CHAPTER 1

LightStream 1010 Product Overview

The LightStream 1010 ATM switch is Cisco's next generation Asynchronous Transfer Mode (ATM) switch for workgroup and campus backbone deployment. Incorporating support for the latest ATM Forum specifications, and building upon the Cisco System's IOS software, the LightStream 1010 offers the most complete, sophisticated, feature set of any ATM switch in its class together with the performance, scalability and robustness required for production ATM deployment.

The LightStream 1010 uses a five-slot, modular chassis featuring the option of dual, fault-tolerant, load-sharing power supplies. The central slot in the LightStream 1010 is dedicated to a single, field-replaceable ATM switch processor (ASP) module that supports both the 5-Gbps shared memory and the fully nonblocking switch fabric. The ASP also supports the feature card and high performance RISC processor that provides the central intelligence for the device. The remaining slots support up to four hot-swappable Carrier Modules (CAMs). Each CAM supports up to two hot-swappable Port Adapter Modules (PAMs) for a maximum of eight PAMs per switch, supporting a wide variety of desktop, backbone, and wide-area interfaces.

The LightStream 1010 ATM switch provides switched ATM connections to individual workstations, servers, LAN segments, or other ATM switches and routers using fiber-optic, unshielded twisted-pair (UTP), and coaxial cable.

The LightStream 1010 ATM switch can accommodate up to 32 Optical Carrier (OC)-3 switched ATM ports in a standard 19-inch (48-centimeter) rack.

Summary of Features

The LightStream 1010 ATM switch provides the following features:

- ATM User-to-Network Interface (UNI) for both network and user sides
- ATM Network-to-Network Interface (NNI) between switches
- Support for the following ATM connection types:
    - Permanent virtual channel connections (PVCCs)
    - Permanent virtual path connections (PVPCs)
    - Soft permanent virtual channel connections (Soft PVCCs)
    - Soft permanent virtual path connections (Soft PVPCs)
    - Switched virtual channel connections (SVCCs)
    - Switched virtual path connection (SPVPs)
    - Virtual path (VP) tunneling

   - Point-to-point ATM connection
   - Point-to-multipoint ATM connections
- ATM fault management operation, administration, and maintenance (OAM) (F4 and F5 flow)
- Resource management to support the following classes of service:
   - constant bit rate (CBR)
   - variable bit rate (VBR)
   - available bit rate (ABR)
   - unspecified bit rate (UBR)
   - quality of service (QOS)
- Interim Local Management Interface (ILMI) as per UNI 3.0/3.1
- ATM User-to-Network Interface (UNI) signaling protocol for both user and network as per UNI 3.0
- ATM Network-to-Network Interface (NNI) signaling protocol
- Interim Interswitch Signaling Protocol (IISP) as defined by the ATM Forum
- Private Network-Node Interface (PNNI) Phase 1—a prestandard release of the ATM Forum PNNI that supports a single peer group
- LAN Emulation Client as defined by the ATM Forum Version 1.0
- In-band device network management using IP over ATM Simple Network Management Protocol (SNMP agent V1/V2 and Telnet)
- In-band device network management using LAN Emulation (SNMP agent V1/V2 and Telnet)
- Out-of-band device network management using Ethernet and console ports
- ATM and other applicable industry Management Information Bases (MIBs)
- Command line interface (CLI) at the RS-232 console and Telnet
- Upload/Download software code image
- Port snooping

The following interfaces are supported:

- 155 Mbps:
   - Synchronous Optical Network (SONET) multimode fiber-optic cable
   - SONET single-mode fiber-optic cable
   - Unshielded twisted-pair (UTP) cable
- 45-Mbps DS-3 coaxial cable
- 34-Mbps E-3 coaxial cable
- 622 Mbps SONET OC-12 single-mode fiber-optic cable

LightStream 1010 System Functions

The following sections describe the implementation used by the Light Stream 1010 to switch cells on an ATM network:

- ATM Addressing and “Plug-and-Play” Operation
- ATM Signaling
- ATM Routing
- Advanced Traffic Management and Resource Management
- Operation, Administration, and Maintenance Support
- LAN Emulation Client
- Classical IP over ATM
- Network Management
- ATM Standards Compliance

ATM Addressing and “Plug-and-Play” Operation

ATM routing protocols operate on the ATM private network, and use network service access point (NSAP) format addresses. Prefixes of such addresses identify individual switches and collections of switches within peer groups. Switches also supply these prefixes to attached end systems, using the ILMI protocol. ATM private network address prefixes can be obtained either from ATM service providers or directly from the various national authorities designated by the ISO to allocate the NSAP address space. The mechanisms for administrating such addresses are not yet well understood by the industry, however, and there are few ATM service providers from whom customers may obtain their addresses.

