Special Specification 6364

Dedicated Short-Range Communications
Roadside Unit

1. DESCRIPTION

Item applies to the furnish, install, and testing of a high-speed, low latency, Roadside Unit (RSU) capable of acting as a network edge device for 5.9 GHz Dedicated Short Range Communication (DSRC) infrastructure for use in the TxDOT Intelligent Transportation System (ITS), as shown in the plans.

2. MATERIALS

Provide new corrosion resistant materials in accordance with the details shown on the plans.

Furnish the following new materials for each RSU:

- DSRC Roadside Unit (as defined in Chapter 2 – System Overview of USDOT RSU Spec v4.1, dated April 28, 2017, FHWA Report No. FHWA-JPO-17-589);
  - Antennas to enable all functionality;
    - Incompatibility issues between antennas and RSU or cables need to be avoided by either:
      - Keyed connections; and
      - Terminating caps (environmentally sealed).
  - Shielded CAT6 cabling;
  - Power-over-Ethernet support with power injector hardware meeting IEEE 802.3at;
  - Mounting equipment to support pole-mounted installations;
  - Environmental protection material (any necessary sleeves, rubberized tape, sealant, gaskets, etc. to meet environmental requirements);
  - Firmware image configured to support the Dedicated Short Range Communications Roadside Unit Specifications dated April 28, 2017, FHWA Report No. FHWA-JPO-17-589;
  - Radio configuration and management software with appropriate defaults to support RSU functionality;
  - Documentation for configuration, operation, management, and maintenance; and
  - All incidentals required for delivering a DSRC radio ready for installation by others.

Provide requested software development kits (SDKs).

In the case of conflicts between referenced standards and/or specifications, this specification will govern.

3. EQUIPMENT

3.1. General.

Provide an RSU that supports IPv6 access to remote network hosts, and broadcast and receives messages as defined in SAE J2735.

Provide an RSU that conforms to the FHWA DSRC Roadside Unit Specifications FHWA-JPO-17-589.

Provide proof of conformance to the DSRC RSU Specification from an OmniAir certified test laboratory.
Provide an RSU that consists of carrier-grade hardware and software components that operate in harsh outdoor environments for extended periods of time (Mean-Time-Between-Failures (MTBF) of 100,000 hours).

Provide an RSU that supports Single Channel Continuous and dual Channel Alternating DSRC Channel Modes simultaneously as defined in IEEE 1609.4.

Provide an RSU that contains internal computer processing and permanent storage capability.

Furnish an RSU supporting the following communication standards and protocols:
- IEEE 802.11-2012;
- IEEE 1609.2-2016;
- IEEE 1609.3-2016;
- IEEE 1609.4-2016; and
- SAE DSRC J2735 2016-03.

3.2. Electrical Requirements.

3.2.1. Power Requirements. Provide an RSU supporting inbound power through a single, dedicated Ethernet port by Power-over-Ethernet (PoE) in compliance with IEEE 802.3at.

3.2.2. Surge Protection. Install RSU converter in an environment that has protection from power surges and sags.

3.2.3. Power Service Transients. Supply equipment in accordance with the requirements in the National Electrical Manufacturers Association (NEMA) Standard TS-2 for Traffic Control System, Sec. 2.1.6, “Transients” or latest revision.

3.2.4. Wiring. Meet the requirements of the most current version of the National Electric Code (NEC). Provide wires that are cut to proper length before assembly. No splicing of cables permitted. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Doubling back of any wire to take up slack is not permitted. Lace wires neatly together with nylon lacing or outdoor rated plastic straps. Secure the cables inside the cabinet with outdoor rated plastic straps.

3.2.5. Power Indication. Provide an RSU that has the following visual LED power indicators:
- Off – No Power
- Solid Green – Device is powered on

Status Indication. Provide an RSU that has the following visual LED status indicators:
- Off – No Power;
- Blinking Green – Device Start-Up;
- Solid Green – Device Operational;
- Amber – Firmware Update in Progress; and
- Red – Fault.

3.3. Radio Requirements.

Provide an RSU that is capable of transmitting and receiving data using the 5.9GHz band dedicated short-range communication (DSRC) for the purpose of supporting connected vehicle applications.

