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LIST OF ABBREVIATIONS

Acronym	Extended name
AV-ITS-S	Automated Vehicle ITS Station
NAP-SER	Application Server
BTP	Basic Transport Protocol
C2C-CC	Car2Car communications Consortium
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
C-ITS	Cooperative Intelligent Transport Systems
C-ITS-S	Cooperative Intelligent Transport Systems Station
DCC	Decentralised Congestion Control
DENM	Decentralized Environmental Notification Message
DP	DCC profile
DPID	DCC profile identifier
DSRC	Dedicated Short Range Communications
ETA	Estimated Time of arrival
GBC	Geo Broadcast
GN	Geo Networking
GPS	Global Positioning System
HST	Header Sub-Type
HT	Header Type
ITS	Intelligent Transport Systems
ITS-G5	<p>ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). ITS-G5 refers to the approved amendment of the IEEE 802.11 (standard IEEE 802.11p). This technology (possibly others) uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications.</p> <p>In this document ITS-G5 stands for IEEE802.11p/ETSI ITS-G5.</p>
IVI	Infrastructure to Vehicle Information
IVIM	Infrastructure to Vehicle Information Message
IVS	In-Vehicle Signalisation
ITS-S	Intelligent Transport Systems Station

Acronym	Extended name
LDM	Local Dynamic Map
LT	Lifetime
LTE	Long Term Evolution
MAP	Geometric information for the intersection
MAPEM	MAP (topology) Extended Message
NAP-SER	National APplication SERver
Nfr-ITS-S	French National Central ITSS
Nxx-ITS-S	National foreign Central ITSS
MHP	Maximum Hop limit
NH	Next Hop
OEM	Original Equipment Manufacturer
MCTO	Multi-Cargo Transport Optimisation
Pfro	Road Operator's Platform
PFcm	Service providerPlatform (can be owned by car manufacturer, road operator, public transport operator,....)
POI	Point of Interest
POIM	Point of Interest Message
PT-ITS-S	Public Transport V-ITS-S
Railway server	Server dedicated to level crossing services
RDNSS	Recursive DNS Server
R-ITS-S	Roadside ITS Station (RSU in the French Terminology)
RSP	Wi-Fi ITS-G5 Roadside System Profile (short also Roadside System Profile)
RSSI	Receiver Strength Signal Indicator
RWW	Roadworks Warning
s	Seconds
SCF	Store Carry Forward
SHB	Single-Hop Broadcast
SPAT	Signal Phase and Timing
SPATEM	Signal Phase and Timing Extended Message
TC	Traffic class
TCC	Traffic Control Centre

Acronym	Extended name
TMS	Traffic Management System
ToMS	Toll Management System
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	V2V and/or V2I
V-ITS-S	ITS-S of Vehicle (user or road operator)
Vpf-ITS-S	ITS-S of Vehicle linked to a Pfcmm
Vro-ITS-S	ITS-S-V Road Operator
Vru-ITS-S	ITS-S-V User

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 C-ITS CEF Project in France.

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 several projects since SCOOP@F, which deal only with IP communications and new use cases.

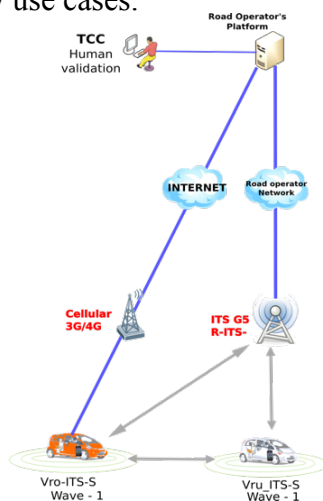


Figure 1 : Wave 1 functional architecture

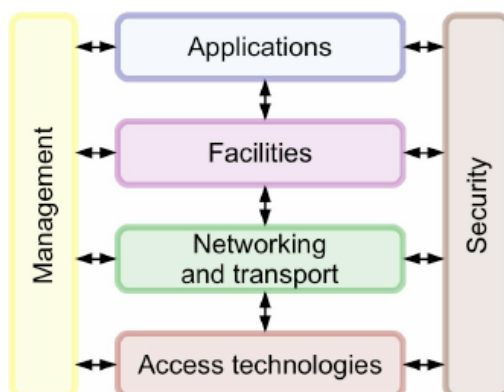


Figure 2 : ETSI ITS reference architecture

2. Functional architecture overview

Hybrid communications imply that C-ITS messages remain the same on long range and short range communications. For C-ITS-S there is no modification on application and facility layers between ITS-G5 and cellular. There might be however some differences linked to the network/transport and access layers.

Hybrid communications allow the use of cellular as a complement on roads not covered by short range.

Note: V-ITS-S refer to Vru-ITS-S, Vro-ITS-S, AV-ITS-S or PT-ITS-S

Id	241H-FUNA-001(1)
Component(s)	Organisation
Requirement	Short range and long-range technologies could be present at the same geographical place.
Additional information	

The architecture (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), MCTO 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.

Figure 3 represents the functional links between all actors of the C-ITS architecture. Flow are not represented on uplink and downlink, but only on a global view. Functional and technical of each new link and servers is described in following chapters.

Id	241H-FUNG-002(1)
Component(s)	Nfr-ITS-S
Requirement	The Nfr-ITS-S shall route C-ITS messages from a sender to a receiver through a global architecture using hybrid communications.
Additional information	

Id	241H-FUNG-003(1)
Component(s)	Nfr-ITS-S
Requirement	The Nfr-ITS-S can have additional functions as translation of C-ITS messages into DATEX II and vice-versa or aggregation CAM

Additional information

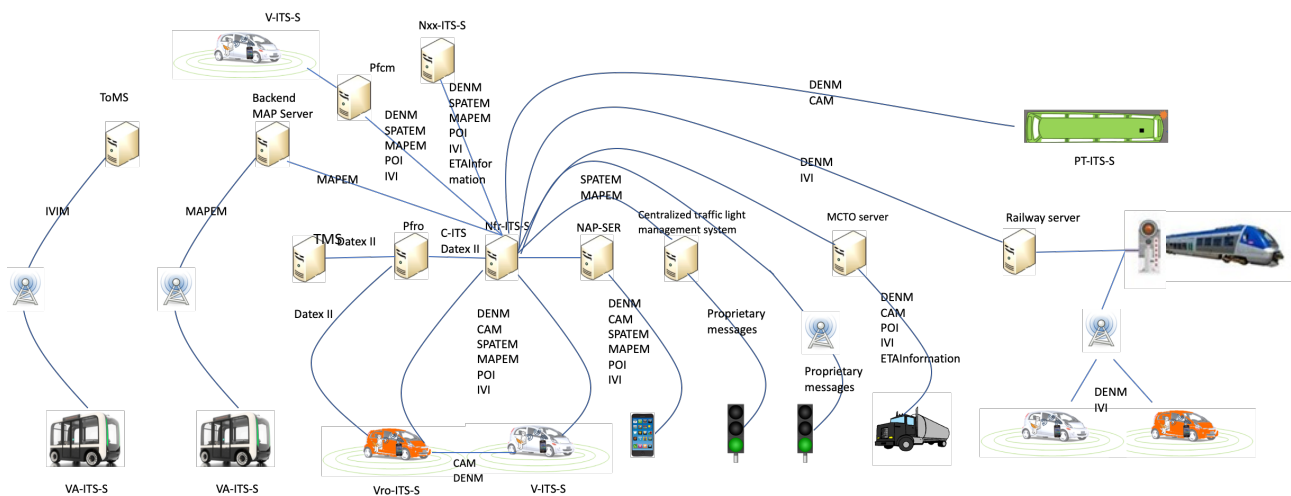


Figure 3 : Functional architecture

All elements from Figure 3 are described in following sections.

Id	241H-FUNG-004(1)
Component(s)	C-ITS-S
Requirement	C-ITS-S shall comply with EN 302665.
Additional information	

Id	241H-FUNG-009(1)
Component(s)	C-ITS-S
Requirement	C-ITS-S shall exchange signed messages within the common EU C-ITS trust domain i.e. under the same certificate policy.
Additional information	

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
AV-ITS-S	X	
Backend MAP server	X	

Centralized traffic light system (when connected to	X	
MCTO server	X	
NAP-SER	X	
Nfr-ITS-S	X	
Nxx-ITS-S	X	
Pfro		X
PFcm		X
PT-ITS-S	X	
Railway Server	X	
R-ITS-S	X	
TMS		X
ToMS		X
Vru-ITS-S	X	
Vro-ITS-S	X	

Table 1: List of C-ITS-S

Id	241H-FUNG-005(1)
Component(s)	C-ITS-S
Requirement	Each transmitter within the C-ITS trust domain shall be responsible of its own messages.
Additional information	

Id	241H-FUNG-007(1)
Component(s)	Nfr-ITS-S
Requirement	On the cellular link, the Nfr-ITS-S shall only sign road operator messages.
Additional information	

Id	241H-FUNG-008(1)
Component(s)	Nfr-ITS-S
Requirement	C-ITS messages signed by a third party shall only be forwarded without modifications.

Additional information	
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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.

Several Interfaces exist in this architecture and are described in chapter 11.

Id	241H-FUNC-001(1)
Component(s)	Vru-ITS-S, Vro-ITS-S, R-ITS-S, PT-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 V-ITS-S even if they are not in the range of an R-ITS-S (cf. Figure
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(1)
Component(s)	National ITS Station, Vru-ITS-S
Requirement	The National ITS Station shall exchange secured and trusted data in the form of valid C-ITS messages which are: CAM according to use cases requirements, DENM. IVIM (from National ITS Station to the V-ITS-S) SPATEM (from National ITS Station to the V-ITS-S) MAPEM (from National ITS Station to the V-ITS-S) POI message (from National ITS Station to the V-ITS-S) ETA (from National ITS Station to the V-ITS-S)
Additional information	CAM is only sent by Vru-ITS-S that do not communicate with Nfr-ITS-S via PfcM

3. Message Security

Id	241H-FUNG-001(1)
Component(s)	C- ITS Station
Requirement	C-ITS-S shall use security signature on GeoNetwork layer.
Additional information	The proposed architecture is compatible with security and privacy requirements of deliverables 2.4.4.8. The implementation specifications of the related features (e.g. protocols, key length...) are given in deliverable 2.4.4.8_M. In short range and long range Geonetwork layer is implemented the same

Id	241H-FUNS-002(6)
Component(s)	Nfr-ITS-S, R-ITS-S, VRO-ITS-S
Requirement	If a station creates and signs an ITS message (from a Datex or not) and the repetition time is greater than 10min, the ITS station must re-sign the
Additional information	

Id	241H-FUNS-003(2)
Component(s)	Nfr-ITS-S
Requirement	When the Nfr-ITS-S receives DENM, MAPEM, POI or IVIM already signed (and their repetitions), it shall store every 9 min the information so it can send them to vehicles.
Additional information	Nfr-ITS-S needs to keep every 9 min messages even if there are considered as duplicate messages.

Id	241H-FUNS-005(2)
Component(s)	Centralized traffic light management system
Requirement	Each time a MAPEM is created by the centralized traffic light management system, it shall be repeated each 9 min.
Additional information	

Id	241H-FUNS-007(1)
Component(s)	V-ITS-S
Requirement	Message types shall be differentiated using the indicated ITS-AID in the security header.
Additional information	In addition to 241H-FUNS-006

4. Dataflows

4.1. Nfr-ITS-S links

Id	241H-FunL-001(1)
Component(s)	Nfr-ITS-S, 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(1)
Component(s)	Nfr-ITS-S, Pfro
Requirement	The Nfr-ITS-S shall exchange data with the different Road Operator's Platform using C-ITS Datex II messages.
Additional information	C-ITS datex are defined in deliverable 2414.

Id	241H-FunL-003(2)
Component(s)	Nfr-ITS-S
Requirement	The Nfr-ITS-S shall convert Datex II into C-ITS messages. Note: The Road Operator's Platform also send Datex II to R-ITS-S. Note: R-ITS-S translate the Datex II message to C-ITS messages.
Additional information	

Id	241H-FunL-004(2)
Component(s)	Nfr-ITS-S

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(1)
Component(s)	Nfr-ITS-S, NAP-SER
Requirement	The Nfr-ITS-S shall exchange C-ITS messages with NAP-SER
Additional information	

Id	241H-FunL-007(1)
Component(s)	Nfr-ITS-S, 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 8 for more information on Glosa

Id	241H-FunL-008(1)
Component(s)	Nfr-ITS-S, PFcm
Requirement	Nfr-ITS-S shall exchange with PFcm C-ITS messages.
Additional information	Pfcm will forward messages to its V-ITS-S.

