



French C-ITS Deployment Coordination committee

Deliverable specifications for Vro-ITS-S : hardware specifications

2.4.2.2 M

Activity 2: Studies

Sub Activity 2.4 > Specifications

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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

W > is the number of the version of the requirement

| ID | 2.4.X.XX-YYYY-ZZZ (W) |
|------------------------|---|
| 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 | |

Deliverable's documents

| Reference | Title | Version & Date |
|-----------|-------|----------------|
| | | |
| | | |

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Acronyms & abbreviations

| | |
|--------------------|--|
| AA | Authorisation authority |
| API | Application Programming Interface |
| AT | Authorization Ticket – certificate of right to perform specific actions |
| BTP | Basic Transport Protocol |
| C2C-CC | Car2Car communications Consortium |
| CA | Cooperative Awareness |
| CAM | Cooperative Awareness Message |
| CAN | Car Access Network – standard access bus to the vehicle electronics |
| CCH | Control channel |
| C-ITS | Cooperative Intelligent Transport Systems |
| DCC | Decentralised Congestion Control |
| DENM | Decentralized Environmental Notification Message |
| DP | DCC profile |
| DPID | DCC profile identifier |
| DSRC | Dedicated Short Range Communications |
| EGO vehicle | The vehicle itself in which the Vro-ITS-S is installed |
| GALILEO | European Global Navigation Satellite System |
| GLONASS | Russia Global Navigation Satellite System |
| GBC | Geo Broadcast |
| GN | Geo Networking |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HMI | Human machine interface |
| HSM | Hardware Secure Module |
| HST | Header Sub-Type |
| HT | Header Type |
| ICPU | Information and Communication Processing Unit (also called UTIC in french) |
| IF_ | Interface |
| ITS | Intelligent Transport Systems |
| IVI | Infrastructure to Vehicle Information |
| IVIM | Infrastructure to Vehicle Information Message |
| LDM | Local Dynamic map |
| LT | Lifetime |
| MAC | Medium access control |
| MAP | Geometric information for the intersection |
| MAPEM | MAP (topology) Extended Message |
| MHP | Maximum Hop limit |
| MIB | Management information base |
| Nfr-ITS-S | French National Node |
| NH | Next Hop |
| OBD2 | On-Board Diagnostic version 2 |
| PER | Packet Error Rate |
| PFro | Platform road operator |
| PKI | Public Key Infrastructure |
| POI | Point Of Interest |

| | |
|------------------|---|
| POTI | Position and Time management |
| R-ITS-S | Roadside ITS Station (RSU in the French Terminology) |
| RHS | Road Hazard Signalling |
| ROHS | Restriction of Hazardous Substances Directive 2002/95/EC |
| RSP | Wi-Fi ITS-G5 Roadside System Profile (short also Roadside System Profile) |
| RWW | Roadworks Warning |
| s | Seconds |
| SCF | Store Carry Forward |
| SHB | Single-Hop Broadcast |
| SPAT | Signal Phase and Timing |
| SPATEM | Signal Phase and Timing Extended Message |
| TC | Traffic class |
| TCC | Traffic Control Centre |
| TMS | Traffic Management System |
| Vro-ITS-S | Road operator vehicle equipped with mobile ITS-S capabilities and specific capabilities |
| Vru-ITS-S | User vehicle equipped with mobile ITS-S capabilities |
| VDP | Vehicle Data Provisioning |
| ITS-G5 | <p>ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). ITS-G5 refers to the approved amendment of the IEEE 802.11 (standard IEEE 802.11p). This technology (possibly others) uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications.</p> <p>In this document ITS-G5 stands for IEEE802.11p/ETSI ITS-G5.</p> |
| | |

Documents

The table of documents below contains the list of applicable references cited in this document. They refer to standards, technical specifications or reports and C-ITS project documents.

The applicable version of the different standards shall be found in project document 2.4.1_M_bis: List of standards.

This document is part of the 2.4.2.2 bundle on Vro-ITS-S, it is complementary to the high level 2.4.2.2_M_Vro_System which describes the Vro-ITS-S global system.

| standards | title |
|----------------------------|--|
| EN 301 893 | Broadband radio access networks (BRAN) ; 5GHz high performance RLAN ; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive |
| EN 302 571 | Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5,855 MHz to 5,925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive |
| TS 102 724 | Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band |
| TS 103 175 | Intelligent Transport Systems (ITS); Cross Layer DCC Management Entity ; for operation in the ITS G5A and ITS G5B medium |
| 2.4.4.8_M | Security System : integration guide for Migration of Pilot Validation PKI |
| 2.4.1_M_Bis | List of Standards |
| 2.4.2.2_M_Vro_System V0.20 | Vro-Global-System 2422_M - Main Document |
| 2.5.2.1_H | Document de conception – FP05 – Gérer un appel de détresse |

1. Introduction

1.1 Purpose of the document

This document aims to specify the first component to elaborate Vro-ITS-S that each road operator should acquire before adding the specific road operator C-ITS software, called SCOOP software.

This document specifies the detailed requirements of the Vro-ITS-S hardware and ICPU software that are deployed in the Scoop Project. The scope of the document includes the entire SCOOP@F wave 1 and a part of SCOOP@F wave 2: the hybridisation.