Provide an RSU that meets IEEE 802.11p standard supporting the Wireless Access in Vehicular Environments (WAVE) in Intelligent Transportation Systems (ITS) applications

Provide an RSU that supports message processing as defined in FHWA Report No FHWA-JPO-17-589 including the following:
- Store and Repeat-Encoded Payload;
- Store and Repeat-Raw Data Payload;
- Immediate Forward-Encoded Payload; and
- Immediate Forward-Raw Data Payload.

Provide an RSU that is compliant with Federal Information Processing Standard (FIPS) 140-2 Level 2 physical security requirements.

3.4. **Equipment.**

Furnish an RSU supporting the configuration and transmission of Wireless Access in Vehicular Environments (WAVE) Service Announcement (WSA) broadcasts.

Furnish an RSU providing dual antenna/dual radio operation.

Furnish an RSU capable of interfacing with traffic signal controllers through the NTCIP 1202 protocol to receive the SPaT data objects pushed by the signal controllers. SPaT data objects will be sent at a rate configured by the signal controller, expected rate is 100 milliseconds.

Furnish an RSU that will convert the SPaT data objects into SAE-J2735 (version 2016) SPaT messages and broadcast out over DSRC every 100 milliseconds, within 50 milliseconds of receiving SPaT data object from signal controller.

Furnish an RSU that will generate SAE-J2735 (2016) MAP messages.

Furnish an RSU that contains a built-in Global Positioning System (GPS) device to support location services and time synchronization.

The furnished RSU will be contained in a dedicated corrosion-resistant enclosure that is compliant with the NEMA4X (IP66) rating.

The furnished RSU will be delivered with the latest stable firmware release (as of ship date) from the vendor.

3.5. **Mechanical Requirements.**

3.5.1. **Temperature.** Provide equipment that conforms to NEMA TS-2 Section 2.1.5.1, or latest revision, and meets all the specified requirements during and after being subjected to any combination of the following conditions:

- ambient temperature range of -30°F to 165°F;
- temperature shock not exceeding 17°F per hour; and
- relative humidity of 95% non-condensing over the temperature range of +40.0°F to +110.0°F.

3.5.2. **Wind.** Provide mounting bracket capable of withstanding winds up to 150 MPH per the sixth edition of the AASHTO Special Wind Regions Specification for Structural Supports for Highways Signs, Luminaires, and Traffic Signals, Section 3.8.

3.5.3. **Shock and Vibration.** Provide equipment that conforms to United States Military Standard MIL-STD-810G for operating shock and vibration. Provide equipment that meets testing procedures specified in IEC-60068 and IEC-60721

3.5.4. **Corrosion.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.10, or latest revision, when located in coastal Districts. Coastal Districts include Beaumont (BMT), Corpus Christi (CRP), Houston (HOU), Pharr (PHR), and Yoakum (YKM).
4. CONSTRUCTION

4.1. General. Use the latest available techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design for ease of maintenance, with all component parts readily accessible for inspection and maintenance.

4.2. Mechanical Components. Use stainless steel for all external screws, nuts, and locking washers. No self-tapping screws are allowed unless specifically approved by the Engineer.

Provide corrosion resistant parts, such as plastic, stainless steel, anodized aluminum or brass.

Protect all materials used in construction from fungus growth and moisture deterioration.

Separate all dissimilar metals by an inert dielectric material.

4.3. Mounting. Provide all mounting hardware as shown on the plans, or as directed at no additional cost to the Department.

4.4. Documentation Requirements. Provide a minimum of 2 complete sets of operation and maintenance manuals, at least 45 days before testing, in hard copy format, bound, as well as an electronic version in Adobe PDF format on a CD/DVD or removable flash drive that includes the following:
- complete network configuration diagram which documents locations of installed equipment, serial and model numbers, communication protocol settings, IP address, cabling, power service connections, and fiber assignments;
- complete installation procedures;
- compliance matrix documenting conformance to this specification;
- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA;
- operations manuals;
- warranty documentation;
- complete maintenance and trouble-shooting procedures;
- testing procedures identifying threshold values;
- recovery procedures for malfunction;
- instructions for gathering maintenance assistance from manufacturer; and provide the Department with certification documentation verifying conformance with environmental and testing requirements contained in this special specification. Certifications may be provided by the manufacturer or through independent Omniair certified labs.

