

French C-ITS Deployment Coordination committee

Detailed functional specifications of PFro

Deliverable 2.4.3.2_M

Activity 2: Studies

Sub-activity 2.4 > Specifications

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Information on the document

Document: Detailed functional specifications of PFro

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Quality rules

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

Requirements identification & traceability

In this document, the following verbal forms are used to indicate requirements: **Shall / Shall not**

Recommendations shall be indicated by the verbal forms: **Should / Should not**

Permissions shall be indicated by the verbal forms: **May / May not**

Possibility and capability shall be indicated by the verbal forms: **Can / Cannot**

Inevitability used to describe behaviour of systems beyond of the scope of this del. shall be indicated by: **Will / Will not**

Facts shall be indicated by the verbal forms: **Is / Is not**

In the table here below:

2.4.X.XX > is the number given to the deliverable (e.g. 2.4.4.8)

YYYY > for digit are given to identifying which component/entity the requirement is addressing (e.g. LTCA for long term certificate authority)

ZZZ > is the numeration of the requirement

ID	2.4.X.XX-YYYY-ZZZ
Component(s)	(e.g.) Vru-ITS-S, Vro-ITS-S, R-ITS-S, PKI
Requirement	(e.g.) An ITS station SHALL be able to request and get a Long-Term Certificate (LTC) from the SCOOP Public Key Infrastructure (PKI).
Acceptance	(e.g.) CA1: Vru-ITS-S sends a LTC request to the LTCA CA2: R-ITS-S relays the LTC request CA3: The LTCA verifies the request and sends a response CA4: The R-ITS-S relays the response CA5: The response is received by the Vru-ITS-S and is valid
Additional information	

Acronyms & abbreviations

ACAI	Common Architecture of Computer Applications
CAM	Cooperative Aware Message
DENM	Decentralized Environmental Notification Message
GNSS	Global Navigation Satellite System
ITS	Intelligent Transport System
ITS G5	Adaptation of the IEEE 802.11p (wifi)
ITS-S	Intelligent Transport System Station
IVI	In Vehicle Information
Nfr-ITS-S	French National Central ITS-S
PFro	Road operator platform
PLO	Reference point for the linear location (French reference)
POI	Point Of Interest
R-ITS-S	Roadside-ITS-S
RP	Reference point for the linear location (French reference)
SCOOP platform	Road operator platform
SOAP	Simple Object Access Protocol
TMS	Traffic Management System
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	V2V and/or V2I
V-ITS-S	Vehicle ITS-S
Vro-ITS-S	Road Operator Vehicle ITS-S
Vru-ITS-S	User Vehicle ITS-S

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1 Introduction

The general objective of the C-ITS project is to test the implementation conditions for the cooperative networked systems. The stakes of the project are as follows:

- Improve road safety
- Optimise traffic management and road information and their impacts
- Help reduce environmental pressures, especially greenhouse gas emissions
- Optimise the costs of managing the infrastructure and develop new services, including intermodal ones
- Help to prepare the vehicles of tomorrow

This deliverable presents the detailed specifications of the common PFro. It completes the prerequisites defined in the deliverables: 2.4.1_M, 2.4.2.4_M and 2.4.1.4_M and must be compatible with the R-ITS-S, Vro-ITS-S and Vru-ITS-S specifications.

2 Description of the PFro

2.1 General presentation of the PFro application

The PFro is an element of the C-ITS project that contribute to communications between the V-ITS-S (Vro-ITS-S and Vru-ITS-S) and the TMS.

The communication from the TMS mainly concerns the messages composed of information for users, by applying a policy predefined by the road operator, and the traffic data and events on the traffic arteries defined in the repository.

The communication from the V-ITS-S concerns the messages of the conditions of circulations noticed by the user of the road and the messages send automatically by the vehicle.

In the wave 1, the C-ITS project used only the communication with the G5 network on Vru-ITS-S. The specifications were given in the deliverable 2.4.3.2.

In the wave 2, hybrid communication allows extension of the area covered by G5 network.

This extension, possible with the cellular network, required changes in the C-ITS architecture. All the architecture is described in the deliverable 2.4.1.H. The main impacting the platform is the creation of a National Central ITS-S

2.2 Architecture of French C-ITS projects

French C-ITS projects components shall designate all physical components that enable users to produce or exchange the messages required to run the use cases. They are listed in the deliverable 2.4.1_M.

Diagram illustrating the architecture of the SIVIS system, showing the central Nfr-ITS-S server and its connections to various components:

- Central Server:** Nfr-ITS-S
- Left Side Components:**
 - Nxx-ITS-S
 - INTERNET (clouds)
 - cellulaire (cellular towers)
 - Vro-ITS-S (Vehicle Road Operator)
 - Vru-ITS-S (Vehicle Road User)
 - Road Operator Network
 - R-ITS-S (Roadside ITS-S)
 - IP sur ITS-G5 (IP on ITS-G5)
- Right Side Components:**
 - App-Serv (Application Server)
 - cellulaire (cellular tower)
 - Pfro (Public Road Operator)
 - MCTO server (Motorway Control and Traffic Optimization)
 - TCC human validation (Traffic Control Center)
 - ITS-G5 (Intelligent Transport Systems - Global Standard)
 - Vro-ITS-S (Vehicle Road Operator)
 - Vru-ITS-S (Vehicle Road User)
- Legend:**
 - Secured IP link
 - - - Geonet link

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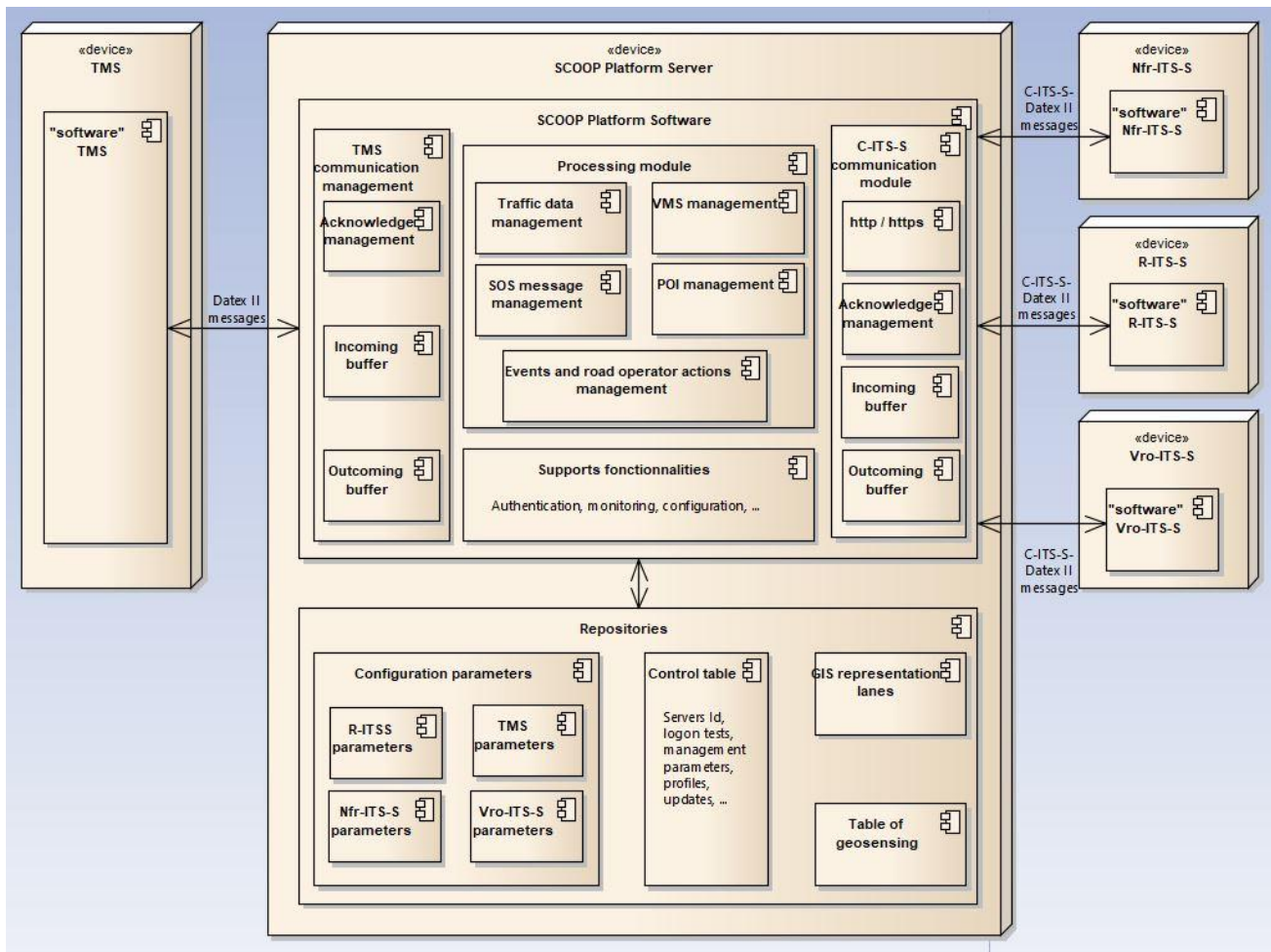


ILLUSTRATION 2: GENERAL SCHEMA OF THE SOFTWARE ROAD OPERATOR PLATFORM OPERATING PRINCIPLE

2.3.2 Development tools

ID	2432_H-DEV-001 (2)
Component(s)	PFro
Requirement	The PFro shall comply with the ACAI coherence environment concerning the ministry applications
Acceptance criteria	
Additional information	

Extract of the terms of reference ACAI_V3 above

*The target general technical architecture is that of web architectures with thin clients.
This means that the clients are the browsers without a particular extension.*

Javascript can be used to enrich the ergonomics while respecting the accessibility principles.

Two notable exceptions are accepted:

- *Visualisation and interaction with geographic data based on the non-accessible Javascript components. The accessibility to such systems can be achieved by other means.*
- *The Business Object decision-making design module*

Some applications may require an operation in disconnected mode. In this case, the use of HTML5 is authorised. Synchronisation mechanisms should be developed as part of these applications.

The main objectives to comply with are:

- *The Internet norms and standards (HTTP and HTTPS as the only protocols between the client station and the server)*

The inter-ministerial directives (interoperability, security, accessibility)

The PFro's hosting (either on the site or by a host) shall take into account the rules used in each site, especially to support GIS functionalities.

The service provider providing the PFro shall provide the list of the information required for the integration on each site.

Legal information and graphic charters provided for as part of the ACAI coherence are exceptional.

ID	2432_H-DEV-002
Component(s)	PFro, Nfr-ITS-S, Vro-ITS-S, R-ITS-S
Requirement	The environment shall be based on the stable version of the Debian operating system and composed of applications enabling to broadcast a dynamic Web service: Java, Apache, Tomcat, PostgreSQL, PostGIS, etc. By default, these applications will be installed in the stable version taken from the Debian (latest stable version) operating system's default packets.
Acceptance criteria	Control that the system uses the reference versions Debian with his components: Apache, tomcat, Postgres with postgis extension, Java
Additional information	

The new versions will have to follow the ministerial recommendations.

The PFro will use a PostgreSQL database and the stable version of PostGIS.

2.3.3 Developments

Any other development will be implemented on the PFro DIR IF (i.e., the PFro ordered and deployed on the benchmark site: DIR IF) and compatible with the data

processing environment defined nationally. Under these conditions, all road operators will benefit from these changes.

A road operator who makes changes independently of the national project runs the risk of losing the benefit of new versions of the PFro or will have to ensure its changes to be adopted for the national PFro.

2.4 The PFro and its data processing environment

The hybrid communication architecture shall allow to send and receive message through different radio links (ITS-G5 or Cellular) from/to V-ITS-S to/From other TMS.

