CHAPTER 2

Introduction to LightStream

What Is a LightStream Switch? • Need for a LightStream Network • LightStream Features • LightStream Product Structure

This chapter introduces the LightStream 2020 enterprise ATM switch. It describes some of the key features of the switch and its structure.

What is a Lightstream Switch?

The LightStream switch is a powerful backbone ATM switch for local and wide area networks. It has premises capabilities in both ATM and fast packet switching to handle frame relay, LAN, and legacy traffic interfaces. The LightStream network creates a mission-critical enterprise backbone network that provides flexible cost-effective allocation of bandwidth, guaranteed quality of service for all applications, interoperability with past and future devices, and scalability for future applications.

Need for a Lightstream Network

Advances in computers and communications during the past 5 years have begun to overburden existing network systems and technologies. For example, today's desktop device speeds continue to grow. In the 1970s, 1.2 Kbps was considered normal speed and 9.6 Kbps was considered high speed. In the 1990s, networks using fiber technology are pushing speeds of 100 Mbps and significant speed increases are expected in the future. Also, widespread use of applications that demand large amounts of data have overburdened existing LAN/WAN technology. These applications include distributed supercomputing, high-resolution graphics (CAD/CAM, imaging, and so on), scientific visualization, network-based client/server computing, and distributed file access.

Such advances have created the need for new network architectures and infrastructures that provide higher throughput, more usable bandwidth, and a broader diversity of services. The LightStream switch was designed with these specific needs in mind.

Lightstream Features

In addition to basing the LightStream switch on ATM technology, there are a number of features that make the LightStream switch a reliable, cost-effective device that provides high-speed, broadband, open networking to many different applications.

Switching in Hardware and Firmware

To achieve the high throughput needed to make the LightStream switch operate effectively, most of the switching functions are performed in hardware and firmware. The hardware and firmware operate much faster than software.

Processing tasks for the LightStream switch have been divided into three classes based on the speed required for each particular task. Because the LightStream switch groups processing tasks by their performance requirements, its overall throughput is very high. Line card hardware and firmware perform functions that must be completed in 10s of microseconds or less, such as protocol processing and cell handling. This implementation increases the overall speed significantly.

The remaining tasks are implemented using distributed, concurrent mechanisms in software. Each line card includes a line card control processor that handles the more complex tasks that must be completed in 10s of milliseconds or less, such as call processing, error handling and line up/down protocol processing. Network processor software performs functions that can be completed in more than 10s of milliseconds, such as servicing network management requests.

Cost-Effective Bandwidth Management

Today's networks feature a wide variety of applications, each with its own performance requirements. One application may need a guaranteed level of service where delay variation must be minimized (for example, SNA). Another application may require service that is more cost-effective, but not guaranteed. The LightStream switch optimizes application performance by providing you with types of service that is right for each application.

Congestion Avoidance

Enterprise ATM switches provide cost savings by minimizing the amount of transmission bandwidth needed from carriers. The extent to which an ATM switch lowers carrier costs depends primarily on the switch's congestion avoidance strategy.

The LightStream switch has a proactive congestion avoidance feature that keeps the network from experiencing the effects of congestion by managing congestion at the edges of the network. When a LightStream network detects congestion, the sources of the congestion are identified and controlled individually based on their service guarantees. Congestion is removed at the source, link use is maximized, and mission-critical service is maintained.

Mission-Critical Networking

The LightStream switch provides mission-critical networking, including:

- Critical element redundancy — The LightStream switch provides options for a redundant switch fabric (concurrent cell switch), network processor, and power supply. If any of these components fail, the redundant unit can take over the load with little or no disruption in service. In addition, the LightStream switch has two blowers and can operate with just one for a period of time in the event of failure.
- Improved fault tolerance — The LightStream switch offers improved fault tolerance by supporting three types of switch card cutover in its switch cards: planned, NP-initiated, and unplanned. Planned and NP-initiated cutovers involve no data loss whereas an unplanned cutover involves minimal data loss. Providing low-loss switch card cutover between the primary and backup switches improves redundancy performance in a LightStream switch.

- Low MTTR — The LightStream switch achieves low mean time to repair (MTTR) by providing diagnostics that isolate a failure to a field replaceable unit (FRU) and allowing remote access to the diagnostics.
- Dynamic routing around failures — LightStream reroutes connections whenever a failure of one or more communications links interrupts existing traffic flows on the configured connections.

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Effective Network Management

You manage the network using a Sun SPARCstation running LightStream management software. In addition to the tools provided by LightStream, you may choose to run HP OpenView management software, from Hewlett-Packard, or another network management system that is SNMP compatible. Many management tasks can also be performed using a simple command line interface (CLI) from a terminal attached to the console port of a LightStream node.

