

Enterprise IBM Internetworking

Environment, Issues, Opportunities

Presented by
Thomas J. Routt
VEDACOM Corporation

to
Bay Networks, Boston
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9825 41st Avenue NE

Seattle, WA 98115-2517, USA

E-Mail: tjroutt@halcyon.com Tel: (206) 527-3434 Fax: (206) 524-3557

Web: <http://www.sirius.com/~alyon/VEDACOM/>



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Enterprise IBM Internetworking

Environment, Issues, Opportunities

- Enterprise IBM Internetworking Issues
- Enterprise IBM Internetworking Requirements
- Networking Trends
- Cisco Systems
- IBM
- Bay Networks Issues, Opportunities, Recommendations



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Enterprise IBM Internetworking Issues

- Business Models in Transition
- Networked Applications in Transition
- Host-to-Client/Server Paradigm Shift
- Extended Corporate Intranet
- Networks Out of Balance
- Enterprise Internetworking Challenges
- Cost Justification
- Network Vision
- Network Services
- Operations
- Enterprise Standards
- Human Resources



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Enterprise IBM Internetworking Issues

- **Business models are in transition**
 - Flattening, reorganizations, rightsizing
- **Networked applications are in transition**
 - Vendors continuously “wave their arms” at users with new products for sale with little or no comprehension or incentive to understand the customer business climate or distributed application environments
 - Host-centric to LAN-centric to 2/3-tier client/server
 - Emerging corporate Intranet (data, image, graphics)
 - Emerging real-time Intranetwork (real-time audio/video)
 - Emerging multiservice network (Integrated video/data/voice)



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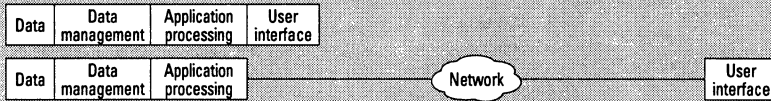
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Host- and LAN-Centric Computing

Host-centric models

Host

Found in mainframes, UNIX hosts, and standalone desktop computers.
Network access methods are based on simple text terminals or X terminals.



Remote data/file sharing

LAN

Found in LAN-based network file storage systems such as NetWare, Windows NT, OS/2, or UNIX NFS file sharing networks. Network access based on IPX/SPX, DecNet, NFS, etc.



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Client/Server Paradigms

1-tier client/server

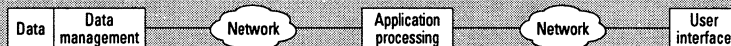
Client/Server

Found in RDBMSs with programs written in a 3GL or 4GL.
Applications run on target desktop machines.



2-tier client/server

Found in RDBMSs with programs written in a 3GL hosted on a dedicated application processor (typically UNIX) with remote display.



3-tier client/server

Found in RDBMSs with programs written in a 4GL or 5GL.
Application logic is distributed across application hosts and target desktop systems.

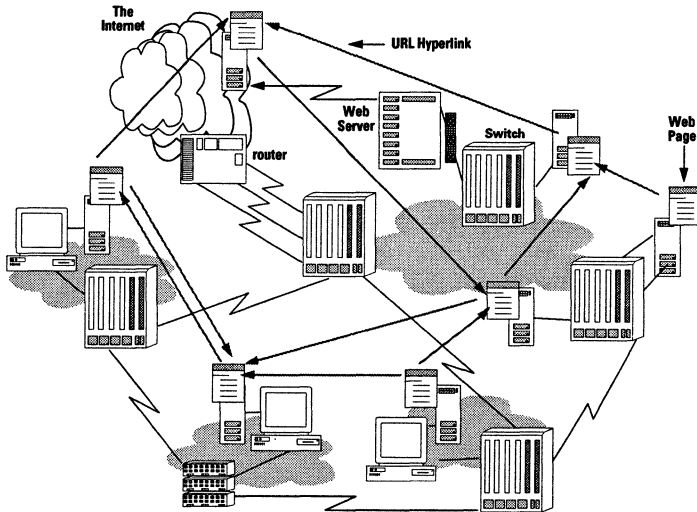


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Extended Corporate Intranet



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Enterprise IBM Internetworking Issues (Con't.)

- **Networks are out of balance**

- ◇ Bandwidth bottlenecks
- ◇ Desktop information integration requirements
- ◇ Cost and complexity of moves, adds, changes
- ◇ Backbone confederations (SNA, APPN/ISR, HPR, TCP/IP, IPX, NetBIOS)
- ◇ Server farms reinvent multiple copy MIS groups
- ◇ Internet / Intranet usage, security issues
- ◇ Vendor product life cycles have contracted to 12 months from the gleam in the engineer's eye to product rollout—investment obsolescence concerns



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Enterprise IBM Internetworking Issues (Con't.)

- **Enterprise Internetworking Challenges**
 - ◊ Complex architectures
 - ◊ Accelerating pace of change
 - ◊ Host- to network-centric paradigm shift
 - ◊ No strategic plan or implementation guidelines
 - ◊ Information intangibles
 - ◊ Users requirements often not considered
 - ◊ Non-standard "standards"
 - ◊ Multivendor, multiprotocol incompatibilities



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WAN Backbone Challenges

- Performance bottlenecks
- Seamless performance
- Voice/data integration
- Multiprotocol convergence
- Integrated management



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Building/Campus Challenges

- Router and server throughput bottlenecks
- Shared media congestion
- Scalable performance
- Guaranteed application service levels
- VLAN requirements
- Network administration
- Multiprotocol convergence
- Reduced complexity, increased flexibility
 - Decouple physical and logical networks
 - Render moves, adds, changes transparent



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Desktop Challenges

- Timely access to mission-critical application resources
- Peak traffic response time issues
- Multimedia capability and QoS



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Cost Justification—Issues



- Inadequate networking ROI
- Network benefits not understood by budget authorizers
- Low awareness of fully-burdened PC/WS costs
- Network planning constrained by absence of business unit planning input
- Benefits claimed by MIS system/application side include network benefits
- High expense of reactive networking not recognized
- Cost savings disincentive
- End-to-end cost of ownership not well known



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Network Vision—Issues



- Network vision not expressed in terms of benefits
- Lack of education about line costs
- LANs not considered today as part of the “network”

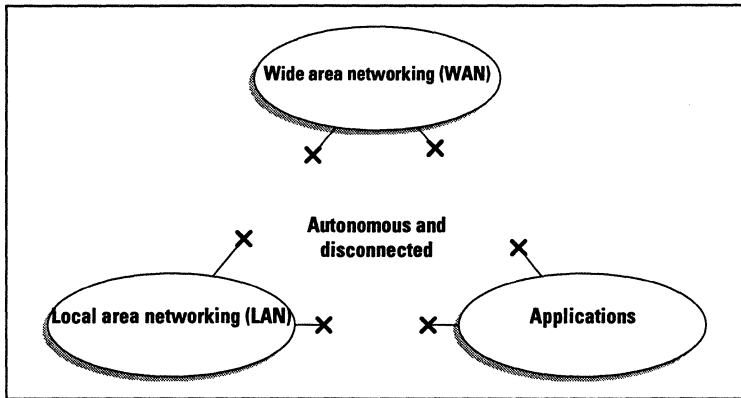


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Administrative/Authoritative Domains

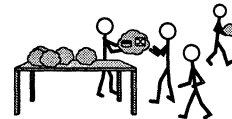


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Network Services— Issues



- Current networks not designed to support emerging application requirements or evolving business models
- Email concerns
 - Multiple, incompatible email solutions
 - May take email four hours or more to deliver within the same building (due to SMTP store-forward)
 - Too many users incorporate large and non-interchangeable attachments
- Low speed lines to several sites
- LAN wiring cumbersome
- Bandwidth concerns

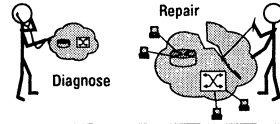


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Operations—Issues



- Reactive staff structure
- Inefficient, costly, unclear “moves, adds, changes”
- No unified Help Desk for workstation/PC, LAN, WAN and system issues
- Lack of awareness by business units of network usage and status

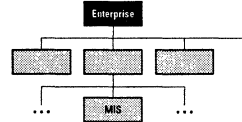


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Organization—Issues



- The network is the central nervous system of the enterprise and becoming increasingly critical as an organizational resource
- Network managers often not have sufficient actual authority and/or budget to execute network vision, plans, integration

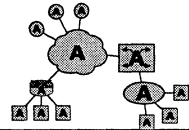


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Enterprise Standards— Issues



- Need flexibility, incentive
- No accepted enterprise-wide LAN NOS
 - ◊ Alternatively, a stable NOS/client solution set is replaced wholesale with a new NOS and client set for religious and/or emotional reasons
 - ◊ Result is departmental islands of data
 - ◊ Cross-departmental file-sharing essentially nonexistent
- No standard core desktop applications
- No standard email
- No remote access policy/procedure
- No standard SNA over IP
- No standard desktop TCP/IP

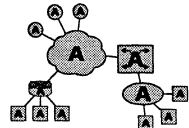


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"Openness" for Enterprise User



- Access any application
 - ◊ ...anywhere
 - ◊ ...any time
 - ◊ ...transparently
 - ◊ ...from/to any hardware
 - ◊ ...from/to any software

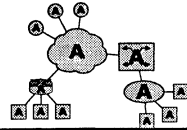


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Non-Standard “Standards”



- "What I like most about standards is that there are so many to choose from."
- Many levels can introduce incompatibility
 - ◊ Model to architecture
 - ◊ Architecture to protocol
 - ◊ Protocol to design
 - ◊ Design to implementation
 - ◊ Implementation to installation
- ... and then the model is obsoleted by new technology



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Human Resources—Issues



- MIS is frequently understaffed
- Non-MIS staff generally spend too much time in MIS-related tasks at the department level
- Critical skills are increasingly outsourced



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Enterprise IBM Internetworking Requirements

- General Requirements
- Network Architecture Drivers
- Enterprise Network Design Process
- Mixed Protocol Internetworking Convergence Model
- Distributed Application Requirements
- Application-Level Convergence
- Session/Transport Convergence
- Desktop Concentration
- Workgroup Switching Requirements



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General Requirements

- Openness, multiprotocol interoperability
- Investment protection
 - ◊ Platform resistance to obsolescence
- End-to-end Quality of Service Guarantees
 - ◊ Access latency, throughput, error thresholds, message priorities
- Robust, end-to-end systems and network management
- World-class vendor support
 - ◊ Includes executive access and leverage



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General Requirements (Con't.)

- Reliability, Availability, Serviceability
- “Vanilla” IBM SNA (subarea, APPN/ISR, HPR), SNA internetworking, and switched SNA solutions
- Vendor end-to-end enterprise vision
- Navigational clarity
- Networking solutions that are:
 - Architecturally coherent
 - Technically elegant
 - Economically rational
 - Politically correct
 - Substantive and precise in step-by-step migration pathway
- Networking solutions that optimize the enterprise business model and distributed application requirements

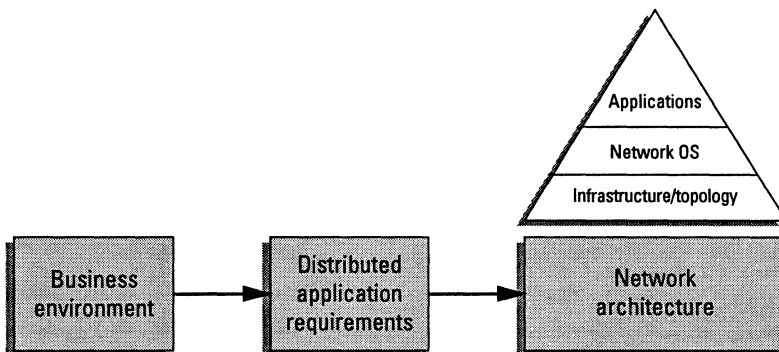


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Requirements— Network Architecture Drivers



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Requirements—Enterprise Network Design Process

- Current/anticipated business climate
- Current/anticipated applications
- Network/Internet/Intranet problem statement
- Background issues
- Alternatives analysis
- Recommendations



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Requirements—Mixed Protocol Internetworking Convergence Model

Application layer



- Protocol awareness in applications
- Application-layer gateways

Session/Transport layer



- Concurrent stacks
- Common APIs with compensation
- Session/Transport gateways

Backbone network layer



- Bridging
- Concurrent routing
- Single stacks with tunneling



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Distributed Application Requirements

- Write once for multiple networks
- Send/receive calls consistent on multiple networks
- Design for requirements, not for network specifics
- Common requests/responses on multiple networks
- Application sees multiple networks as a single logical network



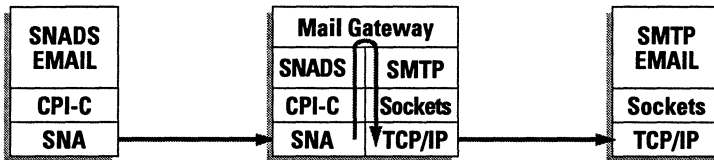
API Requirements

- Run on multiple platforms
- Support full and half duplex
- Support multiple concurrent clients per server
- Provide end-to-end security
- Synchronize multiple, distributed OO RDBMSs
- Robust error reporting

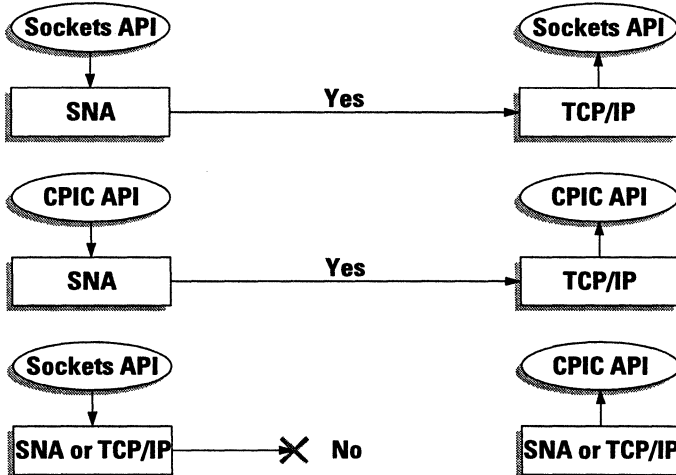


Application-level Convergence

- Application-level
 - Mapping/Gateway
 - Untangle dependencies
 - Functionality lost
 - Processing overhead
 - Simplest
 - Often acceptable



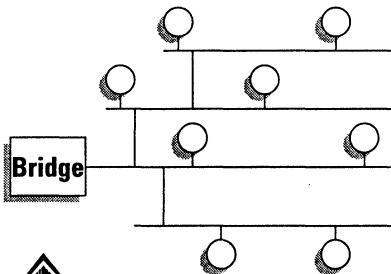
Session/Transport Convergence



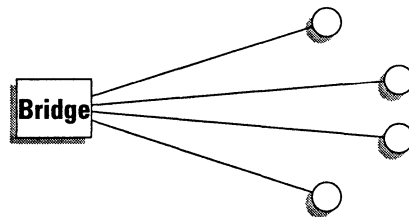
Desktop Concentration

- Control point function is important
- LAN segmentation on a per-port basis
- Virtual LANs: any station can be part of any segment
- Media-speed bandwidth per device

Ad hoc wiring



Hub



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Workgroup Switching Requirements

- End-to-end reliability, availability, manageability
- Low marginal costs at port and adapter levels
- Dedicated port-to-port connections
- End system-to-end system QoS (rapidly emerging requirement)
- Remote manageability
- Sufficient switch uplink capacity (assumes fewer users/switch)
- Low switching latencies
- Support for VLANs
 - Reduce cost and complexity of moves, adds, changes
 - Dramatically reduce wiring closet issues
 - Enable virtual workgroup drag-and-drop based re-definitions



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Enterprise IBM Internetworking

Environment, Issues, Opportunities

- Networking Trends
 - ◊ Networking Trends Overview
 - ◊ Bridging
 - ◊ Enterprise Routing
 - ◊ Tunneling
 - ◊ LAN Switching
 - ◊ IP Switching
 - ◊ VLAN
 - ◊ ATM

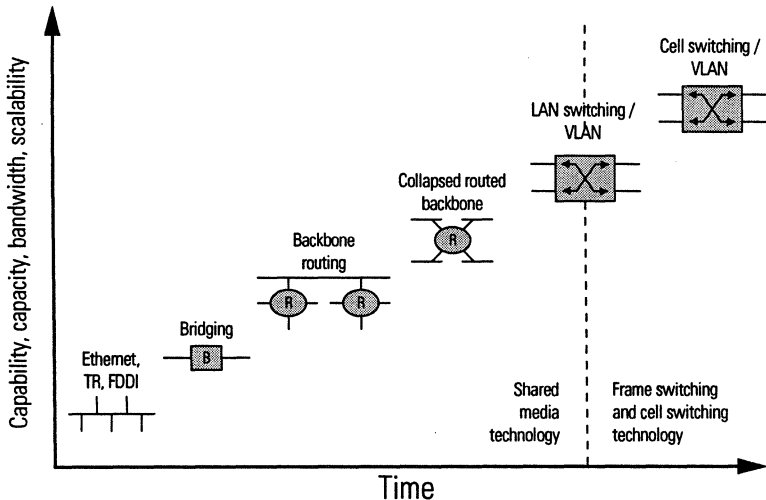


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Networking Trends Overview

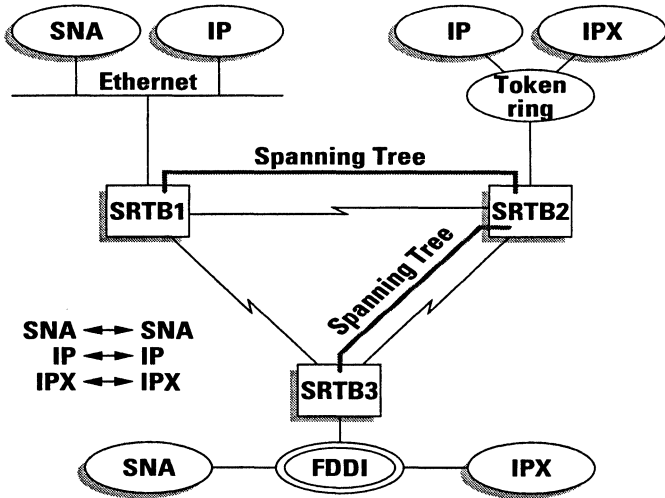


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Bridging Multiple Protocols

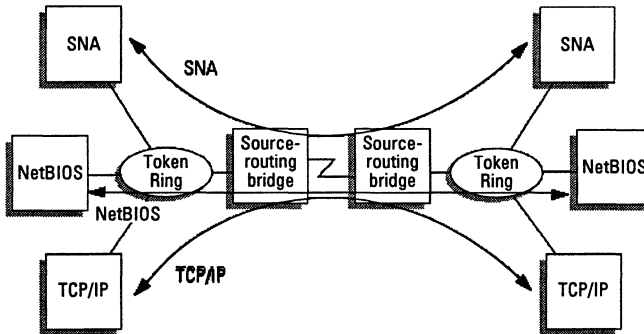


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Source-Route Bridging



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Bridging

- **Advantages**

- ◇ Straightforward protocol support
- ◇ Protocol-independent
- ◇ Relatively low need for network planning and administration
- ◇ Dynamic update of MAC forwarding tables—no need to administer protocol-dependent routing tables
- ◇ Simple topology