The PFro receives data from the Nfr-ITS-S

- PFro-DATEX II messages

The PFro sends data to the Nfr-ITS-S

- PFro-DATEX II messages

The main functions of the PFro:

- Reception :
 - receives messages from Vro-ITS-S and R-ITS-S
 - receives messages from Nfr-ITS-S
 - receives messages from TMS
- Processing:
 - Messages aggregation (uplink flow)
 - validity check
 - Duplication check
 - modifies some messages from DATEX II to prepare the DENM messages
 - modifies some messages from DATEX II to prepare the IVI messages
 - modifies some messages from DATEX II to prepare the POI messages
 - filtering downward sense (selection of the R-ITS-S which will receive the messages according to the location, but all messages are sent to the Nfr-ITS-S)
- Distribution :
 - forwards messages to Nfr-ITS-S
 - forwards messages to R-ITS-S and Vro-ITS-S.
 - Forwards messages to TMS

Concerning exchanges between R-ITS-S, Vro-ITS-S or Nfr-ITS-S and the PFro,

ID	2432_H-COMMUNICATION-001
Component(s)	PFro, Nfr-ITS-S, Vro-ITS-S, R-ITS-S
Requirement	the web-service (with a SOAP envelope) shall be used in push on occurrence with acknowledgement of receipt.
Acceptance criteria	Control that reception of the push information is present in the log
Additional information	

ID	2432_H-COMMUNICATION-002
Component(s)	PFro, Nfr-ITS-S, Vro-ITS-S, R-ITS-S
Requirement	the web-service (with a SOAP envelope) shall be used in pull for snapshot
Acceptance criteria	Control that reception of the snapshot is present in the log.
Additional information	

ID	2432_H-COMMUNICATION-003 (3)
Component(s)	PFro,
Requirement	Regularly, the PFro shall emit keepalive messages (it must be configurable) to verify the connection between R-ITS-S, Nfr-ITS-S, Vro-ITS-S, TMS and the PFro.
Acceptance criteria	Control the acquirement of keepalive Control the periodicity in the configuration file
Additional information	

The model used will be the one recommended in the DATEX II v2.3 technical specifications. (see 2.4.1.4_M).

A snapshot mechanism will be used, especially during communication resumptions.

ID	2432_H-SYNCHRO-001
Component(s)	PFro
Requirement	The time synchronisation of all the elements shall be provided by a time server (using GNSS) through a NTP protocol (normal service).
Acceptance criteria	Control the time in the system log
Additional information	

ID	2432_H-SYNCHRO-002
Component(s)	PFro
Requirement	The PFro shall use the Universal Time Coordinated (UTC)
Acceptance criteria	Control that the time in the DATEX II message is in UTC (GMT +0)
Additional information	DATEX use the Universal Time Coordinated (UTC), but DENM and CAM use the International Atomic Time (TAI). The translation shall be made in the R-ITS-S or Nfr-ITS-S.

2.5 Road operator platform installation in each local sub-project

Installation and acceptance tests of the software are made by each road operator. The necessary documents for these steps are provided to the road operator: the installation and user manuals, necessary acceptance manuals, referential, parameters files, etc.

The PFro is delivered with a default configuration. However, each road operator is responsible for the configuration and inputting the strategy elements and application repositories related to each site.

The full versions of the PFro with a default configuration shall be available online, on an identified server.

The same dispositions shall be made for the local developments.

Each road operator is responsible for preparing its site (and therefore the data processing environment) for the PFro's installation. The application is delivered with all of the executables necessary for its installation from scratch.

For updates, the provider will give the employed process with the necessary files and will specify in detail the evolutions.

Each road operator is responsible for developing the necessary interfaces between the PFro and its TMS.

The Interfaces with the TMS are developed outside the PFro.

3 Road operator platform functionalities

3.1 Summary of C-ITS use cases

The PFro will be used by the French Partners of the four C-ITS projects: SCOOP, INTERCOR, C- Roads and InDiD.

Therefore, the PFro must take into consideration a few use cases of the three projects, which are specified functionally in the deliverable L_2.2: “C-ITS French Use Cases Catalog – Functional descriptions”.

3.2 Interfacing from the PFro

3.2.1 interfacing with the R-ITS-S, Vro-ITS-S

- Uplink flow

ID	2432_H-INTERFACING-001
Component(s)	PFro, R-ITS-S, Vro-ITS-S
Requirement	The communication to the PFro shall made in PFro-DATEX II format.
Acceptance criteria	
Additional information	

The Vro-ITS-S will transmit to the PFro their position in real time via a DATEX II file. The frequency of transmitting this file can vary (e.g., from 5 seconds to 10 minutes).

The position of these Vro-ITS-S can be made available in real time from a road operator server if it wants to process this information.

The communication from the Vro-ITS-S must be secured (http or https based on the other levels of security implemented by the road operators). In the case of white zones, no communication can be established.

When the communication is re-established, the stored information will be sent.

- Downlink flow

ID	2432_H-INTERFACING-002
Component(s)	PFro, R-ITS-S, Vro-ITS-S
Requirement	The communication from the PFro shall made in PFro-DATEX II format.
Acceptance criteria	
Additional information	

3.2.2 Interfacing with the Nfr-ITS-S

The communication between the platform and the Nfr-ITS-S will be made by a web service. All sent and received messages are in PFro-DATEX II format.

- Downlink flow

ID	2432_H-INTERFACING-003
Component(s)	PFro, Nfr-ITS-S
Requirement	PFro-DATEX II messages shall be sent by the PFro to the Nfr-ITS-S (messages going to Vru-ITS-S).
Acceptance criteria	Control that all messages destined to R-ITS-S are sent to the Nfr-ITS-S This send appears in the history files.
Additional information	The Nfr-ITS-S shall be configured as an R-ITS-S, without restriction for the location.

- Uplink flow

ID	2432_H-INTERFACING-005
Component(s)	PFro, Nfr-ITS-S
Requirement	PFro-DATEX II messages coming from Nfr-ITS-S shall be received and treated by the PFro (messages coming from Vru-ITS-S)
Acceptance criteria	The PFro treats the Nfr-ITS-S as R-ITS-S. The message shall appear in the log files.
Additional information	

The specifications of the Nfr-ITS-S are defined in the 2.4.2.4_M

3.2.3 Interfacing with the TMS

ID	2432_H-INTERFACING-006 (2)
Component(s)	PFro
Requirement	<u>Downlink flow:</u> PFro shall understand the Datex II message sent by the TMS
Acceptance criteria	
Additional information	

ID	2432_H-INTERFACING-007 (2)
Component(s)	PFro
Requirement	<u>Uplink flow:</u> DATEX II messages shall be sent by the PFro to the TMS
Acceptance criteria	
Additional information	

The specifications of the TMS are defined in the 2.4.3.1_M

3.3 List of functionalities for the downlinks: from TMS to V-ITS-S

3.3.1 Operating scheme

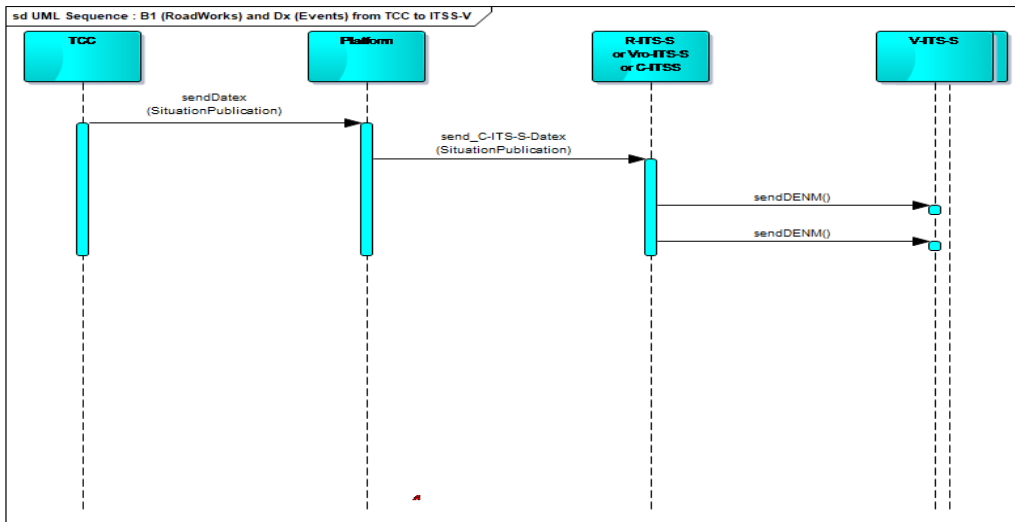


ILLUSTRATION 3: DENM FROM TMS TO V-ITS-S (EXTRACT FROM 2.4.1.4_H)

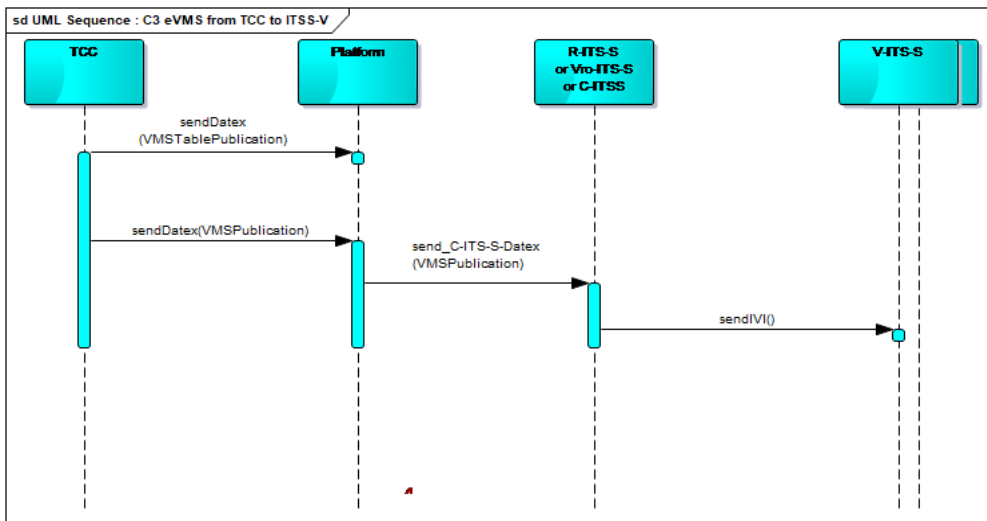


ILLUSTRATION 4: IVI FROM TMS TO V-ITS-S (EXTRACT FROM 2.4.1.4_H)

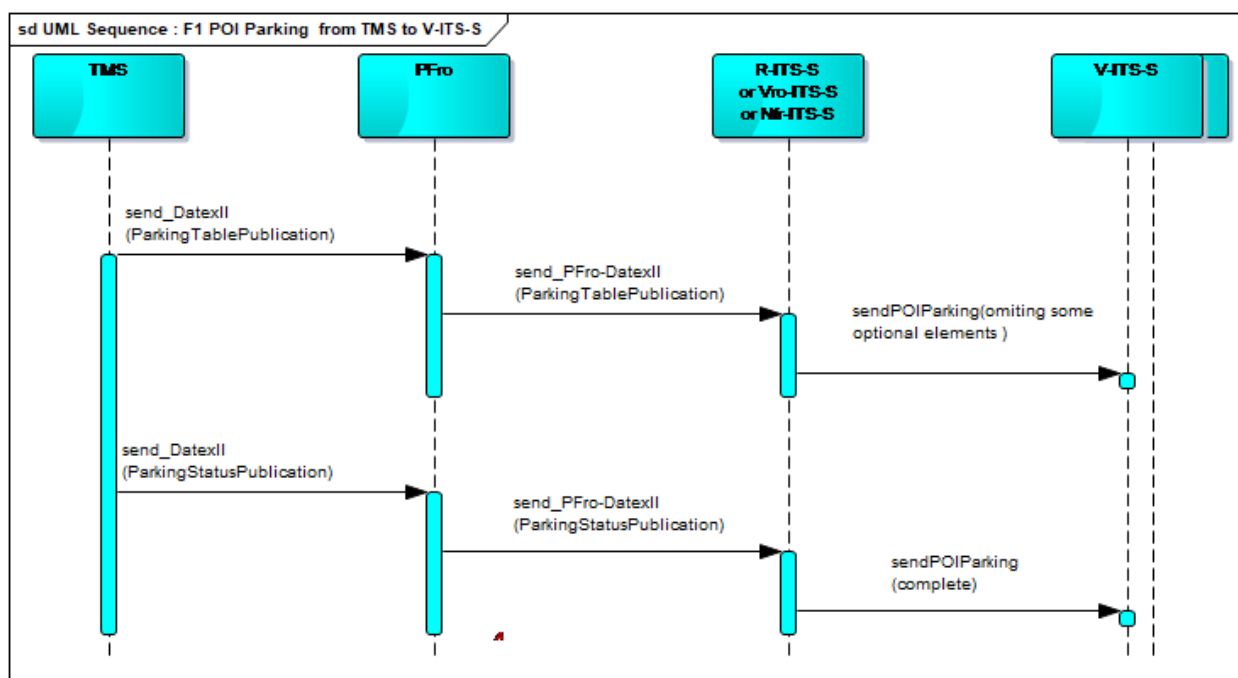


ILLUSTRATION 5: POI FROM TMS TO V-ITS-S (EXTRACT FROM 2.4.1.4_H)

The function of the PFro is to emit a DATEX II message that is fully coherent with the functionalities of the R-ITS-S and the Nfr-ITS-S, especially concerning the location part.

3.3.2 List of use cases concerned: TMS > PFro

The use cases below are specified.

