



Detailed functional specifications of SCOOP platform

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Activity 2: Studies

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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

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The purpose of this document is to complete the platform's general specifications in order to carry out the SCOOP platform development order.

In this document, when an ITSS-R is mentioned, it covers both the fixed ITSS-Rs and the OBUs in mobile ITSS-R mode.

1. Introduction

The general objective of the SCOOP 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 prepare the vehicles of tomorrow

This deliverable presents the detailed specifications of the common SCOOP@F platform. It completes the prerequisites defined in the deliverables: L.2.4.1 and L 2.4.1.4 and must be compatible with the ITSS-R, OBU-RO and OBU-U specifications.

The Guide "Data exchanges for road use – Datex II Use - Part 1: publication of a traffic situation," October 2014, drawn up by the Datex II France Group, is the reference for everything that is not specific to this deliverable.

2. Description of the SCOOP platform

2.1. General presentation of the "common SCOOP@F platform" application

The common modular ITS platform to the SCOOP@F cooperative systems project (which will be called platform in this document for simplification purposes) aims to provide processing and communication between the project partners' traffic management systems (TMS) or management terminals (MT) (for simplification purposes the term TMS will refer hereafter to both TMS and MT) and the road side units (RSU or ITSS-R), which provide the communication through the "ITS G5" standard in the process of being validated with vehicles equipped with on board units (OBU). The standard being defined and validated at the ESC is taken from the ETSI technical specifications. It aims to provide the communication between vehicles (OBU↔OBU) and between vehicles and infrastructures (ITSS-R ↔ OBU) via a dedicated frequency (5.9 GHz) in ITS G5 (IEEE 802.11p).

The platform handles the communication from the TMS to the on board units and processes the information from the equipped vehicles, so the TMS can be informed of new situations (the role of the equipped vehicles is to serve as local sensors for the on board units).

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 concerning the traffic arteries defined in the repository.

The communication between the TMS and the common platform will be in DATEX 00 v2.3 for all currently anticipated use cases.

The data coming from the OBUs and relayed by the ITSS-Rs can originate outside the reference network. These data are transmitted to the platform, which stores them and processes them according to **Erreur ! Signet non défini..**

2.2. List of SCOOP system components

SCOOP system components shall designate all physical components that enable users to produce or exchange the messages required to produce the SCOOP use cases. They are listed in the table below with the SCOOP nomenclature.

The core components of the cooperative systems are the ITS stations as defined in the standard ETSI EN 302 665.

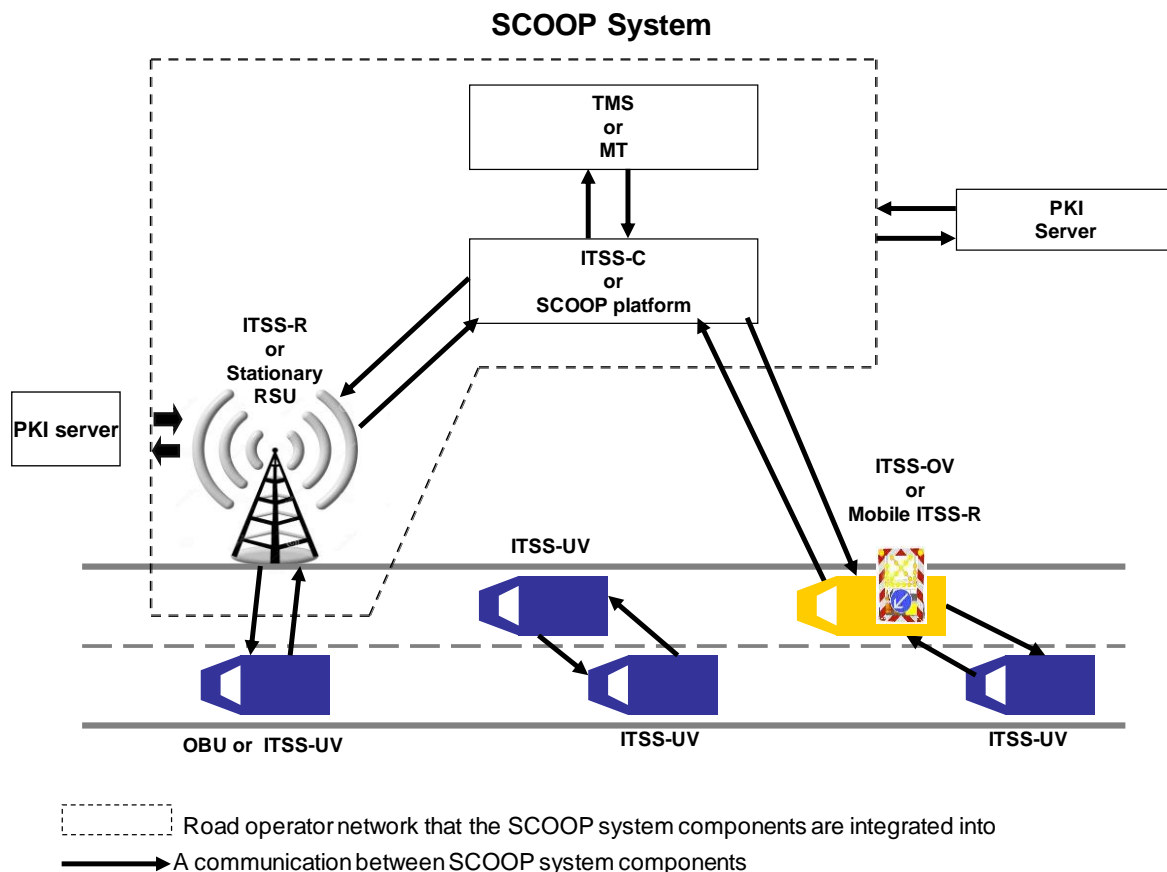
SCOOP system component and nomenclature		
ITSS-R/RSU = Road-Side Unit		
ITSS-V = vehicle ITS station = VEU = Vehicle Embedded Unit	ITSS-VG = ITSS-V manager = VEU manager = VEU m	ITSS-VG in "user" mode (includes the same functions as the ITSS-VU)
		ITSS-VG in "road operator" mode (includes the functions specific to the road road operator (e.g., "mobile ITSS-R" function))
	ITSS-VU = ITSS-V user = ITSS-VU = VEU u = VEU user	ITSS-VU Renault
		ITSS-VU PSA
		ITSS-VG in "user" mode
ITSS-C = central ITS station = SCOOP Platform		
Traffic Management System (TMS) or management terminal (MT)		
Traffic Management Centre (TMC) or Traffic Control Centre (TCC)		
Infrastructure à clés publiques = Public Key Infrastructure (PKI)		