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Bridging

- **Disadvantages**

- ◇ Susceptible to broadcast storms
- ◇ Performance and response time slower than routing protocols
- ◇ Poor congestion control
- ◇ Shared network bandwidth—cannot implement private 10Mbps or 100Mbps technologies to servers or clients
- ◇ Not scalable—Cannot improve aggregate forwarding rates

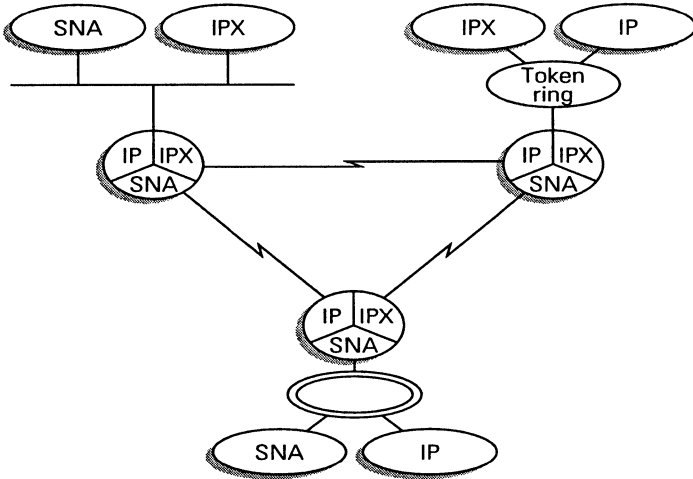


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Enterprise Routing— Concurrent Backbone



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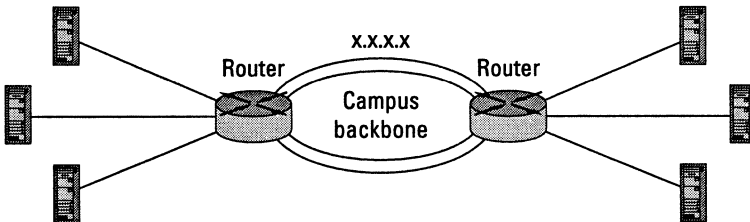
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Enterprise Routing— Router Backbone

Wiring closets

Wiring closets



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Enterprise Routing

- **Advantages**

- ◊ Extant cable plant can generally remain
- ◊ Bandwidth improvements possible as a function of wiring closet connections
- ◊ Routers can prioritize traffic
- ◊ Routers support multiple network technologies (e.g., Enet, TR, FDDI, FR)
- ◊ Traffic decisions based on higher-level protocols and operational state
- ◊ Prevention of broadcasts across subnets
- ◊ Autonomous administrative domains



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Enterprise Routing

- **Disadvantages**

- ◊ Shared media environment
- ◊ Device moves, adds & changes require re-addressing IP parameters
- ◊ Single point of failure
- ◊ Not well-suited to time-sensitive data (video, voice)
- ◊ Cannot guarantee Quality of Service to end systems (e.g., access latency, bandwidth, message priority, error thresholds)
- ◊ Router table maintenance issues
- ◊ Collapsed router backbones increasingly generate throughput bottlenecks to 2/3-tier client/server applications and to desktops that require integrated data, video, graphics, image
- ◊ Unacceptably high utilizations in collapsed backbones

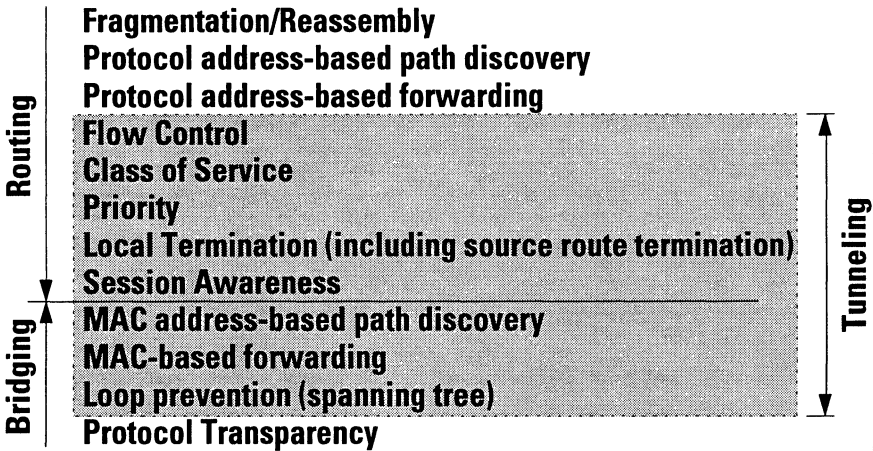


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Bridging, Tunneling, & Routing

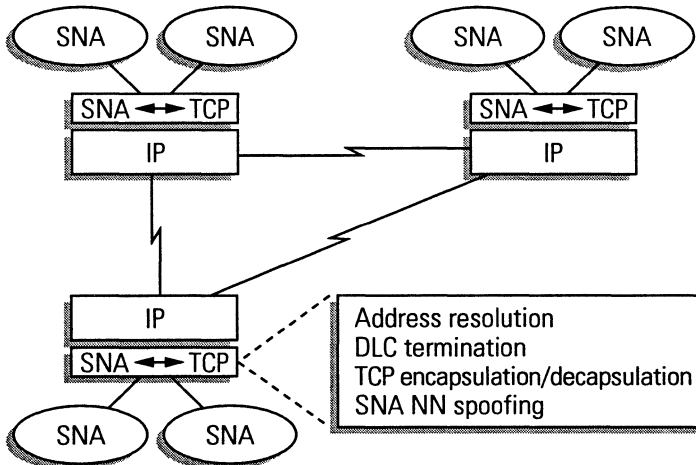


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SNA Tunneled Over IP Backbone

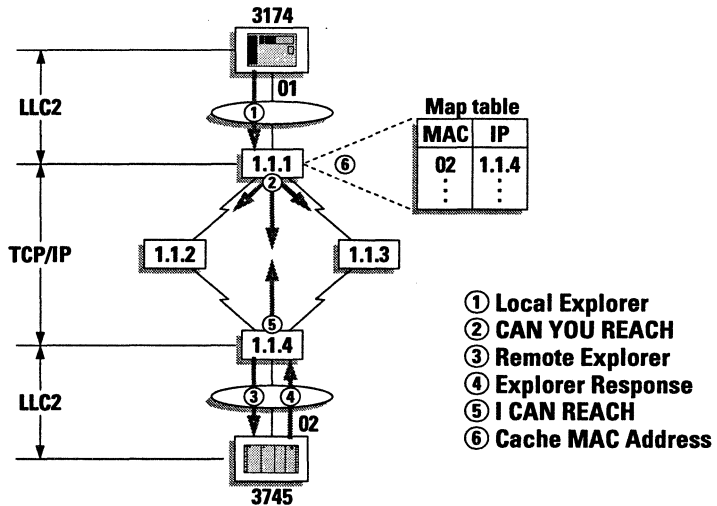


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Data Link Switching

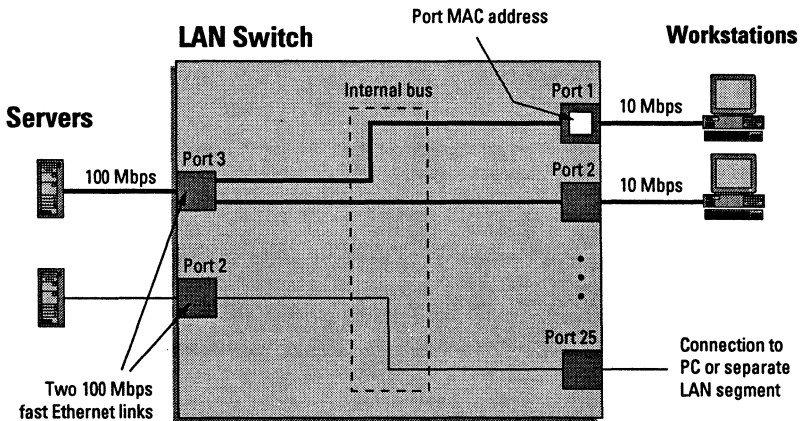


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LAN Switch Environment 10/100 Ethernet Example



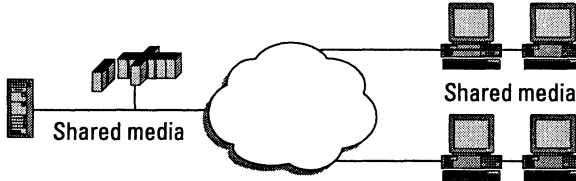
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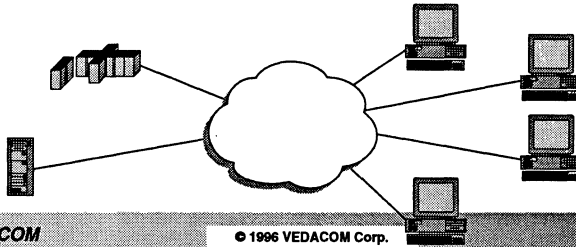
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Partially Vs. Fully Switched

Partially switched



Fully switched

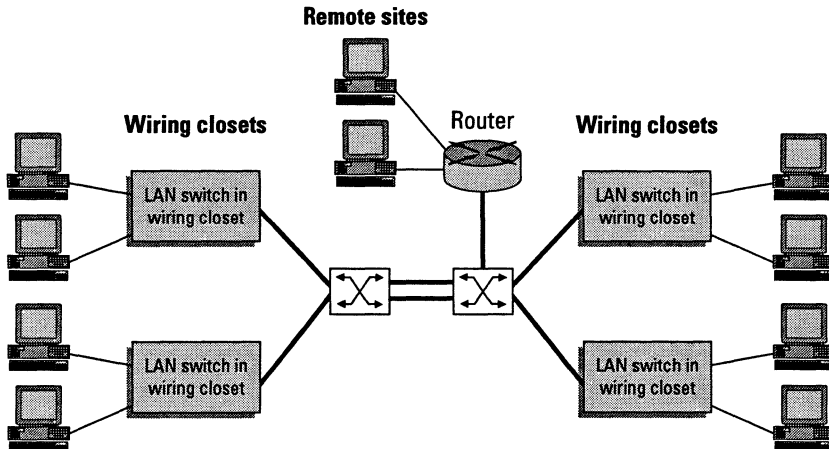


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Example Switched Network Architecture



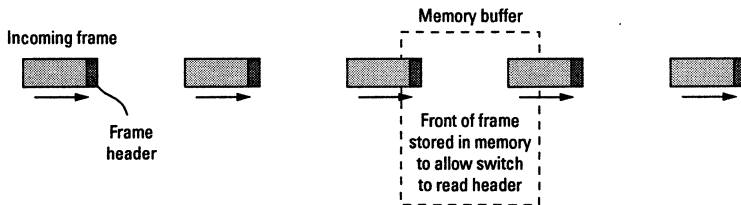
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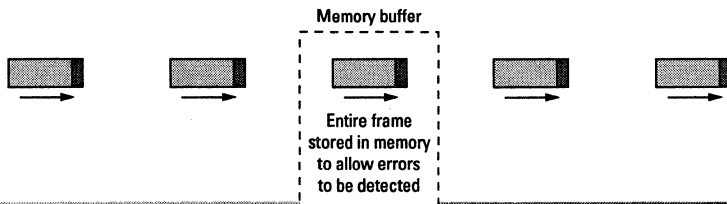
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Cut-Through Vs. Store-Forward Switching

Cut-through switch port



Store-and-forward switch port

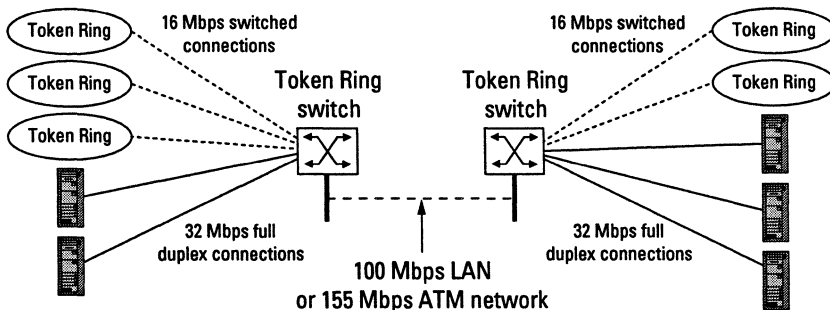


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Token Ring Switching

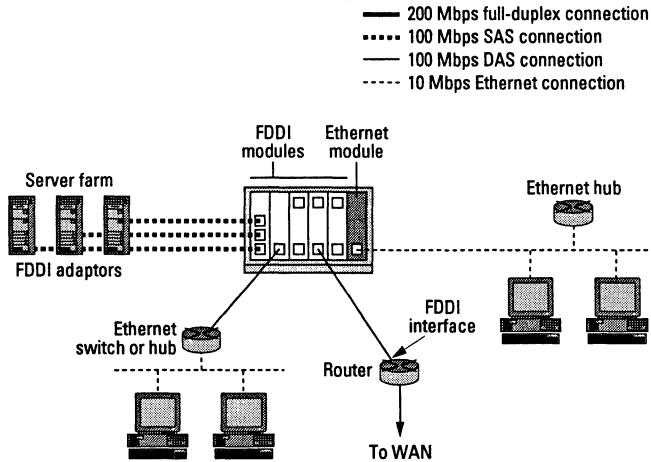


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Multipurpose FDDI Switch



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LAN-Switched Backbone

• Advantages

- Preserves investment in NICs, routers, hubs, cabling
- Enables separation of complex networks into multiple "collision domains"
- Enables entire IP network to be addressed without Layer 3 routing
- Provides each end system with a dedicated attachment
- Highly scalable, provides media speed bandwidth to each user
- Frame switching/cell switching can be combined into mixed speed networks



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LAN-Switched Backbone

• Disadvantages

- Full realization of switching often requires wiring closet change out
- Vendors are only beginning to deploy switch remote monitoring (RMON)
- LAN switches can generate a great deal of traffic which could potentially exceed backbone transmission capacity, therein requiring a backbone architecture upgrade
- Central point of failure
- No provision for end system Quality of Service (QoS)
- Cannot integrate and distribute data, video, voice over single wiring infrastructure with a single adapter set
- Campus frame switching solution for yesterday's, not tomorrow's issues
- Does not enable use-based cost accounting and chargeback

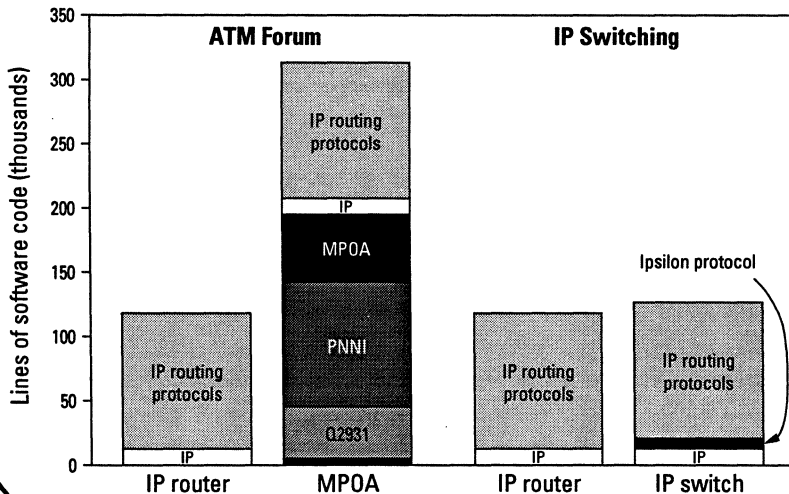


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ATM Forum Vs. Ipsilon IP Switch Protocols



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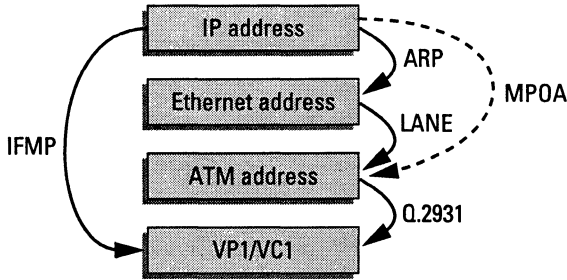
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Address Mapping—IP Switching (Ipsilon) Vs. ATM Forum

IP Switching

ATM Forum



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ATM Switch Vs. Router Design Points

Flow-oriented traffic

ATM switch design point

- File sharing (NFS)
- File transfer (FTP)
- Multimedia audio/video
- Web image downloads
- Web service (HTTP)

Short-lived traffic

Router design point

- Email (SMTP)
- Name look-up (DNS)
- Network Time Protocol
- POP
- SNMP

Source: Ipsilon Networks, Inc.

