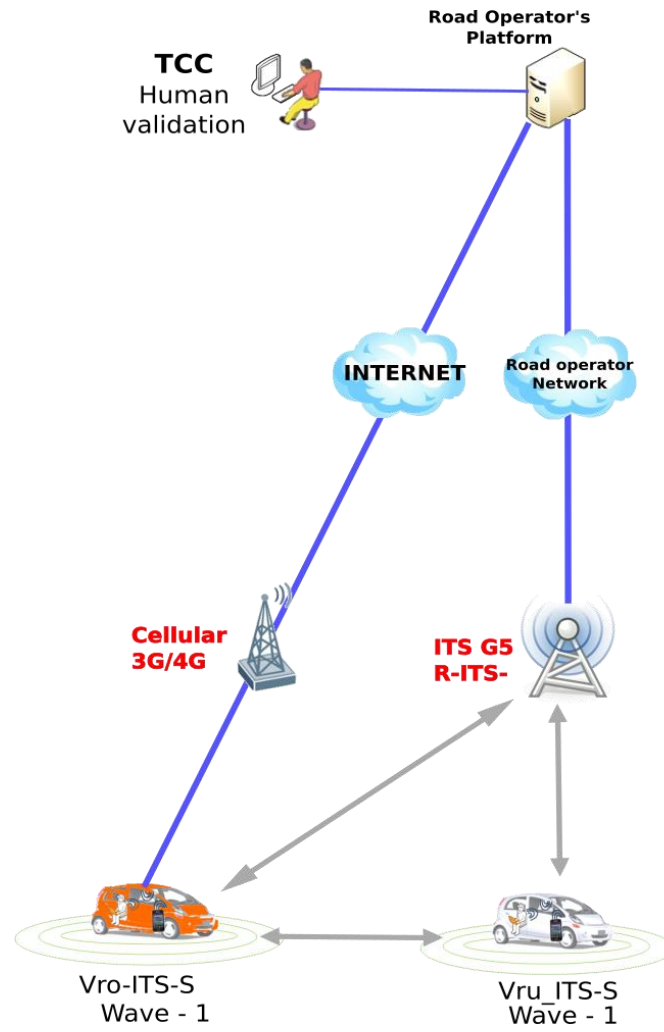


Figure 1 : Wave 1 functional architecture

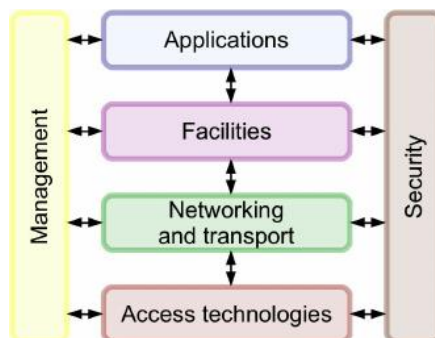


Figure 2 : ETSI ITS reference architecture

2 Functional architecture overview

The SCOOP system (Figure 3) is composed of V-ITS-S (vehicle units), R-ITS-S (roadside units), a N-ITS-S, PKI Servers, application server (for smartphone applications), Noscifel server (for MCTO applications), centralized traffic light system (for GLOSA application) and Road Operator's Platforms. The National ITS Station manages the messages exchanged between each server and each V-ITS-S at a national level using Hybrid communications.

| | |
|------------------------|---|
| Id | 241H-FUNG-002 |
| Component(s) | Nfr-ITS-S |
| Requirement | The Nfr-ITS-S shall route C-ITS messages from a sender to a receiver through hybrid communications. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FUNG-003 |
| Component(s) | Nfr-ITS-S |
| Requirement | The Nfr-ITS-S can have additional functions as translate C-ITS messages into DATEX II and vice-versa or aggregate CAM |
| Additional information | |

As a reminder C-ITS-S need to comply with EN 302665 standard and they need to exchange signed messages within the common EU C-ITS trust domain i.e. under the same certificate policy.

As a consequence, Table 1 presents the list of C-ITS-S of this architecture:

| Component name | C-ITS-S | Not a C-ITS-S |
|---|---------|---------------|
| Vru-ITS-S | X | |
| Vro-ITS-S | X | |
| R-ITS-S | X | |
| PFro | | X |
| N-ITS-S | X | |
| No-ITS-S | X | |
| PFcm | | X |
| TMS | | X |
| APP-Serv | X | |
| MCTO server | X | |
| Centralized traffic light system (when connected to Nfr-ITS-S) | X | |

Table 1: List of C-ITS-S

Each transmitter within the C-ITS trust domain is responsible of its own messages. On the cellular link, the Nfr-ITS-S will be only responsible of road operator messages. Other messages signed by a third party will only be forwarded as such.

Several network architectures using cellular and ITS-G5 are possible. They are described below. But only the

solution including mobility management entities will guarantee a seamless connectivity during a switch of network. Others solutions will need one connection for each available media. For some use cases, the seamless connectivity is not required. The choice of the architecture done by each actor will depend on their requirements in term of connectivity.

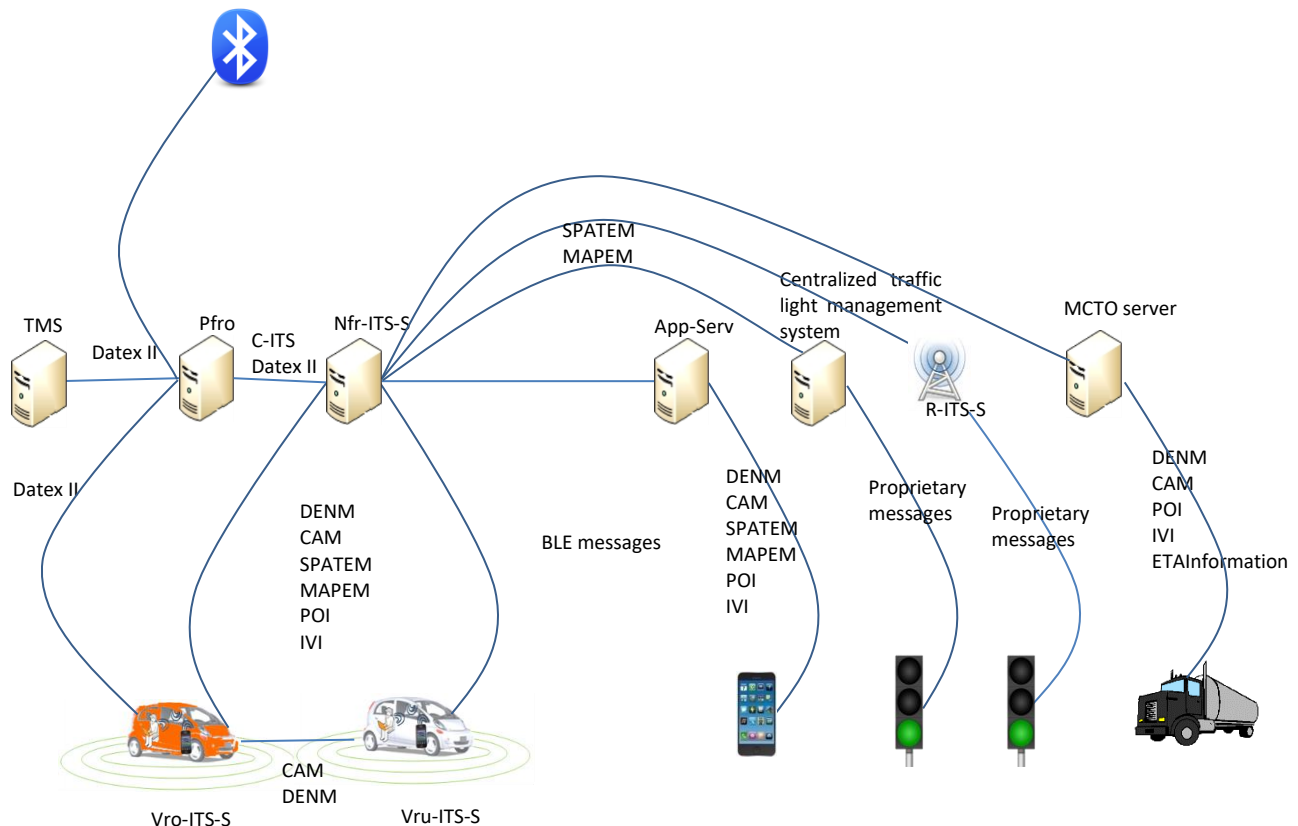


Figure 3 : Functional architecture

Nota: Bluetooth architecture is described in COCSIC_2.4.5.1 smartphone application.

Several Interfaces exist in this architecture and are described in chapter 7.

| | |
|------------------------|---|
| Id | 241H-FUNC-001 |
| Component(s) | Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | The hybrid communication architecture shall allow to send and receive messages through different radio links (IP over 802.11p-SCH1 or Cellular) from/to ITSS-V even if they are not in the range of an R-ITS-S. |
| Additional information | New services are available, through the use of cellular access, and a central server, called Nfr-ITS-S which forwards information at applicative level from/to V-ITS-S and TMS. |

| | |
|------------------------|--|
| Id | 241H-FUNC-002 |
| Component(s) | National ITS Station, Vru-ITS-S |
| Requirement | <p>The National ITS Station shall exchange secured and trusted data in the form of valid C-ITS messages which are:</p> <p>CAM according to use cases requirements,</p> <p>DENM.</p> <p>IVI (from National ITS Station to the V-ITS-S)</p> <p>SPATEM (from National ITS Station to the V-ITS-S)</p> <p>MAPEM (from National ITS Station to the V-ITS-S)</p> <p>POI message (from National ITS Station to the V-ITS-S)</p> <p>ETA (from National ITS Station to the V-ITS-S)</p> |
| Additional information | |

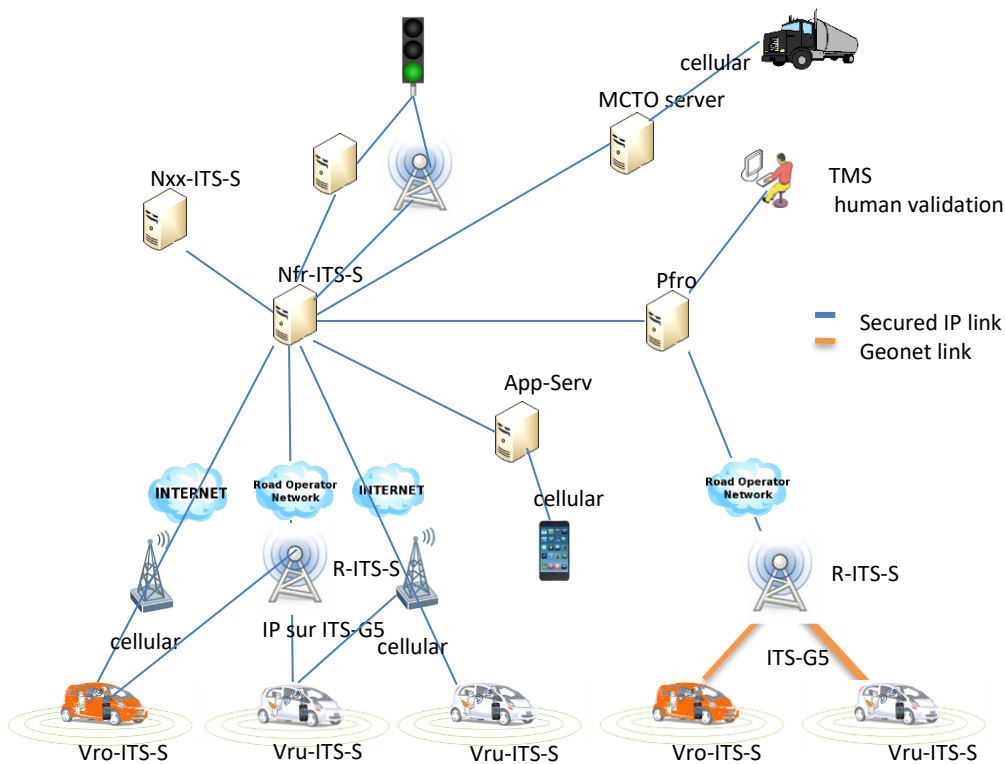


Figure 4 : General functional and communication architecture

3 Dataflows

3.1 Nfr-ITS-S links

| | |
|------------------------|---|
| Id | 241H-FunL-001 |
| Component(s) | National ITS Station, MCTO server |
| Requirement | The Nfr-ITS-S shall exchange C-ITS messages, POI and ETA information with MCTO server |
| Additional information | Messages related to the MCTO server are described in COCSIC_2.4.1.2bis_H_SpecUC-MCTO |

| | |
|------------------------|--|
| Id | 241H-FunL-002 |
| Component(s) | National ITS Station, PFro |
| Requirement | The Nfr-ITS-S shall exchange data with the different Road Operator's Platform using Datex II messages. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunL-003 |
| Component(s) | National ITS Station, PFro |
| Requirement | The Nfr-ITS-S shall convert Datex II into C-its messages. Note: The Road Operator's Platform also send Datex to R-ITS-S. Note: R-ITS-S translate the Datex message to C-ITS messages. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunL-004 |
| Component(s) | National ITS Station, PFro |
| Requirement | From Nfr-ITS-S, The Nfr-ITS-S shall convert C-its messages into Datex II before sending them to Pfro. |
| Additional information | |

| | |
|----|---------------|
| Id | 241H-FunL-005 |
|----|---------------|

| | |
|------------------------|---|
| Component(s) | National ITS Station, App-Serv |
| Requirement | The Nfr-ITS-S shall exchange C-ITS messages with App-Serv |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunL-006 |
| Component(s) | National ITS Station, MCTO server |
| Requirement | The Nfr-ITS-S shall exchange C-ITS messages, POI and ETA information with MCTO server |
| Additional information | MCTO applications and messages related to the MCTO are described in COCSIC_2.4.1.2bis_H_SpecUC-MCTO |

| | |
|------------------------|--|
| Id | 241H-FunL-007 |
| Component(s) | National ITS Station, Centralized traffic light management, R-ITS-S |
| Requirement | For Glosa application, the Nfr-ITS-S shall exchange SPATEM and MAPEM with the Centralized traffic light management and R-ITS-S |
| Additional information | See section 4 for more information on Glosa |

| | |
|------------------------|--|
| Id | 241H-FunL-008 |
| Component(s) | National ITS Station, PFcm |
| Requirement | Nfr-ITS-S shall exchange with PFcm C-ITS messages. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunL-008 |
| Component(s) | National ITS Station, V-ITS-S |
| Requirement | Nfr-ITS-S shall exchange with V-ITS-S C-ITS messages |
| Additional information | |