In order to overcome these problems, all LightStream 1010 switches are preconfigured with Cisco ATM address prefixes. These prefixes are combined with the switch’s preconfigured MAC address in order to develop a unique node identifier. These are used both to configure attached end systems and to automatically bring up the PNNI routing hierarchy, hence offering true plug-and-play operation. Such autoconfigured addresses will suffice for a small peer group of a few dozen switches, permitting small-scale ATM internetworks to be deployed while allowing time for customers to obtain and allocate their own ATM address prefixes. If autoconfiguration of addresses is required, mechanisms implemented on the LightStream 1010 allow automatic address reassignment. Such plug-and-play operation within the context of fully standard routing protocols is a unique capability of the LightStream 1010.

The LightStream 1010 also automatically recognizes the type of any port modules plugged into a carrier module, and, if the new PAM is of the same type as the previously plugged in PAM, will also automatically restore any interface specific configuration and PVCs saved to memory. Upon a reboot, the switch will also automatically restore all PVCs and any other configuration information stored within its nonvolatile memory. The LightStream 1010 also uses the ILMI protocol to automatically recognize the nature of any new ATM interface—for example, whether it is a UNI or NNI, public or private interface—hence eliminating any manual configuration.

Such recognition and restoration mechanisms, when combined with each IP address autoconfiguration mechanisms as BootP, cause the LightStream 1010 to be made fully self-configuring. Through network management applications or the text based CLI the network operators, if desired, will also have the capability to:

- Configure and customize all aspects of the operation of the switch.
- Monitor device and network status through sophisticated troubleshooting or debugging procedures.

ATM Signaling

The LightStream 1010 has full, integrated support for ATM Forum-compliant UNI 3.0 signaling, and, in a future release, UNI 3.1 signaling. All elements of the UNI standards, including both point-to-point and point-to-multipoint signaling capabilities and the ILMI protocol are supported. The ILMI protocol uses SNMP based mechanisms across all interfaces to automatically identify which of its interfaces are UNI, attached to ATM end systems, and which are NNI, attached to other systems. Further, it can differentiate between private and public network links. Such information is used by the ATM routing protocols to automatically discover and bring up a network of interconnected LightStream 1010 switches.

The ILMI protocol is also used for ATM address registration across ATM UNI, in order to program ATM end systems with ATM address prefixes. The ILMI protocol is also used so that the switch can discover the 48-bit Media Access Control (MAC) addresses of the attached systems. ILMI not only reduces the need for manual configuration of attached end systems but is also important for the plug-and-play operation of LightStream 1010 based networks, for instance, it is also used for informing LANE clients of the location of the LANE Configuration Server (LECS).

UNI signaling is also used by ATM end systems to inform LightStream 1010s of the desired traffic characteristics and QOS for new connections and the acceptance or rejection of such connection requests. Fully integrating support for ATM signaling onto the ASP module not only ensures high performance, but also high reliability since no external signaling processor is required.

ATM Access Lists

The access control list is used by the signaling software to filter setup messages on an interface or subinterface as either destination or source. Access lists can be used to deny connections that are known to be security risks and permit all other connections, or to permit those connections that are considered acceptable and deny all the rest. For firewall implementation, denying access to security risks offers more control.

ATM Routing

The Light Stream1010 supports the routing of ATM signaling requests across a network of switches using the ATM routing protocols. Two standard routing protocols have been developed by the ATM Forum—IISP and the PNNI protocol, Version 1. Both protocols are supported by the LightStream 1010—the default IISP software image supports the IISP protocol only; the optional PNNI image supports the PNNI Version 1 protocol.

IISP

The IISP protocol uses a combination of static routing and UNI signaling, and is more suitable for small networks of switches. See the section “ATM Signaling.”

PNNI

The PNNI Version 1 protocol has been designed to scale to the largest possible ATM networks, encompassing thousands of switches, and is the preferred solution for larger networks. Switches running the PNNI image can also be configured to operate in IISP, in order to permit a smooth evolution to the PNNI Version 1 protocol. Additional ATM routing capabilities allow for load-balancing across redundant links, increasing system reliability.