1.2 Document organisation

The complete specification for a Vro-ITS-S in the SCOOP project is comprised of several documents, the details regarding the content of the documents in the bundle are available in document "2.4.2.2_M_Vro_System":

The present deliverable focuses on the hardware of the on-board units of road operators composed of:

- an Information and Communication Processing Unit called "ICPU", enclosed in a case with connectors to other physical and logical resources,
- a tablet,
- back-end servers
- antennas

1.3 Vro-ITS-S interfaces

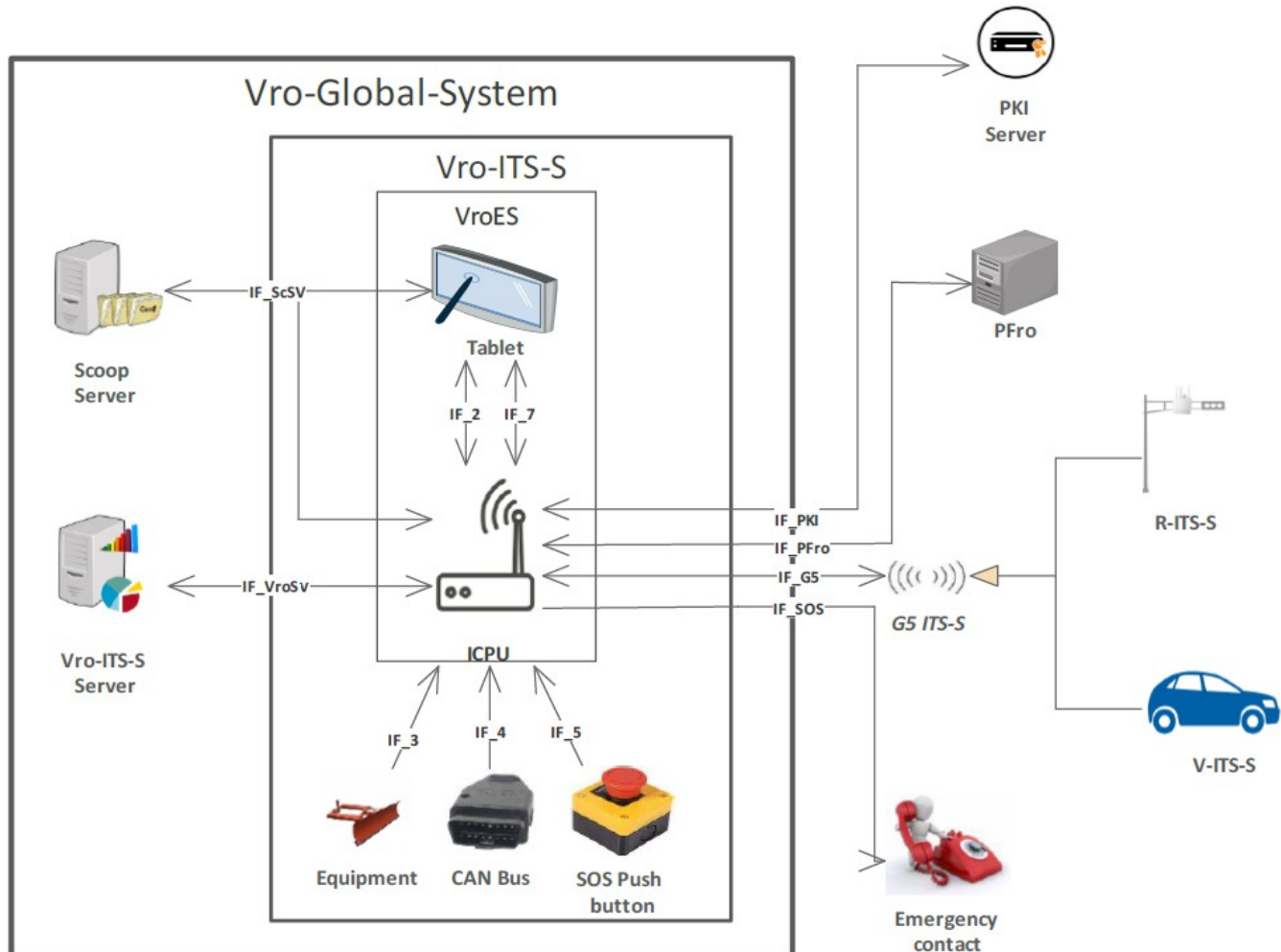


Figure 1: Interfaces between Vro-ITS-S and other components of the C-ITS environment

Figure 1 presents all the communication interfaces between the different elements of the ecosystem of the Vro-ITS-S.

The Vro-Global-System is composed of:

- **ICPU** (+antennas): unit which main feature is to centralise the communication (IP - V2X – GPIO - CAN) and to manage the treatment of a major part of the data.
- **Tablet**: it holds the HMI services that allow the driver to inform / to be informed of an information in its close environment. The tablet is linked to the ICPU via a WiFi connection, IF_2 and IF_7 interfaces described in 2.4.2.2_M_Master_v0.20 § 7.2.3.
- **Vehicle** equipment (including CAN - Equipment – SOS push button): passive or active systems with a wire connection to the ICPU. Their main role is to provide information to the VroES, e.g. CANBus => wipers on; Equipment => Snow plough active

- **Scoop Server:** Scoop Server is a local server on which resides the Scoop Server Software. The hardware does not have to be specifically dedicated for this application. Other applications like Vro-ITS-S Server can reside on it.
- **Vro-ITS-S Server:** same as Scoop Server above.

IF_Pfro, **IF_PKI**, **IF_Nfr**, **IF_ScSv** and **IF_VroSv** may use the wi-fi or cellular capabilities offered by the ICPU as described in this document, paragraphs § 3.3.4 and § 3.3.5.

IF_SOS uses cellular capabilities offered by the ICPU as described in this document, paragraphs § 3.3.5 and § 5.

IF_G5 uses G5 capabilities offered by the ICPU as described in paragraph § 3.3.3.

IF_2 and **IF_7** use the wi-fi capabilities offered by the ICPU as described in this document, paragraph § 3.3.4.