Heading: Download C-ITS use case

B1a : Alert closure of part of a lane, whole lane or several lanes

B1b : Alert planned closure of a road or a carriageway

B1c : Alert planned road works – mobile

B1aAV – Alert closure of part of a lane, whole lane or several lanes (adapted for automated driving systems)

C2: In-vehicle dynamic speed limit information

C3: In-vehicle signage (embedded VMS)
C6: Toll Station Approaching: enhanced orientation of drivers

D1: Alert - temporary slippery road

D2a : Alert animal on the road

D2b : Alert people on the road

D3: Alert - obstacle on the road

D4: Alert - stationary vehicles, breakdown

D5 : Alert accident area

D6 : Alert reduced visibility

D7: Alert wrong-way driving

D8 : Alert unsecured blockage of a road

D9 : Alert temporary mountain pass route closure

D11 : Alert end of queue

E1 : Traffic information about snow on the road

E6 (formerly D9): Alert extreme weather conditions E7: Traffic jam ahead

E8 : Approaching vehicle: Traffic information on the closure of a mountain pass

F1a – Information on parking lots location, availability and services in urban area
F1b – Information on parking lots location, availability and services on highways

H2: Dynamic traffic ban to specific vehicle

H4: Dynamic lane management - reserved lane

H6: HGV overtaking ban

H9 : Flooded road

I6 : I6 – Pedestrian crossing outside signalized intersection: warning to vehicles approaching

I7 : Bicycle lane in opposite direction in a one way road

3.3.3 processing of incoming data

New data is processed in 3 steps:

ID	2432_H-DOWNPROCESSINGIN-001
Component(s)	PFro
Requirement	the container of message shall be verified, (including xsd structure)
Acceptance criteria	Control the message compliance with DATEX II
Additional information	The messages that do not comply with the DATEX II v2.3 xml schema shall be rejected.

ID	2432_H-DOWNPROCESSINGIN-002
Component(s)	PFro
Requirement	the content shall be verified,
Acceptance criteria	Control that the mandatory and optional attributes are compliant with the deliverable L-2.4.1.4_M

Additional information	mandatory attribute of C-ITS and standard DATEX II V.2.3
------------------------	--

ID	2432_H-DOWNPROCESSINGIN-003
Component(s)	PFro
Requirement	the data should be recorded
Acceptance criteria	Control that the data are stored in the hard disk
Additional information	

The verification will concern the accepted schemas and formats (xml, DATEX II v2.3) and the general characteristics of the classes, derivative classes and expected and mandatory attributes (pursuant to the C-ITS deliverables).
The specifications of the TMS are defined in the 2.4.3.1_M

A consistency check is carried out on the incoming data, including in particular:

- existence of the transmitter
- structure of the message (cf. 2.4.1.4_M)
- consistency monitoring of the message (cf. 2.4.1.4_M)

Initially the rejected messages will be analysed through logs, at least during the acceptance phase or even during the operating phase. It should be possible to configure the log's level.
Next the incoming data will be entered in the PFro's database.

3.3.4 Data processing in the PFro

3.3.4.1 Matches tables for translations Datex II toward IVI, DENM...

3.3.4.1.1 NationalIdentifier

Correspondence table to modify the <nationalidentifier> attribute:

	Entity	Value	Entity	Value	Entity	Value	Entity	Value
SCA : xx for SCA with xx is RTTT Coding structure CS1 for toll station								
	ASFA Test	01	SFTRF	02	AREA	03	ASF	04
	COFIROUTE	05	ESCOTA	06	SANEF	07	SAPN	08
	APRR	09	ATMB	10	BPNL	11	ALIS	12
	CEVM	13	ARCOUR	14	ADELAC	15	TFREJUS	16

	ALICORNE	17	ALIENOR	18	ATLANDES	19	ALBEA	20
	REPA	21	REORA	22	EURO TOLL	23	AXXES	24
	SMTPC	25	CCIH	26	TOTAL	27	INDIGO	28
	PARK+	29	REC	30	ATMB PARK	31	RPAS	32
	OSS	33	TEA	34				
Cities : postal code divided by 10								
ex	Bordeaux Métropole	3300	St Brieuc agglom.	2200	Aix Marseille Métropole	1300	...	
DIR : 10 0xx for DIRs with xx the number of department of the central siege								
ex	DIR A	10033	DIR O	10035	DIR N	10059	DIR E	10067
	DIR MED	10013	DIR CE	10069	DIR CO	10087		
	Nfr-ITS-S	10000						
Departments : 10 2xx for department with xx the number of the department								
ex	CD 13	10213	CD 22	10222	CD 87	10287		
Regions : 10 3xx for region if needed, with xx the number of department of central siege								
ex	PACA	10313	Bretagne	10335	...			
Ports : 14 000 to 14 499 are reserved for port operator (MCTO UC)								

3.3.4.1.2 CountryCode

References to write <countrycode> attribute are specified in ISO 3166-1 and specified in table ITA-2 of ISO 14816.

As specified in ISO 3166-1:

France is coded "FR"

and as specified in table ITA-2 of ISO 14816:

- F is coded 10110

- R is coded 01010

<CountryCode> for France is: 10110 01010

PFro send "FR" and R-ITS-S translate toward 10110 01010

3.3.4.2 preparation for a translation DATEX II to IVI

The PFro shall prepare the translation of the DATEX II messages in IVI messages for the embedded VMS (C3)

The list of correspondence between the DATEX II and IVI messages is listed in the deliverable L_2.4.1.4_M and appendices.

The objective of this step is to complete the messages in DATEX II v2.3 before transmitting them to the Nfr-ITS-S or R-ITS-S so they can be translated into IVI for

distribution to the V-ITS-S.

ID	2432_H-IVI-001
Component(s)	PFro
Requirement	The message shall be completed with geographic coordinates compatible with the IVI format (ETRS89, WGS84).
Acceptance criteria	
Additional information	The PFro shall have a table to translate the VMS identifier to a XY location. (see chapter 3.3.4.5)

The PFro shall be respect the requirements of the document “2.4.1.2_M_Master”, paragraph “2.2 IVI”

The PFro shall be respect the requirements of the document “2.4.1.4_M annexe 3_IVI DATEX.ods”

The IVI data element Provider (“serviceProviderID”) contains the ID of the service provider through its two components:

- CountryCode indicates the ISO 3166-1 country code;
- IssuerIdentifier indicates the identifier of the service provider as registered.

ID	2432_H-IVI-002(2)
Component(s)	PFro
Requirement	The PFro shall modify the <nationalidentifier> attribute received for the Nfr-ITS-S value: 10000 (“Issueridentifier” of IVI)
Acceptance criteria	
Additional information	Example: DIR_NORD becomes 10000 (see #3.3.4.1.1. NationalIdentifier) SANEF becomes 10000, SIRIUS becomes 10000.... (in the payload class)

ID	2432_H-IVI-021 (2)
Component(s)	PFro
Requirement	The PFro shall transcode the name of operator in DATEX II towards the name of operator in IVI.
Acceptance criteria	
Additional information	Example: DIR_NORD becomes 10059 (in the exchange class)

TMS sends, depending on the use case, a situation publication message (SituationPublication for C2) or a VMS publication message (VmsPublication for C3). Depending on the case, the mechanism for assigning the unique identifier is not the same.

ID	2432_H-IVI-004
Component(s)	PFro
Requirement	The PFro shall create the attribute <ividentificationNumber> when the received message is a Vms publication.
Acceptance criteria	
Additional information	This attribute is an increment, 16-bit integer in hexadecimal format left padded with 0.

ID	2432_H-IVI-005
Component(s)	PFro
Requirement	The PFro shall create (or modify) the “situationRecordCreationReference” attribute by concatenating the following information: supplier IssuerIdentifier + an incremental number (IN) + a sequence number in each situation starting from 1 when the received message is a situation publication.
Acceptance criteria	
Additional information	See 2.4.1.4_M: supplier IssuerIdentifier: 32-bit integer in hexadecimal format left padded with 0 incremental number: 16-bit integer in hexadecimal format left padded with 0 sequence number: 4-bits integer in hexadecimal format left padded with 0.

ID	2432_H-IVI-006 (3)
Component(s)	PFro

Requirement	the incremental number of “ivIdentificationNumber” and the incremental number (IN) of “situationRecordCreationReference” shall be built with the same sequence parameter.
Acceptance criteria	
Additional information	Explanation: these attributes come from two different publications in DATEX II (publication VMS and publication Situation) but prepare an IVI distribution, which must have a unique identifier.

The pictograms received from the TMS with attribute <pictogramCode> are in 14823 format or IISR9 format. If the format received is in 14823, the PFro transmits without modification.

ID	2432_H-IVI-007
Component(s)	PFro
Requirement	PFro shall retransmit pictogram codes with 14823 format.
Acceptance criteria	
Additional information	PFro shall have a transcode table IISR9 format - 14823 format. The format will be as type “31-105”

3.3.4.3 preparation for a translation DATEX II to DENM message

The list of correspondence between the DATEX II and DENM messages is listed in the deliverable L2.4.1.4_M and appendices.

The objective of this step is to complete the event or traffic management messages in DATEX II v2.3 before transmitting them to the Nfr-ITS-S or R-ITS-S so they can be translated into DENM for distribution to the V-ITS-S (DENM: Decentralized Environmental Notification Message).

The PFro shall prepare translate of the DATEX II messages for DENM messages

for use cases

ID	2432_H-DENM-001
Component(s)	PFro
Requirement	The message shall be completed with geographic coordinates compatible with the DENM format (ETRS89, WGS84).
Acceptance criteria	
Additional information	(see chapter 3.3.4.5)

The PFro shall be respect the requirements of the document “171215-2412H-0Master-SpecUC-v0.12”, paragraph “2.1 DENM”

The PFro shall be respect the requirements of the document “2.4.1.4_M annex1_RSU translation Guide DATEX - DENM v0.05.ods”

The PFro creates “situationRecordCreationReference” because it is used for defining the DENM “actionID” data frame

ID	2432_H-DENM-002
Component(s)	PFro
Requirement	The PFro shall create (or modify) the “situationRecordCreationReference” attribute by concatenating the following information: its stationID + an incremental number (IN) + a sequence number in each situationrecord starting from 1
Acceptance criteria	
Additional information	

3.3.4.4 Geographic_projection

The geopositioning process is described in deliverable 2.4.1.4.

3.3.4.4.1 Location by a point

The message contains a point location defined linearly (also named RP or PLO in

French language):

If PFro uses RIU : when a DATEX II v2.3 message does not contain the location in geographic coordinates, the PFro will calculate the projection of the point (e.g., the marker RP or a representation of the road's geometric axis) in geographic coordinates (ETRS 89 close to WGS84).

If PFro doesn't use RIU: when a DATEX II v2.3 message does not contain the location in geographic coordinates the message will be ignored.

The message contains the location in geographic coordinates (T-PEG)

If PFro uses RIU: when the DATEX II v2.3 message includes a location in geographic coordinates and RP location, these RP locations will be used.

If PFro doesn't use RIU: when the DATEX II v2.3 message includes a location in geographic coordinates and RP location, these geographic coordinates will be used.

Location in slip road

Concerning the events located on access lanes or slip roads, there are several referencing modes.

Mode 1: the referencing is done from the PLO located on the front end of the slip road (intersection with the main road) PLO+abscissa.

Mode 2: the referencing is done from the RP of the main road ahead of the LOP of the start of the slip road, RP+abscissa (via slip road LOP).

Mode 3: the referencing is done by projection on the main road associated with the slip road and then by determining the curvilinear abscissa from the RP ahead of this main road.

Each road operator will configure the mode used on its site.

Then the PFro will translate in xy coordinates theses information.

ID	2432_H-SLIPROAD-001
Component(s)	PFro
Requirement	The PFro shall translate in XY coordinates the information of location depending the politic applied by the operator.
Acceptance criteria	
Additional information	

3.3.4.4.2 Location by a linear

If PFro uses RIU, PFro will push the orientation (gives the bearing) of the event toward the R-ITS-S and Nfr-ITS-S

- with the value "aligned", independently of the orientation given by the TMS (if TMS send aligned or opposed)

- with the value “both” if the TMS send “both”

If PFro doesn't use RIU, PFro will push the orientation (gives the bearing) of the event toward the R-ITS-S and Nfr-ITS-S

This value allows the V-ITS-S to interpret the location as being the direction of the traffic.

(If PFro uses RIU there is on the reference table of the RIU a complete direction, aligned for the increased RP and opposite for the decreased RP).

The PFro have to treat the same situations with the same locations as TIPI.