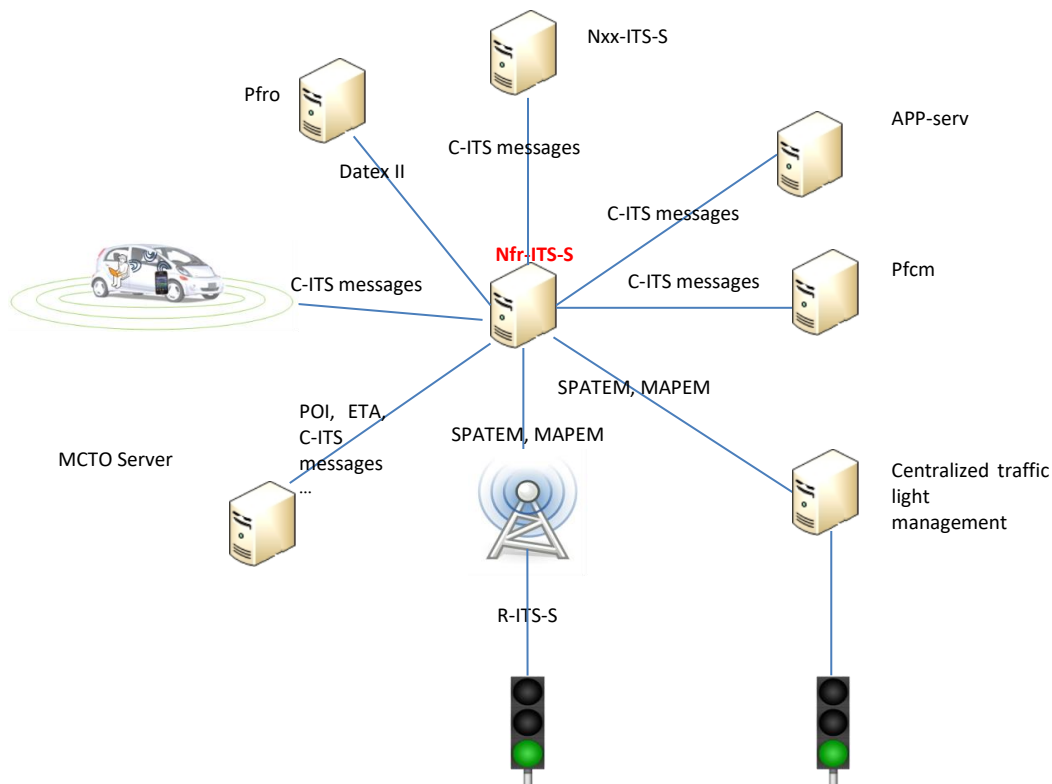


Figure 5: Data flow for the Nfr-ITS-S

3.2 Vru-ITS-S architecture

| | |
|------------------------|---|
| Id | 241H-ARCH -001 |
| Component(s) | Vru-ITS-S |
| Requirement | OEM can have different strategies on using 802.11p and/or cellular. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-ARCH -002 |
| Component(s) | Vru-ITS-S |
| Requirement | OEM can choose to implement one of two possible architectures in SCOOP@F: Using a Car Manufacturer's Platform (Chapter 0) Using a Home Agent (Chapter 3.2.2) |
| Additional information | |

3.2.1 Architecture using a Car Manufacturer's Platform

In this section, the considered messages (IVI, DENM) are those coming from French end-points.

3.2.1.1 Uplink flows

The work flow of data follows the sequence below:

- 1) The V-ITS-S of wave 2 generates DENM.
- 2) DENMs are sent to the Car Manufacturer's Platform which forwards them to the National ITS Station.

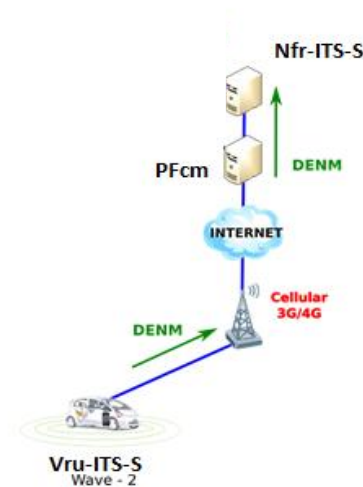


Figure 6 : Uplink flows Vru-ITS-S architecture with a Car Manufacturer platform

3.2.1.2 Downlink flows

The work flow of data follows the sequence below:

- 1) Nfr-ITS-S sends C-ITS messages to the Car Manufacturer's Platform.
- 2) After receiving C-ITS messages, the Car Manufacturer sends these messages to relevant Vru-ITS-S.
- 3) The Vru-ITS-S of wave 2 receives C-ITS messages, and filters out non-relevant messages, and displays the relevant ones.

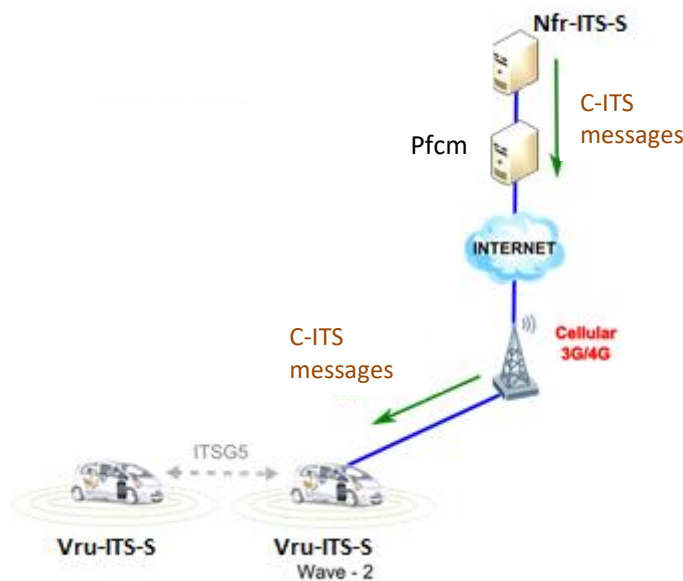


Figure 7: Downlink flows Vru-ITS-s architecture with Car Manufacturer's Platform

3.2.2 Architecture using a Home Agent

This architecture makes it possible to have a seamless connection switching between IP/802.11p and cellular access networks. It involves a dedicated router, called Home Agent which is in charge of masking the mobility of the vehicle to the network. The selection of the access network is left to the choice of the mobile node. This solution is based on the MobileIP protocol suite and is specified in section 9.

3.2.2.1 Uplink flows

The work flow of data follows the sequence below

- 1) The V-ITS-S generates CAM or DENM
- 2) The message is send by the V-ITS-S to the Nfr-ITS-S via the home agent. Between the V-ITS-S and the HA, the message is encapsulated into a secured MobileIP tunnel mounted and sent over IP/802.11p (through R-ITS-S) or LTE link.
- 3) The Nfr-ITS-S converts DENM into DatexII and sends them to the relevant Road Operator's Platform.
- 4) CAM are computed by the Nfr-ITS-S and aggregated. The result is sent to the relevant Road Operator's platform.

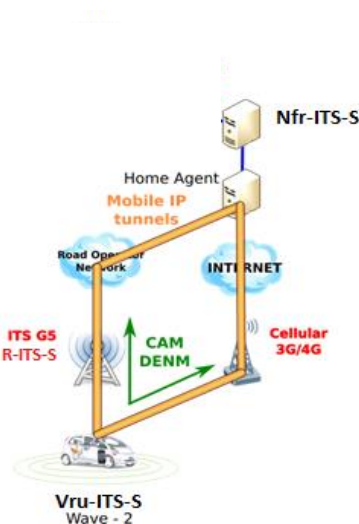


Figure 8 : Uplink flows – ITSS-VU architecture with a home agent

3.2.2.2 Downlink flows

The work flow of data shall follow the sequence below:

- 1) The Nfr-ITS-Sselects the relevant ITSS-V for messages.
- 2) The national central ITSS sends C-ITS messages to relevant ITSS-V.
- 3) The home agent forwards the C-ITS message to the ITSS-V on the link currently chosen by the vehicle through the adequate MobileIP tunnel.

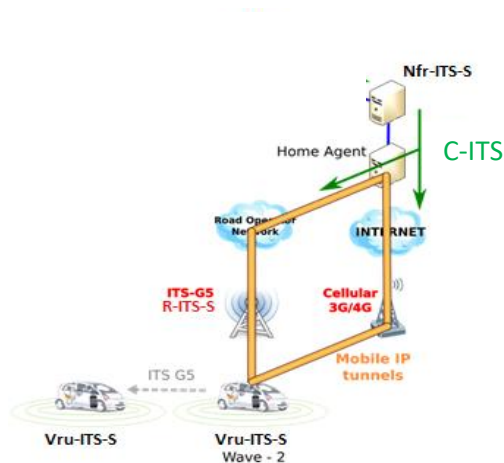


Figure 9: Downlink flows – Vru-ITS-S architecture with a home agent

3.2.3 V2V communication through cellular link

Even in hybrid communication, vehicles can communicate with each other through the Nfr-Irs-S.

The work flow of data shall follow the sequence below (Figure 10):

- 1) V-ITS-S sends DENM to the Nfr-ITS-S through home agent or Car Manufacturer's Platform and CAM

through the home agent, as described in chapter 10 with uplinks scheme

- 2) The Nfr-ITS-S forward without human validation to the relevant vehicles through the home agent, and push to the Car Manufacturer's Platform all DENM, as described in chapter 3.2 with downlinks scheme.

Relevant V-ITS-S receives the message.

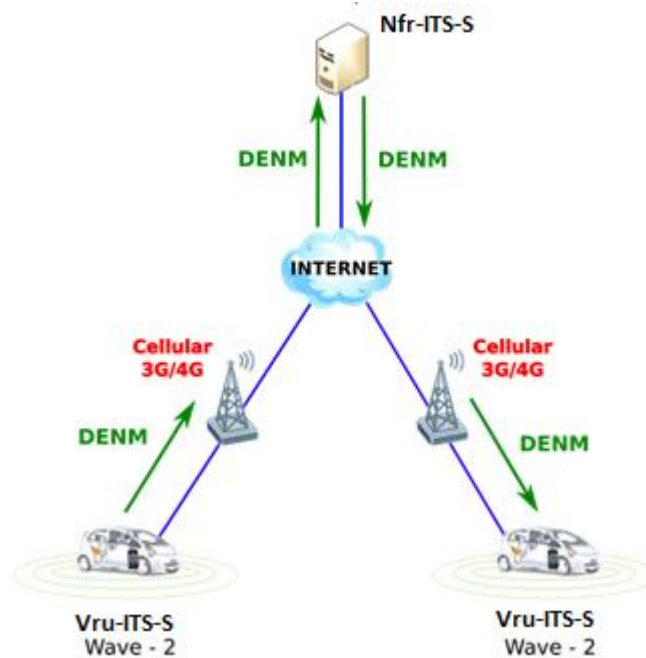


Figure 10 : Global flows for V2V communication via cellular.

3.3 Vro-ITS-S architecture

| | |
|------------------------|---|
| Id | 241H-ARCH -003 |
| Component(s) | Vro-ITS-S |
| Requirement | Road operators can have different strategies on using 802.11p and/or cellular. |
| Additional information | <p>Two possible architectures in SCOOP@F are described:</p> <p>Using direct communication to the Nfr-ITS-S via a VPN (see deliverable 2.4.1.5)</p> <p>Using a Home Agent (see technical specification in 6.3)</p> |

3.3.1 uplink flows

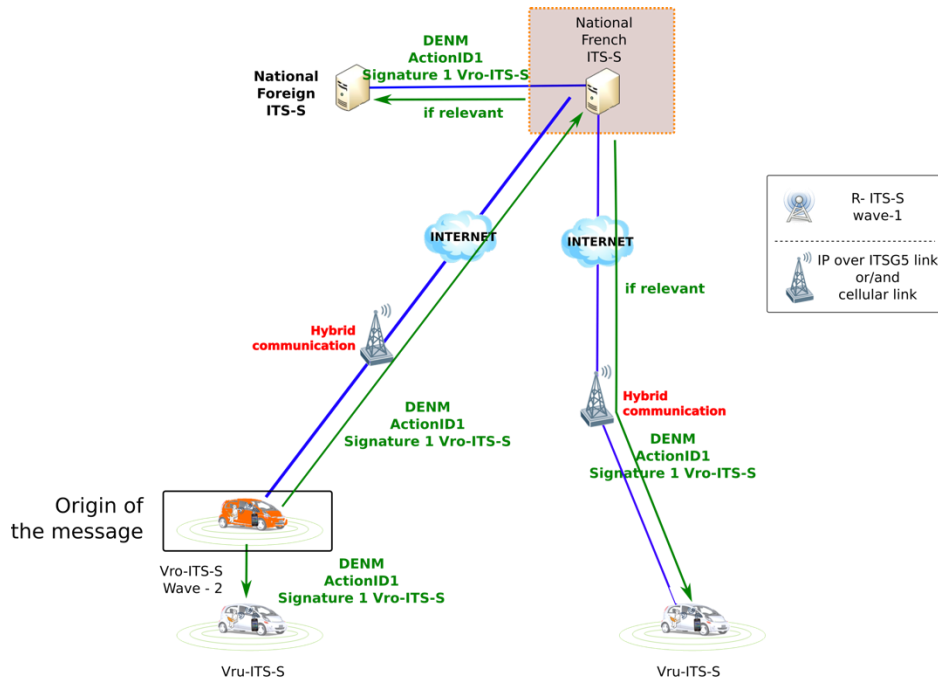


Figure 11: example of uplink flow for V-Ro-ITS-s

The work flow of data shall follow the sequence below:

- 1) The Vro-ITS-S shall send all C-ITS messages signed, created by itself through a hybrid communication to the Nfr-ITS-S.

