CHAPTER 2

Introduction to LightStream 2020

This chapter introduces the LightStream 2020 multiservice ATM switch (LS2020 switch). It describes the structure of the LS2020 switch and presents some of its key features.

What Is an LS2020 Switch?

The LS2020 switch is a powerful backbone, multiservice ATM switch for local and wide area networks. As an integral part of Cisco Systems' product offerings, the LS2020 has capabilities in both ATM and fast packet switching processing, enabling it to handle Frame Relay, circuit emulation, and LAN traffic interfaces. In addition to its ATM capabilities, the LS2020 switch provides FDDI and Ethernet switching that can be easily converted to ATM. Using the LS2020 switch as a basic building block, you can create a mission-critical enterprise backbone network that provides flexible and cost-effective allocation of bandwidth, guaranteed quality of service for all running applications, interoperability with past and future devices, and scalability for future networking applications.

The LS2020 switch interoperates with Cisco Systems' family of internetworking products and can be combined with the LightStream 100 and Cisco ATM NIC cards to form an end-to-end ATM network. With the LS2020 and other Cisco Systems internetworking products, you can have end-to-end networking solutions, regardless of the type of internetworking technology you select.

Need for LS2020 Network

Recent advances in computers and communications have begun to overburden existing network systems and technologies. For example, today's network link speeds continue to grow. In the 1970s, 1.2 kilobits per second (kbps) was considered normal speed, and 9.6 kbps was considered high speed. In the 1990s, networks using fiber optic technology are reaching speeds of 100 megabits per second (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 range of services. The LS2020 switch was designed with these needs in mind.

LS2020 High-Performance Networking

In addition to being based on ATM technology, the LS2020 switch has several features that make it a reliable, cost-effective means for high-speed, broadband, open networking applications. These features are discussed in the following sections.

Switching in Hardware and Firmware

Most LS2020 switching and communications functions are performed at wire speed in application-specific integrated circuits (ASICs) designed specifically for and built into the LS2020 chassis. Thus, the hardware and firmware of the LS2020 eliminate much of the overhead involved when communications functions are software-based.

The entities that perform processing tasks for the LS2020 switch are divided into three general classes, based on the speed required for the task:

- **Line card hardware and firmware**—Accomplishes functions that must be completed *in tens of microseconds or less*, such as traffic policing and cell forwarding
- **Line card control processor**—Accomplishes complex tasks that must be completed *in tens of milliseconds or less*, such as interface management, error handling, and line up/down protocol processing
- **Network processor software**—Accomplishes functions that can be completed *in more than tens of milliseconds*, such as cell processing and 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 level of service in which cell delay variation must be minimized (voice applications, for example). Another application may require service that is more cost-effective, but not as delay-sensitive. The LS2020 switch optimizes application performance by providing services appropriate to the application.

Rate-Based Congestion Avoidance

LS2020 switches provide cost savings by minimizing the 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 LS2020 allows very high line utilization while maintaining user service guarantees.

For example, the LS2020 switch uses ControlStream, a congestion-avoidance mechanism that manages congestion by controlling traffic at the edges of the network. When an LS2020 network detects congestion, the causes of the congestion are identified and controlled individually, based on user service guarantees. Thus, congestion is eliminated at the source, link use is maximized, and mission-critical service is maintained.

Mission-Critical Networking

The LS2020 switch provides the following mission-critical features:

- **Critical element redundancy**—The LS2020 switch provides options for a redundant switch fabric (concurrent cell switch), network processor, power supply, and power cord. If any of these components fails, the redundant unit can take over the load with little or no service disruption. In addition, the LS2020 switch has two blowers and can operate with a single blower if one should fail.
- **Improved fault tolerance**—The LS2020 switch offers improved fault tolerance by supporting two types of cutover in its switch cards, planned, and unplanned. Planned cutovers involve no cell 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 an LS2020 switch.
- **Low MTTR**—The LS2020 switch achieves low mean time to repair (MTTR) by providing diagnostics that isolate a failure to a field-replaceable unit (FRU) and by allowing the diagnostics to be run remotely.
- **Dynamic routing around failures**—LS2020 reroutes connections whenever a failure of one or more communications links interrupts existing traffic flow.