The LightStream network uses SNMP as its management protocol and is compatible with various SNMP-based management systems. LightStream offers StreamView™, an SNMP-based network management system. StreamView lets you monitor, control, and configure your LightStream network. You are provided with a graphical representation of your managed objects and a mouse-driven point and click interface.

For more details on network management, see the “Network Management” chapter.

Migration Path to ATM

A LightStream network provides a very clear migration path to ATM. Often the introduction of a new technology forces you to replace much of your existing equipment because it is no longer compatible with the new technology. Because replacing equipment is a substantial investment, the LightStream switch is designed to let you migrate to ATM gradually.

The switch provides services that make it backward compatible with any current equipment passing constant bit rate (CBR) traffic, Ethernet, FDDI, high-level data link control (HDLC), synchronous data link control (SDLC), or frame relay frames. The LightStream switch can accept this traffic from an external device, convert it to ATM cells, and pass it through the network.

The LightStream switch can also accept ATM cells from an external device and pass those through the network. It also provides services that let it interface with equipment that supports ATM user-network (UNI), and SONET interfaces. As more ATM devices become available on the market, you can add them to your network and pass ATM traffic while still using your existing equipment.

Service Integration

Because of the need of greater integration, a LightStream network offers various types of service to carry traffic, such as frame forwarding, frame relay, ATM UNI, CBR, and bridging over the network.

- Frame forwarding service lets you connect devices that support HDLC and SDLC as well as older devices that may not support frame relay or ATM UNI.

- Frame relay service lets a LightStream network connect routers, packet switches, and other devices that have frame relay DTE interfaces. It also provides NNI interfaces (connection between LightStream networks and external frame relay networks).
- ATM UNI service supplies an ATM interface to let LS100s or other ATM-capable devices use the LightStream network.
- Bridging service supports transparent and translation bridging, the Spanning Tree Protocol and custom filtering. With custom filters, you can define traffic profiles and network layer filtering.

Supports Open Networking

The LightStream switch is based on industry standards allowing it to interoperate with standards-based, high-speed network devices. The LightStream switch adheres to the ATM specifications being developed by ITU-T (formerly CCITT), ANSI, and the ATM Forum. The LightStream switch also adheres to the SNMP specification, enabling it to be managed by any SNMP-compatible network management system.

The LightStream switch conforms to all of the standards listed in Table 2-1; however, not every detail of each standard has been implemented.

Table 2-1 Major Standards the LightStream Switch Uses

Document Number	Title
ANSI T1.403	ATM UNI DS1 interface
ANSI T1.618 (LAP-F) and ITU-T Q. 922 Annex A	Frame Relay (for Frame Format)
ANSI T1.617 Annex D and ITU-T Q .933 Annex D	Frame Relay (for LMI and PVC management)
ANSI T1.627-1993 B-ISDN	ATM Layer Functionality and Specification
ANSI T1.606 and ITUT-T I.233	Frame Relay (for UNI)
ANSI X3T9.5	FDDI Standard for I/O interfaces
FRF.2	Frame Relay (for NNI)
IEEE802.1g	Translation Bridging
IEEE802.3	Ethernet
IEEE802.3	Fiber Ethernet (for 10Base-FL)
IEEE802.1d	Spanning Tree Protocol
ATMF94-003397	Circuit Emulation Service
Internet RFC #1157	Simple Network Management Protocol (for network management)
Internet RFC #1213	Management Information Base (MIB-II)
Internet RFC #1271	Remote Network Monitoring MIB
Internet RFC #1248	Ethernet Interface Type MIB
Internet RFC #1406	DS1/E1 Interface Type MIB
Internet RFC #1407	DS3/E3 Interface Type MIB
Internet RFC #1493	Definition of Managed Objects for Bridges
Internet RFC #1512	FDDI Interface Type MIB