IF_4 uses the CAN interface offered by the ICPU as described in this document, paragraph § 3.5.2.

IF_3 may use the wi-fi or GPIO capabilities offered by the ICPU as described in this document, paragraphs § 3.3.4 and § 5.1.1.

1.4 Vro-ITS-S hardware architecture

Figure 2: Overview of a typical Vro-ITS-S embedded hardware architecture

The Vro-ITS-S physical parts embedded in the vehicle are composed of:

- a central station for data processing : the ICPU,
- a tablet, for the human machine interface
- antennas,
- SOS physical button (if installed),
- Connectors with the rest of the vehicle and equipments.

2. Functional ICPU specifications

The main functionalities of the ICPU that depend on its physical resources are:

- to send and to receive C-ITS messages to/from other local C-ITS stations on G5,
- to send and receive C-ITS messages using data over cellular link,
- to send an emergency call (handle the technical connection),
- to handle the C-ITS security (presence of HSM),
- to handle position, time, and temporal synchronisation (presence of GNSS sensor),
- to handle all inputs/outputs interfaces such as CAN bus, USB, Ethernet, radio communication capabilities (G5,WiFi, cellular...), and secondary equipments,
- to monitor the ICPU state and its capabilities.

3. Hardware specifications

3.1 Summary

All aftermarket-equipped road operators fleet vehicles will be comprised of the same hardware configuration as shown in the illustration below.

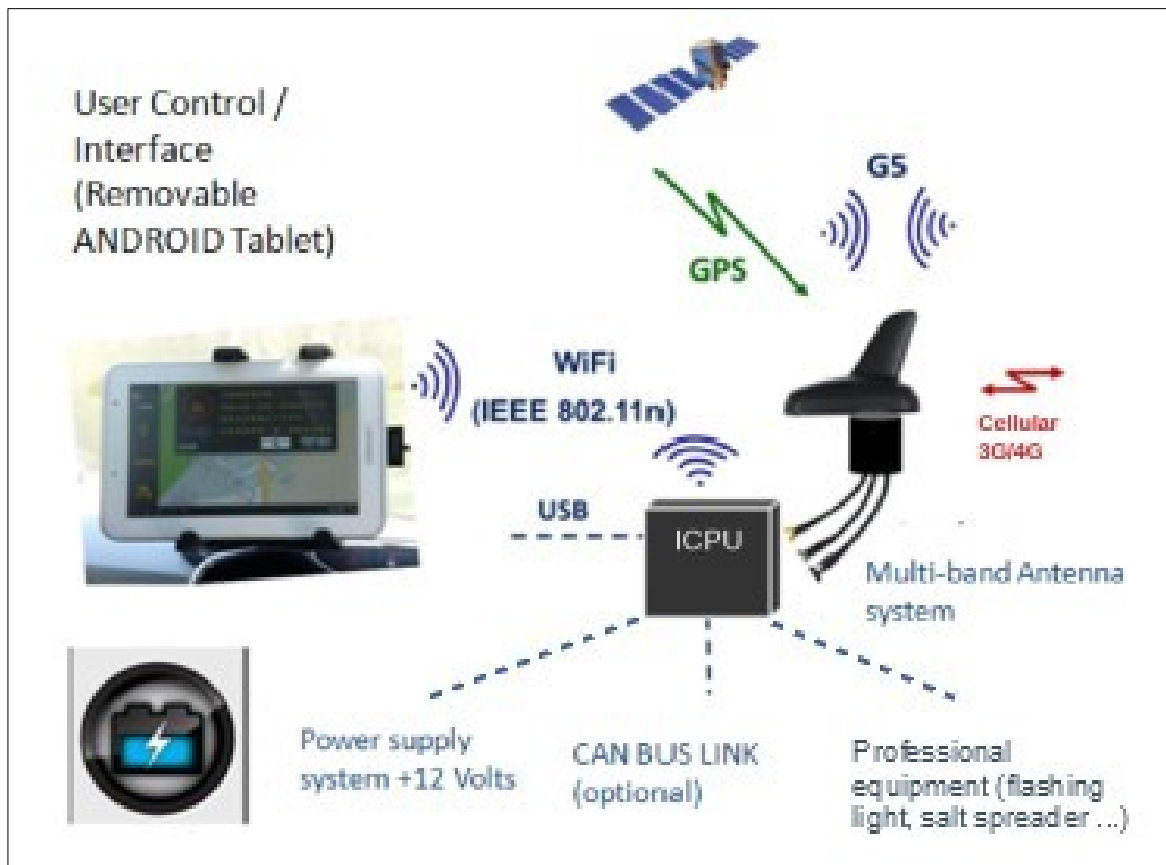


Figure 3: Generic on-board configuration of a Vro-ITS-S

This Vro-ITS-S hardware configuration will be comprised of the following elements:

- **ICPU case:** also described in this document by the generic term “ICPU”.
 - The ICPU motherboard and its components capable of handling all system and application processes:
 - different communication or sensor modules (WiFi, cellular, GNSS, ITS-G5 radiocommunication module...)
 - a +12V/+24V power supply system (vehicle battery or auxiliary battery for towed vehicles),
 - connectors to external devices, sensors, modules and antennas (USB, RJ45, FAKRA, GPIO...)
- **Tablet:** A removable tablet providing the interface with the user (HMI) used to communicate orders / information to the ICPU and receive information from the ICPU to display to the user. This tablet is optional and may not be included in the Vro-ITS-S in some configurations.