Effective Network Management

You manage an LS2020 network using StreamView, which is an SNMP-based network management application that runs on a Sun SPARCstation. This Sun workstation is commonly referred to in LS2020 user documentation as the network management system (NMS). StreamView allows you to configure, monitor, and control a network of LS2020 switches. StreamView provides you with a graphical representation of your managed objects (a view of network topology) and a mouse-driven point-and-click interface.

In addition to StreamView, you may choose to run HP OpenView management software on your NMS, or you can use another network management system that is SNMP-compatible. You can perform a variety of management tasks using a simple command line interface (CLI) from a terminal attached to the console port of an LS2020 switch.

For more details on network management, see the section “Network Management Methods” in the chapter entitled “Network Management.”

ATM Migration Path

An LS2020 network provides a very clear migration path to ATM. The LS2020 switch is designed to let you easily migrate to ATM using your existing equipment. The LS2020 provides services that make it backward compatible with any current equipment that passes constant bit rate (CBR) traffic, Ethernet, FDDI, High-Level Data Link control (HDLC), Synchronous Data Link Control (SDLC), or Frame Relay traffic. In addition, the LS2020 switch can accept such traffic from an external device, convert it to ATM cells, and pass it through the network.

The LS2020 switch also accepts ATM cells from an external device and passes the cells through the network. The switch provides services that allow it to interface with equipment that supports ATM user-network interfaces (UNIs) and SONET interfaces. As more ATM devices become available, you can add them to your network without disrupting existing operations.

Service Integration

Due to the need for greater integration, an LS2020 network offers various services to carry traffic over the network. These services include the following:

- **Bridging**—Supports transparent and translation LAN bridging, the spanning tree protocol, and custom filtering. With custom filters, you can define traffic profiles and network layer filtering.
- **CBR**—Lets an LS2020 network interconnect CBR equipment, such as private branch exchanges (PBXs), T1/E1 multiplexers, and video coders/decoders (codecs). This feature allows ATM trunks to carry both voice and data.
- **ATM UNI**—Supplies an ATM interface, allowing LS100s or other ATM-capable devices to use the LS2020 network.
- **Frame Relay**—Lets an LS2020 network connect routers, packet switches, and other devices that have Frame Relay DTE interfaces. It also provides network-to-network or network-to-node interfaces (NNIs), that is, connections between LS2020 networks and external Frame Relay networks.
- **Frame forwarding**—Lets you connect devices that support HDLC and SDLC communications. This allows you to connect to older devices that may not support Frame Relay or ATM UNI interfaces.

The LS2020 also offers VirtualStream, a LAN internetworking feature that allows you to do the following:

- Assemble geographically dispersed LAN segments into workgroups
- Assign ATM quality of service, called AS/QoS, parameters to LAN flows
- Send multicast and broadcast LAN flows across the LS2020 network at line speeds

Open Networking Support

The LS2020 switch is based on industry standards, allowing it to interoperate with standards-based, high-speed networking devices. The LS2020 switch adheres to the ATM specifications being developed by ITU-T, ANSI, and the ATM Forum. The LS2020 switch also complies with the SNMP specification, enabling it to be managed by any SNMP-compatible network management application.

The LS2020 switch conforms to all the standards listed in Table 2-1; however, not every detail of each standard has been implemented. Compliance with standards ensures that LS2020 switches can interoperate with a wide range of network devices.

