
TII492 Intelligent Transport Systems (ITS) - Equipment Supply and Installation Framework - Generation 2 - Lot 2

Volume A: Works Requirements

**Part 3: Technical Specification
Section 8: C-ITS On-Board Units**

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Contents Table

1.	Introduction	3
1.1	Scope of Works	3
2.	General Requirements	4
2.1	General requirements	4
3.	OBU Requirements	5
3.1	General OBU Requirements	5
3.2	Communication requirements	7
3.2.1	ITS-G5 radio communications	7
3.2.2	Cellular communication	7
3.2.3	Hybrid communications	7
3.2.4	Antennae	7
3.2.5	ITS-G5 radio interface requirements - ITS-G5 OBUs	8
3.3	Service requirements	8
3.3.1	Service information	8
3.3.2	Registration with the CMCC and Service Subscription	9
3.3.3	Handling of duplicate messages received via multiple communication interfaces.	9
3.3.4	Operational modes	9
3.3.5	Configuration, management and monitoring	10
3.3.6	Security and privacy	10
3.3.7	Data logging requirements	11
3.3.8	Data logging and collection - GDPR Compliance	11
3.4	System requirements	11
3.4.1	Performance Requirements	11
3.4.2	HMI Requirements	11
3.4.3	Display of notifications	12
4.	Supply	13
4.1	General Requirements	13
5.	Installation and Maintenance	14
5.1	Support	14
5.2	Coordination	14
5.3	Equipment mounting accessory requirements	14
5.4	Testing and commissioning	14

1. Introduction

1.1 Scope of Works

The scope of works includes the supply, installation, testing and commissioning of OBUs.

OBUs are to be installed in a number of vehicles to facilitate safe, efficient, reliable and consistent use of infrastructure-to-vehicle (I2V), vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications for delivering C-ITS services on the road network, and in compliance with relevant standards and European Union regulations.

The scope of works includes but not limited to the following:

- Supply, install, configure, test and commission OBUs and supporting equipment within selected end-user vehicles;

The Contractor shall carry out the supply, installation, configuration, testing and commissioning of OBUs in selected vehicles.

The Contractor shall supply and install all necessary mounting bracketry, and power connections required for the OBU and supporting equipment to function correctly within the C-ITS ecosystem. Associated equipment, including

- Antennae.
- Wiring and power connections (from vehicle's power source); and
- Communication interfaces.

The Contractor shall supply all specialist tools and test equipment required to facilitate installation, testing and commissioning of the OBUs and associated equipment.

The Contractor shall perform end to end Site Acceptance Tests (SATs) in accordance with procedures as agreed with the NIMS Contractors and Contractor prepared test documentation at each of the OBUs integrated with the NIMS Solution.

The Contractor shall be responsible for testing RSU to OBU and OBU to RSU C-ITS Message communications for C-ITS services.

The Contractor shall provide OBU software update(s), (re)configuration and management and data logging services for supporting the evaluation of C-ITS services.

2. General Requirements

2.1 General requirements

The Contractor shall comply with all the requirements of this specification.

The Contractor shall supply OBU equipment (hardware and software) in alignment with the Commission Delegated Regulation of 13.3.2019 supplementing ITS Directive 2010/40/EU of the European Parliament and of the Council with regards to the deployment and operational use of C-ITS and with the latest C-Roads specifications where appropriate.

The OBU shall refer to the vehicle ITS sub-system and station as detailed in ETSI EN 302 665: Intelligent Transport Systems (ITS); Communications Architecture.

All OBU equipment shall be designed and manufactured in a modular fashion to facilitate simple maintenance with minimal connections to be broken and remade.

The Contractor shall ensure that the supplied OBUs are fully compatible with each other and all types of RSUs as well as with the NIMS Central C-ITS Station solution.

All OBU equipment interfaces (including all interfaces to NIMS) and elements used throughout shall comply with industry recognised interoperable open standards.

The Contractor shall ensure that all equipment shall include all the necessary hardware and software licences.

The Employer reserves the right to perform OBU validation by an independent party for an objective and independent validation.

The supplier shall provide warranties ensuring that spares will be available for a period of 10 years from the date of purchase.

The Contractor shall provide a warranty of 1 year following substantial completion of the works. As part of this warranty, the Contractor shall agree to repair or replace all equipment that are found to be faulting in the warranty period. The Contractor shall provide technical support to the ITS Maintenance Contractor during the warranty period.

3. OBU Requirements

3.1 General OBU Requirements

The OBU shall be capable of achieving the following configuration options:

- ITS-G5 Vehicle OBU.
- Cellular Vehicle OBU.

