The 90s corporate philosophy to cut costs, consolidate services, empower employees via improved information flow, and increase revenues via new service offerings has had a profound impact in networking technology. It has driven the evolution of a high-speed, bandwidth-conscious network that can provide consolidated transport of LAN, legacy, voice and video traffic.

This presentation will focus on the LAN interconnection requirements of a consolidated network. It will detail how Magellan products fulfill these requirements individually, and as part of synergistic, network-wide solutions.

About the presenter:

Tony Kourlas is the product manager responsible for IBM services on all Magellan products, and for LAN/ATM interworking on Passport. Tony has more than eight years experience in the data communications industry, having served in both engineering and product management capacities at Phillips Electronics and Eicon Technology before joining Nortel. Tony holds a Bachelor degree in Electrical Engineering from McGill University in Montreal.

Agenda

- **Trends in network evolution**
- Magellan values: campus, regional, branch
- Magellan values: network-wide
- Evolution to ATM

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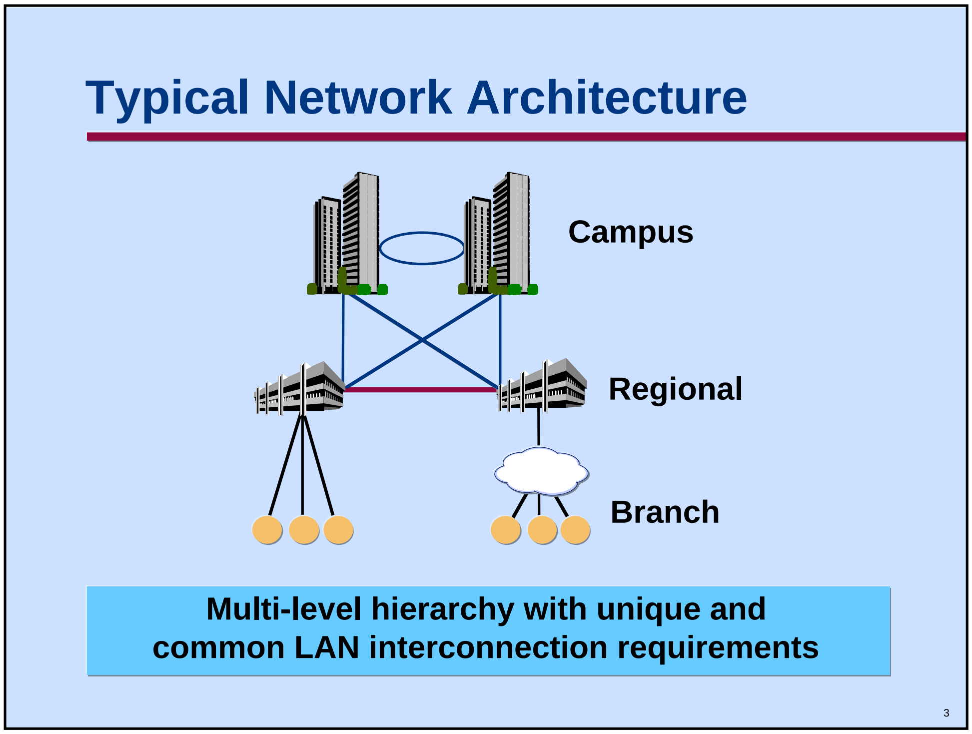
The “Trends” section will summarize networking trends and LAN interworking requirements at the campus, regional and branch offices, and identify the Magellan products that fill these segments.