Id	241H-FunL-009(1)
Component(s)	Nfr-ITS-S, V-ITS-S
Requirement	Nfr-ITS-S shall exchange with V-ITS-S directly connected C-ITS messages
Additional information	

Id	241H-FunL-010(1)
Component(s)	Nfr-ITS-S, Backend MAP server, R-ITS-S
Requirement	Backend MAP server shall send MAPEM to Nfr-ITS-S and R-ITS-S.
Additional information	

Id	241H-FUNS-006(1)
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Component(s)	V-ITS-S
Requirement	<p>The Vehicles shall check the timestamp in the security header against the reception time and accept only CAMs in the last time of pSecCamPastToleranceTime and other messages within the last time of pSecMessagePastToleranceTime.</p> <p>with :</p> <ul style="list-style-type: none"> • pSecCamPastToleranceTime = 2 s, Maximum absolute time difference between the time in the security header of the Cooperative Awareness Message (CAM) and station clock to accept the CAM • pSecMessagePastToleranceTime = 10 min, Maximum absolute time difference between the time in security header of message (other than CAM) and station clock to accept the message
Additional information	

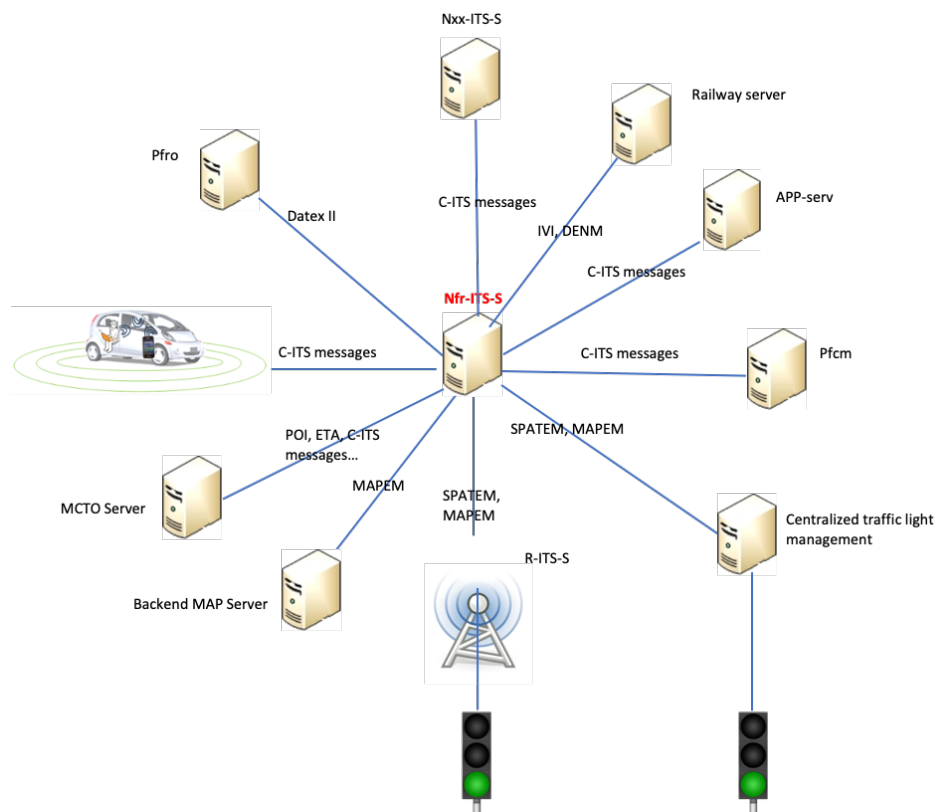


Figure 5: Data flow for the Nfr-ITS-S

4.2.V-ITS-S architecture

Id	241H-ARCH-001(1)
Component(s)	V-ITS-S

Requirement	OEM, road operator or public transport services can have different strategies on using 802.11p and/or cellular.
Additional information	

Id	241H-ARCH -002(1)
Component(s)	V-ITS-S
Requirement	They can choose to implement one of two possible architectures: Using a Car Manufacturer's Platform (section 4.2.1) Using an IP link between the Nfr-ITS-S and the V-ITS-S (section 4.2.2)
Additional information	

4.2.1. Architecture using a Car Manufacturer's Platform

4.2.1.1. Uplink flows

The work flow of data follows the sequence below:

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

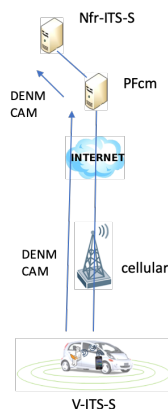


Figure 6 : Uplink flows Vru-ITS-S architecture with a Car Manufacturer platform

4.2.1.2. Downlink flows

The work flow of data follows the sequence below:

1. Nfr-ITS-S sends C-ITS messages to the PfcM.
2. After receiving C-ITS messages, PfcM sends these messages to relevant V-ITS-S.

3. The V-ITS-S of wave 2 receives C-ITS messages, and filters out non-relevant messages, and displays the relevant ones.

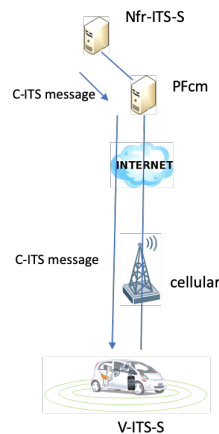


Figure 7: Downlink flows Vru-ITS-s architecture with Car Manufacturer's Platform

4.2.2. V2V communication through cellular link

Note: In the document, Hybrid communication designate either communication through PfcM.

Even in hybrid communication, vehicles can communicate with each other through the Nfr-Its-S. The work flow of data shall follow the sequence below (Figure 8):

1. V-ITS-S sends DENM to the Nfr-ITS-S through Car Manufacturer's Platform, as described in chapter 14 with uplinks scheme
2. The Nfr-ITS-S push to the Car Manufacturer's Platform all DENM, as described in chapter 4.2 with downlinks scheme.
3. Relevant V-ITS-S receives the message.

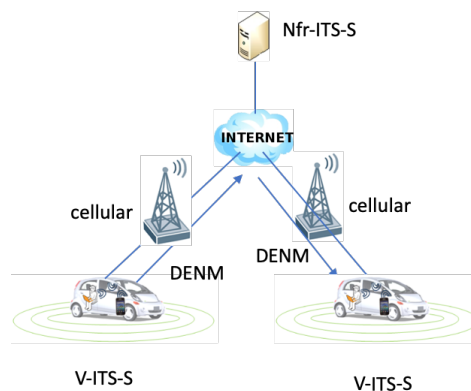


Figure 8 : Global flows for V2V communication via cellular.

4.3.Vro-ITS-S architecture

Id	241H-ARCH -003(3)
Component(s)	Vro-ITS-S

Requirement	Road operators can have different strategies on using 802.11p and/or cellular.
Additional information	

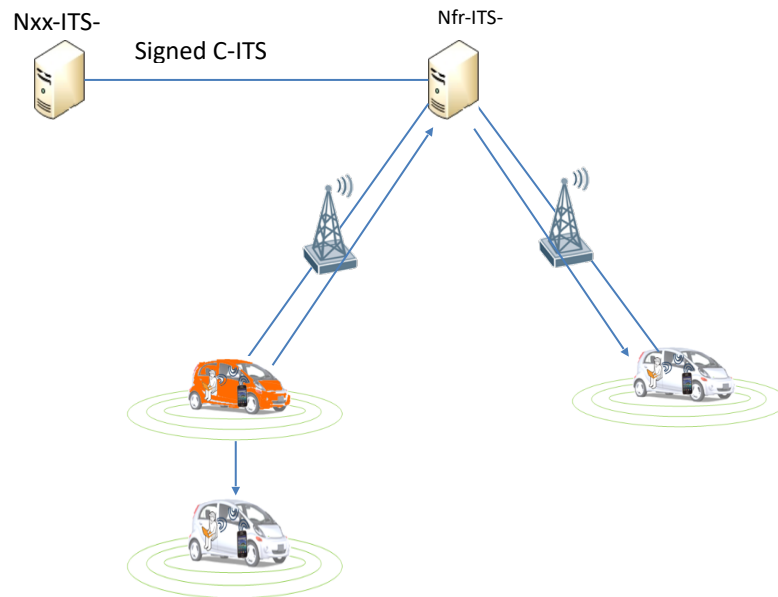


Figure 9: example of uplink flow for V-Ro-ITS-S

4.3.1. uplink flows

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.
2. Note: The R-ITS-S mode defined in 2422bis deliverable will work as defined in wave 1. Only DENM sent by the road operator vehicles are considered for hybrid communications.
3. Hybrid communication is based on IPV4.
4. The Nfr-ITS-S shall send the message to the relevant Vru-ITS-S.
5. The Nfr -ITS-S shall send the message to the relevant Foreign national ITS-S.

4.3.2. 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 is based on IPV4 Hybrid.

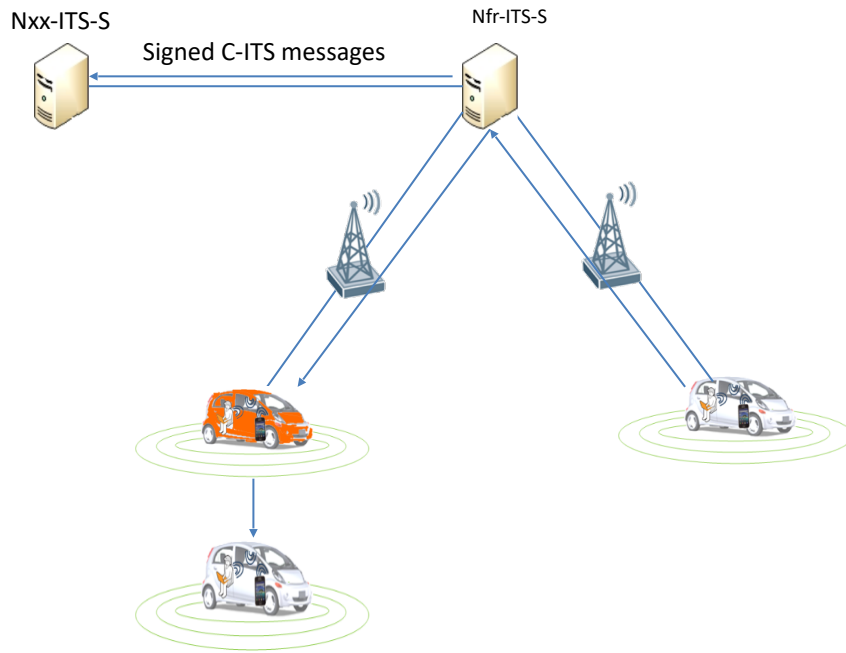


Figure 10: example of downlink flow for V-Ro-ITS-S

5. SPATEM/MAPEM Functional Architecture

GLOSA application implies a specific architecture due to the connection to traffic light. GLOSA application is based on SPATEM and MAPEM

Id	241H-GLOS -001(1)
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(1)
Component(s)	Road operators
Requirement	Road operators can decide to implement both solutions.
Additional information	

5.1.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-ITS-S 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 Nxx-ITS-S the current SPATEM and MAPEM.

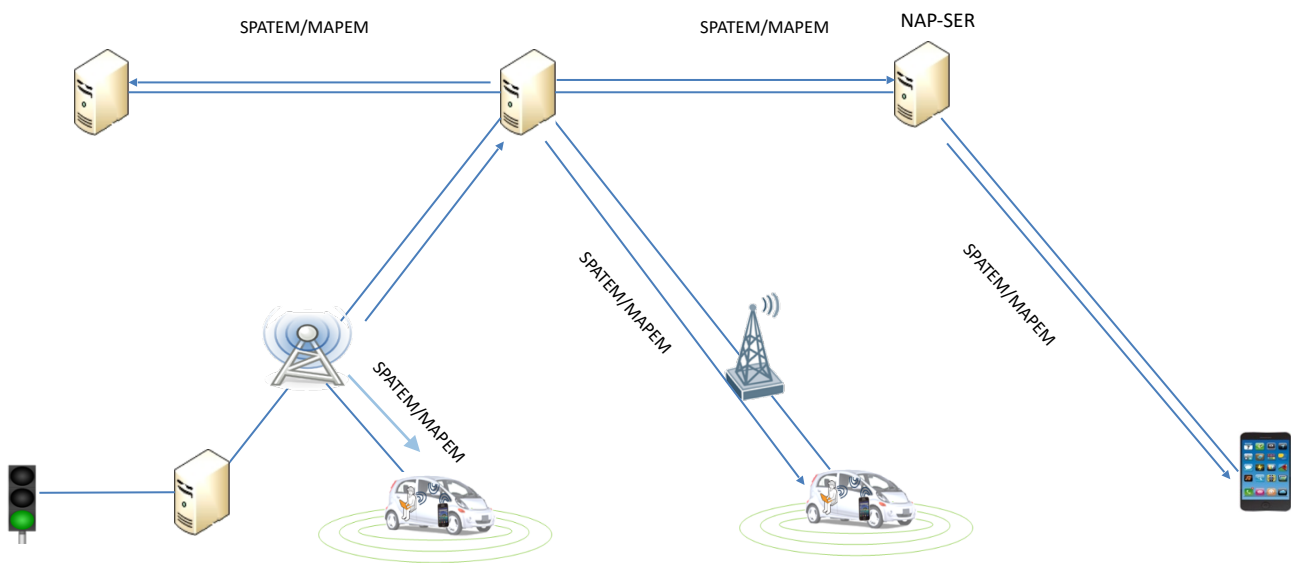


Figure 11: Glosa Architecture – local traffic light

5.2. 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 controller and corresponding SPATEM and MAPEM related to the intersection to the Nfr-ITS-S.
2. The centralized traffic light Management system send eventually to the R-ITS-S of concerned intersection. This one shall send the current SPATEM/MAPEM through ITS-G5.
3. The Nfr-ITS-S shall publish the current SPATEM and MAPEM.
4. The Nfr-ITS-S shall send to relevant server application the current SPATEM and MAPEM.
5. The Nfr-ITS-S shall send to relevant Nxx-ITS-S the current SPATEM and MAPEM.