4.5. Testing.

4.5.1. General. Unless otherwise shown on the plans, perform the following tests on the applicable equipment or systems.

4.5.1.1. Test Procedures Documentation. Provide 5 copies of the test procedures to include tests identified in Article 4.5.1.2 through Article 4.5.1.7 inclusive and blank data forms to the Engineer for review and comment at least 45 days before testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will comment, approve, or reject test procedures within 30 days after Contractor submittal of equipment for tests. Contractor to resubmit, if necessary, rejected test procedures for final approval within 10 days before testing. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Record measured test data on the data forms against threshold values, as well as quantitative results. No bid item measurement or payment will be made until the Engineer has verified the test results meet the minimum
requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hr. of discovery of any testing discrepancy identified during testing by the contractor. Furnish data forms containing the acceptable range of expected results as well as the measured values.

4.5.1.2. Design Approval Test. Conduct a design approval test on randomly selected units from the prototype design manufacturing run. If only 1 design prototype is manufactured, perform this test on that unit. If supplying multiple types of the equipment, provide and test a sample of each type.

Certification from an independent testing laboratory of a successfully completed design approval test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification is grounds for rejection of any certification.

Provide a copy of the certification to the District in which this contract is executed. The data forms for the design approval tests must be signed by an authorized representative (company official) of the equipment manufacturer or by an authorized representative of an independent testing facility.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

Subject the delivered units to the prescribed testing procedures as identified in Article 4.5.1.1. through 4.5.1.5 that conform to the verification methods outlined in FHWA Report No. FHWA-JPO-17-589. In the case of a conflict between the FHWA procedures and this item, this item will govern.

4.5.1.2.1. Temperature and Condensation. The equipment must meet the performance requirements specified in this Item when subjected to the following conditions in the order specified below:

- Stabilize the equipment at -30°F and test as specified in Sections 2.2.7.3, “Low-Temperature Low-Voltage Tests” and 2.2.7.4, “Low-Temperature High-Voltage Tests” of the NEMA TS 2 standard, most current version;
- Allow the equipment to warm up to room temperature in an atmosphere with relative humidity of at least 40%. Operate the equipment for 2 hr., while wet, without degradation or failure; and
- Stabilize the equipment at 165°F and test as specified in Sections 2.2.7.5, “High-Temperature High Voltage Tests” and 2.2.7.6, “High-Temperature Low-Voltage Tests” of the NEMA TS 2 standard, most current version.

4.5.1.2.2. Relative Humidity. The equipment must meet the performance requirements, specified in this Item, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 16% for 48 hr.

4.5.1.2.3. Vibration. The equipment will show no degradation of mechanical structure, soldered components, or plug-in components and must operate in accordance with the manufacturer’s equipment specifications after being subjected to the vibration tests as described MIL-STD-810G and IEC-60068 as described and referenced in FHWA Report No. FHWA-JPO-17-589.

4.5.1.2.4. Power Interruption. The equipment must meet the performance requirements specified in this Item when subjected to nominal input voltage variations as specified in Section 2.2.10 “Power Interruption Test” of the NEMA TS 2 standard, most current version.

4.5.1.3. Demonstration Test. Conduct a demonstration test on applicable equipment at an approved Contractor facility. The Contractor may submit procedures and results from previous contracts in the same District as this contract provided the materials and equipment are identical, provided results are less than 5 years old. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:
4.5.1.3.1. **Examination of Product.** Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of this Item.

4.5.1.3.2. **Operational Test.** Operate each unit for at least 15 min. to permit equipment temperature stabilization and an adequate number of performance characteristics to ensure compliance with the requirements of this Item.

4.5.1.4. **Field Acceptance (Stand-Alone) Test.** Conduct a field acceptance test for each unit after installation as required by the Engineer to demonstrate compliance with the functional requirements with this Item. The test must exercise all stand-alone (non-network) functional operations. Notify the Engineer 5 working days before conducting this test. The field acceptance test may consist of the following:

4.5.1.4.1. **Physical Construction.** Verify physical construction is completed in accordance with the plans and specification.