Table of SCOOP system components and SCOOP nomenclature

The time synchronisation of all the elements is provided by a time server (using GNSS) through a NTP protocol (normal service).

In failsoft mode, in the case where the ITSS-R is equipped with a GNSS sensor, this sensor will provide it with the time synchronisation.

(Make sure that the ITSS converts the TAI time used in the CAMs and DENMs by the UTC time used in Datex II and conversely)

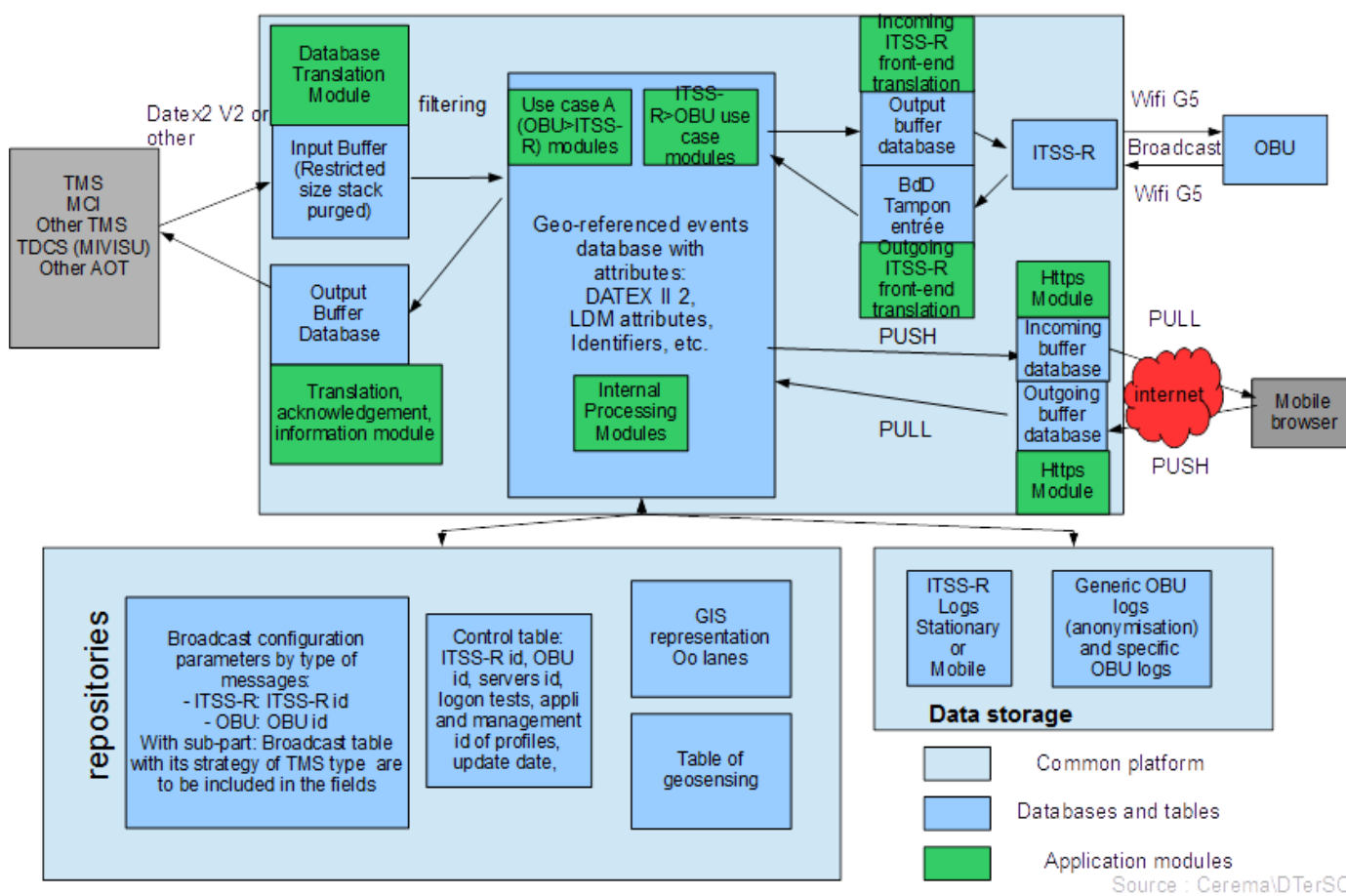


2.3. The platform in its data processing environment

2.3.1. Application schema

The application schema below is based on a DBMS and includes **all of the possible or expected functionalities of the application as well as the interfaces with other IS**. It is not a representation of the expected technical architecture, but only a technical possibility.

