CHAPTER 1

LightStream 100 ATM Switch Overview

The LightStream 100 switch is a desktop Asynchronous Transfer Mode (ATM) switch used to build workgroup local area networks (LANs) or a campus backbone switched internetwork. The LightStream 100 switch supports up to 16 ATM lines at 155 Mbps (megabits per second).

The LightStream 100 switch features an input and output buffer-type switch that provides an aggregate throughput of 2.5 gigabits per second (Gbps) (155 Mbps × 16). The LightStream 100 switch complies fully with the ATM Forum *ATM User-Network Interface Specification, Version 3.0, 9/10/1993*, International Telecommunication Union Telecommunication Standardization Sector (ITU-T), and European Telecommunications Standards Institute (ETSI) specifications and recommendations.

The switch core, called the expandable ATM output-buffer modular switch (XATOMSW), features large-capacity buffering to guarantee quality of service in handling multimedia traffic. Because one line interface card serves one line, adding and changing the line terminating function can occur on a per-line basis.

Interface Types

Different interface types can be mixed on a LightStream 100 ATM switch used as either a backbone, workgroup, or wide-area network (WAN) access switch. Table 1-1 lists the interface types that are available.

Table 1-1 Interface Types

Physical Layer	Data Rate	Media	Connector
STS-3c/STM-1[1]	155 Mbps	Multimode fiber[2]	SC
STS-3c/STM-1	155 Mbps	Single-mode fiber	SC
STS-3c/STM-1	155 Mbps	UTP-5[3]	RJ-45
TAXI[4] 4B/5B	100 Mbps	Multimode fiber	MIC[5] (FDDI[6] type)
DS3/T3	45 Mbps	Coaxial cable	BNC
E3	34 Mbps	Coaxial cable	BNC

1. STS-3c/STM-1=Synchronous Transport Signal Level 1/Synchronous Transfer Module 1.
2. 62.5/125 or 50/125 graded index (GI) optical fiber. Light wavelength is 1.3 micrometer band. Optical allowable loss is 7 dB.
3. UTP-5=Unshielded twisted-pair Category 5.
4. TAXI=Transparent Asynchronous Transmitter/Receiver Interface.
5. MIC=Media interface connector.
6. FDDI=Fiber Distributed Data Interface.

Specifications and Product Compliance

Table 1-2 lists the LightStream 100 ATM switch specifications.

Table 1-2 LightStream 100 ATM Switch Specifications

Device	Component	Specification
Switch	Switch architecture	Input and output buffer type
	Switch capacity	2.5 Gbps (155 Mbps x 16)
	Buffer	Input buffer: 2048 cells per two lines
		Output buffer: 128 cells per two lines
	Cell delay	20 microseconds to 5 milliseconds
Control system	Control processor	Internal 32-bit RISC[1] processor
	Number of concurrent connectable channels	4096 channels per line (VP/VC[2] routing supported)
		All 12 bits of VPI[3] (2^x)
		Lower (12-x) bits of 16 bits of VCI[4]
	NMS interface	SNMP[5]
	Console terminal interface	EIA/TIA-232[6]
	Ethernet interface	DB-15
Traffic control	Policing control	Peak cell rate can be set per connection
	Congestion control	Back pressure: output line —> switch —> input line
	Priority control	Cell loss: Two levels
		Cell delay: Two levels

Device	Component	Specification
Line	Maximum line speed	155 Mbps per line
	Maximum number of lines per switch	16 lines
	Interface types	SONET STS-3c/STM-1, multimode fiber (155 Mbps)
		SONET STS-3c/STM-1, single-mode fiber (155 Mbps)
		STS-3c-STM-1, UTP-5 (155 Mbps)
		TAXI 4B/5B, multimode fiber, MIC (FDDI type, 100 Mbps)
		DS3/T3, BNC (45 Mbps)
		E3, BNC (34 Mbps)

1. RISC=Reduced Instruction Set Computing.
2. VP/VC=Virtual path/virtual channel.
3. VPI=Virtual path identifier.
4. VCI=Virtual channel identifier.
5. SNMP=Simple Network Management Protocol.
6. EIA/TIA-232 was known as recommended stardard RS-232 before its acceptance as a standard by the Electronic Industries Association (EIA) and Telecommunications Industry Association (TIA).

