SPECIAL SPECIFICATION

6220

2.5-10 Gbps ATM Switches

1. Description. Furnish and install ATM Switches at designated locations as shown on the plans, as detailed in accordance with these specifications, and as directed. Ensure all ATM Switches are from the same manufacturer, support Non-Blocking Switch fabrics with a scalable backplane supporting 2.5 to 10 Gbps in 2.5 Gbps increments. Ensure all switches support OC-3, OC-12, DS-1, and DS-3 network interfaces.


A. General Requirements. Provide new equipment in strict accordance with the details shown on the plans and in the specifications.

Include licenses for all equipment, where required, for any software or hardware in the system including PNNI, Lane, etc.

B. Adherence to Standards. Furnish, assemble, fabricate, or install all modular ATM Switches under this Item to be in compliance with:

- ANSI T1.105-1996, Synchronous Optical Network (SONET) Basic Description including Multiplex Structure, Rates and Formats.
- ANSI T1.105.06., Synchronous Optical Network (SONET) Optical Interface Parameters.
- ANSI T1.119., Synchronous Optical Network (SONET) OAM&P Communications.
- ANSI T1.231., Synchronous Optical Network (SONET) In Service Performance Monitoring.
- ANSI T1.627, Broadband ISDN ATM Layer Functionality and Specification.
- ANSI T1.630, B-ISDN ATM Adaptation Layer for Constant Bit Rate Services Functionality and Specification.
- ANSI T1.635, B-ISDN ATM Adaptation Layer Type 5 Common Part Functions and Specifications.
ANSI T1.637, B-ISDN ATM Adaptation Layer Service Specific Connection Oriented Protocol (SSCOP).

ANSI T1.638, B-ISDN Signaling ATM Adaptation Layer Service Specific Coordination Function for Support of Signaling at the User to Network Interface (SSCF at the UNI).


ATM Forum LAN Emulation (LANE) v1.0.

ATM Forum Interim Interswitch Signaling Protocol (IISP) v1.0.

ATM Forum Traffic Management 4.0.

ATM Forum 622.08 Mbps Physical Layer Specification.

ATM Forum Integrated Local Management Interface (ILMI) Specification v4.0.


C. **Functional Requirements.**

1. **Physical Design Requirements.** Conform ATM Switch physical design to the following requirements:

   Be rack mountable in industry standard racks not to exceed 24 in. wide.

   Be modular in design such that major components may be readily replaced in the field without powering-down the equipment, (hot swappable). Ensure modules are able to be inserted in any available slot without restriction.

   Have dust covers placed over all unused card slots.

   Identify clearly all modules and assemblies with name, model number, serial number, or any other pertinent information required to facilitate equipment maintenance.

2. **ATM Switch Requirements.** Ensure all ATM Switches provide the following functionality:
Provide ATM cell-switching with 53 Byte cells on both User Network Interface (UNI) and Network Network Interface (NNI).

Provide for the integration of data communication edge devices (e.g. LAN-based).

Provide for the integration telecommunications edge devices (e.g. WAN-based).

Provide ATM Forum LAN Emulation (LANE) 1.0 services.

Provide enhanced capability for redundant LAN Emulation Server (LES) and Broadcast Unknown Server (BUS) services.

Provide the ability to configure LANE 1.0 LES and BUS services to be collocated on the same device.

Provide for the configuration of an Intelligent Bus (IBUS) which probes the LES address cache prior to issuing a broadcast unknown message.

Support RFC 1483, Multiprotocol Encapsulation over ATM Adaptation Layer 5.

Support RFC 1577, Classical IP Over ATM (CLIP).

Support Switched Virtual Circuits (SVC), Permanent Virtual Circuits (PVC), Virtual Paths (VP), Smart PVCs, SVC Tunneling, and IP Multicast SVC.

Be software manageable in whole and by sub-component.

Use a Time Division Multiplexed (TDM) architecture to guarantee non-blocking performance.

Implement a distributed shared Memory architecture which dynamically allocates shared memory among all ports, while maintaining logical separation between output queues. Ensure the architecture will enable a dedicated queue for each virtual circuit. Ensure the switch will distinguish among virtual circuits and allocate each virtual circuit its own output buffer. Ensure each connection will be treated independently and each connection will be serviced in turn according to its requirements.

Support the User-Network Interface (UNI) in conformance with the ATM Forum UNI v3.1 Specification and ITU I.361.

