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

Volume A: Works Requirements

**Part 3: Technical Specification
Section 9: C-ITS Road Side Units**

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1. Introduction

1.1 Introduction

This specification defines the requirements for the supply, installation, testing and commissioning of new Road Side Units (RSU) for monitoring and management of the motorway network.

The Contractor shall design, supply and install RSUs in accordance with this specification at the locations detailed in the agreement documents.

The Contractor shall test and commission RSUs in accordance with this specification and Volume A - Part 4: Testing and Commissioning Specification.

The document outlines the following for the RSUs display equipment:

- Scope of Works;
- RSU Requirements;
- Design Requirements;
- Supply Requirements;
- Install Requirements.

1.2 Scope of Works

The scope of works includes the site design, supply, installation, testing and commissioning of Roadside Units (RSUs).

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

- The Contractor shall install, configure, test and commission RSUs and supporting infrastructure on gantries or post structures;
- The Contractor shall provide installation, configuration, testing and commissioning of RSUs onto existing mounting structures.
- The Contractor shall supply and install all necessary mounting bracketry, power connections and communications including TII Motorway Telecommunications Network and Cellular Network backhaul communications to the NIMS Central C-ITS Station solution. In the absence of a power source, the contractor shall install the recommended renewable energy solution comprising of wind and solar.
- The Contractor shall supply all specialist tools and test equipment required to facilitate installation, testing and commissioning of the RSUs and associated equipment.
- The Contractor shall integrate their RSUs equipment with the Central C-ITS Station of the Employer's Network Intelligence and Management System (NIMS) using the TII Motorway Telecommunications Network and cellular network.
- The Contractor shall perform Factory Acceptance Tests (FATs), as well as 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 installed RSUs integrated with the NIMS Solution.

- The Contractor shall be responsible for testing RSU to On-Board Units (OBU) and OBU to RSU C-ITS Message communications for C-ITS services.
- The Contractor shall provide RSU software update(s), (re)configuration and management and data logging services for supporting the evaluation of C-ITS services.

The scope of works does not include:

- Supply and installation of civil infrastructure.
- Changes to traffic signal controllers for GLOSA and Traffic Light Prioritisation services.
- 3rd party application software for further C-ITS services.

2. RSU Requirements

2.1 General requirements

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

The Contractor shall ensure that all works are undertaken with reference to the latest versions of the drawings/documents referenced within the volumes of this Specification.

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

The Contractor shall supply RSU (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.

All RSU 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 RSUs are fully compatible with each other and with the NIMS Central C-ITS Station solution.

All RSU 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 Contractor shall provide all technical literature, information and documentation specified in Works Requirements

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

The RSUs shall achieve the following configuration options:

- ITS-G5/ITS Motorway Network Configuration: RSU is physically connected to the NIMS Solution via the TII Motorway Telecommunications Network and establishes ITS-G5 radio communications with OBUs;
- ITS-G5/Cellular Network Configuration: RSU is connected to the NIMS Solution via Cellular and establishes ITS-G5 radio communications with OBUs;
- ITS-G5/Mobile RSU Configuration: RSU is a standalone unit mounted within a vehicle and is configurable to broadcast temporary road work warnings either in stand-alone mode or triggered by the NIMS Solution. The mobile RSU establishes communication with the NIMS Solution via the cellular network. The Mobile RSU establishes ITS-G5 radio communications with OBUs.

RSUs shall be ruggedised and equipped with all necessary antennae, cables, cable management connectors, fixing brackets and waterproof enclosure for housing associated components required to enable operation in harsh outdoor environment for extended periods of time.

RSUs shall be capable of providing continuous unit log of message data being sent/received by the RSU, consisting of but not limited to the types and timing of the messages sent and what triggered that message to be sent.

The ITS-G5/Cellular Network Mobile RSUs configuration shall provide the C-ITS Road Works Warning Service utilising an RSU which shall be mounted in/on an existing portable structure or Incident Support Unit, which also incorporates a power source.

RSUs shall operate in the temperature range of -20°C to +65°C.

RSUs shall operate in the humidity range of 0% to 90% (non-condensing).

All equipment supplied shall have a design life of not less than 15 years within the motorway environment. 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.