Table 1-3 lists the LightStream 100 ATM switch physical specifications.

Table 1-3 LightStream 100 ATM Switch Physical Specifications

Item	Specification
Dimensions	Height: 165 mm (approximately 6 1/2")
	Width: 435 mm (approximately 17 1/8")
	Depth: 420 mm (approximately 16 5/8")
Weight	General: 15 kg (approximately 33 lb)
	Fully equipped: 17 kg (approximately 37 1/2 lb)

Item	Specification
Power	Input: 100–120 (or 85 to 132) VAC at 7A, 50/60 Hz 200–240 (or 170 to 264) VAC at 3.8A, 50/60 Hz Output: +5, +12 VDC at 60A Power consumption: 400W maximum
Cooling	Forced cooling
Recommended operating temperature	64 to 86 °F (18 to 30°C)
Operating temperature range	41 to 104°F (5 to 40°C)
Recommended operating humidity	30 to 60%
Operating humidity range	10 to 80%

The LightStream 100 ATM switch conforms to the product criteria in Table 1-4.

Table 1-4 LightStream 100 ATM Switch Regulatory Compliance

Product Compliance	Agency/Specification
Safety	UL1950 (USA) CSA 22.2-950 (Canada) EN 60950:1992 (Europe)

Product Compliance	Agency/Specification
EMI/RFI	FCC Part 15, Class A: (USA)
	EN 55022 (CISPR-22 Class A and B): (Europe)
	VDE 0878 Part 3 and 30, Class B: (Germany)
	NFC 98020: (France)
	VCCI Class 1 and 2: (Japan)
Immunity	IEC 801-2, ESD up to 15 kV
	IEC 801-3, RFI 10 V/m
	IEC 801-4, Electrical Fast Transients, Level 4
	IEC 801-5, Surge, Level 4
	IEC 801-6
	NFC 98020
Power/Environment	IEC 555-2, Power Factor Correction (over 400W)
	IEC 555-3, AC Input Transients
	Audible Noise ISO7779, Paragraph 7, max. 50 dBa
	IEC 68-2-6 Vibration
	IEC 68-2-27 Shock
	IEC 68-2-31 Drop
	Operating altitude: –500 to 10,000'
	Nonoperating altitude: –1,000 to 30,000'

LightStream 100 ATM Switch Features

The LightStream 100 ATM switch provides the following features:

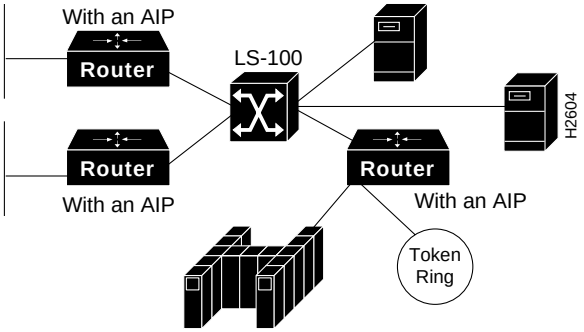
- Supports up to sixteen 155-Mbps ATM interfaces.
- Supports the addition of individual ATM interfaces of any physical layer type.
- Supports fully nonblocking, 2.5-Gbps input/output buffer-type switch fabric with a minimum of 1000 cells of virtual output buffering per port.
- Supports all ATM Adaptation Layers (AAL 1 through AAL 5) and traffic types.
- Supports two priority queues for cell delay: one for delay-sensitive traffic and one for delay-tolerant traffic. Cell loss priority is supported by configurable buffer threshold parameters.
- Provides fully integrated multicast capability without throughput degradation.
- Supports both PVCs and switched virtual circuits (SVCs), including point-to-multipoint SVCs.
- Supports VC, VP, point-to-point, and point-to-multipoint connections and eliminates single points of failure through fully integrated support for ATM Forum UNI V3.0, based on Q.SAAL1 Service Specific Connection-Oriented Protocol (SSCOP) of ITU-T Study Group 11, Document DT/11/3-28 and ITU-T Recommendation Draft Q.93B, May 1993.
- Supports up to 4096 ATM point-to-point connections per interface and 1024 point-to-multipoint connections per switch.
- Allows construction of multiswitch networks using IISP (the phase 0.5 standards).
- Supports soft permanent virtual channel/permanent virtual path (PVC/PVP) connections.
- Supports SVC tunneling.
- Provides standard TCP-UDP/IP protocol stack implementation over both ATM and Ethernet.
- Supports Telnet and ICMP Echo Reply over Ethernet.
- Supports two IP addresses: one for Ethernet and one for ATM.

