

SECTION 905 -- PROPOSAL (CONTINUED)

I (We) hereby certify by digital signature and electronic submission via Bid Express of the Section 905 proposal below, that all certifications, disclosures and affidavits incorporated herein are deemed to be duly executed in the aggregate, fully enforceable and binding upon delivery of the bid proposal. I (We) further acknowledge that this certification shall not extend to the bid bond or alternate security which must be separately executed for the benefit of the Commission. This signature does not cure deficiencies in any required certifications, disclosures and/or affidavits. I (We) also acknowledge the right of the Commission to require full and final execution on any certification, disclosure or affidavit contained in the proposal at the Commission's election upon award. Failure to so execute at the Commission's request within the time allowed in the Standard Specifications for execution of all contract documents will result in forfeiture of the bid bond or alternate security.

Bidder acknowledges receipt of and has added to and made a part of the proposal and contract documents the following addendum (addenda):

ADDENDUM NO. 1 DATED 6/21/2017 ADDENDUM NO. DATED
ADDENDUM NO. 2 DATED 6/22/2017 ADDENDUM NO. DATED

Number	Description
1	Revised Table of Contents; Revised NTB No. 138; Added NTB No. 241; Revised SP No. 907-107-1; Revised Bid Items; Revised or added Plan Sheet Nos. 2, 84, & 86; Amendment EBS Download Required.
2	Revised SP No. 907-663-1; Amendment EBS Download Required.

TOTAL ADDENDA: 2
(Must agree with total addenda issued prior to opening of bids)

Respectfully Submitted,

DATE _____

Contractor

BY _____
Signature

TITLE _____

ADDRESS _____

CITY, STATE, ZIP _____

PHONE _____

FAX _____

E-MAIL _____

(To be filled in if a corporation)

Our corporation is chartered under the Laws of the State of _____ and the names, titles and business addresses of the executives are as follows:

President Address

Secretary Address

Treasurer Address

The following is my (our) itemized proposal.

HSIP-0055-04(099)/ 107037301000

Desoto County(ies)

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION NO. 907-663-1

CODE (SP)

DATE: 01/17/2017

SUBJECT: Networking Equipment

Section 907-663, Networking Equipment, is hereby added to and made part of the 2017 Edition of the Mississippi Standard Specifications for Road and Bridge Construction as follows.

SECTION 907-663 - NETWORKING EQUIPMENT

907-663.01--Description. This work consists of providing networking communication equipment, including network switches, terminal servers, cellular modems, and associated cabling, furnished and installed.

Type A, Type B, Type D, and Type E switches shall be environmentally hardened and rated for an operating temperature of 158°F. These switches support Intelligent Transportation Elements deployed on arterial streets and the highway system. Elements include but are not limited to traffic signals, dynamic message signs, surveillance cameras, and vehicle detection systems. Type C switches will support the Intelligent Transportation System and be installed in the Traffic Management Center and Communications Huts which are environmentally controlled. Type C switches are not required to be hardened.

This section also specifies the minimum requirements for standalone and network switch module Terminal Servers, standalone and network switch module cellular modems, and Category 6 cable. The Terminal Servers shall be hardened. The Terminal Server device, also commonly referred to as a Port Server device, will be used to communicate bi-directionally between IP-based Ethernet network systems and existing field devices that communicate or are controlled via a full-duplex serial interface. Cellular modems shall be used to communicate via cell to remote sites such as portable traffic signal sites, portable CMS, smart work zones or ITS site locations, or sites or devices that need serial or Ethernet communication that can be provided over cellular service.

The Category 6 cable shall be installed in conduit and cabinets between elements that are within 300 feet of each other to eliminate the need for two hardened switches.

The work shall consist of providing all labor, materials, equipment and incidentals necessary to furnish, install and test the networking equipment.