The OBU shall be equipped with all necessary antennae, cables, cable management, connectors, fixing brackets and in-vehicle mounting in a portable hard-shell case. This portable hard-shell case shall accommodate OBU and associated equipment required to enable operation in a vehicle environment for extended periods of time.

The OBUs shall be provided with a touchscreen HMI unit capable of displaying and interacting with C-ITS pilot service applications. The HMI shall be easily mounted in the vehicle by the user. The Contractor shall supply all fixing brackets, cables, in-vehicle mountings required for the HMI.

All OBU equipment supplied shall have a design life of not less than 5 years.

The OBU shall be equipped with a GNSS receiver for receiving positioning and timing services.

The OBUs shall be easy to fit and remove from any vehicle type. Fitment of equipment in vehicle shall be non-invasive (requiring no permanent modifications to the vehicle) and shall not affect the integrity of the vehicle.

The Contractor shall supply specialist tools and test equipment, including vehicle data simulator for C-ITS services, required to perform installation, testing, commissioning and maintenance of OBUs and associated equipment.

The C-ITS services to be deployed are summarised in Table 1. The service definitions shall be in alignment with the latest (at the time of tender) C-Roads specifications. Definitions for new services that have not been defined in C-Roads specifications shall be agreed with the Employer's Representatives as part of collaboration and coordination activities.

The Contractor shall provide application software for OBUs to deliver the C-ITS services listed in Table 1.

Table 1 The C-ITS services

C-ITS Service and Use Case		V2V	V2I		I2V	
		ITS-G5	ITS-G5	Cellular	ITS-G5	Cellular
In Vehicle Signage (IVS)	Traffic Signs (IVS-TS)	x	x	x	✓	✓
	Free Text (IVS-FT)	x	x	x	✓	✓
Hazardous Location Notification (HLN)	Stationary vehicle (HLN-SV)	✓	✓	✓	✓	✓
	Weather Condition Warning (HLN-WCW)	✓	✓	✓	✓	✓
	Traffic Jam Ahead (HLN-TJA)	✓	✓	✓	✓	✓
Road Works Warning (RWW)	Lane Closure (RWW – LC)	x	x	x	✓	✓
	Road Closure (RWW – RC)	x	x	x	✓	✓
	Road Works – Mobile (RWW-RM)	x	x	x	✓	x
Point of Interest (POI)	Electric Vehicle Charging Spot Notification (EVCSN)	x	x	x	x	✓
Probe Vehicle Data (PVD)	Vehicle Data Collection	✓	✓	✓	x	x
	**Event Data Collection	✓	✓	✓	x	x
Notes ** V2V and V2I PVD Event Data Collection use case will notify stationary vehicle, weather condition warning (reduced visibility) and traffic jam ahead (end of queue) events identified by the driver. Additional events may be supported by the OBU.						

3.2 Communication requirements

3.2.1 ITS-G5 radio communications

The OBU's ITS-G5 radio communications shall operate within the frequency range of 5.855 GHz to 5.925 GHz in compliance with ETSI EN 302 663.

The OBU shall implement ITS-G5 protocol stack and relevant functionalities specified in EN302 636 series of ETSI standards.

The OBUs shall implement GeoNetworking as detailed within ETSI EN 302 636 series.

The OBU receiver sensitivity shall be -90dBm at 6Mbps data rate.

The OBU shall communicate with other ITS-G5 OBUs and RSUs (including 3rd party RSUs and OBUs) using ITS-G5 radio communications.

The OBU radio communications should not interfere with the operation of electronic tolling (eToll) services operating at 5.8GHz using CEN DSRC technology. OBUs shall conform to ETSI TS 102 792 for coexistence of ITS-G5 with CEN DSRC.

The OBU should be compatible with ITS-G5 compliant OBUs and RSUs that send or receive data for C-ITS services.

3.2.2 Cellular communication

The OBU shall be equipped with a 3G/4G/5G cellular communication module to communicate with the Employer's central ITS station/NIMS solution. The Contractor shall be responsible for the provision of all necessary SIM cards and appropriate cellular data package for the duration of the Contract.

The cellular OBUs shall send and receive C-ITS messages to/from the C-ITS Web Service of the Employer's NIMS Solution via cellular network.

The OBUs shall be capable of supporting network roaming for a change of cellular service provider at service provider coverage boundaries.

3.2.3 Hybrid communications

The OBUs shall implement hybrid communication if both ITS-G5 and cellular connections co-exist.

In case of hybrid communication, the OBU application shall choose communication interface for the corresponding service. The C-ITS message stack shall ensure that the most up to date message is always considered above out of date messages, even where different latency in different comms paths may mean that older messages are received after more up to date messages.