Table 2-1 Major Standards Observed by LS2020 Switch

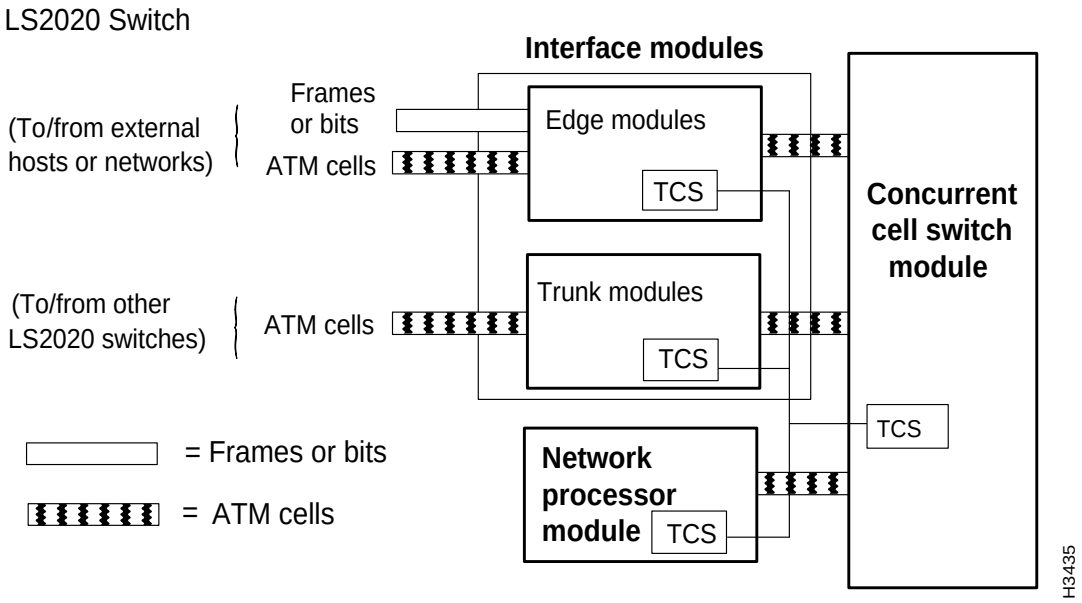
Document Number	Title
ANSI T1.403	ATM UNI DS1 interface
ANSI T1.618 (LAP-F) and ITU-T Q. 922 Annex A	Frame Relay (for Frame Format)
ANSI T1.617 Annex D and ITU-T Q.933 Annex D	Frame Relay (for LMI[1] and PVC management)
ANSI T1.627-1993 B-ISDN	ATM Layer Functionality and Specification
ANSI T1.606 and ITUT-T I.233	Frame Relay (for UNI)
ANSI X3T9.5	FDDI Standard for I/O interfaces
ATM Forum UNI Specification V2.0, 3.0, 3.1	ATM UNI Service
ATM Forum UNI 3.0/3.1	User Network Interface
ATM Forum IISP	Interim Inter-Switch Protocol
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
Internet RFC #1213	Management Information Base (MIB-II)
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
ITU-T I.150	BISDN Asynchronous Transfer Mode Functional Characteristics
ITU-T I.311	BISDN General Network Aspects
ITU-T I.361	BISDN ATM Layer Specification
ITU-T I.363	BISDN ATM Adaptation Layer (AAL) Specification (AAL 5 only)
ITU-T I.371	Traffic Control and Congestion Control in B-ISDN

1. The LS2020 product supports three LMI options: ANSI T1.617 Annex D; the original Frame Relay Consortium (now known as FR Forum) LMI version; and Frame Relay interface with no LMI.

LS2020 Structure

Figure 2-1 shows the key components of an LS2020 switch.

Figure 2-1 Key Components of LS2020 Switch



The LS2020 architecture includes the following major elements:

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

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

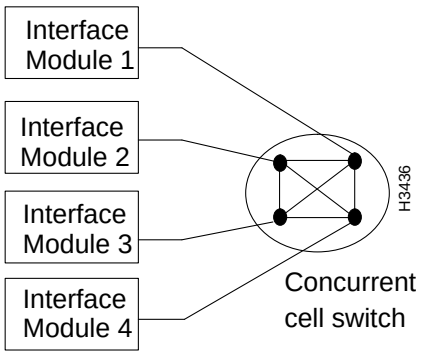
The following sections describe these modules.