- Provides ILMI support in the following ways:
  - ILMI address registration on UNI 3.0
  - LECS address discovery by the host
  - ILMI VPI/VCI range matching
  - ILMI and the IP address of the neighbor
  - UNI/NNI differentiations
- Provides additional SNMP MIB objects
- Provides Enhanced SNMP/network management support, including the following:
  - SNMP support over management PVCs
  - SNMP support over Ethernet
- PVP/PVC setup through signaling
- Operation Administration and Maintenance (OAM) through both the command line interface and MIBs, including the following:
  - Segment loopback generation and reporting
  - End-to-end loopback pass through
  - VPC/VCC alarm indication signals (AIS) and far end reporting failure (FERF)

Applications and Network Architecture

The LightStream 100 ATM switch is designed primarily for constructing ATM workgroup and campus backbone networks (see Figure 1-1) that connect a number of ATM routers, multilayer switches, and high-performance servers into a router cluster. ATM routers allow existing LANs to be interconnected across ATM backbones while paving the way for new applications, such as virtual LAN internetworking.

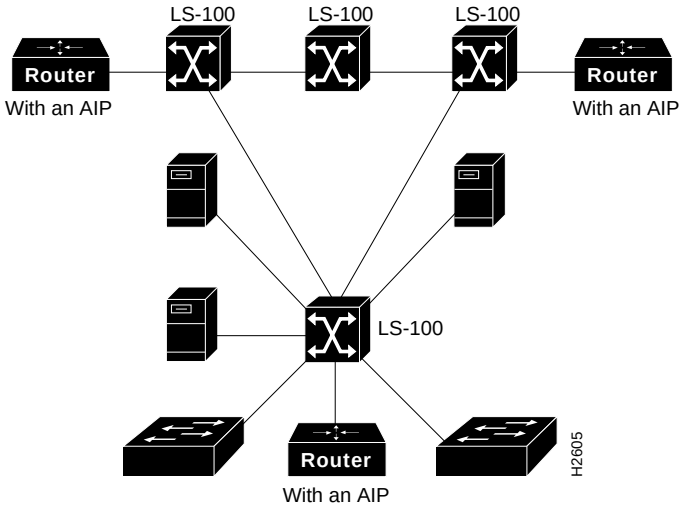
Figure 1-1 ATM Building or Campus Backbone



A router cluster can scale to many gigabits of bandwidth and millions of packets per second to alleviate the congestion on the backbone networks by allowing migration from the existing backbone technologies. While a router ATM interface module provides for transparent internetworking of current LAN and WAN protocols across the ATM backbone, high-speed servers can also be directly connected to the LightStream 100 switch, linking with desktop clients on multilayer switches through virtual LAN protocols.

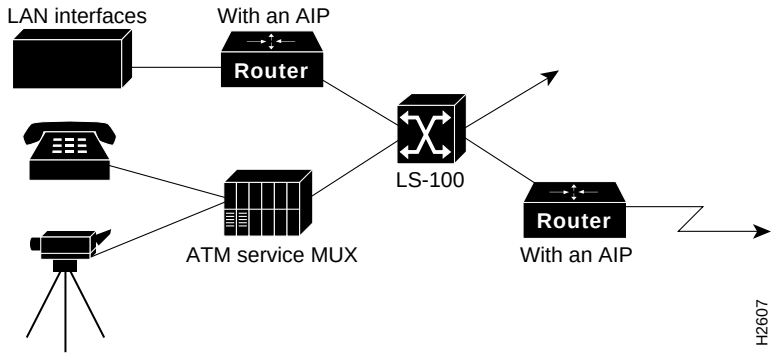
As network backbones increase in size, multiple switches can be interconnected to increase the scale and port density of the backbone. ATM routing protocols such as the Private Network-to-Node (PNNI) protocol currently being developed by the ATM Forum will be used to facilitate the construction of these large-scale ATM backbone networks. (See Figure 1-2.)

