MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
MANAGED FIELD ETHERNET SWITCH

a. Description. This work consists of one or more of the following:

1. Furnish and install an environmentally hardened managed field Ethernet switch (MFES) and all required mounting hardware, power supplies, cables, patch cords, and jumpers;

2. Remove and salvage a MFES and all required mounting hardware, power supply, cables, patch cords, and jumpers;

3. Install a salvaged MFES and all required mounting hardware, power supply, cables, patch cords, and jumpers.

b. Materials. Ensure the MFES is fully compatible and interoperable with MDOT's ITS network.

1. General.

A. Furnish a MFES that is suitable for an ITS cabinet without the need for special environmental conditioning. The MFES must have no fan or other moving parts.

B. Ensure the MFES supports full-duplex Ethernet communication.

C. Provide a MFES that complies with the *Institute of Electrical and Electronics Engineers (IEEE)* networking standards *IEEE-802.1* and *IEEE-802.3*. Specifically, the MFES must comply with the following *IEEE 802.1* standards:

(1) *IEEE 802.1D* Media Access Control (MAC) Bridges, including Rapid Spanning Tree Protocol (RSTP).

(2) *IEEE 802.1Q* Virtual Local Area Network (VLAN) tagging and Multiple Spanning Tree Protocol (MSTP).

(3) *IEEE 802.1X* Port-Based Network Access Control.

D. Provide a MFES that can be managed using Simple Network Management Protocol (SNMP) Version 3.

E. Provide a power supply that interfaces the MFES to 120 volts alternating current (VAC) power, 60 hertz (Hz), single-phase power.

F. Provide a MFES resistant to electromagnetic interference (EMI).

G. Provide a MFES and power supply that has an operating temperature range of at least -40 degrees Fahrenheit (F) to 158 degrees F.

H. Provide a MFES and power supply that has an operating humidity range of at least 10 percent to 95 percent relative humidity (RH).

I. Provide a MFES with diagnostic light-emitting diodes (LED). These indicators must include link, activity, and power LEDs.

J. Provide a MFES capable of using Secure File Transfer Protocol (SFTP) to transfer configuration files to and from a central server.

K. Provide power cables and Category 5e (CAT-5e) or Category 6 (CAT-6) patch cables as required.

L. Provide a MFES that has *American Standard Code for Information Interchange (ASCII)* based configuration files for offline editing and bulk configuration.

M. Provide all mounting hardware needed to mount the MFES and power supply. If the MFES is mounted on a shelf, provide a grid-type shelf that minimizes the interference with air flow.

N. Provide a MFES that is configurable using a Command Line Interface (CLI) via Secure Shell (SSH) -2.

O. Provide a MFES capable of centralized authentication and authorization through Remote Access Dial-In User Service (RADIUS).

2. Layer 2 MFES.

A. Provide a minimum of 8 copper ports with Registered Jacks (RJ)-45 connectors that are capable of 10/100Base-TX communications.

B. Provide a minimum of 2 small form-factor pluggable (SFP) ports equipped with 100Base-FX transceivers capable of transmission distances between MFESs as required by the plans. Additional ports may be shown on plans. Provide a MFES that meets the port configuration on the plans in addition to the requirements identified in this special provision.

(1) Ensure ports utilize LC-type connectors that are 100Base-FX.

(2) Ensure that the launch power of the optical ports is great enough such that when coupled with the receiver sensitivity of the connecting device, the optical budget of the link is not exceeded.

C. Provide a MFES capable of mounting on a Deutsches Institut für Normung (DIN) rail, and provide all DIN rail hardware necessary to mount the MFES on an *EIA* standard 19 inch rack.

D. The MFES must consume no more than 45 watts of power.

E. The MFES must perform multicast filtering using Internet Group Management Protocol (IGMP) snooping.

3. Layer 2 MFES, Gigabit.

A. The MFES must meet the requirements of a Layer 2 MFES except for the following:

(1) Ensure the fiber ports are capable of 1000Base-LX or 1000Base-ZX communication, depending on the transmission distance between MFESs.

