784   INTELLIGENT TRANSPORTATION SYSTEMS – NETWORK DEVICES. (REV 11-10-10) (FA 1-24-11) (7-11)

SUBARTICLE 784-1.2.1 (of the Supplemental Specifications) is deleted and the following substituted:

784-1.2 Materials:

784-1.2.1 General: Ensure that the ITS network administrator will be able to manage each MFES individually and as a group for switch configuration, performance monitoring, and troubleshooting. Ensure that the MFES includes Layer 2+ capabilities, including, QoS, IGMP, rate limiting, security filtering, and general management.

Ensure that the furnished MFES is fully compatible and interoperable with the ITS trunk Ethernet network interface, and that the MFES supports half and full duplex Ethernet communications.

Furnish an MFES that provides 99.999% error-free operation, and that complies with the Electronic Industries Alliance (EIA) Ethernet data communication requirements using single-mode fiber optic transmission medium and Category 5E copper transmission medium. Provide a switched Ethernet connection for each remote ITS field device.

Ensure that the MFES has a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

784-1.2.2 Networking Standards: Ensure that the MFES complies with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

1. IEEE 802.1D standard for media access control (MAC) bridges used with the Spanning Tree Protocol (STP).

2. IEEE 802.1Q standard for port-based virtual local area networks (VLANs).

3. IEEE 802.1P standard for Quality of Service (QoS).

4. IEEE 802.1w standard for MAC bridges used with the Rapid Spanning Tree Protocol (RSTP).

5. IEEE 802.3 standard for local area network (LAN) and metropolitan area network (MAN) access and physical layer specifications.

6. IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX.

7. IEEE 802.3x standard regarding flow control with full duplex operation.

784-1.2.3 Optical Ports: Ensure that all fiber optic link ports operate at 1,310 or 1,550 nanometers in single mode. Verify that the optical ports are Type ST, SC, LC, or FC only, as specified in the plans or by the Engineer. Do not use mechanical transfer registered jack (MTRJ) type connectors.

Provide an MFES having a minimum of two optical 100 Base FX ports capable of transmitting data at 100 megabits per second. Each optical port shall consist of a pair of fibers; one fiber will transmit (TX) data and one fiber will receive (RX) data. The optical ports shall have an optical power budget of at least 15 dB.

784-1.2.4 Copper Ports: Provide an MFES that includes a minimum of four copper ports. All copper ports shall be Type RJ-45 and shall auto-negotiate speed (i.e., 10/100 Base) and duplex (i.e., full or half). All 10/100 Base TX ports shall meet the

specifications detailed in this section and shall be compliant with the IEEE 802.3 standard pinouts.

All Category 5E unshielded twisted pair/shielded twisted pair network cables shall be compliant with the EIA/TIA-568-B standard.

784-1.2.5 Management Capability: Ensure that the MFES supports all Layer 2 management features and certain Layer 3 features related to multicast data transmission and routing. These features shall include, but not be limited to:

1. An STP healing rate that meets or exceeds specifications published in the IEEE 802.1D standard.

2. An RSTP healing rate that meets or exceeds specifications published in the IEEE 802.1w standard.

3. An MFES that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard, and has a minimum 4-kilobit VLAN address table.

4. A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second.

5. A minimum 4-kilobit MAC address table.

6. Support of Traffic Class Expediting and Dynamic Multicast Filtering.

7. Support of, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).

8. Support of remote and local setup and management via telnet or secure Web-based GUI and command line interfaces.

9. Support of the Simple Network Management Protocol (SNMP). Verify that the MFES can be accessed using the resident EIA-232 management port, a telecommunication network, or the Trivial File Transfer Protocol (TFTP).

10. Port security through controlling access by the users. Ensure that the MFES has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network.

11. Support of remote monitoring (RMON) of the Ethernet agent and the ability to be upgraded to switch monitoring (SMON), if necessary.

12. Support of the TFTP, the Network Time Protocol (NTP), or the Simple Network Time Protocol (SNTP). Ensure that the MFES supports port mirroring for troubleshooting purposes when combined with a network analyzer.

784-1.2.6 Mechanical Specifications: Ensure that all wiring complies with NEC requirements and standards. Furnish and identify all equipment and appurtenances by name, model number, serial number, technical support and warranty telephone numbers, and any other pertinent information required to facilitate equipment maintenance.

Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting, conductive metal.

Ensure that all external screws, nuts, and locking washers are type 04 or 316 passivated stainless steel. Do not use self-tapping screws.

All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

784-1.2.7 Electrical Specifications: Ensure that the MFES operates and power is supplied with 115 volts of alternating current (V_{AC}). Ensure that the MFES has a minimum operating input of 85 V_{AC} and a maximum operating input of 265 V_{AC}. If the device requires

operating voltages other than 120 V_{AC}, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 50 watts.

Ensure that the MFES has diagnostic light emitting diodes (LEDs), including link, TX, RX, speed (for Category 5E ports only), and power LEDs.

784-1.2.8 Environmental Specifications: Ensure that the MFES performs all of the required functions during and after being subjected to an ambient operating temperature range of -30 degrees (°) to 165° Fahrenheit (F) as defined in the environmental requirements section of the NEMA TS 2 standard, with a noncondensing humidity of 0 to 95%.

Verify that the MFES manufacturer certifies their device has successfully completed environmental testing as defined in the environmental requirements section of the NEMA TS 2 standard. Verify that vibration and shock resistance meet the requirements of Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.

Ensure that the MFES is protected from rain, dust, corrosive elements, and typical conditions found in a roadside environment.

