MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
CELLULAR MODEM

a. Description. This work consists of the complete furnishing, installation, integration and testing of an environmentally hardened cellular modem, and service coordination with MDOT to complete an end-to-end communications link. The cellular modem, as designated on the plans, provides Ethernet connectivity from the ITS field device(s) to the Transportation Operations Center (TOC). Ensure this work is performed in accordance with the standard specifications, except as modified herein.

1. General.

A. Furnish, install, integrate, test, and provide manufacture warranty on all equipment and components to provide a complete functionality without additional expense to the contract. Components include antennas, and antenna cables necessary.

B. All cellular data service will be provided by the MDOT statewide cellular data service provider agreement. It is the Contractor's responsibility to determine the optimal equipment configuration to be used at the proposed location. Coordinate with MDOT and provide all information required to obtain cellular data service for cellular modems including cell service types; long term evolution (LTE), code division multiple access (CDMA) or global system for mobile communications (GSM) high speed uplink packet access (HSUPA). LTE modems must support fallback to CDMA and/or GSM HSUPA.

C. Coordinate final equipment selection, procurement, and provisioning with MDOT and the Michigan Department of Technology, Management, and Budget (DTMB).

b. Materials. Furnish equipment that meets the following requirements.

1. Functional and Performance Requirements.

A. Support Virtual Private Network (VPN) connections.

B. Support firewall capabilities, including IP address based block/allow listings.

C. Provide an "always-on" connection, without dialing.

D. Support local and remote management.

E. Domain name addressable.

F. Port Filtering.

G. Full duplex transceiver.

H. Generic Routing Encapsulation (GRE) Tunneling.

I. IP Filtering.

J. Media Access Control (MAC) Address Filtering.

K. Support Network Mobility as specified by *Internet Engineering Task Force (IETF)* Request for Comments (RFC) 5177.

2. Frequency Band and Cellular Network Interface.

A. Fourth Generation (4G) LTE models:

(1) Tri-band support for 700/1900/2100 megahertz (MHz) or operating Tri-band 13/2/4.

B. Ensure modem is capable of providing a broadband communications link between field location(s) and MDOT via:

(1) The public cellular network, and

(2) Carrier-based private cellular network.

3. Ethernet Interfaces.

A. Support Transmission Control Protocol (TCP)/IP and User Datagram Protocol (UDP)/IP.

B. Registered Jacks (RJ)-45, *IEEE 802.3* standard 100 Base-TX Ethernet ports for 4G modems.

C. Provide network cables that are *Electronic Industries Alliance (EIA)/Telecommunications Industry Association (TIA)-568-A* complaint.

4. Antenna.

A. Modem mountable omnidirectional external antennas rated for outdoor usage and meet environmental requirements as defined in subsection b.7 of this special provision. Specific antenna type to be used at each site is to be determined by the Contractor to maximize cellular coverage.

B. 50 Ohm SubMiniature version A (SMA) male connector.

C. Provide an antenna cable with required adapters per the manufacturer's recommendation. Minimize signal loss due to cable length in order to maximize throughput.

D. Minimum Antenna gain of 2 decibels isotropic (dBi).

E. Right-angle swivel connector that allows for the antenna to be upright when

connected to the cellular modem.

F. Operating Frequencies of 698-896 and 1700-2700 MHz or supplemental frequencies as indicated by manufacturer and/or the *FCC*.

5. Management, Security and Diagnostic.

A. LED indicators for Ethernet, power, cellular link/activity and signal strength.

B. Support signals for Transmit Data (TXD), Receive Data (RXD), Request To Send (RTS), Clear To Send (CTS), Data Terminal Ready (DTR), Data Set Ready (DSR), Data Carrier Detect (DCD), and hardware and software flow control.

C. Provide compatibility with Hypertext Transfer Protocol (HTTP)/HTTP Secure (HTTPS), Dynamic Host Communications Protocol (DHCP), Simple Network Management Protocol (SNMP) v3, Simple Mail Transfer Protocol (SMTP), Secure Socket Layer (SSL), Secure Shell (SSH)-2.

D. Web-based Graphical User Interface (GUI).

E. Command Line Interface (CLI) access via SSH connection.

F. SNMP Management Information Base (MIB)-II and SNMP Traps.

6. Power. Ensure required power supply is supplied with device.

7. Environment.

A. Operating Temperature for Cellular Modem, Power Supply, Antenna, and all connectors. -22 ºF to 158 ºF.

B. Storage Temperature for Cellular Modem, Power Supply, Antenna, and all connectors. -22 ºF to 158 ºF.

C. Relative humidity for Cellular Modem, Power Supply, Antenna, and all connectors. Five percent to 95 percent non-condensing.

8. Mounting. Ensure all mounting hardware is supplied with device.

9. Use identical and completely interchangeable equipment at each field location.

c. Construction.

1. General.

A. Install the cellular modem as indicated on the plans.

B. Conduct a cellular site survey and submit to the Engineer for approval prior to the procurement of materials. The purpose of the survey is to measure the signal strength and throughput of cellular coverage at the project locations. Testing must include upload/download speeds, latency, and received signal strength to show that the

equipment will meet the minimum requirements shown on the plans. Alert the Engineer of any sites that do not have signal strength or upload/download speeds adequate for intended downstream device operation. Testing is an appurtenance to the cellular modem and will not be paid for separately.

C. Install antenna(s) inside the cabinet unless otherwise directed by the Engineer. Cabinet wall penetrations are not allowed unless approved by the Engineer.

D. Install using settings that were approved at equipment mock-up (if required per 20SP-826H - System Integration and Testing) or as approved by the Engineer to ensure interoperability and security, including VPN settings, local IP address, port forwarding and Network Address Translation (NAT), and IP-based filtering.

E. Integrate and test to meet MDOT specifications for integration and as shown on the plans.

2. Warranty. Provide cellular modem with a standard manufacturer's warranty, transferable to MDOT. The cellular modem must carry a warranty (parts, software, and labor) of 5 years from the date of shipment with at least 4 years of warranty remaining at the start of burn-in. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to final written acceptance.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	**Pay Unit**
Cellular Modem, 4G	Each

Cellular Modem, 4G includes all work necessary to complete the communications link in accordance with the plans and the special provisions. It also includes any necessary payments to the cellular data service provider for testing the communications link at the locations indicated on the plans and in this special provision. The Contractor is responsible for scheduling, coordination, installation, and payment of work provided by the cellular data service provider, as indicated on the plans, special provisions, and as directed by the Engineer.