2.2 Communication requirements

2.2.1 ITS-G5 radio communications

The RSU'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 RSU shall implement ITS G5 protocol stack and relevant functionalities specified in EN 302 636 series of ETSI standards.

The RSU receiver sensitivity shall be -92dBm at 6Mbps data rate.

The RSU radio communications shall not interfere with the operation of electronic tolling (eToll) services operating at 5.8GHz using CEN DSRC technology. The RSUs and their site design shall conform to ETSI TS 102 792 for coexistence of ITS-G5 with CEN DSRC. The Contractor shall implement the required mitigation techniques to avoid any interference.

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

2.2.2 Antenna

The RSUs ITS-G5 antenna/e type shall be omni-directional at 5.9GHz operating frequency to suit local conditions.

The RSUs shall be equipped with built-in antenna or shall be equipped with multiple antenna ports for connecting external ITS-G5 compatible antenna/e.

Distributed antenna solution shall be used to improve line of sight coverage, where appropriate.

Distance between RSU and antenna shall be kept to the minimum (preferably less than 1m) to minimise antenna cable signal loss.

The RSU antenna/e shall be off-set from the mounting structure to minimise near field interference.

The Contractor shall submit a list of the available antenna options currently available for their RSU equipment to the Employer's Representative for review, including typical EIRP plots for each antenna option.

The typical RSU antenna/e height shall be mounted at a typical height of 6-8m for providing line of sight with vehicle OBUs.

2.2.3 Network communication

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

The RSUs shall establish a secure IP connection for two-way communication with the NIMS Solution using an industry recognised security protocol in agreement with the Employer's Representative.

The RSUs shall be capable of integrating with the Employer's NIMS Solution.

The RSU equipment shall be provided with an IEEE 802.3ab Ethernet-over Copper (EoC) interface port (minimum 1000BASE-T) which shall be used to connect the RSU to the Employer's Motorway Telecommunications Network.

The RSUs shall support IPv4.

The RSUs shall support IPv6 with backward compatibility to IPv4.

The Contractor shall work with the Employer's Representative and the MOCC Operator to integrate ITS-G5 RSUs into the Employer's Motorway Telecommunications Network and configure RSU's communication network protocols (including IP and security) such that the RSUs shall be addressed in the existing Layer-2 site VLAN, or onto a unique VLAN number at each new cellular site.

RSUs shall interface correctly with the NIMS Solution for fault management using industry recognised open protocols, which shall include but not limited to the Simple Network Management Protocol (SNMP).

The RSUs shall have an internal clock and shall use Network Time Protocol (NTP) to synchronise the time and date with NIMS.

2.3 Service requirements

2.3.1 Service information

In order to communicate C-ITS services with other C-ITS Stations, the RSUs 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 30.1).

The RSU equipment shall support C-ITS services for signalised intersections, providing both Green Light Optimal Speed Advisory (GLOSA) and Traffic Light Prioritisation Services to the road users.

The RSUs shall generate CAM, DENM, IVIM, SPATEM and SSEM.

The RSUs shall periodically broadcast CAM.

The RSUs shall receive CAM, DENM and SREM messages from OBUs and other RSUs.

The RSUs shall aggregate CAM data received from the OBUs. The parameters of CAM aggregation shall be configurable, and the aggregation parameters shall be agreed with the Employer's Representative

The RSUs shall send aggregated CAM information to the Central C-ITS Station.

The RSUs shall send DENM messages to the Central C-ITS Station.

The RSUs shall forward all received DENM and SREM messages from OBUs to the Central C-ITS Station.

The RSUs shall receive DENM, IVIM, MAPEM, SSEM and SPATEM messages from the Central C-ITS Station.

The RSUs shall send DENM, IVIM, MAPEM, SPATEM and SSEM messages to OBUs.

The RSUs shall forward all received DENM, IVIM, MAPEM, SPATEM and SSEM messages from the Central C-ITS Station to OBUs and other RSUs.

The RSU shall periodically broadcast Protected Communication Zone information in CAM to OBUs to warn of the presence of electronic tolling station operating on 5.8GHz using CEN-DSRC technology.