The PNNI Version 1 protocol supports sophisticated mechanisms to permit both QOS based routing of ATM connection requests and scalability. Routing is supported by a link state routing protocol, and the exchange of QOS routing metrics and attributes between all nodes. The metrics and attributes supported by the Cisco Systems PNNI implementation include the following:

- Administrative weight
- Peak-to-Peak (maximum) Cell Delay Variation for constant bit rate (CBR) and variable bit rate (VBR) connections
- Maximum Cell Transfer Delay for CBR and VBR connections
- Available Cell Rate per class
- Maximum Cell rate per interface
- Maximum Loss Ratio for the CLP=0 cells of CBR and VBR connections
- Cell Rate Margin
- Variance Factor

While the PNNI Version 1 protocol specifies the formats and types of information exchanged by the protocol, and PNNI signaling is used to forward signaling requests across the network, many other aspects of the protocol are left as a matter of implementation. The PNNI implementation on LightStream 1010 incorporates many value-added capabilities to extend beyond the base standards.

Crankback

Both IISP and PNNI Version 1 implementations on the LightStream 1010 support crankback, which allows connections to be rerouted around nodes whose local CAC reject the connection, thus reducing set-up latency. Load balancing mechanisms allow for the support of redundant links, with either first-fit or round-robin selection algorithms.

Advanced Traffic Management

The LightStream 1010 supports the most advanced traffic management and ATM signaling and routing capabilities. In addition to ATM Forum-compliant ABR congestion control, the LightStream 1010 supports the following mechanisms required to deliver QOS on demand to all ATM traffic classes and ATM adaptation layer (AAL) types:

- Traffic policing
- Multiple levels of priority
- Intelligent packet discard
- Connection admission control
- Traffic pacing

Many of these capabilities are supported on the field-replaceable feature card on the ASP module. The feature card allows easy upgrading as and when newer mechanisms are standardized or required. The LightStream 1010 also supports the UNI 3.0 signaling protocols and the ILMI, both required for full support of both signaled and permanent ATM connections (PVC/SVC). Soft PVC support facilitates PVC setup by using signaling protocols across the network, while VP tunneling enables signaling across public networks.

The following different mechanisms are required in order to support the guaranteed QOS classes:

- CBR
- VBR

Best effort classes:

- UBR
- ABR

In order to set up a connection with a guaranteed QOS across a network of LightStream 1010 switches, an end system must first inform the switch, attached across a UNI, of the required QOS parameters and the characteristics of the intended traffic flow.

UNI 3.0 and UNI 3.1 do not explicitly specify individual QOS parameters or explicitly request traffic classes. Since only the ATM Forum for UNI 4.0 does, the LightStream 1010 will map the UNI 3.0/3.1 service classes into the appropriate UNI 4.0 traffic classes and QOS parameters. These characteristics together constitute the traffic descriptor for the connection.

Connection Admission Control

Sophisticated connection admission control (CAC) algorithms, based upon the particular architecture of the LightStream 1010, allow maximization of switch and link utilization, while precluding the possibility of preestablished guarantees being violated. These algorithms, together with the ATM Forum specific generic CAC (GCAC) algorithm, permits the rapid, accurate determination of source routes across a network of LightStream 1010 ATM switches. User controls allow regulation of strictness or looseness of the CAC algorithm, providing either greater network utilization or stricter control over guarantees.

Once the traffic descriptor is derived, the source switch first performs a CAC function to determine whether local resources exist to support the requested connection. If this is positive, the LightStream 1010 will use the PNNI Phase 1 protocols to determine a source route through the network that its GCAC algorithms suggest will be able to support the requested connection, and will then forward the request using PNNI Phase 1 signaling. If and when the connection is routed through to the final destination, and is accepted, then the LightStream 1010 will complete the connection and will inform the requesting end system.

Classes of Service

In order to deliver such guarantees, the LightStream 1010 implements the following four configurable levels of delay priority into which the various traffic classes are mapped:

- CBR—Used to support isochronous applications such as high quality video.
- VBR—Used to support information retrieval services in which large amounts of video are sent to the user followed by delays as the user examines the information.
    - VBR-RT—real-time
    - VBR-NRT—non real-time
- ABR—Used to support bursty data traffic.
- UBR—Used to support bursty data traffic.