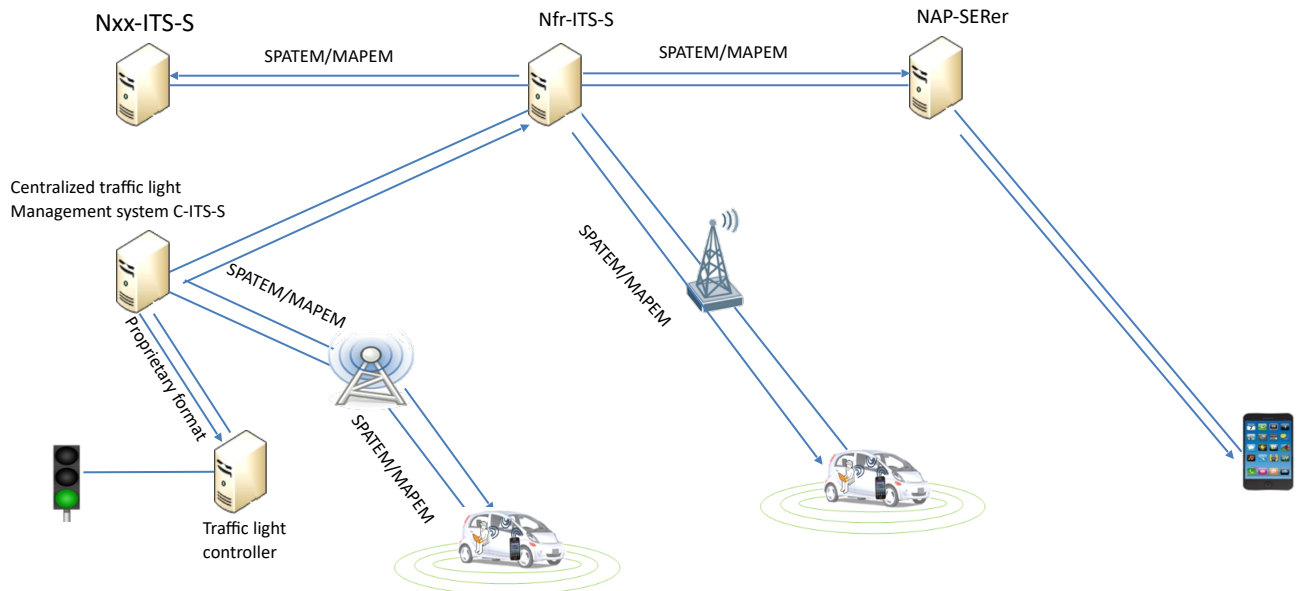


Figure 12: Glosa Architecture – centralized traffic light

6. Level crossing communication architecture

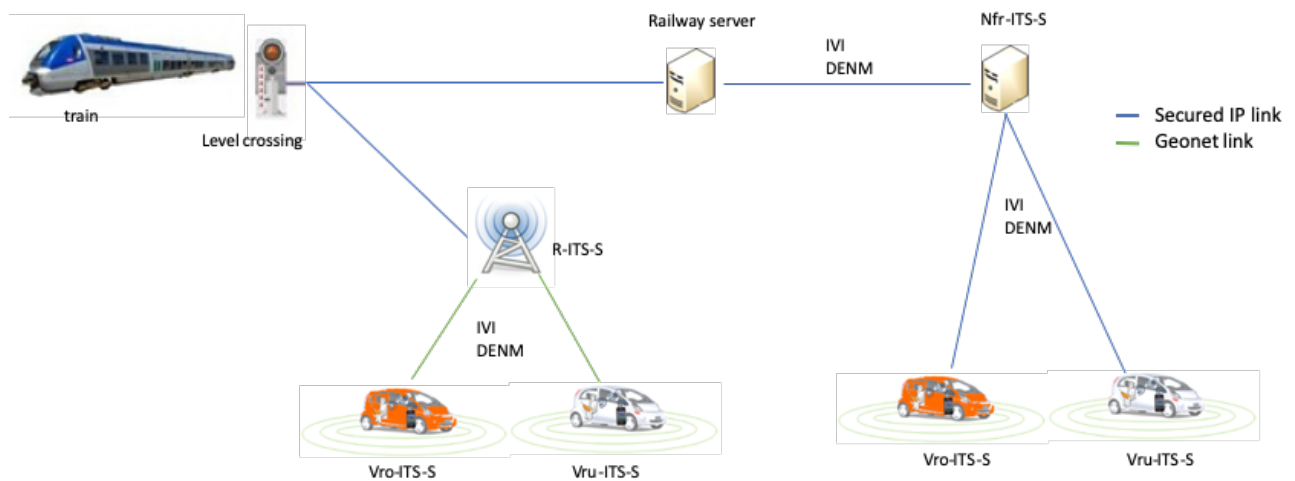


Figure 13: Rail crossing communication architecture

6.1. Information of level crossing state by DENM

The work flow of data shall follow the sequence below:

1. The R-ITS-S shall send through LTE to the SNCF server the corresponding DENM related to the intersection.
2. The R-ITS-S shall send through ITS-G5 the corresponding DENM related to the intersection.
3. The SNCF server shall send to the Nfr-ITS-S the corresponding DENM
4. The Nfr-ITS-S shall send to relevant V-ITS-S or PfcM the current DENM.
5. The Nfr-ITS-S shall send to relevant server application the current DENM.
6. The Nfr-ITS-S shall send to relevant Nxx-ITS-S the current DENM.

6.2. Information of level crossing characteristics by IVIM

The work flow of data shall follow the sequence below:

1. The R-ITS-S shall send through LTE to the SNCF server the corresponding IVIM related to the intersection..
2. The R-ITS-S shall send through ITS-G5 the corresponding IVIM related to the intersection.
3. The SNCF server shall send to the Nfr-ITS-S the corresponding IVIM
4. The Nfr-ITS-S shall send to relevant V-ITS-S or PfcM the current IVIM.
5. The Nfr-ITS-S shall send to relevant server application the current IVIM.
6. The Nfr-ITS-S shall send to relevant Nxx-ITS-S the current IVIM.

7. ToMS architecture

“Toll Station Approaching: Orientation of Automated Vehicles” is an I2V use case using only ITS-G5 to send IVIM to AV-ITS-S.

ToMS is directly linked to R-ITS-S (cf. Figure 16). The ToMS sends configuration and status of lanes to the R-ITS-S using Messages to be defined later following POC in order to allow the R-ITS to convert information in IVIM.

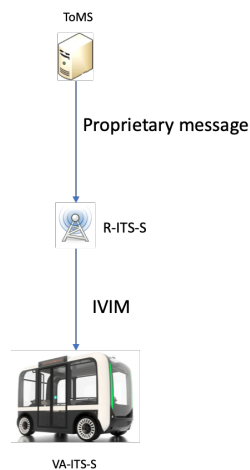


Figure 14: ToMS architecture without PfcM

Note: This architecture is for now specified only for ITS-G5. Studies are ongoing to integrate cellular communications into this architecture.

8. Sequence diagram

All messages exchanges are represented in the following sequence diagram.

As presented in section 4.2, a V-ITS-S can be a V-ITS-S or a Vpf-ITS-S (a vehicle linked to a PfcM).

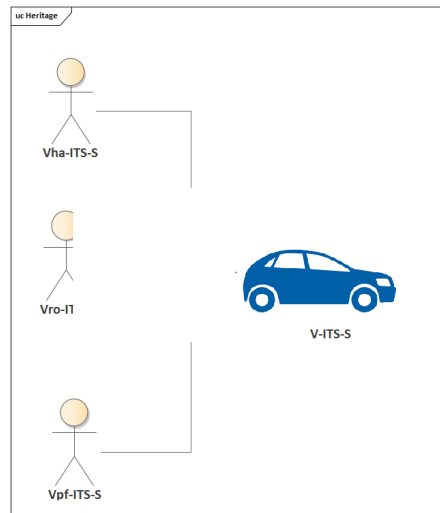


Figure 15: Sequence diagram for heritage

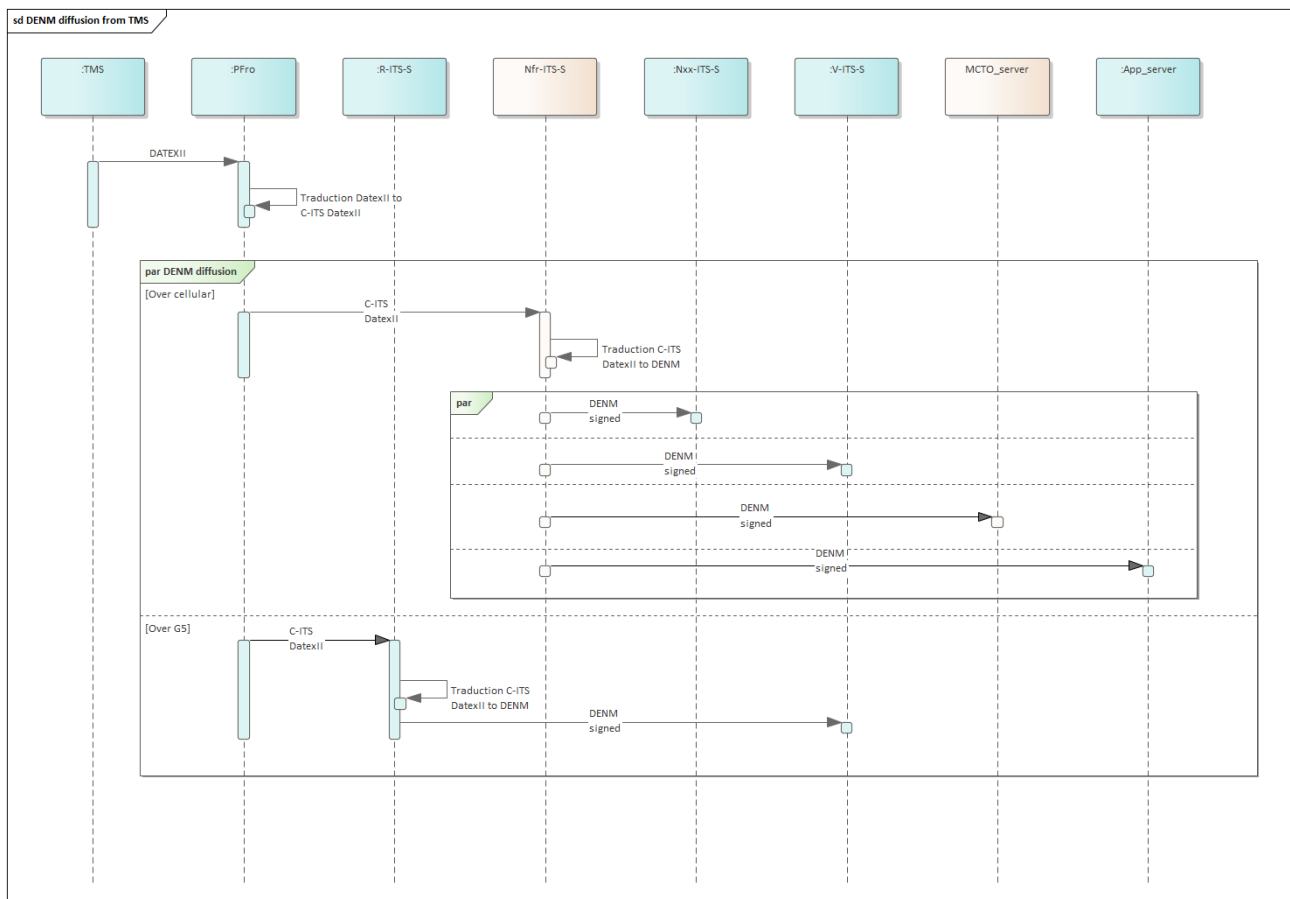


Figure 16: Sequence diagram for DENM diffusion from the TMS

Functionalities of the different actors are defined in :

- TMS: section 9.11
- Pfro : section 0
- R-ITS-S : section 9.9
- Nfr-ITS-S: section 9.1
- V-ITSS: section 0, section 9.6 and section 9.7

- App_server is described in section 9.4
- Technical specifications for
- Link between Nxx-ITS-S and Nfr-ITS-S are described in InterCor_M4-Upgraded-Specifications-Hybrid
- Link between R-ITS-S and Nfr-ITS-S are described in SCOOP_R-ITS-S specification_2.4.2.1_H
- Link between TMS and PFro are described in deliverable TCC Specification for C-ITS and COCSIC_2.4.3.2_H_roadoperator_platform
- Link between Pfro and Nfr-ITS-S are described in section 10.3.3 and in COCSIC_2.4.3.2_H_roadoperator_platform
- Technical specifications of
- Nfr-ITS-S are in deliverable COCSIC_2.4.2.4_H_Nfr-ITS-S
- Pfro are in COCSIC_2.4.3.2_H_roadoperator_platform
- R-ITS-S are in SCOOP_R-ITS-S specification_2.4.2.1_H
- V-ITS-S are in COCSIC_2.4.2.3_R_H_ and COCSIC_2.4.2.3_P_H
- App_server is in deliverable COCSIC_2.4.5.1 smartphone application
- MCTO server is described in deliverable 2.1.4.2_H MCTO
- Technical specifications for C-ITS messages are in COCSIC_2.4.2.1_H.
- Technical specifications for C-ITS Datex messages are in COCSIC_2.4.1.4_H_Specification of DATEX II v2.3 messages in conjunction with C-ITS messages

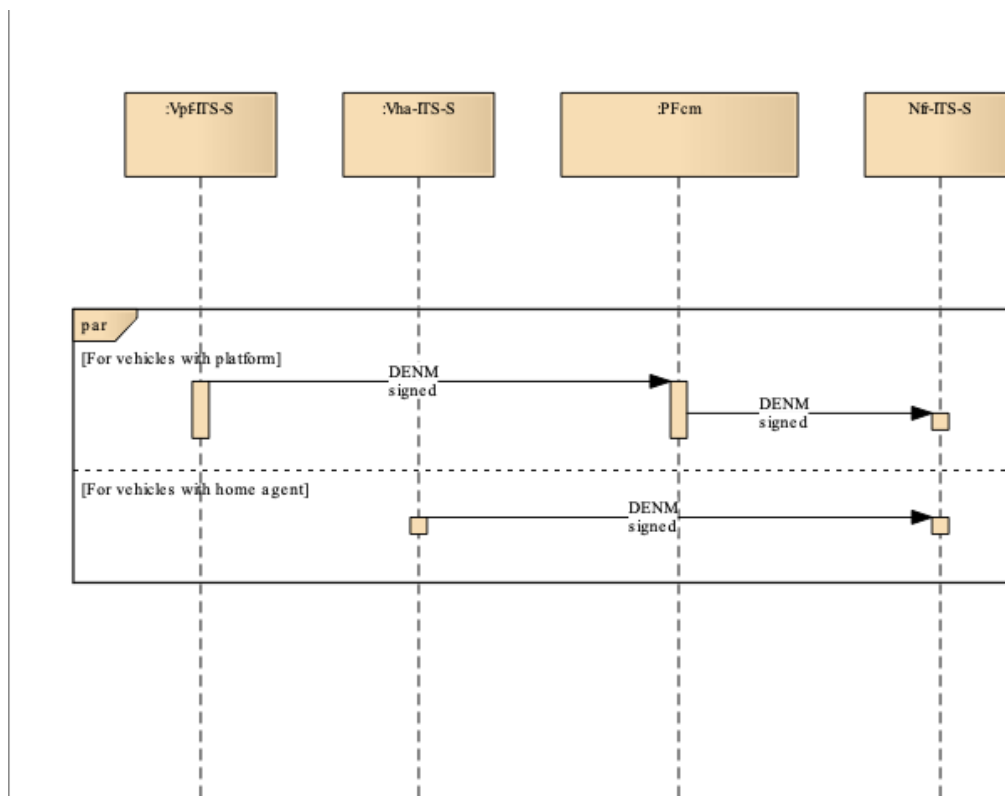


Figure 17: Sequence diagram for DENM diffusion for Vpf-ITS-S and Vha-ITS-S

Technical specifications for mobile IP link between the Vha-ITS-S and the Nfr-ITS-S is described in :

- section 10.3,
- section 11,
- section 12
- section 13.