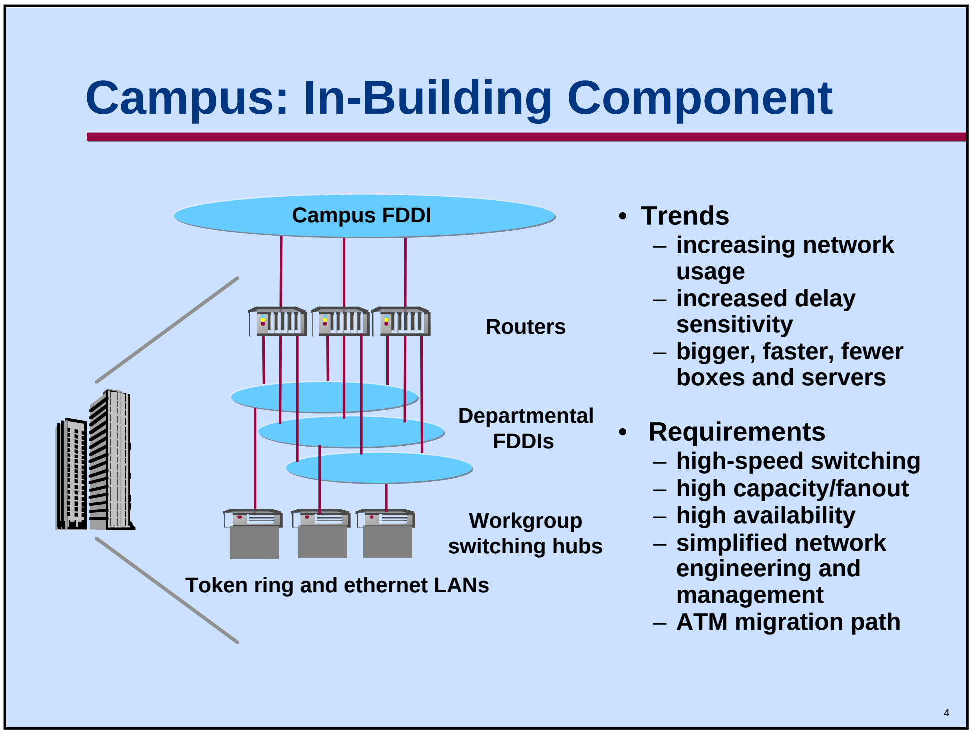
The next three sections will detail how Magellan products provide the necessary features and functions to meet these requirements:

- Magellan values: campus, regional, branch: will concentrate on requirements that are more or less unique to each level in the network hierarchy .
- Magellan values: network-wide: will focus on requirements that span all levels of the network.
- Evolution to ATM: will outline the Magellan evolution path to ATM from the perspective of LAN interworking.



Generally speaking, an enterprise network can be split into a four level hierarchy from the standpoint of LAN interworking:

- Campus
  - – Corporate Headquarters
  - – One or more buildings in campus
  - – Major buildings can span metropolitan area
  - – Thousands of local users
  - – Corporate-wide data center
  - – Fibre connections between major buildings
  - – Link concentration point for local branches
- Regional Office
  - – 50 to 500 local users
  - – In-building/branch hybrid
  - – Branch link concentration point (wide area)
  - – Regional file servers
  - – T1/E1 to T3/E3 links
  - – Meshed together for redundancy
- Branch Office
  - – 15 local users
  - – 56K/64K to T1/E1
- Remote LAN Users, Small Office (not shown)
  - – 1-2 people
  - – Dial up links