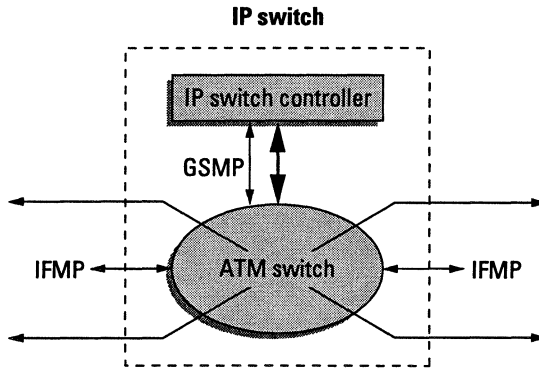


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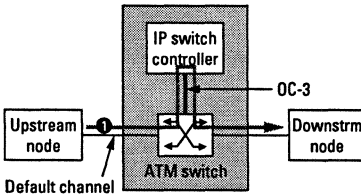
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Ipsilon IP Switch Structure

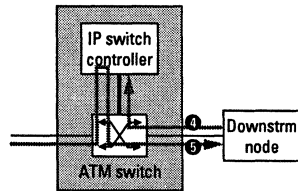


Ipsilon IP Switch Dynamic Cut-Through

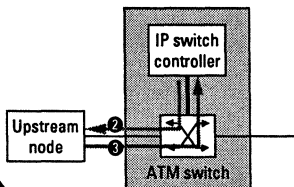
A. Default operation



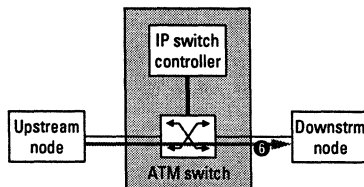
C. Flows downstream labeled



B. Flows upstream labeled



D. Cut-through switching complete



IP Switching

• Advantages

- IP Switching (Ipsilon solution) combines proven IP functionality with hardware switching speed of ATM
- IP is ubiquitous
- High IP backbone throughput for bandwidth-intensive applications
- Support for diverse media
- TCP congestion control
- Emerging protocols to support Multiservice traffic
 - ReSerVation setup Protocol (RSVP)
 - Real-time Transport Protocol (RTP)
- Significant reduction in coding/protocol overhead as compared to ATMF PNNI, MPOA, SSCOP
- IFMP (RFCs1953/1954) and GSMP (RFC1987)



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IP Switching

• Disadvantages

- IP Switching does not support several additional, key enterprise IBM network protocols
 - SNA, APPN/ISR, HPR, IPX, NetBIOS'
- IP throughput is, in fact, throttled by TCP end system MTU constraints
 - MTU size ≤ 64 KBytes
 - MTU window size = 1
 - To be resolved in RFC1323—TCP Extensions for Long, Fat Networks—backwardly compatible, negotiable option for larger windows that should solve (RTT)X(BW) issue, even for gigabit WANs
- TCP congestion control is sliding windows-based, not rate-based
- Ipsilon IP Switch consists of Intel Pentium Pro-based router with MMC Networks, Inc. 16-port ATM switch fabric—not WAN or ISP-scaleable
- Switch controller software is proprietary

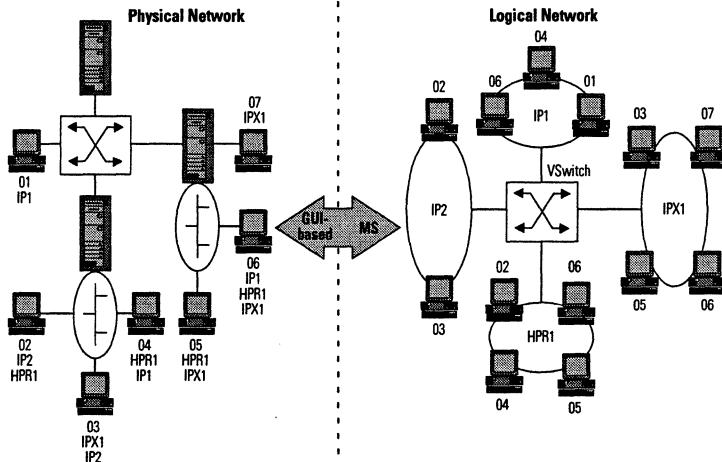


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VLAN



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VLAN

• Advantages

- Three classes of VLAN products
 - Physical port-based, Layer 1 (Class 1 VLANs)
 - MAC address-based Layer 2a (Class 2 VLANs)
 - VLANs based on Layer 3 protocols and address (Class 3 VLANs)
- Reduction of administrative burdens and costs associated with moves, adds, changes
- Move, add, change drag-drop preferable to wiring closet physical changes
- Multicast VLAN enables router emulation
- End user client and server processes and associated resources can logically co-reside while retaining separate physical topologies
 - Users can be grouped into logical broadcast domains independent of physical topologies
- Switching price points have decreased significantly



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VLAN

- **Disadvantages**

- Standards (ITU-T, ATMF) still developing
- Major users find the technology confusing
- VLANs require the majority of user stations to connect directly to their own switched ports, which, in Class 1 VLANs, can add complexity to moves, adds and changes
- VLAN solutions may be more complex than simply throwing bandwidth and routers at problems as they arise
- VLANs require user investment in switching technology
- VLANs are coupled to switching solutions
- Most VLAN candidates through the end of 1997 are large networks that need to interconnect 5,000-10,000+ stations, and have already begun the transition from routing to switching (enterprise opportunity)



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ATM— Business Case, Drivers, Enablers, Marketplace

- ATM Business Case
- Advantages, Disadvantages
- Switching Revolution
- Broadband Network Trends
- ATM Drivers
- ATM Enablers
- Corporate Business Case for ATM25
- ATM Market Environment
- Decision Factors, Migration Issues
- Marketplace
- Router-Centric and Hub-Centric ATM



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Why ATM?

ATM Business Case

- Provides high-bandwidth solutions for production, latency-sensitive, mission-critical applications
- Handles all types of network traffic (data, voice, video, graphics, multimedia) in an integrated way
- Works equally well in LAN and WAN environments
- Enables virtual workgroups and networks without regard to geography and changing projects
- Provides a cost-effective alternative to conventional, shared-media LANs, through scalable switching
- Supports existing solutions (SNA/APPN, TCP/IP, IPX)
- Connection-oriented



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ATM

• Advantages

- ◊ End system Quality of Service (QoS) for access latency, throughput, error thresholds
- ◊ Dedicated bandwidth on a VC basis
- ◊ Connection oriented
- ◊ Connection basis for use-based accounting/chargeback
- ◊ Inherently “muxable”
- ◊ Highly scaleable
- ◊ Network component consolidation
- ◊ LAN/WAN integration into a single switch fabric
- ◊ Robust end system network management



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ATM

• Disadvantages

- Lower level of firewall capability relative to router environment
- Standards still in flux
- Requires new hardware
- Single point of failure at the building level
- Vendor proprietary solutions, interoperability issues
- Cable plant re-wire to end nodes
- Network administration tool limitations
- Higher initial cost of equipment
- MAC sublayer conversions needed from legacy attachments
- LANE, PNNI, MPOA coding inefficiencies relative to IP Switching
- Port and adapter marginal costs significantly higher than for LAN Switching solutions

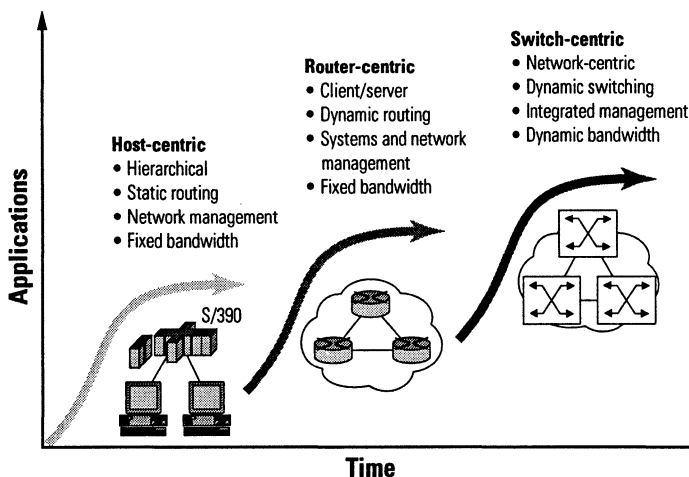


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Switching Revolution



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All-Important 10-Layer Model

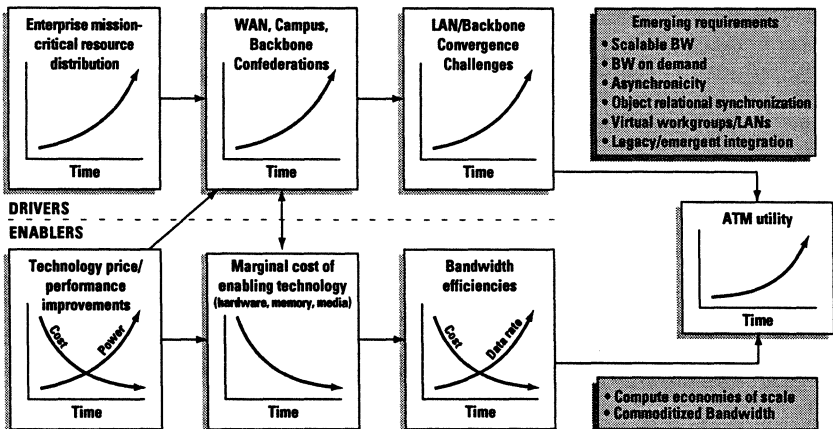
		Layer Name
Layer Number	10	Religion
	9	Politics
	8	Money
	7	
	6	
	5	
	4	
	3	
	2	ATM
	1	ATM



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Broadband Network Trends



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Broadband Application Drivers

- Telemedicine—TeleRadiology, TeleDiagnosis, TeleSurgery
- LAN Emulation
- Worldwide financial services
- Multimedia conferencing and mail
- Integrated desktop data, voice, video
- Distance learning
- Data Visualization
- Video servers
- Distributed OO DB
- Data-intensive, distributed simulations
- Graphic-intensive subsecond refresh CAD



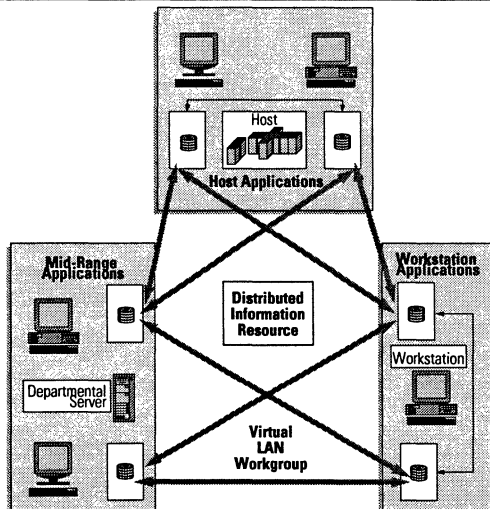
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ATM Drivers—Distributed Data Requirements

- Network-centric computing architecture
- Integrated services
- Virtual LAN/Workgroup
- Common Interface
- Single logical network
- Interoperable, open
- Highly available
- Negligible access/delivery latencies



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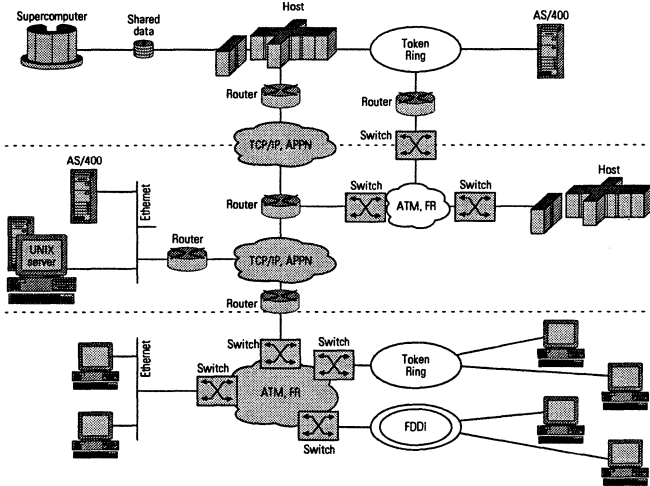
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ATM Drivers Enterprise Processing Model

Enterprise Processors

Departmental Processors

PC/Workstation Processors

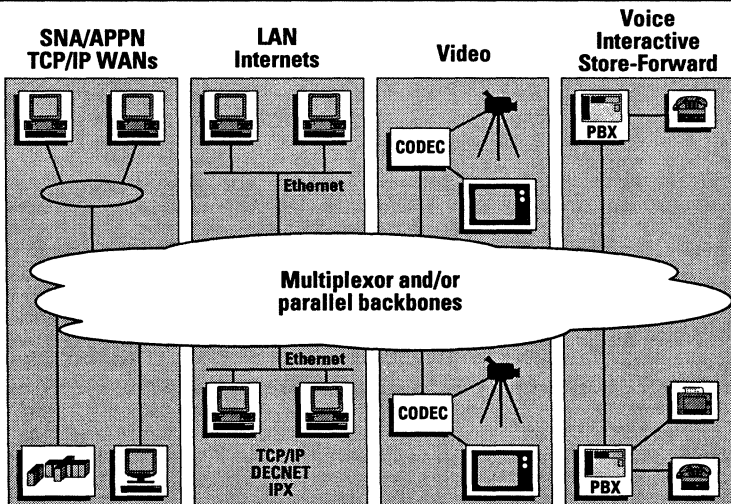


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ATM Drivers—Pre-ATM Backbones



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ATM Drivers—WAN, Campus, Backbone Confederations

• WAN

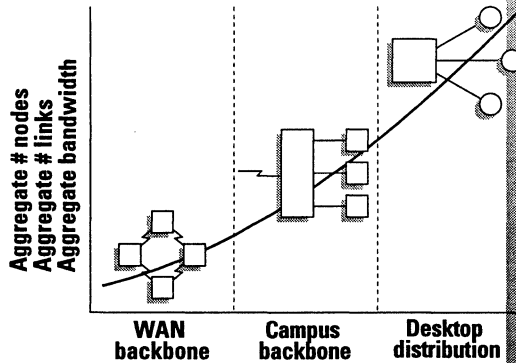
- Tens to thousands of kilometers
- *Issue*—Maximize line efficiency

• Campus

- Hundreds of meters to a few kilometers
- *Issues*—Performance, flexibility, scalability, reachability

• Desktop

- *Early Issues*—Media, cost/port, management
- Today—Scaleable BW



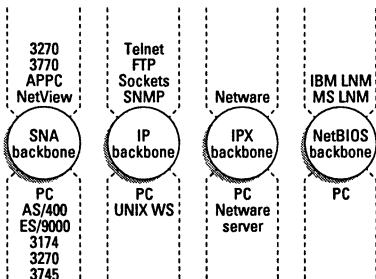
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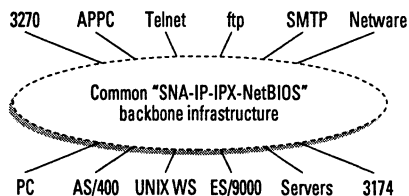
ATM - 2-77

ATM Drivers—LAN/Backbone Convergence Challenges

From Confederations—Circa 1985-1995



To Coherence—Circa 1995-1996+

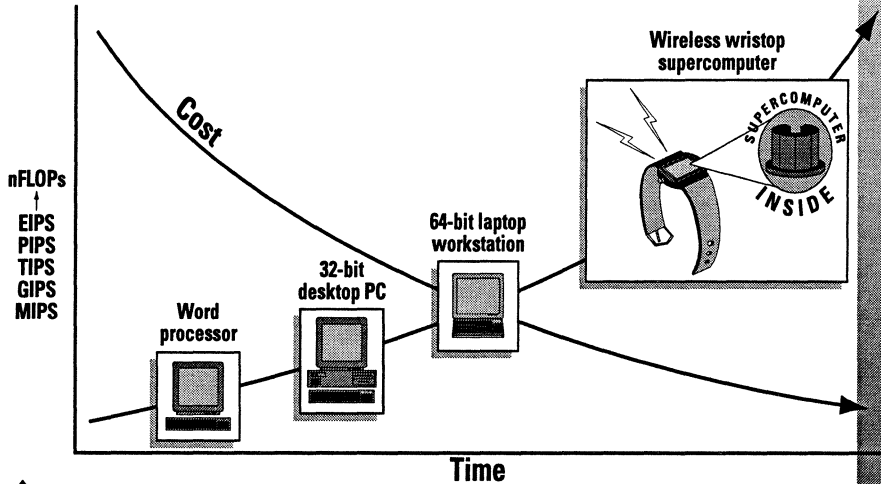


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Enablers—Price-Performance

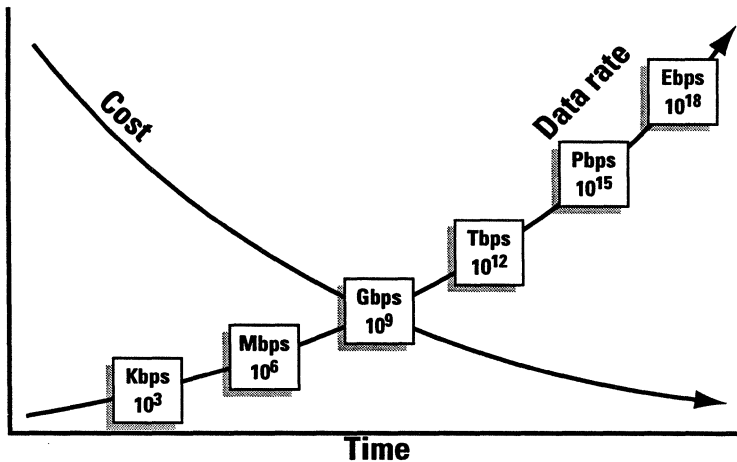


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Enablers—Bandwidth Efficiencies