General schema of the software platform's operating principle



The acquisition and transmission of incoming or outgoing data must not disrupt the platform's ongoing operation and processing.

The platform's configuration, management and monitoring will be managed by the MMIs through web pages.

Access to the platform and web services will be authenticated. The MEEM's authentication tool called Cerbère (which is a personal secure authentication for one use session) will be usable for this authentication. Cerbère offers a standardised procedure that ensures secured and controlled accesses to data and programmes on the RIE Intranet, ADER inter-ministerial and Internet networks. This generic system makes it possible to manage the authentication of users (internal or external) accessing an application site and the access rights to the different modules of an application. This standard procedure can be used to ensure the homogeneity and reduce the costs of security developments in the applications.

For the non-ministry sites, other solutions will be implemented:

- It shall be possible to use Cerbère in dongle mode (with a local management of rights and profiles).
- The platform will be able to work with an authentication tool chosen by the site manager, which will interface with the platform (e.g., LDAP authentication server).
- Access to the platform through the MMI (web pages) will be differentiated according to several profiles (administrators, road operators, etc.), where each profile can be configured by the site administrator via the administrator profile.

2.3.2. Development tools

The platform should comply with the ACAI coherence environment concerning the MEEM's applications; see the address: <http://www.developpement-durable.gouv.fr/Le-cadre-de-coherence-technique.html>

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 platform'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 platform 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.

The SCOOP@F steering committee or the client may propose dispensing with other coherence environment rules.

The environment will 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 operating system's default packets.

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

For developments held in 2016, the Debian version in the process of being validated by MEEM is Debian 8 Jessie and the related environment: apache 2.4, postgres9.3/9.4 and Postgis 2.1.

A compatibility of the developments with the Redhat operating system will be sought.

2.3.3. Changes

Any other development on the platform will be implemented on the national platform (i.e., the platform ordered and deployed on the benchmark site: DIRIF) 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 platform or will have to ensure his changes to be adopted for the national platform.

2.4. The platform and its data processing environment

Incoming data come from traffic management systems, organising authorities (AOT or AOM according to the sites), road side units or other information suppliers. This may be traffic data, miscellaneous event data (traffic jams, accidents, incidents, obstacles, planned work, interventions and partial or total closure) or information messages for users. The format of incoming and outgoing data will be Datex II v2.3 on TMS, ITSS-R or OBUo for SCOOP messages.

Datex II v2.3 data will be acquired and transmitted based on several modes (push and pull) and via the web-service protocol.

Concerning exchanges between ITSS-R and the platform, the web-service (with a SOAP envelope) will be used in push on occurrence with acknowledgement of receipt. The platform will regularly (configurable) emit keepalives that make it possible to maintain the connection of the ITSS-Rs and OBUos to the platform. The model used will be the one recommended in the Datex II v2.3 technical specifications. (site www.datexII.eu). A

snapshot mechanism will be used, especially during communication resumptions.

The networks with which the platform will interact mostly use an IPv4 protocol. The ITSS-R/OBU communications can use indifferently the two protocols IPv4 and IPv6. Consequently, the interactions between the two protocols have to be anticipated in the operating system and application so the platform can operate indifferently under IPv4 and IPv6.

2.5. Construction of the SCOOP platform installation in each local sub-project

Five sites are planned in this project:

- part of the network of the Direction interdépartementale des routes de l'Île-de-France (DiRIF) (Greater Paris roads department)
- part of the network of the Direction interdépartementale des routes Atlantique (DIRA) (Atlantic roads department)
- part of the Brittany road network within the SCOOP@Ouest project
- part of the road network of the Isère department
- The A4 motorway, managed by SANEF

Each road operator is responsible for the installation and specific acceptance of the application. The necessary documents for these steps are provided to the road operator: the installation and user manuals, necessary acceptance manuals, etc.

The platform 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.

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

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

3. SCOOP platform functionalities

3.1. Summary of Scoop use cases

Extract of the deliverable 2.4.1.4 and referring to the chapter of this deliverable.