ID	2432_H-situation-001
Component(s)	PFro
Requirement	The PFro shall manage only one location for each information.
Acceptance criteria	
Additional information	The PFro shall understand and interpret the following situation <situation> <situationrecord1> <groupOfLocation1> <situationrecord2> <groupOfLocation2> <situationrecord3> <groupOfLocation3 >

ID	2432_H-situation-002
Component(s)	PFro

Requirement	The PFro shall interpret the groupOfLocation if it has zero or one linear. This linear describes a single road.
Acceptance criteria	
Additional information	

For a linear and bi-directional event ('directionRelativeOnLinearSection'='both' or TpegDirection='bothWays')

ID	2432_H-split-001(2)
Component(s)	PFro
Requirement	The PFro will identify from receipt of a linear event the value 'both' for attribute 'directionRelativeOnLinearSection' for RIU or 'bothWays' for attribute 'tpegDirection'. In that case the PFro shall create two events from the initial event with two different identifiers (one for each direction).
Acceptance criteria	Control in the history files that a message received on a bi-directional road event is sent in 2 messages, one by direction.
Additional information	That is true pour bidirectional roads and divided carriage-ways roads

The coordinates of the initial event are not modified.

Only the traces, event history and event position (see 3.2.4.7) are modified, so the vehicles can identify more easily the events that concern them.

3.3.4.5 Conversion of the lane attribute

ID	2432_H-LANE-001 (2)
Component(s)	PFro

Requirement	The PFro shall convert the "lane" attribute transmitted by the TMS according to the specification of 2.4.1.4, with the lane number (attribute numberOfOperationalLanes (use in priority) or originalNumberOfLanes)
Acceptance criteria	
Additional information	If TMS send an unknown attribute, PFro transmits the value without change.

The PFro will transfer to the R-ITS-S a DATEX II message with just the numbered lanes. However, it may receive from the TMS a message using a lane description (and not the expected numbering).

For example, the PFro could receive, concerning the middle lane of a bidirectional road: carriageway = mainCarriageway and lane = "middleLane." In this case, it has to transform the message so the R-ITS-S can understand it. If it is a bidirectional road with three lanes, it should transmit the R-ITS-S a message with: carriageway = "mainCarriageway" and lane = "Lane2".

3.3.4.6 Decomposition of messages

ID	2432_H-DECOMPO-001
Component(s)	PFro, R-ITS-S, Vro-ITS-S, Nfr-ITS-S
Requirement	The DATEX II v2.3 situations shall be broken down into simple elements.
Acceptance criteria	Control in the history files that a message received with n event is sent in n messages with one element.
Additional information	

In enhanced level, the PFro has to properly code the group of events from TMS in consecutive event linked before sending the appropriate DATEX II to R-ITS-S.

ID	2432_H-DECOMPO-002 (2)
Component(s)	PFro
Requirement	The PFro shall add an attribute "relatedsituation" to link two or more linked message (road Work Warning enhanced).
Acceptance criteria	Control that the attribute "relatedsituation" is present in the sent message. Control that each message is linked with the others.

Additional information	
ID	2432_H-DECOMPO-0003 (2)
Component(s)	PFro
Requirement	If the event overpasses 20,9 km, the PFro shall split the message into 2 or more messages.
Acceptance criteria	
Additional information	This rule is applicable for all linear location.

3.3.4.7 Extension DATEX II and PFro-DATEX II

3.3.4.7.1 Roadtype

The “roadType” information in the LocationContainer (DENM) isn’t used in generating the DATEX II.

So the “roadType” will be managed from a DATEX II extension (roadTypeScoopExtension class) defined in 2.4.1.4.

The PFro shall verify that the roadtype is properly filled in. The knowledge of network is necessary to verify the roadtype.

ID	2432_H- ROADTYPE-001 (3)
Component(s)	PFro
Requirement	If this information of roadtype is missing, the PFro can do the processing to extract the road Type information from its geographic repository
Acceptance criteria	
Additional information	Bear in mind, this information will then be transmitted by the Vro-ITS-S, R-ITS-S and Nfr-ITS-S in the DENM message.

The PFro's processing to define the roadtype will be developed from the map repository. Any repository must be adapted to correspond to this data formatting.

If the data in question are not present natively in each road operator's existing repositories, the road operators must first process the data to integrate the missing data in the repository, if necessary by cross-comparing files and attributes.

The possible values for roadtype are:

- 0: urban: no structural separation with opposite lane
- 1: urban: structural separation with opposite lane
- 2: non urban: no structural separation with opposite lane
- 3: non urban: structural separation with opposite lane

The inability to extract "roadtype" information from a repository will not be blocking: if the necessary information is not present, the PFro will not do the processing and will transmit the DATEX message to the Nfr-ITS-S or to R-ITS-S without the information, which consequently will not be transmitted to the V-ITS-S in the DENM.

3.3.4.7.2 Traces (DENM) (equivalent to DetectionZonesIds in IVI)

"eventPosition": Geographical position of the detected event (DENM) (equivalent to "referencePosition" in IVI).

"Traces": this data frame is the location referencing information of "eventPosition" (DENM)

Each trace describes a set of consecutive PathPoint positions leading to the event position. For each trace, multiple PathPoint positions are provided to describe the trace path."

ID	2432_H-TRACES-001 (2)
Component(s)	PFro
Requirement	The PFro shall create one (or more) linear of points for an event from a geographic repository to create the trace on roadworks as described in deliverable 2.4.1.4.
Acceptance criteria	Control the new marker in the history file
Additional information	PFro creates traces with the Douglas–Peucker algorithm.

ID	2432_H-TRACES-002
Component(s)	PFro
Requirement	The distance value of traces (DetectionZonesIds) shall be able configurable in the PFro according to the use cases.
Acceptance criteria	The road operator provides the information of configuration for each use case.
Additional information	

ID	2432_H-TRACES-003
Component(s)	PFro
Requirement	PFro shall prioritize the linears by size of roads : The first is highway, second is national road, third is departmental road and fourth is city road.
Acceptance criteria	

Additional information	
------------------------	--

3.3.4.7.3 Eventhistory (DENM) (equivalent to RelevanceZonelds in IVI)

“EventHistory” indicates the list of positions that a plain event has been detected prior to the “eventPosition” (DENM)

ID	2432_H-EVENTHISTORY-001 (2)
Component(s)	PFro
Requirement	The PFro shall create one (or more) linear of points for an event from a geographic repository to create event history on roadworks as described in deliverable 2.4.1.4.
Acceptance criteria	Control the new marker in the history file
Additional information	

The PFro constructs a RelevanceZonelds for the linear of the road to next interchange or on a default distance set by road operator in the PFro (1 to 5km)

ID	2432_H-EVENTHISTORY-002
Component(s)	PFro
Requirement	The distance value of RelevanceZonelds (Eventhistory) shall be built by the PFro by the information sent from TMS according to the use cases.
Acceptance criteria	
Additional information	

3.3.4.7.4 <IvidentificationNumber>

See chapter 3.3.4.1 preparation for a translation DATEX II to IVI

3.3.4.7.5 <ValidTo>

For the needs of the C-ITS French project, in the message between the platform and the R-ITS-S, a new attribute shall be created. Its name <ValidTo> is the name of the IVI attribute that shall be filled with.

This attribute is mandatory for the message from the platform to R-ITS-S.

ID	2432_H-EVENTHISTORY-003 (2)
Component(s)	PFro, R-ITS-S
Requirement	The PFro shall complete the value <ValidTo> according to the table of the current VMS.
Acceptance criteria	As this IVI attribute is a "TimestampIts", the corresponding DATEX attribute is a time in GMT. It corresponds to the end time of the message validity period.
Additional information	

This attribute shall not be used for the message from TCC to the platform.

3.3.4.7.6 Speed limits

<SpeedLimits> indicates the speed limitation applied to the roadwork zone (DENM)

ID	2432_H-SPEEDLIMITS-001 (2)
Component(s)	PFro
Requirement	The PFro shall create one (or more) linear of points for an event from a geographic repository to create speed limits on roadworks as described in deliverable 2.4.1.4_M
Acceptance criteria	Control the new marker in the history file
Additional information	

These straight lines are added on the PFro, which has a geographic repository, so the R-ITS-S can then fill in the mandatory values of the DENM file sent. The generation of these straight lines is specified in deliverable 2.4.1.4.

These straight lines are sent by a point list of X, Y, for the generating trace and the event history.

3.3.4.8 Use cases

The technical specifications will provide for each use case, the content of the DATEX II v2.3 message to transmit. This dictionary, presented in the attached deliverable L_2.4.1.4_M with the associated table, can be used to identify the items to complete in the DATEX II v2.3 message emitted by the TMS of the different road operators (to be defined based on the DATEX II message models supplied by road operators in their use cases).

3.3.4.8.1 B1a&b - road Work Warning enhanced (I2V)

In enhanced level, the PFro has to properly code the group of events from TMS in consecutive event linked before sending the C-ITS- DATEX II to V-ITS-S.

ID	2432_H-UC_RWW-001 (2)
Component(s)	PFro
Requirement	If n events are linked, the PFro shall use the attributes "relatedSituation", to make the link between each event.
Acceptance criteria	
Additional information	

The events can be linked by the attribute "Relatedsituation" (DATEX II), which corresponds to the attribute "referenceDenms" (DENM). These linked events, can be received in the same DATEX message, or into separate DATEX messages, but shall be sent into separate DATEX messages

Ex: For a situation decomposed into 4 messages, the PFro shall add for each message DATEX II, these attributes « relatedSituation" to the situation

- add three attributes « relatedSituation" to the situation1: id of situation 2; id of situation 3; id of situation 4
- add three attributes « relatedSituation" to the situation 2: id of situation 1; id of situation 3; id of situation 4
- add three attributes « relatedSituation" to the situation 3: id of situation 1; id of situation 2; id of situation 4
- add three attributes « relatedSituation" to the situation 4: id of situation 1; id of situation 2; id of situation 3

The other elements are the same than for the road work warning basic use case.

ID	2432_H-UC_RWW-002 (2)
Component(s)	PFro

Requirement	Only one event is linear, the other are punctual.
Acceptance criteria	
Additional information	

3.3.4.8.2 B1c – Mobile planned roadworks

ID	2432_H-B1C-001
Component(s)	V-ITS-S, R-ITS-S
Requirement	Mobile planned roadworks shall be treated like all the planned roadworks. The only difference is the type of mobility: it's "mobile"
Acceptance criteria	
Additional information	

3.3.4.8.3 C2: Dynamic speed limit (I2V)

This use case is done by a publication of situation who prepares an IVI message. This measure is applied on a road section called "RelevanceZonelds".

The PFro verifies the locations in the publication situation received if the situation contains two "SituationRecord"

ID	2432_H-UC_Dynamic_speed-001 (2)
Component(s)	PFro
Requirement	If the locations are different, PFro shall delete the message.
Acceptance criteria	
Additional information	

ID	2432_H-UC_Dynamic_speed-002 (2)
Component(s)	PFro

Requirement	“DetectionZonelds” shall be built on each entry slip road of the road where the speed management is applied.
Acceptance criteria	
Additional information	

3.3.4.8.4 C3: Embedded VMS

The “VmsPublication” used between the platform and the R-ITS-S is the one from the TMS, completed with the <VmsLocationOverride> which contains the location of the VMS, the relevance zone and the detection zone.

ID	2432_H-UC_eVMS-001
Component(s)	PFro; R-ITS-S
Requirement	The platform shall find the location in the “VMSTablePublication”
Acceptance criteria	Control in history file associated to receipt of “VMSTablePublication”
Additional information	thanks to the linked attributes <VmsUnitReference> and <VmsUnitTableReference>.

ID	2432_H-UC_eVMS-002
Component(s)	PFro; R-ITS-S
Requirement	The position of the VMS on the road, either real or virtual shall be given by the “referencePosition”
Acceptance criteria	The DATEX II class associated is “vmsLocationOverride: LocationforDisplay”. Control if the that class exist in the message.
Additional information	Transverse position is in the middle of the carriageway.

ID	2432_H-UC_eVMS-003
Component(s)	PFro; R-ITS-S
Requirement	The heading direction of the carriageway concerned by the VMS shall be given by the PFro with the attribute "zoneHeading".
Acceptance criteria	The associated DATEX II class is "vmsLocationOverride: LocationforDisplay.bearing". Control if the that class exist in the message.
Additional information	

ID	2432_H-UC_eVMS-004
Component(s)	PFro - R-ITS-S
Requirement	By default, the length of the relevance zone shall be 1 km. These values shall be configurable.
Acceptance criteria	Control the class "externalReferencingSystem" in the sent messages
Additional information	The attribute is "zoneld"/ If attribute "vmslocationoverride" is filled, it shall be used.