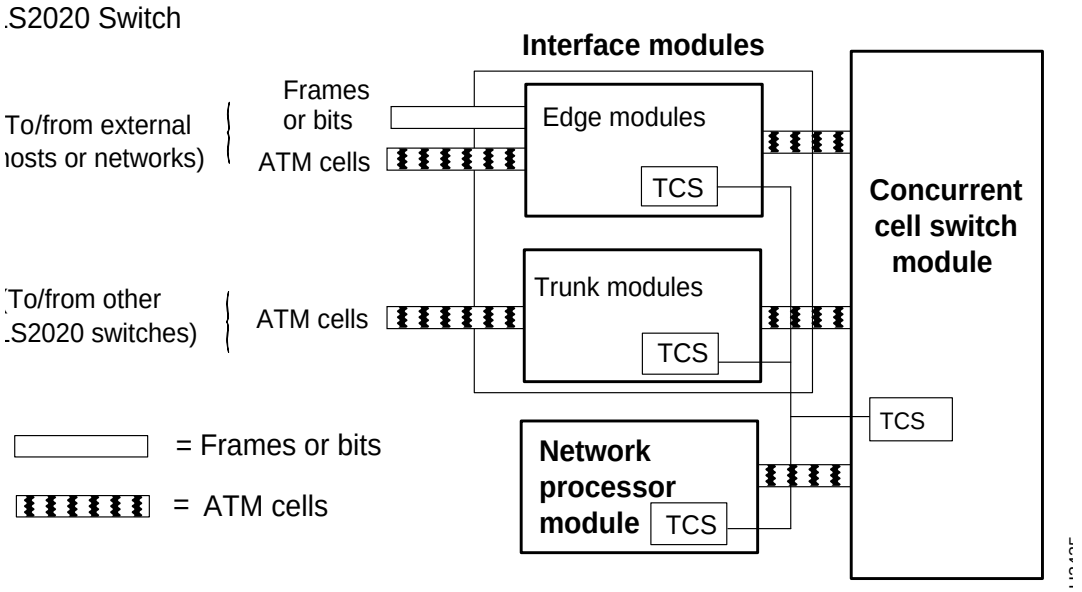
Internet RFC #1595	SONET Interface Type MIB

Compliance with standards ensures that LightStream switches can interoperate with older products and future products.

LightStream Product Structure

Figure 2-1 shows the key components in a LightStream switch.

Figure 2-1 Key components of a LightStream switch: interface modules, network processor, concurrent cell switch and Test and Control System (TCS).



The major elements in the LightStream architecture are

- Concurrent cell switch module
- Network processor (NP) module
- Interface modules

Together, these modules provide the functions needed to receive non-ATM frames or ATM cells from external devices and transfer ATM cells across a network.

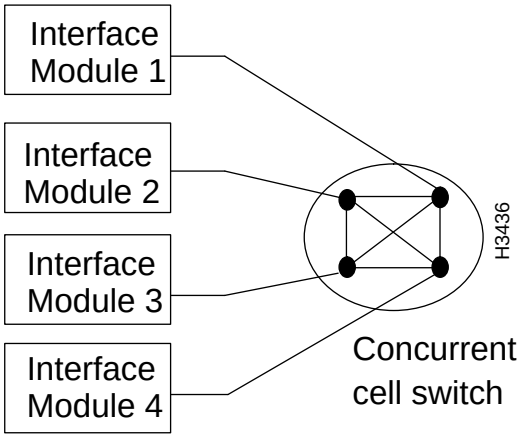
The following sections detail each of these components.

Concurrent Cell Switch Module

In a LightStream switch, the concurrent cell switch module consists of a switch card plus a console/modem assembly. The switch card contains the concurrent cell switch, which interconnects all interface and NP modules. The console/modem assembly provides the physical interfaces for the console and modem ports on the switch card.

Figure 2-2 illustrates the concurrent switch architecture.

Figure 2-2 Switch architecture.



In a concurrent cell switch architecture, each interface module or NP module is interconnected with every other interface module or NP module through a concurrent cell switch that allows multiple transactions to occur between these devices simultaneously.

The use of many parallel paths allows the aggregate throughput of a LightStream switch to be extremely high, without requiring that the speed of each individual interface match the aggregate speed.

The concurrent cell switch on the switch card has 10 input ports and 10 output ports. Each output port has two channels to reduce the probability that data passing through the switch will be blocked. The total bandwidth on each port is 200 Mbps full duplex. Allowing for cell headers and switch contention (more than two switch input lines destined for the same output), this provides a sustained payload throughput of approximately 160 Mbps full duplex. All switch ports can pass traffic simultaneously resulting in a peak transfer rate of 2 Gbps and an aggregate sustained payload throughput of 1.6 Gbps full duplex.

Network Processor Module

The network processor (NP) module performs system-level tasks for the LightStream switch. It contains an NP card plus an NP access card. The NP card establishes the network connections on which traffic passes through the LightStream network. Once you establish the network connection, the interface modules recognize the traffic flows and route the traffic without further assistance from the NPs.

The NPs also do the following:

- Perform monitor and control tasks using the CLI
- Discover network topology
- Provide access by the SNMP-based network management system into the LightStream network through an Ethernet port
- Distribute routing information
- Maintain network statistics, accounting information, and routing databases

The NP access card houses an Ethernet interface for the NP module. This makes it possible for a network management station to attach to the LightStream network that has no network interface modules. Each NP module also has a disk assembly associated with it. The disk assembly contains

a floppy disk drive and a hard disk drive. The floppy drive is used to load new NP and interface module software. The hard drive contains operational software, boot and configuration information, and storage for statistics.