By supporting so many levels of priority, the LightStream 1010 can ensure full separation of the various traffic classes, and hence ensure absolute priority for the guaranteed services over the best-effort services.

The buffering of the LightStream 1010 can be flexibly allocated between each of the traffic classes and output port in order to ensure that the switch can be tuned for any particular traffic profile or deployment scenario. The following configurable buffer controls are available:

- Per-switch controls on maximum buffer limits for each service class
- Per-service class maximum buffer sizes per port

The maximum buffer controls on the service classes can be modified to adjust the over-subscription factor. This controls the degree of random multiplexing—and hence of the amount of effective buffering—within the switch fabric. Fixed minimum buffer limits preclude the possibility of buffer starvation where high priority traffic consumes all available switch buffers, leading to the possibility of head-of-line blocking.

In addition to the use of CAC, delay priority, and buffer controls in order to deliver QOS guarantees, the LightStream 1010 also uses traffic policing, or usage parameter control (UPC), in order to monitor the compliance of ATM end systems to agreed traffic contracts. As per the ATM Forum UNI specification, the LightStream 1010 supports a dual mode leaky bucket algorithm a highly flexible algorithm that permits the automatic policing of the most important parameters for each of the traffic classes—for instance, the peak cell rate and cell delay variation of CBR connections, the burst size and sustainable cell rate of VBR connections, or the peak cell rate and burst size for UBR/ABR connections. Such traffic policing parameters are extracted automatically from UNI signaling and programmed into the switch fabric.

Cells found to be noncompliant by the UPC function with their stated traffic contracts can either be dropped or, if buffer resources permit, passed but tagged for preferential dropping by having their Cell Loss Priority (CLP) bits set to 1. Correspondingly, the LightStream 1010 also implements two levels of CLP. A configurable threshold can be set on each of the per-service class port buffers; beyond the threshold the switch will accept only cells with the CLP bit not set, favoring conforment traffic. Cells with the CLP bit set to 1 will be preferentially dropped. However, such cells, particularly for the best-effort services, will not be dropped arbitrarily, but by using the intelligent packet discard mechanisms of the LightStream 1010.

Intelligent Packet Discard

The ATM Forum UNI signaling protocols allow end systems to designate which particular connections carrying packet-based traffic can be eligible for packet drop; the LightStream 1010 interprets such signaling and automatically identifies the connections. These connections will typically be used to carry traffic from protocols such as TCP/IP, which analysis has shown to yield far higher throughput in networks employing packet rather than cell-based discard policies. The LightStream 1010 builds upon such analysis with its intelligent packet-discard mechanisms, ensuring that any event that might cause a cell drop—cell-tagging threshold being exceeded, or that of buffer overflows—invokes the packet-dropping mechanisms.

Upon a cell-dropping threshold being exceeded for a cell of a particular packet flow, the LightStream 1010 will put the associated connection into a tail-drop mode, dropping all the other cells that might arrive for that particular packet. The only cell that remains is the final cell in the packet, which is forwarded with the CLP bit re-set to 0. This setting ensures that the cell reaches the final destination, and so allows completion of any packet re-assembly that may have started. A second, higher threshold is defined for each port buffer that defines the intelligent packet discard (PD) point. Beyond this threshold, the switch will begin the discard of all packets along a particular connection, with future enhancements to allow for connections to be picked for discard based upon various policies; for example, highest volume, so as to increase fairness in throughput.

These mechanisms act together to make the LightStream 1010 essentially emulate a packet switch such as a LAN switch or router, which also acts upon and drops entire packets. These packet discard mechanisms work closely with higher layer protocols such as TCP, which are designed to rapidly adjust packet flow rates in response to network congestion, as signaled by packet discards, or, conversely, rapidly increase packet throughputs so as to take advantage of network bandwidth availability. Through such mechanisms, the LightStream 1010 can give ATM networks the same scalability of current packet networks—which, the global Internet, with its millions of nodes attests, are essentially scalable without limit.

The LightStream 1010 can also go beyond current packet based mechanisms, however, for even greater scalability and faster network convergence, through its support of the ATM Forum available bit rate (ABR) congestion control mechanisms.

ABR Support and ATM Congestion Control

The ABR Specifications define a series of congestion control mechanisms which switches and ATM end-systems can use to regulate the amount of traffic sent across ABR connections, and hence minimize cell loss.