907-663.02--Materials. Network Switches Type A, Type B, Type C, Type D, Type E, Terminal Servers, Cellular Modems, and associated cabling will be placed in the field device cabinets and shall meet the following requirements:

907-663.02.1--Network Switch Requirements. The Type A, Type B, Type C, Type D, and Type E Network switches shall adhere to the following minimum requirements.

- 1) Field switch optical ports shall meet the following:
 - a. The minimum optical budget between transmit and received ports shall be 18dB.
 - b. It shall include LC connector types.
 - c. Optical receiver maximum input power level shall not be exceeded.
 - d. Optical attenuators shall be added as needed; fiber optic attenuator patch cords shall be in accordance with Section 657. It is the Contractor's responsibility to determine where attenuators are needed and shall be included in the cost of the switch.
 - e. The Contractor shall be required to measure the optical power on each optical port to ensure that power entering the receiver is within the acceptable power budget of the optical port.
 - f. Optical interface equipment shall operate at 1310 nm.
- 2) It shall operate from 100 VAC to 200 VAC.
- 3) The field switches shall operate between -29° to +165°F, including power supply.
- 4) The field switches shall operate from 10% to 90% non-condensing humidity.
- 5) Meet the IEEE 802.3 (10Mbps Ethernet) standard.
- 6) Meet the IEEE 802.3u (Fast Ethernet 100 Mbps) standard.
- 7) Meet the IEEE 802.3x (Full Duplex with Flow Control) standard.
- 8) Meet the IEEE 802.1p (Priority Queuing) standard.
- 9) Meet the IEEE 802.1Q (VLAN) standard per port for up to four VLAN's.
- 10) Meet the IEEE 802.1w (Rapid Spanning Tree Protocol) standard.
- 11) Meet the IEEE 802.3ad (Port Trunking) standard for a minimum of two groups of four ports.
- 12) The field switches shall meet IEEE 802.3D (Spanning Tree Protocol) standard.
- 13) Capable of mirroring any port to any other port within the switch.
- 14) Password manageable through:
 - a. SNMP
 - b. Telnet/CLI
 - c. HTTP (Embedded Web Server) with Secure Sockets Layer (SSL)
- 15) Full implementation of SNMPv1 and SNMPv2c.
- 16) Full implementation of GVRP (Generic VLAN Registration Protocol).
- 17) Full implementation of IGMP and IGMP snooping.
- 18) Minimum MTBF of 100,000 hrs. using Bellcore TS-332 standard.
- 19) Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.
- 20) UL approved.
- 21) The field switch shall provide status indicators as follows: 1) power on an off, 2) network status per port (transmit, receive, link, speed), and 3) status indicators shall be LED.
- 22) Unused ports (copper and optical) shall be covered with rubber or plastic dust caps/cover.

907-663.02.1.1--Type A Network Switch. Type A network switches shall adhere to the following minimum requirements.

- 1) Minimum of six 10/100Base-TX ports. Each port shall connect via RJ-45 connector.
- 2) Minimum of two 1000 Base Long Reach optical ports.
- 3) Full implementation of RMON I and RMON II.

- 4) Rack, shelf or DIN Rail mountable. If shelf mounted, the Contractor shall furnish and install a shelf if shelf space is not available in the facility. Any shelf used shall be ventilated as per the Network Switch manufacturer recommendation.
- 5) All power transformers provided shall be "fastening mechanism" type. No plug-in types shall be permitted. All corded transformers shall be mountable with the ability to neatly secure power cords.

907-663.02.1.2--Type B Network Switch. Type B network switches shall adhere to the following minimum requirements.

- 1) Minimum of twelve 10/100 Base-TX ports. Each port shall connect via RJ-45 connector.
- 2) Minimum of one 10/100/1000 Base-TX ports. Each port shall connect via RJ-45 connector.
- 3) Full implementation of RMON I and RMON II.
- 4) Minimum of two 1000 Base Long Reach optical ports.
- 5) Rack, shelf or DIN Rail mountable. If shelf mounted, the Contractor must furnish and install a shelf if shelf space is not available in the facility. Any shelf used shall be ventilated as per the Network Switch manufacturer recommendation.
- 6) All power transformers provided shall be "fastening mechanism" type. No plug-in types shall be permitted. All corded transformers shall be mountable with the ability to neatly secure power cords.