Name	Covered in this doc
A - Data collection	
A1: traffic data (position, speed, direction)	Chapter 3
A2 and A3: event data produced by the vehicle	Chapter 4
A4: vehicles' consumption data	NOT SPECIFIED
B: Alert - roadwork	
B1: alert - scheduled roadwork (stationary and mobile)	Chapter 5
B2: Alert - work on lanes	Chapter 5
B3: alert - priority winter road maintenance vehicles	Chapter 5
C - On-board signalling - driving information	
C1: Stationary signalling	NOT SPECIFIED
C2: real-time speed signalling	NOT SPECIFIED
C3: On-board VMS	NOT SPECIFIED
D - On-board signalling - unexpected and dangerous events	
D1: alert - temporarily slippery road	Chapter 4
D2: Alert - animal or person on the road	Chapter 4
D3: Alert - obstacle on the road	Chapter 4
D4: alert - stationary vehicles, breakdown	Chapter 4
D5: alert - unprotected accident area	Chapter 4
D6: Alert - low visibility	Chapter 4
D7: alert - wrong way drivers	NOT SPECIFIED - Chapter 4
D8: Alert - unmanaged blockage of a road	Chapter 4
D10: alert - emergency braking	Chapter 4
D11: alert - end of queue	Chapter 4
E - Information on road traffic	
E1: traffic colour	NOT SPECIFIED
E2: Transit time	NOT SPECIFIED
E3: Recommended itinerary – rerouting related to traffic conditions	NOT SPECIFIED
E4: information on access to amenities	NOT SPECIFIED
E5: information on access to services	NOT SPECIFIED
E6 (formerly D9): Alert - exceptional weather conditions	Chapter 4
F - Relay fleets and multimodality	
F1: location and availability of relay parking sites - static information	NOT SPECIFIED
F2: Location and availability of relay parking sites - real-time information	NOT SPECIFIED
F3: timetable of next TC departures (fixed)	NOT SPECIFIED
F4: timetable of next TC departures (real-time)	NOT SPECIFIED

3.2.3. PROCESSING OF INCOMING DATA

New data is processed in 3 steps:

- 1, the container is verified,
- 2, the content is verified,
- 3, the data is entered in the database.

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 Scoop deliverables).

The messages that do not comply with the Datex II v2.3 xml schema will be rejected.

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

- a check of the ITS station's or TMS' identifier (nationalIdentifier)
- a check of the event's identifier and version numbers
- a consistency check of dates: in particular make sure that the overallEndTime field is completely filled in, that the publication dates are after the event creation dates, etc.
- etc.

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 platform's database.

3.2.4. DATA PROCESSING IN THE PLATFORM

The list of correspondence between the Datex II and DENM messages is listed in the deliverable L2.4.1.4 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 OBU so they can be translated into DENM for distribution to the OBU (DENM: Decentralized Environmental Notification Message).

In particular it should be completed with geographic coordinates compatible with the DENM format (ETSR89, WGS84).

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 2.4.1.4 with the associated table, can be used to identify the items to complete in the Datex II v2.3 message emitted by the TMSs of the different road operators (to be defined based on the Datex II message models supplied by road operators in their use cases).

The geopositioning process is described in chapter 7 of deliverable L2.4.1.4.

When a Datex II v2.3 message does not contain the location in geographic coordinates, the platform will calculate the projection (geocoding) of the point (PR or Alert-C) + abscissa in geographic coordinates (ETSR 89 close to WGS84 used by the DENM format). This information will be provided in the "pointsbycoordinates" class.

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) LOP+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.

When the DATEXII v2.3 message includes a location in geographic coordinates within the "GroupOfLocations" class (PointByCoordinates or tpegPointLocation), these coordinates must be used.

The DATEXII v2.3 situations will be broken down into simple elements.

The type of roadway (single lane roads or separated lanes, in town or out of town) will be determined through the characteristics of each road operator's geographic repository.

The RoadType will be managed from a Datex II extension (RoadTypeScoopExtension class) defined in L2.4.1.4.

The platform must verify that the RoadType is properly filled in. If this information is missing, the platform must do the processing to extract the Road Type information from its geographic repository. Bear in mind, this information will then be transmitted by the ITSS-Rs in the DENM message.

The platform's processing to define the roadtype will be developed from the RIU type information (repository of the ministry in charge of transportation). Any other 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 inability to extract "Roadtype" information from a repository will not be blocking: if the necessary information is not present, the platform will not do the processing and will transmit the Datex message to the ITSS-Rs without the information, which consequently will not be transmitted by the ITSS-Rs to the vehicles in the DENM.

The platform will identify the receipt of a linear event on a bi-directional road. In such case, it will create two events from the initial event with two different identifiers (one for each direction) for the ITSS-Rs. The coordinates of the initial event are not modified. Only the traces, event history and event position are modified, so the vehicles can identify more easily the events that concern them.

The platform will convert the "lane" attribute transmitted by the TMS according to the specification of 2.4.1.4, with the lane number determined based on the geographic repository. The platform will transfer to the ITSS-R a DATEX II message with just the numbered lanes. As a reminder, in Datex the lanes in France are numbered right to left as in the DENM norm. However, it may receive from the TMS a message using a lane description (and not the expected numbering).

For example, the platform 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 ITSS-Rs can understand it. If it is a bidirectional road with three lanes, it should transmit the ITSS-Rs a message with: carriageway = "mainCarriageway" and lane = "Lane2".

Note that in the uplink direction it will not receive lane="middleLane" but only numbers.

3.2.5. TRANSMIT A MESSAGE – MANAGE GEOGRAPHIC REPOSITORIES

Based on a predefined traffic management policy (configuration and repository), the message will only be transmitted to the ITSS-Rs concerned by the message, whether they are fixed or mobile (the platform knows in real time the position of the mobile ITSS-Rs).

To this end, the configuration of the ITSS-R described in 3.6.2 defines among other things the notion of zone of influence by ITSS0R. Beyond the ITSS-Rs' 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 ITSS-Rs will transmit the message to the OBUs. This could be the ITSS-Rs 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.