Institute Connection Admission Control (CAC) and Usage Parameter Control (UPC) functions as defined in ATM Forum Traffic Management 4.0.

Implement the ATM Forum Generic Cell Rate Algorithm (GCRA) as specified in ATM Forum UNI 3.x.

Support an SNMP agent for network management.

Generate its timing clock from either an internal clock or an incoming timing stream to one of the ATM ports. Ensure the switch is able to accept clocking from one interface and be able to distribute clocking to other interfaces, regardless of
what switch fabric the interface is on. Ensure each network module support a primary and secondary internal and external clocking source.

Submit all requirement types to interoperability testing with a large number of ATM vendors at an independent test facility within the last 18 months.

Support redundant, load balancing power supplies and fans. Ensure switch fabrics support a redundant processor.

Ensure software upgradeable to take advantage of new features and standards, as they are commercially available.

a. **Switch Control Processor (SCP):** Provide with the CPU grade and clock speed as directed and be compatible with other switch control processors in the intended ATM Switch.

Provided with a minimum of 64 MB DRAM and 16 MB of Level 2 (L2) cache.

Provide a minimum performance of 700 calls per second and a minimum of 400 call setups and teardowns per second.

Configure in a chassis that supports a scalable backplane that expands from 2.5 to 10 Gbps in 2.5 Gpbs increments.

Ensure all expansions and upgrades be accomplished without powering down or disrupting the operation of the ATM switch, by the installation, or removal and installation of current version, or version specified by the Engineer, switch control processor and switch module (switch fabric) as shown on the plan sheets and quantities.

Have a non-blocking switching capability able to simultaneously switch every port the equipment can physically accommodate with cell streams operating at 100% with no cell loss. (i.e., shall be capable of simultaneously switching all input ports running at line rate to all output ports running at line rate without cell loss).

Support a nonblocking ATM multicast method by allowing only a single cell to be sent into the shared memory buffer carrying multiple dequeueing indicators. Ensure the queueing function of the switches memory controller will dequeue a single copy of the cell to multiple VC outputs.

Support the establishment of connections using CBR, Variable Bit Rate (VBR) both real-time and non-real-time, and Unspecified Bit Rate (UBR) as specified by the ATM Forum.

Support the ATM Forum Interim Interswitch Protocol (IISP).

Offer a hierarchical ATM Forum PNNI implementation that allows the network to limit routing topology updates to within a single peer group. Ensure only summary information about the “external edges” of the peer group
be made visible to other peer groups. Ensure hierarchical ATM Forum PNNI implementation supports a minimum of two levels of hierarchy.

Support latency and jitter requirements, where latency is the time it takes for cells to enter the switch, be forwarded to their output port and exit the switch; jitter is the fluctuation of the constant rate at the output port of Constant Bit Rate (CBR) traffic. Ensure the jitter measurements is based upon a CBR stream configured for 1 percent of bandwidth across a PVC through the switch. Have a maximum latency of less than 17 microseconds under 90% background loading.

Have a maximum jitter of 5 microseconds under 90% background loading.

Support OC-3c/STM-1 interfaces.

Support OC-12c/STM-4 interfaces.

Support DS-1 and DS-3 circuits directly into the switch, i.e., no external CSU./DSU.

3. **Optical Interface Requirements.** Ensure the optical interfaces conform to the SONET standards as stated in Sub-Article 2.B. Additional requirements for the optical interfaces are stated below:

   a. **OC-3c Interfaces:**

      Support 4 SONET/SDH per interface module.

      Support a data rate of 155.52 Mbps.

      Have an output buffering capacity of 13,312 cells.

      Have support for Multi-Mode fiber media with either ST or SC physical connectors.

      Accept Single Mode, short reach or Single Mode, Long Reach fiber media with FC physical connectors.

      Support a maximum line length of up to 2 km for Multi-mode fiber media.

      Support a maximum line length of up to 2 km for Single Mode, Short Reach fiber.

      Support a maximum line length of 40 km for Single Mode, Long Reach fiber.

      Support Non Return Zero (NRZ) line encoding.

      Support STS-3c/STM-1 Framing.

      Have a clock accuracy of +/- 20 ppm.

      Derive primary and secondary 8kHz timing from internal or external source.
Support transmit and receive loopback diagnostics.

Have a transmit power of -14 to -20 dBm.