- **Antennas:** A multi-band antenna system integrating all antennas necessary for external communications (G5, 3G/4G, GNSS) in the same package (see the type of package to use based on the type of vehicle).
- **Cables:** the cables required to interconnect the Vro-ITS-S's various components among themselves and to the vehicle's on-board electronic system via the CAN bus. They are used to connect to the secondary equipments of the vehicle, depending on the vehicle type (e.g. salting and snowplow equipments for a wintry viability truck, trailers for intervention, vans, etc.)
 - The CAN bus, if available
 - The battery
 - The emergency physical button, if installed

3.2 Environmental specifications

All of the Vro-ITS-S components will be mounted inside the vehicle except for the antennas, which will be mounted on the roof of the vehicle or on components on the outside of the car/truck body depending on the type of vehicle (pre-study to be carried out by type of vehicle to ensure the radio waves are propagated omnidirectionally to the required distances (e.g., min. 300 m for ITS-G5, 360° around the antenna).

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-001 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Vro-ITS-S station shall comply with Regulation (EC) No 661/2009 of the European Parliament and of the Council of 13 July 2009 concerning type-approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefor (Text with EEA relevance), specifically regarding radio interference and electric safety. |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-002 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Vro-ITS-S station shall comply with Regulation No 10 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility. |
| Additional information | In the event that an ICPU is mounted on a towed vehicle, the suitability of automobile norms for this type of vehicle will have to be verified |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-003 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Vro-ITS-S station shall comply with Recommendation 1999/519/CE of the Council of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-004 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Vro-ITS-S station shall comply with Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-005 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall comply with EN 302 571 regarding radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive. |
| Additional information | The version of EN 302 571 to be followed is indicated in 2.4.1_M_Bis. |

3.3 Information and Communication Processing Unit (ICPU)

The Information and Communication Processing Unit (ICPU) to be supplied is a case integrating all of the hardware and software components necessary to run the C-ITS station, manage the Vro-ITS-S applications, and all communications exchanges linked to V2V and V2I communications, 3G/4G communications and WiFi communications (dedicated to the interface with the tablet or dedicated professional equipments and administration functions). This case also includes all the plugs and interfaces with the vehicle's antenna system, CAN bus (if available for the type of vehicle in question) or dedicated professional equipments.

The ICPU motherboard and its components contained inside the case are in charge of handling all system and application processes:

- handling of all protocols and exchanges necessary for the functional specifications to run smoothly (WiFi, cellular, ITS-G5, GNSS sensor, CAN bus, GPIO connected devices...).
- implementation of the needed stacks such as ITS-Stack, IpV4-Stack, IpV6-stack...,
- running the different software applications installed,

The modules associated to the motherboard are typically the external communication modules such as ITS-G5 radiocommunication module, WiFi module, cellular module, GNSS module.

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-006 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The design of the ICPU should be as modular as possible to facilitate any repair processes, technology upgrades or changes in the means of communication used. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-007 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU motherboard characteristics shall be adjusted so as to support all software requirements detailed in 2.4.2.2_M_Vro_System. |
| Additional information | |

3.3.1 ICPU Case

This case (see Figure 4, which provides an indicative example of size and wiring) shall be positioned in the vehicle near the multi-band antenna system so as to reduce the length of cable between these two components (on the order of 2 m long maximum) and thereby reduce the attenuation losses of the radio signals transmitted and received. This case shall be connected to a +12V or +24V battery and to the vehicle's ground according to the specifications provided in section 3.3.2.

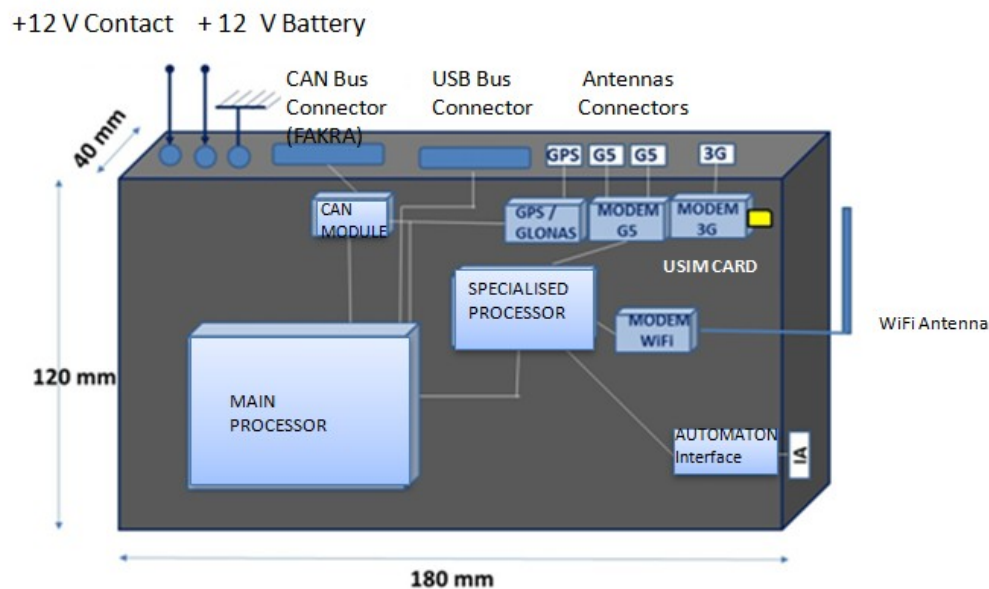


Figure 4: Indicative example of an ICPU case

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-CAS-001 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall be protected in a case whose dimensions shall not exceed 200 x 180 x 50 mm. |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-CAS-002 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The case shall respect the minimum following protection level : IP65 and IK08, related respectively to the protection against external objects and water intrusion, and against the external mechanical impacts. |
| Additional information | |

3.3.2 Power supply system + 12 V/+24 V

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-POW-001 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU will be powered on +12 Volts or +24 Volts (depending on the vehicle type) by a direct connection to the vehicle's battery or to an auxiliary battery. |
| Additional information | |