907-663.02.1.3--Type C Network Switch Requirements. The Type C Network Switch will be installed in the Communication Hubs and shall meet the following requirements:

- 1) Each switch shall be populated with the following modules:
 - a. Two redundant switch fabric modules that meet the following minimum requirements:
 - i. Layer 2/3/4 switching and routing services
 - ii. 64Gbps/48Mpps module Bandwidth
 - iii. Min of 2-GE uplinks available per card. The Contractor shall provide an uplink SFP optical module compatible with the interface for the uplink as indicated in the Comm Node notice to bidders for each uplink
 - b. In one (or more) SFP-based module(s): a minimum of 48 ports of 1000Base-X (SFP-based) compatible. The Contractor shall provide whichever is greater between a min number of SFP optic modules to interface to the fiber as indicated in the plans and NTBs, or a min of 14 and shall meet the following minimum requirements:
 - i. Optical budget of 18dB
 - ii. Hot-swappable
 - iii. Same optical wavelength as Type A & B switches
 - iv. Same optical transmitter power as Type A & B switches
 - c. In one (or more) modules: 24 Ethernet 10/100/1000 ports
- 2) Optical receiver maximum input power level shall not be exceeded.
- 3) Optical attenuators shall be added as needed; fiber optic attenuator patch cords shall be in accordance with Section 657 of the Mississippi Standard Specifications for Road and Bridge Construction. It is the Contractor's responsibility to determine where attenuators are needed and shall be included in the cost of the switch.

- 4) 19" rack mountable.
- 5) Operate from 5 to 40 degree Celsius.
- 6) NEBS Level 3 compliant.
- 7) Operate from 5 to 80 non-condensing humidity
- 8) Designed as a chassis with easy to remove modules.
- 9) Chassis backplane shall be passive.
- 10) All modules shall be hot-swappable.
- 11) Meet the IEEE 802.1d (Virtual Bridge) standard.
- 12) Meet the IEEE 802.1x (authentication) standard.
- 13) Meet the requirements of :
 - a. IEEE 802.3z
 - b. IEEE 802.3ah
 - c. GR-20-CORE: Generic requirements for Optical Fiber and Optical Fiber Cable
 - d. GR-326-CORE: Generic Requirements for Singlemode
- 14) Full implementation of RIP protocol as outlined by RFCs: 1058, 1723, 1812
- 15) Full implementation of OSPF protocol as outlined by RFCs: 2178, 1583, 1587, 1745, 1765, 1850, 2154, 2328, 1850, 1997, 2385, 2439, 2842, 2918, 2370.
- 16) Capable of mirroring any port to any other port within the switch.
- 17) Password manageable through:
 - a. SSHv2 (Secure Shell)
- 18) Full implementation of GMRP (Generic Multicast Registration Protocol).
- 19) Full implementation of IGMPv2.
- 20) Full implementation of PIM-SM and PIM-DM.
- 21) Full implementation of DVMRPv3.
- 22) Full implementation of VRRP.
- 23) Comply with FCC 47 CRF Part 15 Class A emissions.
- 24) Bandwidth flow rate limiting policing support per port.
- 25) Full security implementation of
 - a. Support SSH2, 802.1x (rel 2)
 - b. Access Control Lists (ACL's)
 - c. RADIUS
 - d. TACACS
- 26) Have redundant power supplies installed.
- 27) The power supply units shall be hot swappable.
- 28) Switch chassis shall have a minimum of 6 module slots.
- 29) Blank covers for all remaining slots.