Technical specification for link between PfcM-ITS-S and Nfr-ITS-S is described in :

- section 10.3.1
- section 11.2.2.

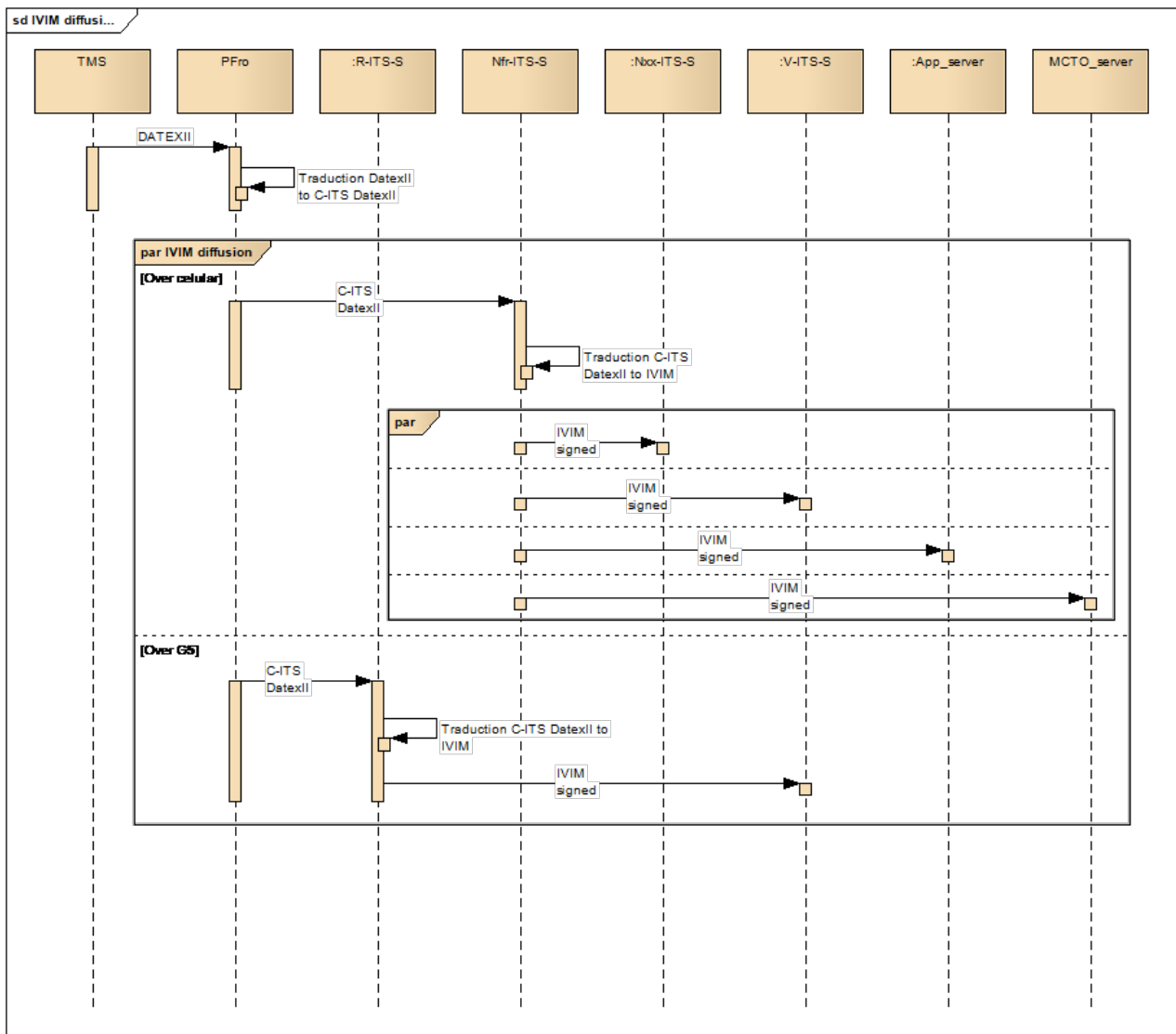


Figure 18: sequence diagram for IVIM diffusion from the TMS

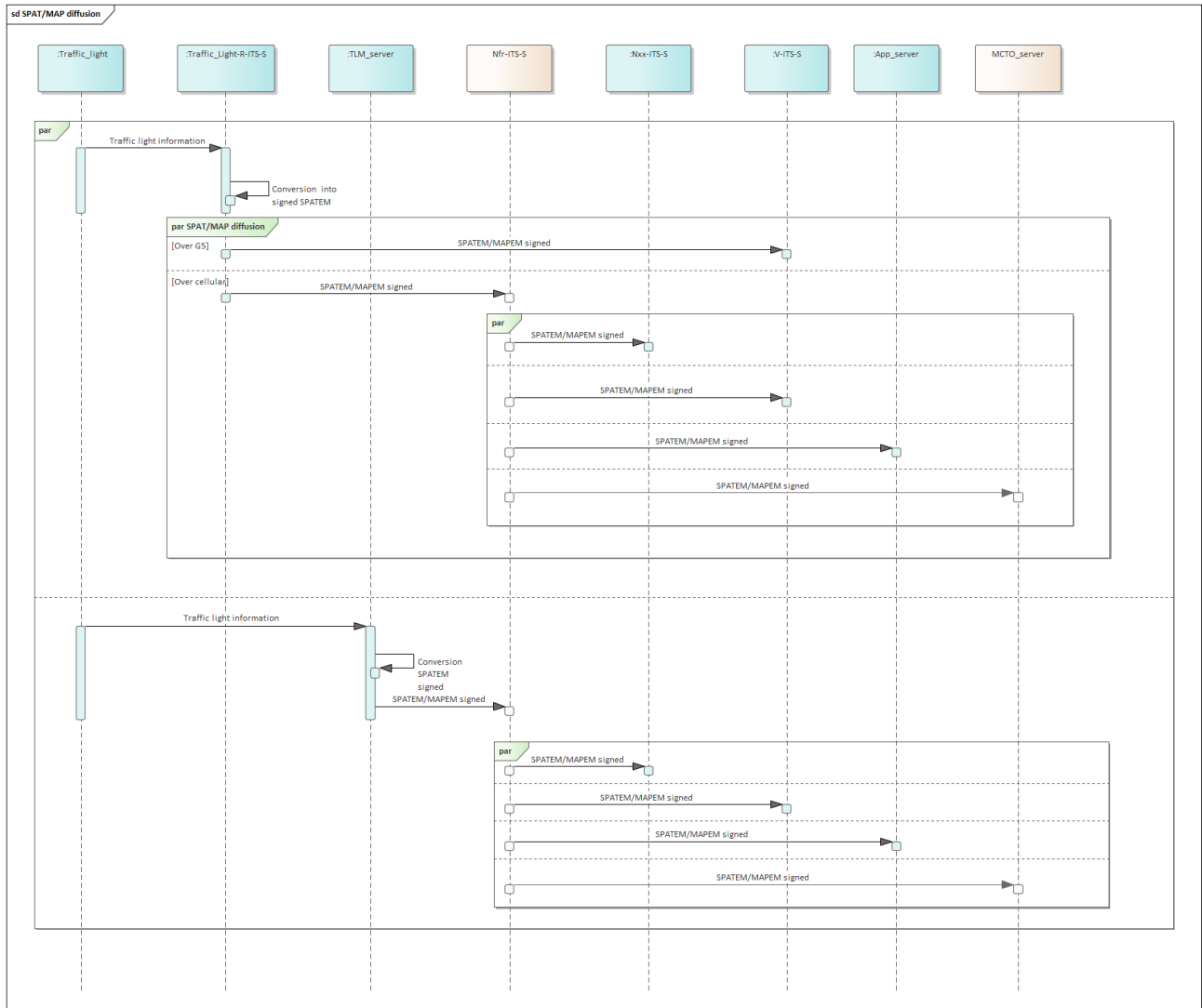


Figure 19: sequence diagram for SPATEM/MAPEM diffusion from the traffic light

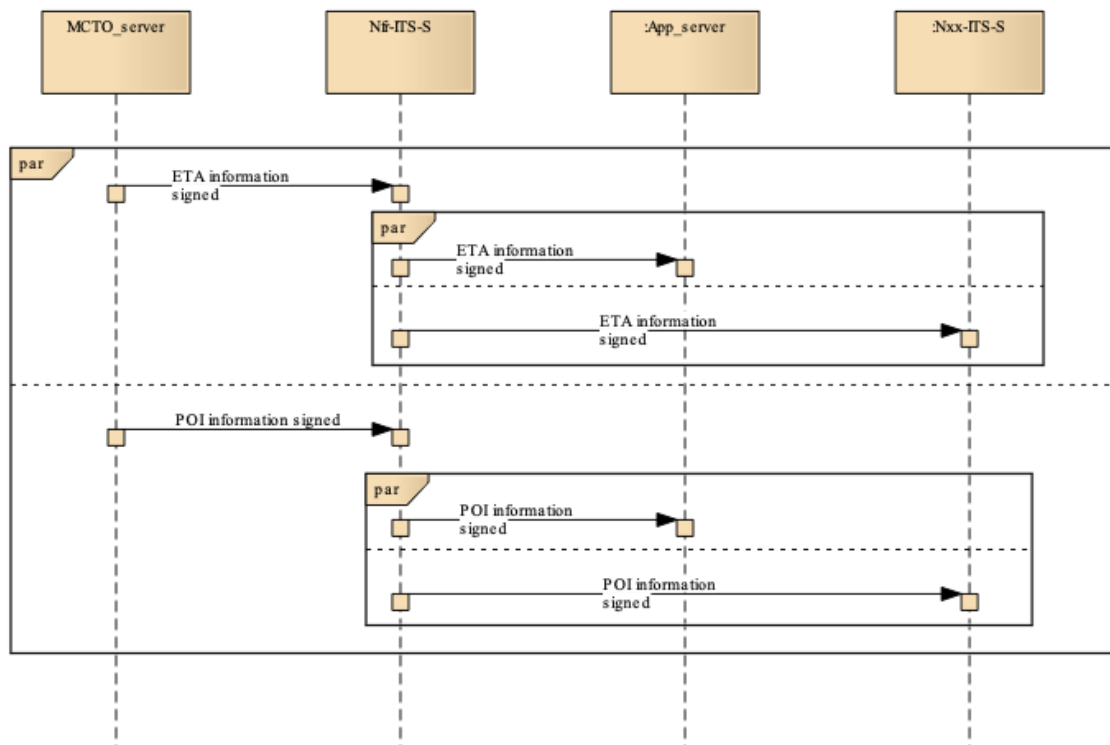


Figure 20: Sequence diagram for MCTO messages diffusion from the MCTO server

9. Functions of main components of the architecture

9.1.Nfr-ITS-S functions

Id	241H-FunN-001(1)
Component(s)	Nfr-ITS-S, C-ITS-S, PfcM
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(2)
Component(s)	Nfr-ITS-S
Requirement	The N-ITS-S shall receive different types of messages: IVIM, CAM, DENM, MAPEM, SPATEM, POI messages, ETA messages and Datex II
Additional information	

Id	241H-FunN-003(1)
Component(s)	Nfr-ITS-S and Nxx-ITS-S
Requirement	The Nfr-ITS-S shall exchange messages with Nxx-ITS-S.
Additional information	

Id	241H-FunN-004(1)
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	Not applicable for link through PfcM

Id	241H-FunN-005(2)
Component(s)	Nfr-ITS-S
Requirement	Vehicle position shall be erased after 241H-FunN-004 operation or after aggregation process of the position for Road operator services purpose.