In order to allow the ICPU to be disconnected from the vehicle's battery without risk of affecting this unit's clean restart, it will have to be installed as shown in the illustration below.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-POW-002 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU complete shutdown shall be triggered by a voltage drop that is characteristic of a complete vehicle stop, special care shall be taken to select the correct connection point and not to misinterpret the voltage drops due to functions such as "start and stop" or the consumption of other electrical components |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-POW-003 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The installation of the ICPU shall allow for a clean backup of the context before disconnecting from the battery, which may be necessary if the vehicle is immobilized for a long period of time or if there is a battery problem. The default timeout before complete shutdown of the ICPU after the car is powered down shall be set to <i>p_lcpu_ShutdownDuration</i> seconds. |
| Additional information | <i>p_lcpu_ShutdownDuration</i> shall be configurable, its value is comprised between 1 and 60 (default value is 1) |

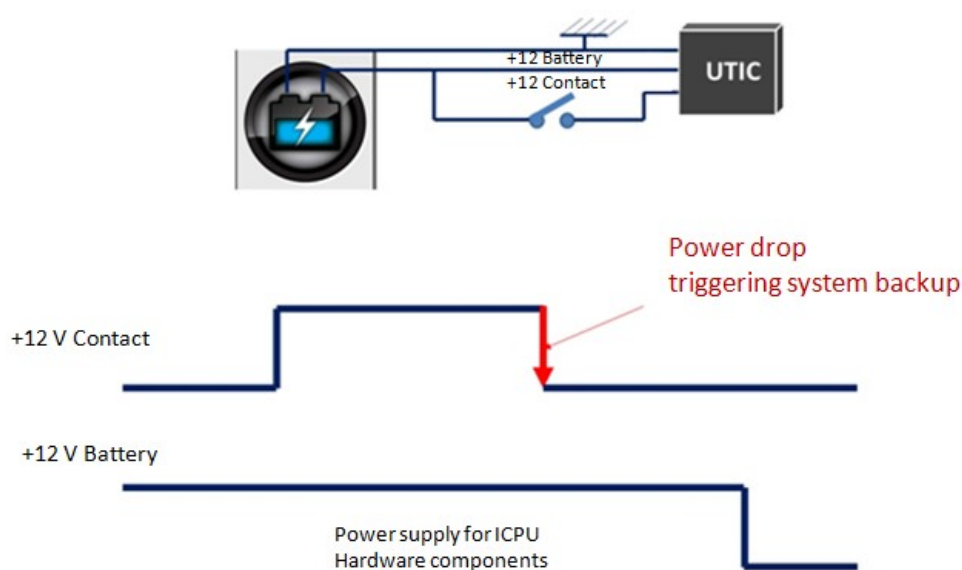


Figure 5: Context backup before disconnecting from the battery

3.3.3 G5 module

The interface IF_G5 uses the G5 communication capabilities offered by the G5 module, embedded in the ICPU, and that shall itself comply with the following requirements.

The ICPU shall integrate a G5 modem in accordance with the following ETSI norms. It shall have passed the related compliance tests (e.g., latest ETSI PLUG TESTS):

- Norm EN 302 571: *“Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive”*.
- Norm EN 302 663: *“Intelligent Transport Systems (ITS); Access Layer Specification for Intelligent Transport System Operating in the 5 GHz frequency band”*.

The versions to be used for those norms are detailed in deliverable 2.4.1_M_bis.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-009 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall be able to communicate on two G5 channels that can transmit and receive simultaneously in the assigned frequency bands (G5A and G5B), namely 5.855 and 5.905 Gigahertz as specified in TS 103 175. |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-FAC-001 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | Emission power and message frequency shall be adjustable according to DCC mechanisms in order to comply to TS 102 687, TS 103 175 and TS 102 724 |
| Additional information | |

3.3.4 WiFi module

The interfaces IF_2, IF_7 use the WiFi communication capabilities offered by the WiFi module embedded in the ICPU, and that shall itself comply with the following requirements.

Optionally the interfaces IF_PKI, IF_VroSv, IF_ScSv and IF_3 may use the WiFi communication capabilities offered by the WiFi module.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-010 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall integrate a WiFi modem that meets at least the IEEE 802.11g/n norms. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-011 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | If the 5GHz band is used for WiFi communications, the ICPU shall comply with EN 301 893: Broadband Radio Access Network (BRAN); 5 GHz high performance RLAN; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive. |
| Additional information | The version of EN 302 893 to be followed is indicated in 2.4.1_M_Bis. |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-012 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall allow the power transmission to be adjusted so it can be limited to the strict minimum required to ensure good communication inside the vehicle (even with the removable tablet located a few metres outside the vehicle in some scenarios). |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-013 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The WiFi module shall allow WiFi direct with the use of WPA2 or ulterior to secure the connection. |
| Additional information | |

3.3.5 Cellular module

The interfaces IF_PFro, IF_Nfr, IF_PKI, IF_SOS, IF_ScSv, IF_VroSv use the cellular communication capabilities offered by the cellular module embedded in the ICPU, and that shall itself comply with the following requirements.