ID	2432_H-UC_eVMS-005 (2)
Component(s)	PFro
Requirement	If the PFro receives a message who contains only a temperature or a time, it shall send a message with a termination which will erase precedent messages
Acceptance criteria	
Additional information	This information is filled in <VmsMessageInformationType>

ID	2432_H-UC_eVMS-006
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Component(s)	PFro
Requirement	If the PFro receive e-VMS message which contains more than 2 alternated displays, it deletes this message.
Acceptance criteria	
Additional information	

ID	2432_H-UC_eVMS-007 (2)
Component(s)	PFro
Requirement	If the PFro receives an e-VMS message which contains more 4 lines with 21 characters by page, it shall truncate his message.
Acceptance criteria	
Additional information	

3.3.4.8.5 C6: Toll Station Approaching: Orientation of Automated Vehicles (I2V)

ID	2432_H-UC_TOLL-001 (2)
Component(s)	PFro, R-ITS-S
Requirement	PFro shall transmit to the concerned R-ITSS only dynamic message C6
Acceptance criteria	
Additional information	<p>PFro will received two messages:</p> <p>A static description of the characteristics of the VMS (publication by <VmsPublicationTable></p> <p>A dynamic description of the VMS (publication by <signSetting> in a <SituationRecord>)</p>

ID	2432_H-UC_TOLL-002 (2)
Component(s)	PFro, R-ITS-S
Requirement	PFro shall apply the C3 specified operations to the C6, with the exception of mapping of RelevanceZone
Acceptance criteria	
Additional information	The toll system sends in the <vmsTablePublication> the description of the RelevanceZone.

ID	2432_H-UC_TOLL-001
Component(s)	PFro, R-ITS-S
Requirement	PFro shall create the <IvIdentificationNumber> in ascending order according to the specifications of the deliverable 2.4.1.4_M
Acceptance criteria	
Additional information	

3.3.4.8.6 D7: alert wrong way driving

Due to technical limitation, length of linear event may not overpass 20,9 km in DENM (see eventHistory in DENM Master document table). Therefore, if the operator would set a very long zone (over 20,9 km), the PFro may have to split the event in several consecutive events to cover the whole linear.

ID	2432_H-WWD-002
Component(s)	PFro
Requirement	The messages shall be treated with the same provisions as all other event messages (traces, eventhistory....)
Acceptance criteria	
Additional information	

3.3.4.8.7 D9, H9 : deviations

ID	2432_H-deviation-001
Component(s)	PFro
Requirement	PFro shall link the first message (always a road blocked) with the second message (a vmsUnit or a reroutingManagement).
Acceptance criteria	
Additional information	This connection is made by relatedSituation.

3.3.4.8.8 E7: Traffic Jam Ahead (I2V)

This use case is treated as a standard linear use case. (see 2.4.1.4_M chapter « special cases for traffic jam ahead »)

3.3.4.8.9 F1: Information on parking lots location, availability and services (POI / I2V)

The schema is showed in “3.3.1 Operating scheme”. The DATEX II specifications are described in “2.4.1.4_M Specification of DATEX II 2.3 messages” and “2.4.1.4_M ANNEXE 5 _ DATEX II adapted for POI between PF and R-ITS-S”

The TMS or parking control system sends the static data with <ParkingTablePublication>, respectively the dynamic information with <ParkingStatusPublication>, to the platform. The platform completes data accordingly to the Nfr-ITS-S DATEX II rules and its rules (location...) and sends it to the R-ITS-S.

- ParkingTablePublication: the platform does not need to enhance the data from the TMS.
- ParkingStatusPublication: the platform transcodes 2 attributes in PayloadPublication.publicationCreator to provide serviceProviderId in POI message.
 - country (towards CountryCode in POI)
 - nationalIdentifier (towards IssuerIdentifier in POI)

ID	2432_H-POI-001(2)
Component(s)	PFro

Requirement	The PFro shall modified the attribute <nationalIdentifier>
Acceptance criteria	
Additional information	See 2432_H-IVI-002(2)

ID	2432_H-POI-002
Component(s)	PFro
Requirement	The PFro shall send POIs with the refPoint at all R-ITSS within 20km of the POI.
Acceptance criteria	
Additional information	

ID	2432_H-POI-003
Component(s)	PFro
Requirement	Information shall be transmitted by the PFro every minute to each concerned R-ITS-S. The format of the transmission should be DATEX II.
Acceptance criteria	
Additional information	

ID	2432_H-POI-004
Component(s)	PFro

Requirement	If a PFro receives a message with 2 main functionalities, then the PFro shall reject the message.
Acceptance criteria	
Additional information	like truckParking and parkAndRide,

The tables of transcoding (as Poitype for ParkingUsageScenarioEnum in DATEXII) will be in R-ITSS

3.3.4.8.10 H1 – Permanent traffic ban to specific vehicles (I2V)

This use case is the same for PFro as H2.

3.3.4.8.11 H2: dynamic traffic ban to specific vehicle (I2V)

The PFro adapts the DATEX II coming from the TMS for the R-ITS-S and Nfr-ITS-S. The data for future(s) IVI/detectionZone (similar to DENM/trace) are calculated as usually. The data for IVI/relevanceZone(s) (similar to DENM/eventHistory) are calculated as usually if the event set in TMS is a linear.

However, the road operator should set the linear of the relevance zone in the TMS for a better information to the driver.

The DATEX II specifications are done in “2.4.1.4_M_Specification of DATEX II 2.3 messages” and “2.4.1.4_M ANNEXE 8 _ Datex II adapted for H-IVI between PF and R-ITS-S”

3.3.4.8.12 H4 : dynamic lane management – reserved lane

The PFro needs the geometry of the reserved lane, the current status of the lane (activation/inactivation) and the type of road users concerned by the reserved lane (HOV, bus). All those configuration parameters need to be defined through the DATEX II message that enters the PFro.

The PFro adapts the DATEX II coming from the TMS for the R-ITS-S and Nfr-ITS-S.

The data for IVI/detectionZone (similar to DENM/trace) and for IVI/relevanceZone (similar to DENM/eventHistory) are calculated as usually. The event received by the PFro is a linear.

ID	2432_H-H4-1
Component(s)	PFro

Requirement	If this linear includes interchange, the message shall be cut in several events: one for each section from beginning of measure to the next ramp of entrance until the end of the measure.
Acceptance criteria	
Additional information	

The DATEX II specifications are done in “2.4.1.4_M_Specification of DATEX II 2.3 messages” and “2.4.1.4_M ANNEXE 8 _ Datex II adapted for H-IVI between PF and R-ITS-S”

3.3.4.8.13 H6 : Overtaking ban

The PFro adapts the DATEX II coming from the TMS (or other) for the R-ITS-S and Nfr-ITS-S.

The data for IVI/detectionZone (similar to DENM/trace) and the data for IVI/relevanceZone (similar to DENM/eventHistory) are calculated as usually.

ID	2432_H-H6-1
Component(s)	PFro
Requirement	If the linear of HGV overtaking ban includes interchange, the message should be cut in several events: one for each linear between interchange Each linear shall be end at the junction of a ramp of entrance. The next linear shall be begin at this junction.
Acceptance criteria	
Additional information	

The DATEX II specifications are done in “2.4.1.4_M_Specification of DATEX II 2.3 messages” and “2.4.1.4_M ANNEXE 8 _ Datex II adapted for H-IVI between PF and R-ITS-S”

3.3.4.8.14 Use Cases who no impact PFro

The PFro isn't impacted by the use cases below.

D12: Emergency vehicle approaching

G2 - Traffic signal priority request by designated vehicles

I3: Road workers in the field

I5 - Pedestrians crossing at a bus stop

K1 – Level Crossing out of order

K2 - Level Crossing approaching

K3 - Level crossing in process of closing

L2- Stationary law enforcement vehicles

3.3.5 Transmitting a message

3.3.5.1 Message identification

In DENM, each message has a unique ID called “action ID”, based on a station ID and an incremental number and a sequence number.

ID	2432_H-IDENTIFICATION-001
Component(s)	PFro
Requirement	DENM message: The PFro shall send “situationRecordCreationReference” with a format in compliance with the deliverable L2.4.1.4
Acceptance criteria	
Additional information	See chapter 3.3.4.2

Similar to actionID for DENMs, the combination of serviceProviderId + ivIdentificationNumber unique ID of an IVI event.

ID	2432_H-IDENTIFICATION-002
Component(s)	PFro

Requirement	IVI message: The PFro shall send the information for filled the IVI fields "serviceProviderId" and "IvidentificationNumber"
Acceptance criteria	
Additional information	See chapter 3.3.4.1

When the R-ITS-S emits a DENM after receiving a DATEX II from the PFro, it emits its own station ID, but constructs its action ID from the PFro's ID (see: L 2.4.1.4)

3.3.5.2 **Message recipients: management of geographic repositories**

ID	2432_H-DOWNTRANSMITTING-001
Component(s)	PFro
Requirement	Based on a predefined traffic management policy (configuration and repository), all messages shall be transmitted to the Nfr-ITS-S and some messages shall only be transmitted to R-ITS-S, or Vro-ITS-S.
Acceptance criteria	Control in the history file that some R-ITS-S and Vro-ITS-S are no recipient of the messages
Additional information	the PFro knows in real time the position of the Vro-ITS-S

Downward, the Nfr-ITS-S, configured like an R-ITS-S, must receive all messages from the platform, without restriction.

To this end, the configuration of the R-ITS-S defines among other things the notion of zone of influence by R-ITS-S. Beyond the R-ITS-S message distribution parameters contained in the message itself (zone of relevance, period of validity of the message, etc.), it is a matter of determining which R-ITS-S will transmit the message to the V-ITS-S. This could be the R-ITS-S present in a radius around the event, configurable based on the type of event, in a predefined zone, on one or more given roads or over an entire region.

ID	2432_H-DOWNTRANSMITTING-002
Component(s)	PFro

Requirement	All messages shall be set in XY for sending to R-ITS-S
Acceptance criteria	
Additional information	

In all exchanges, the events are located in relation to a repository in XY (ETRS89 or WGS84 specified by the road operator in its configuration).

3.3.5.3 Synchronisation messages

ID	2432_H-DOWNTRANSMITTING-003 (2)
Component(s)	PFro
Requirement	The PFro shall also verify that the R-ITS-S, Vro-ITS-S and Nfr-ITS-S acknowledge the message.
Acceptance criteria	Control in history files: equipment are out of order if no acknowledge
Additional information	

The PFro acknowledges the messages sent by the TMS.

3.3.6 Event lifetime

3.3.6.1 Update

- The attribute of the situation record, (called <situationRecordCreationReference> in DATEX II) is mandatory. It is created by the original supplier.
- The time of the event observation is mandatory (called <situationRecordObservationTime> in DATEX II)
- These two attributes identify the update of event.

ID	2432_H-UPDATE_LOC-001 (2)
Component(s)	PFro

Requirement	<p>When PFro receives an update with a new location, then :</p> <ul style="list-style-type: none"> • If the location concerns the same R-ITS-S, PFro shall send the new location to the concerned R-ITS-S • If the location concerns a new R-ITS-S, <ul style="list-style-type: none"> ○ PFro shall update the message to the R-ITS-S that received it previously. ○ PFro shall send the message to the concerned R-ITS-S
Acceptance criteria	
Additional information	

3.3.6.2 Configuration

ID	2432_H-CONF-001
Component(s)	PFro, R-ITS-S, Vro-ITS-S, Nfr-ITS-S
Requirement	The publication tables (VMS and POI) shall be provided by webservice by PFro. R-ITS-S, Vro-ITS-S, Nfr-ITS-S make a request by pull.
Acceptance criteria	
Additional information	The dynamic publications are provided by push by PFro. The mechanism is similar between TMS and PFro.

3.3.6.3 Snapshots

Beyond the specific transmission of each message, a complete transmission of all valid events will be planned, including in particular:

- when restarting the PFro,
- when re-establishing a connection with an R-ITS-S, Vro-ITS-S, Nfr-ITS-S,
- periodically (one to several times per day).

This is the snapshot mode broadcast by the PFro, periodically or on demand from the R-ITS-S, Vro-ITS-S, Nfr-ITS-S, corresponding to the DATEX II operating mode 2 and 3.