907-663.02.1.4--Type D Network Switch Requirements. The Type D Network Switch shall be of chassis design. The switch shall be able to accept a minimum of four (4) different type modular cards and have Layer 2 switch and Layer 3 routing capabilities. The Type D Network Switch shall meet the minimum requirements specified below:

- 1) The switch shall be chassis designed with a minimum of 4 module slots.
- 2) Each switch shall be able to accept the following type modules:
 - a. Ethernet module:
 - i. A minimum number of six (6) 10/100Base-TX compatible RJ45 ports.

- ii. The Contractor shall provide the minimum number of modules necessary to meet or exceed the required number of ports as indicated in the plans and NTBs.
 - iii. Total required bandwidth shall per chassis shall not exceed 10 Gbps
 - b. Fiber based modules:
 - i. The module shall accept SFP type fiber modules
 - ii. The Contractor shall supply any necessary fiber modules that meet the requirements of speed, type of fiber, and link budget connection.
 - iii. The Contractor shall provide the minimum number of modules necessary to meet or exceed the required number of ports as indicated in the plans and NTB
 - c. WAN module:
 - i. T1, DS3 or Metro Ethernet Interface (as per NTB or project plans)
 - 1. The Interface shall be T1, DS3 or Metro Ethernet
 - 2. The ports shall connect via RJ45 connector.
 - ii. Cellular Interface
 - 1. Contractor shall provide information to the Project Engineer to enable activation of the modem.
 - 2. Contractor shall get prior approval from the Project Engineer on selection of cellular radio type (HSPA/EVDO)
 - d. Terminal Server module:
 - i. Module that meets Terminal Server requirements Subsection 907-663.02.6
 - e. Power Supply module:
 - i. The power module provided shall be “screw terminal block” type. No pluggable terminal block.
 - ii. Input power: Same as Type A and Type B switches.
 - iii. Power module shall be hot-swappable.
 - iv. The Contractor shall supply the necessary amount of power supplies to meet power requirements for all cards installed and the chassis itself
- 3) The software license shall be provided to match functionality of installed modules.
- 4) It shall be DIN or Panel mountable.
- 5) The switch shall provide layer 2 and 3 switching and routing services
- 6) It shall meet the IEEE 802.1d (Virtual Bridge) standard.
- 7) It shall meet the IEEE 802.1x (authentication) standard.
- 8) Password manageable through:
 - a. SSHv2 (Secure Shell)
- 9) Full implementation of VRRP.
- 10) It shall comply with FCC 47 CRF Part 15 Class A emissions.
- 11) Bandwidth flow rate limiting policing support per port.
- 12) Full security implementation of
 - a. Support SSH2, 802.1x (rel 2)
 - b. Access Control Lists (ACL's)
 - c. RADIUS
- 13) Blank covers for all remaining slots.
- 14) Electronic surfaces shall be covered with conformal coating for additional environmental protection.

907-663.02.1.5--Type E Network Switch Requirements. The Type E Network Switch will be installed in locations where multiple backbone fiber converge or high concentration of ports are needed for a field location but need a hardened switch and shall meet the following requirements:

- 1) Each switch shall be populated with redundant switch fabric modules that meet the following minimum requirements:
 - a. Layer 2/3/4 switching and routing services
 - b. 64Gbps/48Mpps module Bandwidth
 - c. Min of 2-GE uplinks available per card with a minimum capability to expand to 4. The Contractor shall provide an uplink SFP optical module compatible with the interface for the uplink as indicated in the Comm Node Notice to Bidders for each uplink
- 2) Optical interfaces shall include 1000 Base-X (SFP-based module(s)) with a minimum of 8 ports. The Contractor shall provide whichever is greater between a min number of SFP optic modules to interface to the fiber as indicated in the plans and NTBs, or a min of 6 and shall have a minimum Optical budget of 18dB and be the same optical wavelength as Type A and B switches.
 - a. Optical receiver maximum input power level shall not be exceeded.
 - b. Optical attenuators shall be added as needed; fiber optic attenuator patch cords shall be in accordance with Section 657. It is the Contractor's responsibility to determine where attenuators are needed and shall be included in the cost of the switch.
- 3) Include a minimum 8 Ethernet 10/100/1000 ports
- 4) 19" rack mountable.
- 5) Operate from -22°F to +158°F.
- 6) Operate from 10 to 90 non-condensing humidity
- 7) Chassis backplane shall be passive.
- 8) All modules shall be hot-swappable.
- 9) Meet the IEEE 802.1d (Virtual Bridge) standard.
- 10) Meet the IEEE 802.1x (authentication) standard.
- 11) Meet the requirements of :
 - a. IEEE 802.3z
 - b. IEEE 802.3ah
 - c. GR-20-CORE: Generic requirements for Optical Fiber and Optical Fiber Cable
 - d. GR-326-CORE: Generic Requirements for Singlemode
- 12) Full implementation of RIP protocol as outlined by RFCs: 1058, 1723, 1812
- 13) Full implementation of OSPF protocol as outlined by RFCs: 2178, 1583, 1587, 1745, 1765, 1850, 2154, 2328, 1850, 1997, 2385, 2439, 2842, 2918, 2370.
- 14) Capable of mirroring any port to any other port within the switch.
- 15) Password manageable through:
 - a. SSHv2 (Secure Shell)
- 16) Full implementation of GMRP (Generic Multicast Registration Protocol).
- 17) Full implementation of IGMPv2.
- 18) Full implementation of PIM-SM and PIM-DM.
- 19) Full implementation of DVMRPv3.
- 20) Full implementation of VRRP.
- 21) Comply with FCC 47 CRF Part 15 Class A emissions.
- 22) Bandwidth flow rate limiting policing support per port.

- 23) Full security implementation of
 - a. Support SSH2, 802.1x (rel 2)
 - b. Access Control Lists (ACL's)
 - c. RADIUS
 - d. TACACS
- 24) Have redundant power supplies installed.
- 25) Blank covers for all remaining slots.
- 26) Have options or modules to add a terminal server as specified in Subsection 907-663.02.2
- 27) Have options or modules to add a cellular interface as specified in Subsection 907-663.02.3

907-663.02.2--Terminal Server. Terminal server shall adhere to the following minimum requirements.

- 1) 10/100 Base-T Ethernet port connection
- 2) RJ-45/DB9 Serial port connection
- 3) RS-232/422/485 selectable serial connections
- 4) Baud rates up to 230 Kbps
- 5) Full Modem and hardware flow control
- 6) TCP/UDP Socket Services
- 7) UDP Multicast
- 8) Telnet and Reverse Telnet
- 9) Modem emulation
- 10) SNMP (Read/Write)
- 11) PPP
- 12) Port buffering
- 13) HTTP
- 14) Remote management
- 15) DHCP/RARP/ARP-Ping for IP address assignment
- 16) LED status for link and power
- 17) The Terminal Server shall support a minimum of Four (4) bi-directional serial communications over Ethernet 10/100 Base-TX.
- 18) Each Terminal Server shall have a minimum of four (4) EIA-232/422/485 serial interface ports. These ports shall be individually and independently configurable, directly or over the network, to EIA-232/422/485 mode of operation as defined by the EIA for data format, data rate and data structure (e.g., the number of bits, parity, stop bits, etc.). Each serial port shall support up to 230 Kbps.
- 19) Each serial port shall support IP addressing and socket number selection.
- 20) The equipment shall provide the capability to establish an IP connection directly from a workstation to any encoder IP address and socket number transport serial data.
- 21) Each Terminal Server shall have an Ethernet Interface (10/100Base-TX protocol, Full/Half-Duplex, Auto Sense (802.3), RJ-45).

907-663.02.3--Cellular Modem. Cellular Modem and associated equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance and meet the following requirements.