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-014 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall integrate a standard cellular modem of the third generation minimum (3G minimum). |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-015 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | An easy physical access shall be given to the SIM card slot in order to allow an easy change of card by an operator. |
| Additional information | |

3.3.6 Satellite signals receiving module

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HAR-016 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall integrate a GNSS module capable at a minimum of receiving and processing the information received from the Galileo positioning system and GPS positioning system. |
| Additional information | The GNSS module may use complementary positioning systems (GLONASS, BeiDou, other actual or future systems) in order to improve positioning accuracy. |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HAR-017 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The ICPU shall integrate a GNSS module capable at providing position and time information at a rate of 10Hz to the POTI module. |
| Additional information | |

3.3.7 Position and Time management (POTI)

The POTI (Position & Time management) function will supply the necessary position data (longitude, latitude, altitude and accuracy) and time (with a high level of precision) for the EGO vehicle to constitute messages and to operate its applications. Precise time is of utmost importance in numerous processes (CA basic service, DEN basic service, LDM, etc.).

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-FAC-005 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | POTI facility shall provide position, time and related indicators (precision accuracy) at least at a 10Hz frequency. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-FAC-006 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | POTI facility shall comply with EN 302 890-2. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-FAC-007 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | Complementary to positioning information, POTI facility shall provide positioning accuracy information (eg a confidence ellipse) as specified in EN302 637-2. |
| Additional information | Semi-axis length of the ellipse are provided to other services. |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-FAC-014 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | Under optimal GNSS conditions (open field, no sky obstruction), the confidence values shall be equal to or lower than the following values in at least 95 % of 3D position data points in a dataset: horizontal position confidence of 5 m, vertical position confidence of 15 m |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-FAC-015 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | In order to ensure higher accuracy and continuity of service, the GNSS sensor shall be able to estimate the position of the Vro-ITS-S using at least two different satellite constellations (GPS, GALILEO, GLONASS, BEIDOU, ...) |
| Additional information | |

3.3.8 HSM hardware security module

The ICPU shall manage the security of V2X communications in accordance with the ETSI standards. The security of the V2X module and in general the on-board system requires a specific hardware component to store critical data (certificates and identifiers) and to process in real time the messages transmitted and received (signed and authenticated messages). This hardware component identified as HSM (Hardware Security Module) shall comply with the ETSI norms (for more details see the deliverable 2.4.1_M_bis).

The Hardware Security Module is a physical computing device that is highly secure. It generates, stores, protects cryptographic keys and provides cryptoprocessing. If it is handled physically, it can erase its data.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HSM-001 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall respect international security standards like EAL4+ Common Criteria and shall support cryptographic APIs. |
| Additional information | |

3.3.8.1 Mandatory Functions

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HSM-002 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall store the critical security components like private keys. |
| Additional information | |
| ID | 2.4.2.2_H-HSM-003 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall perform cryptographic operations with the stored private keys. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HSM-004 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall support Cryptography algorithms presented in ETSI TS 103 097 V1.2.1: <i>"Intelligent Transport Systems (ITS); Intelligent Transport Systems (ITS); Security; Security header and certificate formats"</i> |
| Additional information | |

3.3.8.2 Optional Functions

The HSM shall be able to perform the operations below, these functions shall be executed upon request from the application, security or management layer. Nevertheless, if the HSM does not perform these processes, the ICPU must perform them.

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HSM-005 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall be able verify the certificates. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HSM-006 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall be able to compute the signature of the received messages according to specifications in 2.4.4.8_M. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HSM-007 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall be able to store the certificates and the public keys of the certificate authorities. |
| Additional information | |

3.3.8.3 Self-erasure of data

Optionally, The HSM can self-erase its data.

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-HSM-008 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall have optional self-erasure functions (for instance, in case of wrongful handling, wrongful opening or connection with an unauthorized device, either on the USB port or via Ethernet cable...) |
| Additional information | The erasure can be deactivated for the tests on the prototypes. |

3.3.8.4 Minimum performances linked with security;

This module shall have the following capabilities:

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HSM-009 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall be able to perform tamper-proof identity management ($\geq 3,000$ keys) and signature generations ($\geq 20/s$, ≤ 50 ms latency), |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-HSM-010 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Hardware Security Modules shall be able to perform message signature verification with high rate ($\geq 200/s$) and low latency (≤ 5 ms). |
| Additional information | |

This performance can be achieved using this single hardware module or the support of another processing unit.

3.4 Multi-band antenna system

The Vro-ITS-S requires the access to at least 4 frequency bands. The multi-band antenna system should be integrated in the same case with an appropriate shape factor for the type of vehicle considered (e.g., shark fin for consumer vehicles) and located outside the vehicle. These 4 bands are:

- The GNSS antenna used to received satellite signals from the GALILEO, GPS and GLONASS constellations,
- Two G5 antennas (5.855 to 5.905 GHz) used to transmit and receive in the G5A and G5B bands specified by ETSI,
- One 3G/4G cellular antenna

Optionnaly, antennas dedicated to the WiFi may be integrated or connected to the Vro-ITS-S.

Optionally, the vehicle can be equipped with a DSRC radio sensor operating in the 5.795 to 5.815 GHz band to be used for mitigation in the DCC mechanism as exemplified in EN 302 571.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-ANT-001 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The GNSS, cellular and G5 antennas shall be mounted outside the vehicle and grouped in the same package and positioned so that the G5 bands can propagate 360° (circular propagation) over a minimum line of sight distance of 300 m. |
| Additional information | Depending on the vehicle, if it is impossible to secure this G5 circular propagation, a configuration using two G5 antennas can be used to optimize the emission in front and behind the vehicle. |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-ANT-002 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The WiFi antenna must allow communications between vehicle equipment in or near the vehicle, its transmit power must be adaptable to minimize power emission while ensuring communication capabilities. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-ANT-003 (1) |
| Component(s) | Vro-ITS-S ICPU |
| Requirement | The Vro-ITS-S can be equipped with a CEN DSRC radio detector working in the 5.795 to 5.815 GHz band that complies with the EN 12573 standard. |
| Additional information | |

| | |
|--------------------------------|--|
| Type of system | Antennas |
| > ELECTRICAL DATA | |
| Emission | Omnidirectionnal radiation |
| Type | Multiband mobile antenna: cellular (3G+) / GNSS / ITS-G5 |
| Impedance | 50 ohms |
| Connector | SMA |
| Gain | >0 dBi on all the bands |
| Max input power | >5W |
| SWR | 2 on all the bands |
| > MECHANICAL DATA | |
| Material | fibreglass or anti-UV handled PVC |
| Height or length | maximum envelope of 200 mm |
| > ENVIRONMENTAL DATA | |
| Temperature range | -35°C til + 70°C |
| Ingress protection | IP67 |