(2) Ensure ports utilize LC-type connectors that are 1000Base-LX or 1000Base-ZX.

4. Layer 3 MFES.

A. Provide a minimum of 8 ports capable of 10/100Base-TX communications. The copper ports must have RJ-45 connectors but may be SFP ports fitted with appropriate transceivers.

B. Provide a minimum of 2 SFP ports equipped with 1000Base-LX or 1000Base-ZX transceivers capable of transmission distance between MFESs as required by the plans. Additional ports may be shown on plans. Provide a MFES that meets the port configuration on the plans in addition to the requirements identified in this special provision.

(1) Ports must utilize LC-type connectors that are 1000Base-LX or 1000Base-ZX.

(2) Ensure the launch power of the modules is great enough such that when coupled with the receiver sensitivity of the connecting device, the optical budget of the link is not exceeded.

C. Ensure ports are independently configurable to operate as Layer 2 or Layer 3.

D. The MFES must consume no more than 45 watts of power.

E. The MFES must have full Layer 3 capabilities, including:

(1) Internet Protocol Version 4 (IPv4);

(2) Internet Protocol Version 6 (IPv6);

(3) Open Shortest Path First (OSPF);

(4) Generic Routing Encapsulation (GRE);

(5) Border Gateway Protocol (BGP);

(6) Inter-VLAN Internet Protocol (IP) routing for full Layer 3 routing between two or more VLANs;

(7) Virtual Router Redundancy Protocol (VRRP);

(8) Address Resolution Protocol (ARP);

(9) IP multicast routing utilizing Protocol Independent Multicast (PIM) and Internet Group Management Protocol, Version 2 (IGMPv2). Support for PIM sparse mode (PIM-SM) and PIM dense mode (PIM-DM);

(10) Quality of Service (QoS);

(11) Security utilizing Access Control Lists (ACLs).

c. Construction.

1. Mount Layer 2 MFESs in the cabinet on a DIN rail, and mount Layer 3 MFESs on a DIN rail or on a shelf. Mount MFESs so they are fully accessible by field technicians.

2. Connect the MFES to the communications network and ensure connections are made to each Ethernet/IP appliance within the cabinet. Use CAT-5e or CAT-6 patch cords for twisted pair connections to the MFES.

3. Warranty. Provide a MFES with a standard manufacturer's warranty, transferable to MDOT. The MFES 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.

4. Remove. If MFES removal is specified in the contract, the following procedures apply:

A. Do not damage the ITS cabinet or associated equipment.

B. Remove the MFES, mounting hardware, power supply, and power cabling associated with the MFES. Disconnect all communication cables from the MFES. The equipment will remain the property of the Contractor.

C. Notify the Transportation Operations Center (TOC) and the Engineer a minimum of 7 days in advance of decommissioning the MFES hardware.

5. Remove and Salvage. If MFES removal and salvage is specified in the contract, the following procedures apply:

A. Do not damage the ITS cabinet or associated equipment.

B. Remove the MFES, mounting hardware, power supply, and power cabling associated with the MFES. Disconnect all communication cables from the MFES and leave them in place unless otherwise directed by the Engineer.

C. Notify the Transportation Operations Center (TOC) and the Engineer a minimum of 7 days in advance of decommissioning the MFES hardware.

D. Salvage the MFES, including mounting hardware, power supply, surge protectors (if any) and cabling, as directed by the Engineer. The salvaged equipment is to be stored at a location free of moisture, and rodent/insect intrusion. If the MFES is to be reinstalled it must be stored until then, otherwise notify the Engineer once the equipment has been salvaged for pickup to be arranged.

6. Install Salvaged. If a salvaged MFES is to be installed at a location specified in the contract, follow the procedures detailed in section c of this special provision.

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

Pay Item	**Pay Unit**
Managed Field Ethernet Switch, Layer 2	Each
Managed Field Ethernet Switch, Layer 2, Gigabit	Each
Managed Field Ethernet Switch, Layer 3	Each
Managed Field Ethernet Switch, Rem	Each
Managed Field Ethernet Switch, Rem and Salv	Each
Managed Field Ethernet Switch, Install Salv	Each