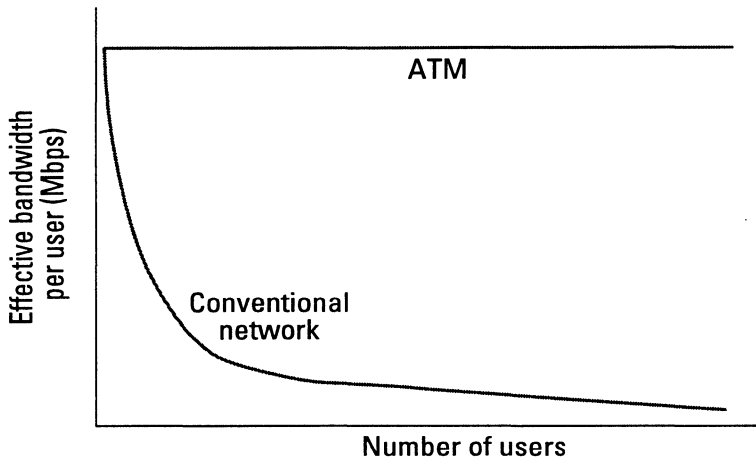


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Enablers—Scalable Bandwidth

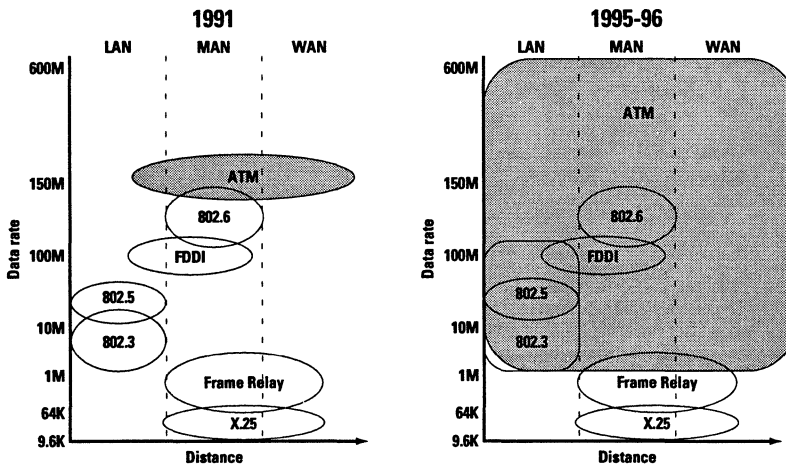


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Enablers—Increasing Reach

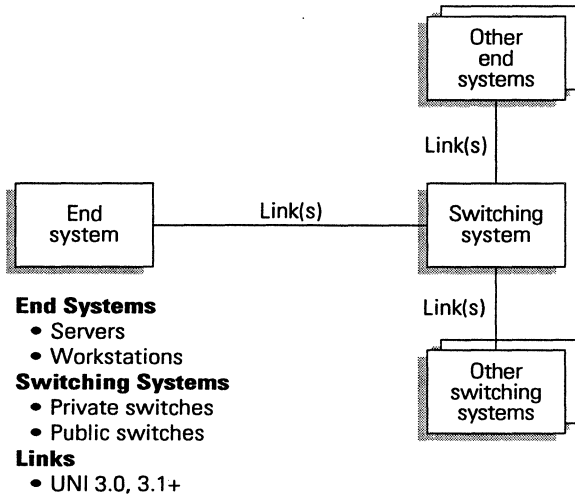


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ATM Model

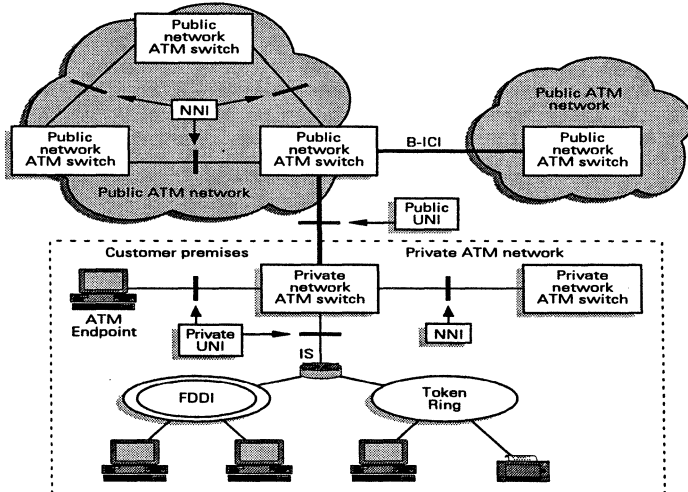


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ATM Conceptual Overview



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Agenda—ATM Decision Factors, Switched Network Migration

- **Broadband Networking Decision Factors**
 - Wiring
 - Backbone/Workgroup
 - Changes and reliability
 - Multimedia and price
- **Switched Network Migration Issues**
 - Collapsed router backbone
 - Intelligent hub collapsed backbone
 - Parallel backbone
 - Frame-switched backbone
 - Cell-switched backbone



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Broadband Networking Decision Factors (Wiring)

Wiring	Category 3 UTP Installed (100 meter runs)	Category 5 UTP Installed (100 meter runs)
FDDI	Not Available Not technically elegant nor economically rational.	Available Products available. Prices dropping, several vendors, dual-homing, interoperability.
Frame Switched Ethernet	Available Completely compatible. Major advantage for old UTP wiring.	Available Already operational.
Fast Ethernet 100VG-AnyLAN	Special Requirement Useable, but only where four pair of cable were run to each connection.	Not Yet Standard Standard development underway.
Fast Ethernet 100Base-T X	Not Viable Not seen as useable for 100Base-TX in the near future.	Standard Compatible with Cat5 UTP.
ATM	Low-Speed Only Lower-speed ATM (51 Mbps and below) may run over Cat. 3, but standards still emerging.	Standard 25.6Mbps Cat5 UTP in several workgroups. 155.52Mbps Cat5 UTP to servers 100m runs.



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Broadband Networking Decision Factors (Backbone/Workgroup)

Backbone or Workgroup	High-Speed Backbone	High-Speed Workgroup
FDDI	Application Specific FDDI is an established backbone technology. FDDI has fault tolerance. Optimal use is in inter-building connections as hierarchical backbone architecture.	Application Dependent In the near term, FDDI server clusters interconnected to Ethernet workgroups can offer substantial performance gains
Frame Switched Ethernet	Not Recommended Frame switched Ethernet implementations have little security, filtering or firewall capabilities	Application Dependent Switched Ethernet can improve workgroup performance based on the nature of the bottleneck. Investigation of the nature and location of bottleneck required.
Fast Ethernet 100Base-VG	Not Recommended Short transmission distances of Fast Ethernet will limit application to workgroups. Limited fault tolerance and redundancy.	Application Dependent Could provide an additional gain for some workgroups as a means to provide concentration of multiple Ethernets to a shared server. Difference in MAC layer would be an issue.
Fast Ethernet 100Base-X	Application Specific Short transmission distances of Fast Ethernet will limit application to workgroups. Limited fault tolerance and redundancy.	Application Dependent Could provide an additional gain for some workgroups as a means to provide concentration of multiple Ethernets to a shared server. If Ethernet in use, MAC layer not an issue.
ATM	Recommended ATM is highly scalable; well-suited to backbone applications. As ATM matures, it will be widely adopted as an enterprise backbone.	Application Dependent Most likely not required until high bandwidth applications, such as multimedia with full motion video, are in place



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Broadband Networking Decision Factors (Changes & Reliability)

Changes and Reliability	Changes Required to Routers	Reliability
FDDI	Special HW/SW Specialized FDDI interfaces are required	Very Good FDDI can be designed as inherently fault-tolerant with dual counter-rotating rings or the use of dual homing
Frame Switched Ethernet	Existing Ethernet Same connections as standard Ethernet	No special traits Not inherently designed for fault tolerance
Fast Ethernet 100Base-VG	Special HW/SW Needs specialized hardware and software	No special traits Not inherently designed for fault tolerance
Fast Ethernet 100Base-X	Special Hardware Same MAC interface, but specialized 100Base-X interfaces will be required	No special traits Not inherently designed for fault tolerance
ATM	Special HW/SW ATM interfaces and new software will be required on existing routers for ATM	Excellent ATM networks can be designed using multiple paths to provide for redundancy and fault-tolerance



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Broadband Networking Decision Factors (Multimedia & Price)

Multimedia and Price	Multimedia Support	Price
FDDI	Good Video and audio can be sent over FDDI, and multiple uses possible in compressed formats, but HDTV and other high bandwidth media may quickly use up available bandwidth	Prices Declining Prices for FDDI connections are below \$1000 and increasing availability will keep the pressure on lower prices
Frame Switched Ethernet	Limited Only limited use of compressed video can be expected, and only for a very limited set of users	Low Cost Standard Ethernet interfaces are used and frame switching costs are declining, with prices of <\$100/port possible
Fast Ethernet 100Base-VG	Somewhat Limited Video and audio can be sent over FDDI, and multiple uses possible in compressed formats, but HDTV and other high bandwidth media may quickly use up available bandwidth. Lacks the reliability of FDDI.	Questionable Will depend on number of suppliers ultimately, but present pricing is being aggressive, with NICs under \$700
Fast Ethernet 100Base-X	Somewhat Limited Video and audio can be sent over FDDI, and multiple uses possible in compressed formats, but HDTV and other high bandwidth media may quickly use up available bandwidth. Lacks the reliability of FDDI.	Prices Declining Early products have been priced low, with NICs at \$250-\$750 and switches under \$500/port. Products are still somewhat limited and time will determine price.
ATM	Good Match ATM provides scalable bandwidth and performance required for multimedia	Prices Declining Most switch prices still over \$1000/port and NICs over \$1000 as well. As standards allow for more vendors, price will drop.



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Migration to a Switched Network

- Migration will not be instantaneous
- Existing investment will not be easily or quickly abandoned
- Migration should be viewed as a process
 - Phase in new technologies when benefit is clear
 - Minimize cost of transition by waiting for price/performance improvements
 - Protect existing investment



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ATM and Competing Technologies

- Campus Alternatives
 - ◊ 10 Base-T, 100 Base-TX, 100 VG/AnyLAN, Gigabit Ethernet
 - ◊ FDDI
 - ◊ Token Ring
 - ◊ LAN Switching
 - TR, Enet, Fast Enet, FDDI
- Wide area alternatives
 - ◊ Frame relay, SMDS, X.25
- All will co-exist



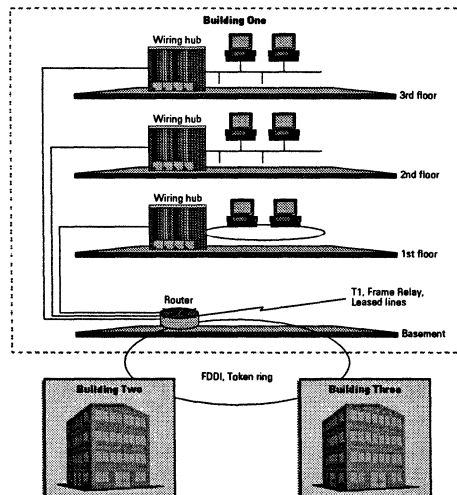
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Migration Issues Collapsed Router Backbone

- Router key roles
 - ◊ WAN access
 - ◊ Basis of campus backbone
 - ◊ Collapsed backbone support in each building
- Router key issues
 - ◊ Bottlenecking
 - ◊ Impediments to LAN application growth and scalability
 - ◊ Unstable wide area BW mgt
 - ◊ Costly/complex moves, adds, changes

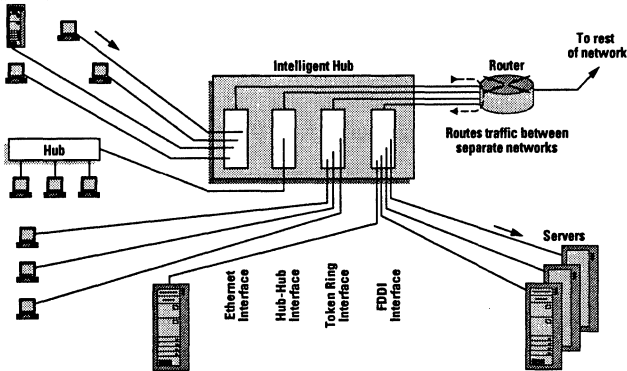


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Migration Issues Intelligent Hub Collapsed Backbone



- Logical networks connected to hub servers without the need for a router hop
- Central location for ease of administration

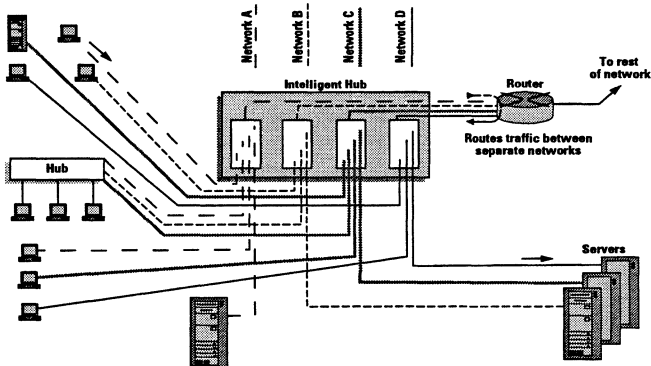


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Migration Issues—Parallel Backbone



- Each segment has access to the LAN independent from the physical location of each wiring closet, fewer required router ports



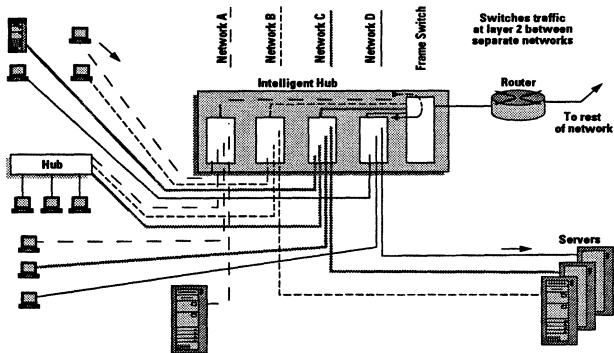
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Migration Issues

Frame-Switched Backbone



- Frame switches (LAN switches) can then be added to the main concentration hub, providing ease of access between network segments and to shared server resources



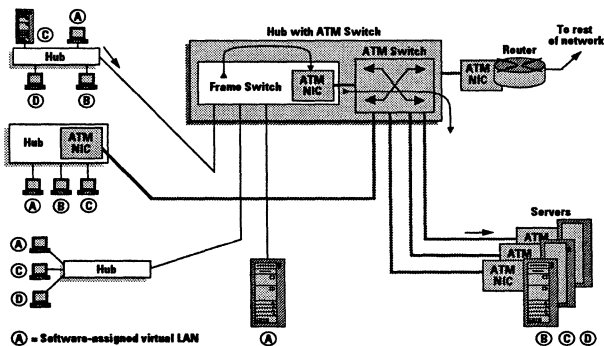
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Migration Issues

Cell-Switched Backbone



- Frame/LAN switch has become a legacy system device, multiple network segments share ATM high speed and inherent "muxability", reducing number of hub physical connections



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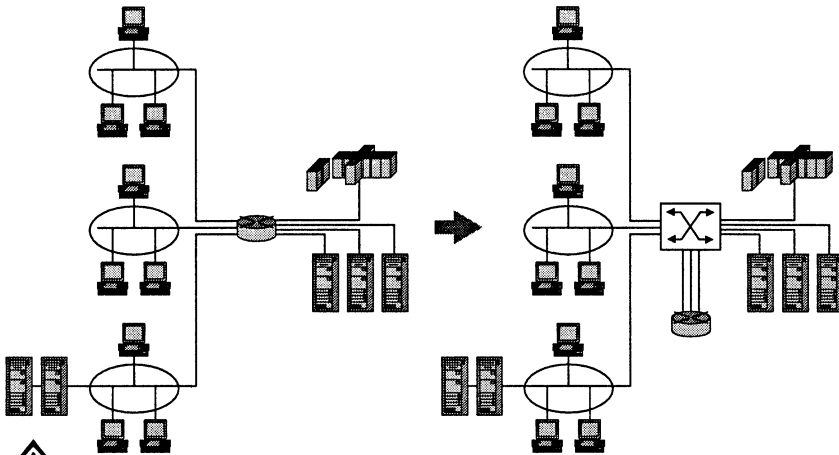
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Collapsed Router Backbone to Switched Backbone

Collapsed Router Backbone

Switched Backbone



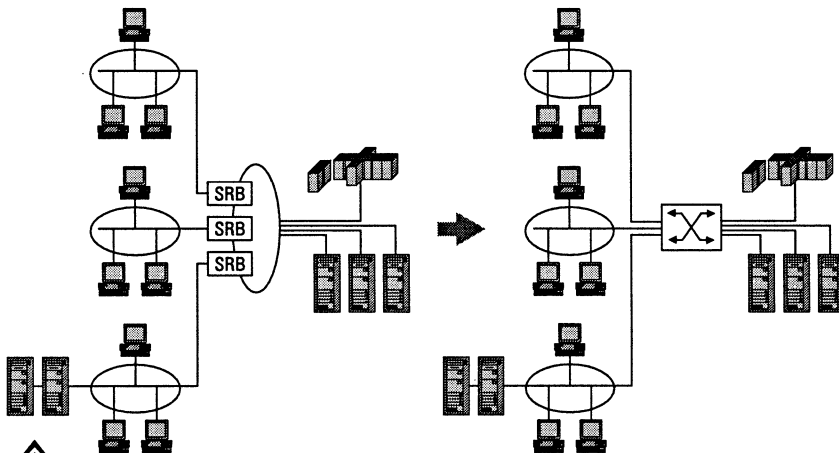
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ATM - 2-97

Bridged Backbone to Switched Backbone

Bridged Backbone

Switched Backbone



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Corporate Business Case for 25 Mbps to the Desktop

- Based on a detailed requirements analysis within a Fortune 500 corporation
- Requirements for desktop, data, video, voice
- Committed to ATM rollout 1996-2001
 - Phased migration
 - End-to-end ATM by 2001



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ATM - 2-99

25Mbps to the Desktop “Ridiculous” Case Calculation—1996-2001 “Standard” Users

• Data Communications	5.0 Mbps
• Voice	0.064 Mbps
• Video Conferencing	
◦ 2 ISDN links at 2B+D	0.288 Mbps
◦ 1 High-end session	0.384 Mbps
• Motion Video	
◦ MPEG-1 SIF NTSC	0.6 Mbps
– 352h X 240v X 30fps	
◦ MPEG-2	
– 1/2 D-1 NTSC (3-6 Mbps)	3.0 Mbps
■ 352h X 480v X 30fps	
– D-1 (6-15Mbps) Broadcast Quality	
■ 720h X 480v X 30fps	
	<u>15.0 Mbps</u>
	<u>24.336 Mbps</u>