907-663.02.3.1--Functional Requirements. Cellular Modem, antenna, wiring assemble, configuration software, and installation necessary shall be provided and furnished for a working cellular wireless communication connection in accordance with plans and specifications and compatible with the requirements of the Department system, and the wireless service carrier used by the Department. Unless otherwise indicated on the plans, all items that are required to complete the installation and ensure an operational system shall be supplied by the contractor whether listed above or not. Items required but not listed above shall be at no direct pay. All components supplied by the contractor are the responsibility of the contractor. It shall be the responsibility of the contractor to properly configure and deliver a working cellular communications system. It shall be the responsibility of the contractor to determine the final configuration of all electrical connections. Cellular account setup shall be coordinated with MDOT Traffic Engineering Division. Warranty and cellular carrier account shall be transferred into the Department's name upon acceptance of the project.

907-663.02.3.2--Cellular Modem System. The Cellular Modem shall adhere to the following minimum requirements.

- 1) Model and Type provided shall be pre-approved on a Department cellular service carrier.
- 2) Highest available on a Department cellular service carrier of 4G, EVO, or higher service.
- 3) Minimum of one 10/100 Base-T RJ45 Ethernet port
- 4) Minimum of one RS-232 serial port
- 5) Minimum of one external antenna connector
- 6) GPS Data available
 - a. Acquisition Time under 2 seconds
 - b. Accuracy: under 5m 90% of time
 - c. Tracking Sensitivity: -161 dBm
- 7) Device Configuration and Management Software via web interface.
- 8) Communications and Protocols supported:
 - a. Network: TCP/IP, UDP/IP, DNS
 - b. NAT and DHCP routing with VLAN, VRRP, and Static Routes configurable
 - c. Includes TELNET, SMTP, SNMP, SMS sessions and services
 - d. Serial: TCP/UDP PAD Mode, Modbus (ASCII,
 - e. GPS: NMEA V3.0, TAIP, RAP
 - f. Provides VPN security with up to 5 tunnels
- 9) Provides event reporting for GPS/AVL, Network Parameters, Data Usage, Time, Power, and Device Temperature over SMS, SNMP, or Email, SNMP.
- 10) Input Voltage: 10 to 36 VDC
- 11) Operating Temperature of -22°F to +158°F

907-663.02.4--Category 6 Cable. Category 6 cable shall adhere to the following minimum requirements.

- 1) 4 Pair #24 AWG UTP Category 6 Cable
- 2) This item is paid for Category 6 cables installed between cabinets and does not apply to other patch cords installed inside cabinets or huts.

- 3) Supplied Category 6 cable shall be suitable for use outdoors in duct and as a minimum meet the following requirements:
- 4) Fully water blocked
- 5) Conforms to the National Electrical Code Article 800
- 6) UL 1581 certified
- 7) Voltage Rating 300 Volts or greater
- 8) Operating and installation temperature (-4°F to 140°F)
- 9) Bend Radius 10 x Cable OD or smaller
- 10) Recommended for 1000Base-T applications for a distance of 100 meters.

907-663.02.4.1--Category 6 Patch Cords. The Cat 6 Patch Cords shall be furnished and installed as needed to connect the Network Switches with other equipment. Cat 6 Patch Cords shall be considered an incidental component for this project and furnished and installed as needed to provide a functional system. Cat 6 Patch Cords shall meet the following minimum requirements:

- 1) All patch cords shall be from the same manufacturer.
- 2) It shall incorporate four (4) pair 24 AWG stranded PVC Category 6.
- 3) It shall be factory made; Contractor or vendor assembled patch cords are not permitted.
- 4) It shall be TIA/EIA 568-B.2-1 compliant. Patch Cords shall be compliant to T568B pin configuration (whichever is used).
- 5) Certified by the manufacturer for Category 6 performance criteria.
- 6) Length as needed. Excessive slack is not permitted.