Have a receive sensitivity of -14 to -30 dBm.

Have a path attenuation of 0 to 10 dB.

Have a line impedance of 100 ohms nominal.

Report the following SONET/SDH statistics/alarms: Loss of Signal (LOS), Loss of Frame (LOF), Loss of Pointer (LOP), Far End Block Errors (FEBE), Alarm Indication Signal (AIS), Far End Receive Failure (FERF), Yellow Alarm, Bit Interleaved parity Errors (Line BIP-24, Section BIP-8, Path BIP-8), Header Check Sequence (HCS) errors.


b. **OC-12C Interfaces:**

Support 1 SONET/SDH per interface module.

Support a data rate of 622.08 Mbps.

Have an output buffering capacity of 13,312 cells.

Support Multi-Mode fiber media with ST or SC physical connectors.

Support a maximum line length of 500 m for Multi-mode fiber media.

Support Single Mode, Intermediate Reach fiber media with SC physical connectors.

Support a maximum line length of 15 km for Single Mode, Intermediate Reach fiber media.

Support Single Mode, Long Reach fiber media with SC physical connectors.

Support a maximum line length of 60 km for Single Mode, Long Reach fiber media.

Support Non Return Zero (NRZ) line encoding.

Support STS-12c/STM-4c Framing.

Have a clock accuracy of ± 20 ppm.

Derive primary and secondary 8kHz timing from internal or external source.

Support transmit and receive loopback diagnostics.

Have a transmit power of -8 to -15 dBm.
Have a receive sensitivity of -8 to -28 dBm.

Have a path attenuation of 0 to 13 dB.

Have a line impedance of 100 ohms nominal.

Report the following SONET/SDH statistics/alarms: Loss of Signal (LOS), Loss of Frame (LOF), Loss of Pointer (LOP), Far End Block Errors (FEBE), Alarm Indication Signal (AIS), Far End Receive Failure (FERF), Yellow Alarm, Bit Interleaved parity Errors (Line BIP-24, Section BIP-8, Path BIP-8), Header Check Sequence (HCS) errors.

Be in compliance with ATM Forum STS-12c UNI v3.1, ITU-T I.432, ANSI T1E1.2/93-020, T1S1/92-185, ITU-T G.957, Bellcore TR-NWT-000253

4. **Low Speed Interface Requirements**. Furnish, assemble, fabricate, or install all ATM switches under this Item and configured for the ATM network have the following low speed interface requirements:

   a. **DS-1 Interfaces:**

      Support up to 6 DS-1 ports per interface module.

      Support a data rate of 1.544 Mbps.

      Have an output buffering capacity of 13,312 cells.

      Accept Unshielded Twisted Pair (UTP) media with RJ-45 connectors conforming to RJ-48c CPE pinouts.

      Have line drivers that support a maximum cable of up to 650 ft.

      Support Bipolar 8 Zero Substitution (B8ZS) line encoding.

      Support Extended Super Frame (ESF) framing or Physical Layer Convergence Protocol Framing.

      Have a clock accuracy of ± 32 ppm.

      Derive primary and secondary 8kHz timing from internal or external source.

      Support transmit and receive loopback diagnostics.

      Have a line impedance of 100 ohms nominal.

      Report the following statistics/alarms: Line Code Violations (LCV), Framing Bit Errors (FER), CRC-6 Bit Error Events (BEE), Out of Frame events (OOF), Header Check Sequence (HCS) errors, Cells Received (RxCells), Cells Transmitted (TxCells), Signal/Clock Detection, and AIS indication.

      Be in compliance with ATM Forum ATM Forum-PHY-0016.000, ANSI/Bellcore T1.102, T1.107, T1.408, TR-TSY-000009, ITU-T G.703, G.704, G.804.
b. **Circuit Emulation Service Module.** Ensure the circuit emulation service module has the following requirements:

* **Port Capacity:** 6 port DS1 and E1 network modules.
* **Data Rate:** DS1 1.544 Mbps.
* **Media:** Unshielded twisted pair.
* **Connector:** RJ-48c.

**Circuit Framing:**

* **Structured Service:** Digital cross-connect emulation where N\times 64 Kbps and N\times 56 Kbps circuits are mapped to unique ATM virtual connections (VCs); N=1 to 24/1 to 31 contiguous or non-contiguous Digital Signal Level Zero (DS-0) channels per DS1/E1 VoicePlus port.