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ATM - 2-100

ATM Hub, Router, Switch Vendors "Marketectures" Predominate

- Primarily hub, router, and wide area switch vendors
- Number of announced products, direction statements and "marketectures" far exceeds actual shipments

Local Switch	Enterprise Access	Cross Connect
AT&T	ADC	Alcatel
Bay Networks	Alcatel	AT&T
Cisco/Lightstream	AT&T	DSC
First Virtual	Bay Networks	Ericsson
Fore Systems	Cascade	Fujitsu
GDC	Cisco/Lightstream	GTE
GTE	Fore Systems	Hitachi
Hughes	Fujitsu	IBM
IBM	GDC	NEC
NEC	GTE	Nortel
Newbridge	Hitachi	Siemens
UB	Hughes	TRW
3Com/Chipcom	IBM	
	NEC	
	Newbridge	
	Nortel	
	Siemens	
	Stratocom	
	Telematics	
	Timeplex	
	3Com	



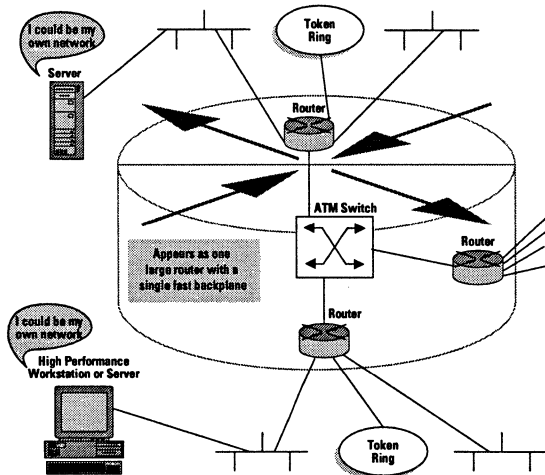
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Router-Centric View of ATM

- ATM provides backbone network via interconnected routers, creating a large "virtual router"
- ATM viewed as fat dumb pipe
- Classical IP and ARP over ATM, RFC 1577



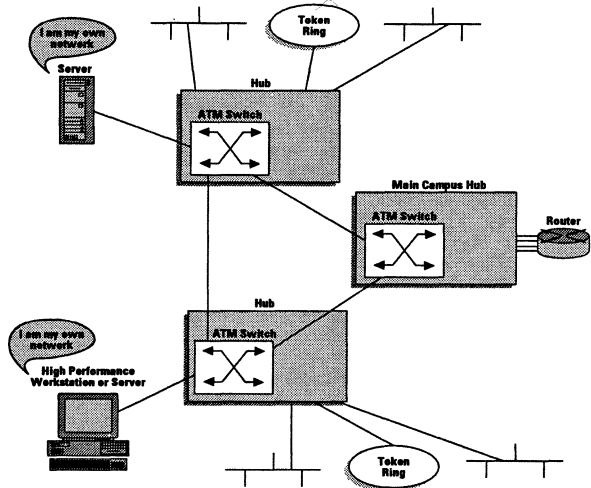
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ATM - 2-102

Hub-Centric View of ATM

- ATM provides direct connections for devices needing high bandwidth (file servers, workstations); other users served by conventional LANs



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Cisco Systems, IBM, Bay Networks

- Cisco Systems
 - ◊ Strategy, Products, Strengths, Challenges
- IBM
 - ◊ Strategy, Products, Strengths, Challenges
- Bay Networks
 - ◊ Strategy, Strengths, Challenges, Opportunities



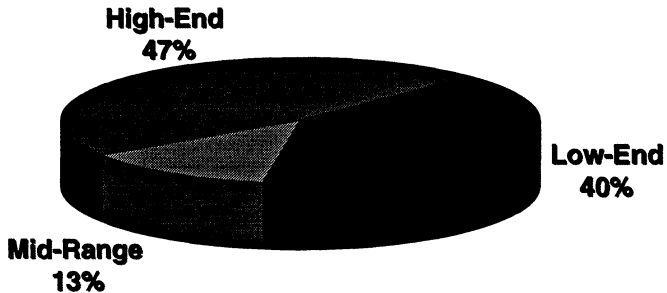
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ATM - 2-104

Cisco's Revenue

- Breakdown of Cisco's Router Revenue*
 - Low-End: <US\$8,000
 - Mid-Range: \$US8,000 - \$20,000
 - High-End: >US\$20,000
 - Router contribution to Cisco revenue is 82+%



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ATM - 2-105

Cisco: Focal Points

- Routing is Cisco's primary business
- Cisco is front runner in the router market
- Installed base of 80,000+ routers worldwide
- Has moved into the bridge/router and switch market sectors
- High-speed workgroup switching is key to Cisco

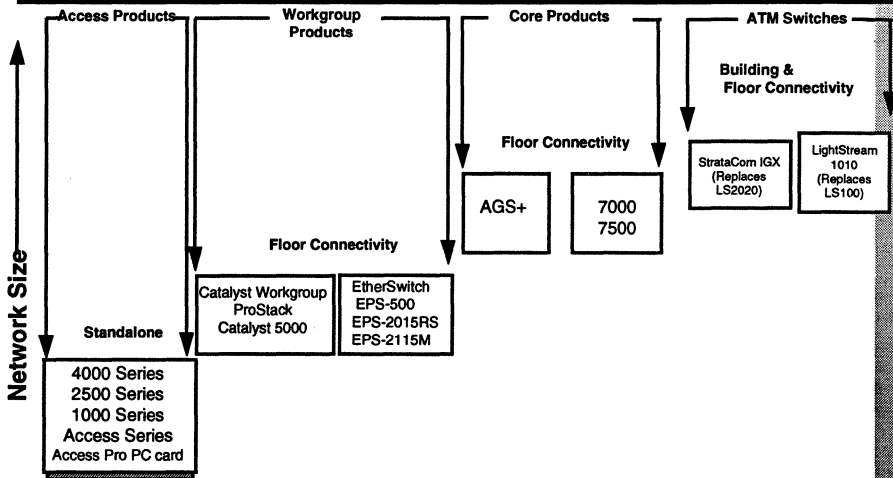


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Major Product Line Positioning



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Core Products: 7000 Series Router

- 7000 Router
 - ◊ 5 slots for interface processors (IPs)
 - ◊ Ethernet (EIP), Token Ring (TRIP), FDDI (FIP), High-Speed Serial (HIP), Fast Serial (FSIP), ATM (AIP), MultiChannel (MIP), & Channel (CIP)
 - ◊ Dual power supply (option)
- 7010 Router
 - ◊ 3 slots for IPs
 - ◊ Same interface options as 7000
 - ◊ Dual power supply (option)



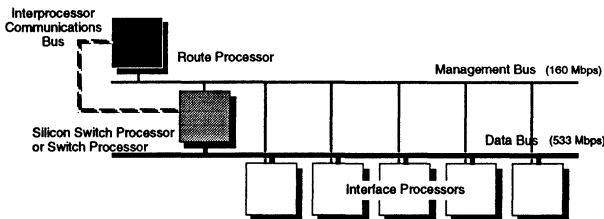
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7000 Series Standard Architecture

- Modified Central Processor Architecture
 - Route Processor (RP=main CPU)
 - Handles overhead and route determination
 - Switch Processor (SP or SSP)
 - Forwards data packets



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ATM - 2-109

Cisco 7000: Problems

- Disparate processing types
 - Process switching (~2,000 pps) [all protocols]
 - Fast switching (~25,000 pps) [some protocols]
 - Autonomous switching (~110,000 pps) [7000 only]
 - Silicon switching (~220,000pps) [7000 w/SSP only]
- Inconsistent performance between protocols
 - IP is silicon switched, AppleTalk is process switched
- Inconsistent performance within protocols
 - IP forwarding is silicon switched; IP extended access lists are process switched
- Operating System not backbone ready
 - No hot-swap; no fault isolation and recovery



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ATM - 2-110

The High-End Core: Cisco's 7500

- Up to 2Gbps CyBus
- Route Switch Processor (RSP)
- Versatile Interface Processor (VIPs)
- Three models
 - ◊ 7505
 - ◊ 7507
 - ◊ 7513



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ATM - 2-111

7500 Series Models

- Model 7505
 - ◊ 4 interface processors, 1 CyBus, 1 RSP, 1 power supply
- Model 7507
 - ◊ 5 interface processors, dual CyBuses, 2 RSP, redundant power supplies (dual RSPs & power are options)
- Model 7513
 - ◊ 11 interface processors, dual CyBuses, 2 RSP, redundant power supplies (dual RSPs & power are options)



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ATM - 2-112

Cisco Switched Network Strategy

- Distributed at N+I Las Vegas in an April 1995 BCR Supplement
- No specified migration strategy; potential exists for several forklift upgrades
 - ◊ Phase 1—LAN switches coexist with routers/hubs
 - ◊ Phase 2—LAN switching integrated at desktop
 - ◊ Phase 3—"Multilayer" switches combine Layer 2 and 3 capabilities
 - Routers function as the "brains" of the network to maintain and distribute routing tables to multilayer switches
 - ◊ Phase 4—Multilayer switches, end-to-end ATM



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ATM - 2-115

What Is CiscoFusion? IOS?

- Cisco's migration path to Switched Internets and ATM
 - ◊ CiscoFusion does not appear to have design specs
 - ◊ Does not appear to be a formal architecture
 - ◊ CiscoFusion is not software or hardware
- IOS (IOS 11.0 - 11.3 and onward) appears to essentially be re-named router software



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ATM - 2-116

IOS Software

- **What is IOS?**
 - ◊ Today: IOS is just router software
 - ◊ Future: IOS will be the term for all software on Cisco Switches & Routers
- **CiscoFusion Architecture**
 - ◊ Split routing and switching functions
 - ◊ Route processor can be migrated to ATM switch
 - ◊ Switch processor can be distributed to become virtual LAN switches
 - ◊ Remaining issue: sending between VLANs—need layer 3 router
 - ◊ Solved by distributed virtual internetworking



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ATM - 2-117

IOS in a Nutshell

- IOS:NOS::NOS:OS
- NOS
 - ◊ Directory
 - ◊ Resource sharing
- IOS - 3 Basic Functions
 - ◊ Route Determination
 - ◊ Frame Forwarding
 - ◊ MAC layer conversions
- Internetwork appears as a whole
- IOS “needed” for virtual LAN capability



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ATM - 2-118

IOS Software Current Packages

- “IOS” comes in many flavors
- Present situation
 - 7XXX series = 3 software sets
 - 4X00 series = 9 software sets
 - 2500 series = 9 software sets
- There is no one unified form of “IOS”



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ATM - 2-119

Cisco LAN Switches Catalyst 5000

- Modular switching platform for wiring closets
 - Single integrated switching fabric
 - Switched 10 Mbps Ethernet and 100 Mbps Fast Ethernet
 - Backbone connections to Fast Ethernet, FDDI, ATM
 - Supports ≤ 98 switched 10 Mbps Ethernet interfaces, or ≤ 50 switched 100 Mbps Fast Ethernet interfaces
 - Supports ≤ 1024 virtual LANs (VLANs) with Fast Ethernet, FDDI, or ATM interface between multiple Catalyst 5000 systems and Cisco routers
 - SNMP management—Ethernet MIB, ILMI MIB, FDDI MIB, Bridge MIB, AToMIC, MIB II
- Enhancements include:
 - Switched FDDI, switched Token Ring
 - Layer 3 engine, Remote monitoring (RMON)



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ATM - 2-120

Key Problems for Catalyst

- **Over subscription of 1.2 Gb backplane**
 - 50 ports @100Mbps = 5.0 Gb
 - 98 ports Full Duplex Ethernet + 2 Fast Enet = 2.160Gbps
- **Layer 3 Switching model**
 - Assumes 80% of net traffic is local to the wiring closet vs. across the network
- Requires IOS—Proprietary Software
- Proprietary network messaging system
- CiscoWorks is inadequate to properly manage entire enterprise network



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ATM - 2-121

Cisco's Competition for the Catalyst 5000

- **Competition**
 - **BayNetworks**
 - Centillion 100
 - System 5000
 - LattisSwitch
 - **3Com**
 - LinkSwitch and LanPLEX Families
 - CELLplex 7200, 7600
 - **Cabletron**
 - MMAC+, FastNet (formerly SMC TigerSwitch), SmartSwitch
 - **Other Companies**
 - NetEdge, Xylan, Agile Networks



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ATM - 2-122

Workgroup Products

- **Catalyst Workgroup Switch (Crescendo)**
 - Eight 10Base-T ports or 10Base-FL ports
 - CDDI/FDDI A/B port cards
- **Workgroup Concentrator**
 - 2 slot CDDI/FDDI concentrator
 - 2, 4, 8, 10, & 16 port line cards (16 port for CDDI only)
 - A/B port line card available for linking concentrators together
- **Catalyst 1600**
 - 8 or 12 port Token Ring switch
 - OEM from Madge Networks



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ATM - 2-123

Workgroup Products (cont.)

- ProStack System (Kalpana)
- EtherSwitch Pro 16 stackable
 - 16 10Base-T ports with 2 high-speed ports
 - ProPort 100T (100Base-TX)
 - ProPort 4T (4 - 10Base-T ports)
 - ProPort ATM (future)
 - ProStack Matrix - An 8-port, non-blocking, cross-point switch for connection of multiple EtherSwitch Pro 16's
 - Can be configured as cut-through or store-and-forward
- Kalpana EtherSwitch EPS-2115M
 - 15-port with hot-swappable modules supporting 10BaseT, 10Base2, 10BaseFL
- Kalpana EtherSwitch EPS-2015RS
 - 15-port 10BaseT EtherSwitch with slim, rack-and-stack design



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ATM - 2-124

Products for the Markets

- Workgroup/Campus Switch
 - ◇ LightStream 100 (NEC switch)
 - ◇ LightStream 1010 (LS100 replacement)
 - ◇ Competition:
 - Bay Networks LattisCell, Centillion
 - Fore ASX-200, 1000
 - IBM 8285, 8260
 - Newbridge VIVID
 - ◇ Fastest growing market segment



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ATM - 2-125

Products for the Markets

- Core/WAN Gateway
 - ◇ StrataCom IGX (replaces the LS2020)
 - ◇ Competition:
 - Bay Networks System 5000 ATM Backbone
 - Fore Systems ASX-1000
 - General Datacom Apex
 - IBM 8260, 2220, Cascade 9000/8000/6000
 - Newbridge 36150/36170 Mainstreet
 - ◇ Market is beginning to heat up



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ATM - 2-126

Markets Needing Products

- Central Office Access
 - ◊ StrataCom BPX
 - ◊ Competition
 - Cascade Communications
 - ◊ Slowest market to develop but critical mass should be achieved during 1997-98



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ATM - 2-127

Cisco's LightStream 100

- **LightStream 100 ATM switch (NEC A100)**
 - ◊ A.k.a Cisco HyperSwitch A100
 - ◊ 16 ports, 2.4 Gbps backplane
 - ◊ Input buffers have one high and one low priority queue per port, but output buffers have one queue per port
 - Output buffers can overflow into the input buffers due to backpressure mechanisms
 - ◊ No apparent traffic shaping or congestion control
 - ◊ No apparent network management
 - ◊ Essentially a dead product: Replaced by the 1010



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ATM - 2-128

LightStream 100 Network Management Apparent Challenges

- No remote SNMP configuration
- No network management GUI
- No auto-topology discovery feature
- No ILMI
- No OAM flows
- No remote software downloads
- No traffic flow statistics by port or connection
- No traffic flow graphics by port
- No traffic flow visibility by VPI/VCI pair



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ATM - 2-129

New ATM Switch: LightStream 1010

- **LightStream 1010**
 - A100 replacement and upgrade
 - Same Chassis as Catalyst 5000—different backplane
 - 5Gbps, 32-port ATM switch
 - First in a family planned to scale to 10Gbps
 - 5 Slots, 1 dedicated to ATM Switch/Processor (ASP)
 - No ASP redundancy
 - PCMCIA Card Slot
 - 4-8 ports SONET STS3c (MMF, SMF or UTP-5)
 - 1 port SONET STS12c (622 Mbps) SMF
 - 25Mbps ATM
 - E3/DS 3
 - “IOS” Capabilities for P-NNI
 - Focal point for Cisco: ABR



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ATM - 2-130

Key Issues for the LightStream 1010

- Upgrade path from A100 to LS1010 makes earlier product look “abandoned”
 - ◊ What is Cisco’s long-term commitment to OEMed products?
- Past reliance on “buffers” giving way to ABR positioning
 - ◊ ABR is a “best-effort” service using rate-based congestion avoidance to optimize throughput and minimize cell loss
- Which is the high end?



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ATM - 2-131

LightStream 2020 Switch

- Second generation ATM switch
 - ◊ 9 configurable user slots, up to 72 ports
 - ◊ 2Gbps bus-less switching matrix
 - ◊ Midplane runs through switch center
- Dual-power supply chassis with 12 slots
- LAN interfaces
 - ◊ Ethernet/802.3, FDDI, translational/transparent bridging
- WAN interfaces
 - ◊ T1/E1, T3/E3, OC-3c/STM-1 (MM GRIN and SM OF)
- External devices connect via edge interface modules
 - ◊ 56Kbps to OC-3
- Switches interconnect via trunk interface modules
 - ◊ ATM UNI above T3
- ControlStream traffic management—QoS and congestion avoidance, and Early Packet Discard



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ATM - 2-132

Key Issues for the LightStream 2020

- Low port density for ATM (2 ports/slot)
- Expensive
 - Price between US\$75,000-\$150,000
- Low speed “midplane”
 - 2Gbps
- Future of this unit after the IGX?