Interface Modules (Edge and Trunk)

The interface modules are divided into the following two types:

- Edge modules — Connect LightStream switches to non-LightStream devices, using the device's protocol
- Trunk modules — Connect LightStream switches to other LightStream switches in the network using ATM protocols

Edge Module

LightStream switches carry traffic received from external devices in frames, ATM cells, or a constant bit stream. If the traffic is in frames, the edge module parses incoming frames and determines the connection on which the traffic should be sent. The edge module segments the frames into ATM cells and transmits the cells across the LightStream network. It also reassembles ATM cells received from the LightStream network back into the original frames and transmits the frames from the edge interface to external devices.

If the traffic from external devices is in ATM cells, the edge module examines incoming cells and determines the connection on which the traffic should be sent, and then transmits the cells across the LightStream network; no segmentation or reassembly is needed. It also receives ATM cells from the LightStream network and transmits the cells from the edge module to external devices.

If the traffic is a constant bit stream, the edge module segments the stream into cells across the LightStream network. It also reassembles the cells back into the original bit stream and transmits the stream from the edge interface to external devices.

Edge modules contain an onboard control processor that works with the NP to set up new connections and to provide low-level information required by the network management system through the NP.

Edge modules support many different speeds and external devices. The types of edge modules are

- Low-speed edge module — Consists of a low-speed line card (LSC), edge software, and a low-speed access card (LSAC). Connects to frame relay, HDLC, or SDLC devices
- T3 edge module — Consists of a medium-speed line card (MSC), edge software, and a T3 access card (MSAC) for connection to ATM UNI devices
- E3 edge module — Consists of a medium-speed line card (MSC), edge software, and a E3 access card (MSAC) for connection to ATM UNI devices
- Ethernet edge module — Consists of a packet line card (PLC), edge software, and an Ethernet access card (EAC) for connections to LANs
- FDDI edge module — Consists of a packet line card (PLC), edge software, and an FDDI access card (FAC) for connections to LANs
- OC-3c edge module — Consists of a cell line card (CLC), edge software, and OC-3c access card (OC3AC MM for multimode or OC3AC SM for single mode) for connection to ATM UNI devices

Trunk Module

Trunk modules connect one LightStream switch to another LightStream switch to form the LightStream backbone network. All traffic passed between trunk modules is packaged as ATM cells. The trunk module receives cells from a trunk line, recognizes the connection on which the cells arrived, and routes the cells to the next LightStream switch in the connection.

Trunk modules, like edge modules, support different speeds. The types of trunk modules are

- Low-speed trunk module — Consists of a low-speed line card (LSC), trunk software, and a low-speed access card (LSAC)
- T3 trunk module (2 ports) — Consists of a medium-speed line card (MSC), trunk software, and a T3 access card (MSAC).
- OC-3c trunk module — Consists of a cell line card (CLC), trunk software, and an OC-3c (OC3AC MM for multimode or OC3AC SM for single mode) access card

Test and Control System

The Test and Control System (TCS) is a fully integrated, yet autonomous, computer system located within the LightStream chassis. It is fully integrated in that there is a TCS microcomputer located on each NP, interface and switch module in a LightStream chassis. It is autonomous in that its communications path is completely separate from the LightStream switch. The TCS does not rely on the operation of any other LightStream assemblies. As long as the TCS components have power, and are themselves operational, the TCS can function.

The TCS has two primary functions:

- It manages low-level operations of each module. This includes monitoring voltage and temperature levels, and supervising logic resets, soft logic loading, and loading and monitoring power-on self tests.
- It provides access to all modules in the chassis through a local console port and a modem port, which are supported by the TCS microcomputer on the switch card. This interface supports a number of commands that are used for diagnostic or control purposes.

Connecting LightStream Switches in a Network

Figure 2-3 shows three LightStream switches connected in a LightStream network. As shown in the figure, external devices are connected to the LightStream switches by edge modules and traffic passing between the external devices and the edge modules is packaged as frames or ATM cells. Trunk modules connect LightStream switches to one another. Traffic passing between LightStream switches (or between any cards within a LightStream switch) is passed as ATM cells.

Note For simplicity, Figure 2-3 does not show the NPs in each LightStream switch. Each LightStream switch must have an NP to establish the connections through the network and for other network control functions.

Figure 2-3 **Simplified view of LightStream network. The illustration shows the modules within each LightStream switch that provide interface to external devices and between other LightStream switches.The illustration also shows the different types of traffic that can flow between the various interfaces.**