Concurrent Cell Switch Module

In an LS2020 switch, the concurrent cell switch module consists of a switch card and 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 shows the architecture of the concurrent cell switch module.

Figure 2-2 Concurrent Cell Switch Architecture



In a concurrent cell switch, 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 among all modules simultaneously.

The use of many parallel paths allows the aggregate throughput of an LS2020 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 ten input ports and ten 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 in full-duplex mode. Allowing for cell headers and switch contention (more than two switch input lines contending for the same output line), this bandwidth capability provides a sustained *payload* throughput of approximately 160 Mbps in full-duplex mode. 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.

Network Processor Module

The NP module contains an NP card and an NP access card. The NP module supports RouteStream, a highly sophisticated distributed network routing protocol.

NP tasks include the following:

- Performing call processing and rerouting
- Performing LAN bridging and address translation
- Performing CLI monitoring and control functions
- Discovering network topology
- Acting as SNMP agent for LS2020 chassis
- Maintaining network statistics, accounting information, and routing databases

The NP access card houses an Ethernet interface for the NP module, making it possible for a network management station to attach to the LS2020 network that has no LAN interface modules. Each NP module also has an associated disk assembly. The disk assembly contains a floppy disk drive and a hard disk drive. The floppy disk 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)

Two types of interface modules are present in an LS2020 switch:

- **Edge interface**—Connects LS2020 switches within a network to non-LS2020 devices outside the network using the protocol(s) of the attached devices
- **Trunk interface**—Connects LS2020 switches to other LS2020 switches within a network using ATM protocols

Edge Modules

LS2020 switches carry traffic received from external devices in frames, ATM cells, or constant bit rate streams. 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 LS2020 network. The edge module also reassembles ATM cells received from the LS2020 network into the original frames and transmits them 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. It then transmits the cells across the LS2020 network; no cell segmentation or reassembly is needed. The edge module also receives ATM cells from the LS2020 network and transmits them from the module to external devices.

If the traffic is a constant bit stream, the edge module segments the stream into cells. The edge module also reassembles the cells into the original bit stream (preserving the original bit timing) and transmits the stream from the edge module interface to external devices.

Each edge module contains an onboard control processor that works with the NP to set up new connections and provide low-level information required by the network management system.

The edge modules for the LS2020 switch are as follows:

- **First-generation, low-speed interface module (eight ports)**—Consists of a low-speed line card (LSC), edge software, a low-speed access card (LSAC), data cables, and a fantail. Connects to Frame Relay, HDLC, or SDLC devices.
- **Second-generation, low-speed serial interface module (SIM) (eight ports)**—Consists of a packet line card (PLC), edge software, a serial access card (SAC), data cables, and a fantail. The PLC works in conjunction with the 8-port SAC to provide eight full-duplex serial lines. Connects to Frame Relay, HDLC, or SDLC devices.

  The second-generation SIM provides functionality equivalent to that of the first-generation low-speed interface module described above, but offers the advantages of lower cost and higher performance. Thus, the SIM is an attractive customer upgrade option.
- **First-generation, medium-speed T3/E3 interface modules (two ports)**—Consists of a medium-speed line card (MSC), edge software, a T3 or E3 medium-speed access card (MSAC) for connection to ATM UNI devices, and data cables.
- **Second-generation, medium-speed T3/E3 interface modules (four or eight ports)**—Consists of a cell line card (CLC), edge software, a T3 access card (T3AC) or an E3 access card (E3AC) to support DS3 connectivity, data cables, and a fantail.

  The second-generation T3/E3 interface modules offer the advantages of lower cost and higher port density than the first-generation T3/E3 interface modules described above, thereby providing an attractive customer upgrade option to LS2020 users.