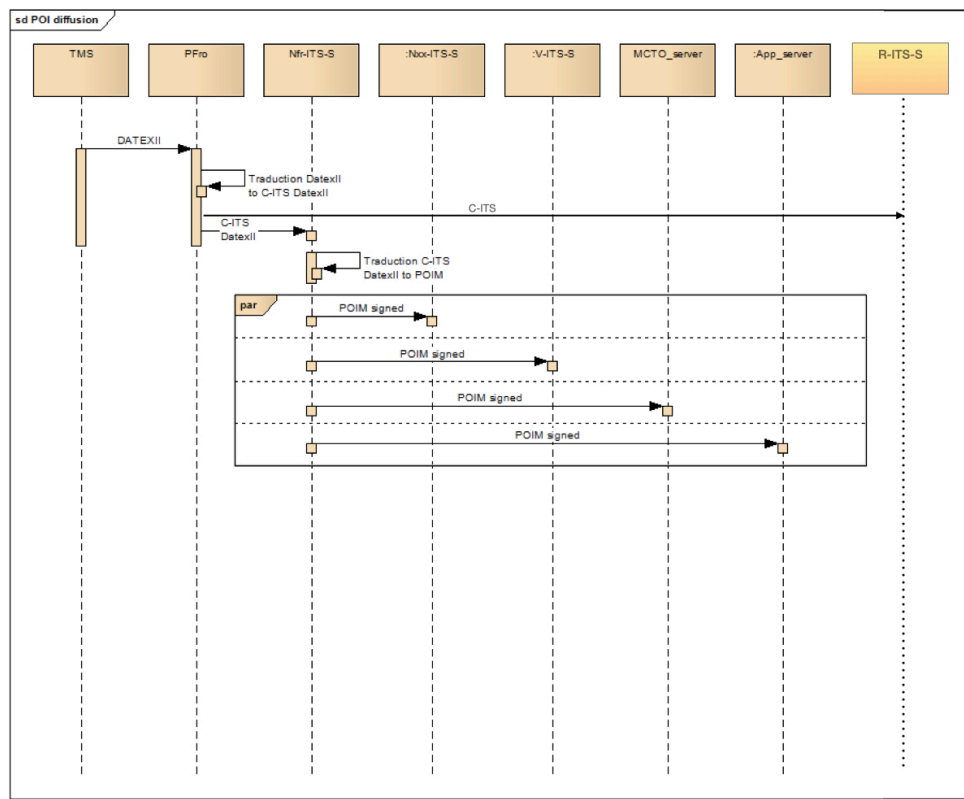


Figure 21: sequence diagram for POIM diffusion from the TMS

Id	241H-FunN-006(3)
Component(s)	Nfr-ITS-S
Requirement	The Nfr-ITS-S can use the position of V-ITS-S for road operator purpose: calculate travel time, speed..
Additional information	That function already exists in R-ITS-S and are described in SCOOP@F deliverables.

Id	241H-FunN-008(1)
Component(s)	Nfr-ITS-S, V-ITS-S
Requirement	The Nfr-ITS-S shall push information to V-ITS-S directly connected.
Additional information	

Id	241H-FunN-009(1)
-----------	-------------------------

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(1)
Component(s)	Nfr-ITS-S
Requirement	The Nfr-ITS-S shall forward the DENM to every relevant 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-013(1)
Component(s)	N-ITS-S
Requirement	The Nfr-ITS-S shall translate received DATEX II messages into DENM, POI messages or IVIM.
Additional information	This function will be described in deliverable 2.4.1.4_H.

Id	241H-FunN-014(2)
Component(s)	N-ITS-S
Requirement	The Nfr-ITS-S shall transmit MAPEM at the first inscription of a V-ITS-S (direct link) in the geographical database and then transmit only updates to avoid any network overload.
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 manoeuvres 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-FunN-015(1)
Component(s)	N-ITS-S
Requirement	The Nfr-ITS-S shall store MAPEM until it receives an update.
Additional information	

Id	241H-FunN-016(1)
Component(s)	Nfr-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(1)
Component(s)	Nfr-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
Additional information	Apply only to V-ITS-S directly connected to Nfr-ITS-S

Id	241H-FunN-018(1)
Component(s)	Nfr-ITS-S, Vro-ITS-S
Requirement	The Nfr-ITS-S shall exchange only C-ITS messages with Vro-ITS-S.
Additional information	

Id	241H-FunN-019(1)
Component(s)	Nfr-ITS-S, Nxx-ITS-S
Requirement	The Nfr-ITS-S shall exchange SPATEM and MAPEM on IP link between servers as defined in ETSI TS 103 301.
Additional information	

Id	241H-FunN-020(1)
Component(s)	Nfr-ITS-S
Requirement	Nfr-ITS-S shall push DATEX messages to relevant PFro.
Additional information	

Id	241H-FunN-021(1)
Component(s)	Nfr-ITS-S
Requirement	Nfr-ITS-S shall publish each MAPEM received from Backend MAP server.

Additional information	A backend Map server can be operate by service provider, road operator, etc...
Id	241H-FunN-022(1)
Component(s)	Nfr-ITS-S
Requirement	Nfr-ITS-S shall not send to a PFro a message received from another PFro.
Additional information	

9.2.Backend MAP server

Id	241H-FunM-001(1)
Component(s)	Backend MAP Server
Requirement	Backend MAP server shall send same MAPEM to the R-ITS-S and the Nfr-ITS-S.
Additional information	

Id	241H-FunM-002(1)
Component(s)	Backend MAP Server
Requirement	Backend MAP server shall built each MAPEM needed to be send.
Additional information	

9.3.Railway server Functions

Id	241H-FunRS-001(2)
Component(s)	railway server, Nfr-ITS-S
Requirement	The railway server shall exchange, through AMQP link, signed DENM and IVIM with the Nfr-ITS-S
Additional information	

9.4.Applications server Functions

Id	241H-FunAP-001(1)
Component(s)	Application server

Requirement	The application server shall store the received MAPEM until it receives an update (IntersectionGeometry.revision +1) of this one.
Additional information	The old one is erased.

Id	241H-FunAP-002(1)
Component(s)	Application server
Requirement	The application server shall transmit to relevant smartphones IVIM, DENM, SPATEM, MAPEM and POI messages.
Additional information	

9.5.V-ITS-S Functions

9.5.1. Function #1: message sending

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

Id	241H-FUNV-001(1)
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	Sending CAM through cellular doesn't apply to vehicles that use the PFcm.

Id	241H-FUNV-002(1)
Component(s)	V-ITS-S
Requirement	On cellular link, when V-ITS-S sends CAM, it 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(1)
Component(s)	V-ITS-S
Requirement	Forward of received messages from the Nfr-ITS-S should be implemented.
Additional information	

Id	241H-FUNV-004(1)
Component(s)	V-ITS-S
Requirement	V-ITS-S can receive through a hybrid link DENM, IVIM, SPATEM, MAPEM or POI messages.
Additional information	

9.5.2. Function #2: V2V via cellular link

Id	241H-FUNV-005(1)
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(1)
Component(s)	V-ITS-S
Requirement	The station ID of V-ITS-S shall periodically change.
Additional information	

9.5.3. Function #3: Security

Security objectives for V-ITS-S messages are integrity and authentication provided by signature using Authorization Ticket. Details are provided in deliverable 2.4.4.8 and 2.4.4.8_M.

Id	241H-FUNV-007(1)
Component(s)	V-ITS-S
Requirement	If the pseudo changes, then a CAM is sent on hybrid link without PfcM.
Additional information	See deliverable 2.4.2.3.P_H

9.5.4. Function #4: MAPEM

Id	241H-FunV-008(1)
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 SPATEM

9.6.Vro-ITS-S function

Id	241H-FURO-001(1)
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 of the vehicle and to be able to send relevant messages.

Id	241H-FURO-002(1)
Component(s)	Vro-ITS-S
Requirement	Messages received by Vro-ITS-S shall not be forwarded through hybrid link.
Additional information	

9.7.Pfcm functions

Pfcm is a server that can be used by road operator, public transport operator and car manufacturer.

Id	241H-FunR-001(1)
Component(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 including repetition from V-ITS-S.
Additional information	Security is defined in del. 2.4.4.8 and 2.4.4.8_M .

9.8.R-ITS-S functions

Id	241H-FuRS-007(1)
Component(s)	R-ITS-S
Requirement	If relevant, The R-ITS-S shall transmit each new MAPEM and SPATEM in
Additional information	

Id	241H-FuRS-008(1)
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(1)
Component(s)	R-ITS-S
Requirement	The R-ITS-S shall transmit ETA and POI over ITS-G5.
Additional information	

Id	241H-FuRS-010(1)
Component(s)	R-ITS-S, ToMS
Requirement	R-ITS-S shall convert messages received from ToMS and send them through ITS-G5.
Additional information	Between ToMS and R-ITS-S, only proprietary messages are exchanged. Following experimentations during the POC, messages could be defined.

Id	241H-FuRS-012(1)
Component(s)	R-ITS-S
Requirement	R-ITS-S shall send through ITS-G5 each MAPEM received from Backend MAP server.
Additional information	As the Backend MAP server is the originating station of the message, it is responsible of sending messages and repetitions to R-ITS-S. The R-ITS-S is only a forward station.

Id	241H-FuRS-013(1)
Component(s)	R-ITS-S

Requirement	R-ITS-S shall forward all signed messages received from the Backend Map Server
Additional information	As the Backend MAP server is the originating station of the message, it is responsible of sending messages and repetitions to R-ITS-S. The R-ITS-S is only a forward station.

Id	241H-FuRS-014(1)
Component(s)	R-ITS-S
Requirement	R-ITS-S shall be able to generate and transmit CAM (to support certificate requests) and those infrastructure messages (e.g. DENM, SPATEM, MAPEM, IVIM, SSEM) for the use cases it is intended to support.
Additional information	

Id	241H-FuRS-019(1)
Component(s)	R-ITS-S
Requirement	R-ITS-S shall transmit CAM to the Nfr-ITS-S if the road operator wants to transmit C-ITS-S messages from the Nfr-ITS-S through R-ITS-S.
Additional information	

Id	241H-FuRS-015(2)
Component(s)	R-ITS-S
Requirement	Roadside equipment (e. g. R-ITS-S) shall use the control channel CCH SCH 0 to send the messages it generates (DENM, IVIM if the automated vehicle container is not used, SPATEM, MAPEM, CAM, SSEM).
Additional information	

Id	241H-FuRS-016(1)
Component(s)	R-ITS-S

Requirement	Roadside equipment (e. g. R-ITS-S) shall use the service channel SCH 1 to send the IVIM containing the automated vehicle container. Note: This is relevant for the automated vehicle guidance use cases.
Additional information	
Id	241H-FuRS-017(2)
Component(s)	R-ITS-S
Requirement	Roadside equipment (e. g. R-ITS-S) shall use the service channel SCH1 2 to send the CPM.
Additional information	

Id	241H-FuRS-018(1)
Component(s)	R-ITS-S
Requirement	If service channels are used, the roadside equipment should announce the availability of the services on the service channels (e. g. CPS and/or IVIM AVG services) using the service announcement service according to EN 302 890-1 [36].
Additional information	

9.9.PFro Functionalities

Id	241H-FunP-001(1)
Component(s)	PFro, TMS
Requirement	The Road Operator's platform shall transmit and receive, only, DATEX II messages from/to the TMS.
Additional information	

Id	241H-FunP-002(1)
Component(s)	PFro, Nfr-ITS-S
Requirement	The Road Operator's platform shall transmit and receive, only, C-ITS DATEX II messages from/to the Nfr-ITS-S.
Additional information	

Id	241H-FunP-006(1)
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Component(s)	PFro
Requirement	The Road Operator's platform shall convert DATEX II messages into C-ITS DATEX II messages (Datex II with data element useful for C-ITS)
Additional information	See COCSIC 2.4.3.2_H _road operator platform
Id	241H-FunP-003(1)
Component(s)	PFro, Nfr-ITS-S
Requirement	PFro shall configure the connection with the Nfr-ITS-S: The URL of reception of C-ITS Datex II messages (including the corresponding port number). The URL of sending of C-ITS Datex II messages (including the corresponding port number).
Additional information	The security procedure: cf. deliverable 2.4.4.8 and 2.4.4.8_M.
Id	241H-FunP-004(1)
Component(s)	PFro
Requirement	PFro shall consider the Nfr-ITS-S as a source of information and transfer the information to the TMS.
Additional information	
Id	241H-FunP-005(1)
Component(s)	PFro, Nfr-ITS-S
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	
Id	241H-FunP-006(1)
Component(s)	PFro, Nfr-ITS-S
Requirement	PFro shall push all DATEX II messages to the Nfr-ITS-S.
Additional information	

9.11.TMS Functionalities

Id	241H-FunT-001(1)
Component(s)	TMS
Requirement	TMS shall exchange Datex II with PFro and Nfr-ITS-S related to C-ITS use cases.
Additional information	

9.12. Centralized traffic light management system

Id	241H-FuCT-001(1)
Component(s)	Centralized traffic light management system
Requirement	Centralized traffic light management system shall convert phase information into SPATEM
Additional information	

Id	241H-FuCT-002(1)
Component(s)	Centralized traffic light management system
Requirement	Centralized traffic light management system shall send SPATEM and MAPEM to Nfr-ITS-S and R-ITS-S
Additional information	

Id	241H-FuCT-003(1)
Component(s)	Centralized traffic light management system
Requirement	Centralized traffic light management system shall transmit on IP link MAPEM at R-ITS-S once and then only update.
Additional information	

9.13. Public Transport ITS-S

Id	241H-FuPT-001(1)
Component(s)	PT-ITS-S
Requirement	PT-ITS-S shall send C-ITS messages through cellular or ITS-G5 to others C-ITS-S.

