CHAPTER 2

BPX, IGX, and IPX Architecture

Introduction

The following paragraphs describe the StrataCom nodes used to build cell-based Wide Area Networks: the broadband BPX, the multiband IGX, and the narrowband IPX. For further information, refer to the BPX, IGX, and IPX reference manuals. Also, for further information on associated products, refer to the AXIS, EdgeConnect, and FastPAD Reference Manuals. For Network Management Information, refer to the StrataView Plus Operations Guide.

BPX Broadband Multi-Service ATM Switch

General

The StrataCom BPX is a standards-based, broadband, scalable, ATM network switch utilizing very high-speed-switching and asynchronous transfer mode technologies. It supports large, high-capacity networks for existing users whose private networks have grown in size and for public service providers who demand the latest in high-speed technology for their large networks.

The BPX provides the following features:

- Increased node switching capacity to facilitate the deployment of larger, higher-capacity networks.
- A platform for providing multiple services such as frame relay, ATM, SMDS, CES.
- Increased network capacity by using T3, E3, or OC3/STM-1 trunks to facilitate statistical bandwidth aggregation as frame relay Committed Information Rates increase.
- A clear migration path to networks utilizing the 53-byte cell relay network protocols defined by ATM standards.
- Ability to support higher-speed network access interfaces such as SONET, and SDH to access rates up to 622 Mbps.
- Advanced congestion management and routing features such as FairShare, ForeSight, AutoRoute, and Opticlass.
- Higher-speed network management interfaces and access for real-time, per-connection statistics collection.

The BPX employs a redundant 9.6 Gbps non-blocking crosspoint switch matrix for cell switching. The switch matrix can establish up to 20 million point-to-point connections per second between ports. A single BPX provides twelve high-speed switch ports, each of which is capable of operating at 800 Mbps. Access to and from the crosspoint switch is through multi-port network and user access cards.

An arbiter is utilized to set up and release each cell path based on those ports with traffic data to switch. The arbiter can set up 20 million point-to-point connections per second between the BPX switch ports. For maximum reliability, the switch matrix, data paths, and all control and arbiter functions are provisioned in a fail-safe 1:1 redundant configuration.

Each BPX node is configured with twelve slots (switch ports) for network or user interfaces and three slots for common equipment cards. Each Broadband Network Interface (BNI) card provides high-speed network interfaces for trunking to other BPX nodes, to IPX nodes equipped with an ATM trunking card, or to other networks. Each of the BPX's high-speed trunk cards can be configured for 1:1 redundancy. An ATM Service Interface (ASI) card provides two DS3, E3, or OC3/STM-1 ATM ports for connection to ATM customer premise equipment.

The BPX is a virtual circuit switch. It can switch on VCI and/or VPI fields in the ATM cell header. Individual connections, as well as groups of connections within a path, may be switched. This greatly enhances the versatility of the BPX as a network switch.

StrataCom utilizes three techniques for using ATM cells for transmitting user information. For pure cell-relay traffic, incoming ATM cells from ATM customer premise equipment are relayed and switched through the network in standards-based cell formats. Cells are routed based on address information in the ATM cell header.

Frame Relay to ATM Interworking enables frame relay traffic to be connected across high-speed ATM trunks. Interworking allows users to retain their existing Frame Relay services, and as their needs expand, migrate to the higher bandwidth capabilities provided by BPX ATM networks. Two types of interworking are supported, network interworking and service interworking. The network interworking function is performed by the AIT card on the IPX and by the BTM card on the IGX. The FRSM card on the AXIS supports both Network Interworking and Service Interworking. On the AXIS, IPX, or IGX, Frame Relay data is received directly from the user equipment, converted from the Frame Relay protocol to the ATM protocol, and the data streamed into the ATM cell's 48-byte payload, sending ATM cell after cell, until the end of a frame is reached. This is repeated for each frame received from the user until the last frame is transmitted.

If the traffic is voice or constant bit rate, low-speed data, which will terminate on an IPX or IGX, the 24-byte FastPackets are combined within the 48-byte ATM payload, normally two FastPackets to a cell. If the connection carries data or voice that is very delay sensitive, the StrataCom switch may, as an option, occasionally pack only one FastPacket into a cell payload to reduce delay to a minimum. Once data is segmented into cells, the cells can easily be converted from one size to another without requiring additional adaptation simply by changing the cell size and streaming the data into a different capacity payload.

The BPX may also be used to provide a smooth migration path for network operators currently using IPX and IGX nodes in their networks who need additional capacity and would like to build on their existing equipment. Since the BPX can be integrated into an existing IPX/IGX network by adding only a single card to each of the IPX or IGX nodes that need to connect to the BPX, the hardware costs are kept to a minimum.

The ATM cell payload is ideally suited to transporting IPX FastPackets since both are fixed length and the size of the ATM cell is larger than the FastPacket cell length (no segmentation of the cell is necessarily required). Packets of data that are created by IPX and IGX nodes in a mixed environment are encapsulated in the ATM cells for transmission throughout the network.