The content of the Datex II v2.3 message sent by the TMS can also force the transmission of the message to specific ITSS-Rs through the platform, independently of the management rules established during the configuration. This point supposes defining a class of the Datex II v2.3 message containing the field dedicated to this information and disabling the ITSS-R's chosen processing.

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), as a reference point (RP) or an Alert-C point.

This section is described in the deliverable 2.4.1.4 chapter 7 for both the coordinated part and the trace part.

The platform must also verify that the ITSS-Rs acknowledge the message.

Beyond the specific transmission of each message, a complete transmission of all valid events to one or more ITSS-Rs will be planned, including in particular:

- when restarting the platform,
- when re-establishing a connection with an ITSS-R,
- periodically (one to several times per day).

This is the snapshot mode broadcast by the platform, periodically or on demand from the ITSS-R (or OBUo), corresponding to the Datex II operating mode 2 and 3.

METHODS OF CREATING THE STATION ID

The platform's station ID is unique and configurable for each road operator so it is unique (with a conf format in compliance with the deliverable 2.4.1.4: full 32-bit in hexadecimal format and completed to the left by 0s).

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

The incoming data are verified with respect to the expected format and the content, and then entered in the platform's database (see 3.2.3).

3.2.6. GENERATING TRACES AND EVENT HISTORY

The platform must make it possible to create one (or more) linears of points for an event from a geographic repository to create the trace, event history and speed limits on jobsites as described in deliverable 2.4.1.4.

These straight lines are added on the platform, which has a geographic repository, so the ITSS-Rs 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.

As a reminder and so ITSS-Rs that do not have mapping can perceive the event history, the platform has to generate a "HISTORY" linear totally enclosing the event's linear. This implies adding LOPs outside the jobsite zone (the points transmitted in the traces and the event history are the TMS's LOPs). This will make it possible for the ITSS-Rs to calculate the "topoint" distance between the last two RPs of the event history sent by the platform.

Refer to paragraph "7.5.4.3.2 DENM CREATION WITH EVENTPOSITION, WITH TRACES" of 2.4.1.4.

Explanatory schema below with an example of a linear jobsite

* All the stars are sent by the platform and all the dots (or their delta) must be present in the DENM.