4.5.1.4.2. **Electrical and Communication.** Verify that all connectors for grounding, surge suppression, and electrical distribution are tightened correctly. Verify all power supplies and circuits are operating under the proper voltages. Verify all power and communications cables are terminated correctly, secured inside the cabinet, and fitted with appropriate connectors.

4.5.1.4.3. **Communication Link Quality.** Conduct signal tests for each communication link, including data transmit, data receive, bandwidth, proper operation of alarm and switches, and bit error rate (BER). Document results in a written report to the engineer.

4.5.1.5. **Final Acceptance Test.** Following completion of the demonstration test, and field acceptance test for all subsystems, provide completed data forms containing all of the data taken, including quantitative results for all tests, a set of “as built” working drawings, and a written request to begin a data communication and final acceptance test.

Within 10 calendar days of the request, execute a data communications test using a Contractor supplied software application that demonstrates the message processing, security, operational states, and operational modes. The data communications test may be executed by the Engineer or the Contractor with the prior approval of the Engineer. The purpose of this test is to verify that the RSU operates per the intention shown on the plans.

Provide all additional test results to the Engineer for review once a successful data communications test has been completed. If all the requirements of this special provision have been satisfied, contract time will be suspended and all subsystems will be placed into operation and operate as a complete system for a period of at least 90 calendar days.

Notify the Engineer of any defects suspected in integration or function of material or equipment. Investigate any suspected defects and correct if necessary. Provide a report of findings within 2 calendar days of notice of any suspected defects. Describe the nature of the any defects reported and any corrective action taken in the report. The integrated subsystems must operate defect free as a single complete system for at least 72 continuous hours during the 30 calendar day review period. If the number of defects or frequency of failures prevents all subsystems from operating as described above, the Engineer may reject the entire system integration test results and resume contract time. Provide any necessary corrections and resubmit system integration test results and a request to begin a final acceptance test which may include “as built” plans and a data communications test.

The project will not be accepted, notwithstanding other provisions in the Contract, until the system, inclusive of all subsystems, has operated satisfactorily for a period of 90 days and in full compliance with the plans and specifications after approval of all submitted test results and reports.

4.5.1.6. **Consequences of Test Failure.** If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation before modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 14 days of written notice to the Engineer. If a unit requires replacement, provide a new
unit and then repeat the test until successfully completed. Major discrepancies that substantially delay receipt and acceptance of the unit are sufficient cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the contract period.

4.5.1.6.1. Consequences of Design Approval Test Failure. If the equipment fails the design approval test, correct the fault within 30 days and then repeat the design approval test until successfully completed.

4.5.1.6.2. Consequences of Demonstration Test Failure. If the equipment fails the demonstration test, correct the fault within 30 days and then repeat the demonstration test until successfully completed.

4.5.1.6.3. Consequences of Field Acceptance (Stand-Alone) Test Failure. If the equipment fails the stand-alone test, correct the fault within 30 days and then repeat the stand-alone test until successfully completed.

4.5.1.6.4. Consequences of Final Acceptance Test Failure. If a defect within the system is detected during the final acceptance test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a 30 consecutive day period free of defects is achieved.

4.6. Training. Conduct a training class (minimum of 1 hour, up to 4 hr., unless otherwise noted in the plans) for up to 10 representatives designated by the Department on procedures of installation, operations, testing, maintenance and repair of all equipment specified within this specification for each type of unit provided. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer.

4.7. Warranty. Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 3 yr. or in accordance with the manufacturer’s standard warranty if that warranty period is greater. The start date of the manufacturer’s standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any field equipment with less than 90% of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer’s published specifications. Assign, to the Department, all manufacturer’s normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Media converters must be repaired or replaced at the Contractor’s expense prior beginning the final acceptance test plan in the event of a malfunction or failure. Furnish replacement parts for all equipment within 10 days of notification of failure by the Department.

5. MEASUREMENT

This Item will be measured by each Dedicated Short Range Communication Roadside Unit.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price for “Dedicated Short Range Communication Roadside Unit.” This price is full compensation for furnishing and installing units including all equipment, mounting brackets, hardware, antennas, all cables and connectors, all documentation and testing; and will include the cost of furnishing all labor, materials, tools, training, software, warranty, equipment, and incidentals.