ABR is a very sophisticated specification with multiple possible modes of operation, specifying the behavior of both source and destination end-systems, and of intermediate switches. Source end-systems periodically generate in-line Resource Management (RMs) cells which are sent intermixed with data cells along all connections. These are then received by destination end-systems and returned along the backward connection to the source indicating whether or not intermediate switches had experienced congestion. There are three methods by which switches can indicate congestion:

1. In explicit forward congestion indication (EFCI) marking mode, switches can set a bit in the headers of forward cells to indicate congestion; these are then turned round at the destination and sent back to the source.
2. In relative rate marking mode, switches can set a bit within either forward *or* backward or both; forward *and* backward RM cells indicate congestion.
3. In explicit rate marking mode, switches can indicate within either forward *or* backward or both; forward *and* backward RM cells indicate exactly which rate they are willing to receive along a particular path.

The source end-system uses specified algorithms to control the allowed cell rate (ACR) depending upon the type of feedback received. In general, this list of mechanisms is ranked in order of both sophistication and complexity. In general terms, EFCI marking, though widely available particularly on wide area switches, can give only minor improvements in performance, due to the latency of turning around the forward congestion indication. As with any feedback mechanism, congestion control schemes operate optimally when the latency of the feedback path is minimized—indeed, excessive latencies can be counterproductive, since they might cause sources to slow down unnecessarily once the network congestion has already eased.

For this reason, the Relative Rate Mode can deliver much greater performance than the EFCI mode, since the ability to use the backward RM cells to send the congestion indication rather than relying upon the destination end-system to turn it around, can greatly reduce latency.

The LightStream 1010 allows individual thresholds to be set for EFCI or Relative Rate marking, and a higher threshold for Early Packet and CLP discard. Any occasion on which a cell is dropped, however, including UPC, will trigger the Tail Packet Discard mechanism. This intelligent packet discard, in which no cell is ever arbitrarily dropped, is a unique, patented capability of the LightStream 1010.

Traffic Pacing

In addition to traffic policing and congestion control mechanisms, the LightStream 1010 also supports a unique traffic pacing mechanism. This allows the rate at which traffic is sent across any port to be limited to any of a wide variety of peak traffic rates. This capability is particularly important when connecting across a public UNI to a public network, since many such networks will base their tariffs to a particular aggregate bandwidth. Future enhancements to the LightStream 1010, implemented on the next version of the feature card, will implement even greater traffic shaping capabilities such as on a per connection or virtual path basis. See the section "Test the Configuration" in the chapter "Initially Configuring the LightStream 1010 ATM Switch" for an example of traffic pacing.

Operation, Administration, and Maintenance Support

The LightStream 1010 has full support for ATM Operations, Administration and Management (OAM) cell flows-F4 flows used within virtual paths and F5 flows used within virtual channels. The LightStream 1010 can be configured either for end-to-end or segment loopback F4 and F5 flows; cells can be sent either on demand, or periodically, in order to verify link and connection integrity. Alarm indication signal (AIS) and remote defect indication (RDI) functions are also supported on both F4 and F5 flows.

Over and above the standard OAM functions, the LightStream 1010 also has the unique value added capability to send OAM pings, OAM cells that contain the ATM node prefixes or IP addresses of intermediate switches, allowing network administrators to determine the integrity of a chosen connection at any intermediate point, from any other point along the connection, hence greatly easing network debugging and troubleshooting.

Port Snooping

The LightStream 1010 offers a unique port snooping and connection steering mechanism, which allows all of the connections, in any given direction, on a selected port to be transparently mirrored across to a particular monitoring port, to which an external ATM analyzer can be attached. This capability is critical for the monitoring and troubleshooting of ATM switching systems, since, unlike with current shared medium LANs, network traffic flows cannot easily be monitored with external devices. Future enhancements will increase even further the transparent monitoring capabilities of the LightStream 1010, since such monitoring is critical to the ability of network managers to confidently deploy switching technologies.

LAN Emulation Client

The LightStream 1010 provides an interface to switched LANs across an ATM network, providing LAN users with access to ATM-based services. LAN emulation extends virtual LAN (VLANs) throughout the network by establishing point-to-point ATM virtual-circuit connections between switches on the same VLAN.

A LANE client can be configured for the ASP CPU for in-band management (Telnet and SNMP).