ID	2432_H-EVENTLIFE-001
Component(s)	PFro, R-ITS-S, Vro-ITS-S, Nfr-ITS-S

Requirement	At their request, the R-ITS-S, Vro-ITS-S, Nfr-ITS-S, TMS shall receive snapshots that can be used to reinitialise each R-ITS-S, Vro-ITS-S, Nfr-ITS-S, TMS event tables and to make sure that the updated event are taken into account.
Acceptance criteria	Control in history files that all the events asked with the snapshot are present
Additional information	

ID	2432_H-EVENTLIFE-002 (2)
Component(s)	PFro
Requirement	Pursuant to the DATEX norm, the PFro shall be able to request the snapshots (e.g., in case the PFro restarts) from both the TMS (first) and the R-ITS-S, Vro-ITS-S, Nfr-ITS-S, TMS.
Acceptance criteria	After an interrupted communication, control that PFro send a request of snapshot in log files.
Additional information	

ID	2432_H-EVENTLIFE-021(2)
Component(s)	PFro, R-ITS-S, Vro-ITS-S, Nfr-ITS-S
Requirement	3 types of snapshots exist: <ul style="list-style-type: none"> • one for situation (SituationPublication) • one for VMS (VmsPublication) • one for POI (ParkingPublication) For each type of snapshot, all information received or sent by the PFro are returned.
Acceptance criteria	
Additional information	

3.3.6.4 Repetition of event messages by PFro

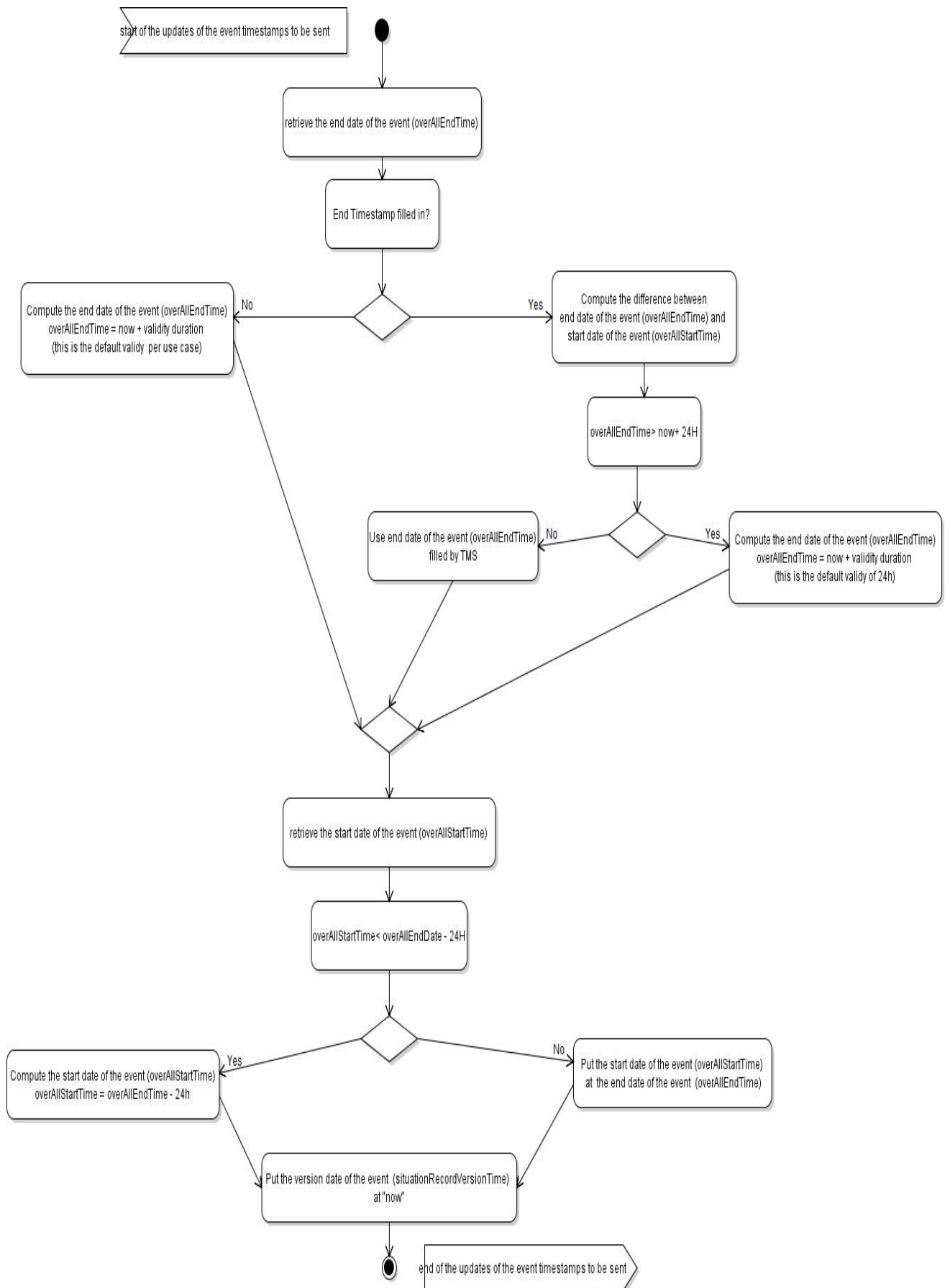
An update is a revision of the Datex II message written and sent by the TMS. PFro can repeat a message without update by the TMS : it is a repetition in C-ITS-Datex.

ID	2432_H-EVENTLIFE-006 (2)
Component(s)	PFro
Requirement	Numerous events transmitted by the TMS contain only a state of activity and have no date of the end (e.g accident). The dates of the beginning and the end for event messages are mandatory in DENM, If TMS doesn't send the end, PFro shall compute it.
Acceptance criteria	
Additional information	

ID	2432_H-EVENTLIFE-007(2)
Component(s)	PFro
Requirement	All messages shall be repeated by PFro until the end of the event. The repetition frequency is configurable per use case. By default, the repeat is set to 9 min.
Acceptance criteria	
Additional information	This requirement is true whether or not TMS sends the end of the event.

ID	2432_H-EVENTLIFE-008
Component(s)	PFro
Requirement	The timestamps shall be updated before each sending.
Acceptance criteria	
Additional information	

The update of the timestamps is done according to the following algorithm:



ID	2432_H-EVENTLIFE-003 (2)
Component(s)	PFro
Requirement	The PFro continues to send messages with a frequency dependent of the validity of the use case and until termination of the event. (e.g. from 5 seconds to 10 minutes)
Acceptance criteria	
Additional information	The frequency of repetition is computed based on the default value of the parameter "validityDuration" of the use cases. At the approach of the date of the end, the message is resent with a new date of the end, calculated according to the same principle, as long as the event was not updated by the TMS (see L_2.4.1.2_H)

3.3.6.5 Management of scheduled roadwork

As soon as the entry of a scheduled event is done in a TMS, it is sent to the PFro. This part deals with of futures events cases.

ID	2432_H-EVENTLIFE-004 (2)
Component(s)	PFro
Requirement	Upon its receipt in the PFro, scheduled event shall be stored but not processed
Acceptance criteria	Control in the log files
Additional information	These scheduled events can be stored up to 1 year (sliding) of potential scheduling.

The requirement 2432_H-EVENTLIFE-005 has been deleted: If the scheduled event lasts more than 24 hours, the event is cut up into events of a maximum length of 24 hours

The requirement 2432_H-EVENTLIFE-009 has been deleted

Confirmation of the event:

In case the initial event "initial scheduled event" is updated, the initial file is updated and an update or cancel message for the sub-part of the event underway (potentially impacted) is sent to the Nfr-ITS-S and R-ITS-S.

A scheduled event is likely to be confirmed by a road operator a short time before the event starts or when it starts. The confirmation of a scheduled event will make it possible to increase its quality level. Since all road operators do not have the

possibility to confirm an event, the road operator will mention whether it wants to activate or not the confirmation (parameter).

If the quality level in the message is not filled in, it shall be then calculated according to the following rule: see 2.4.3.2_M chapter 3.2.7

3.4 List of functionalities for the uplinks: from V-ITS-S to TMS

3.4.1 Operating scheme

This involves aggregating a set of DATEX II events based on type, zone, duration and quality criteria. If these criteria are reached, the PFro will transmit a DATEX II message to the TMS and to the Nfr-ITS-S.

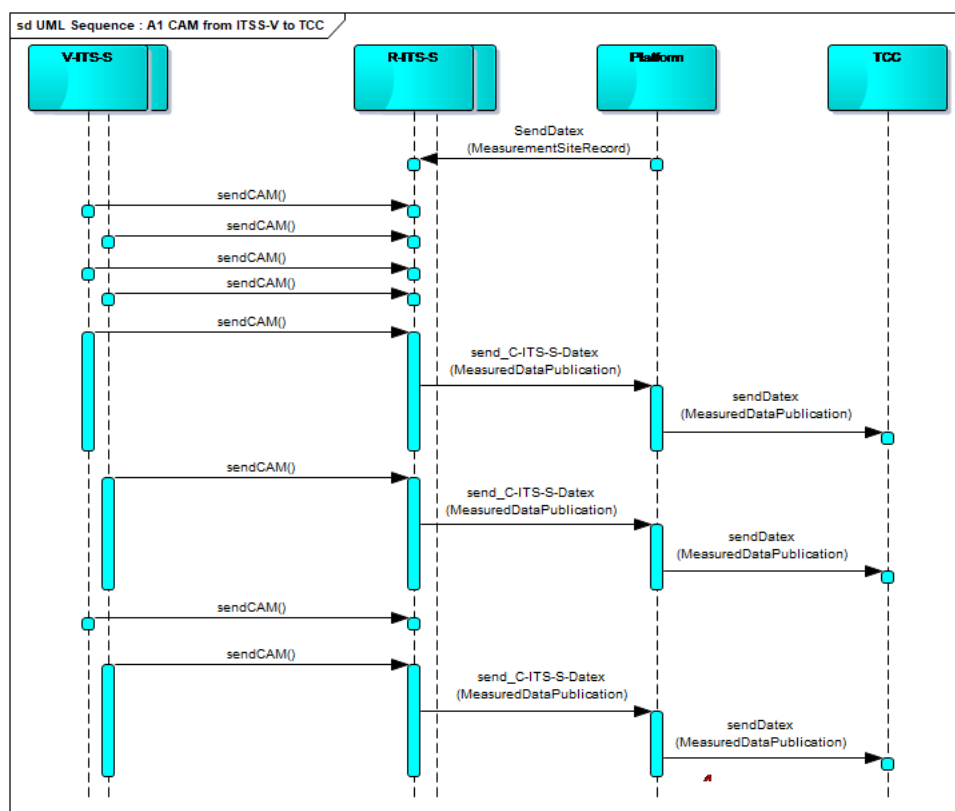


ILLUSTRATION 6: CAM FROM V-ITS-S TO TMS (EXTRACT FROM 2.4.1.4_M)

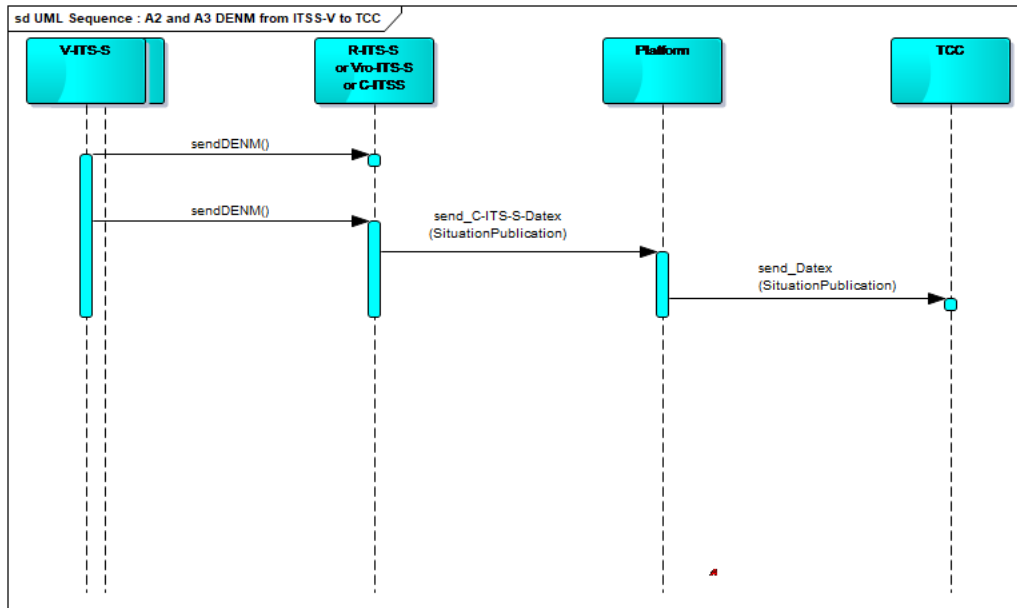


ILLUSTRATION 7: DENM FROM V-ITS-S TO TMS (EXTRACT FROM 2.4.1.4_M)

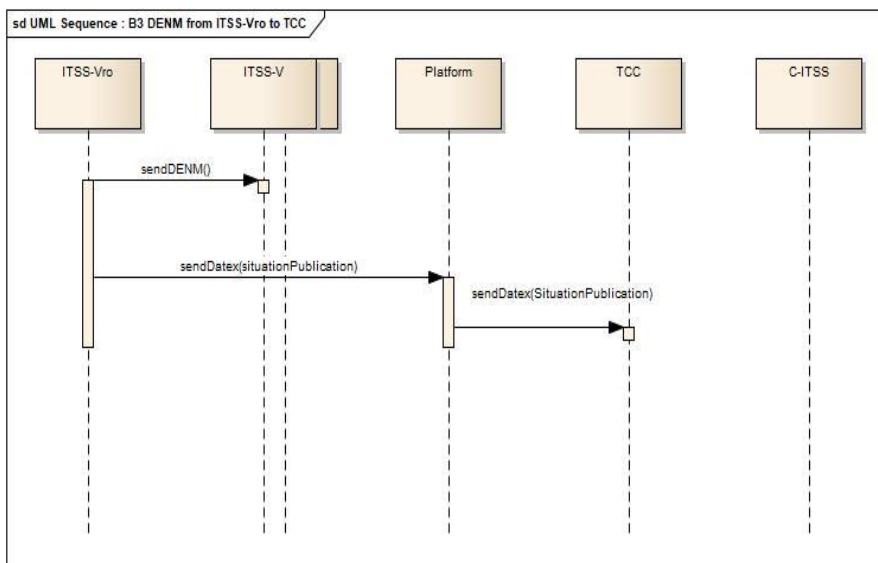


ILLUSTRATION 8: DENM FROM VRO-ITS-S TO TMS (EXTRACT FROM 2.4.1.4_M)

3.4.2 List of use cases: V-ITS-S > PFr

The use cases below are specified.