* **Unstructured Service:** Full bandwidth 1.54 Mbps (DS1) clear channel service per VoicePlus port.

**Circuit Signaling:** Channel Associated Signaling (CAS) and Basic modes supported with Structured Service.

**Line Framing:** DS1 Version: ESF (Extended Superframe) and SF (Superframe).

**Line Coding:** DS1 Version - AMI and B8ZS.

**Clocking:** Synchronous Clocking - Structured and Unstructured Services: Primary and secondary 8 KHz reference source from internal fabric (default), network port, or on-card crystal.

**Variable Cell Fill:** Configurable AAL1 ATM cell payload fill from 9 to 47 bytes.

**Loopbacks:** Per port line/payload loopback.

**Statistics/Alarms:** Header errors, pointer reframes, lost cells, buffer underflows, buffer overflows, errored seconds (ES), severely errored seconds (SES), severely errored framing seconds (SEF), unavailable seconds (UAS), controlled slip seconds (CSS), path coding violations (PCV), line errored seconds (LES), bursty errored seconds (BES), degraded minutes (DM), line coding violations (LCV), cell loss status, loss of frame (LOF), alarm indication signal (AIS), loss of signal (LOS), loss of multi-frame (LOMF).

**Compliance:** ATM Forum Circuit Emulation Service Interoperability Specification v2.0 (ATMForum/95-1504R1), ANSI/Bellcore T1.403, ITU-T G.703, G.704, G.823, G.824.

c. **DS-3 Interfaces:**
Support up to 4 DS-3 ports per interface module.
Support a data rate of 44.736 Mbps.
Have an output buffering capacity of 13,312 cells.
Have line drivers that support cable length(s) of up to 450 ft.
Accept Coaxial media with BNC connectors.
Support Bipolar 3 Zero Substitution (B3ZS) line encoding.
Support C-Bit Parity or clear channel, optionally support Physical Layer Convergence Protocol (PLCP) Framing.
Have a clock accuracy of ± 20 ppm.
Derive primary and secondary 8kHz reference from internal or external source.
Support transmit and receive loopback diagnostics.
Have a line impedance of 75 ohms nominal.
Report the following statistics/alarm: Line Code Violations (LCV), Framing Bit Errors (FER), P-bit and C-bit errors, Header Check Sequence (HCS) errors, Cells Received (RxCells), Cells Transmitted (TxCells), Signal/Clock Detection, and AIS indication.

D. **Power Requirements.** Ensure the ATM Switch operates at input voltage is 115 VAC ±10%, 60±3 Hz.

Provide equipment operations that are not affected by the transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

1. **Wiring.** Provide wiring that meets the requirements of the National Electric Code. Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not doubled-back wire to take up slack. Lace wires neatly into cable with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

2. **Transient Suppression.** Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

3. **Power Service Protection.** Provide equipment that contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.
4. **Fail Safe Provision.** Provide equipment that is designed such that the failures of the equipment must not cause the failure of any other unit of equipment.

E. **Mechanical Requirements.**

Coat printed circuit boards with a clear-coat moisture and fungus resistant material (conformal coating).

1. **Modular Design.** Provide equipment that is modular in design to allow major portions to be readily replaced in the field. Ensure modules of unlike functions are mechanically keyed to prevent insertion into the wrong socket or connector.

   Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2. **Connectors and Harnesses.** Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and/or appropriately mark wires to and from the connectors.

   Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

   Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

   Ensure patch fibers with mixed connectors are uniquely color coded for easy identification.

3. **Environmental, Safety, and Reliability Requirements.** Furnish, assemble, fabricate, or install all ATM Switches under this Item and configured for the ATM network architecture be in compliance with the following:

   a. **Environmental Requirements.** Ensure all specified requirements are met during uncontrolled environmental operations characterized by a temperature range of 5°C to +40°C and a humidity range of 10% to 90% (non-condensing).


      Ensure the ATM Switch meet the requirements as specified by ANSI/IEEE C39-90 for Electromagnetic Susceptibility compliance and meet requirements as specified by Bellcore TR 1089 for Lightning Protection.

   b. **Safety Requirements.** Underwriter's Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electrical Code for customer premise installations.

      Require fire resistance specified by Underwriter's Laboratories in UL 1459, 2nd Edition.
4. **Operations and Maintenance Requirements.** Provide the ATM Switch to meet the following operations and maintenance requirements.

   a. **Alarm Indications.** Ensure individual ATM network modules have face plate LEDs to indicate an alarm or failure condition.