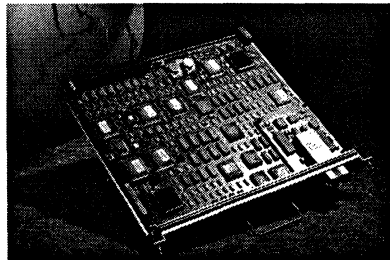
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ATM - 2-133

AIP: ATM Interface Processor

- Designed for the Cisco 7000 (7 slots)/7010 (5 slots) Router
- Supports UNI 3.0, AAL 3/4, AAL 5, SONET/SDH, TAXI, DS3/E3, RFC1577 (no LANE)
- Provides connections to legacy networks
- Will provide support for virtual LANs
- 7000 (single) bus operates at 533Mbps, SPOF
- OC-3c (MMF or SMF)
- US\$20,000 for one ATM port
- Continues Cisco's vision of the Router-centric network



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ATM - 2-134

NetFlow Switching

- ATM-like high-speed approach apparently designed for 4000 and 7000 series routers
- Method to improve packet processing efficiency within a Cisco router by caching additional data
- High-speed, fixed-sized, “cell-like” switching approach
 - Uses routers with specialized interfaces
- Performance characteristics and transmission speeds apparently similar to ATM
- However, NetFlow is a Cisco development and not bounded by the standards process
 - Interswitch communications, traffic control



Tag Switching

- Enhancement to IOS
- Design points
 - Increase router and switch PPS throughput
 - Carve a QoS-based path through a carrier cloud that avoids latency of router hops
 - Path originates in routers at network edge
- Cisco-developed protocol for tagging IP packets to associate with specific flows
 - Signals StrataCom switch or Cisco router to assign flow to a particular VC or route as a function of priority and QoS requirements
- Positioned against Ipsilon’s GSMP and IFMP



Cisco's ATM Strengths and Challenges

• Strengths

- Products are viewed as strategic, and Cisco is a leader
- Breadth of products, from Legacy connections to a ATM hub and a large switch
- Support for LAN and WAN
- Seen as having a vision: CiscoFusion

• Challenges

- Network management is disjointed (LS not integrated yet)
- Poor NMS, no port stats, no autotopology, etc.
- LightStream does not yet support "IOS"
- Confusing "high end" has less port capability than the "workgroup switch"
- Products are disjoint
- No native NICs
- 7000/7500 expensive ATM



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ATM - 2-137

Cisco Strengths and Challenges (con't)

Strengths

- StrataCom acquisition provides WAN switching clout
- Experience in emerging standards integration (Frame Relay)
- Migration path— Ethernet to Ethernet/ FDDI to Ethernet/ATM to ATM

Challenges

- "Router centric" view of switching
- IOS is proprietary and is mostly router s/w
- No desktop ATM
- Integration of StrataCom into existing acquisition mix
- Potential downside to NetFlow and Tag Switching non-standards



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ATM - 2-138

Cisco Strengths and Challenges (Summarized)

- **Cisco Strengths**

- Leader in Internetworking and large base of "IOS" users
- Single vendor meets needs for legacy connections, workgroup & campus switch
- Experience and connection for ATM in LAN and WAN
- LightStream switch supports ATM, LAN & WAN traffic
- TR switch based on Catalyst (Crescendo)
- Cisco/ZeitNet ATM adapters/APIs to come (RSVP, MPOA, RFC1577, LANE); ATM SBus adapters for Sun WSs/servers—however, Cabletron has acquired ZeitNet

- **Cisco Challenges**

- "Router-centric" view of the network and switching
- Weak in Network Management, and LightStream product is not integrated with CiscoWorks
- LightStream 100/1010 legacy connections are expensive routers



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ATM - 2-139

StrataCom

- Acquisition agreement announced April 22, 1996
 - Approximate transaction value of US\$4Billion
 - Transaction to be completed end of June 1996
 - Concurrent with transaction agreement
 - Both companies have entered into licensing and OEM arrangements
 - StrataCom will license Cisco IOS software for integration into its WAN switching products
 - Cisco will distribute and resell StrataCom's entire product line worldwide



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ATM - 2-140

StrataCom

- Founding member of the Frame Relay Forum
- Principal member of the ATM Forum
- Leading provider of high-speed WAN networking solutions
 - ◊ Special strength in the public carrier marketplace for both frame relay and ATM
- Major StrataCom product lines
 - ◊ BPX, BPX/AXIS, IGX, IPX, FastPAD, EdgeConnect



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ATM - 2-141

StrataCom BPX

- Multi-service backbone switch
- Aggregate 9.6Gbps FDX throughput
 - ◊ ATM UNI3.0, DS1, DS3, E3, ATM-to-FR
 - ◊ Frame relay, SMDS
- 12 X 12 crosspoint switch architecture
 - ◊ Each of 12 general purpose card slots are connected to the crosspoint switch via two lines
 - ◊ One for XMIT, one for RECV, with 800Mbps per connection



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ATM - 2-142

StrataCom IGX

- Integrated Gigabit Switch (IGX) family
 - ◊ IGX 16 (16-slot unit)
 - ◊ IGX 32 (32-slot unit)
- Frame relay with up to four channels totaling 2.048Mbps
- ATM with CBR, VBR, ABR over OC-3/STM-1, T3/E3, T1/E1
- IGX LAN modules
 - ◊ Ethernet, Token Ring, FDDI



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ATM - 2-143

StrataCom IPX, FastPAD, EdgeConnect

- IPX is a Narrowband ATM switch family
 - ◊ IPX 8, IPX 16, IPX 32
- FastPAD is a multimedia frame relay access device
 - ◊ FastPAD micro, FastPADmp, FastPADImp
- EdgeConnect supports up to 16 Ethernet, 12 Token Ring and 3 FDDI LANs



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ATM - 2-144

Cisco as a Competitor

- Cisco views main competition as:
 - ◊ Bay Networks
 - ◊ 3Com
 - ◊ Fore Systems/Alantec
 - ◊ Limited competition from Cabletron
- Main messages
 - ◊ Shared media is giving way to switching
 - Don't invest in shared media, move to frame switching
 - ◊ "IOS Everywhere"
 - Cisco will deliver on Layer 3 switching and the key is IOS



IBM Internetworking

- Key Messages
 - ◊ Networks are becoming open
 - ◊ SNA is giving way to new networks
 - ◊ Cisco can provide for your "SNA Network in Transition"



Cisco Provides for SNA

- Cisco supports APPN
 - ◊ DLSw+: Cisco's "better than DLSw" implementation
 - "Third generation" Data Link Switching
 - A "superset" of RSRB and DLSw
 - Backwards compatibility with RSRB
 - Standards compliance and interoperability
 - Multi-thousand, and any-to-any scalability
 - Network design flexibility
 - ◊ Part of Cisco's overall SNA/IBM Internetworking Strategy



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ATM - 2-147

IBM Access by Cisco

- High-Level View
 - ◊ RFC 1490 support for SNA
 - ◊ Cisco Frame Relay Access Devices (CFRADs)
 - ◊ QLLC Conversion for SNA over X.25
 - ◊ Bisync Tunneling
 - ◊ Native Client Interface Architecture
 - ◊ Downstream Physical Unit Concentration



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ATM - 2-148

Cisco Network Management Overview

- Cisco has nearly 20 Network Management products for Unix, Windows, and MVS
- “Big Three” packages are:
 - ◊ CiscoWorks for UNIX
 - ◊ CiscoView for UNIX
 - ◊ CiscoWorks for Windows
- Recent focus has been RMON and management of switching



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ATM - 2-149

CiscoWorks for UNIX

- Graphical Enterprise Network Management Tool
- Key features:
 - ◊ AutoInstall Manager
 - ◊ Cisco Connect
 - ◊ Configuration File Manager
 - ◊ Global Command Facility
 - ◊ Health Monitor
 - ◊ Path Tool
 - ◊ Security Manager
 - ◊ Software Manager
 - ◊ Workgroup Manager



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ATM - 2-150

CiscoWorks for UNIX: Strengths/ Weaknesses

- Strengths
 - ◊ Strong Router Configuration Tool
 - ◊ Powerful database system
 - ◊ Support-oriented applications
- Weaknesses
 - ◊ Cannot manage all Cisco devices
 - ◊ Reliant on Sybase DBMS
 - ◊ Weak for configuration and management of hubs, switches (non-routers)



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ATM - 2-151

CiscoView for UNIX

- Device Management Application
- Sold separately or bundled with CiscoWorks
- Key Features:
 - ◊ Graphical based representation of Cisco devices
 - ◊ Port configuration information
 - ◊ Chassis/version information
 - ◊ Performance statistics



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ATM - 2-152

CiscoView for UNIX: Strengths/ Weaknesses

- Strengths
 - ◊ It is from Cisco
 - ◊ Integration into CiscoWorks
- Weaknesses
 - ◊ High cost for little functionality
 - ◊ Cannot display multiple module/port configurations
 - ◊ Displays of devices are static
 - ◊ Performance statistics display weak
 - ◊ Weak configuration display
 - ◊ Cannot show port VLAN assignments



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CiscoWorks for Windows

- Based on HP OpenView for Windows
- Has done relatively well in the market
- Key features:
 - ◊ Configuration Builder
 - ◊ Show Commands
 - ◊ Health Monitor
 - ◊ CiscoView



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ATM - 2-154

CiscoWorks for Windows: Strengths/Weaknesses

- Strengths
 - Good HP OpenView integration
 - Strong product for routers
 - Many commands adopted from CiscoWorks for UNIX
- Weaknesses
 - Very expensive for target market at low end
 - Only supports Cisco Routers with full functions
 - Can be difficult to use
 - Device monitoring weak



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ATM - 2-155

Switched Management Strategies

- Switched Internetwork Management Strategy
 - CiscoWorks for Switched Internetworks application suite consisting of
 - CiscoView and VlanDirector (Current products)
 - TrafficDirector and AtmDirector
 - Agent enhancements to support Topology protocol
 - Agent enhancements for RMON
- Cisco & Frontier Advanced Management
 - Cisco shipping Frontier SwitchProbe
 - RMON 2 developments



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ATM - 2-156

The Cisco Switching Message

- Shared Media is dead
 - Switching is the future of networks
 - Switching can be frame- or cell-based
- Cisco is the leader
 - Largest company in networking and internetworking
 - Largest company in switching
 - The technology leader
- Cisco is the Switching Company
 - Layer 2 switching
 - Layer 3 switching with IOS
 - NetFlow and Tag Switching



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ATM - 2-157

Typical Access Sales Approach

- Come from Strength: IOS
 - Connects to the largest number of routers available
 - E-IRGP based, will allow connections to your "Main Office"
 - Wide variety of software options "to suit your needs"
 - Routers for every size company
- Variety: Cisco Connects it ALL
 - Synch, Asynch, T1/E1, ATM, Enet. TR, FDDI, FastEthernet (100BaseT and 100Base-VG) HSSI
 - More Protocols and options



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ATM - 2-158

Cisco's Frame Switching Approach

- Set the Agenda for Frame Switching
 - For Frame-based networks, push IOS and Layer 3 Switching
 - Catalyst 5000 is the key product for large networks workgroups
 - Smaller products to match specific needs
 - "Raise the Bar" so other companies cannot compete
 - Key message: "Layer 3 Switching is essential for VLANs"
 - IOS = Layer 3 Switching



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ATM - 2-159

Cisco ATM Sales Strategy

- Key is What and Where
 - IGX for Enterprise/WAN/Service Providers
 - LS 1010 for Workgroup switching/limited Backbone
 - Key focus is on ABR
 - Helps Cisco eliminate most competitors
- Other strong points
 - Cisco as the enabler of a "Total ATM Solution"
 - Catalyst 5000 (5500 to come) for Legacy Connections
 - Routers to provide VLAN servicing for ATM nets



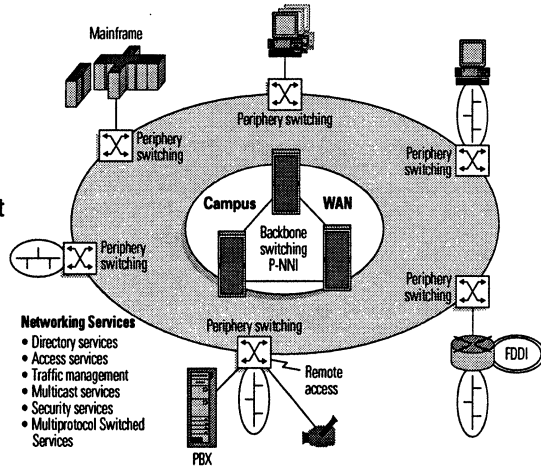
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ATM - 2-160

IBM's Switched Virtual Networking Model

- Switch-based model
- Enterprise-wide, end-to-end solutions
- Virtual computing (VLANs) with multicast and SVCs
- Periphery Switching
- Networking Services
- Backbone Switching



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ATM - 2-161

IBM SVN Components

- **Periphery Switching**
 - LAN and ATM workgroup switches
 - No changes required to existing nets to deploy
- **Networking Services**
 - Built on Networking Broadband Services (NBBS)
 - Multiprotocol Switched Services (MSS)
 - Distributed routing functions
 - LAN Emulation, Classical IP over ATM, VLANs
 - Broadcast / traffic management
- **Backbone Switching**
 - Switches (LAN/WAN) scale from OC-3 (155.52 Mbps) to OC-48 (2.48 Gbps)
 - P-NNI, B-ICI



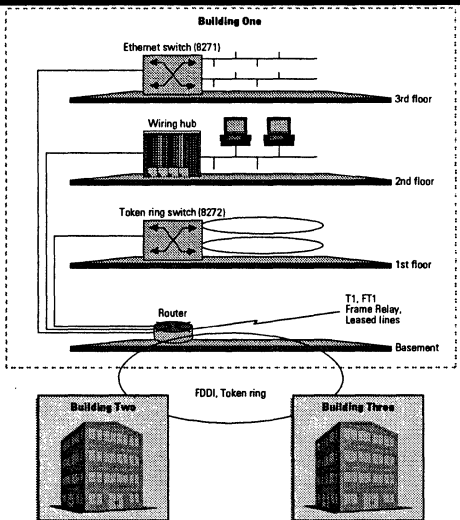
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ATM - 2-162

IBM SVN Phase 1 LAN Switches—2H/95

- Nways 8271 Ethernet LAN Switch (EtherStreamer)
- Nways 8272 Token-Ring LAN Switch (LANStreamer)
- 827X-108—1 feature slot, 8 fixed ports
- 827X-216—16 fixed copper ports, 2 Universal Feature Card (UFC) slots, for medium-sized wiring closets and workgroups
- 827X-800—no fixed ports, 8 UFC slots, redundant power option



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ATM - 2-163

IBM LAN Switch Technology

- LAN segmentation, FDX
- Reduce congestion and server bottlenecks
- Common UFCs across switch products
- Virtual LANs (VLANs)
- ATM LAN Emulation (LANE)
- “Adaptive cut-through” technology—Best of both
 - Cut-through—Inbound frames forwarded as soon as destination address received and prior to receipt of entire frame; minimizes intra-switch delay but can result in delivery of bad frames
 - Store-and-forward—Frames not forwarded until received and checked in entirety; increases likelihood of error-free frames yet performance cost

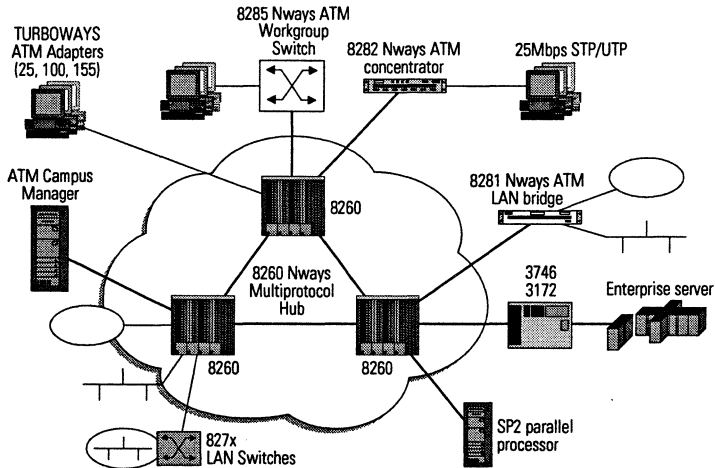


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ATM - 2-164

IBM ATM Campus Family



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ATM - 2-165

IBM Nways 8260 ATM Hub

- 8260 ATM Backplane is premounted in Model A17 Hubs, or field-retrofitted to existing Model 017 Hubs
- 8260 ATM Switch/Control Point Module integrates ATM cell switching functions and network control functions
 - Call setup processing, topology discovery, route selection
- Switch/Control Point Module uses a Switch-on-a-Chip configured as a 16 X 16 8-bit parallel switch with an aggregate throughput of 8Gbps
 - Supports PVC, ATMF UNI3.0/3.1 SVC, ILMI, pt-to-pt, pt-to-MP, reserved BW, independent queueing
- 8260 ATM 100Mbps Fiber Concentration Module
 - 4 100Mbps, ATMF UNI3.0 I/F ports to MM GRIN OF (MIC or SC connectors); ASICs handle distributed functions (traffic mgt, congestion avoidance)



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ATM - 2-166

IBM Nways 8285 ATM Workgroup Switch

- 8285 consists of a base unit and optional, stackable expansion unit
- 8285 can support standalone workgroups (with optional 155Mbps server link), floor hub feeding a backbone switch, or as a workgroup switch within a network of other switches
 - Base unit provides 12 25Mbps ATM ports and one feature slot for a 155Mbps I/O card
 - Expansion unit supports up to 3 8260 ATM concentration or ATM LAN Bridge modules for a total of up to 48 25Mbps ATM ports
 - ATM modules developed under the IBM ATMkit development program can also be used in the expansion unit

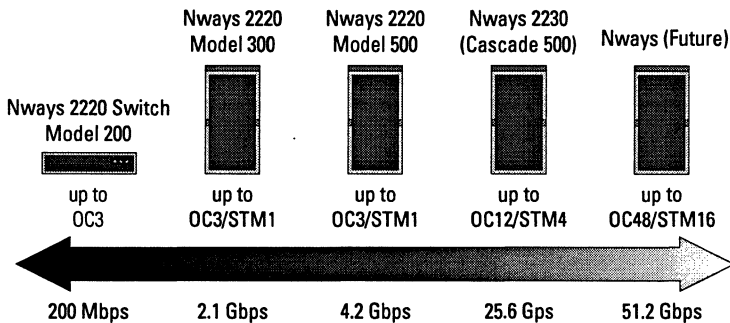


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ATM - 2-167

IBM Nways ATM WAN Family



- Common 2220 technologies—NBBS, h/w, s/w, net mgt
- Common access services— ATM, FR, HSSI/DXI, ISDN, SMDS/CBDS, HDLC, LAN routing/bridging



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ATM - 2-168

IBM Nways 2220 Broadband Switches

- **Models 300 and 500/501**
 - ATM
 - OC-3c/STM-1, DS3 by end of 1996
 - Frame relay
 - UNI up to 52Mbps, ANSI T1.617 Annex D Signalling
 - ITU Q.933 Annex A Signalling, ANSI T1.618 and ITU Q.922 Data Transfer Protocol, NNI to 52Mbps
 - HDLC with idle removal, 2.4Kbps - 52Mbps
 - SMDS-DXI
 - Up to 14 slots, Model 500 cell switching at 4.2Gbps
 - Port I/Fs—Serial, T1, Fractional T1, J1, E1, E2, E3, J2, T3 clear channel
 - Trunk I/Fs—Serial, T1, Fractional T1, J1, E1, E2, E3, J2, T3 clear channel



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ATM - 2-169

IBM - Cascade Alliance

- Business and technology alliance announced March 26, 1996
 - WAN frame relay and ATM
- Cascade Communications Corp. (Westford, MA, USA) is a global provider of enterprise and public carrier network WAN switch solutions
 - Cascade customers include Centel Corp, GTE, LDDS WorldComm, Airtouch, McCaw (AT&T Wireless), Bridge Information Systems, Industrial Bank of Korea, BT, Deutsche Bundestpost Telekom, Telecom Finland, Toshiba Corp, Ameritech, Bell Atlantic, BellSouth, US West, PacBell



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ATM - 2-170

IBM - Cascade Switches

- Cascade 500 High-Scalability ATM Switch
 - Non-blocking output buffered with 4 QoS buffer planes; supports T3/E3, OC3c/STM-1, OC12c/STM-4
 - 4 x 4 matrix with 640Mbps per port (2.5Gbps)
 - 8 X 8 matrix with 640Mbps per port (5Gbps)
 - 8 X 8 matrix with 1280Mbps per port (10Gbps)
 - Dedicated SVC signalling processor on every line card
 - Supports 3000 connection requests/second/switch, up to 16,000 point-to-multipoint connections and 240,000 VCs per switch
- IBM Nways 2230 Model 600
 - 14 Slots, 6 I/O Slots, 4 X 4 @ 2.5Gbps, T3/E3 - OC12c/STM-4
- IBM Nways 2230 Model 650
 - 14 Slots, 14 I/O Slots, 8 X 8 @ 5Gbps, T3/E3 - OC12c/STM-4



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ATM - 2-171

IBM - Cascade Switches (Con't.)