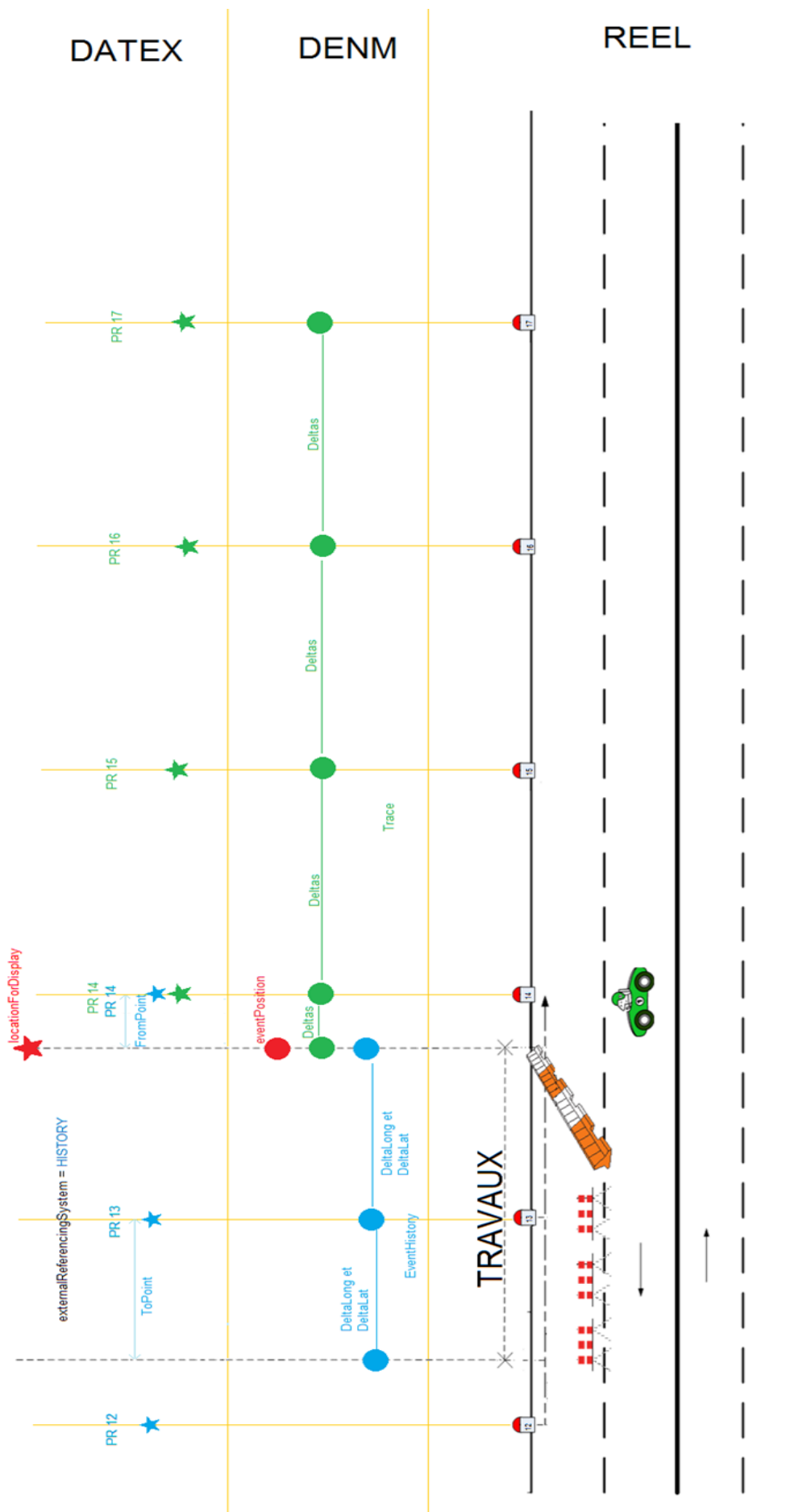


Schéma explicatif pour le cas du chantier linéaire

(valable pour les cas : EventHistory + au moins une trace)

3.2.7. LIFE OF THE EVENT

The platform must transmit all the updates (including the end of events) of Datex events sent to the ITSS-Rs, based on the Datex situations received from the TMS.

At their request, the ITSS-Rs will receive snapshots that can be used to reinitialise each ITSS-R's event tables and to make sure that the event updates are taken into account. Pursuant to the Datex norm, the platform will also request the snapshots (e.g., in case the platform restarts) from both the TMS (first) and the ITSS-R.

SPECIAL CASES OF SCHEDULED JOBSITES

Management of jobsite type scheduled events:

As soon as the entry of a scheduled event is finished in a TMS, it is sent to the platform.

Upon its receipt in the platform, it is stored. These scheduled events can be stored up to 1 year (sliding) of potential scheduling.

Case A - When the length of the scheduled event is less than 24 hr., it is sent as is to the ITSS-Rs, when the date and time of the start of the event have been reached, like any other unscheduled event except that the start time is defined in the <overallStartTime> attribute (Remember, the DENM norm does not authorised an event of more than 24 hr.).

Case B - If the event received by the platform will last more than 24 hr., it is cut up into n events of a maximum length of 24 hr. So constituted, these events are called "sub-parts of the event."

Planned procedure:

[Start of the loop]

The platform sends the first sub-part of the event if the following two conditions are valid:

- the start time (overallStartTime) has been reached, and
- the validPeriod is also valid.

The sub-part of the event ends as soon as the "validPeriod" time amplitude has been reached or the planned period of the initial event (overallEndTime) has been reached. A sub-part of the next event starts if it meets the start criteria of a new sub-part of the event; this causes the platform to transmit an update of the first sub-part of the event (same ID).

and so on for the subsequent days.

[End of loop]

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 ITSS-Rs.

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).

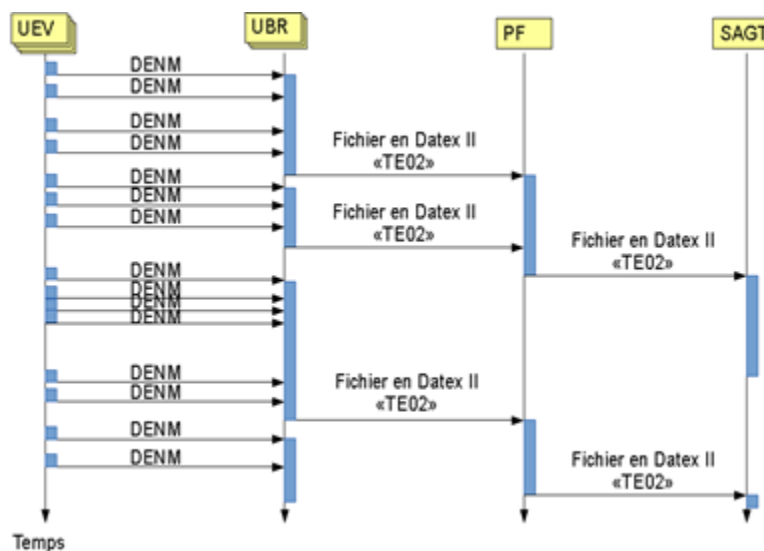


Illustration : Reporting events from DENMs

If the quality level in the message is not filled in, it is then calculated according to the following rule:

- if the confirmation option is activated: confirmed => Q3; just provisional => Q2; automatically confirmed if the scheduled event is entered in a lead-time less than the configurable threshold (168 hr by default). Therefore, the event must be confirmed to have a high-quality level. In the case where the confirmation would not appear, the event keeps its default quality level.
- if the confirmation option is not activated: Q3 if the event is scheduled in a lead-time less than this same configurable threshold (168 hr by default); otherwise Q2.

3.3. List of functionalities for the uplinks: From OBU to TMS

3.3.1. OPERATING SCHEMA

This involves aggregating a set of Datex II events based of type, zone, duration and quality criteria. If these criteria are reached, the platform will transmit a DATEX II message to the TMS.

3.3.2. LIST OF ITSS-R > PLATFORM USE CASES CONCERNED (DATEX CLASSES)

Extract of the deliverable 2.4.1.4 and referring to the chapter of this deliverable.

Uplink SCOOP 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-D10: Alert emergency braking
A2-D11: Alert traffic tailback
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
B1: Alert - scheduled roadwork
B2: Alert work on lane
B3: Alert - priority winter road maintenance vehicles

3.3.3. DATA PROCESSING IN THE ACQUISITION MODULE

Before being transmitted to the platform, the messages with vehicle data are pre-processed by the ITSS-Rs. The resulting data, which can be average speed type data, are then transferred by time intervals to the platform in Datex II v2.3 format.