3.2.4 Antennae

The OBU shall be equipped with an ITS-G5 radio equipment with omni directional antenna for short-range communication of C-ITS messages.

The ITS-G5 OBU shall be provided with an external omni directional ITS-G5 antenna with a peak gain of 7.5dBi or greater. The external antenna shall be able to be magnetically mounted on the roof top of the vehicle.

The OBU shall be equipped with a 3G/4G/5G cellular modem with omni directional antenna for IP based long-range communication. The OBU shall have an external SIM interface for a SIM card. The contractor responsible for the supply of OBU Equipment shall ensure that necessary SIM card and appropriate cellular data packages are included and available for the duration of the Contract.

The OBU shall be equipped with a GNSS receiver with omni directional antenna for receiving positioning and timing information from the GNSS services.

The C-V2X OBU shall be provided with an external omni directional C-V2X antenna with a peak gain of 7.5dBi or greater. The external antenna shall be able to be magnetically mounted on the roof top of the vehicle.

The OBU shall be equipped with a Bluetooth communication unit for communication with the HMI.

Short-range radio communication of ITS-G5 and C-V2X OBUs shall not interfere with the operation of electronic tolling (eToll) services that operate at 5.8GHz using CEN DSRC technology. The OBUs shall implement appropriate interference mitigation techniques for avoiding harmful interference to CEN DSRC based eToll services.

3.2.5 ITS-G5 radio interface requirements - ITS-G5 OBUs

The ITS-G5 OBU shall implement ITS-G5 protocol stack and corresponding functionalities specified in ETSI EN 302 636-1 to 6, EN 302 663 and EN 302 571 standards for short-range communication of C-ITS messages.

The OBU's ITS-G5 radio communication shall be compatible with C-Roads Roadside ITS G5 System Profile v2.0.0 for interoperability with The Employer's ITS-G5 RSUs.

The ITS-G5 OBU shall be able to communicate with other ITS-G5 OBUs and RSUs (including 3rd party RSUs and OBUs) which comply with C-Roads Release 2.0 via its ITS-G5 interface.

The OBU's ITS-G5 radio equipment shall operate within the frequency range of 5.855 GHz to 5.925 GHz with corresponding spectrum mask and output power in compliance with ETSI EN 302 571.

The OBU shall use ITS-G5 Control Channel (G5-CCH) specified in EN 302 663 to send and receive C-ITS messages via ITS-G5 communication.

3.3 Service requirements

3.3.1 Service information

The OBUs shall support the C-ITS services listed in Table 1.

The OBUs shall support Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I) and Infrastructure-to-Vehicle (I2V) communications for the C-ITS Services.

The OBUs shall support the triggering conditions for the C-ITS services in alignment with the latest C-Roads specifications, where appropriate.

The OBU applications shall communicate with the NIMS Solution to deliver the I2V/V2I C-ITS services being deployed.

In order to communicate C-ITS services with other C-ITS stations, the OBUs shall support C-ITS messages, including but not limited to CAM (EN 302 637-2) and DENM (EN 302 637-3) as well as IVIM, MAPEM, SPATEM, SREM and SSEM (ETSI TS 103 301).

The OBUs shall generate and send CAM, DENM and SREM.

The OBUs shall receive CAM, DENM, IVIM, MAPEM, SPATEM and SSEM.

The OBUs shall interpret CAM, DENM, IVIM, MAPEM, SPATEM, SREM and SSEM.

The OBUs shall connect to a graphical display unit to show relevant information received in C-ITS messages of the services being piloted.

The OBUs shall receive Protected Communication Zone information of CEN DSRC electronic tolling stations in CAM.

3.3.2 Registration with the CMCC and Service Subscription

The OBU will be registered with the Connected Mobility Control Center (CMCC) for accessing the C-ITS services via the web service. Therefore, the OBU HMI shall facilitate registration of OBU with the CMCC.

Upon registration of OBU with the CMCC, the OBU will be given JSON Web Tokens (JWTs) by the CMCC granting the required permissions (long-term and short-term) to take part in the C-ITS services via cellular/IP networks. Therefore, the OBU shall use the JWTs to get access to receive and send (i.e., subscribe and publish) C-ITS messages from and to the CMCC web service.

The CMCC uses quadtree-based representation of geographic areas for publication of C-ITS messages via its web service. The OBU shall use the same quadtree-based representation for subscription and publication of C-ITS messages from, and to, the CMCC via 3G/4G/5G cellular network/s.