Nota: The R-ITS-S mode is defined in 2422bis deliverable will work as defined in wave 1. Only DENM sent by the road operator vehicles are considered for hybrid communications.

- 2) Hybrid communication can be on IPV4 and IPV6, through a home agent or not.
- 3) The Nfr-ITS-S shall send the message to the relevant Vru-ITS-S.
- 4) The Nfr-ITS-S shall send the message to the relevant Foreign national ITS-S.

3.3.2 Downlink flows

The work flow of data shall follow the sequence below:

- 1) The Vro-ITS-S shall receive all relevant C-ITS messages signed through a hybrid communication to the Nfr-ITS-S.
- 2) Hybrid communication can be on IPV4 et IPV6, through a home agent or not.

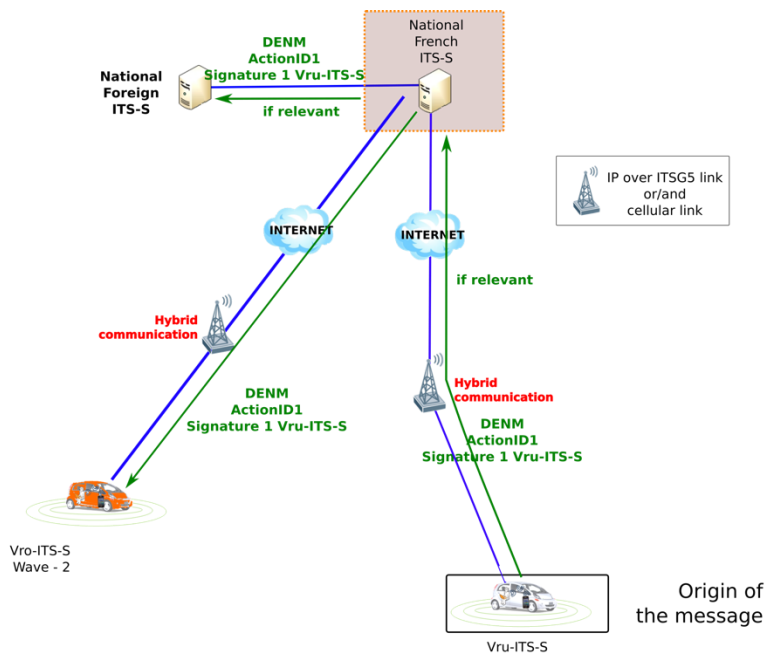


Figure 12: example of downlink flow for V-Ro-ITS-s

4 GLOSA Functional Architecture

GLOSA application implies a specific architecture due to the connection to traffic light.

| | |
|------------------------|--|
| Id | 241H-GLOS -001 |
| Component(s) | Road operators |
| Requirement | Considering that traffic light can be managed by a central server or having a static phase schedule. We define two type of architecture described below. Road operators can decide which solution they want to implement. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-GLOS -002 |
| Component(s) | Road operators |
| Requirement | Road operators can decide to implement both solutions. |
| Additional information | |

4.1 For local traffic light

The work flow of data shall follow the sequence below:

- 1) The traffic light sends through its traffic light controller to the R-ITS-S the current and next phases.
- 2) The R-ITS-S shall send through ITS-G5 the corresponding SPATEM and the MAPEM related to the intersection.
- 3) The R-ITSS shall send to the Nfr-ITS-S the corresponding SPATEM and MAPEM to the Nfr-ITS-S
- 4) The Nfr-ITS-S shall send to relevant V-ITS-S the current SPATEM and MAPEM.
- 5) The Nfr-ITS-S shall send to relevant server application the current SPATEM and MAPEM.
- 6) The Nfr-ITS-S shall send to relevant No-ITS-S the current SPATEM and MAPEM.

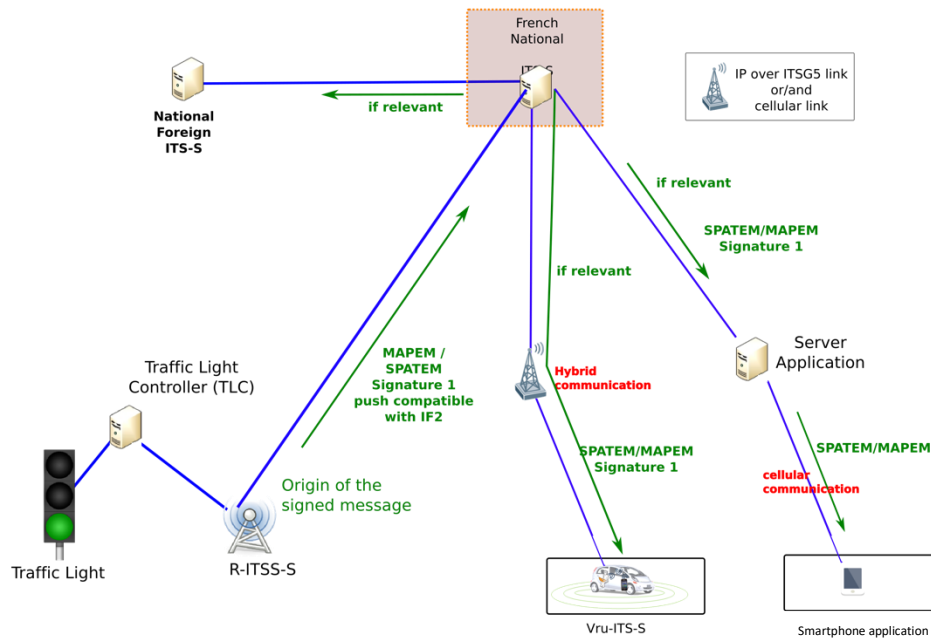


Figure 13: Glosa Architecture – local traffic light

4.2 For centralized traffic light

The work flow of data shall follow the sequence below:

- 1) The centralized traffic light Management system send simultaneously traffic light phases to the traffic light, corresponding SPATEM and the MAPEM related to the intersection to the Nfr-ITS-S and eventually to the R-ITS-S of concerned intersection.
- 2) The Nfr-ITS-S shall send to relevant V-ITS-S the current SPATEM and MAPEM.
- 3) The Nfr-ITS-S shall send to relevant server application the current SPATEM and MAPEM.
- 4) The Nfr-ITS-S shall send to relevant No-ITS-S the current SPATEM and MAPEM.

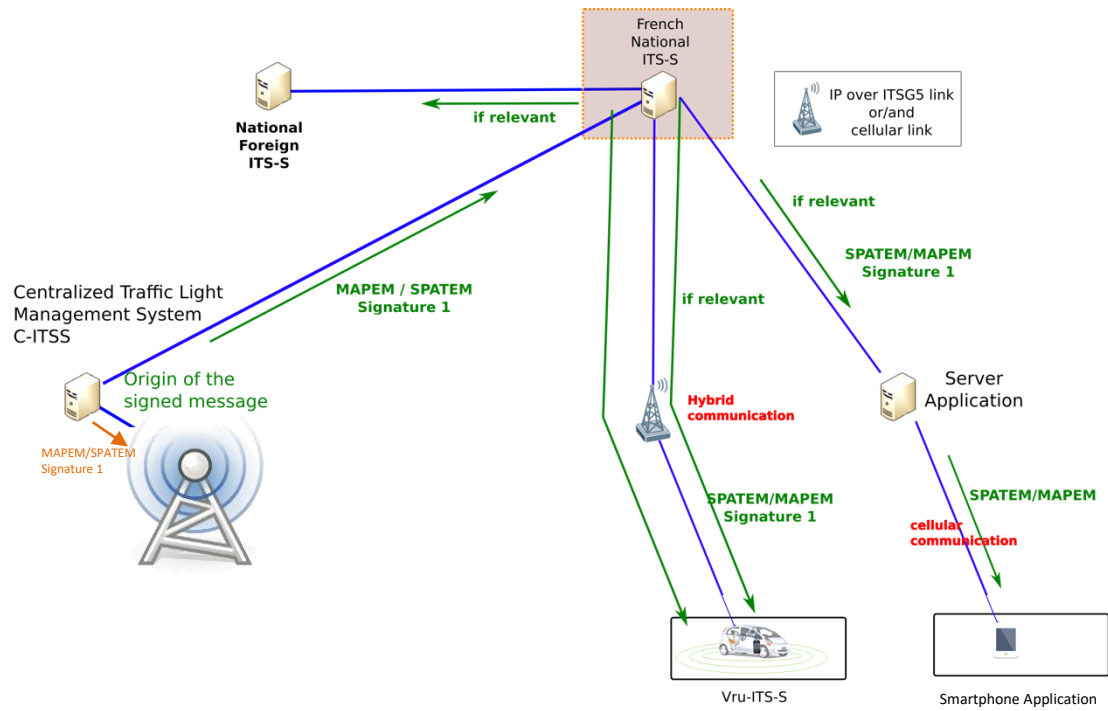


Figure 14: Glosa Architecture – centralized traffic light

5 Functions of main components of the architecture

5.1 Nfr-ITS-S station functions

| | |
|------------------------|--|
| Id | 241H-FunN-001 |
| Component(s) | Nfr-ITS-S |
| Requirement | Nfr-ITS-S shall exchange with other C-ITS-S and Car Manufacturer's Platform trusted messages in a secured way. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunN-002 |
| Component(s) | Nfr-ITS-S, PFro, Vru-ITS-S, Vro-ITS-S |
| Requirement | The N-ITS-S shall receive different types of messages: IVI, CAM, DENM, MAPEM, SPATEM, POI messages and Datex II messages. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunN-003 |
| Component(s) | Nfr-ITS-S and No-ITS-S |
| Requirement | The Nfr-ITS-S shall exchange messages with No-ITS-S. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunN-004 |
| Component(s) | Nfr-ITS-S |
| Requirement | The CAM message shall enable the creation of a list of V-ITS-S located in an area for sending future event messages. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunN-005 |
| Component(s) | Nfr-ITS-S |
| Requirement | Vehicle position shall be erased after 241H-FunN-004 operation. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunN-006 |
| Component(s) | Nfr-ITS-S |
| Requirement | The Nfr-ITS-S shall use the position of V-ITS-S for road operator purpose: calculate travel time, origin/destination matrix, etc. |
| Additional information | That function already exists in R-ITS-S and are described in SCOOP deliverables. |

| | |
|------------------------|---|
| Id | 241H-FunN-007 |
| Component(s) | Nfr-ITS-S |
| Requirement | If a No-ITS-S decide to subscribe to the list of events of the French one, the Nfr-ITS-S shall push all related messages. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunN-008 |
| Component(s) | Nfr-ITS-S, V-ITS-S |
| Requirement | The Nfr-ITS-S shall push information to V-ITS-S. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunN-009 |
| Component(s) | Nfr-ITS-S, PFcm, PFro |
| Requirement | Every PFro and PFcm registered in the Nfr-ITS-S shall receive messages, taking into account an area of interest configured in the Nfr-ITS-S. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunN-010 |
| Component(s) | Nfr-ITS-S, V-ITS-S |
| Requirement | The Nfr-ITS-S shall forward the DENM to every V-ITS-S except the one who is at the origin of the DENM. |
| Additional information | Not applicable for V-ITS-S managed by a Car Manufacturer's Platform. |

| | |
|------------------------|---|
| Id | 241H-FunN-011 |
| Component(s) | Nfr-ITS-S, V-ITS-S, MCTO server, Nxx-ITS-S |
| Requirement | DENM SPATEM, MAPEM, POI messages, ETA messages and IVI shall need authentication process. |
| Additional information | This function will be described in deliverable 2.4.4.11_H. |

| | |
|------------------------|--|
| Id | 241H-FunN-012 |
| Component(s) | N-ITS-S |
| Requirement | The Nfr-ITS-S shall translate received DATEX II messages into DENM, POI messages or IVI. |
| Additional information | This function will be described in deliverable 2.4.1.4_H. |

| | |
|------------------------|---|
| Id | 241H-FunN-013 |
| Component(s) | N-ITS-S |
| Requirement | The Nfr-ITS-S shall transmit on IP link MAPEM at the first inscription of a V-ITS-S in the geographical database and then transmit only updates to avoid any network overload. |
| Additional information | <p>From ETSI TS 103 301V1.1.1</p> <p>“MAPEM shall be transmitted continuously together with the SPATEM to inform the traffic participant (driver, pedestrian, etc.) about the status of allowed maneuvers within the intersection conflict area. Due to potential different communication paths to the end users, the MAPEM may be disseminated using different access technologies for short range and long range communication. “</p> <p>Sentence not clear. We decided to transmit MAPEM less often than SPATEM.</p> |

| | |
|------------------------|--|
| Id | 241H-FunN-016(0) |
| Component(s) | N-ITS-S |
| Requirement | The Nfr-ITS-S shall store MAPEM until it receives an update. |
| Additional information | |

| | |
|----|---------------|
| Id | 241H-FunN-016 |
|----|---------------|

| | |
|------------------------|---|
| Component(s) | N-ITS-S, PfcM |
| Requirement | The Nfr-ITS-S shall transmit current MAPEM and SPATEM to the Car Manufacturer's Platform |
| Additional information | The Car Manufacturer's Platform shall send to the relevant V-ITS-S current SPATEM and MAPEM |

| | |
|------------------------|--|
| Id | 241H-FunN-017 |
| Component(s) | N-ITS-S |
| Requirement | The Nfr-ITS-S shall transmit on IP link POI messages at the first inscription of a V-ITS-S in the database and then transmit only updates to avoid any network overload. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunN-018 |
| Component(s) | Nfr-ITS-S, Vro-ITS-S |
| Requirement | The Nfr-ITS-S shall exchange only C-ITS messages with Vro-ITS-S through hybrid communications. |
| Additional information | |

5.2 Applications server Functions

| | |
|------------------------|--|
| Id | 241H-FunAP-001 |
| Component(s) | application server |
| Requirement | The application server shall store the received MAPEM until it receives an update of this one. |
| Additional information | From ETSI TS 103 301V1.1.1 "MAPEM shall be transmitted continuously together with the SPATEM to inform the traffic participant (driver, pedestrian, etc.) about the status of allowed maneuvers within the intersection conflict area. Due to potential different communication paths to the end users, the MAPEM may be disseminated using different access technologies for short range and long range communication. " |

| | |
|--------------|--|
| Id | 241H-FunAP-002 |
| Component(s) | application server |
| Requirement | The application server shall transmit to relevant smartphones IVI, DENM, SPATEM, MAPEM and POI messages. |

Additional information

.