As a reminder, the incoming data from the vehicles equipped with OBUs are transmitted to the ITSS-R as a vehicle data message (CAM: Cooperative Awareness Message) or a DENM event message. The data contained in the DENM messages can also be automatic or manual alerts (obstacle, accident, etc.) of events from equipped vehicles. These data, after prior verifications and translation of the DENM into Datex II v2.3, are transferred by the ITSS-R to the platform.

The messages received by the platform will be subject to an Action ID verification in order to eliminate potential duplicates. To this end, the acquisition module will keep all of the IDs of messages received for a configurable time interval. Duplicates can also be distinguished through the position and timestamp of the transmitted event (in case of a change of ID).

3.3.4. DATA PROCESSING ON THE PLATFORM

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

3.3.4.1. VEHICLE DATA MESSAGE

The content of these messages may be subject to a statistical treatment, like average, aggregation or sampling. The possible treatments for these data will be configurable on the platform.

The data will be associated with predefined measurement zones (predefined repository and unique identifier per zone). Based on a configurable time interval, the platform will transmit a Datex II "MeasuredDataPublication" type publication cumulating all of the measurement zones (see deliverable 2.4.1.4). The running count will be done on the last data uploaded by the ITSS-Rs, excluding the data located outside a configurable time interval (by default 10 minutes) from the instant the platform publishes.

In the first upgrade no statistical processing will be done. The platform will be limited to transmitting the Dates II files after the processing described in 3.3.4.2.

3.3.4.2. 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 platform will not be systematically uploaded to the TMS. The conditions for uploading to the TMS will be configured based on the types of event.

All events from the ITSS-Rs received by the platform will be positioned in X,Y and azimuth. They will carry a level of confidence, determined when the DENM is translated into Datex II using the probabilityOfOccurrence attribute.

The layout of each road operator's road network is integrated in the platform's GIS in vectorial form along with its reference points (RP and LOP). This network is geo-referenced.

The platform will include a set of information from the ITSS-Rs:

- the events received from the ITSS-Rs (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.

The log files will be used to monitor the operation of the algorithm, aggregations and uploads to the TMS. A log file will record all movements and all process carried out. The events outside the scope of the repository will be systematically logged with a specific message.

3.3.4.3. LOADING AND CREATING AN EVENT

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

If x identical events from the fixed or mobile ITSS-Rs (ITSS-R events) occur in a defined zone and in a defined time interval, an aggregation makes it a unique event (PFT event) transmitted to the TMS as soon as the transmission conditions are satisfied (type, duration, zone, quality).

If an aggregation of ITSS-R events (set of related events in a given zone, during a defined time period) corresponds to the upload conditions, the platform continues to process the ITSS-R events received as long as the aggregation continues, even if a PFT event was already created from this aggregation. This makes it possible to update the PFT event resulting from the processing.

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

If the platform receives a cancellation of an ITSS-R event, the ITSS-R event is noted cancelled and is no longer taken into account in the aggregation, thereby making it possible to create an event for the TMS.

3.3.4.4. UPDATING EVENT PREVIOUSLY UPLOADED TO TMS

In the case of a new version related to a type A2 or A3 pending event already uploaded by a PFT 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.

No update is transmitted to the TMS where only the location has changed.

This is true for use cases A2 and A3.

The algorithm could be upgraded later for certain mobile events (e.g., loose animal).

Events generated by road operator vehicles (different from DATEX II messages from OBUu's DENMs retransmitted by the OBUo) will be processed specifically. In this case the event will be uploaded to the TMS at the first occurrence with its quality level (normally Q3). 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 a update being uploaded to the TMS (case provided for in Datex II format). The cancellation or end of the event by the OBUo will result in the transmission to the TMS 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.

In the case of "blitz" messages sent directly from the OBUos to the platform, it should be possible to transfer a Datex2 message, depending on the TMS. This upload will be configurable.

3.3.4.5. LOCATION OF AN ITSS-R EVENT

Location in RP+abscissa

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+Abscissa (curvilinear abscissa) by orthogonal projection

If several segment or axis candidates are possible, the location and XY aggregation must be used.

If no portion of the network is found, the event is not kept.

Location in X,Y (on vectorial map)

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.

In both cases, a resolution with the postgis2.1 MIS tools may be proposed with a similar result.

3.3.4.6. AGGREGATION BY LOCATOR

To check whether the ITSS-T 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' RPs).

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:

- distance of (X,Y) 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 centre 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 $Da(\text{type})$ 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.

3.3.4.7. LOCATING AGGREGATED EVENTS

Location in RP

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

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

- the earliest point (if the use case is oriented)
- the latest point (if the use case is oriented)
- the average point
- 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 (RCS)).

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 RCS type).

Example 2: A3-D5 Accident is not oriented. The manual declaration could concern the opposite direction of traffic flow (even on RCS). 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.