Figure 1-2 Multiple Switch Backbone Network



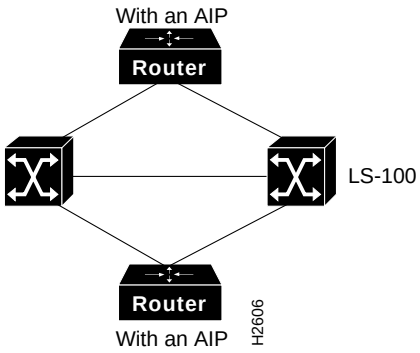
The LightStream 100 switch can also be used to build core and WAN access networks, supporting a heterogeneous mixture of cell, packet, and time-division multiplexing (TDM) trunk interfaces. (See Figure 1-3.) With the LightStream 100 switch as the core interconnect, ATM routers can be used to support the packet WAN and LAN interfaces, while ATM service multiplexers can support voice and video interfaces. In this way, a flexible solution can be deployed.

Figure 1-3 Core Network Design



Reliable backup network configurations are possible with the LightStream 100 switch through the use of redundant network connections. (See Figure 1-4.) The LightStream 100 switch will automatically tear down any switched virtual connections through a failed link, allowing end systems to resignal for a new connection while bypassing the failed link. Cisco ATM routers can also support dual-homed connections and route around failed links, thus providing the same level of reliability on ATM backbones that can currently be achieved using router backbones.

Figure 1-4 Redundant Network Design



Broad Interface Support

The LightStream 100 ATM switch supports a wide range of LAN and WAN ATM interfaces. All interfaces conform to the relevant applicable standards, including those of the ATM Forum, ETSI, T1S1.5, and the ITU-T.

Because the LightStream 100 switch is designed for workgroup and campus backbone deployment, it supports such WAN interfaces as DS3, E3, and single-mode fiber Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH). This capability allows seamless connectivity between the ATM campus backbone and ATM public and private WANs. In workgroups, the LightStream 100 switch supports power users with direct ATM desktop interfaces. To facilitate such deployment, the LightStream 100 switch supports the ATM Forum copper (UTP-5) interfaces.

Standards Supported

The relevant aspects of the ITU-T specifications are listed in Table 1-5.

Table 1-5 Supported ITU-T Recommendations

Number	Topic
G.707	SDH speeds
G.708	SDH basic frame structure
G.709	SDH detailed frame structure
G.782	SDH multiplexer types and general characteristics
G.783	SDH multiplexer characteristics
G.7XX	ATM cell mapping into SDH
G.803	Transmission network architecture
G.82X	Code error rules in physical layer
G.93B	B-ISDN subscriber line signal Layer 3
G.96X	B-ISDN digital section
I.113	B-ISDN terminology
I.121I	B-ISDN basic principles

Number	Topic
I.150	B-ISDN ATM functionality
I.211	B-ISDN services
I.311	B-ISDN network side, signaling principles
I.321	B-ISDN protocol reference model and application
I.327	B-ISDN functional structure
I.35B	B-ISDN ATM layer cell transfer function
I.361	B-ISDN ATM layer specifications
I.362	B-ISDN AAL[1] functions
I.363	B-ISDN AAL specifications
I.364	B-ISDN connectionless services
I.371	B-ISDN traffic control and congestion control
I.413	B-ISDN user network interface
I.414	ISDN and B-ISDN: concept of recommendations on user access in Layer 1
I.432	B-ISDN user network interface Layer 1 specifications
I.580	B-ISDN and 64 Kbps internetworking
I.610	B-ISDN OAM[2] principles
Q.2931	B-ISDN signaling Layer 3
(Old Q.93B)	Q.2100 (Old Q.SAAL0)B-ISDN: concept of AAL for signaling
Q.2110 (Old Q.SAAL1)	B-ISDN: AAL SSSCOP[3] for signaling
Q.2130 (Old Q.SAAL2)	B-ISDN: AAL SSCP[4] for UNI signaling
Q.2140 (Old Q.SAAL3)	B-ISDN: AAL SSCP for NNI[5] signaling

1. AAL=ATM Adaption Layer
2. OAM=Operation and Maintenance
3. SSCOP=Service-Specific Connection Oriented Protocol
4. SSCP=Service-Specific Coordination Protocol
5. NNI=Network Node Interface

Functional Overview

The LightStream 100 ATM switch has three primary functions:

- Cell switching
- Traffic control
- Connection control

Cell Switching Function

Following is a description of the cell switching function along the flow of ATM cells.