Additional information	
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9.14.ToMS functionality

Id	241H-FUNC-003(1)
Component(s)	R-ITS-S, ToMS
Requirement	ToMS shall send in a proprietary message configuration and state of lanes of the toll station to R-ITS-S with the appropriate translation to make possible the IVIM creation by R-ITS-S (C-ITS-S).
Additional information	

10. Technical architecture

10.1. Geonetworking

Id	241H-GEON-001(1)
Component(s)	C-ITS-S
Requirement	Packet repetition shall not be performed by GN and the corresponding steps in the packet handling procedures in ETSI EN 302 636-4-1 [7] (clause 10.3) shall not be executed. The parameter 'Maximum repetition time' of the service primitive GN-DATA.request is not applicable. Also, the GN protocol constant itsGnMinPacketRepetitionInterval is not applicable.
Additional information	From RSP, MSP

Id	241H-GEON-002(1)
Component(s)	R-ITS-S, Nfr-ITS-S
Requirement	“Anonymous address” may be chosen for GN address configuration (itsGnLocalAddrConfMethod set to ANONYMOUS (2)) by roadside equipment (e.g. R-ITS-S) and Nfr-ITS-S.
Additional information	

Id	241H-GEON-003(1)
Component(s)	R-ITS-S, Nfr ITS-S
Requirement	“Roadside equipment shall use the following GeoNetworking packet header types as defined in EN 302 636-4-1 [7]: <ul style="list-style-type: none">- SHB on all CAM it generates.- GBC on all DENM, IVIM, SPATEM, MAPEM, SREM, SSEM it generates.
Additional information	

10.2. Communication profiles

Section 4.2 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. Figure 25 describes each possible communication link between C-ITS-S and will be detailed in next sections.

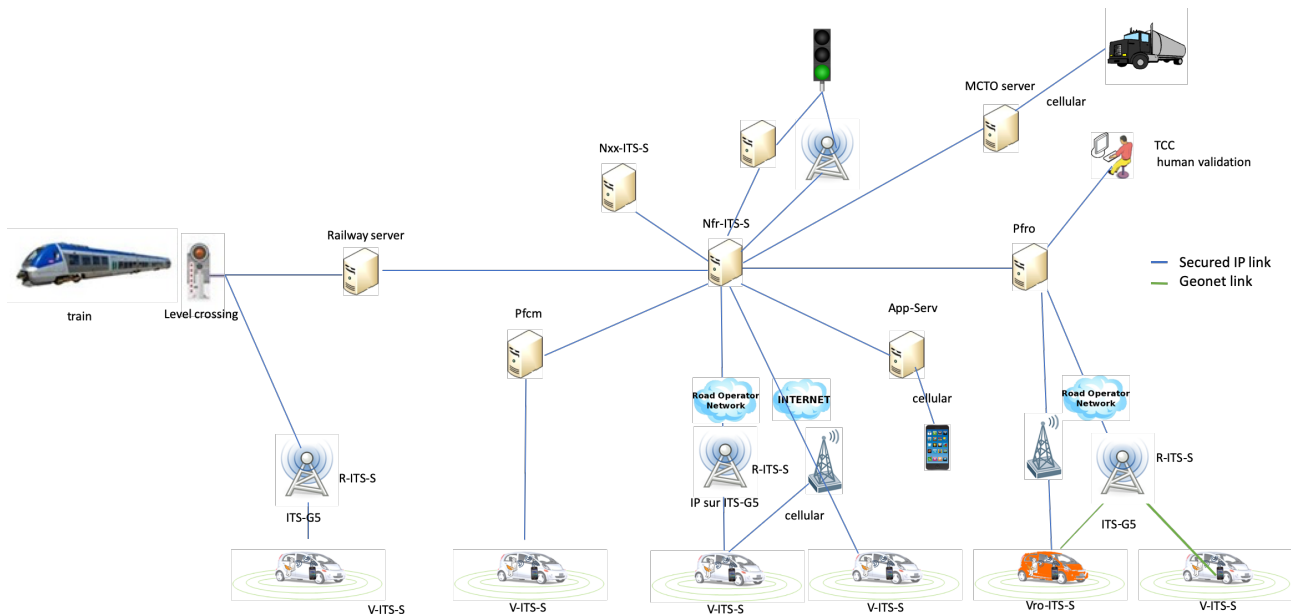


Figure 21 : Global ITSS links view

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 SCH 0
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
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Table 2: Communication Profiles

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

Cas d'usage	Profil
DENM	CP1-CP11-CP15
CAM	CP1-CP11
IVIM	CP1-CP11- CP15
POI	CP11- CP15
ETA	CP11-CP15
Security	CP2-CP5
SPATEM	CP1-CP11- CP15
MAPEM	CP1-CP11- CP15
DATEX	CP15-CP16

Table 3: Communication Profiles by Messages

10.3.Network architecture

Id	241H-NETA-001(2)
Component(s)	C-ITS-S, Pfro, Pfcem
Requirement	The different stakeholders (PT-ITS-S, Vro-ITS-S, Vru-ITS-S, PFro, Nfr-ITS-S, R-ITS-S) can belong to separated administrative entities
Additional information	

Id	241H-NETA-002(2)
Component(s)	Nfr-ITS-S, V-ITS-S, R-ITS-S
Requirement	Functions described in Figure 26 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 26 and will be detailed in the following sections

10.4.Interconnection

Figure 22 represents all interfaces which are described in this section. Interfaces 1, 2, 6 and 7 are IP based. 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 for car manufacturers in 2.4.2.3R-H.

All vehicles in Figure 22 can communicate on ITS G5 with each other and with R-ITS-S; these interfaces are not indicated in this deliverable because they were integrated in deliverable 2.4.1.1 M.
 Nota: PT-ITS-S is an V-ITS-S and can use either Interfaces 1, 2 or 3 and 4.
 Note: V-ITS-S refer to Vru-ITS-S, Vro-ITS-S or PT-ITS-S

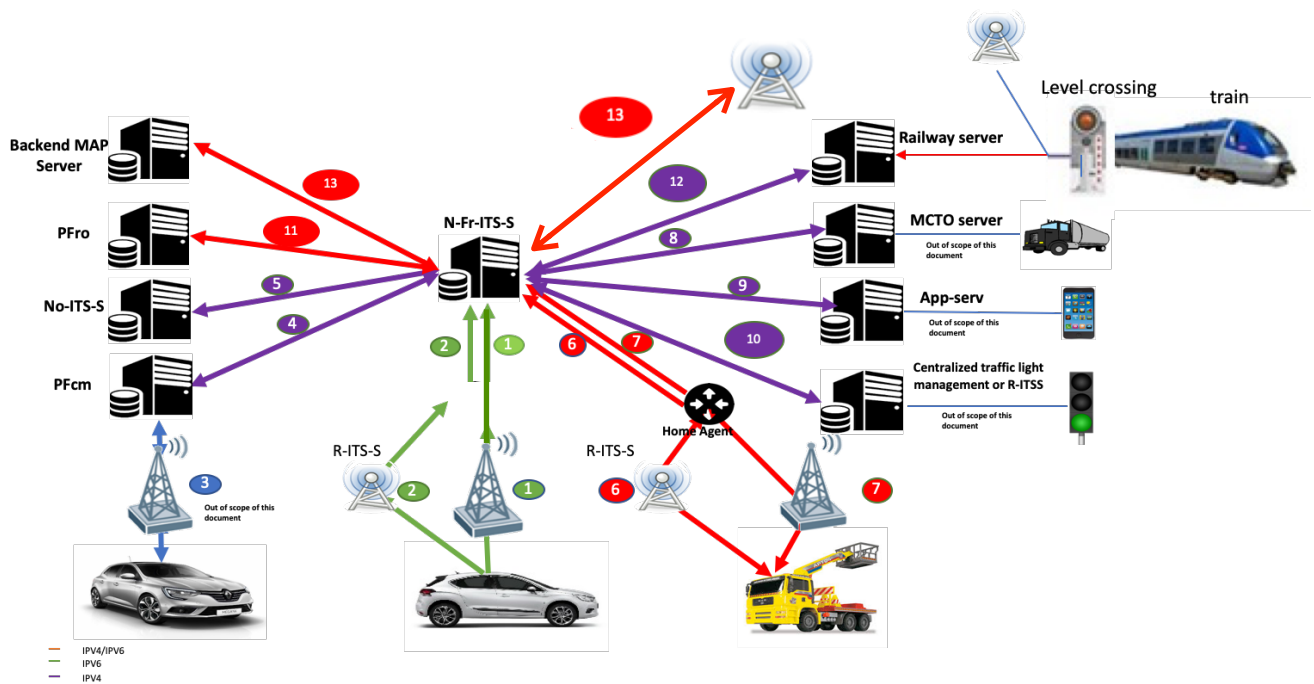


Figure 22: *Interfaces definition*

10.4.1.For IP interfaces between servers or R-ITSS linked to traffic light (4, 5, 8, 9,10, 12 and 13)

Id	241H-INT1-008(2)
Component(s)	Nfr-ITS-S, Nxx-ITS-S, Vru-ITS-S, MCTO server, NAP-SER, Centralized traffic light management, R-ITSS, railway server, Backend MAP server
Requirement	IPV4 should be used.
Additional information	

10.4.2.For interface with the Pfro (11)

Id	241H-INT1-010(1)
Component(s)	Nfr-ITS-S, PFro
Requirement	TCP over IPv4 should be used on dedicated port.
Additional information	One specific port is used for C-ITS Datex II.

Id	241H-INT1-012(1)
Component(s)	Nfr-ITS-S, PFro
Requirement	Messages between Nfr-ITS-S and PFro are not signed; But the link shall be secured.
Additional information	See deliverable 2.4.4.8 and 2.4.4.8_M.

11.Interface description

11.1.General description

Id	241H-INT2-001(2)
Component(s)	Nfr-ITS-S, Vru-ITS-S, Vro-ITS-S, R-ITS-S, Pfro, PfcM, MCTO server, NAP-SER, centralized traffic light management server, railway server, Backend MAP server
Requirement	Each Interface shall respect communication profiles described in Table 4: .
Additional information	Project implementation choices are described in chapter 14

Interface Number	Access	Network	Transport	Application layer OSI	Data uplink	Data downlink
1	cellular	IPV4	TCP	Websocket	DENM/CAM	DENM/IVIM/POIM/SPATEM/MAPEM
2	802.11p SCH1	IPV4	TCP	Websocket	DENM/CAM	DENM/IVIM/POIM/SPATEM/MAPEM
4		IPV4	TCP	AMQP	DENM	DENM/IVIM/POIM/SPATEM/MAPEM
5		IPV4	TCP	AMQP	DENM/IVIM/SPATEM/MAPEM/POIM/ETAinformationM	DENM/IVIM/SPATEM/MAPEM/POIM/ETAinformation
6	802.11p SCH1	IPV4	TCP	websocket	DENM/CAM	DENM/CAM/POIM
7	cellular	IPV4	TCP	websocket	DENM/CAM	DENM/CAM/POIM
8		IPV4	TCP	AMQP	POI/CAM	DENM/IVIM/POIM/POISlotReferenceStatusM / POIM notification for Dockslot /SPATEM, MAPEM
9		IPV4	TCP	AMQP	DENM/CAM	DENM/IVIM/POIM/SPATEM/MAPEM
10		IPV4	TCP	AMQP	SPATEM/MAPEM	
11		IPV4	TCP	websocket	DatexII V2.3	DatexII V2.3
12		IPV4	TCP	AMQP	DENM, IVIM	DENM/IVIM
13		IPV4	TCP	websocket		MAPEM

Table 4: Communication Profiles by Interfaces

11.2. Message format

11.2.1. For Interface using mobileIP (1, 2, 6 and 7)

Id	241H-INT2-002(2)
Component(s)	Nfr-ITS-S, Vru-ITS-S, R-ITS-S, Vro-ITS-S, MCTO server, centralized traffic light management
Requirement	All messages shall be composed of ASN.1 encoded Useful data (using unaligned PER), as defined in the ITS-G5 profiles (for DENM, IVIM and CAM, POIM, SPATEM, MAPEM, ETA information)
Additional information	

Message Repetition

Id	241H-INT2-006(1)
Component(s)	C-ITS-S
Requirement	In cellular link, C-ITS-S shall repeat messages, at least every 9 min for DENM and IVIM.
Additional information	

CAM frequency see 9.5.1.

11.2.2. For Interface with servers and R-ITS linked to a traffic light (4, 5, 8, 9, 10 and 12)

Id	241H-INT2-004(2)
Component(s)	Nfr-ITS-S, Nxx-ITS-S, Vru-ITS-S, PFro, MCTO server, NAP-SER, Centralized traffic light management, R-ITSS, railway server
Requirement	Interface 4, 5, 8, 9, 10 and 12 shall respect interface described in [0] in order to exchange information for all technical aspect unless messages format and security.
Additional information	See Table 5 for AMQP application properties content common to all C-ITS Messages. For added elements in DENM, IVIM, Spatem, Mapem see [0]
Id	241H-INT2-005(1)
Component(s)	Nfr-ITS-S, Vru-ITS-S, MCTO server, NAP-SER, Centralized traffic light management, R-ITSS
Requirement	Format for C-ITS messages shall include geonet secured header.