The RSUs shall receive information about CEN-DSRC electronic tolling stations (e.g. Protected Communication Zone information) from the NIMS Solution.

2.3.2 Configuration, management and monitoring

The RSUs shall support remote configuration, management and monitoring by the NIMS Solution and in addition any manufacturer provided systems required for configuration, management and monitoring from a designated maintenance depot.

The RSUs shall provide APIs for remote configuration, management and fault monitoring to the AFMS and NIMS.

The RSUs shall support remote software and firmware upgrades.

The RSU shall support local configuration, management and monitoring via a suitable secure access port in the roadside equipment enclosure/cabinet.

2.3.3 Security and privacy

The RSUs shall support implementation and validation of authentication and authorisation certificates and signatures in alignment with the 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 to ensure security, trust and privacy of C-ITS services and users.

Until PKI certification authorities (as detailed in the Delegated Regulation) are established for Ireland, the RSUs shall connect to the EU PKI system to obtain security certificates. The RSUs shall be registered with the EU PKI system to obtain the certificates. Once the PKI certification authorities are established for Ireland, the RSUs shall connect to Ireland's PKI service to obtain the security certificates.

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

2.3.4 Data logging

The RSUs shall log all the messages sent/received to/from the OBUs in line with C-Roads guidance.

The RSUs shall log all the data sent/received to/from the Central C-ITS Station in line with C-Roads guidance.

The RSUs shall log all the data sent/received to/from the traffic light controller system(s) in line with C-Roads guidance.

The RSUs 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.

2.4 Performance requirements

2.4.1 RSU coverage area

The RSUs shall support a minimum transmit coverage distance of 500m (in case of line of sight between RSU and OBU) in both driving directions with maximum transmit power of +23dBm measured with a reference equipment (typically an OBU with receiver sensitivity -90dBm), at a data rate of 6Mbps.

2.4.2 System Requirements

The RSU shall have system resources including CPU and RAM for operating with the following minimum performance:

- transmit of minimum 10 signed C-ITS messages per second;
- processing of minimum 220 received C-ITS messages within a second (min. 200 CAM and 20 DENM);
- validation of received certificates for new C-ITS Stations (min. 30 per second).

The RSU shall be equipped with minimum 1GB RAM.

The Contractor shall provide each RSU 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 micro SD cards.

To avoid the need for roadside visits to modify or upgrade equipment software or firmware, the RSU Equipment:

- shall meet all operational requirements of the product using less than 50% of the available processor bandwidth;
- software and constant data shall occupy less than 50% of the installed non-volatile memory;
- transient data shall occupy less than 50% of the installed volatile memory, under all operating conditions;
- shall support remote installation and configuration of system software, updates and patches;
- shall support remote installation and configuration of C-ITS service specific application software, updates and patches.

The Contractor shall propose the inclusion of test software to facilitate system performance testing and diagnosis of faults. The test software shall not interfere with or prevent the normal operation of the RSU and shall be protected to prevent inadvertent or unauthorised use.

2.4.3 Reliability

The RSU hardware and software components shall be able to operate in outdoor environments for extended periods of time (typical Mean Time Between Failures (MTBF) of 100,000 hours).

3. Supply

3.1 General Requirements

The Contractor shall supply all equipment new and manufactured from new components.

The Contractor shall supply and install any additional shock and vibration interface to RSU mounts to ensure that the RSU is not affected by the vibration and wind caused by the motorway environment.

The Contractor shall submit all the materials, software and services necessary to install all RSU equipment that complies with the functional requirements of this specification.

The Contractor shall supply and install all the required cables between the communication cabinet and the RSU, in the appropriate ducts.

The Contractor shall supply all brackets and fixtures required to mount the RSU equipment on the existing and new gantry and cantilever structures.

The Contractor shall supply all RSU from one manufacturer to allow interchange if a RSU fails.