- Cascade B-STDX 9000 (FR, SMDS, ATM)
 - IBM Nways 2225 Model 450
 - 16 Slots, 14 I/O Slots, 1.2 Gbps switching capacity, 56/64Kbps - 44.736Mbps
- Cascade B-STDX 8000 (FR, SMDS, ATM)
 - IBM Nways 2225 Model 400
 - 8 Slots, 6 I/O Slots, 56/64Kbps - 44.736Mbps
- Cascade STDX 6000 Multiservice WAN Switch (FR)
 - IBM Nways 2219 Model 250
 - 6 Slots, 5 I/O Slots, 24Mbps switching capacity, 2.4Kbps - 4Mbps

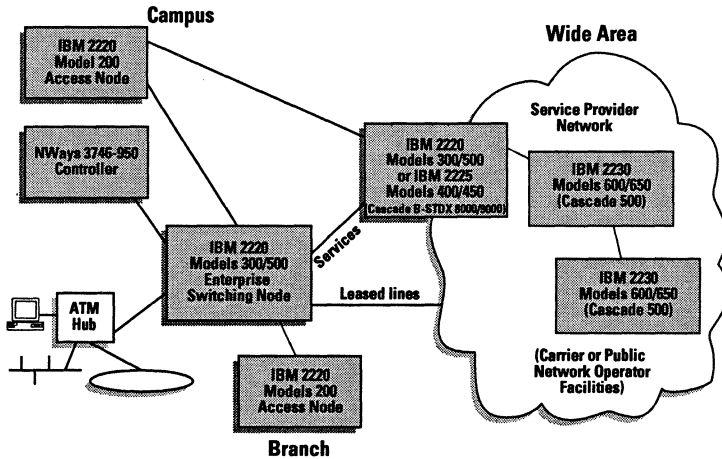


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ATM - 2-172

IBM 2220/2225/2230 Nways Switch Placement



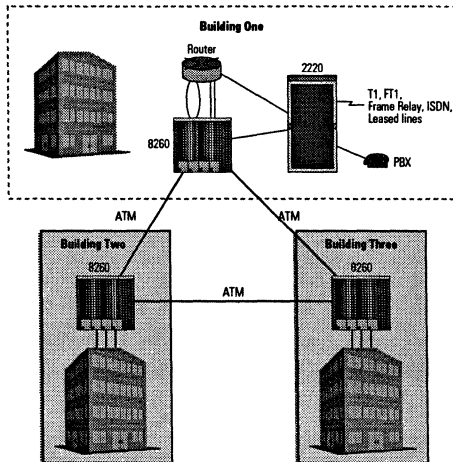
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ATM - 2-173

IBM SVN Phase 2a ATM Backbone—1H/96

- 8260 ATM Hub provides a high-speed ATM switching backplane and interconnect
- Addresses campus backbone bottlenecking issues
- Traffic between buildings 1-2 no longer affected by traffic between buildings 1-3 or 2-3
- Existing routers are retained to route traffic between subnets, maintain firewalls and minimize broadcast traffic across subnets



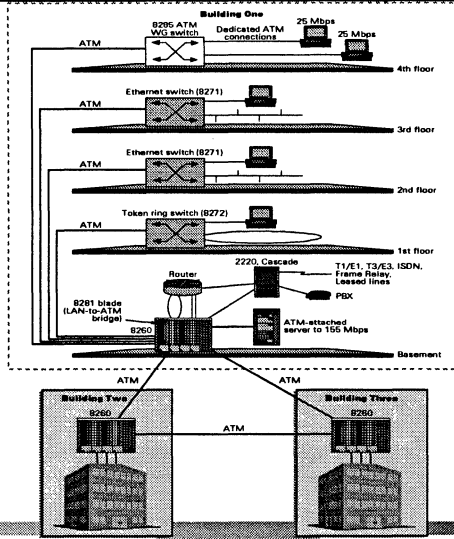
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ATM - 2-174

IBM SVN Phase 2b ATM High-Speed Links—1H/96

- Concurrent with SVN Phase 2a
- LAN switches connected to 8260 ATM Hub via high-speed (155.52 Mbps) links
- Nways 8285 workgroup switch supports 25.6 Mbps ATM connections to the desktop and 155.52 Mbps hub connection
- Combination of ATM links to ATM switch improves inter-floor performance
- In-place routers are retained and perform their traditional functions

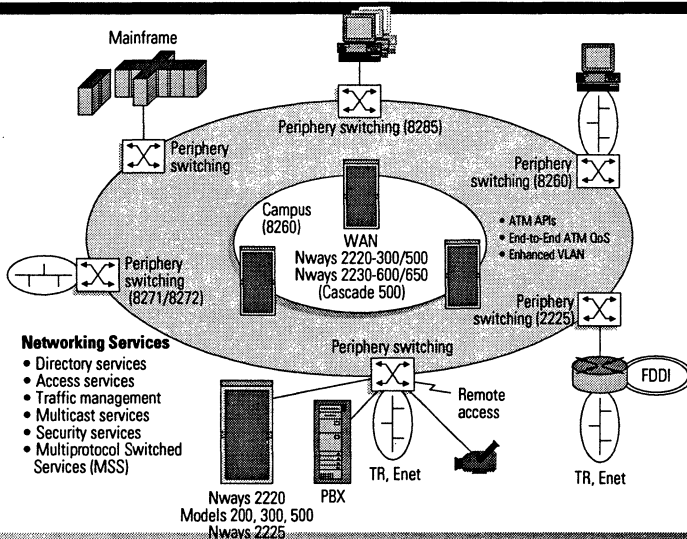


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ATM - 2-175

IBM SVN Phase 3—End-to-End ATM with APIs



Networking Services

- Directory services
- Access services
- Traffic management
- Multicast services
- Security services
- Multiprotocol Switched Services (MSS)

Nways 2220
Models 200, 300, 500
Nways 2225

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ATM - 2-176



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IBM ATM Products—1995-96

	1995	1996
Adapters	Turboways 25 LANE (ISA) Turboways 100 LANE and classical IP (MCA) LANE server for NetWare (MCA)	Turboways 25 (ISA, MCA, SBus, PCI) Turboways 100 LANE and classical IP (MCA) Turboways 155 LANE and classical IP (MCA, SBus) Turboways 25 LANE for AIX (ISA, PCI) Turboways 25 classical IP (ISA, PCI) Turboways 155 LANE and classical IP (PCI) LANE server for OS/2 (MCA) LANE server for AIX
Hub/LAN	Nways 8260 ATM hub Nways 8281 ATM bridge Nways 8271 Ethernet switch Nways 8272 Token ring switch	Nways 8260 integrated bridge P-NNI Phase 0 HSP and P-NNI Phase 1 Integrated 25 Mbps concentrator Integrated LANE server Nways 8285 workgroup switch
WAN	Nways 2220 broadband switch Model 300/500	Low-end Nways 2220 Model 200 access switch Nways 2230-600/650 (C500), Nways 2225-400/450 (C STDx 9000); HPR COS mapped to ATM QOS
Network Management	Network management for campus and wide area	NetView for AIX, LAN Manager for AIX ATM Campus Manager, VLAN Net Mgt
Additional		Multiprotocol switched services (MSS) OSA support AS/400 support ATM APIs

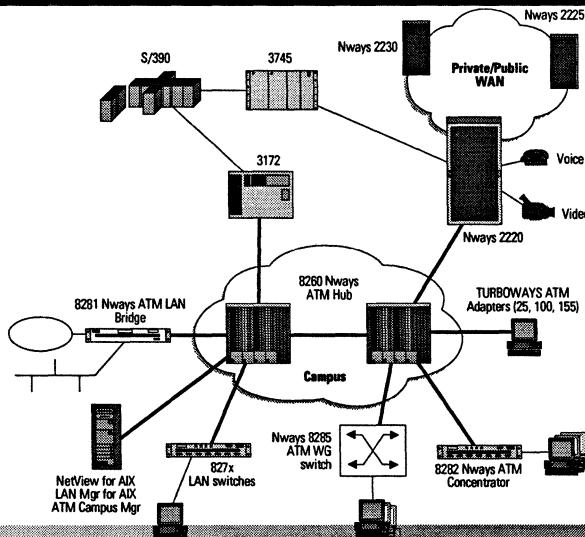


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ATM - 2-177

IBM SVN Products—1996



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ATM - 2-178

SVN MSS Strategy

- Build a strategic network based upon switching
- Make incremental network upgrades to solve tactical problems
- Extend the life of routers without upgrades
- Use standards-based solutions
 - Multivendor interoperability
- Significantly improve price/performance
 - Leverage switched (vs. router) infrastructures
- Simplify network management
 - MSS builds VLANs dynamically
 - MSS builds dynamic filters to suppress broadcasts within and between VLANs



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ATM - 2-179

MSS Model

- One-hop routing, Zero-hop routing
 - IP/IPX routing
 - 2-5x routing price/performance
 - Reduced latency
- MSS Inbound Forwarding Client
 - Destination cache (L3 host address, host phy addr)
- No outbound forward client required
- MSS Server
 - Route calculation
 - Directory services—based on IETF ROLC Subgroup NHRP
 - LANE Server
 - Broadcast suppression



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ATM - 2-180

MSS Standards Approach

- **LANE**
 - ◊ LEC—ELAN registration
 - ◊ Resolves broadcasts
 - ◊ Reformats to unicast
 - ◊ Broadcast for unknown addresses
 - ◊ Resolve MAC to ATM
 - ◊ Multiplex multiple VLANs on single VC using LE headers
- **NHRP**
 - ◊ Resolve L3 to MAC
- **Routed frames**
 - ◊ L3 encapsulation
 - ◊ OSPF/RIP—resolve next external router hop



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ATM - 2-181

IBM's VLANs

- VLAN provided by protocol, media type, subnet, network
- VLANs can span multiple “systems”
 - ◊ Systems auto-detect physical migration
- Configuration Options
 - ◊ Automatic—default and learned
 - ◊ Manual override—to port level
- Broadcast Management
 - ◊ Multicast to directed frames
 - ◊ Multicast response



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ATM - 2-182

MSS VLAN Broadcast Reduction

- VLAN based on traditional routing
 - ◊ Broadcasts blocked at Layer 3 by routing
 - ◊ BUT, can traverse the enterprise at Layer 2 through VLAN
- MSS converts broadcasts to Directed Frames
- Broadcast firewall INSIDE and between VLANs

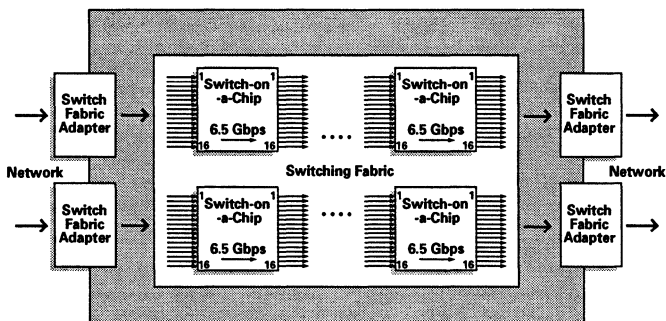


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ATM - 2-183

Basic Switching System with IBM Switch-on-a-Chip



- PRIZMA first demonstrated at ComNet in January 1994, commercialized as Switch-on-a-Chip in June 1994
- 16 inputs, 16 outputs, 300-400 Mbps/port, yielding 6.5Gbps aggregate, highly scalable



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ATM - 2-184

IBM SNA/ATM Migration

- ATM can concurrently interconnect IP-IP, IPX-IPX, SNA-SNA, APPN-APPN, HPR-HPR, CBR-CBR, VOD-VOD
- Over 30,000 enterprises still running mission-critical business applications on host-centric SNA networks
- SNA networks support application requirements for high availability, predictable response times, message priority, end-to-end management



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ATM - 2-185

IBM SNA/ATM Migration (Con't.)

- **Local Host Access**
 - SNA users deploy ATM in LAN environment, then extend the ATM infrastructure to the WAN
 - Users in this scenario likely to implement ATM as a campus backbone solution with LAN (Ethernet/TR) switching to the desktop
 - LANE is key in enabling SNA/APPN to access ATM campus environment
 - IBM will provide attachment to ATM backbone to the host via 3746 Nways Controller Models 900 and 950 by 2H/96, 3172 Interconnect Controller by 4Q/95, and native ATM switch attachment via OSA by mid-96—all at OC3 for SNA subarea, APPN, HPR



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ATM - 2-186

IBM SNA/ATM Migration (Con't.)

- **Remote Wide Area Network Access**
 - ATM services in the WAN to be deployed more gradually
 - In near-term, users relying on frame relay to lower costs
 - Stage 1 (Today) enables FR at both remote access point to WAN and the host site
 - Nways 2220, 3746 Nways Controller, 3172 Interconnect Controller, 2210 Nways Router, 2217 Nway MP Concentrator support public and private FR
 - Stage 2 (1996-97) host interface to change from FR to ATM
 - Enabled by FR-to-ATM interworking on 2220 and 3746
 - Stage 3 (1996-97) emphasis to shift to converting remote locations to ATM
 - Several enterprises use FRADs and routers today
 - Nways 2220 Model 200, Nways 2225, 2210 Nways Router as multi-service access nodes, integrate SA, APPN, HPR



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ATM - 2-187

IBM SNA/ATM Migration (Con't.)