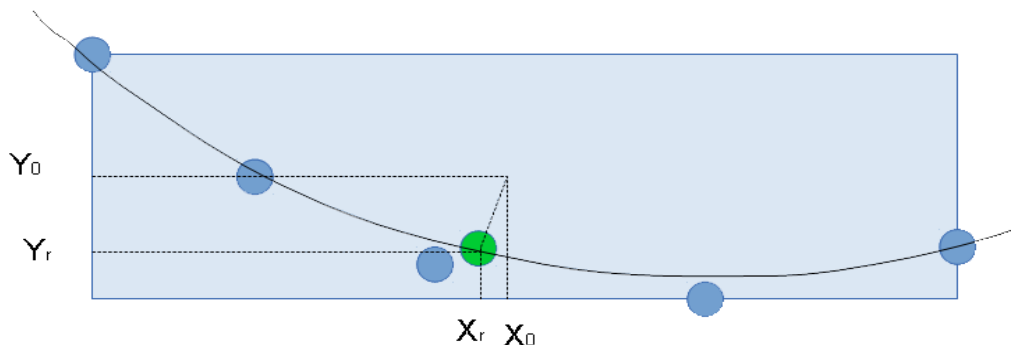
Location in X,Y

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:

$$X_0 = 1/2 [\min (X_1, \dots, X_n) , \max (X_1, \dots, X_n)]$$

$$Y_0 = 1/2 [\min (Y_1, \dots, Y_n) , \max (Y_1, \dots, Y_n)]$$

Point X_r, Y_r is obtained by projection of the X_0, Y_0 point on the segments of the network.



3.3.4.8. 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). In future upgrades, it will be possible to vary the values of variables based on time slots, type of day and level of traffic on the segment where the event is attached to.

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

Level of confidence condition

We attribute a weight to each level of quality: $Q_1 \rightarrow k_1$, $Q_2 \rightarrow k_2$, $Q_3 \rightarrow k_3$ and we set a minimum confidence level S_q (for each type of event).

We calculate the weighted level of confidence:

$$Q_p = k_1 \cdot N_{\text{messages}Q_1} + k_2 \cdot N_{\text{messages}Q_2} + k_3 \cdot N_{\text{messages}Q_3}$$

The upload condition is reached if the threshold is reached ($Q_p \geq S_q$).

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 an road operator vehicle, the event is uploaded,
- If the level of confidence condition is satisfied, the event is uploaded.

3.3.4.9. RECAP OF THE PARAMETERS TAKEN INTO ACCOUNT IN THE ALGORITHM

Type of network repository: PR+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

Alpha = 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.

3.3.5. 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.

3.4. Interfacing with the ITSS-Rs (fixed or mobile)

By default, the plan is for the communication with the ITSS-R interfaces to be done in Datex II v2.3 format.

The road operator OBUs will transmit to the platform their position in real time via a Datex II file (see appendix). The frequency of transmitting this file can vary (e.g., from 5 seconds to 10 minutes).

The position of these mobile ITSS-Rs (OBUos) can be made available in real time from an road operator server if it wants to process this information.

The communication from the road operator OBU 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.

3.5. Restitution MMI

The platform will offer to display in real time as web pages the information (Datex II, ITSS-R position) it has collected as well as the operating status of the OBUo. In no case should the application allow OBUos to be located. This way the user can have access to the platform's known ongoing events, traffic data, the status of operation of the ITSS-Rs (fixed or mobile), OBUos, etc.

These different data can be subject to differentiated displays via filters (type, source, status, 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. Repository, configuration and archiving

3.6.1. OTHER INTERNAL PLATFORM MODULES

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

The backup procedure will differentiate the repository and monitoring parts from the events and messages part. An automatic backup procedure with different time intervals will be developed.

The partial or total restoration will be done manually from the backups.

The archiving module will integrate a configured purge system, which will clean the database of elements past the retention time defined for archiving.

The archiving database and the logs should make it possible to replay prior situations and to diagnose the problems encountered.

3.6.2. CONFIGURATION REPOSITORY

A specific module will 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 platform will be delivered with default parameters.

3.6.3. GEOGRAPHIC REPOSITORY

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

This repository will be used in particular to calculate all of the necessary coordinates for the content of messages as well as to define the ITSS-Rs' zones of influence.

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

It may also be possible to export the platform's vectorial repository in a standard GIS format (e.g., SHP), in ETSR89 or WGS84 at the road operator's choice, to modify it with an external GIS tool, then to reimport it in the platform with the modifications.

3.6.4. MONITORING MODULE

All of the items used to monitor the system (servers, ITSS-R status, road operator OBU status, connections) will be put in a database and accessible via the monitoring module.

The status of the ITSS-R and OBUo equipment will be displayed on the cartographic MMI and browser via a colour code (green, orange, red), function of the equipment status (nominal, minor error or major error) and function of the returns on keepalive and data from the ITSS-R servers. For the OBUos, the on-screen location must be configurable and independent of the actual location.

3.6.5. ARCHIVING

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

3.6.6. LOGGING MODULE

It should be possible to independently log each process based on 3 trail levels (road operator, administrator and debugging).

3.7. Applications interfaced with common platform

DIRIF: SIRIUS2 application, DatexII v2.3 format, webservice, RP repository (isidor2)

DIRA: TIPI webservice application (coming), Datex II v2.2 format, future webservice, RP repository (isidor2)

ISERE: ITINISERE application, Datex II v2.2 format, https, webservice (client or server), XY and RP repository

SANEF: SAE SANEF, DatexII v2.3 format, webservice, RP repository (RIU), in principle no return from the platform to the TMS.

For the Ouest project, the development of a management terminal should adapt to the platform's technical specifications.