- **Circuit emulation interface module (eight ports)**—Consists of a packet line card (PLC), edge software, and a circuit emulation access card (CEMAC) for support of a clear channel DSX-1 or a 2-Mbps G.703 interface. This module provides connectivity to PBXs and TDM multiplexors, for example.
- **Ethernet interface module (eight ports)**—Consists of a packet line card (PLC), edge software, and an Ethernet access card (EAC). This module embodies attachment unit interface (AUI) and twisted pair Ethernet (TPE) ports and provides LAN bridging services.
- **Fiber Ethernet interface module**—Consists of a packet line card (PLC), edge software, and a fiber Ethernet access card (FEAC). This module embodies fiber Ethernet ports and provides LAN bridging services.
- **FDDI interface module (two dual attachment station ports)**—Consists of a packet line card (PLC), edge software, and an FDDI access card (FAC). This module provides connectivity to LANs.
- **OC-3c interface module (two ports)**—Consists of a cell line card (CLC), edge software, and an OC-3c access card (OC3AC). This module provides ATM UNI services.

  The OC-3c access card is available in two versions: an OC3AC-MM (multimode) card with simplex SC connectors, and an OC3AC-SM (single mode) card with ST connectors.

Trunk Modules

Trunk modules connect one LS2020 switch to another LS2020 switch to form an LS2020 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 LS2020 switch in the connection.

The trunk modules for the LS2020 switch are as follows:

- **First-generation, low-speed interface module (eight ports)**—Consists of a low-speed line card (LSC), trunk software, a low-speed access card (LSAC), data cables, and a fantail.
- **Second-generation, low-speed serial interface module (SIM) (eight ports)**—Consists of a packet line card (PLC), trunk software, a serial access card (SAC), data cables, and a fantail.

  The second-generation SIM provides functionality equivalent to that of the first-generation low-speed interface module described above, but offers the advantages of lower cost and higher performance. Thus, the SIM is an attractive LS2020 upgrade option.
- **First-generation, medium-speed T3/E3 interface module (two ports)**—Consists of a medium-speed line card (MSC), trunk software, a T3 or E3 medium-speed access card (MSAC), and data cables.
- **Second-generation, medium-speed T3/E3 interface module (four or eight ports)**—Consists of a cell line card (CLC), trunk software, a T3 access card (T3AC) or an E3 access card (E3AC), data cables, and a fantail.

  The second-generation T3/E3 interface modules offer the advantages of lower cost and higher port density than the first-generation T3/E3 interface modules described above. Thus, the four-port/eight-port versions of the T3/E3 interface modules provide attractive upgrade options to LS2020 users.
- **OC-3c interface module (one port)**—Consists of a cell line card (CLC), trunk software, and an OC-3c access card (OC3AC).

  The OC-3c access card is available in two versions: an OC3AC-MM (multimode) card with simplex SC connectors, and an OC3AC-SM (single mode) card with ST connectors.

Test and Control System

The Test and Control System (TCS) is a fully integrated, yet autonomous, computer system within the LS2020 chassis. A TCS microcomputer is located on each NP, interface, and switch module in an LS2020 chassis. The TCS communications path is completely separate from the LS2020 switch. As long as the TCS components have power and are themselves operational, the TCS can function independently.

The TCS has two primary functions:

- Managing low-level operations of each module
- Providing access to all modules in the chassis through a local console port and a modem port, both of which are supported by the TCS microcomputer on the switch card

Connecting LS2020 Switches in Network

Figure 2-3 shows three LS2020 switches connected in an LS2020 network. As shown in the Figure 2-3, external devices are connected to the LS2020 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 LS2020 switches to each other in a network. Traffic passing between LS2020 switches (or between any two cards within an LS2020 switch) is passed as ATM cells.

Note For simplicity, Figure 2-3 does not show the NPs in each LS2020 switch. Each LS2020 switch must have an NP to enable the switch to establish connections throughout the network and to perform other network processing and control functions.

Figure 2-3 Simplified View of LS2020 Network