For more details on the BPX hardware, refer to the *BPX Reference*. For information on the BPX commands, refer to the *Command Reference*.

AXIS Shelf

The AXIS is a standards-based ATM interface shelf for the BPX that a provides a service interface to multi-service networks and is usually co-located with a BPX. The AXIS allows users to economically concentrate large numbers of PVC connections over high-speed ATM trunks. Release 3 of the AXIS provides T1/E1 and subrate frame relay, T1/E1 ATM, and FUNI (frame based UNI over ATM), and frame relay service interfaces for routing traffic over the ATM network via the BPX. For additional information on the AXIS, refer to the *AXIS Reference Manual.*

BPX Architecture

The BPX consists of the following elements:

- Common Core (Controller) Modules, which perform the node control and cell switching functions.
- Network Interface Modules, which provide the physical and electrical interface to the network trunks.
- Access Interface Modules, which provide standard interfaces for connecting the BPX directly to user devices.

ATM connections can be made between user devices equipped with DS3, E3, and OC3 ATM interfaces. These user devices connect directly to a BPX switch port over an ATM User-Network Interface on the ATM Service Interface (ASI) card and through AXIS or IPX shelves.

The ASI-1, supports up to 1000 network ATM connections over DS3, E3, interfaces and can be optimized for either continuous bit rate (CBR), or variable bit rate (VBR) data, or available bit rate (ABR) data. The ASI-155 supports up to 1000 connections on each of two ports over OC3/STM-1 interfaces and 1000 ungrouped or 5000 grouped connections per BPX node for either CBR or VBR data.

The BPX offers 45 Mbps DS3, 34 Mbps E3, and 155.52 Mbps OC3/STM-1 network interfaces utilizing ATM cell relay technology. Functions performed by the BNI (Broadband Network Interface) modules include queuing and servicing cells, implementing congestion control mechanisms, address translation and routing of cells to the switching matrix. Physical connection to the network is accomplished through simple line interface cards.

Segmentation and reassembly, cell switching, interface to the switch matrix, and system timing and status monitoring are performed by the BPX controller card. A non-blocking, 16x16 crosspoint switching matrix, operating at 9.6 Gbps is the heart of the BPX. A switch arbiter is used to determine which matrix input port needs to connect to which matrix output port to properly route the cells. This individual crosspoint switching technique provides superior performance at broadband speeds when compared with a system bus architecture.

Each BPX switch port has a capacity of operating at 800 Mbps and is capable of supporting OC-12 data rates in each of the twelve switch ports on the BPX when this interface becomes available.

All data flow through the switch is monitored at every process to detect any corruption of the data or addressing. Flow-through parity recomputation and checking is performed within the individual cards and data paths on the backplane to detect data path and memory faults that would otherwise be difficult to detect with periodic checks.

The controller, switch matrix, backplane data paths, and all control and timing signals are redundant throughout the BPX switch to provide maximum reliability. Both Broadband Controller Cards (BCCs) are synchronized to each other and data paths are buffered so any switchover will be transparent.

IGX (Multi-band ATM Switch)

General

StrataCom's IGX product family, consists of the IGX 8, IGX 16, and IGX 32 multiservice ATM switches. As multi-band members of the StrataCom's ATM portfolio, IGXs seamlessly integrate with StrataCom's IPX, BPX, AXIS, INS, and FastPAD platforms under StrataSphere management, to provide multiband ATM solutions from the access to the core layer with integrated network management and call processing.

The IGX 16 and IGX 32 are network backbone node systems for large sites with multiple trunks and considerable local traffic requirements, where a large number of physical ports and gigabit-scale throughput are required. Both IGX systems are available as stand-alone units or can be rack mounted with other equipment.

All IGX services are supported by standard ATM narrowband and broadband trunk resources. IGX systems support trunk speeds from 128 Kbps to OC3 and FastPAD access trunk connectivity from 9.6 Kbps to 2 Mbps. IGX systems can be fully interconnected in a logical mesh through public ATM services, or provide edge switching in and out of such services, and can network to FastPAD systems over public frame relay services at up to 2 Mbps. IGX systems also support the IPX FastPacket trunk protocol for seamless connectivity with IPXs at smaller sites.

IGX Architecture

The IGX uses a 1.2 Gbps cell switching redundant bus to pass ATM cells between optionally redundant adaptation, trunking and gateway modules within the system. This architecture allows any amount of bandwidth to be assigned to any slot, and makes the IGX the only system in its class with more than 16 slots, for greater scalability.

Hardware, firmware and software are designed for maximum availability, non-stop networking, even during maintenance windows. Availability design features, common to all StrataCom switching systems, include:

- 100% Component Redundancy
- Extensive Background Diagnostics
- "Hot" Card Swapping
- Rapid power fail recovery
- Background software download

- Firmware and software upgrades (remote download)
- Class B EMI certified enclosures
- Hard and soft alarm interfaces including “call home”
- Minimum internal cabling

All switches use a mid-plane design with front cards performing processing functions and back cards providing interfacing and physical connectivity. This allows most system maintenance to be performed at the front cards, without disconnecting interface cables.