The CMCC supports publication and subscription (pub/sub) of C-ITS messages based on geolocation of the event/notification via its web service for cellular OBUs. The OBU that is connected to the CMCC via a cellular network shall subscribe to the C-ITS messages published by the CMCC based on its (i.e., vehicle's) current geolocation.

The OBU that is connected to the CMCC via a cellular network shall subscribe to receive I2V C-ITS messages at quadtree zoom level 15 from the CMCC.

The OBU that is connected to the CMCC via a cellular network shall publish/send V2I C-ITS messages at quadtree zoom level 18 to the CMCC.

3.3.3 Handling of duplicate messages received via multiple communication interfaces.

In the case of receiving the same C-ITS message via multiple communication interfaces (e.g., via ITS-G5 and cellular), the OBU shall use the Message ID to identify any duplicate message received and discard it.

3.3.4 Operational modes

The OBU shall be able to be configured to operate in either 'test mode' or 'pilot mode':

- In 'test mode', the OBU shall be able to receive test messages via ITS-G5 and 3G/4G/5G cellular connections and display on the HMI for testing purpose; and

- In 'pilot mode', the OBU shall not display test messages on the HMI. The test messages will be flagged by the CMCC before communication via V2XII and transmitted by the RSUs via ITS-G5 using a shifted BTP port.

3.3.5 Configuration, management and monitoring

The contractor responsible for the supply of OBU Equipment shall provide a remote management system for remote configuration, management and monitoring of OBUs (Note: the remote management system shall operate in compliance with GDPR). Therefore:

- The OBU shall support remote configuration, management and monitoring from the remote management system;
- The OBU shall connect to the remote management system via cellular networks;
- The OBU shall support local software and firmware updates via its Ethernet interface;
- The OBU shall support remote software and firmware updates via its cellular interface from the remote management system;
- The remote management system shall support remote software and firmware updates to the OBUs; and
- The Contractor shall provide software and firmware updates to the supplied OBUs.

3.3.6 Security and privacy

The OBUs shall implement industry recognised security mechanisms so that appropriate levels of best practice system security are achieved.

The Contractor shall provide self-certification guaranteeing safe and secure operation of supplied OBUs in the in-vehicle environment.

The OBU shall be able to be enrolled with the EU PKI to obtain 'Level 0' EU PKI certificates. The Contractor shall provide all required OBU information (e.g., ID and key, permissions – template file provided by the EU PKI provider to be used) to register the OBU with the EU PKI.

Configuration of the EU PKI Level 0 service may evolve over the system life-span. The Contractor shall be responsible for configuring and updating the EU PKI certificates in the OBUs.

The OBU shall use 'Level 0' EU PKI certificates as ETSI PKI certificates for signing and validating C-ITS messages but must be level 1 ready and compatible with the requirements of Level 1 PKI certification.

The OBU shall be able to sign and validate the C-ITS messages communicated via ITS-G5 technology in compliance with C-Road Release 2.0 specifications.

For cellular based communications, the C-ITS messages are to be signed at the facility layer with EU PKI certificates. The OBU shall be able to validate 'Level 1' EU PKI certificates on the C-ITS messages received via cellular communications. The OBU may validate the certificates based on imported 'Level 1' Trust List Manager (TLM) certificates and European C-ITS Trust Lists (ECTLs) published by the European Commission C-ITS Point of Contact (CPOC) for testing purposes.

The OBU shall sign the C-ITS messages with 'Level 1' EU PKI certificates at the facility layer when sending them out via long-range 3G/4G/5G cellular interface.

Once relevant PKI certification authorities are established for the Republic of Ireland, the OBUs shall be able to obtain the PKI certificates from the relevant authorities and use those PKI certificates to sign and validate the C-ITS messages.

The OBUs shall encode/decode C-ITS messages to/from RSUs and other OBUs.

3.3.7 Data logging requirements

The OBU shall log all the C-ITS messages sent and received to and from other C-ITS stations in binary (UPER) format at the facility layer (i.e., ETSI facility layer C-ITS messages in UPER encoding format).

The OBU shall implement an appropriate mechanism to manage the log data within the OBU to prevent overloading its data storage.

The OBUs shall upload the logged data automatically at a defined interval to a remote server for evaluation purposes. The log management shall be agreed with the Employer's Representative.

The OBUs shall be capable of connecting with a test message generator (emulator) of CAM and DENM.

The OBUs shall send real data where appropriate or emulated data on CAM and DENM messages.

3.3.8 Data logging and collection - GDPR Compliance

All data collected by OBU equipment shall comply with the provisions and guidelines of EU data protection law (GDPR - General Data Protection Regulation) in relation to personal data pertaining to owners, or drivers/users and occupants of vehicles in which OBU equipment is installed.