The line interface (LINF) card receives a cell sent over a line. A header translator checks the header error check (HEC) in the cell header and generates internal switch-specific overhead (SSO) information using VPI, VCI, and payload type (PT) in the cell header. The LINF inserts new VPI and VCI values in the cell header if the cell belongs to a point-to-point connection. The SSO transfers to the Expandable ATM output-buffer modular switch (XATOMSW) along with the cell.

The XATOMSW switches and sends the cell and SSO to the destination LINF according to the SSO information. When a specific line is congested, the system temporarily saves overflow cells in a 2048-cell input buffer and a 128-cell output buffer. Two lines share a buffer pool.

The LINF inserts new VPI and VCI values in the cell header according to information in the SSO after receiving the cell and SSO if the cell belongs to a point-to-multipoint connection.

This series of events results in cell transmission to the destination line.

Traffic Control Function

This section describes policing control, congestion control, priority control, and monitoring items.

Policing Control

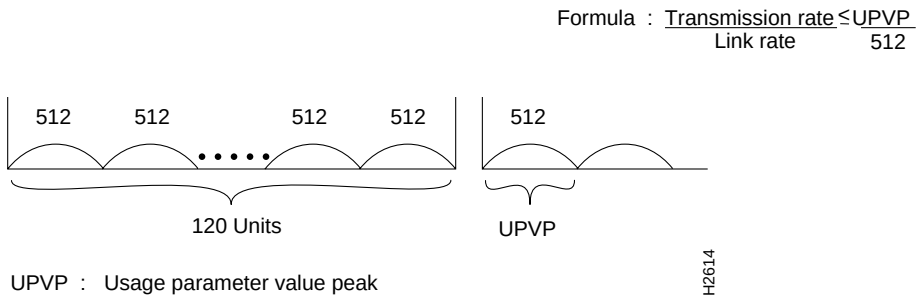
The LINF monitors each connection and discards any cell in excess of the preconfigured peak rate (set in advance). This policing control, known as usage parameter control (UPC), prevents any connection from unjustly dominating the switch bandwidth.

A peak transmission rate is set per connection; once a peak rate is exceeded, the LINF discards excess cells (if configured to do so with the **pvc establish** command). Specifically, the LINF counts the number of cells received per channel over a period of cell time (T) before the present moment. When the number of cells received over T exceeds a configured threshold (P), the system discards further cells.

The range of the cell time window (T) is 512 through 61,440. The cell time window (T) is divided into units of 512. Dividing the 61,440 window size into units of 512 yields 120 units.

The measurement period can be specified in units of 1 through 120. Each unit represents a window time of 512 cells. The usage parameter value peak (UPVP) represents the number of cells within a measurement period. The peak value equals the UPVP x unit. The measurement period within the window is Nw. P4 of the **set tparam** command sets Nw (see the section “set tparam” in the appendix “Command Reference”). Figure 1-5 shows the traffic measurement period formula:

Figure 1-5 Traffic Measurement Period Formula



Congestion Control

In the LightStream 100 ATM switch, a form of port congestion control takes place by applying a back pressure (BP) to restrict the number of input cells. The following format shows the direction that BP is applied:

Output line —> switch —> input buffer

Priority Control

Either high priority or low priority can be established for cell loss and cell delay on a per-connection basis. For cell delay, control is performed per the predetermined priority at connection setup phase. For cell loss, control is performed per the value of the Cell Loss Priority (CLP) bit in the cell header. The system handles a cell for which the CLP bit in the header is set to 0 as high loss priority and during congestion will discard CLP bits set to 1 first.

In the switch, a cell delay of 20 microseconds to 5 milliseconds occurs, depending on the degree of congestion and degree of priority of the passing cells. Priority on the delay can be set according to cell type:

- Guaranteed cell: high priority
- Best effort cell: low priority

In the LightStream 100 switch, two lines share one input buffer pool (2048 cells). The maximum size allowed for guaranteed cells, best effort cells, and CLP threshold can be set in 128-cell increments for this input buffer. (Smaller cell increments will be supported in future software releases.) This setting applies to the entire LightStream 100 switch; a different parameter cannot be set for each input buffer.