The supplier shall provide the following indications:

- Antenna gain,
- Dimensions,
- Weight,
- Shape factors,
- Method of attachment,
- Temperature range,
- Vibration and impact resistance,
- Types of connecting cables and connectors available,
- Cables' attenuation per metre.

3.5 Connection to on-board electronics

3.5.1 General principle

Connection to the vehicle's on-board electronics should be done via the one or more available CAN BUS. In principle, a connection to the standard OBD2 (On-Board Diagnostic version 2) socket should make it possible to collect the required data, constitute CAM and fulfil the triggering conditions for automatic event messages (DENM).

However, it should be verified that the car manufacturer accepts a connection to the OBD2 socket when the vehicle is moving and therefore does not risk interfering with his expected behaviour or movement.

In the event that it would be impossible to easily connect to the vehicle's CAN BUS (old model, technical difficulty), the ICPU will only process a restricted number of DENM messages triggered manually.

3.5.2 CAN interface

The interface IF_4 use the CAN Bus communication capabilities offered by the CAN Bus interface embedded in the ICPU, and that shall itself comply with the following requirements.

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-CAN-001 (1) |
| Component(s) | Vro-ITS-S CAN Interface |
| Requirement | The vehicle's electronics shall be accessed via the vehicle's CAN bus. This access will be by preference via the standard OBD2 (On Board Diagnostic version 2) socket. |
| Additional information | The access hardware shall previously be certified by the vehicle manufacturer or an accredited certification body (e.g., UTAC). |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-CAN-002 (1) |
| Component(s) | Vro-ITS-S CAN Interface |
| Requirement | It shall be possible to connect the ICPU to the CAN bus using an USB type connector integrated in the ICPU and a USB/OBD2 cable. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-CAN-003 (1) |
| Component(s) | Vro-ITS-S CAN Interface |
| Requirement | The parsing and processing of data circulating on the CAN bus shall be easily configurable depending on the vehicle (type, brand) through the use of a dedicated interface and appropriate libraries. |
| Additional information | |

3.6 Connectors

The ICPU and the tablet should be connected together via a wireless connection (IEEE 802.11g/n) but may be connected via a USB solution depending on the road operator's preference.

Other cabled connections will be necessary:

- The connection between the ICPU and the access to the vehicle's CAN BUS (via the OBD2 socket). This connection has no length constraints and shall be made with a standard cable sold for this type of connection. An adaptation case may be required depending on the type of connector and the electronic characteristics of the hardware components used in the ICPU. Preference shall be given to a direct connection without adaptation.
- The connection between the ICPU and the external antennas (GPS, G5 and cellular). This connection should be as short as possible in order to limit losses in the cable. This constraint results in positioning the ICPU near the antennas in order to limit the length of cable to less than two metres. The GPS cable shall be equipped with a connector that can connect directly to the ICPU. "SMA" type connectors will be preferred for the G5/GNSS/cellular antennas in the ICPU. A direct connection will be preferred. The use of SMA connectors can be considered both in the antenna outlet and the ICPU case.
- The Vro-ITS-S may use its GPIO connector to interface with proprietary secondary equipments (road operator specific equipments). This GPIO shall be programmable using management functions of the access layer.
- The +12V or +24V power supplies and the ground will be taken from the vehicle at the available locations, both for the ICPU and the tablet. Since the antenna system is passive, it does not need a power supply.

4. Tablet specifications

When the ICPU is interfaced with the tablet via the local WiFi network. WiFi direct must be used, which doesn't require the presence of a Hotspot. The bidirectional communications between the ICPU and the tablet will be supported by the communication profile TCP/IPV4.

This tablet will also include a navigation system used to geolocate the vehicle and the necessary events / POI for dedicated professional applications. This navigation system may also be used to guide the vehicle's driver.

The HMI interface messages will be exchanged between these two elements (see 2.4.4.2_M_Vro_HMI for details).

4.1 Human Machine Interface

4.1.1 Description

The user HMI will be provided by the tablet, which will be removable, mounted on an appropriate support.

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-TAB-001 (2) |
| Component(s) | SCOOP Tablet HMI |
| Requirement | This tablet shall be powered by the vehicle with or without a power adapter. |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-TAB-002 (1) |
| Component(s) | SCOOP Tablet HMI |
| Requirement | This tablet shall be equipped with an OS allowing the installation of professional road operator software as described in document 2.4.2.2_M_bis. |
| Additional information | |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-TAB-003 (1) |
| Component(s) | SCOOP Tablet HMI |
| Requirement | The supplier shall propose a method of attachment for the removable tablets. |
| Additional information | This method of attachment will depend on the type of vehicle considered. |

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-TAB-004 (1) |
| Component(s) | SCOOP Tablet HMI |
| Requirement | The supplier shall provide a tablet able to conform to the needs and functions presented in 2.4.2.2_M_Vro_HMI. |
| Additional information | |