Uplink C-ITS use cases

A1: Traffic Data

A2-D1: road temporarily slippery

A2-D4a: Stationary vehicle

A2-D4b: Vehicle in breakdown

A2-D5: Vehicle in an accident

A2-D6: Alert low visibility

A2-D11: Alert end of queue

A2-E6: Alert - exceptional weather conditions

A3-D2a: Animal on the road

A3-D2b: Person on the road

A3-D3: Obstacle on the road

A3-D5: Unsecured accident zone

A3-D8: Unmanaged obstacle on the road

A5 : Wrong Way Users Detection (UC triggered by R-ITSS)

B2: Alert work on lane (from Vro-ITS-S)

B3: Alert - priority winter road maintenance vehicles (from Vro-ITS-S)

3.4.3 Data processing in the acquisition module

Before being transmitted to the PFro, the messages with vehicle data are pre-processed by the Nfr-ITS-S or R-ITS-S. The resulting data, which can be average speed type data, are then transferred by time intervals to the PFro in DATEX II v2.3 format.

As a reminder,

- the PFro receives the incoming data coming from Vro-ITS-S:
 - by the R-ITS-S (communication with ITS G5 between Vro-ITS-S and R-ITS-S)
 - directly with cellular
- the PFro receives the incoming data coming from Vru-ITS-S:
 - by the R-ITS-S (communication with ITS G5 between Vru-ITS-S and R-ITS-S)
 - by the Nfr-ITS-S (communication with cellular between Vru-ITS-S and Nfr-ITS-S)

ID	2432_H-UPDATAPROCESS-001
Component(s)	PFro
Requirement	The messages received by the PFro shall be subject to a verification of the Action ID and the time used by the R-ITS-S to construct the “detectionTime” (data element of DENM) in order to eliminate potential duplicates.
Acceptance criteria	The PFro verifies that the couple “ActionID” and “detectionTime” is unique. (in DATEX the “detectiontime” is in “ObservationTime” and “ActionID” “in “SituationRecordCreationReference”
Additional information	To this end, the acquisition module will keep all of the ID of messages received for a configurable time interval.

ID	2432_H-UPDATAPROCESS-002
Component(s)	PFro
Requirement	The PFro shall verify the coherence of the present various dates in the message
Acceptance criteria	
Additional information	

ID	2432_H-UPDATAPROCESS-003
Component(s)	PFro
Requirement	The PFro shall verify the membership in the network of the administrator of the location of the event
Acceptance criteria	Control that event is on the network in the log files
Additional information	

3.4.4 Data processing on the PFro

The list of correspondence between the DATEX II v2.3 and DENM messages is listed in the deliverable L2.4.1.4 and appendices.

3.4.4.1 Vehicle data message

ID	2432_H-UPDATAPROCESS-004
Component(s)	PFro
Requirement	Speeds may be subject to a statistical treatment, like average, or sampling. The possible treatments for these data will be configurable on the PFro.
Acceptance criteria	Control the incoming values with the values calculated.
Additional information	The data will be associated with predefined measurement zones (predefined repository and unique identifier per zone).

ID	2432_H-UPDATAPROCESS-005
Component(s)	PFro
Requirement	Based on a configurable time interval, the PFro shall transmit a DATEX II "MeasuredDataPublication" type publication cumulating all of the measurement zones.
Acceptance criteria	Check that the calculation is done and sent in the log files.
Additional information	see deliverable 2.4.1.4_M

3.4.4.2 processing of the DATEX II event: general provisions

A message from an uplink DATEX II v2.3 is processed in three steps:

Step 1: make sure that the messages are processed corresponding to the same event.

Step 2: locate the aggregated event (associate a position and a direction with it).

Step 3: associate a reliability with it.

For each of them, different parameters will be taken into account.

All DATEX II events received by the PFro shall not be systematically uploaded to the TMS or to the Nfr-ITS-S. The conditions for uploading to the TMS will be configured based on the types of event.

All events from the R-ITS-S, Nfr-ITS-S or Vro-ITS-S received by the PFro are positioned in X,Y and azimuth. They have a level of confidence, determined when the DENM is translated into DATEX II using the "ProbabilityOfOccurrence" attribute.

The layout of each road operator network is integrated in the PFro's GIS in vectorial

form along with its reference points (RP and PLO). This network is geo-referenced.

ID	2432_H-LOG-001
Component(s)	PFro
Requirement	The log files shall be used to monitor the operation of the algorithm, aggregations and uploads to the TMS and the Nfr-ITS-S.
Acceptance criteria	Control the presence of the log file
Additional information	A log file will record all movements and all processes carried out.

ID	2432_H-LOG-002
Component(s)	PFro
Requirement	Each day and for each equipment, a log file shall be created.
Acceptance criteria	Control the presence of the log file
Additional information	This file will be cut and renamed with the date of the day.

ID	2432_H-LOG-003
Component(s)	PFro
Requirement	The events outside the road network manager shall be systematically logged with a specific message.
Acceptance criteria	Control the log files.
Additional information	

3.4.4.3 Creating and transmitting an event

- Each DATEX II message received by the PFro will be stored in a database.
- The PFro will verify whether the event is on the road operator's road network (see Locating an event)
- The PFro will search whether one or more events of the same type exist already in the database with which it could be aggregated (see Aggregation).

Event activated by Vru-ITS-S

ID	2432_H-UPTRANSMITTING-001
Component(s)	PFro
Requirement	If x identical events (from R-ITS-S, Vro-ITS-S or Nfr-ITS-S) are located in a defined zone and in a defined time interval, an aggregation makes it a unique event (called PFro event in this deliverable) transmitted to the TMS and the Nfr-ITS-S as soon as the transmission conditions are satisfied (type, duration, zone, quality)
Acceptance criteria	
Additional information	See chapters 3.3.4.4, 3.3.4.5, 3.3.4.6 of 2.4.3.2

The PFro continues to process the events received as long as the aggregation continues, even if a PFro event was already created from this aggregation. This makes it possible to update the PFro event resulting from the processing

Systematically, the PFro will verify in the pending related events (type, timestamp and geoposition) whether the aggregation lead-time T (type) has not expired for some of them. In this case, the PFro will no longer take into account the expired R-ITS-S event(s).

ID	2432_H-UPDATAPROCESS-006
Component(s)	PFro
Requirement	If the PFro receives a cancellation of an event, the event is noted cancelled and shall no longer considered in the aggregation.
Acceptance criteria	Control in the HMI that the event is not considered
Additional information	

Event activated by Vro-ITS-S

ID	2432_H-UPTRANSMITTING-002
Component(s)	PFro
Requirement	the event shall be uploaded to the TMS and the Nfr-ITS-S at the first occurrence with its quality level (normally Q3).
Acceptance criteria	Control in the log files that all messages received from the Vro-ITS-S are transmitted
Additional information	See chapter 3.3.4.4, 3.3.4.5, 3.3.4.6 of 2.4.3.2

An update of the initial event (the road operator vehicle will transmit the updates of its location or the event's location) will result in an update being uploaded to the TMS and the Nfr-ITS-S (case provided for in DATEX II format). The cancellation or end of the event by the Vro-ITS-S will result in the transmission to the TMS and the Nfr-ITS-S of a cancellation or end of event message.

If a second road operator vehicle transmits the same event nearby, since there is no aggregation, they will be managed as two separate events and will be regularly updated to the TMS and the Nfr-ITS-S.

ID	2432_H-UPTRANSMITTING-003
Component(s)	PFro
Requirement	In the case of "SOS" messages sent directly from the Vro-ITS-S to the PFro, it should be possible to transfer a DATEX2 message to the TMS.
Acceptance criteria	
Additional information	This upload will be configurable.

3.4.4.4 Updating event previously uploaded to TMS and Nfr-ITS-S

- In the case of a new version related to a type A2 or A3 pending event already uploaded by a PFro event, the new version is only uploaded if the following conditions are satisfied:
 - the new quality level is greater than the level already uploaded to the TMS (Q2 for Q1 previously uploaded, Q3 for Q2 or Q1 previously uploaded): a new version of the event is then recorded.
 - If the quality level was Q3, the event is not updated.

ID	2432_H-UPDATAPROCESS-008
Component(s)	PFro
Requirement	New version of A2 or A3 event: the new version shall be only taken into account if the new quality level is greater than the level already uploaded to the TMS
Acceptance criteria	
Additional information	There is no update transmitted to the TMS where only the location has changed. This is true for use cases A2 and A3, except if the message is sent by an Vro-ITS-S.

ID	2432_H-UPDATAPROCESS-009
Component(s)	PFro
Requirement	At the first update of an event by PFro, the quality shall be reduced from “certain” (6) to “probable” (4). If the update is sent by the TMS, the quality remains or returns at “certain” (6).
Acceptance criteria	
Additional information	

3.4.4.5 Location of an event

Location from R-ITSS is expressed in X, Y and bearing.

ID	2432_H-LOCATION-001
Component(s)	PFro
Requirement	Each localizable event shall be located according to the algorithm above.
Acceptance criteria	
Additional information	

Location in RP+abscissa to send toward TMS

The algorithm seeks all segments or parts of the network located less than a distance D_r from the event and whose azimuth (or the tangent) is compatible with the event (i.e., the same orientation, or opposite orientation if the event is not oriented) in a range of compatibility Alpha (defined in degrees and configurable).

- If there is only one segment or one compatible axis, the location on the network is deduced in X_r , Y_r , Axis, Direction (Right or Left or Indefinite) and $RP + \text{Abscissa}$ (curvilinear abscissa) by orthogonal projection
- If several segment or axis candidates are possible, the location and XY aggregation must be used. (see 3.3.4.6)
- If no portion of the network is found, the event is not kept.

If the event is localised by X, Y , the procedure of location in XY is applied.

Location in T-PEG

The algorithm seeks all segments or parts of the network located less than a distance D_r from the event and whose azimuth or the tangent is compatible with the event (i.e., the same orientation, or opposite orientation if the event is not oriented) in a range of compatibility α (defined in degrees).

- Only the closest is kept and the position on the segment is calculated by projection of the X, Y point. The location is deduced on the network in X_r , Y_r and Axis.
- If no portion of the network is found, the event is not kept.

3.4.4.6 Aggregation by locator

To check whether the events should be aggregated, the algorithm checks whether the Axis and Direction are identical. Then it compares the location of the new event in the current "situation."

Control by RP

An aggregation is related to x incoming events positioned as $RP + \text{abscissa}$. The algorithm checks that the same axes and directions are used. If this is not the case, X, Y control is used. Then the algorithm checks the RP position of the new event vis-a-vis other events (compared to the minimum and maximum of events' RP).

- If it is included between the minimum RP and maximum RP of events, the new event is aggregated with the others.
- Otherwise, the algorithm looks at the minimum variance between the position of the new event and the most remote event.
- If this distance is less than twice the aggregation distance $D_a(\text{type})$, then the event is aggregated. Since this distance is considered as a radius, 2 events located at the outside of the diameter are aggregated, hence the comparison to $2D_a$.
- Otherwise, we consider that it is a new event.

Control by X, Y (the sections with just a road name and the network layout. We use the algorithm of the minimum rectangle).

A new incoming event of X, Y coordinates of the same type is compared with an aggregation located in X_o, Y_o (provisional centre of the minimum rectangle of related

events).

Initially, the algorithm checks whether the distance to a pending event is less than 2 times the aggregation distance of the type:

$$\text{distance of } (X,Y) \text{ to } (X_o,Y_o) \leq 2 \times D_a(\text{type})$$

- If not, it is a new event.
- If yes, we calculate the new provisional center of the minimum rectangle:
 - $X'o = 1/2 [\min (X_o,X) , \max (X_o,X)]$
 - $Y'o = 1/2 [\min (Y_o,Y) , \max (Y_o,Y)]$

then we check that all the points are in the circle of the $X'o,Y'o$ circle and the $D_a(\text{type})$ radius.