5.3 V-ITS-S Functions

V-ITS-S design Vro-ITS-S and Vru-ITS-S. Functions can apply to both ITS-S.

5.3.1 Function #1: message sending

| | |
|------------------------|---|
| Id | 241H-FUNV-001 |
| Component(s) | V-ITS-S |
| Requirement | V-ITS-S can send CAM through ITS-G5 and cellular but not at the same frequency. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FUNV-002 |
| Component(s) | V-ITS-S |
| Requirement | On cellular link, V-ITS-S shall send a CAM when one of these conditions is reached: every 250 m. every 120 s (if the ITSS-V drives less than 250m during 120s). |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FUNV-003 |
| Component(s) | V-ITS-S |
| Requirement | Forward of received messages from the Nfr-ITS-S should be implemented. |
| Additional information | Different strategies can impact the forward of a message: to keep or not the same stack as ITS-G5 (so hoplimit could be different from 1) to share or not messages to non-cellular V-ITS-S (No forward could be done) |

| | |
|------------------------|---|
| Id | 241H-FUNV-004 |
| Component(s) | V-ITS-S |
| Requirement | V-ITS-S can receive through a hybrid link DENM, IVI, SPATEM, MAPEM or POI messages. |
| Additional information | |

5.3.2 Function #2: V2V via cellular link

| | |
|------------------------|---|
| Id | 241H-FUNV-005 |
| Component(s) | V-ITS-S |
| Requirement | V-ITS-S can send DENM through cellular to other V-ITS-S by sending messages to the Nfr-ITS-S. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H- FUNV-006 |
| Component(s) | V-ITS-S |
| Requirement | The station ID of V-ITS-S shall periodically change. |
| Additional information | |

5.3.3 Function #3: Security

Security objectives for V-ITS-S messages are integrity and authentication provided by signature using pseudonym certificates. Details are provided in deliverable 2.4.4.11_H and 2.4.4.8_H.

| | |
|------------------------|--|
| Id | 241H-FUNV-007 |
| Component(s) | V-ITS-S |
| Requirement | If the pseudo changes, then a CAM is sent. |
| Additional information | See deliverable 2.4.2.3.P_H |

5.3.4 Function #4: MAPEM

| | |
|------------------------|---|
| Id | 241H-FunV-006 |
| Component(s) | ITSS-V |
| Requirement | Through hybrid link, ITSS-V shall store the received MAPEM until it receives an update of this one. |
| Additional information | Through Car Manufacturer's Platform, V-ITS-S will receive continuously together MAPEM and SPTEM |

5.4 Vro-ITS-S function

| | |
|------------------------|---|
| Id | 241H-FURO-001 |
| Component(s) | Vro-ITS-S |
| Requirement | Vro-ITS-S shall send their own signed DENM and CAM through hybrid link to the Nfr-ITS-S. |
| Additional information | CAM information are used to store in a geographical database the vehicle and to be able to send relevant messages. No messages received by Vro-ITS-S are sent through hybrid link. |

5.5 Car Manufacturer's Platform functions

| | |
|------------------------|---|
| Id | 241H-FunR-001 |
| Component(s) | V-ITS-S, NFR-ITS-S , PFcm |
| Requirement | The PFcm shall be able to: Receive messages from Nfr-ITS-S and V-ITS-S Send to V-ITS-S relevant messages Forward to the Nfr-ITS-S all DENM from V-ITS-S. |
| Additional information | Security is defined in del. 2.4.4.11_H and 2.4.4.8_H. |

5.6 Functionalities of the Home Agent functions

| | |
|------------------------|--|
| Id | 241H-FunH-001 |
| Component(s) | HA |
| Requirement | <p>The home agent shall be able to:</p> <p>Mounting and maintaining Mobile IP tunnels between V-ITS-S and Home Agent</p> <p>Management of Mobile IP tunnels upon ITS G5 and LTE communication links</p> <p>For security aspect, authentication, integrity, confidentiality, privacy and availability are required as security objectives for signalling messages. Details are given in deliverable 2.4.4.11_H and 2.4.4.8_H.</p> |
| Additional information | |

5.7 R-ITS-S functions

| | |
|------------------------|--|
| Id | 241H-FuRS-001 |
| Component(s) | R-ITS-S |
| Requirement | In Hybrid communications, R-ITS-S shall be an IPV6 router. |
| Additional information | See Figure 17: Interfaces definition. |

| | |
|------------------------|---|
| Id | 241H-FuRS-002 |
| Component(s) | R-ITS-S |
| Requirement | <p>The ITSS-R shall support two services on the 802.11p SCH1 channel:</p> <p>IPv6 router</p> <p>And the Recursive DNS</p> |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FuRS-003 |
| Component(s) | R-ITS-S |
| Requirement | The R-ITS-S shall configure two IPv6 addresses on the 802.11p-SCH1 link: Link-local address in the fe80::/64 range Global address, following the IPv6 router global prefix range |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FuRS-004 |
| Component(s) | R-ITS-S |
| Requirement | The R-ITS-S IPv6 router shall transmits periodically a router advertisement to the multicast group address ff02::1. |
| Additional information | It is an ICMPv6 packet type 134. The R-ITS-S router advertisement contains the link local address of the router configured via EUI-64 algorithm, and the destination address set to ff02::1. |

| | |
|------------------------|--|
| Id | 241H-FuRS-005 |
| Component(s) | R-ITS-S |
| Requirement | Following the RFC 6275, the R-ITS-S IPv6 router shall transmit unsolicited multicast Router Advertisement each 100ms. The following flags are used: A=1: for IPv6 address auto-configuration M=0: for IPv6 address configuration, the host does not require the use of a DHCP server |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FuRS-006 |
| Component(s) | R-ITS-S |
| Requirement | The option RDNSS shall be provided by the R-ITS-S router through the Router Advertisement to enable hosts to configure IPv6 DNS address. |
| Additional information | The Ethernet Type field in the Logical-link control header shall be set to 0x86dd to indicate that the frame transports an IPv6 packet. |

| | |
|--------------|---------------|
| Id | 241H-FuRS-007 |
| Component(s) | R-ITS-S |

| | |
|------------------------|--|
| Requirement | If relevant, The R-ITS-S shall transmit each new MAPEM and SPATEM in ITS-G5. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FuRS-008 |
| Component(s) | R-ITS-S |
| Requirement | The R-ITS-S shall transmit each new MAPEM and SPATEM built from information received from a traffic controller to the Nfr-ITS-S. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FuRS-009 |
| Component(s) | R-ITS-S |
| Requirement | The R-ITS-S shall transmit ETA and POI over ITS-G5. |
| Additional information | |

5.8 PFro Functionalities

| | |
|------------------------|---|
| Id | 241H-FunP-001 |
| Component(s) | PFro |
| Requirement | The Road Operator's platform shall transmit and receive, only, DATEX II messages. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-FunP-003 |
| Component(s) | PFro, Road Operator Network |
| Requirement | PFro shall configure the connection with the Nfr-ITS-S: The URL of reception of Datex II messages (including the corresponding port number). The URL of sending of Datex II messages (including the corresponding port number). |
| Additional information | The security procedure: cf. deliverable 2.4.4.11_H and 2.4.4.8_H. |

| | |
|------------------------|---|
| Id | 241H-FunP-004 |
| Component(s) | PFro |
| Requirement | PFro shall consider the Nfr-ITS-S as a source of information and transfer the information to the TMSfor validation. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-FunP-005 |
| Component(s) | PFro |
| Requirement | PFro shall configure the sending information to the Nfr-ITS-S like for a R-ITS-S. That means, that all event messages transmitted from the PFro to an R-ITS-S shall also be transmitted to the Nfr-ITS-S |
| Additional information | |

6 Technical architecture

6.1 Communication profiles

Section 3.2 describes any elementary dataflow. Each of them operates at the same time. The global flow between C-ITS-S is the sum of all elementary dataflows. **Erreur ! Source du renvoi introuvable.** Figure 15 describes each possible communication link between C-ITS-S and will be detailed in next sections.

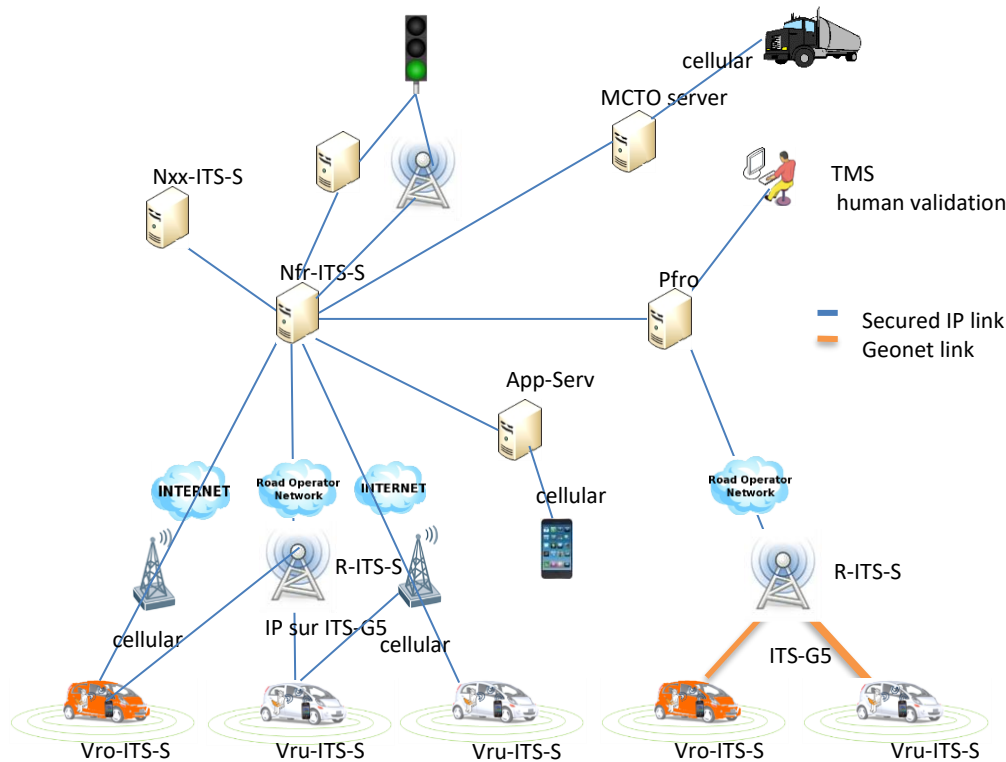


Figure 15 : Global ITSS links view

From SCOOP_2.4.1_Common set of functional and technical specifications_V3.00, profiles are defined:

| Communication Profile | Transport | Network | Access |
|-----------------------|--------------------------------|---------------|-------------|
| CP1 | BTP (Basic transport Protocol) | Geonetworking | ITS G5 CCH |
| CP2 | BTP (Basic transport Protocol) | Geonetworking | ITS G5 SCH1 |
| CP3 | BTP (Basic transport Protocol) | Geonetworking | ITS G5 SCH2 |
| CP4 | BTP (Basic transport Protocol) | Geonetworking | ITS G5 SCH3 |
| CP5 | TCP | IPV4 | ITS G5 SCH1 |
| CP7 | UDP | IPV4 | ITS G5 SCH1 |
| CP8 | TCP | IPV6 | ITS G5 SCH1 |
| CP9 | UDP | IPV6 | ITS G5 SCH1 |
| CP11 | TCP | IPV4 | 3G/4G |
| CP12 | UDP | IPV4 | 3G/4G |

| | | | |
|------|-----|------|----------|
| CP13 | TCP | IPV6 | 3G/4G |
| CP14 | UDP | IPV6 | 3G/4G |
| CP15 | TCP | IPV4 | Ethernet |
| CP16 | UDP | IPV4 | Ethernet |
| CP17 | TCP | IPV6 | Ethernet |
| CP18 | UDP | IPV6 | Ethernet |

Table 2: Communication profiles

Considering the different use cases, profiles by message to send are:

| Cas d'usage | Profil |
|-------------|--------------------------------|
| DENM | CP1-CP8-CP11-CP13- CP15 – CP17 |
| CAM | CP1-CP8-CP11-CP13 |
| IVI | CP1-CP8-CP11-CP13- CP15 – CP17 |
| POI | CP3-CP8-CP11-CP13- CP15 – CP17 |
| ETA | CP11- -CP15 – CP17 |
| Security | CP2-CP5 |

Table 3: Communication profiles by messages

6.2 Network architecture

| | |
|------------------------|--|
| Id | 241H-NETA-001 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | The different stakeholders (Vro-ITS-S, Vru-ITS-S, PFro, Nfr-ITS-S) can belong to separated administrative entities |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-NETA-002 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | Functions described in Figure 16 can be hosted and/or provided by different organisations. |
| Additional information | It is therefore necessary to define an open interface to interconnect these entities. This architecture is represented on the Figure 16and will be detailed in the following sections |

| | |
|------------------------|---|
| Id | 241H-NETA-003 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | The architecture can host the Home Agent (HA) function by different stake holders (Road Operator, Cellular Operator, Car Manufacturer) (cf. §9.1). |
| Additional information | It should be mentioned that there are still discussions on the governance linked with the HA function as it involves at the same time different stakeholders that need to trust each other" |

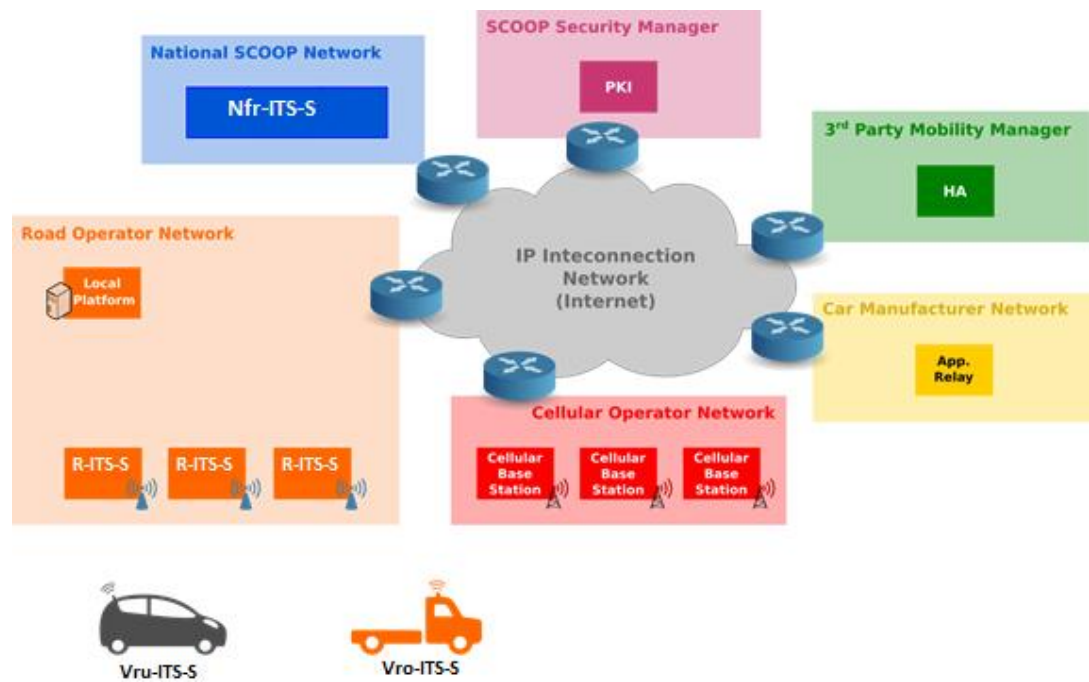


Figure 16: Interconnection architecture

6.3 Interconnection

Figure 17 represents all interfaces which are described in this section. Interfaces 1, 2, 6 and 7 are IPV6 based and they use a Home Agent to allow seamless connection during mobility. Interfaces 4, 5, 8, 9 10 and 11 are related to servers' connection with different technical specifications. Interface 3 is out of the scope of this document and will be described in 2.4.2.3R-H.