4. Install

4.1 Site configuration design

The Contractor shall consider the elements below for RSU site configuration and design depending on whether the RSU will be mounted on an existing gantry or CCTV pole:

- RSU and Associated Equipment
- RSU Gantry Mounting Extension Pole
- Mounting / Fixing Arrangement onto Gantry
- Equipment Cabinet (existing)
- CAT6/6A Ethernet Connection (100m)
- Copper patching
- Mounting / Fixing Arrangement (onto gantry or on existing post)
- Mains Power Connection (100m) or Renewables Connection
- Equipment Enclosure (new)
- Cellular Connection to MOCC

The Contractor shall work collaboratively with the Employer's Representative to verify and confirm design of RSU sites and produce As-Built drawings including mounting arrangements, cabling and alignment.

The RSU site and installation shall be designed such that an RSU shall be serviceable within the time limits of a site maintainer's short stop.

The Contractor shall be responsible for installation, configuration and commissioning of RSU equipment at sites as approved in the detailed design.

The RSU equipment shall be installed on to existing infrastructure, i.e. gantries, overbridges, masts or cantilever poles.

The Contractor shall install the RSU and all associated equipment at the agreed site location and to the design install configuration as agreed in the detailed site design.

The RSU equipment cabinet and mounting structure shall be in close vicinity to each other to maximise the RSU placement range, which is restricted by a maximum of 100 metres Cat6/6A cabling interface length.

The Contractor shall install RSU specific cable (e.g. CAT6/6A or composite cable) between the RSU and the roadside equipment cabinet or equipment enclosure.

The Contractor shall be responsible for integration of RSUs with the TII Motorway Telecommunications Network.

The Contractor shall be responsible for integration of RSUs with the MOCC over cellular network in locations where there is no direct access to the TII Motorway Telecommunications Network.

The Contractor shall support integration of RSUs with NIMS.

The Contractor shall perform drive through tests and supply test results for RSU's ITS-G5 communication performance to the Employer's Representative in alignment with work programme. These results shall include but not limited to received signal strength, packet delivery ratio and communication latency.

Where applicable, the Contractor shall supply test results demonstrating co-existence operation of ITS-G5 RSUs with CEN DSRC electronic tolling stations.

The Contractor shall supply in-field measurement of cellular signal strength at the proposed RSU locations.

The Contractor shall supply specialist tools and test equipment, including a test message generator for C-ITS Services, required to perform installation, testing, commissioning and maintenance of RSUs and associated equipment.

The Contractor shall liaise with the Employer's Representative and the MOCC operator in order to connect any test equipment (e.g. test message generator for C-ITS Services) required to perform RSU ITS-G5 communication performance tests, with the RSUs via the TII Motorway Telecommunication Network.

The Contractor shall comply with MOCC Operator change control and access procedures and requirements when connecting the equipment with the TII Motorway Telecommunication Network.

The Contractor shall make available an existing vehicle and equip it with a reference OBU and necessary radio signal measurement equipment and tools for drive through tests.

4.2 Equipment mounting

The RSU mounting arrangements shall include the facility to adjust and align the radio antennae axes of the RSU according to the road geometry.

The Contractor shall supply an extension pole for mounting an RSU on a gantry where required to achieve optimum line of sight configuration.

The Contractor shall submit details of positioning and mounting arrangements to achieve optimum coverage to the Employer's Representative for review 20 working days in advance of installation.

When the required RSU mounting position on the Gantry exceeds a safe working height, an extension pole shall be fitted by the Contractor which shall remove the need to work at height, and may include fold-down, wind-down or telescopic pole types.

The RSU mounting brackets shall be installed in accordance with the manufacturer instructions.

The RSU mounting brackets shall be installed such that access and maintenance (including the replacement of RSU) is not restricted.

All equipment shall be securely fixed in place eliminating the opportunity for tools or equipment to fall to the roadside below.

All bolts, with the exception of high strength friction-grip bolts, shall have locking nuts to prevent loosening by vibration.

There shall be no drilling or welding on any part of the gantry or any mounting extension pole.

The mounting arrangements for the RSU equipment shall provide protection against bi-metallic corrosion at the contact points with the gantry or mounting extension pole.

The Contractor shall design, supply and fix all suitable mounting brackets, fixings and enclosure, considering maximum supported load, wind factor, vibration and the height at which the equipment is required to operate.

The brackets shall be designed to minimise deflection of the RSU during high winds of 120km/h providing a continuous connection with OBU in vehicles.

The Contractor shall provide cable containment at gantry sites.