907-663.02.5--Project Submittal Program Requirements. The Contractor shall provide project submittals for network switches including scheduling requirements. The project submittals for network switches, terminal servers, and cellular modems shall include but are not limited to the following specific requirements.

The Contractor shall submit detailed cut sheets which document compliance with all parameters required in this section. If a parameter is not covered in the cut sheet a signed statement from the manufacturer on letterhead shall be submitted as an attachment. Failure to address all requirements will result in rejection of the submittal.

The Contractor shall submit documentation and proof of manufacturer-recommended training and certification for the installation and configuration of network switches.

The Contractor shall submit technical specifications for the minimum transmitter port to receiver port optical attenuation required for the switches to function in accordance with this specification for the optical links shown on the plans.

907-663.03--Construction Requirements. All networking equipment shall be installed according to the manufacturer's recommendations, the plans, and as follows.

Network switches shall only be configured and installed by the switch manufacturer trained personnel in accordance with manufacturer's guidelines and requirements.

The Contractor shall request from the Department, switch configuration information (such as IP address, VLAN Tag values, etc.) not more than 30 days after the switch submittals have been approved.

The Contractor shall provide as needed the necessary Cat 6 patch cords and fiber optic patch cords for a complete and functional installation. Category 6 cable installed in conduit shall be installed and terminated per the manufacturers recommended procedures. Five feet of spare slack shall be provided in the pull boxes nearest each Type B or Type C cabinet.

The Contractor shall provide training for proper management of the equipment installed. This training should cover daily operation as well as maintenance and configuration of the switching equipment installed as part of this project and meet the requirements of Subsection 907-663.03.5.

The Contractor shall provide the Department with a written inventory of items received and the condition in which they were received. Inventory shall be inclusive of make, model, and serial numbers, MAC address, and installation GPS coordinates. All equipment shall be installed according to the manufacturer's recommendations or as directed by the Department.

Any new, additional or updated drivers required for the existing ATMS software to communicate and control new Networking Equipment installed by the Contractor shall be the responsibility of the Contractor.

907-663.03.1--Switch Configuration Requirements. The Contractor shall configure Network Switches as follows.

All 100 Base-TX ports shall be configured as follows:

- a. RSTP/STP – Off.
- b. Unused TX ports shall be disabled.
- c. Operating TX ports shall be programmed to filter only for the MAC address of the connected device.

All 1000 Base-FX ports shall be configured as follows:

- a. RSTP/STP – On.
- b. IGMP Snooping – On.

The Type D switch configuration shall be as outline in the plans and contract documents.

All network switches shall be installed and configured with the same firmware configuration. The optimum settings shall be used consistently system-wide. Any locations that require different settings for optimum performance shall be approved by the Engineer.

The switches shall be configured to enable multicasting and turn on multicast protocols.

The Contractor may submit an alternate switch configuration to the ITS Engineer for review and approval. The ITS Engineer will review alternate switch configuration documentation. The goal of the switch configuration is to reduce the network delay, as well as provide network redundancy.

The Contractor shall submit an electronic copy of all final and approved configurations of all switches to the Project Engineer and to the ITS Engineer.

907-663.03.2--Testing. The Contractor shall conduct a Project Testing Program as required below. All costs associated with the Project Testing Program shall be included in the overall contract price; no separate payment will be made for any testing.

All test results shall confirm physical and performance compliance with these specifications.

Each test shall fully demonstrate that the equipment being tested is clearly and definitely in full compliance with all project requirements.

Contractor shall submit all test results documentation to the Engineer for review within 14 calendar days of completion of the tests.

All tests deemed by the Project Engineer to be unsatisfactorily completed shall be repeated by the Contractor. In the written request for each test occurrence that is a repeat of a previous test, the Contractor shall summarize the diagnosis and correction of each aspect of the previous test. The Contractor shall summarize the diagnosis and correction of each aspect of the previous test that was deemed unsatisfactory. The test procedures for a repeated test occurrence shall meet all the requirements of the original test procedures, including review and approval by the Project Engineer and ITS Manager or designee.