Connection Control

The LightStream 100 switch performs resource allocation and path establishment when a PVC or SVC setup request occurs.

The number of VPI and VCI bits necessary for ATM connection are configured per line. A total of 12 bits is supported for VPI and VCI (up to 4096 channels per line). Because VPIs/VCIs are distributed to PVC and SVC, when using SVC, the number of available PVCs diminishes accordingly.

The LightStream 100 switch supports 12 bits of VPI/VCI address space:

- The default number of allocated VPI/VCI bits is four for VPI and eight for VCI.
- The range of VCIs that can be assigned using eight bits is 1 to 255.
- 255 VCI values can be used for PVCs and SVCs.
- When using ITU-T, the four least significant VCI bits (0 through 15) are reserved.
- When using ATM Forum, the five least significant VCI bits (0 through 31) are reserved.

The LightStream 100 switch can have both point-to-point and point-to-multipoint connections. The following list indicates the current number of each connection type per system. The number of point-to-point connections does not decrease if the maximum number of point-to-multipoint connections are established, and vice versa. The number of possible PVCs and SVCs follow:

- Point-to-point PVC: 8,192
- Point-to-multipoint PVC: 1,024
- SVC: 1,024

Entering commands at the console terminal can establish or disconnect connections and can add endpoints on a point-to-multipoint connection. Registering a PVC setting automatically establishes the registered PVC. A command from the console terminal or a GET request from the NMS displays connection information. The LightStream 100 switch controls the following items for each PVC connection:

- Connection type (unidirection/bidirection/multicast)
- Traffic type (guaranteed/best effort)
- Throughput (guaranteed only, forward and backward directions)
- Line number (low/high)
- VPI (low/high)
- VCI (low/high)
- Allowable cell count in a sliding window (low)
- Option upon UPC violation (low)

Setting Fixed Paths

Use the console terminal to make additions and deletions of PVC entries and PVC connection information saved in Flash memory. Upon system reset, control (CTL) initializes the header translator table in each LINF and the multicast bit-map table in the XATOMSW according to the PVC information saved in Flash memory.

Using Soft PVC/PVP

To shorten the time-consuming and error-prone task of end-to-end manual configuration of PVCs, the LightStream 100 switch supports soft PVC/PVP. With soft PVC/PVP support, you can create a PVC across a multiswitch network by designating only the two endpoints of the connection. The software dynamically establishes a connection between those points, eliminating manual configuration of the switches between the two endpoints. Without soft PVC/PVP support, every link in the path between the two ATM hosts must be manually configured as a PVC. By reducing manual configuration, soft PVC/PVP can save you considerable time configuring a network.

Setting Switched Paths

The system supports SVCs point-to-point connections and point-to-multipoint connections. The use of a network address-line corresponding table, set from the console terminal, implements this function.

Using SVC Tunneling

To enable the use of standards-based signaling over public carriers, which only provide ATM PVC services, the LightStream 100 switch supports switched virtual circuit (SVC) tunneling. SVC tunneling allows you to set up temporary SVCs over previously established permanent virtual path (PVP) connections. The LightStream 100 switch supports a maximum of 64 virtual paths.

Communicating with the NMS Manager

Using SNMP over UDP/IP/AAL5, the LightStream 100 switch communicates with the NMS manager via an ATM line (in-band) or the Ethernet interface (out-of-band). This function is implemented with the use of Management Information Base (MIB)-II defined in RFC 1213. A console terminal connection is needed to set the system configuration.

The LightStream 100 only supports AAL5 SNAP encapsulation for the packets that go to the switch through the ATM.

Signaling Control

The LightStream 100 switch also supports Interim Inter-Switch Signaling Protocol (IISP) static routing. Static routing necessitates manually setting the address prefix or the full address and information on the high line connecting to a device with that address.

LAN Emulation Support

The LightStream 100 switch supports automatic ILMI registration for LAN emulation in a multiple switch environment. The switch can store the ATM addresses of up to four LAN emulation configuration servers (LECSs). LAN emulation clients (LECs), LAN emulation servers (LESs), and hosts obtain the ATM address of the LAN configuration server to access for operating parameters and LAN information. The ATM addresses of the LECS can be also be manually entered.