The Contractor shall provide RSU cable management unit for the RSU site where required.

4.3 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 RSU equipment.

As the Contractor shall install RSU equipment on existing gantries and cantilever structures, the Contractor shall liaise with the Employer's Representative to confirm the mounting arrangements for each RSU equipment.

4.4 Electrical interface

The RSU equipment shall be capable of being powered from a mains/low voltage regulated (DC) Power Supply Unit (PSU) housed in the local equipment cabinet or enclosure.

In addition, the RSU equipment ITS Network port shall be configurable for a 4-pair mode 90W Power-over-Ethernet (PoE) feed from the local equipment cabinet or enclosure.

All RSU external connections shall include in-line surge protection.

The Contractor shall provide appropriate power supply connection for their RSUs.

4.5 Power distribution

The Contractor shall connect the RSU and associated equipment to mains power supply network or an alternative power source as part of the works where compliance with I.S. 10101:2020 National Rules for Electrical Installation and General Application Regulations can be achieved.

The Contractor shall provide alternative power source (e.g. wind or solar) for the RSU sites where there is no access to mains power supply network. The Contractor shall collaborate with and supply design information to the Employer's Representative for the design and build of the required infrastructure.

4.6 Enclosure

The RSU external equipment enclosures and housings shall be compliant with Category IP66 of BS EN 60529 Standards Publication which describes a classifying system for degrees of protection provided by equipment enclosures.

The RSUs and all associated equipment and enclosures must be IEC 62368-1:2014 listed by an accredited safety laboratory and will bear the CE mark on the outside of the RSU enclosure.

Enclosures manufactured from aluminium or steel shall comply with EN 1090: Execution of steel structures and aluminium structures.

The RSU enclosure shall be designed to prevent damage from heating resulting from operation outside of the equipment's specifications.

All RSU enclosures shall be designed to allow dispersal of heat generated during operation.

The RSU enclosure must be corrosion resistant in accordance with EN 12899-1:2007 and environmentally controlled. The material used shall conform to the European Standards for the appropriate material.

The RSU enclosures shall be designed to retain full structural integrity for 15 years without maintenance.

4.7 Integration and interworking

The Contractor shall support integration of RSUs with the NIMS Solution and shall fully cooperate with the Employer's Representative, the NIMS Contractor and the MOCC Operator to achieve successful integration.

The RSU shall be integrated such that they can be monitored, managed and controlled from the NIMS Solution.

The RSU shall be integrated such that C-ITS messages can be exchanged between the NIMS Solution and the OBUs for delivering the C-ITS services.

The RSU shall be integrated such that they can report faults to the NIMS Solution and Asset Fault Monitoring System.

The Contractor shall supply suitable test harnesses or provision of actual kit to support testing of RSU integration with the NIMS Solution.

The Contractor shall support RSU change configuration management as required, including but not limited to:

- adding or deleting RSU sites;
- updating IP addresses, subnetting and VLAN configuration;
- updating GIS mapping data;
- software update and (re)configuration;
- maintaining asset data.

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

The communication protocol between the RSUs and the NIMS Solution shall be an industry recognised interoperable open standard (subject to the Employer's Representative's agreement).

4.8 Testing and commissioning

The Contractor shall test and commission all RSU equipment in accordance with the requirements of Volume A – Part 4, Section 1: Testing and Commissioning and to demonstrate compliance with the requirements of Section 4.7 ("Integration and interworking") above.

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

4.9 Maintenance

The Contractor shall provide supply, installation, commissioning and maintenance instructions for the RSUs. In addition, separate instructions, maintenance information cards or booklets shall be supplied for each module or sub-assembly likely to be installed separately and be packaged with the item. To facilitate maintenance, particularly at outstations, equipment shall be constructed from lightweight materials. Units and modules over 10kg shall be marked with their mass. All units shall have instructions for safe handling on the individual packaging, included as a separate instruction on each pallet and also inserted in the maintenance instructions.

The ITS-G5 Network shall be added to the routine maintenance manual, procedures and routines for the ITS EMC roads maintenance and schemes as appropriate.

Equipment shall be maintainable at the roadside with the minimum of basic hand tools and general-purpose test equipment.