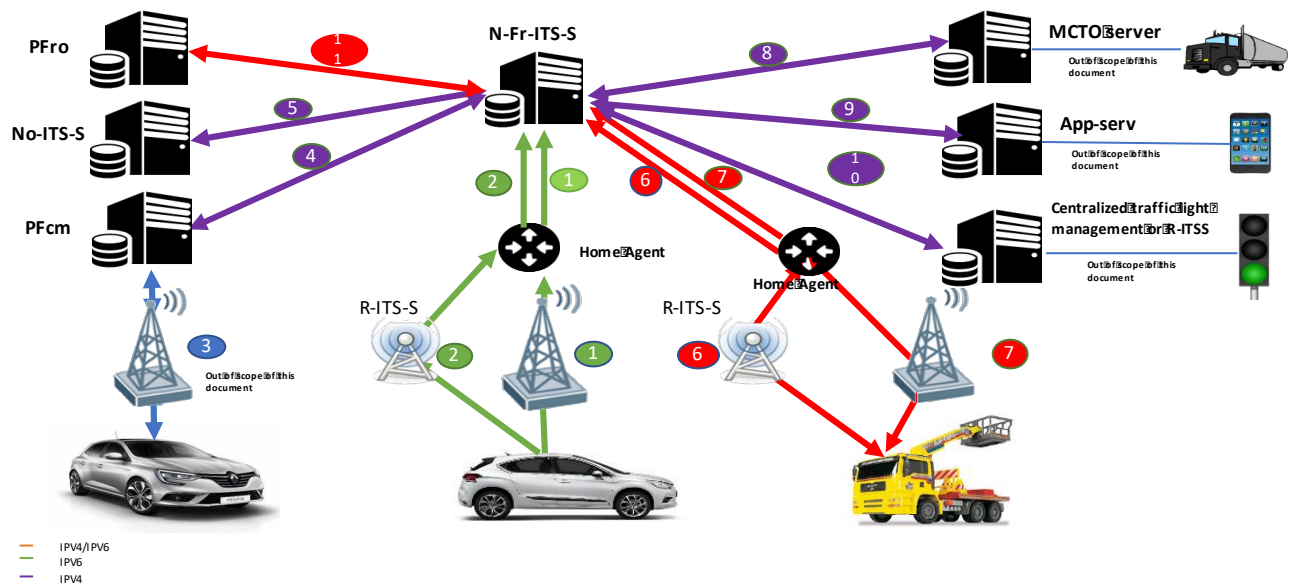


Figure 17: Interfaces definition.

6.3.1 For interfaces 1, 2, 6, 7

| | |
|------------------------|--|
| Id | 241H-INT1-001 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | IPv6 (RFC 8200) shall be the nominal standard for interconnection at the network layer. |
| Additional information | IPv6 ensure a large enough addressing space for all devices and vehicles at the scale of the world. Entities can be linked either directly or through the Internet. In any case, some additional requirements shall apply to guaranty the security of the communications (using VPN, typically). These requirements are specified in deliverable 2.4.4.11_H and 2.4.4.8_H. |

| | |
|------------------------|---|
| Id | 241H-INT1-002 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | The interfaces between stakeholders shall use IPV6 |
| Additional information | Each stakeholder can use any technology to implement the communications inside its own network (e.g. 6to4 tunnels). But, in any case, it shall be possible to establish an end to end IPV6 connection with any SCOOPw2 device. An exception to this requirement is possible (see 241H-INT1-003). Mobile IPV6 connection make possible to have a seamless connection during ITSS-V mobility. |

| | |
|------------------------|--|
| Id | 241H-INT1-003 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | As an exception to the requirement 241H-INT1-002, it can be tolerated to use IPV4 to establish the communication between two nodes that mutually agree to do so. |
| Additional information | When using IPV4, the seamless connection is no more available but service continuity can still be ensured at application level (by the Nfr-ITS-S) |

| | |
|------------------------|--|
| Id | 241H-INT1-004 |
| Component(s) | N-ITS-S, Vro-ITS-S |
| Requirement | Vro-ITS-S can use IPV6 or IPV4 link. It's up to the road operator to decide which IP technology he wants to use. |
| Additional information | 241H-INT1-001 to 241H-INT1-003 are related to IPV6 link. |

A drawback of the hybrid architecture is that IP addresses of vehicles will change frequently due to the mobility across the different networks and pseudonym changes. This can be a problem for some applications or use cases which require to maintain a constant connectivity or to directly address vehicles.

| | |
|------------------------|--|
| Id | 241H-INT1-006 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | A mobility management function shall be set up at the network level. |
| Additional information | Its role is to mask the mobility of the vehicles to the rest of the network. For that, it will replace the temporary addresses obtained by the vehicles (so called Care of Address: CoA) by a fixed one (so called Home Address: HoA). The mobility management function is specified in chapter 9. It needs to run the MobileIPv6 protocol suite on the V-ITS-S and on dedicated servers on ground. These servers are called Home Agents (HA). |

| | |
|------------------------|---|
| Id | 241H-INT1-007 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | Each vehicle shall be associated with only one HA. |
| Additional information | Several HA can coexist in the network and can be operated by different parties (e.g. Telco, road operators, dedicated mobility operators, etc). |

The vehicle owner has the choice of the HA he wants to bind with. And this association is supposed to remain stable for a quite long period of time (typically years). Based on this hypothesis, the present specification let each HA operator the choice to implement specific mobility management solutions that would be only available to vehicles implementing the appropriate software. Thus, this document only gives a typical common set of specifications based on MobileIPv6 (RFC 6275) and NEMO (RFC 3963) but keep the possibility for HA operator to propose additional "premium services" on top of this stack

6.3.2 For interfaces 4, 5, 8, 9 and 10

| | |
|------------------------|--|
| Id | 241H-INT1-008 |
| Component(s) | Nfr-ITS-S, No-ITS-S, Vru-ITS-S, MCTO server, App-Serv, Centralized traffic light management, R-ITS-S |
| Requirement | IPv4 should be used. |
| Additional information | |

6.3.3 For interface 11

| | |
|------------------------|---|
| Id | 241H-INT1-010 |
| Component(s) | Nfr-ITS-S, PFro |
| Requirement | TCP over IPv4 should be used on dedicated port. |
| Additional information | One specific port is used for Datex. |

| | |
|------------------------|--|
| Id | 241H-INT1-011 |
| Component(s) | Nfr-ITS-S, PFro |
| Requirement | Messages exchanged shall be in Datex II. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-INT1-012 |
| Component(s) | Nfr-ITS-S, PFro |
| Requirement | Messages are not signed; But the link shall be secured. |
| Additional information | See deliverable 2.4.4.11_H and 2.4.4.8_H. |

7 Interface description

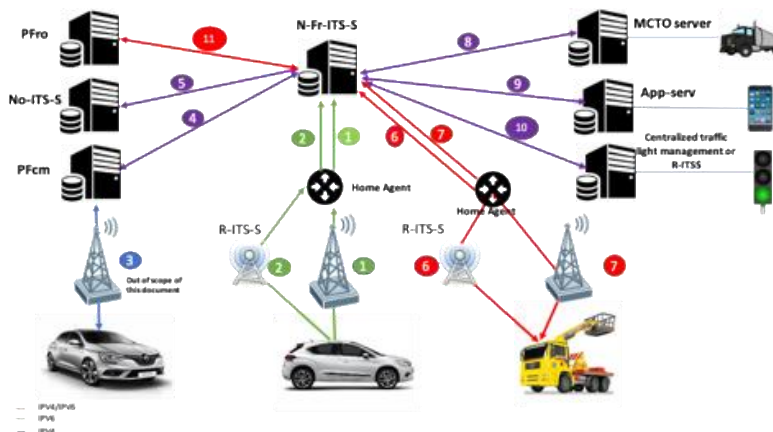


Figure 18: Overall view of interfaces

7.1 General description

| | |
|------------------------|---|
| Id | 241H-INT2-001 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | Each Interface shall respect communication profiles described in Table 4: . |
| Additional information | Project implementation choices are described in chapter 10 |

| Interface Number | Access | Network | Transport | Application layer OSI | Data uplink | Data downlink |
|------------------|--------------|-----------|-----------|-----------------------|--|--|
| 1 | cellular | IPV6 | TCP | Websocket | DENM/CAM | DENM/IVI/POI/SPATEM/MAPEM |
| 2 | 802.11p SCH1 | IPV6 | TCP | Websocket | DENM/CAM | DENM/IVI/POI/SPATEM/MAPEM |
| 4 | | IPV4 | TCP | AMQP | DENM | DENM/IVI/POI/SPATEM/MAPEM |
| 5 | | IPV4 | TCP | AMQP | DENM/IVI/SPATEM/MAPEM/POI/ETAinformation | DENM/IVI/SPATEM/MAPEM/POI/ETAinformation |
| 6 | 802.11p SCH1 | IPV4/IPV6 | TCP | websocket | DENM/CAM | DENM/CAM/POI |

| | | | | | | |
|----|----------|-----------|-----|-----------|--------------|---|
| 7 | cellular | IPV4/IPV6 | TCP | websocket | DENM/CAM | DENM/CAM/POI |
| 8 | | IPV4 | TCP | AMQP | POI/CAM | DENM/IVI/POI/POISlotReferenceStatus / POI notification for Dockslot / SPATEM, MAPEM |
| 9 | | IPV4 | TCP | AMQP | DENM/CAM | DENM/IVI/POI/SPATEM/MAPEM |
| 10 | | IPV4 | TCP | AMQP | SPATEM/MAPEM | |
| 11 | | IPV4/IPV6 | TCP | websocket | DatexII V2.3 | DatexII V2.3 |

Table 4: Communication profiles by interfaces

7.2 Message format

7.2.1 For Interface 1, 2, 6 and 7

| | |
|------------------------|--|
| Id | 241H-INT2-002 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, R-ITS-S, Vro-ITS-S |
| Requirement | All messages shall be composed of ASN.1 encoded Useful data (using unaligned PER), as defined in the ITS-G5 profiles (for DENM, IVI and CAM, POI, SPATEM, MAPEM, ETAinformation) |
| Additional information | |

Message Repetition

| | |
|------------------------|--|
| Id | 241H-INT2-003 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, R-ITS-S, Vro-ITS-S |
| Requirement | In cellular link, C-ITS-S should not repeat messages. |
| Additional information | During evaluation process, the repetition will be analysed to define the good level of repetition. The requirement could be adapted according to the message and the C-ITS sender. |

CAM frequency see 5.3.1.