      Provide alarms to indicate:

      One or more lines out of Service

      A potential loss of service or maintainability (minor alarms)

      Loss of incoming power (power alarm)

   b. **Maintenance and Control.** Provide the ATM switch to support of the following maintenance and control functions to include:

      Have an out-of-band maintenance port.

      Support an in-band and out-of-band remote software download capability.

      Support diagnostics and switch configuration both in-band and out-of-band. In-band access shall be available via Telnet.

      Support authentication for download and diagnostic access both in-band and out-of-band.

   c. **Message-based Operations Interface Requirements.** Ensure the ATM Switch will offer a management application which:

      Use a Graphical User Interface (GUI) for mapping, reporting, and displaying ATM network data.


      Provide network event and alarm monitoring capabilities.

      Operate on a Windows NT 4.0, or version directed by the Engineer, platform and be supported by HP OpenView application. Ensure network management software will integrate with HP OpenView enabling both programs to run on a single platform simultaneously and interactively.

      Provide the means to remotely monitor and configure all ATM switches in the network.

      Be able to perform auto-discovery on the ATM switches in the network.

      Provide the means to configure and reconfigure the ATM switch for ports, PVCs, SVCs, VPIs, VCl, throughput.
Provide the capability to monitor interface utilization by interface and VPI/VCI.

Be able to collect, display, create, and print reports on throughput statistics, channel utilization and error conditions.

Be able to interface with the ATM switch and run diagnostics to assist in fault isolation.

Be able to provide accounting management functions to provide billing and tracking functions.

Be able to support security management functions.

Provide the ability to specify user privileges and assign a minimum of 3 different levels of access to the monitoring and configuring of the ATM equipment in the network.

Support both in-band and out-of-band management interfaces.

Interface with a network management application to provide fault isolation support and reporting, performance monitoring and reporting, configuration of the switch, traffic accounting, and security management of the switch.

Be configurable to forward raw data (i.e., Alarms) as well as tailored data (i.e., Reports) to an external network management application.

Provide the ability to configure error reporting thresholds and event notices.

Report fault messages to multiple network management application locations and at configurable/user selected time intervals.

Support a minimum of three levels of error significance (e.g., routine, major, critical).

3. Construction.

A. General. Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

B. Electronic Components. Provide electronic components in accordance with Special Specification, "Electronic Components".

C. Mechanical Components. Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect
materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

D. **Documentation Requirements.** Provide documentation in accordance with Article 4, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty”.

E. **Testing.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty.”

F. **Experience Requirements.** The Contractor or designated subcontractors involved in the installation and testing of the ATM Switch shall, as a minimum, meet the following requirements:

Three years experience in the installation of ATM equipment.

Two installed systems where ATM Switches, greater than DS-3, are installed and the systems have been in continuously satisfactory operation for at least 2 years. The Contractor shall submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the system.

One communication system involving ATM switches greater than OC-3 (which may be one of the two in the preceding paragraph) which the Contractor can arrange for demonstration to the Engineer and/or his representative.

Provide necessary documentation of subcontractor qualifications pursuant to contract award.

G. **Technical Assistance.** Ensure that a manufacturer's technical representative is available on site to assist the Contractor's technical personnel at each installation site and with ATM Equipment installation and communication system configuration.

Do not execute the initial powering up of the ATM equipment without the permission of the manufacturer's representative.

H. **Training.** Provide training in accordance with Article 3, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

I. **Warranty.** Provide a warranty in accordance with Article 6, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

4. **Measurement.** This Item will be measured as each unit furnished, installed, made fully functional and tested in accordance with these special specifications or as directed by the Engineer.

5. **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 bid for “2.5 Gbps ATM Switch”, “4 Ports ATM OC-3 MM”, “4 Ports ATM OC-3 SM”, “1 Port ATM OC-12 SM (Intermediate Reach)”, “1 Port ATM OC-12 SM (Long Reach)”, “6 Ports T1 Circuit Emulation DS1A”, “SCP-P5/200 with Switch Module”, or “SCP-P5/200 without
Switch Module”. This price will include all equipment described under this Item with all cables and connectors; all documentation and testing and shall also include the cost of furnishing all labor, materials, warranty, training, equipment, and incidentals.