Classical IP over ATM

Cisco implements classical IP and ARP over ATM as described in RFC 1577. RFC 1577 defines an application of classical IP and ARP in an ATM environment configured as a logical IP subnetwork (LIS). It also describes the functions of an ATM ARP server and ATM ARP clients in requesting and providing destination IP addresses and ATM addresses in situations when one or both are unknown. Our switches can be configured to act as an ARP client.

The ATM ARP mechanism is applicable to networks that use SVCs in a pure PVC environment. It requires a network administrator to configure only the device's own ATM address and that of a single or multiple ATM ARP server into each client device. When the client makes a connection to the ATM ARP server, the server sends ATM Inverse ARP requests to learn the IP network address and ATM address of the client on the network. It uses the addresses to resolve future ATM ARP requests from clients. Static configuration of the server is required.

In Cisco's implementation, the ATM ARP client tries to maintain a connection to the ATM ARP server. The ATM ARP server can tear down the connection, but the client attempts once each minute to bring the connection back up. No error messages are generated for a failed connection, but the client will not send packets until the ATM ARP server is connected and translates IP network addresses.

For each packet with an unknown IP address, the client sends an ATM ARP request to the server. Until that address is resolved, any IP packet sent to the ATM interface will cause the client to send another ATM ARP request. When the ARP server responds, the client opens a connection to the new destination so that any additional packets can be sent to it.

The LightStream 1010 may be configured as an ATM ARP Client to work with any ATM ARP server conforming to RFC 1577.

Network Management

You can manage your LightStream 1010 ATM switch through the administrative interface. The administrative interface connects directly to a console terminal, or through a modem that connects to the EIA/TIA-232 interface on the ASP. See the chapter "Configuring Terminal Lines and Modem Support." Alternatively, you can access the administrative interface using Simple Network Management Protocol (SNMP), Telnet, and Serial Line Internet Protocol (SLIP) and Point-to-Point Protocol (PPP).

Simple Network Management Protocol

Today, Simple Network Management Protocol (SNMP) is the most popular protocol for managing diverse commercial, university, and research internetworks. SNMP is an application-layer protocol designed to facilitate the exchange of management information between network devices. The SNMP system consists of three parts: SNMP manager, SNMP agent, and Management Information Base (MIB).

Instead of defining a large set of commands, SNMP places all operations in a *get-request*, *get-next-request*, and *set-request* format. For example, an SNMP manager can get a value from an SNMP agent or store a value into that SNMP agent. The SNMP manager can be part of a network management system (NMS), and the SNMP agent can reside on a networking device such as a switch. The SNMP agent can respond to MIB-related queries being sent by the NMS.

Following are basic functions supported by SNMP agents:

- Accessing a MIB variable using the *get-request* or *get-next-request* format—Initiated by the SNMP agent as a result of a request for the value of a MIB variable from a network management station. The SNMP agent gets the value of a MIB variable by accessing information stored in the MIB and then responding to it.
- Setting a MIB variable—Initiated by the SNMP agent as a result of a message from a network management station. The SNMP agent requests that the value of a MIB variable be changed.
- SNMP trap—Notifies a network management station that an extraordinary event has occurred at an agent. When a trap condition occurs, the SNMP agent sends an SNMP agent trap message to each of the network management stations as specified in the trap receiver table.

CiscoView for the LightStream 1010

The CiscoView application for the Cisco LightStream 1010 ATM switch is a graphical user interface (GUI)-based device management application that provides dynamic status, statistics and configuration information for the LightStream 1010. This application is a subset of the CiscoView application that offers similar feature for the other switched internetworking products such as Catalyst LAN switches and Cisco routers.

The CiscoView application is also included within CiscoWorks, Cisco's enterprise network management application suite. It displays a graphical view of any Cisco device and shows the real-time LED in interface status. The CiscoView application provides comprehensive monitoring functions and simplifies basic troubleshooting tasks.

With the CiscoView application for the LightStream 1010, users can more easily understand the complex management data and configuration parameters available for ATM switches. It organizes this information into a graphical representation in a clear, consistent format.

The CiscoView application for the LightStream 1010 can be integrated with several of the leading network management platforms, providing management application integration. CiscoView can be run on UNIX workstations as a fully functional, independent LightStream 1010 management application. In addition, it can be launched from the AtmDirector topology map by simply double-clicking on a LightStream icon.