3.4 System requirements

3.4.1 Performance Requirements

The OBU shall be equipped with minimum of 1GB RAM and shall have system resources, including CPU and RAM, to ensure operation within the following minimum performance requirement:

- transmit of minimum 10 signed C-ITS messages per second;
- processing of minimum 220 received C-ITS messages within a second;
- validation of received certificates for new C-ITS Stations (min. 10 per second).

The Contractor shall provide each OBU with accessible and expandable storage with a minimum storage capacity of 128GB for software and data storage. The storage device shall include either internal hard drive or external devices like SD or microSD cards.

The OBU shall be equipped with a USB port to communicate with the external devices.

The OBUs shall be capable of maintaining clock synchronisation with a GNSS clock source.

The OBUs shall be capable of supporting Network Time Protocol for clock synchronisation.

The OBUs shall be able to operate from a fused connection to the vehicle's DC supply.

3.4.2 HMI Requirements

In this context, 'the HMI' shall mean the physical device that is used to present C-ITS notifications and other driver information to the driver of a vehicle over a graphical user interface (GUI).

The HMI and its holder shall be designed in such a way as to not encourage the user to adjust the HMI whilst driving.

The HMI screen shall not be more than 8 inches in width. This does not include the device's bezel, which should be as small as is practicable.

The design of the GUI that is displayed on the HMI shall consider, and make allowance for, the positioning of the device and how, from a human factors' perspective, the driver may view and interact with that GUI. Conversely, the design of the mounting arrangement shall consider the limitations of the GUI vis-à-vis human factors in relation to the various potential mounting positions.

3.4.3 Display of notifications

The HMI shall display:

- information that relates to events and traffic signs that the user is likely to encounter, and that is relevant to the vehicle and its location on the road network; and
- information that relates to up to three events and three traffic signs. If more events or traffic signs are to be displayed, the events or traffic signs to display to the user shall be chosen based on priority levels.

Information shall be presented to the driver in such a manner as not to cause distraction to that driver, i.e., no scrolling text or continuously moving toggling information.

The HMI shall allow the user to turn on and off the display (i.e., the user shall be able to turn off the HMI if the user finds that it is distracting, while the OBU continues functioning as normal).

While driving, the driver shall not be required to interact with the HMI in any way other than brief glances to view information.

For the C-ITS Use Cases, the HMI shall display pictograms that are standard in the Republic of Ireland, and text (in English). Note: The set of allowed pictograms and text will be provided by TII.

4. Supply

4.1 General Requirements

The Contractor shall comply with all the requirements of this section.

All equipment shall be supplied new and manufactured from new components.

The Contractor shall supply all equipment and materials specified in the Volume A – Part 3 – Technical Specification for OBU, including software, services, associated equipment and hardware and software licences.

The Contractor shall supply a minimum of 5% of the OBU equipment quantities as spares.

5. Installation and Maintenance

5.1 Support

The Contractor shall provide OBU software updates and (re)configuration for testing the C-ITS services.

The Contractor shall support retrieval of OBU data logs for evaluating the C-ITS services.

The Contractor, in the presence of the Employer's Representative, shall perform drive-through tests to ensure the installed RSUs and Contractor supplied OBUs support the C-ITS services. The Contractor shall supply the evidence to the Employer's Representative.

5.2 Coordination

The Contractor shall participate in collaboration meetings with the Motorway Operations Control Centre (MOCC) Operators, the NIMS Contractor and the Employer's Representatives to agree all matters required to support the programming of works, joint responsibilities and the successful installation, testing and commissioning of all C-ITS equipment.

5.3 Equipment mounting accessory requirements

The requirements of this section relate to accessories that facilitate mounting of OBU Equipment in-vehicle.

Mounting accessories for OBU equipment shall be non-invasive - mounting accessories shall not require permanent modifications to the vehicle and shall not affect the safety of the vehicle or impair its performance in any way.

OBUs shall be contained within a portable hard-shell case, with supporting cable harnesses, power connections, antennas and communications interfaces.

5.4 Testing and commissioning

The Contractor shall test and commission all OBU equipment in accordance with the requirements of Volume A – Part 4: Testing and Commissioning. All testing shall demonstrate full compliance with the requirements described in Section 3 (“OBU Requirements”) above.

The Contractor shall supply test results demonstrating interworking of RSUs with ITS-G5 compliance third party OBUs.

The Contractor shall provide evidence for C-ITS OBU compliance with relevant standards, technical specifications and European regulations for C-ITS.