Additional information

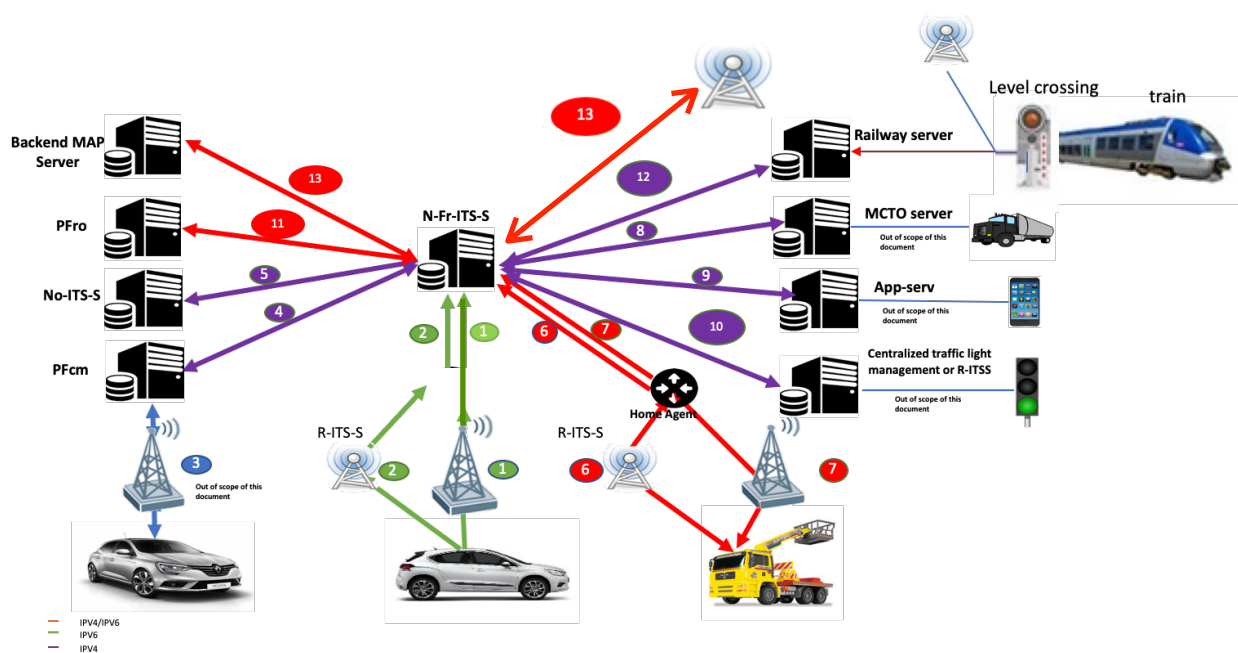
Name	Value and type	Description	Mandatory/Optional
publisherId	string A two-letter country code (based on ISO 3166-1 alpha-2 [8]) and a numerical identifier (value between 0 and 16383 including leading zeroes) based on ISO 14816:2005 [9] (same as used for providerIdentifier in IVIM),	Unique ID of the publisher. It is Linked to the country where the provider wants to register. It could be in one country or several.	M
publicationId	String Concatenation of publisherId and a unique identifier for the dataset/publication with a ":" between, e.g. "DE15608:IVIM_BERLIN_067" or "NO73944:679ABX92"	publisherId defined in table 1. Each dataset/publication identifier needs to be unique for the given publisher. When using the II, the publicationId shall uniquely identify a single capability entry.	O (Mandatory when using II, see chapter 4)
originatingCountry	string Country code (based on ISO 3166-1 alpha-2 [8])	Country code where the C-ITS message is created	M
protocolVersion	string E.g. "DENM:1.3.1" or "IVIM:1.2.1"	Represent the version of standard used to create the message, i.e. for DENM the version of ETSI EN 302 637-3 [12], for IVIM, SPATEM the version of ETSI TS	M
serviceType	string Comma separated list starting and ending with a comma E.g. ",HLN-RLX," or ",SI-GLOSA,SI-SPTI,"	Acronym of C-ITS use case(s) defined in latest version of Common C-ITS Service and Use Case Definitions [16]	O

baselineVersion	String E.g. "1.8.0"	The baseline version indicates which release of the C-Roads specifications were used to create the C-ITS message	O
messageType	string DENM, IVIM, SPATEM, MAPEM, SREM, SSEM, CAM	For this version of the specification the string shall be one of the following: DENM, IVIM, SPATEM, MAPEM, SREM, SSEM, and CAM. The list may be subject to changes in future versions of the specification	M
longitude	float Decimal degrees According to WGS84/ EPSG:4326	Longitude of the event published; for DENM (eventPosition) and for IVI and SPATEM/MAPEM/SSEM/SREM	O
latitude	float Decimal degrees According to WGS84/ EPSG:4326	Latitude of the event published; for DENM (eventPosition) and for IVI and SPATEM/MAPEM/SSEM/SREM	O
quadTree	string Comma separated list of quadtree tiles starting and ending with a comma, e.g. ",202320120232120101," (single value) or ",202320120232120101,202320120232120102,202320120232120103," (multiple values chained)	Relevant spatial index location of the C-ITS message	M

shardId	integer	The shard number of the current message if sharding is enabled for the capability for the message. <u>The id starts at 1 and the highest id is equal to the shardCount</u> . See appendix G “Sharding” for more	O (but mandatory if sharding is enabled by message producer)
shardCount	integer	Defines the amount of shards for the capability. See appendix G “Sharding” for more details.	O (but mandatory if sharding is enabled by message producer)

Table 5: AMQP Application Properties Content for Interface With Servers and R-ITS Linked to a Traffic Light (4 5, 8, 9 and 10) for all Messages

Detailed specifications of format messages are in C-ITS IP based interface profiles deliverable from the C-roads Platform.



12.Implementation Choices

Id	241H- NetM-020(2)
Component(s)	V-ITS-S
Requirement	The V-ITS-S shall implement the functionalities of the IPv4 protocol.
Additional information	The 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-021(2)
Component(s)	V-ITS-S
Requirement	The IPv4 communication flows shall not have access to the 802.11p SCH 0 channel
Additional information	

Id	241H- ImpC-001(1)
Component(s)	C-ITS-S
Requirement	C-ITS messages are secured by using signature at Geonet layer in all
Additional information	

Id	241H- ImpC-002(2)
Component(s)	VITS-S, Nfr-ITS-S
Requirement	Interface 1 shall respect: downlink: DENM IVIM SPATEM MAPEM POIM (ASN1 upper)/BTP/Geonet/TCP/IPV4/cellular (security at Geonet level) uplink: CAM et DENM (ASN1 upper)/BTP/Geonet/TCP/IPV4/cellular (security at Geonet level)
Additional information	

Id	241H- ImpC-003(2)
Component(s)	V-ITS-S, Nfr-ITS-S
Requirement	Interface 2 shall respect : downlink: DENM IVIM SPATEM MAPEM POIM (ASN1 upper)/BTP/Geonet/TCP/IPV4/ITS-G5 (security at Geonet level) uplink: CAM and DENM (ASN1 upper)/BTP/Geonet/TCP/IPV4/ ITS-G5 (security at Geonet level)
Additional information	

Id	241H- ImpC-004(3)
Component(s)	V-ITS-S, Nfr-ITS-S
Requirement	Interface 4 shall respect : <ul style="list-style-type: none"> • uplink: DENM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) • downlink: DENM IVIM SPATEM MAPEM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level)
Additional information	AMQP 0.9 is implemented -

Id	241H- ImpC-005(2)
Component(s)	Nfr-ITS-S, Nxx-ITS-S
Requirement	Interface 5 shall respect : DENM IVIM SPATEM MAPEM POIM (ASN1 UPPER)/AMQP/TCP/
Additional information	AMQP 1.0 is implemented to be in line with C-ROADS specifications. AMQP 0.9 will be supported until all actors migrate to AMQP 1.0.

Id	241H- ImpC-006(1)
Component(s)	Nfr-ITS-S, Vro-ITS-S

Requirement	Interface 6 shall respect: <ul style="list-style-type: none"> • downlink: DENM IVIM SPATEM MAPEM POIM (ASN1 upper)/BTP/Geonet/TCP/IPV4/802.11p (security at Geonet level) • uplink: CAM and DENM (ASN1 upper)/BTP/Geonet/TCP/IPV4/802.11p (security at Geonet level)
Additional information	

Id	241H- ImpC-007(1)
Component(s)	Nfr-ITS-S, Vro-ITS-S
Requirement	Interface 7 shall respect: <ul style="list-style-type: none"> • downlink: DENM IVIM SPATEM MAPEM POIM (ASN1 upper)/BTP/Geonet/TCP/IPV4/cellular (security at Geonet level) • uplink: CAM et DENM (ASN1 upper)/BTP/Geonet/TCP/IPV4/cellular (security at Geonet level)
Additional information	

Id	241H- ImpC-008(2)
Component(s)	Nfr-ITS-S, MCTO server
Requirement	Interface 8 shall respect: <ul style="list-style-type: none"> • uplink: DENM POIM ETA information (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) • downlink: DENM IVIM POIM ETA information (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level)
Additional information	AMQP 1.0 is implemented to be in line with C-ROADS specifications. AMQP 0.9 will be supported until all actors migrate to AMQP 1.0.

Id	241H- ImpC-009(2)
Component(s)	Nfr-ITS-S, NAP-SER
Requirement	Interface 9 shall respect <ul style="list-style-type: none"> • uplink: DENM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level) • downlink: DENM IVIM SPATEM MAPEM POIM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level)
Additional information	AMQP 1.0 is implemented to be in line with C-ROADS specifications. AMQP 0.9 will be supported until all actors migrate to AMQP 1.0.

Id	241H- ImpC-010(1)
Component(s)	Nfr-ITS-S, Centralized traffic light management, R-ITS-S

Requirement	Interface 10 shall respect: <ul style="list-style-type: none"> uplink: SPATEM, MAPEM (ASN1 UPPER)/AMQP/TCP/IPV4/ (security at Geonet level)
Additional information	AMQP 1.0 is implemented to be in line with C-ROADS specifications. AMQP 0.9 will be supported until all actors migrate to AMQP 1.0.

Id	241H- ImpC-011(1)
Component(s)	Nfr-ITS-S, PFro
Requirement	Interface 11 shall respect : To Nfr-ITS-S: IVIM (ASN1 UPPER) et DATEX II/ websocket/TCP/IPV4 To PFro: Datex II/websocket/TCP/IPV4
Additional information	

Id	241H- ImpC-005(1)
Component(s)	Nfr-ITS-S, railway server
Requirement	Interface 12 shall respect : <ul style="list-style-type: none"> DENM IVIM (ASN1 UPPER)/AMQP/TCP/IPV4/
Additional information	AMQP 1.0 is implemented to be in line with C-ROADS specifications. AMQP 0.9 will be supported until all actors migrate to AMQP 1.0.

Id	241H- ImpC-012(1)
Component(s)	Nfr-ITS-S, Backend MAP server
Requirement	Interface 13 shall respect : To Nfr-ITS-S: MAPEM/ websocket/TCP/IPV4
Additional information	

13.ANNEX: GeoNet structure

All Interfaces for C-ITS messages 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 Nfr-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 = 600s
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	3 for Vru-ITSS and 10 for Nfr-ITS-S, Vro-ITS-S and R-ITS-S	
9	Reserved	0	

GBC extended header			
3	SN	for each new packet	
4	Reserved	0	
5	SO-PV	GN_ADDR	
			M
			ST
			SCC
			MID
		TST	
		Lat	
		Long	
		PAI	
		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	

Table 6: Geonet Parameters

itsGnStationType is set with the identical value of the station type contained in the C-ITS message.

GeoNetworking *Secured Packet* are as specified in ETSI TS 103 097 v1.2.1

14.ANNEX Data flow of Road operator messages

Vro-ITS-S have two operational mode:

- “Work mode” where DENM sent are related to the road work done by the worker,
- User mode

In both cases, a R-ITS-S function can be activated so the Vro-ITS-S can act as a R-ITS-S without interfering with previous mode.

Figure 23 describe, in the first part of the diagram, dataflow from a Vro-ITS-S sending working DENM (DENM1) with R-ITS-S function activated.

DENM1 is sent through Hybrid communication to V-ITS-S, Nfr-ITS-S and R-ITS-S.

In the second part, is described the path of a new DENM sent by the TMS after qualifying the event from DENM 1 when it's not related to a roadworks message of Vro-ITS-S. As shown, R-ITS-S, Nfr-ITS-S and the Vro-ITS-S receive the same DATEX II messages, translate it in 3 different DENM but with the same actionID.

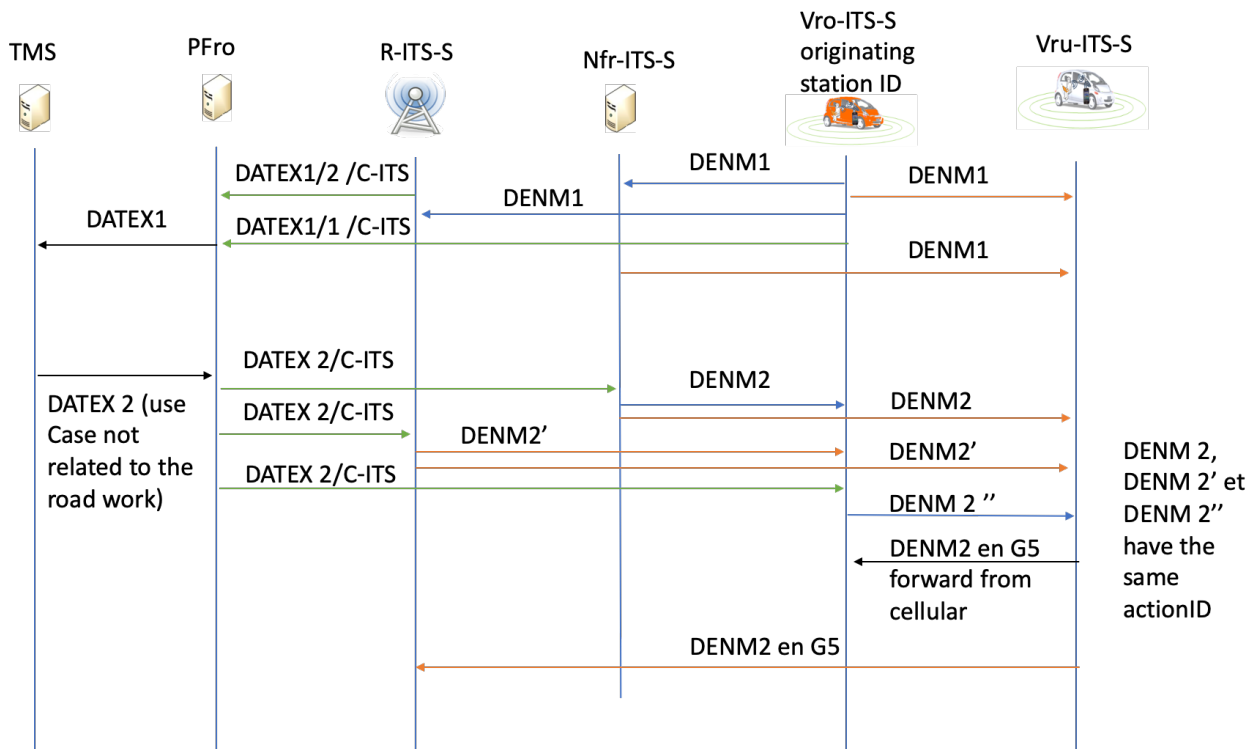


Figure 23 : Dataflow from a Vro-ITS-S sending DENM “work mode” with R-ITS-S function activated.