7.2.2 For Interface 4, 5, 8, 9 and 10

| | |
|--------------|---|
| Id | 241H-INT2-004 |
| Component(s) | Nfr-ITS-S, No-ITS-S, Vru-ITS-S, PFro, MCTO server, App-Serv, Centralized traffic light management, R-ITSS |

| | |
|------------------------|--|
| Requirement | Interface 4, 5, 8, 9 and 10 shall respect interface IF2 described in InterCor_2.1b_IF2_specs-v2.0 in order to exchange information for all technical aspect unless messages format and security. |
| Additional information | The specification of this interface is related to work done in InterCor Project (see InterCor_2.1b_IF2_specs-v2.0 for more information on specifications of this platform interface). |

| | |
|------------------------|---|
| Id | 241H-INT2-005 |
| Component(s) | Nfr-ITS-S, No-ITS-S, Vru-ITS-S, MCTO server, App-Serv, Centralized traffic light management, R-ITSS |
| Requirement | Format for C-ITS messages shall include geonet secured header. |
| Additional information | See Table 5: Message format for interface 4 |

| Field | Required | Description |
|-----------------|-----------|--|
| Message | Mandatory | The actual message/payload. Currently foreseen DENM/IVI/MAP/SPAT/POI/ETAInformation. The content of the messages should follow the profile, as defined in [1]. Messages should not be transcoded, e.g. to DATEX II messages. The same ASN.1 encoding rules should be followed as used on the ITS-G5 channel. |
| Message type | Optional | Message type name (DENM/IVI/MAP/SPAT/...) |
| Message version | Optional | Version of the message type |
| Originator | Optional | The source of the information, typically a (short) name of the road operator. This can be relevant for the trustworthiness of the information, and for business aspects. |
| Location | Optional | Relevant target location of this message. The intent is to be able to use it for filtering. The detailed location information is contained inside the message. These should be consistent |
| Time validity | Optional | Messages have a limited validity. "Old" messages do not have to be forwarded. The time validity can be specified based on an absolute timestamp, or on a generation timestamp and a validity time. |
| Signature type | Optional | The type of signature included in the message, if any. Technical details will be worked out in a later stage, and will be included in (InterCor, to be published). |

Table 5: Message format for interface 4 5, 8, 9 and 10

8 Access and Network layers

| | |
|------------------------|---|
| Id | 241H-ACNE- 001 |
| Component(s) | R-ITS-S, Cellular network, ITS-G5, HA |
| Requirement | The access provider (e.g. IP over ITS-G5 operator, or cellular operator) shall provide each mobile node (i.e. V-ITS-S) with a global IPv6 prefix address that can be used by this node to reach services over the Internet and be reached by them. For ITS-G5, the mechanism is described in deliverable 2.4.1.6. |
| Additional information | It is the responsibility of each access provider to get the addresses requested for its end nodes from the Internet authorities. |

| | |
|------------------------|---|
| Id | 241H-ACNE-001 |
| Component(s) | Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S |
| Requirement | Due to their mobility, vehicles (i.e. Vro-ITS-S and Vru-ITS-S) shall use a radio link to access to the IP interconnection network. |
| Additional information | The possible options for this link are: IPv6 over ITS-G5 obtained through the R-ITS-S of a road operator; IPv6 obtained through a cellular network. Such access could be provided by a third party like a telecom operator. Foreseen technologies for this access are 3GPP 3G, 4G, but any IPv6 enabled radio access could be used (e.g. satcom). |

| | |
|------------------------|---|
| Id | 241H-ACNE-002 |
| Component(s) | Vro-ITS-S, Vru-ITS-S, PFcm, HA, Nfr-ITS-S |
| Requirement | For the road operators' network, the hosting company which provides 6to4 tunnels filters IPV6 access through firewalls. It shall be updated with server IP address of hybrid communications (N-ITS-S, HA, PFcm) |
| Additional information | The 6to4 tunnels are described in the deliverable 2.4.1.5 |

8.1 Full IPv6 access network

When the network of the access provider is compatible with IPv6, IPv6 addresses are directly routed to the end node across this network. The only requirement is then to implement an address allocation mechanism as described in deliverable 2.4.1.6.

The following paragraphs give some indicative guidelines about how to deploy IPv6 directly to the end nodes depending on the access network architecture.

8.2 Transition Mechanisms for IPv4 road operator core networks

Frequently, network from road operators are using IPv4 only (and often using private IPv4 addresses). In this case, one solution is to add an IPv6 to IPv4 gateway at the border between the Road Operator network and the internet (in a DMZ for instance) and to implement IPv6 in IPv4 tunnels between the ITSS-R and this gateway. Doing so, ITSS-Rs appear to be directly connected to the IPv6 internet, and this case become equivalent to the previous one.

| | |
|------------------------|---|
| Id | 241H-Trans- 001 |
| Component(s) | R-ITS-S, Cellular network, HA |
| Requirement | The gateway shall have a short enough IPv6 prefix to distribute IPv6 sub-prefixes to the R-ITS-S. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-Trans- 002 |
| Component(s) | R-ITS-S, Cellular network, ITS-G5, HA |
| Requirement | Allowing IPv6 on IPv4 can be implemented using various kinds of tunnels (network or transport layer...). See deliverable 2.4.1.5 and 2.4.1.6. |
| Additional information | Since the gateway might be accessible from the Internet, it is recommended to implement an authentication check but cyphering is not mandatory if confidentiality and integrity are managed at a higher level. |

9 Mobility Management (Home Agent and Mobile Node stack)

9.1 Home agent function hosting

As introduced in section 6.2, there can be several HA operators. Various reasons exist for a stakeholder to be interested in operating a home agent service. Typical operators considered at this stage are:

- Road Operators (for their own fleets of vehicles),
- Cellular Network Operators (to provide added value based on the variety of their access networks),
- Car Manufacturers (to offer turnkey service to car owners),
- Third Party (interested in developing added value service like enhanced privacy guaranties),
- Managers of fleets of vehicles (like logistic operators)
- ...

| | |
|------------------------|---|
| Id | 241H-MOBI-001 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The car owner shall choose one and only one of the available HA operators and configure accordingly the HA parameters of the V-ITS-S. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-MOBI-002 |
| Component(s) | Vru-ITS-S, Vro-ITS-S, HA |
| Requirement | During the life of the car, the car owner can change the HA he wants to use. Doing so necessitates to reconfigure the HA parameters in the V-ITS-S and shall require a software update of the V-ITS-S. During this reconfiguration, the communication can be interrupted. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOBI-003 |
| Component(s) | Vru-ITS-S, Vro-ITS-S, HA |
| Requirement | <p>Each Home Agent and each V-ITS-S shall at least implement the common mobility stack made up of:</p> <p>MobileIP v6 (RFC 6275). Only the basic and security functionalities of MobileIP are required for SCOOP wave 2. Requirements of RFC 6275 related to “Route Optimisation” and “Dynamic Home Agent Address Discovery” are not applicable for SCOOP wave 2.</p> <p>NEMO (RFC 3963)</p> <p>Associated security requirements are described in deliverable 2.4.411_H. In particular, signalling tunnel has to be secured using IPsec...</p> |
| Additional information | |

9.2 Common Mobility Stack

This paragraph describes the common set of specifications that have to be followed by all SCOOP stakeholders dealing with mobility (i.e. ITSS-V, Access Networks Operators, HA Operators).

Note: Router advertisement is sent by the infrastructure in SCH1, see deliverable 2416.

| | |
|------------------------|--|
| Id | 241H-MOBI-004 |
| Component(s) | HA |
| Requirement | Home Agent implementations shall go beyond these specifications to implement additional services (e.g. Multiple Care of Address (MCoA), Flow Binding, Dual-Stack MobileIP (DS-MIPv6) ...). |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOBI-005 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | In the V-ITS-S, it shall be possible to configure the IP address of the HA to use. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOBI-006 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S and the HA can implement provisioning mechanisms (automatic configuration of network and security parameters) described in deliverable 2.4.4.16 H (configuration parameters for the IPmobility). |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOBI-007 |
| Component(s) | HA |
| Requirement | The Home Agent must provide the V-ITS-S with a global unicast IPv6 addresses (HoA). This address shall be the same at each connection of the V-ITS-S. Since it is provided by the HA operator this address can however not be conserved when changing from an HA to another. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOBI-008 |
| Component(s) | HA |
| Requirement | To enable implementation of network mobility (NEMO), the Home Agent shall allocate a 64 bits long IPv6 prefix to each V-ITS-S (Mobile Router). This prefix shall be the same at each connection of the V-ITS-S. Since it is provided by the HA operator this address can however not be conserved when changing from an HA to another. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- MOBI-009 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | On the on-board network (internal vehicle network), the V-ITS-S which implements NEMO shall distribute IPv6 addresses taken from the prefix that has been allocated to him by the HA. |
| Additional information | The V-ITS-S can be a mobile node and will not then distribute IPV6 addresses. |

9.3 Mobility security

See deliverables 2.4.4.11_H

9.4 DS-MIP based solution

ITS messages exchanged between vehicles and between vehicles and infrastructure are supported by hybrid V2I and V2V communications. The two access technologies used to support V2V and V2I communications are 3GPP LTE and ITS G5.

The three common components of the hybrid architecture are: the vehicle ITS station entailing the V-ITS-S, the roadside ITS station and finally the Home agent. Each of these items has to implement the relevant network protocols to provide the overall hybrid architecture which compose one of the main innovations of SCOOP phase2. The overall architecture is presented on Figure 4.

The following paragraphs will describe the different network features to be implemented in the three types of ITS stations to run the hybrid architecture.

The network mobility architecture is composed of two functional networks, the mobile network and the home network.

As the hybrid architecture offers the capability to transmit data packets on simultaneous access networks and according to the availability of the ITS G5 access technology in SCOOP pilot sites, better coverage and better capacity will be provided to the vehicle ITS stations thanks to the availability of LTE network. This architecture will

benefit to SCOOP use cases and services delivery with an increased overall efficiency. This architecture takes benefit of an IPv6 end to end connectivity which confers the SCOOP system with more scalability and flexibility to cope with full fledge of ITS services, especially for SCOOP phase2.

The vehicle ITS station entails a V-ITS-S which implements a mobile router with multi radio interfaces. The V-ITS-S implements all network protocols of the ITS stack.

The solution consists of configuring the network in end to end IPv6 connectivity from the mobile router on the V-ITS-S (the mobile network) to the Home Agent (HA) (the home network).

The mobile router is responsible for the network mobility management across communications links where NEMO tunnels are operated upon the LTE and ITS G5 radio communication links.

Using DS-MIP instead of MobileIPv6 enables to transparently manage communications across any kind of network, whatever it is operated in IPv4 or IPv6 protocol, to be well fitted to SCOOP road operator networks which are mainly operated in IPv4 addressing and routing.

If the mobile router and the HA implement MCoA (Multi Care of Address) as well, the connected car gets the capability to simultaneously transmit the service streams on multiple links.

Of course, the direct link between vehicles (V2V communications) remains operated in ITS G5.

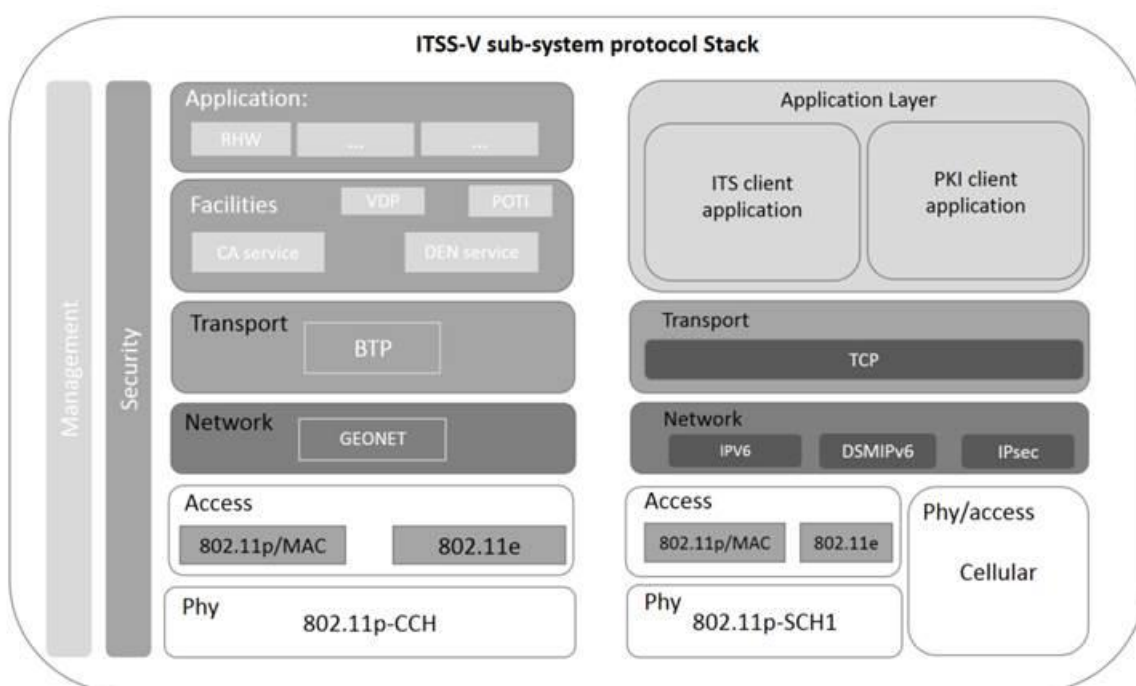


Figure 19 : ITS Stack in V-ITS-S for ITS-G5 and representation of OSI Stack for Hybrid communications

9.5 Architecture Using a Home Agent Entity

This chapter aims at describing the hybrid reference architecture making use of a Home Agent for IPv6 related communication flows. The Home Agent is an intermediary entity that provides seamless connection to the central ITS station as presented in the following figure:

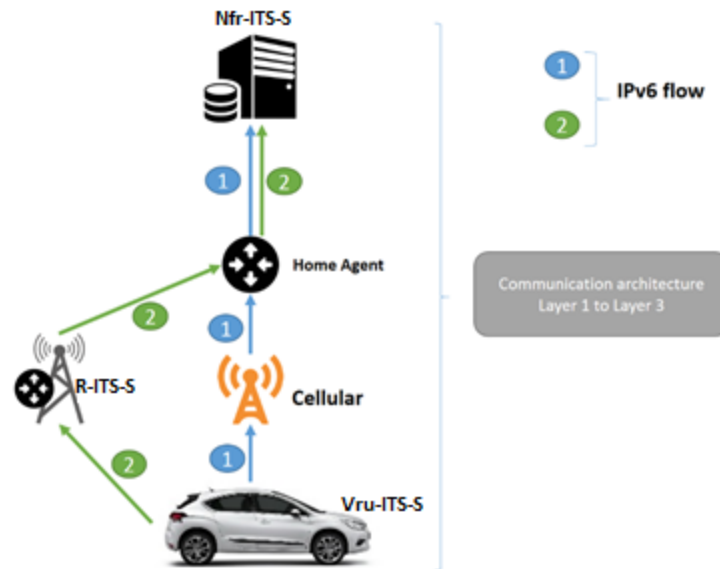


Figure 20: Reference architecture for IPv6 related communication flows (one possible implementation)

Under this reference architecture, the Intermediary entity 'Home Agent' plays a key role, which provides functionalities allowing seamless connection through different access technologies. It involves a dedicated router, hosted in the core network, which enables V-ITS-S to hide its mobility to the outer IP network.

Note: The V-ITS-S sub-system internal networking specification is out of the scope of this document.

Note: The V-ITS-S sub-system specification is limited only to the components and entities required to ensure interoperability with the SCOOP phase 2 overall ITS system

Note: The selection of the appropriate access technology is left to the choice of the implementer.