ATM Standards Compliance

ATM is defined by a large number of cross-referenced specifications from a variety of standards bodies including the ATM Forum, the ANSI T1S1 Committee, Bellcore, ETSI and the ITU-T. The Forum specifications can be regarded as preeminent since they build upon, and refer to, specifications from all other ATM standards bodies; compliance with ATM Forum specifications implies compliance with all referenced specifications. The LightStream 1010 as a whole supports the following general standards:

- ATM Forum UNI 3.0
- ATM Forum ILMI
- ATM Forum PNNI Version 1
- ATM Forum IISP
- ATM Forum Available Bit Rate (UNI 4.0) Protocol
- ATM Forum LAN Emulation Release 1.0 Protocol

Internet Protocols

The LightStream 1010 ATM switch uses the following standard internet protocols:

- RFC 1483: Multiprotocol Encapsulation over ATM AAL 5.
- RFC 1577: Classical IP and ARP over ATM AAL 5.
- Address Resolution Protocol (ARP)—Determines the destination MAC address of a host using its known IP address.
- BOOTP —Uses connectionless transport layer User Datagram Protocol (UDP). BOOTP allows the switch (BOOTP client) to get its IP address from a BOOTP server.

- Internet Control Message Protocol (ICMP)—Allows hosts to send error or control messages to other hosts. ICMP is a required part of IP. For example, the **ping** command uses ICMP echo requests to test if a destination is alive and reachable.
- Internet Protocol (IP) or IP over ATM—Suite used to send IP datagram packets between nodes on the Internet.
- Transmission Control Protocol (TCP)—A reliable, full duplex, connection-oriented end-to-end transport protocol running on top of IP. For example, the TELNET protocol uses the TCP/IP protocol suite.
- Packet internet groper (ping)—Tests the accessibility of a remote site by sending it an ICMP echo request and waiting for a reply.
- Trivial File Transfer Protocol (TFTP)—Downloads network software updates and configuration files (Flashcode) to workgroup switch products.
- Reverse Address Resolution Protocol (RARP)—Determines an IP address knowing only a MAC address. For example, BOOTP and RARP broadcast requests are used to get IP addresses from a BOOTP or RARPD server.
- Serial Line Internet Protocol (SLIP)—A version of IP that runs over serial links, allowing IP communications over the administrative interface.
- Point-to-Point Protocol (PPP)—Provides host-to-network and switch-to-switch connections over synchronous and asynchronous circuits.
- Simple Network Management Protocol (SNMP)—Agents that process requests for network management stations and report exception conditions when they occur. This requires access to information stored in a MIB. (For more information, refer to the following section, “MIBs Supported.”)
- Telnet—A terminal emulation protocol that allows remote access to the administrative interface of a switch over the network (in-band).
- The User Datagram Protocol (UDP)—Enables an application (such as an SNMP agent) on one system to send a datagram to an application (a network management station using SNMP) on another system. UDP uses IP to deliver datagrams. UDP/IP protocol suites are used by TFTP.

MIBs Supported

The LightStream 1010 ATM switch supports standard and enterprise-specific MIBs. The following MIBs are supported:

- RFC 1573 (Interfaces MIB)
- Cisco proprietary MIBs. (Refer to the appendix, “Workgroup MIB Reference” of the *LightStream 1010 ATM Configuration Guide and Command Reference (1.4)* publication for a description of the MIBs offered.)
- MIB II (system, ip, icmp, tcp, udp, snmp) (RFC 1213)
- AToM MIB (RFC 1695)
    - ATM interface configuration
    - ATM interface DS3 PLCP
    - ATM interface TC sublayer
    - ATM interface virtual link (VPL/VCL) configuration
    - ATM VP/VC cross-connect

  - AAL5 connection performance statistics
- LEC MIB (draft from AtomMIB)
- Signaling MIB (draft from AtomMIB or ATom WG)
- SONET MIB (subset of RFC 1595)
- DS-3 MIB (subset of RFC 1407)
- Cisco proprietary MIBs. (Refer to the appendix “Workgroup MIB Reference” of the *LightStream 1010 ATM Switch Software Configuration Guide* publication for a description of the MIBs offered.)
  - Per-VC AAL5 PDU counters
  - OAM MIB
  - PNNI Version 1 Routing/MIB (Subset of MIB used for IISP)
  - Misc (Address of LECS, per VC cell counters)
  - Object corresponding to all other CLI commands
  - LightStream 1010 Specific MIB extensions