Figure 24 represents data flow of a DENM sent by Vro-ITS-S with R-ITS-S function deactivated. DatexII messages from the TMS are not sent to the Vro-ITS-S.

Figure 25 and Figure 26 represent data flow of a DENM “user mode” from a Vro-ITS-S and respectively R-ITS-S function deactivated and activated. Main difference with Figure 32 and Figure 33 is that DENM are not sent to the Road Operator via DATEX II.

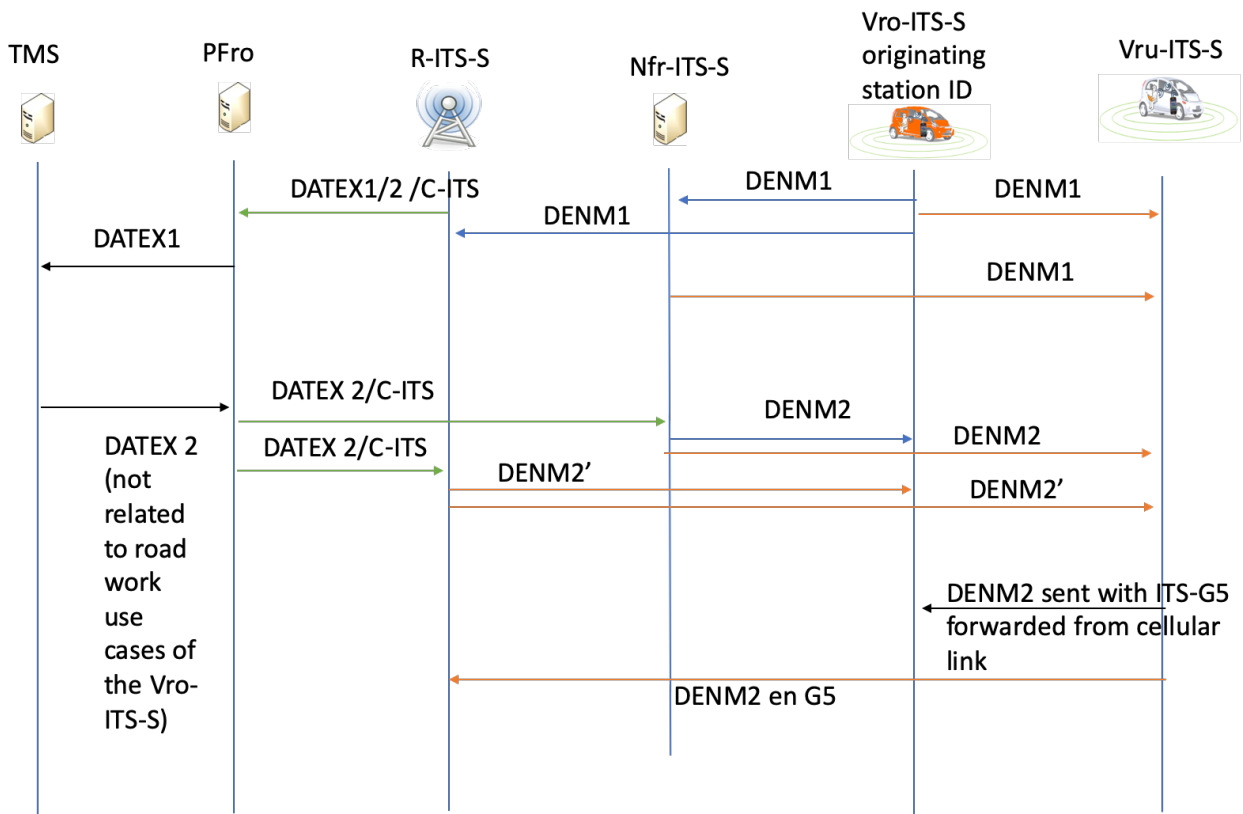


Figure 24: Data flow of a DENM "work mode" sent by Vro-ITS-s when R-ITS-S function are deactivated

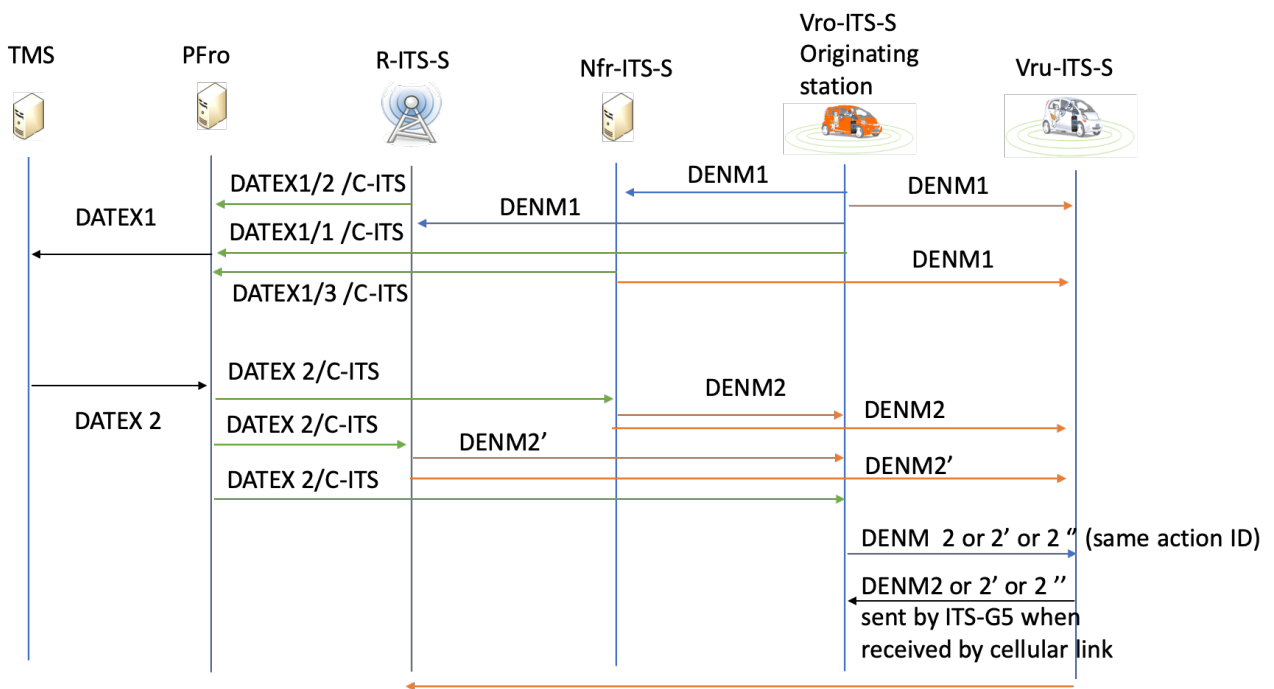


Figure 25: Data flow of a DENM "user mode" from a Vro-ITS-S and R-ITS-S function activated

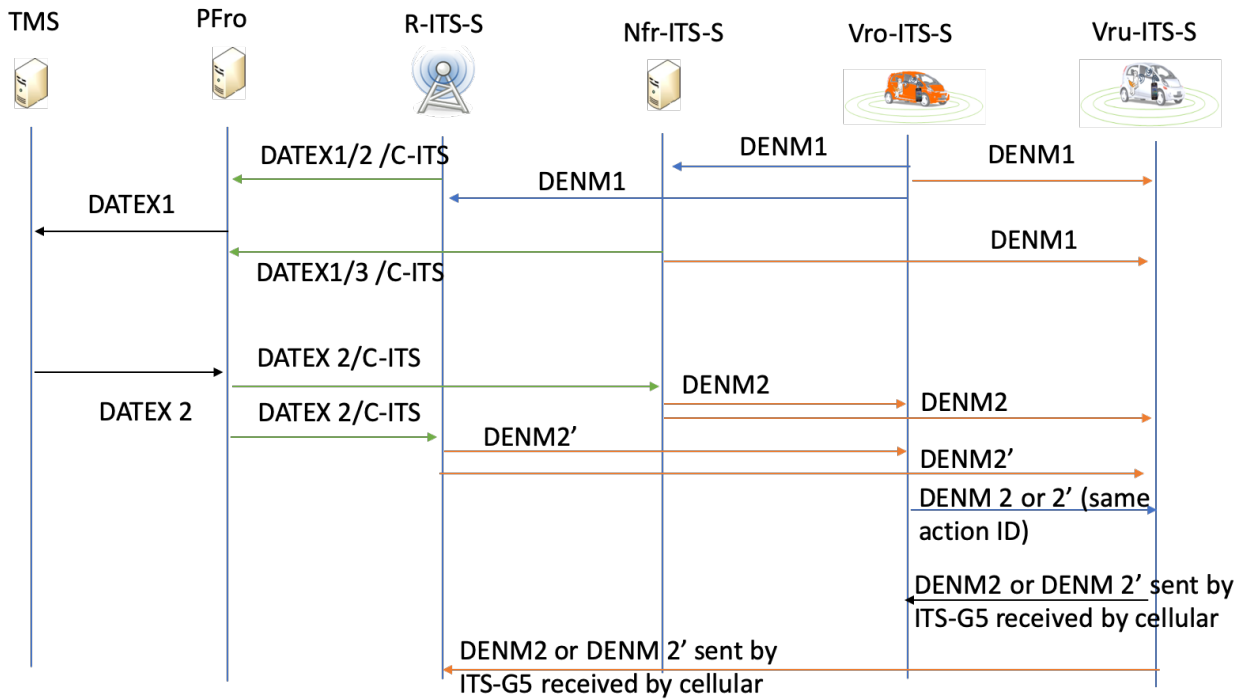


Figure 26: Data flow of a DENM "user mode" from a Vro-ITS-S and R-ITS-S function deactivated

Id	241H- REQF-001(1)
Component(s)	Vro-ITS-S
Requirement	When R-ITS-S function is active, Vro-ITS-S shall never forward messages from Nfr-ITS-S to PFro.
Additional information	When R-ITS-S function is active, Vro-ITS-S forward all received messages from road operators like an R-ITS-S.
Id	241H- REQF-002(1)
Component(s)	Vro-ITS-S
Requirement	Vro-ITS-S shall send to PFro in DATEX II all received messages through
Additional information	
Id	241H- REQF-004(1)
Component(s)	R-ITS-S, Vro-ITS-S
Requirement	Vro-ITS-S and R-ITS-S shall not forward to PFro a DENM with the same action ID than a previous one.
Additional information	

Id	241H- REQF-005(1)
Component(s)	Nfr-ITS-S
Requirement	Nfr-ITS-S shall never send a DENM for B2/B3 use cases.
Additional information	See deliverable French C-ITS catalog of Use Cases

Id	241H- REQF-006(1)
Component(s)	C-ITS-S
Requirement	Use case related to roadworks from Vro-ITS-S shall never be translated in DATEXII.
Additional information	

Id	241H- REQF-007(1)
Component(s)	Pfro
Requirement	if C-ITS DATEX received by PFro are related to a single DENM, PFro shall send a unique DATEX to the TMS.
Additional information	

Id	241H- REQF-007(1)
Component(s)	Vro-ITS-S, R-ITS-S
Requirement	When Vro-ITS-S or a R-ITS-S receive several C-ITS DATEX related to a single actionID, They shall consider only one C-ITS DATEX and send only
Additional information	Rules to consider one C-ITS DATEX are described in 2.4.2.2. Master

References

[0] Specification for interoperability of backend hybrid C-ITS communication from C-roads Platform / TF4 C-ITS IP based Interface, C-Roads Platform

Annex A

The table below lists the changes in requirements compared to the previous main version of the current bundle.

(SPEC_XX_XX_vx.y and associated documents). Only added, modified, and deleted requirements are listed.

Table created the 12/02/2025 and does not provide information on previous modifications on requirements

A number preceded by the symbol # indicates a reference to a ticket (retroaction).

Requirement	Status	Comments
ID requirement (version)	Modified/Created	Deactivation of the mobile R-ITS-S function in user mode and conservation of the parameter
241H-FuRS-017(2)	Modified	Modification of SCH2 to SCH1
241H-FuRS-015(2)	Modified	CCH0 replaced by SCH0
241H- NetM-021(2)	Modified	CCH0 replaced by SCH0
241H-FUNS-002(6)	Modified	Additional information is removed
241H-FUNS-005(2)	Modified	Additional information is removed
241H-FUNS-006(1)	Created	<p>The Vehicles shall check the timestamp in the security header against the reception time and accept only CAMs in the last time of pSecCamPastToleranceTime and other messages within the last time of pSecMessagePastToleranceTime.</p> <p>with :</p> <ul style="list-style-type: none"> • pSecCamPastToleranceTime = 2 s, Maximum absolute time difference between the time in the security header of the Cooperative Awareness Message (CAM) and station clock to accept the CAM • pSecMessagePastToleranceTime = 10 min, Maximum absolute time difference between the time in security header of message (other than CAM) and station clock to accept the message
All IPV6 requirement	Removed	As IPV6 is not used

241H-FUNS-007(1)	Created	ITS AID for V-ITS
241H-FuRS-001(1)	Removed	IPV6