IPX (Narrowband ATM and FastPacket Switch)

General

The IPX narrowband switch is an intelligent network bandwidth manager. It accepts frame relay, digitized voice and FAX, encoded video, and data streams from user equipment and adapts these voice and data streams into fixed length cells. It then routes these cells to appropriate network trunk interfaces (ATM or FastPacket). The receiving node dis-assembles the received cells or packets and outputs the data streams to the proper voice and data ports. The IPX seamlessly integrates with the IGX, BPX, INS, FastPad, Port Concentrator, and StrataSphere NMS. The IPX routes traffic to appropriate network interfaces, either ATM or FastPacket.

The following are some of the features provided by the IPX narrowband switch:

- Adapts customer frame relay, voice/FAX, synchronous and asynchronous data, and digital video into high-speed, fixed length cells (either ATM cells or FastPackets).
- Transmits data utilizing high-speed digital transmission facilities and simple transmission protocol resulting in very low end-to-end delays.
- Maximizes network bandwidth utilization by compressing voice data, eliminating silent periods, eliminating repetitive patterns and idle codes in data streams, and transmitting packets only when there is actual circuit data to be sent.
- Connections are easily established and automatically routed.
- Users can assign a hierarchy of class of service and priorities for various types of traffic.
- Monitors all trunk activity, detects trunk failures, and automatically reroutes around failed trunks without loss of service (as long as sufficient spare bandwidth is available).
- Provides tools for detecting and dynamically avoiding and/or managing network congestion.
- Collects status and traffic statistics on all trunks, circuits, connections, frame relay ports.
- Display of network configuration and status from any node.

The IPX family consists of different configurations designed to meet the needs of small, medium, and large sites. There are three basic IPX packaging options: the IPX 8, IPX 16, and IPX 32. All three systems use virtually identical hardware and software; they differ only in the number of card slots provided. The IPX 8 extends the benefits of FastPacket technology to the edge of networks without losing bandwidth efficiency.

Note The term IPX is used to refer to the generic system. Where necessary to differentiate between the various systems, the terms IPX 8, IPX 16, or IPX 32 are used.

The IPX also uses voice compression to provide increased capacity. Voice interfaces, such as PABX's and channel banks, transmit Pulse Code Modulation (PCM) voice streams to the IPX for processing. The IPX processes voice streams using Voice Activity Detection VAD). With VAD, voice packets are transmitted only when speech is present (in typical phone conversations, speech is present only 40% of the time). This results in greater than 2-to-1 compression, with no degradation in voice quality. This compression ratio allows many more voice channels to share a single trunk.

In addition to Pulse Code Modulation (PCM), the IPX provides various levels of Adaptive Differential Pulse Code Modulation (ADPCM) to give another 2, 3, or 4-to-1 compression to voice. In this way, the IPX provides voice compression for as many as 256 (E1) or 192 (T1) voice channels on a single trunk.

The IPX uses Data Frame Multiplexing (DFM) to provide low-speed data compression. DFM is implemented using Repetitive Pattern Suppression (RPS). If data packets contain a repetitive data pattern, the IPX will suppress sending the packets across the network and merely regenerate the pattern at the far end. The net result of this suppression is a significant savings in bandwidth.

Non-disruptive diagnostics continuously monitor the performance of each component in the node. In the event of a failure, a backup component is automatically switched into service with no effect on the user. All cards and power supplies are hot-replaceable; they can be added or replaced on-line with no interruption in service.

IPX systems can be configured to operate in network applications at any world-wide network location. Options include interfaces to both North American and International standard trunks and ports. Power supply options include 208 VAC, 240 VAC, and 48 VDC modules. All cards are programmable, with downloadable firmware, to operate with various network parameters and are easily upgraded to take advantage of new features as they are developed.

For more details on the IPX hardware, refer to the *IPX Reference Manual*. For information on the IPX commands, refer to the *Command Reference Manual*. Appendix B lists the available manuals and their StrataCom part numbers.

IPX Architecture

Information enters an IPX from attached terminal equipment in the form of digital streams, through a circuit mode service interface, or in the form of LAP-D frames through a packet mode service interface. These interfaces segments the streams or frames into cells, addresses the cells, and transmits them onto a switching bus.

Each trunk interface monitors the system bus and receives any cells to be transmitted through it. Queuing of cells for transmission is done by the trunk interface. Cells that are being switched through an intermediate node are transmitted onto the system bus by the receiving trunk interface and picked up by another trunk for transmission out. When cells reach the destination node, they are put on the bus by the receiving trunk, picked up by the appropriate service interface, converted back to data streams or frames and transmitted to the attached user equipment.

All information entering an IPX, whether circuit or packet, streaming or framed, constant or variable bit rate, is converted to a single common multimedia format, a fixed-sized cell. These cells are switched and transmitted to their destination, where the original information is reconstructed and delivered. The benefits of IPX FastPacket networks arise from the power and flexibility of the universal switching architecture.