The satisfactory completion of any test shall not relieve the Contractor of responsibility to provide a completely acceptable and operating system that meets all requirements of this project.

907-663.03.3--Documentation. As-built plans showing switch configuration and connections shall be provided to the Project Engineer and ITS Engineer in electronic format.

The Contractor shall submit documentation and proof of measured optical power budgets to all optical links of all type switches.

All equipment and software must be fully functional and pass a Final Inspection by the ITS Manager and Project Engineer before being accepted by the Department

907-663.03.4--Warranty. All warranties and guarantees shall be assigned to the Mississippi Department of Transportation. The warranty shall be a minimum of one (1) year warranty

907-663.03.5--MDOT Employee Training. After the installation is complete, the Contractor shall provide formal classroom training and "hands-on" operations training for proper operation and maintenance of the network switch. The training shall be provided for up to six personnel designated by the ITS Engineer and shall be a minimum of four hours in duration. The training

shall cover as a minimum preventive maintenance, troubleshooting techniques, fault isolation and circuit analysis. All training materials shall be provided by the Contractor.

Prior to training, the Contractor shall submit resume and references of instructor(s). The Contractor shall submit a Training Plan which includes an outline of the training course. The plans shall be submitted within 90 days of Notice-to-Proceed. Approval of the plans shall be obtained from the Engineer and the Traffic Engineering ITS Department. The Plan shall detail the contents of the course and the time schedule of when the training will be given.

Training shall be conducted in the Jackson area. For the training, a same models of equipment furnished for the project shall be presented. During the training, handouts, manuals, and product information shall be distributed. All media and test equipment needed shall be present at the training. Training instructor(s) shall be manufacturer-certified, experienced in the skill of training others. The training shall be conducted by a trainer with a minimum of four years of experience in training personnel on the operation and maintenance of fiber optic systems.

907-663.04--Method of Measurement. Network Switch of the type specified, Terminal Server, and Cellular Modem will be measured per each installation as specified in the plans.

Category 6 Cable, Installed in Conduit, will be measured for payment by the linear foot, horizontally between cabinets.

907-663.05--Basis of Payment. Network Switch, measured as prescribed above, will be paid for at the contract unit price bid per each, which price shall be full compensation for all labor, tools, materials, equipment, furnishing, installing, system integration and testing of a network switch including all chassis, modules, power cables, power supplies, software, license, fiber optic patch cords, fiber optic attenuator patch cords, Cat 6 patch cords, attachment hardware, mounting shelf and hardware, testing and training requirements, all system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other material necessary to document the operation of the switch and network, and all incidentals necessary to provide a fully functional switch ready for use.

Terminal server, measured as prescribed above, will be paid for at the contract unit price bid per each, which price shall be full compensation for all labor, tools, materials, equipment, furnishing, installing, system integration and testing of a terminal server including all incidental components, attachment hardware, mounting shelf and hardware, testing and training requirements, and all incidentals necessary to provide a fully functional Terminal Server ready for use.

Cellular modem, measured as prescribed above, will be paid for at the contract unit price bid per each, which price shall be full compensation for all labor, tools, materials, equipment include the, modem, antenna, reset timers, cabling, factory and manufacturing inspection, testing, storage, packaging, shipping, warranty, and all incidentals necessary to effect the full operation and control of the cellular modem complete in place and ready for use

Category 6 Cable, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall include all labor, tools, materials, equipment, and all incidental necessary to complete the work.

Payment will be made under:

- 907-663-A: Network Switch, Type ___ - per each
- 907-663-B: Terminal Server - per each
- 907-663-C: Cellular Modem - per each
- 907-663-D Category 6 Cable, Installed in Conduit - per linear foot