4.1.2 Technical characteristics of the HMI system

| | |
|-----------------------------|---|
| Type of system | Tablet / mini tablet |
| Size | Length: $170 < L < 230$ mm Width: $110 < W < 140$ mm Thickness: $10 < T < 15$ mm |
| Weight | Maximum 500g |
| Water and dust resistance | IP68 |
| OS | See 2.4.2.2_M_bis recommendations |
| Battery | > 4 000 mAh |
| Internal memory | > 16 Gb |
| Card reader | Yes |
| CPU | > Octo-core 1,6Ghz |
| RAM | > 3 Go |
| Graphics chipset | No preference |
| GNSS | yes |
| <u>> DISPLAY</u> | |
| Resolution | 1280 x 800 |
| Type of screen | No preference |
| Multipoint | Optional |
| <u>> MULTIMEDIA</u> | |
| Flash | yes |
| Webcam (frontal) | Optional |
| Video (resolution, formats) | Optional |
| <u>> CONNECTORS</u> | |
| Mobile network | To be defined by the operator |
| Bluetooth | Optional |
| WiFi | 802.11 g/n |
| USB | Minimum USB 2.0 preferably (USB 3.0/3.1) |
| HDMI | Optional |
| <u>> OTHER</u> | |
| Accessories to Supply | Charger 240/220V Vehicle charger, 12V adaptable on cigarette lighter Vehicle support (Support characteristics, see B.2) Protective case against breakage and excess heat and cold (Case characteristics, see B.3) Screen protector in glass or Plexiglas 32 Gb memory card, compatible with the system |
| OS requirements | Availability of Google Play Open system with the ability to access in debug mode from the most common IDE (Eclipse / NetBeans) |
| Other | Compatible Adobe Flash |

4.1.3 System mounting bracket

4.1.3.1 General requirements:

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-TAB-005 (1) |
| Component(s) | SCOOP Tablet HMI |
| Requirement | The supplier shall provide a tablet bracket capable of holding the tablet, this bracket shall not use glue or magnets and shall resist daily sunlight. |
| Additional information | |

The main characteristics expected of this support are the following:

- A base with a suction mechanism that makes it possible to position the suction pad solidly on almost any surface like glass, wood, metal, plastic, plaster, etc.
- A silicon covered clamp to hold the tablet
- A bracket that can be adjusted at any angle to adapt to the user's position

4.1.3.2 Technical description of the bracket:

- Suction pad to solidly attach the bracket to any smooth, flat surface
- Rotary axis that can adapt to any angle
- Clamp that can adapt to all tablets that fall within the following dimensions:
 - Length: $170 < L < 230$ mm
 - Width: $110 < W < 140$ mm
 - Thickness: $10 < T < 15$ mm



Figure 6: Photograph of a bracket that could correspond to the desired type of bracket

Other mechanisms than suction could be used to fix the bracket to the dashboard, depending on the vehicle type and configuration.

4.1.4 Protective case

4.1.4.1 General requirements:

In order to protect the tablets from impacts and any bad weather we want them to be equipped with a case made from a durable and shock absorbing material compatible with the tablet described in the main document, capable of protecting our tablets against impacts, scratches, rain, snow, etc.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-TAB-006 (1) |
| Component(s) | SCOOP Tablet HMI |
| Requirement | The supplier shall provide a tablet case capable of protecting the tablet against impacts, scratches and water. |
| Additional information | |

4.1.4.2 Technical description of the case:

- Colour(s): no preference
- Type of accessory: Case for tablet
- Size compatible with the model of tablet
- Multi-position stand: Optional
- Vibration resistance: yes
- Integral rain-resistant screen protection: yes (resistance < 150 mm/hour)
- Impact protection: yes (resistance to an impact from a height of 1.8 m on a hard surface)
- Sealed ports to block sand and dust: yes



Figure 7: Photograph that could correspond to the desired type of protective case

5. SOS Emergency push button

If the emergency push button is included in the Vro-ITS-S, it uses the IF_5 interface to transmit the state of the SOS emergency button to the UTIC. In this case, the UTIC must be able to detect a push on the physical SOS button. Pressing the physical SOS button will be detected by the change from "inactive" (not engaged, up) to "active" (engaged, down).

| | |
|-------------------------------|--|
| ID | 2.4.2.2_H-SOS-001 (1) |
| Component(s) | ICPU, Vro-ITS-S |
| Requirement | The SOS emergency punch button shall be connected to the ICPU using a dedicated wired connection or a connection allowing for other equipment to connect (such as USB, RJ45 or GPIO) |
| Additional information | |

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-SOS-002 (1) |
| Component(s) | ICPU, Vro-ITS-S |
| Requirement | The punch button remains engaged after being pressed. |
| Additional information | To disengage it, the user must unscrew it or manually disengage it using the proper procedure (this does not cancel the call) |

Consequently, a physical SOS button which has not been disengaged by the user after use, and which has therefore remained permanently depressed, will not cause a false alarm and a message will be displayed on the tablet, will prompt the user to disengage this SOS button.

6. Secondary equipments interface

The purpose of this interface IF_3 is to detect the changes in the states of professional equipment that reflect the road operator's activities. The interface IF_3 uses the communication capabilities offered by the ICPU such as WiFi module, GPIO, RJ45, USB.

Such secondary equipment can be the control for the Merge / Emergency Arrow Board trailer, for the "worker / AK5" removable panel, for switching on blue flashing lights, for the state of a salt spreader or snowplow type vehicle (active or not), etc.

| | |
|-------------------------------|---|
| ID | 2.4.2.2_H-EQU-001 (1) |
| Component(s) | ICPU, Vro-ITS-S |
| Requirement | The ICPU shall have the ability to communicate with external professional equipments via the ICPU GPIO interface, the WiFi interface, the USB interface or the RJ45 interface by sending and receiving analogical or digital electric signal. |
| Additional information | |