If this is the case, then the new event is associated with the current situation.

When the aggregation conditions are satisfied (especially when the aggregation threshold is reached), the event should be located (see 3.3.4.7)

ID	2432_H-AGGREGATION-001
Component(s)	PFro
Requirement	Each event that can be aggregated shall be aggregated according to the algorithm above.
Acceptance criteria	
Additional information	

3.4.4.7 Locating aggregated events

Location in RP

An aggregation is related to x incoming events positioned as $RP + \text{abscissa}$.

The algorithm will use a location mode configured by use case and thus by type of event to define which point will be kept among the 4 possibilities:

- 1 the earliest point (if the use case is oriented)
- 2 the latest point (if the use case is oriented)
- 3 the average point
- 4 the median point

An incoming event is positioned in X,Y and Azimuth. Depending on the type of event, we can distinguish the direction of traffic flow (i.e., 2 close declarations but made in 2 distinct directions are considered as 2 distinct events, provided that the associated road network is a carriageway with separated lanes (CSL).

Example 1: A2-D5 Vehicle in an accident is an oriented event. It is the vehicle itself that is in an accident and its orientation gives us the direction of traffic flow (provided that the network in this place is CSL type).

Example 2: A3-D5 Accident is not oriented. The manual declaration could concern the opposite direction of traffic flow (even on CSL). In this case, 2 close declarations are considered as the same event.

An "oriented event" parameter will be defined for each type of event and make it possible to take into account (or not) the orientation in the location and aggregation algorithm.

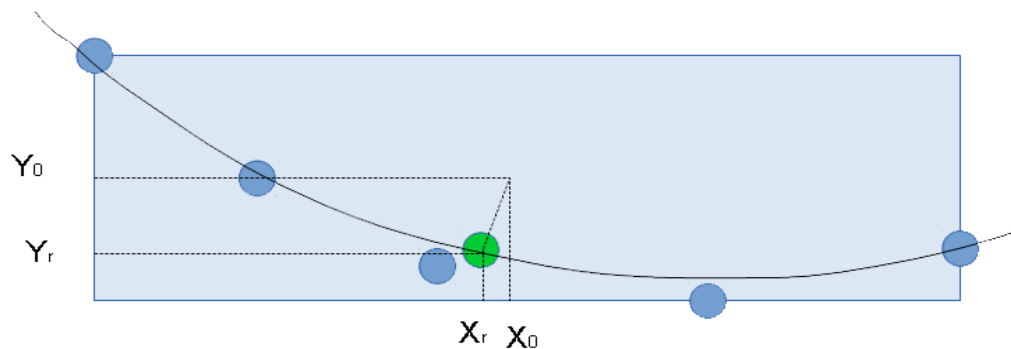
Location in X,Y

The position of the event is the projection of the centre of the smallest rectangle that contains all the points on the segments of the network:

$$X_o = 1/2 [\min (X_1, \dots, X_n) , \max (X_1, \dots, X_n)]$$

$$Y_o = 1/2 [\min (Y_1, \dots, Y_n) , \max (Y_1, \dots, Y_n)]$$

Point X_r, Y_r is obtained by projection of the X_o, Y_o point on the segments of the network.



ID	2432_H-LOCAGGREGATION-001
Component(s)	PFro
Requirement	Each aggregated event shall be located according to the algorithm above.
Acceptance criteria	
Additional information	

3.4.4.8 Condition of generating the aggregated message

The variables of the event included in the message are associated with the type of event (each type has its set of parameters).

Thus we have 2 types of producer: User or Road operator (in principle the user cannot upload the B cases or the AxBy cases mentioned).

Level of confidence condition

We attribute a weight to each level of quality: $Q1 \rightarrow k1$, $Q2 \rightarrow k2$, $Q3 \rightarrow k3$ and we set a minimum confidence level Sq (for each type of event).

We calculate the weighted level of confidence:

$$Qp = k1 * N_{messagesQ1} + k2 * N_{messagesQ2} + k3 * N_{messagesQ3}$$

The upload condition is reached if the threshold is reached ($Qp \geq Sq$).

To define the weighting values and the threshold of confidence, we can reason based on the number of events received.

The algorithm used the two conditions separately (equivalent to an "OR"):

- If the message is emitted by a road operator vehicle, the event is uploaded,
- If the level of confidence condition is satisfied, the event is uploaded.

If several points are to be aggregated, the aggregated event is the point with the highest quality and the aggregated position is the one of the event with the highest quality

3.4.4.9 **Recap of the parameters taken into account in the algorithm**

Type of network repository: RP+abs or geographical coordinates

By type of event:

Type A algorithm (road operator without aggregation)

Oriented event (Y/N)

If yes: Type of location aggregated = Upstream, Downstream, Middle, Median

Dr = maximum acceptable distance of an event on the road network

α = maximum angle between the azimuth of the event and the network segment

Da = maximum radius for the aggregation of events

T = lead-time taken into account for the aggregation of events

$K1$ = relative weight of the $Q1$ level

$K2$ = relative weight of the $Q2$ level

$K3$ = relative weight of the $Q3$ level

Sq = minimum threshold of the weighted level of confidence

Dr , α , Da and Sq depend on the type of event and the type of network.

3.4.5 processing and calculation modules

The functions common to several modules (calculation of coordinates, processing, etc.) will be developed as independent modules, which will be used by the different modules corresponding to the use cases.

3.5 HMI

ID	2432_H-HMI-001
Component(s)	PFro
Requirement	The PFro shall include a set of information from the TMS, R-ITS-S, the Nfr-ITS-S, Vru-ITS-S and Vro-ITS-S. It shall be possible to filter this information.
Acceptance criteria	Check on display HMI
Additional information	<ul style="list-style-type: none"> the events received (excluding duplicates), the situations that are in preparation to transmit potential events to the TMS, when the upload conditions are satisfactory. At this level an event can be an aggregation of several events of the same type. the events transmitted to the TMS or the Nfr-ITS-S.

ID	2432_H-HMI-002
Component(s)	PFro,
Requirement	The PFro shall display in real time <ul style="list-style-type: none"> web pages the information (event, R-ITS-S position) it has collected the operating status of the Vro-ITS-S, the TMS, and R-ITS-S
Acceptance criteria	Check on display HMI
Additional information	

In no case should the application allow Vro-ITS-S to be located.

This way the user can have access to the PFro's known ongoing events, traffic data, the status of operation of the R-ITS-S, Vro-ITS-S, etc.

These different data can be subject to differentiated displays via filters (transmitter, ID, date of creation, validity, version number, type, source, status, RP + abs, etc.). The information will be presented in a list (browser type) or graphical form using the road network's repository on a map background.

A specific web page will make it possible to replay and display in browser mode (and mapping mode if possible) former situations that will be loaded from the archive database with these same filters.

3.6 Support functionalities

3.6.1 Authentication

ID	2432_H-AUTHENTICATION-001
Component(s)	PFro
Requirement	The PFro's configuration, management and monitoring shall be managed by a web interface and configuration files.
Acceptance criteria	
Additional information	

ID	2432_H-AUTHENTICATION-002 (2)
Component(s)	PFro
Requirement	Access to the PFro and web services will be authenticated.
Acceptance criteria	
Additional information	

For the non-ministry sites, other solutions will be implemented: It can be possible to use “Cerbère” in dongle mode (with a local management of rights and profiles).

ID	2432-AUTHENTICATION-003
Component(s)	PFro
Requirement	the PFro shall be able to work with an authentication tool chosen by the site manager, which will interface with the PFro (e.g., LDAP authentication server).
Acceptance criteria	
Additional information	

ID	2432-AUTHENTICATION-004
Component(s)	PFro
Requirement	Access to the PFro through the HMI (web pages) shall be differentiated according to several profiles (administrators, road operators, etc.), where each profile can be configured by the site administrator via the administrator profile.
Acceptance criteria	
Additional information	

3.6.2 Other internal PFro MODULES

In administration mode, the application should provide monitoring modules specific to the PFro as well as backup, restoration, purge and automatic and manual archiving modules for the database. The PFro's logs will also be archived.

ID	2432_H-ADDMODULES-001
Component(s)	PFro
Requirement	The backup procedure shall differentiate the repository and monitoring parts from the events and messages part. An automatic backup procedure with different time intervals will be developed.
Acceptance criteria	The configuration shall be saved automatically
Additional information	The partial or total restoration will be done manually from the backups.

ID	2432_H-ADDMODULES-002
Component(s)	PFro
Requirement	The archiving module shall integrate a configured purge system, which will clean the database of elements past the retention time defined for archiving.
Acceptance criteria	
Additional information	

ID	2432_H-ADDMODULES-003
Component(s)	PFro
Requirement	The archiving database and the logs should make it possible to replay prior situations and to diagnose the problems encountered.
Acceptance criteria	
Additional information	

3.6.3 Configuration repository

ID	2432_H-ADDMODULES-004
Component(s)	PFro
Requirement	The parametrizable values of all functionalities shall be done on the HMI.
Acceptance criteria	
Additional information	

A specific module shall be used to define in a database the different distribution and archiving parameters predefined by the road operator: priority, zone of influence, zone of distribution and length of validity.

This module will also be able to define the types of processes implemented: sampling, aggregation, average, etc.

The PFro will be delivered with default parameters.

3.6.4 Geographic repository

The objective of the repository is to describe cartographically and alphanumerically certain functional characteristics of the road network and the R-ITS-S equipment on it.

This repository shall be used in particular to calculate all of the necessary coordinates for the content of messages as well as to define the R-ITS-S' zones of influence.

A vectorial cartographic repository will be integrated in the PFro, including the network and reference points (PLO, RP) in a shape format.

It may also be possible to export the PFro's vectorial repository in a standard GIS format (e.g., SHP), in ETRS89 or WGS84 at the road operator's choice, to modify it with an external GIS tool, then to reimport it in the PFro with the modifications.

3.6.5 Monitoring module

All of the items used to monitor the system (servers, R-ITS-S status, Vro-ITS-S status, connections) shall be put in a database and accessible via the monitoring module.

The status of the R-ITS-S and Vro-ITS-S equipment shall be displayed on the cartographic HMI and browser via a colour code (green, orange, red and grey), function of the equipment status (nominal, minor error or major error or disconnected) and function of the returns on keepalive and data from the R-ITS-S servers.

For the Vro-ITS-S, the on-screen location must be configurable and independent of the actual location.

A warning message should exist when the communication with the Nfr-ITS-S is cut off.

3.6.6 Archiving

The purpose of these archived data is to be processed in batch mode to evaluate a project independently of the PFro.

3.6.7 Logging module

ID	2432_H-ADDMODULES-005
Component(s)	PFro
Requirement	It shall be possible to independently log each process based on 4 trail levels (error, warning, info and debugging).
Acceptance criteria	It shall be possible to set log levels on the HMI
Additional information	

3.7 Synthesis of main functionalities of the PFro

<u>Main functionalities</u>	<u>precision</u>
Visualize R-ITS-S	
Visualize event	
Management of R-ITS-S	
Management of TMS	
Management of users	
Management of logs	Configurable levels
Management of geographical reference table	
Initialisation PFro	
Receive a DATEX II message	Acquittal of a received message
Oversee equipment	Sending or reception keepalive
equipment status	Sending or reception snapshot
Message from TMS: preparation for a translation DATEX II to IVI message	
Message from TMS: preparation for a translation DATEX II to DENM message	
Treat a message coming from R-ITS-S or Nfr-ITS-S or Vro-ITS-S	<ol style="list-style-type: none"> 1. Store received message 2. Verify SOAP 3. delete envelope SOAP 4. Verify XSD 5. Verify event 6. Verify if A1 message or event message

	<ol style="list-style-type: none"> 7. Cut the message on unique event 8. Verify the consistency of the DATEX II format 9. Verify double 10. Decode message 11. Record event 12. Control of the dates 13. Convert location 14. Verify location on the network 15. Update status 16. Save event after treatment 17. Aggregating events in message 18. Integrate contents A1 19. Send messages to the TMS
Treat a message coming from TMS	<ol style="list-style-type: none"> 1. Store received message 2. Verify SOAP 3. delete envelope SOAP 4. Verify XSD 5. Verify event 6. Cut the message on unique event 7. Verify the coherence of the DATEX II format 8. Verify if event is bidirectional 9. Duplicate event, one by direction 10. Verify double 11. Decode message 12. Record event 13. Control of the dates 14. Add situationRecordCreationReference 15. Convert location (XY) 16. Verify location on the network 17. Modify nature 18. Create a unique ID 18. Generate traces and eventhistory 19. Update status 20. Save event after treatment 21. Choice the R-ITSS for sending 22. Send messages to the R-ITS-S, Vro-ITS-S and Nfr-ITS-S
Send a message	