In order to access the Nfr-ITS-S services, the V-ITS-S relies on two access technologies namely the ITS access network and the private access network:

- The private access network refers in this section to interface 1 depicted in the figure 'reference architecture for IPv6 related communication flows'. It is made available through cellular access technology (3G (HSPA)/ 4G (LTE))
- The ITS access network refers in this section to the interface 2 depicted in the figure 'reference architecture for IPv6 related communication flows'. It is made available through the R-ITS-S over the 802.11p access technology operating in SCH1 channel.

| | |
|------------------------|---|
| Id | 241H- MOHA-0001 |
| Component(s) | Vru-ITS-S, C-ITS, Vro-ITS-S |
| Requirement | The ITSS-V shall communicate with the Nfr-ITS-S station either through IPv6 over 802.11p-SCH1 or through IPv6 over 3G (HSPA) / 4G (LTE) |
| Additional information | |

Data exchanges with the central ITS station rely on the two following interfaces:

- Interface 1: refers to a communication interface where IPv6 packets are routed to the central ITS station through IPv6 over 3G /4G access technologies and where the IPv6 flow is necessarily routed via the mobile IP Home Agent.
- Interface 2: refers to a communication interface where IPv6 packets are routed to the central ITS station through IPv6 over 802.11p on the channel SCH1 and where the IPv6 packets are tunneled in 6rd or IPsec between the ITSS-R and the tunnel broker. Once reaching the tunnel broker, IPv6 packets are necessarily routed via the mobile IP Home Agent.

| | |
|------------------------|--|
| Id | 241H- MOHA-0002 |
| Component(s) | Vru-ITS-S, C-ITS Vro-ITS-S |
| Requirement | With the central IPv6 global mobility management entity, The V-ITS-S shall switch seamlessly from one communication interface to another without affecting the session continuity with the corresponding C-ITS-S services. |
| Additional information | |

9.5.1 Interface 1 and 7- Technical requirements:

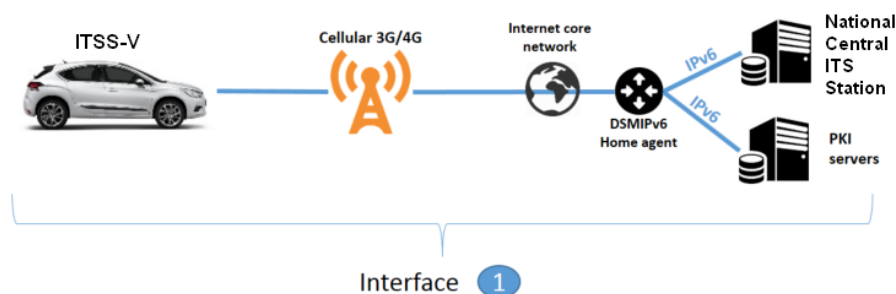


Figure 21: Interface One End-to-end IPv6 communication flow

| | |
|------------------------|---|
| Id | 241H- MOHA-0003 |
| Component(s) | Vru-ITS-S, C-ITS Vro-ITS-S |
| Requirement | The V-ITS-S shall communicate with the Nfr-ITS-S station through the interface One. |
| Additional information | The interface one relies on the two IP network entities: <ul style="list-style-type: none"> The private access network: It refers to 3G (HSPA) and 4G (LTE) cellular access technologies The IPv6 mobility Management entity: refers to the entity in charge of managing the seamless switching between the two IPv6 communication interfaces |

9.5.1.1 The private access network entity:

| | |
|--------------|-----------------------------|
| Id | 241H- MOHA-0004 |
| Component(s) | Vru-ITS-S, C-ITS, Vro-ITS-S |

| | |
|------------------------|---|
| Requirement | The V-ITS-S shall use the available 3G (HSPA) and 4G (LTE) cellular access technologies to access the internet core network. |
| Additional information | <p>For that, the V-ITS-S requires a SIM card to have access to such a private network.</p> <p>Upon configuration of the V-ITS-S IPv6 global address on the interface one, ITSS-V can communicate with the Nfr-ITS-S station for the envisioned SCOOP wave 2 services.</p> |

| | |
|------------------------|---|
| Id | 241H- MOHA-0005 |
| Component(s) | Vru-ITS-S, R-ITS-S, Vro-ITS-S |
| Requirement | Before using the cellular access technology, the V-ITS-S must first make sure to be not in the coverage area of an R-ITS-S where a sufficient RSSI level for the received RA on the SCH1 channel is detected. |
| Additional information | Multi-care of address is an option. Parameters for the RSSI Level are listed in 2.4.2.3_P_H. |

9.5.1.2 The IPv6 mobility Management Entity

| | |
|------------------------|--|
| Id | 241H- MOHA-0006 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | In order to ensure the V-ITS-S IPv6 seamless mobility, a network mobility Management entity is used. It enables transparent switching between the different access technologies at the networking layer. For that end and under this reference architecture, all the IPv6 communication flows from the V-ITS-S to the internet core network shall necessarily be routed through the Mobile IP Home Agent. |
| Additional information | |

9.5.2 Interface 2 and 6 – Technical requirements:

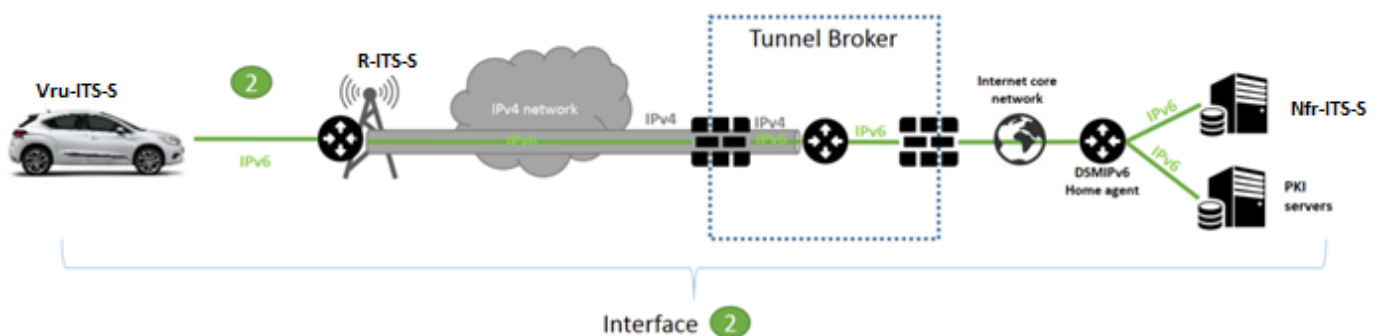


Figure 22: Interface 2 End-To-End IPv6 communication flow

| | |
|------------------------|--|
| Id | 241H- MOHA-0007 |
| Component(s) | Vru-ITS-S, C-ITS, Vro-ITS-S |
| Requirement | The V-ITS-S can communicate with the Nfr-ITS-S through the communication interface Two. |
| Additional information | The Interface 2 relies on the three following IP network entities: 1) The ITS access network entity: it refers to the IPv6 over 802.11p-SCH1 link between the V-ITS-S and the R-ITS-S. 2) The road operator private network entity: Refers to the road operators private |

network where the V-ITS-S IPv6 communication flow is routed and tunnelled to the internet core network

- 3) The IPv6 mobility Management Entity: refers to the entity in charge of managing the seamless switching between the two IPv6 communication interfaces.

9.5.2.1 The ITS access network entity:

The ITS access network communication link is made available by the Roadside unit through IPv6 over 802.11p as shown in the following figure:

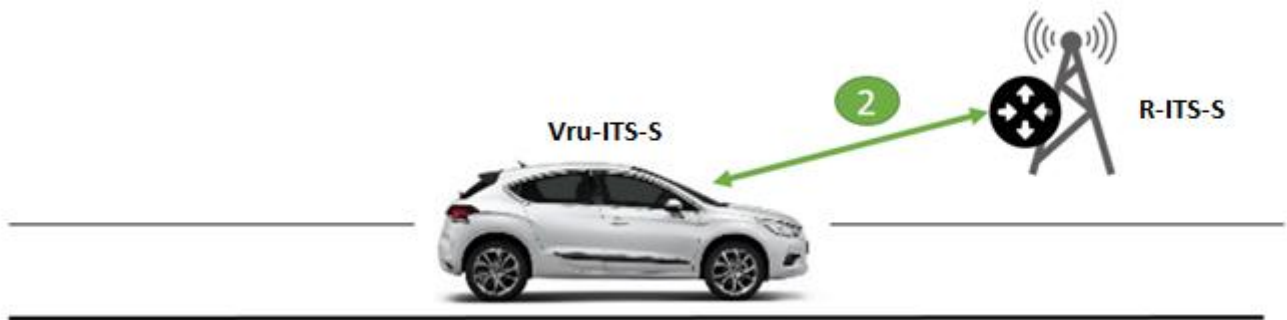


Figure 23:IPv6 acces by Roadside unit

| | |
|------------------------|---|
| Id | 241H- MOHA-0010 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The reference document for this interface is the draft-ietf-ipwave-ipv6-over-80211ocb-12. The V-ITS-S must follow the indications of the latter IETF draft. |
| Additional information | |

9.5.2.2 The ITSS-R IPv6 router:

| | |
|------------------------|--|
| Id | 241H-MOHA-011 |
| Component(s) | Vru-ITS-S, HA, R-ITS-S, Road operator network, Vro-ITS-S |
| Requirement | The R-ITS-S shall configure two IPv6 addresses on the 802.11p-SCH1 link: Link-local address in the fe80::/64 range Global address, following the IPv6 router global prefix range |
| Additional information | |

| | |
|--------------|--|
| Id | 241H-MOHA-012 |
| Component(s) | Vru-ITS-S, HA, R-ITS-S, Road operator network, Vro-ITS-S |
| Requirement | The R-ITS-S IPv6 router shall transmit periodically a router advertisement to the multicast group address ff02::1. |

| | |
|------------------------|--|
| Additional information | It is an ICMPv6 packet type 134. The R-ITS-S router advertisement contains the link local address of the router configured via EUI-64 algorithm, and the destination address set to ff02::1. |
|------------------------|--|

| | |
|------------------------|---|
| Id | 241H-MOHA-013 |
| Component(s) | Vru-ITS-S, HA, R-ITS-S, Road operator network, Vro-ITS-S |
| Requirement | Following the RFC 6275, the R-ITS-S IPv6 router shall transmit unsolicited multicast Router Advertisement each 100ms. |
| Additional information | The following flags are used: <ul style="list-style-type: none"> • A=1: for IPv6 address auto-configuration • M=0: for IPv6 address configuration, the host does not require the use of a DHCP server |

| | |
|------------------------|---|
| Id | 241H-MOHA-014 |
| Component(s) | Vru-ITS-S, R-ITS-S, Road operator network, Vro-ITS-S |
| Requirement | The Ethernet Type field in the Logical-link control header shall be set to 0x86dd to indicate that the frame transports an IPv6 packet. |
| Additional information | |

9.5.2.3 The ITSS-V host

| | |
|------------------------|---|
| Id | 241H-MOHA-015 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S host shall use the EUI-64 to configure the IPv6 addresses: <ul style="list-style-type: none"> • Link local IPv6 address • Global IPv6 address |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-MOHA-016 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S host cannot require sending frequently Router solicitation request. |
| Additional information | |

| | |
|--------------|---|
| Id | 241H-MOHA-017 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S can rely on the periodic unsolicited multicast RA sent by the R-ITS-S IPv6 router to configure its IPv6 global address. |

| | |
|------------------------|--|
| Additional information | |
|------------------------|--|

| | |
|------------------------|--|
| Id | 241H-MOHA-018 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S can use the Optimistic DAD for IPv6 address configuration as indicated in ISO 21210. |
| Additional information | |

9.5.2.4 The road operator private network entity

| | |
|------------------------|--|
| Id | 241H-MOHA-019 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | When the V-ITS-S is communicating with the Nfr-ITS-S through the Roadside unit, the IPv6 packets shall be routed via the R-ITS-S in the road operator private network. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOHA-020 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The IPv6 communication flow between the V-ITS-S and the Nfr-ITS-S shall be tunnelled in 6rd or IPsec between the R-ITS-S and the tunnel broker in the road operator private network. |
| Additional information | <p>The 6rd or IPsec tunnels are needed in order to allow IPv6 packets to be transmitted over the road operator IPv4 private network from the R-ITS-S to the tunnel broker.</p> <p>The tunnel broker defines the filtering rules which allows only the V-ITS-S IPv6 communication flows to be tunnelled in 6rd.</p> |

| | |
|------------------------|--|
| Id | 241H-MOHA-021 |
| Component(s) | R-ITS-S, Vro-ITS-S |
| Requirement | In order to ensure the correct functioning of the Interface 2 for the V-ITS-S, Road operators shall follow the specifications defined in the SCOOP wave 1, 2.4.1.5 'Network architecture of the SCOOP project for road operators'. |
| Additional information | |

9.5.2.5 IPv6 mobility Management Entity

| | |
|------------------------|---|
| Id | 241H-MOHA-022 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | To ensure the V-ITS-S IPv6 seamless mobility, a network mobility Management entity shall be used. It enables transparent switching between the access technologies at the networking layer. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOHA-023 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | For that end and under this reference architecture, all the IPv6 communication flows from the V-ITS-S to the internet core network shall necessarily be routed through the mobile IP Home Agent. |
| Additional information | |

9.5.3 Interface two - IPv6 communication flow with Internet Core Network entities

| | |
|------------------------|--|
| Id | 241H-MOHA-024 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall first make sure to be in the coverage area of an R-ITS-S with a sufficient RSSI level of the received RA on the SCH1 channel |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-MOHA-025 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall have an IPv6 Link-local address already configured before reaching the R-ITS-S coverage area. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-MOHA-026 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall send a Router Solicitation request or shall receive the unsolicited multicast RA from the R-ITS-S (IPv6 prefix and RDNSS) |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOHA-027 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall auto-configure its global address within IPv6 prefix range of the Router Advertisement |
| Additional information | Note: The process can be quickened by taking into account a prefix sent by using CAM-I. |

| | |
|------------------------|---|
| Id | 241H-MOHA-028 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall configure the IPv6 router gateway |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-MOHA-029 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S can use DAD if the ODAD mechanism is not used (Usage of ODAD is preferable) |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOHA-030 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | <p>The V-ITS-S shall configure the DNS server address</p> <p>If the DNSv6 server is in the local network</p> <p>The V-ITS-S must send a Neighbor Solicitation request to get the MAC address of the DNSv6 server</p> <p>The DNSv6 server sends a Neighbor advertisement response.</p> <p>If the DNSv6 is outside the local network, the V-ITS-S sends a DNS request which is routed by the R-ITS-S IPv6 router</p> |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-MOHA-031 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S can send requests to the DNS server to get the IPv6 addresses of the N-ITS-S and the PKI server. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-MOHA-032 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall exchange IPv6 communication flow with the correspondent internet services as envisioned in SCOOP wave 2. |
| Additional information | Upon reception of the IPv6 flow, the R-ITS-S router relies on its IPv6-IPv4 dual-stack to encapsulate the IPv6 flow over the road operator IPv4 network. This encapsulation relies on the permanently mounted 6rd tunnel between the R-ITS-S and the tunnel broker. |

| | |
|------------------------|---|
| Id | 241H-MOHA-033 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | Vru-ITS-S shall follow applicable IETF RFC standards. |
| Additional information | See deliverable 241_H bis_List of standarts |