- **Guaranteed Service Levels for Applications**
 - Fundamental SNA-to-ATM migration driver is need for guaranteed service levels on mission-critical SNA and APPN applications
 - LANE and FR are limited to providing “best effort” services in terms of BW allocation and response time guarantees
 - HPR will be enhanced for ATM 2H/96
 - HPR application COS (e.g., delay, error rate, BW) will be mapped to a corresponding ATM QoS

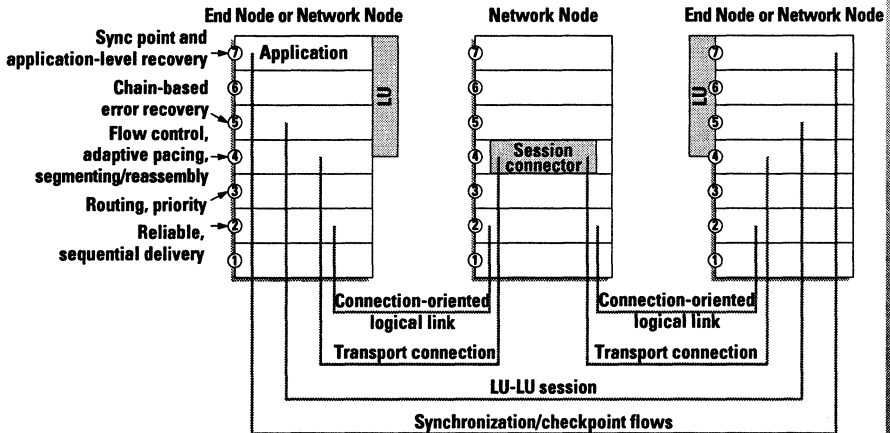


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APPN/ISR

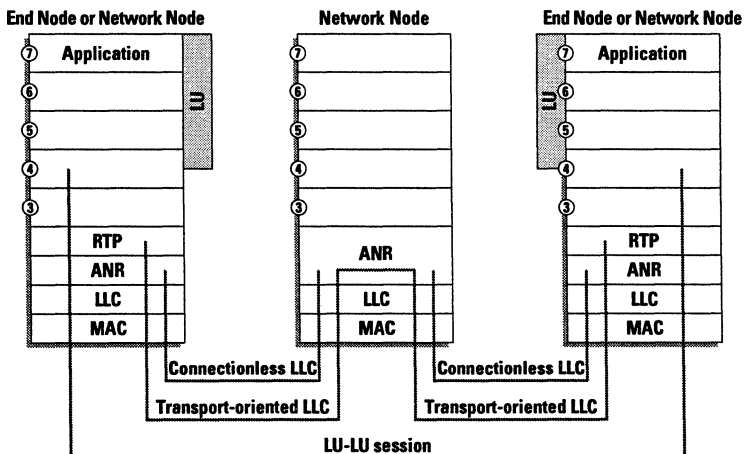


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APPN/HPR

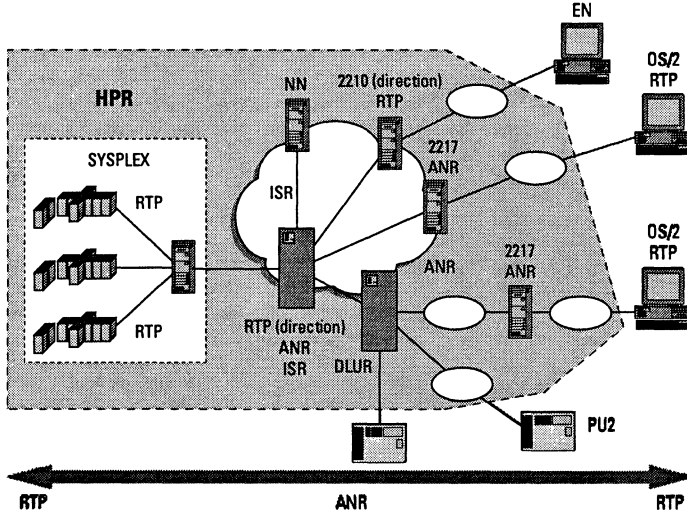


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ATM - 2-190

HPR Sysplex Example

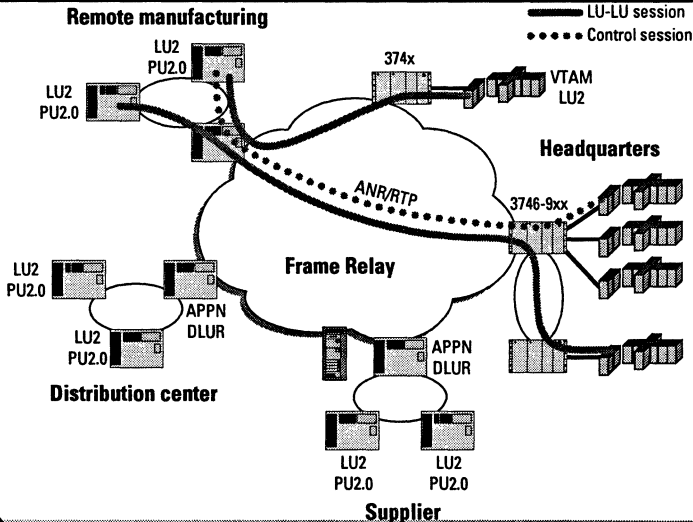


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APPN/Frame Relay

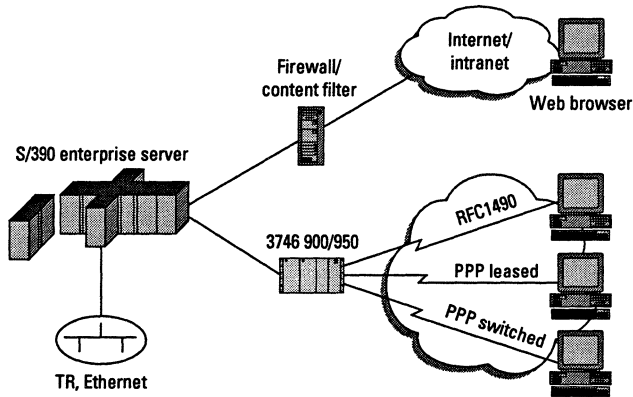


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ATM - 2-192

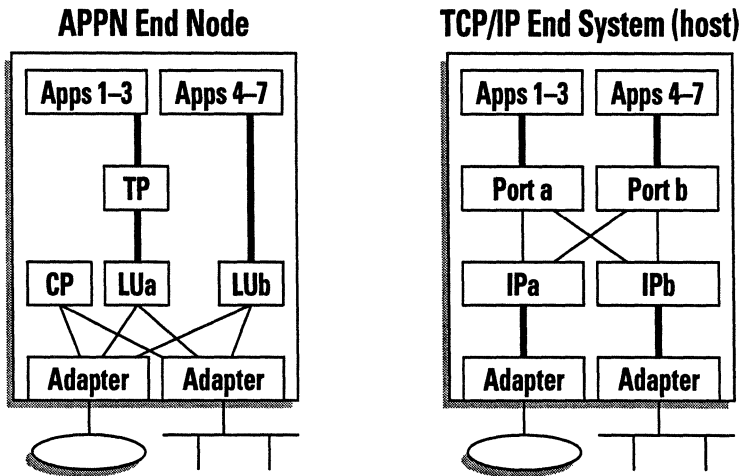
Native IP



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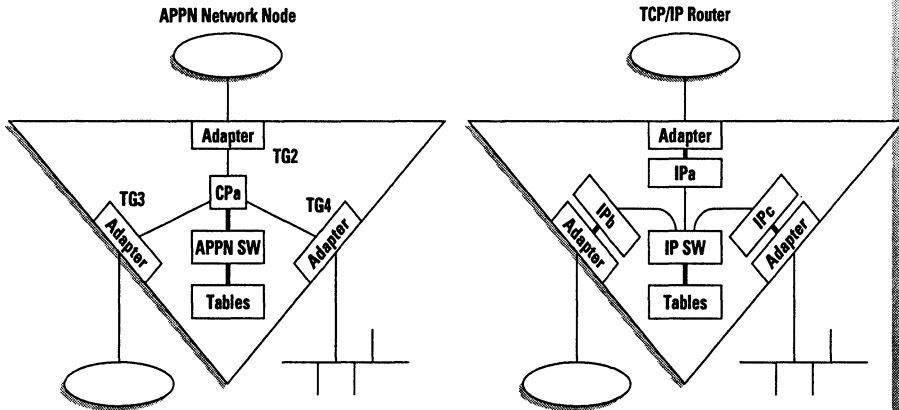
End Systems Compared



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ATM - 2-194

Intermediate Systems Compared

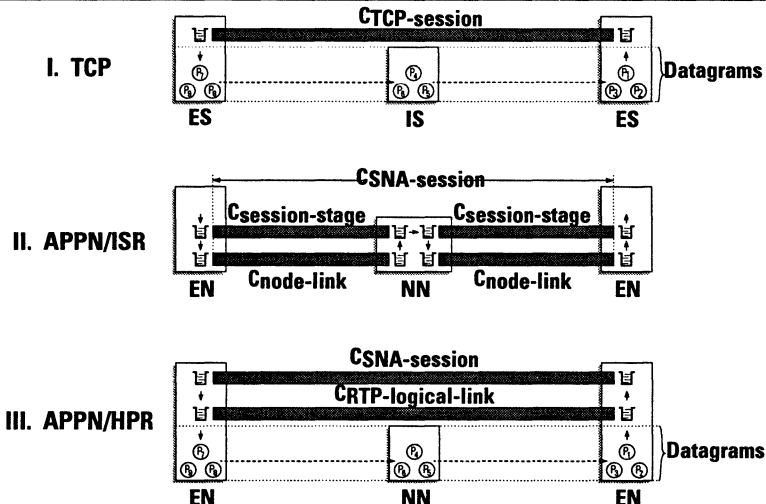


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ATM - 2-195

Connection Vs. Connectionless TCP/IP, APPN/ISR, APPN/HPR



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ATM - 2-196

Links: To Connect or Not?

- Connectionless
 - No start-up overhead
 - All resources available to all
- Connection-oriented
 - Low-overhead addressing
 - Resource reservation
- APPN/HRP
 - Paradigm shift
 - Connectionless routing with
 - connection-oriented services
 - Resource reservation, determinism, dynamic re-routing



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ATM - 2-197

IBM Strengths

- SVN is substantive, not a *marketecture*
- Full range of ATM products
 - NICs, LAN switches, ATM campus switches, ATM WAN switches, ATMF LANE, Switch-on-a-Chip
- NBBS/MSS are industry leading ATM and FPS control/management architectures
- Aggressive pricing, especially at the low end
- ATM25 Token-Ring MUNI, UTP-3/5 re-use
- IBM expertise in complex systems and architectures
- IBM international service reputation
- IBM traditional end system-end system leadership in systems and network management
- SNA market ownership with clearly articulated switched SNA/APPN/HRP and switched multiprotocol strategy/tactics



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ATM - 2-198

IBM Challenges

- IBM perceived as an ATM late-comer
- NBBS fixed-cell plus variable packet perceptions
- Cascade vs. StrataCom
- 1995 product GA slippages
- Still not regarded by many as a major network player outside of host-centric SNA
- Stealth marketing—other end of the spectrum from Cisco
- Big wins still limited to classically “Blue” space
 - “Blue” users often convert aging controller fleets to Cisco solutions
 - IP shops rarely regard IBM as a serious contender



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ATM - 2-199

Bay Networks Issues, Opportunities, Recommendations

- Need to clearly articulate an end-to-end enterprise strategy
 - Previous iteration of BaySIS was a complex and incoherent document
 - Enterprise IBM customers:
 - Are beset with a siege of vendor marketectures
 - Are concerned with vendor diminishing product life cycles, product abandonment
 - Require investment obsolescence protection
 - Require navigational clarity
 - Require step-by-step architectural migration



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ATM - 2-200

Bay Networks Issues, Opportunities, Recommendations

- Bay Networks customer confusion over new switches, coupled with market perceptions over lack of internal direction coherence, precipitated a 50% reduction in stock valuation
 - ◊ Feb 9, 1996 high of \$49/share
 - ◊ July 23, 1996 low of \$21 3/8/share
 - ◊ Several customers are taking a wait-and-see approach in the face of switch announcements to determine which platforms Bay will strategically support



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ATM - 2-201

Bay Networks Issues, Opportunities, Recommendations

- Switch sale impacts on hub sales
- Market perceptions of SynOptics-Wellfleet merger
- Production split between two coasts
- Need marketing leadership
 - ◊ Stealth marketing issues
 - ◊ SynOptics and Wellfleet are better known names than Bay Networks



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ATM - 2-202

Bay Networks Issues, Opportunities, Recommendations

- WAN presence constrained to routers
 - BNX functions as a FR switch—barely
- Almost no presence in Enterprise IBM markets
 - Limited to TR and SNA network connection
 - Bay sales people do not know who to call on and how to speak their language
 - Need SNA-related technical and account intensive training
 - Still thinking in terms of Enet, TR, conventional LAN technologies



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ATM - 2-203

Bay Networks Issues, Opportunities, Recommendations

- Never had a true IBM strategy
 - Have point products
 - DLSw, SDLC-LLC conversion
 - Have pieces, no single, unified strategy or offering
- Focus in bids after Cisco has set ground rules
 - Only countering Cisco, letting Cisco set the agenda
 - Not saying “Let’s talk about your network requirements and get off this Cisco el toro poopoo”
- Enterprise IBM market is at least 2/3 size of entire present Bay market
- IBM sells the entire solution—adapters to enterprise switches



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ATM - 2-204

Bay Networks Issues, Opportunities, Recommendations

- Consolidate and strengthen the BaySIS story
- Tie directly to key customer segment business models and distributed applications
 - Manufacturing
 - Financial services
 - Retail
 - Government agencies
 - Education
- Provide a compelling case for Bay Networks switch, router and hub products within all key segments



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ATM - 2-205

Bay Networks Issues, Opportunities, Recommendations

- Develop and articulate a coherent, end-to-end, enterprise SNA internetworking strategy
 - Build a unified enterprise IBM story
 - Differentiate from Cisco marketectures and poor worldwide support
 - Emphasize BaySIS and supporting products as interoperable between release levels
 - Provide internal and intensive SNA and SNA internetworking education
 - Demonstrate seamless IBM interoperability
 - APPN/ISR, HPR
 - DLSw
 - Articulate robust end system-based systems/network management



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ATM - 2-206

Cisco Price Wars

- Cisco will *heavily* discount to win in critical sales
 - ◊ Workgroup products most likely to see discounts
 - ◊ Software will be discounted in Access
 - ◊ Catalyst 5000 has been discounted over 60% in critical accounts
- Set discounts for End Users are not the norm
 - ◊ Cisco discounts on a “bid” basis
 - ◊ Once they have the account, the discounts are less frequent



Win by Price

- Cisco's routers and high-end switches are expensive
 - ◊ The inroad *may* be through price alone
 - ◊ Smaller customers will sacrifice function for price
 - ◊ Larger customers want both, but will look at more than price
 - ◊ Examine the “per-port” buy-in and “cost of ownership” issues
 - ◊ Calculate user unexpected downtime costs



Support and Service: Cisco's Weak Point

- Cisco's high growth rate, coupled with major acquisitions, has impaired service
 - ◊ Larger number of Customer Complaints
- Add in a Complex Software Set
 - ◊ Release 9.X finally obsolete
 - ◊ Release 10.X still gets "bug fixes"
 - ◊ Release 11.X shipped in rev 3
 - ◊ Multiple variants and multiple platforms
- Cisco Service is straining to meet the load
- To regard Cisco as an unbeatable giant is a mistake



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ATM - 2-209

Cisco Sales Approaches

- Direct Sales in Most of US, Canada & Europe
 - ◊ Use Channel only to attack smaller, specialized accounts
- Partner in "low-volume" markets
 - ◊ Use resellers in small countries
- Position as the Strategic Network Asset
 - ◊ Sell to the CIO/Director level
 - ◊ Position the Router/ATM as a key element of the net
 - ◊ Maintain a "Cisco-only account"



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ATM - 2-210

Marketing Against Cisco

- Address Layer 3/2 switching with a comprehensive counter-strategy coupled with products delivered soon thereafter
- Highlight Cisco's limitations
 - No shared media
 - Reliance on IOS
 - Limitations in Network Management
 - Multiple packages, lack of true integration
 - Recent history
 - Less than one year after the “advance” of separating Route and Switch processing, Cisco re-combined these on the RSP
 - LS100 abandoned for LS1010
 - LS2020 abandoned for IGX
 - Catalyst 5000 soon to be abandoned for Catalyst 5500



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ATM - 2-211

Cost Justification Recommendations to Major Users



- Maintain ongoing dialogue
- Require business units to submit written plans
- Present budget with costs and benefits, including cost of not doing, future expected benefits
- Plan for possible cutbacks and their impacts
- Some projects are better to cut than cut back on
- Educate on network- vs. computer benefits
- Educate on data network vs. telephony technology
- Track PC/WS expenses; demonstrate network ratio
- Allocate portion of major cost savings to group for special projects
- **Allocate network expenses by attached user**



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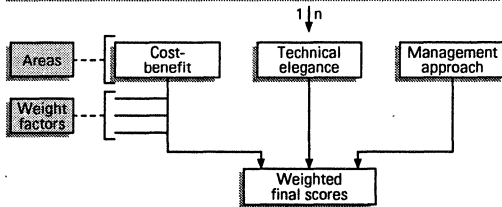
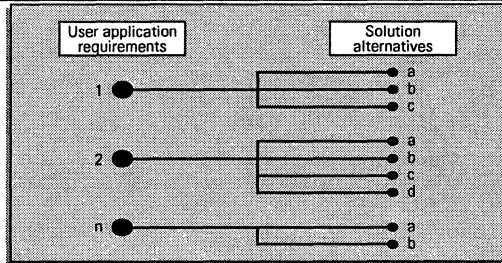
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ATM - 2-212

Elegance, Economics, Politics



- Build application-driven network business cases
- Optimize
 - ◊ Technical Elegance
 - ◊ Economic Rationality
 - ◊ Politics



- Select score(s) with highest (weight factor X ratings) by area as weighted sum(s)

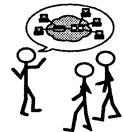


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ATM - 2-213

Network Vision Recommendations to Major Users



- Develop/evangelize long-term (3-year) network vision
 - ◊ Broadcast throughout the year
 - ◊ The alternative is continuous budget battles
- Translate the vision in terms of business benefit
- Develop/execute network architecture that embraces business computing plans, departmental LANs, NOSs, hardware standards, core desktop applications, workgroup/workflow, WAN
- Adopt "End-to-End" networked application view

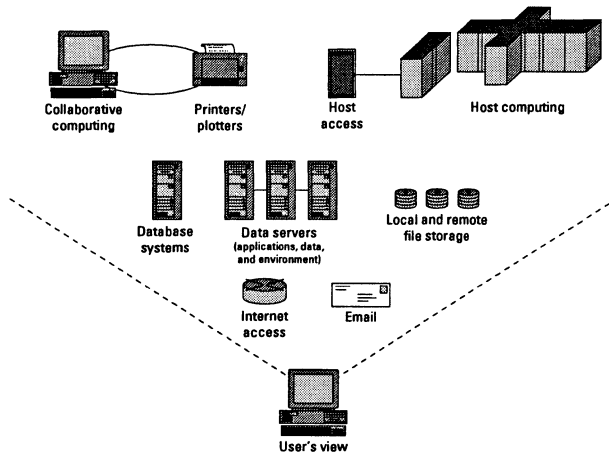


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ATM - 2-214

The Network as Service Enabler

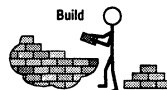


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ATM - 2-215

Operations Recommendations



- Develop/execute policy for moves, adds, changes
 - ◊ Incorporate department, business unit, corporate procedures, policies, focal points
- Develop an integrated Help Desk function
- Implement periodic report on network status/activity
- Develop/execute standards/policies

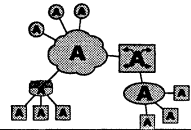


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ATM - 2-216

Enterprise Standards Recommendations



- Create standards/guidelines incentives and disincentives
- Establish standard network operating system
- Establish standard core desktop applications
 - ◊ Word processing
 - ◊ Spreadsheet
 - ◊ Presentation graphics/text/images/video
 - ◊ Time management/resource scheduling
 - ◊ Email
 - ◊ Workflow/workgroup management
- Incorporate flexible standards

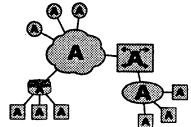


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ATM - 2-217

Enterprise Standards— Recommendations



- Establish standard email
- Establish remote access policy, procedure, tools
- Establish standard SNA transition
- Establish standard desktop
- Establish standard file server hardware platforms



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ATM - 2-218