SUBARTICLE 784-2.2.3 (of the Supplemental Specifications) is deleted and the following substituted:

784-2.2.3 Network Interface: Ensure that the device server includes a minimum of one Ethernet port, which must provide a 10/100 Base TX or a 10/100 Base FX connection as specified in the plans. Verify that all Category 5E, unshielded twisted pair/shielded twisted pair network cables and connectors comply with the EIA and Telecommunications Industry Association (TIA) requirements as detailed in the EIA/TIA-568-B standard. Verify that all copper-based network interface ports utilize registered jack (RJ)-45 connectors. Verify that the optical ports are Type ST, SC, LC, or FC only, as specified in the plans or by the Engineer. Mechanical transfer registered jack (MTRJ) type connectors are not allowed.

SUBARTICLE 784-2.2.5 (of the Supplemental Specifications) is deleted and the following substituted:

784-2.2.5 Mechanical Specifications: Ensure that all parts are made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. Ensure that all exposed fasteners are type 304 or 316 passivated stainless steel.

Ensure that the dimensions of the device server accommodate the unit's installation in a control cabinet as specified in the plans.

SUBARTICLE 784-3.2.3 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.2.3 MPEG-2 Format: Furnish DVE and DVD components that utilize the Moving Picture Experts Group's MPEG-2 video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 13818 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF)

RFC 2974. Ensure that the DVE provides 99.999% error-free operation. Ensure MPEG-2 DVE and DVD equipment supports programmable bit rates from 1 Mbps to 8 Mbps. Ensure that MPEG-2 equipment supports fixed bit rate mode.

SUBARTICLE 784-3.2.4 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.2.4 H.264 Format: Furnish DVE and DVD components that utilize video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, and Real Time Streaming Protocol (RTSP). Ensure that the DVE provides 99.999% error-free operation. Ensure H.264 DVE and DVD equipment supports programmable bit rates from 64 kbps to 8 Mbps. Ensure that H.264 equipment supports fixed bit rate mode.

SUBARTICLE 784-3.2.9 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.2.9 Serial Interface: Ensure that hardware-based DVEs and DVDs provide a minimum of one serial data interface and connector that conforms to EIA-232/422/485 standards. Ensure that the serial interface supports 2-wire and 4-wire EIA-485 connections. Ensure that the serial port(s) support data rates up to 230 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).
Ensure that hardware-based DVEs and DVDs provide a TCP/IP interface to their serial port using a network socket connection with configurable IP address and port number. Serial interface ports may utilize RJ-45 connectors, D-sub connectors, or screw terminals.

SUBARTICLE 784-3.2.10 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.2.10 Network Interface: Ensure that the DVE/DVD local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. Provide a DVE/DVD having a minimum of one Ethernet port, which shall be a 10/100 Base TX connection or a 100 Base FX ST, SC, LC or FC interface capable of multi-hop configuration using two sets of optical ports (e.g., Tx^1, Rx^1, Tx^2, Rx^2). Ensure that the connector complies with applicable EIA and TIA requirements. Provide copper-based network interface ports that utilize RJ-45 connectors. Ensure that all fiber-based ports are single mode and provide a link budget of 30 dB or greater.
Ensure that all Category 5E, unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard. Ensure that the network communication conforms to User Datagram Protocol (UDP), Version 4 of the Internet Protocol (IP) and Version 2 of the Internet Group Multicast Protocol (IGMP).

SUBARTICLE 784-3.3 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.3 Installation Requirements: Ensure that the DVE is shelf- and/or rack-mountable, and designed for use in roadside control cabinets without climate control. Ensure that the dimensions of the DVE allow installation in a control cabinet as specified in the plans. Ensure that front panel status indicators remain unobstructed and visible. Use only type 304 or 316 passivated stainless steel external screws, nuts, and locking washers. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized or painted aluminum, brass, or gold-plated metal.

Because a DVD may be hardware or software-based, these mechanical specifications apply only to hardware-based DVDs. Field-hardened DVDs shall be shelf- and rack-mountable, and designed for use in roadside control cabinets without climate control. The dimensions of the DVD shall allow installation in a control cabinet as specified in the plans.

Non-hardened DVDs shall be shelf- and rack-mountable, and designed for use in a climate-controlled TMC. The rack-mounted DVD shall be designed to fit in a standard EIA 19 inch rack and shall not require shielding from other electronic devices, such as power supplies and other communication equipment. The dimensions of the DVD shall allow installation as specified in the plans.

Due to the nature of the equipment, complexity of the electronics, and harsh environmental conditions at installation locations, use DVEs and DVDs that can be replaced immediately when defective or damaged units must be removed and replaced. The Department shall return damaged units to the manufacturer for warranty repair or replacement.

SUBARTICLE 784-3.4.2 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.4.2 Field Testing: Perform local field operational tests at the device field site and end-to-end video streaming tests as required by the Engineer in order to demonstrate compliance with Department specifications. Testing will include, but not be limited to, the following:

1. Verify that physical construction has been completed as detailed in the plans.

2. Inspect the quality and tightness of ground and surge protector connections.

3. Verify proper voltages for all power supplies and related power circuits.

4. Connect devices to the power sources.

5. Verify all connections, including correct installation of communication and power cables.

6. Verify video image is present and free from oversaturation and any other image defect in both color and monochrome mode.

7. Verify network connection to the DVE and DVD through ping and telnet session from a remote PC.

8. Verify serial data transmission through the DVE and DVD serial ports.

9. Verify support of unicast, multicast, and SAP.