9.5.3.1 Network Mobility

| | |
|------------------------|---|
| Id | 241H-NetM-0001 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The Home network of the V-ITS-S router can be the cellular network. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-NetM-0002 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | When the V-ITS-S router leaves the Home network, it shall configure a Care of Address (CoA) |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H-NetM-0003 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S router CoA shall be registered in HA following the Binding procedure. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-NetM-0004 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S router Binding Update shall contain the HoA (Home Address), Care Of address (CoA). |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-NetM-0005 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | It shall also contain the MNP (Mobile node prefix) registered in the Home Agent Binding cache. |
| Additional information | |

| | |
|--------------|--|
| Id | 241H-NetM-0006 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | All the traffic sent by the Nfr-ITS-S to the V-ITS-S shall be intercepted by the HA. |

| | |
|------------------------|--|
| Additional information | |
|------------------------|--|

| | |
|------------------------|--|
| Id | 241H-NetM-0007 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | All the traffic sent by the Nfr-ITS-S to the V-ITS-S must be forwarded to the V-ITS-S router (case of NEMO) or the MNN (Mobile network nodes). |
| Additional information | This latter is possible only if the Home Address of MNN is associated to Mobile Node Prefix. |

| | |
|------------------------|--|
| Id | 241H-NetM-0008 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | The IPv6 data traffic between the V-ITS-S router and the Nfr-ITS-S shall be encapsulated in bidirectional tunnels between the HA and the V-ITS-S router (Mobile Router). |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-NetM-0009 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | Upon reception of a Router advertisement from the R-ITS-S IPv6 router in the visited network and when the service context is favourable, the V-ITS-S must generate its CoA with stateless Auto-configuration |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-NetM-0010 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | The Vru-ITS-S router shall send a Binding Update to Home Agent with the following tuple information (CoA, HoA) |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-NetM-0011 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | The V-ITS-S router shall receive Binding acknowledgement from Home Agent |
| Additional information | Thus, a bidirectional tunnel is mounted between the V-ITS-S router and the HA. |

| | |
|------------------------|--|
| Id | 241H-NetM-0011 |
| Component(s) | Vru-ITS-S, HA, Vro-ITS-S |
| Requirement | <p>The mobility management functionalities must be implemented by the V-ITS-S router following the list of standards below:</p> <ul style="list-style-type: none"> • IETF RFC 3963: Network Mobility (NEMO) Basic Support Protocol • IETF RFC 5555: Mobile IPv6 support for Dual Stack Hosts and routers • IETF RFC 6089: Flow Bindings in Mobile IPv6 and Network Mobility (NEMO) Basic Support • IETF RFC 6275: BU/BA mobility support IPv6 • IETF RFC 5648: Multiple Care-of Address |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H-NetM-0012, Vro-ITS-S |
| Component(s) | Vru-ITS-S, HA |
| Requirement | In order to be compliant with the security and privacy objectives, the signalization exchanges between the V-ITS-S router and the Home Agent must be secured through IPsec Protocol. |
| Additional information | |

9.5.3.2 Mobile IPv6

| | |
|------------------------|---|
| Id | 241H- NetM-0013 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall support an implementation for mobile router with multiple radio interfaces available. |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- NetM-0014 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S network configuration shall ensure end-to-end IPv6 connectivity from the mobile router to the Home Agent (HA) which is located in the home network in the Network Operating Center (NOC). |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- NetM-0015 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S mobile router shall transparently manage communications across any kind of network, whatever it is in IPv4 or IPv6 protocol. |
| Additional information | The V-ITS-S mobile router is responsible of the network mobility management across the available communication links when NEMO tunnels are operated upon the 3G (HSPA)/4G (LTE) and 802.11p-SCH1 communication links. |

| | |
|------------------------|---|
| Id | 241H- NetM-0016 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | When different communication links are available, the V-ITS-S mobile router shall use MCoA (Multi-Care of Address protocol) to provide to the V-ITS-S host applications the capability to simultaneously transmit the application services streams on multiple links depending on the QoS required by the V-ITS-S applications. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H- NetM-0017 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall implement the required IPsec functionalities in order to secure the signalization exchanges between the V-ITS-S router and mobile IP Home Agent. |
| Additional information | |

9.5.3.3 IPv6 and IPv4

| | |
|------------------------|---|
| Id | 241H- NetM-0018 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall implement the basic functionalities of the IPv6 protocol. |
| Additional information | |

| | |
|--------------|--|
| Id | 241H- NetM-0019 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall implement the IPv6 functionalities to support mobility |

| | |
|------------------------|--|
| Additional information | |
|------------------------|--|

| | |
|------------------------|---|
| Id | 241H- NetM-0020 |
| Component(s) | Vru-ITS-S, Vro-ITS-S |
| Requirement | The V-ITS-S shall implement the functionalities of the IPv4 protocol. |
| Additional information | The IPv6 and IPv4 protocol must be interfaced only with the following access technologies: 802.11p-SCH1 3G (HSPA) and 4G (LTE) Cellular access technologies |

| | |
|------------------------|--|
| Id | 241H- NetM-0021 |
| Component(s) | V-ITS-S |
| Requirement | The IPv6 and IPv4 communication flows shall not have access to the 802.11p CCH channel |
| Additional information | |

10 Implementation Choices

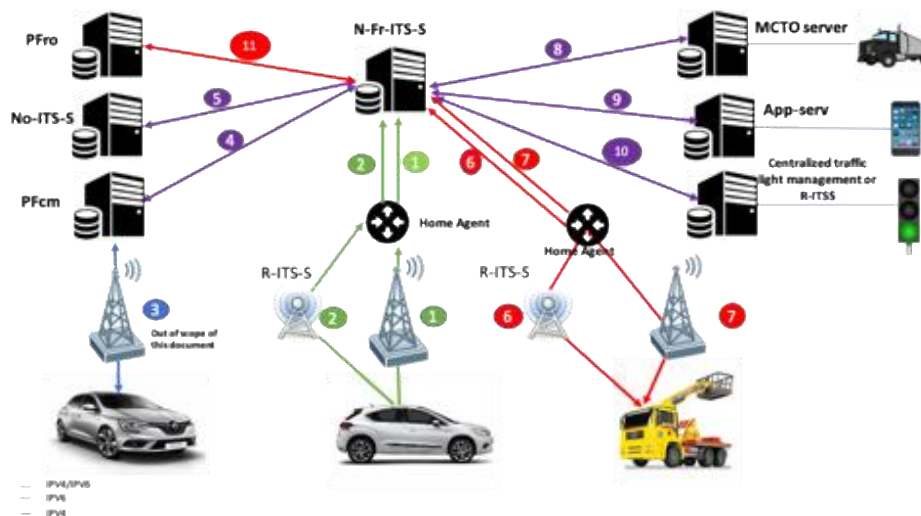


Figure 24: Overall view of interfaces

| | |
|------------------------|--|
| Id | 241H- ImpC-001 |
| Component(s) | all |
| Requirement | C ITS messages are secured by using signature at Geonet layer in all interfaces. |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H- ImpC-002 |
| Component(s) | Vru-ITS-S, Nfr-ITS-S |
| Requirement | Interface 1 shall respect: downlink: DENM IVI SPATEM MAPEM POI (ASN1 upper)/BTP/Geonet/TCP/IPV6/cellular (security at Geonet level) uplink: CAM et DENM (ASN1 upper)/BTP/Geonet/TCP/IPV6/cellular (security at Geonet level) implementation of DSMIP tunnel |
| Additional information | |

| | |
|--------------|--|
| Id | 241H- ImpC-003 |
| Component(s) | Vru-ITS-S, Nfr-ITS-S |
| Requirement | Interface 2 shall respect : • downlink: DENM IVI SPATEM MAPEM POI (ASN1 |

| | |
|------------------------|---|
| | <ul style="list-style-type: none"> upper)/BTP/Geonet/TCP/IPV6/802.11p (security at Geonet level) uplink: CAM and DENM (ASN1 upper)/BTP/Geonet/TCP/IPV6/802.11p (security at Geonet level) |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- ImpC-004 |
| Component(s) | Vru-ITS-S, Nfr-ITS-S |
| Requirement | <p>Interface 4 shall respect :</p> <ul style="list-style-type: none"> uplink: IF2 from InterCor/ DENM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) downlink: IF2 from InterCor / DENM IVI SPATEM MAPEM POI (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H- ImpC-005 |
| Component(s) | Nfr-ITS-S, No-ITS-S |
| Requirement | <p>Interface 5 shall respect :</p> <ul style="list-style-type: none"> InterCor specifications / DENM IVI SPATEM MAPEM POI (ASN1 UPPER)/AMQP/TCP/IPV4/ |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- ImpC-006 |
| Component(s) | Nfr-ITS-S, Vro-ITS-S |
| Requirement | <p>Interface 6 shall respect:</p> <ul style="list-style-type: none"> downlink: DENM IVI SPATEM MAPEM POI (ASN1 upper)/BTP/Geonet/TCP/IPV6 or IPV4/802.11p (security at Geonet level) uplink: CAM and DENM (ASN1 upper)/BTP/Geonet/TCP/IPV6 or IPV4/802.11p (security at Geonet level) |
| Additional information | |

| | |
|--------------|--|
| Id | 241H- ImpC-007 |
| Component(s) | Nfr-ITS-S, Vro-ITS-S |
| Requirement | <p>Interface 7 shall respect:</p> <ul style="list-style-type: none"> downlink: DENM IVI SPATEM MAPEM POI (ASN1 upper)/BTP/Geonet/TCP/IPV6 or IPV4/cellular (security at Geonet level) uplink: CAM et DENM (ASN1 upper)/BTP/Geonet/TCP/IPV6 or IPV4/cellular (security at Geonet level) |

| | |
|------------------------|---|
| | <ul style="list-style-type: none"> • implementation of DSMIP tunnel if using IPV6 link |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- ImpC-008 |
| Component(s) | Nfr-ITS-S, MCTO server |
| Requirement | <p>Interface 8 shall respect:</p> <ul style="list-style-type: none"> • uplink: IF2 from InterCor/ DENM POI ETA information (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) • downlink: IF2 from InterCor / DENM IVI POI ETA information (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) |
| Additional information | |

| | |
|------------------------|---|
| Id | 241H- ImpC-009 |
| Component(s) | Nfr-ITS-S, App-Serv |
| Requirement | <p>Interface 9 shall respect</p> <ul style="list-style-type: none"> • uplink: IF2 from InterCor/ DENM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) • downlink: IF2 from InterCor / DENM IVI SPATEM MAPEM POI (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H- ImpC-010 |
| Component(s) | Nfr-ITS-S, Centralized traffic light management, R-ITS-S |
| Requirement | <p>Interface 10 shall respect:</p> <ul style="list-style-type: none"> • uplink: IF2 from InterCor/ SPATEM, MAPEM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) |
| Additional information | |

| | |
|------------------------|--|
| Id | 241H- ImpC-011 |
| Component(s) | Nfr-ITS-S, PFro |
| Requirement | <p>Interface 11 shall respect :</p> <ul style="list-style-type: none"> • To NC-ITS: IVI (ASN1 UPPER) et DATEX/TCP/IPV4/IPV6 • To local platform: Datex/websocket/TCP/IPV4/IPV6 |
| Additional information | |

11 ANNEX: GeoNet structure

Interface 1, 2 and 4 are using GeoNet structure to be able to send signed messages.

For Hybrid communication, the transmitter will use Geonet structure the same way on ITS-G5 and cellular link.
The destination area will also be used by the national C-ITS-S.

Parameters needed are (based on version EN 302 636-4-1 V1.2.1 of the standard):

| Fields | Name | Value | Comment |
|---------------|----------|--------------------------|--|
| Basic Header | | | |
| 1 | Version | 0 | |
| 2 | NH | 2 | (1 without signature ou 2 with signature)/ 1 may be used for testing puposes. |
| 3 | Reserved | 0 | |
| 8 | LT | To format to have 60sec | ItsGnDefaultPacketLifetime = 60s |
| 9 | RHL | Automatically calculated | The National C-ITS will always set up the value egal to MHL (since it's the first emitter) |
| Common header | | | |
| 1 | NH | 2 | BTP-B |
| 2 | Reserved | 0 | |
| 3 | HT | 4 | Geobroadcast |
| 4 | HST | 0 | GEOBROADCAST_CIRCLE |
| 5 | TC | SCF | 0 |
| | | Channel Offload | 0 |
| | | TC ID | Depending on the Use Case |
| 6 | Flags | 0 | stationary |
| 7 | PL | automatically calculated | |
| 8 | MHL | 10 | |
| 9 | Reserved | 0 | |

| GBC extended header | | | |
|---------------------|---------------------|--------------------|---------------------------|
| 3 | SN | for each new event | |
| 4 | Reserved | 0 | |
| 5 | SO-PV | GN_ADDR | |
| | | | M |
| | | | ST |
| | | | SCC |
| | | | MID |
| | | TST | |
| | | Lat | |
| | | Long | |
| | | PAI | 0 |
| | | S | 0 |
| | | H | 0 |
| 6 | GeoAreaPosLatitude | | |
| 7 | GeoAreaPosLongitude | | |
| 8 | Distance a | Configurable | Depending on the use case |
| 9 | Distance b | 0 | |
| 10 | Angle | 0 | |
| 11 | Reserved | 0 | |

GeoNetworking Secured Packet are as specified in ^[11]_{SEP} ETSI TS 103 097.