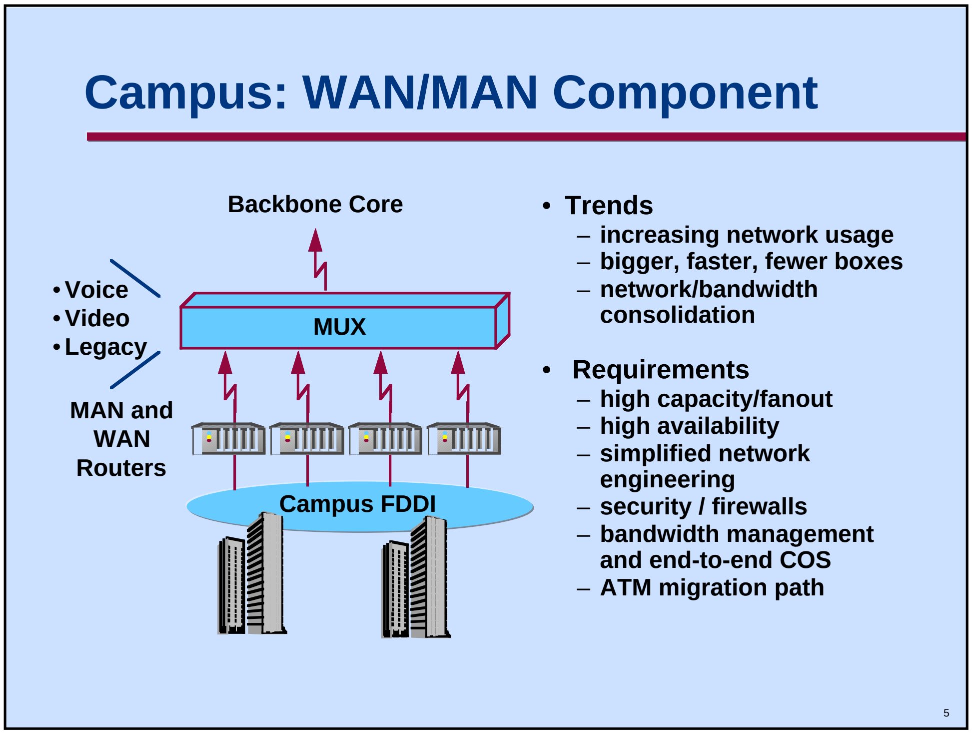
The campus has two networking components: "in-building", which handles needs of local users, and "WAN" which provides corporate data access for remote users, and provides access to external resources (i.e. Internet) for local users.

Trends

- growing response time needs driven by use of interactive applications (Netscape, etc)
- growing interaction rates
- growing number of users—corporations are downsizing, but putting more users on LAN
- need for more bandwidth
- growing engineering and management complexity brought on by rollout of multiple, capacity limited network devices (routers, file servers); unstructured rollout of LAN interworking technology (complex network architecture, many moves/adds/changes required to reassign users)
- above is driving service consolidation—consolidate multiple low-speed servers into single high-speed server, consolidate multiple routers into single large router
- mission critical applications on LAN to replace unplugged mainframe applications
- conformance to standards—keep doors to other vendors wide open
- Internet access—how to limit and monitor access while stopping intruders from entering your network

LAN switching requirements

- collapse multi-router backbones to a high-speed, low-latency switching fabric
- consolidation requires that switch supports:
  - high capacity/fanout
  - high availability and redundancy
- simplify network engineering and management
- provide ATM migration path to replace saturated FDDI or collapsed router backbones, to support multimedia at the desktop, and integrate isochronous technologies



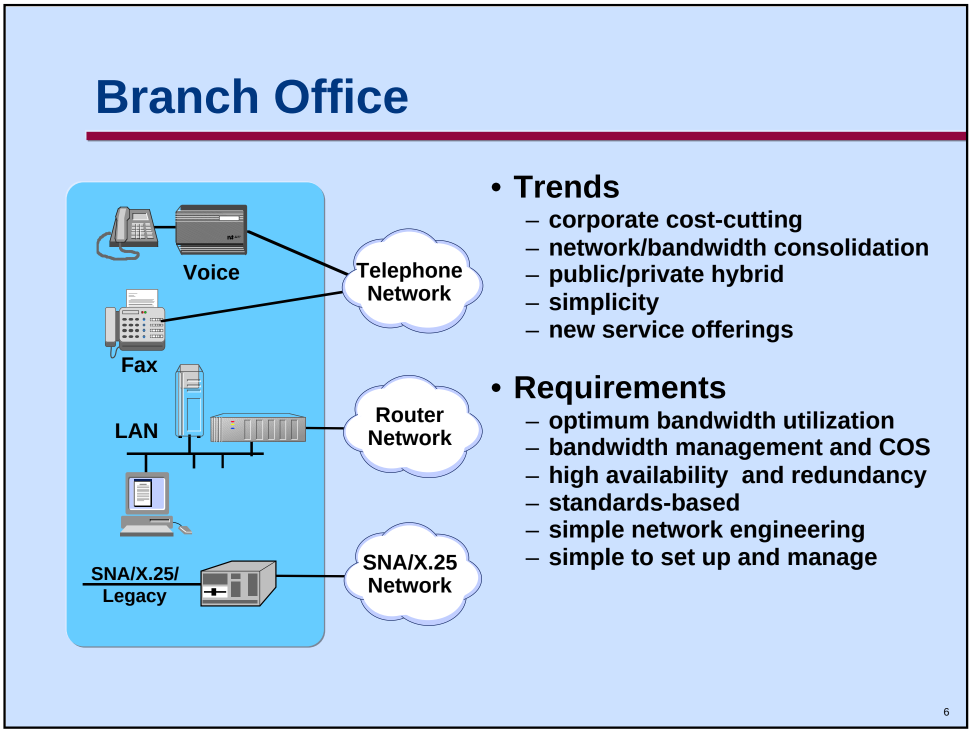
The WAN/MAN component of the campus has the following trends and requirements:

Trends

- increasing network usage—more local users requesting external access (i.e. backbone, Internet), more remote users as LAN invades branch
- bigger, faster, fewer boxes
- network/bandwidth consolidation—consolidate LAN transport with other services, such as voice and video, to minimize bandwidth costs

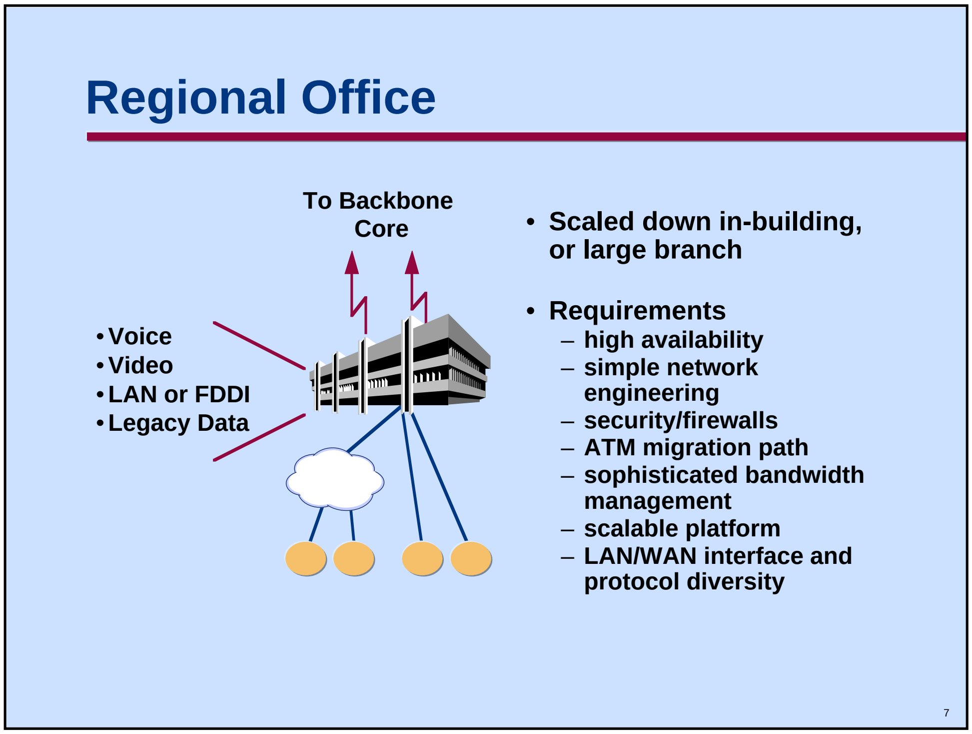
Requirements

- high capacity/fanout
- high availability and redundancy
- simplified network engineering
- security/firewalls (internet, etc)
- preserve pre-consolidation environment—dynamic, fair bandwidth allocation to meet relative class of service requirements (delay and throughput characteristics) of LAN versus voice, video, legacy
- ATM migration path for WAN for higher bandwidth, network consolidation, and ability to leverage public ATM services



Given that most enterprise networks' composition is over 90% branch, corporate cost cutting has had its most profound impact at this level in the network hierarchy. A branch switch has to:

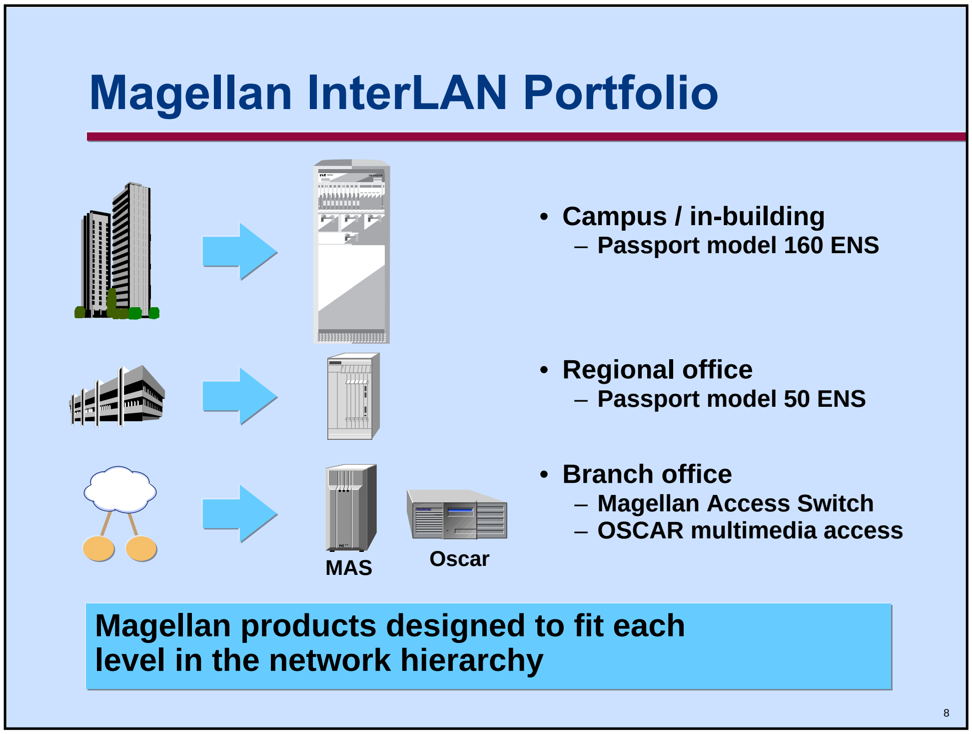
- consolidate multiple traffic types (legacy, LAN, voice, video, etc) to eliminate requirement for multiple parallel networks and associated capital (i.e. multiple boxes) and operational (i.e bandwidth, multiple links) costs;
- match the delay and throughput characteristics of each class of traffic it supports, and ensure bursty LAN traffic does not overwhelm other traffic types;
- provide backup capabilities to provide high availability (i.e. redundant, on demand link);
- be standards-based;
- support public and private services as required for least-cost networking;
- be simple to engineer to cut network wide engineering costs; and
- be simple to setup to minimize installation and support costs.



Two requirements that are especially critical at regional sites are scalability and diversity.

Scalability means the switch must have scalable fanout characteristics to meet increasing connectivity needs and grow with user demand for minimal upgrade cost.

Because network switches targeted for regional offices sit at the crossroads of the network—between the backbone core and branch offices—they need to support a diverse set of LAN/WAN protocols and interfaces to meet requirements on both sides of the network divide. For instance, WAN links to the backbone and branch have different link characteristics, and different routing protocols may be used at the branch versus the backbone to simplify network engineering.



To meet the requirements of campus in-building networks, Nortel engineered the 16-slot Passport model 160 enterprise network switch. Passport meets the high capacity and performance requirements of campus switches while simultaneously providing WAN access to support local and remote users. Passport consolidates voice, legacy, and LAN traffic to maximize bandwidth dollars.

A 5 slot version of the Passport model 50 ENS is directed at regional sites.

At the branch, the Magellan Access Switch (MAS) is targeted for SNA/LAN consolidation, while Oscar provides multimedia access.

The remote/small-office LAN access class will not be covered in this presentation in the interest of time. Nortel provides two solutions in this area:

- Integrated modems for dialup LAN access to MAS
- Rapport high density dialup switch

Agenda

- Trends in network evolution
- Magellan values: campus
  - high-speed switching
  - high-capacity/fanout
  - high-availability
- Magellan values: network-wide
- Evolution to ATM

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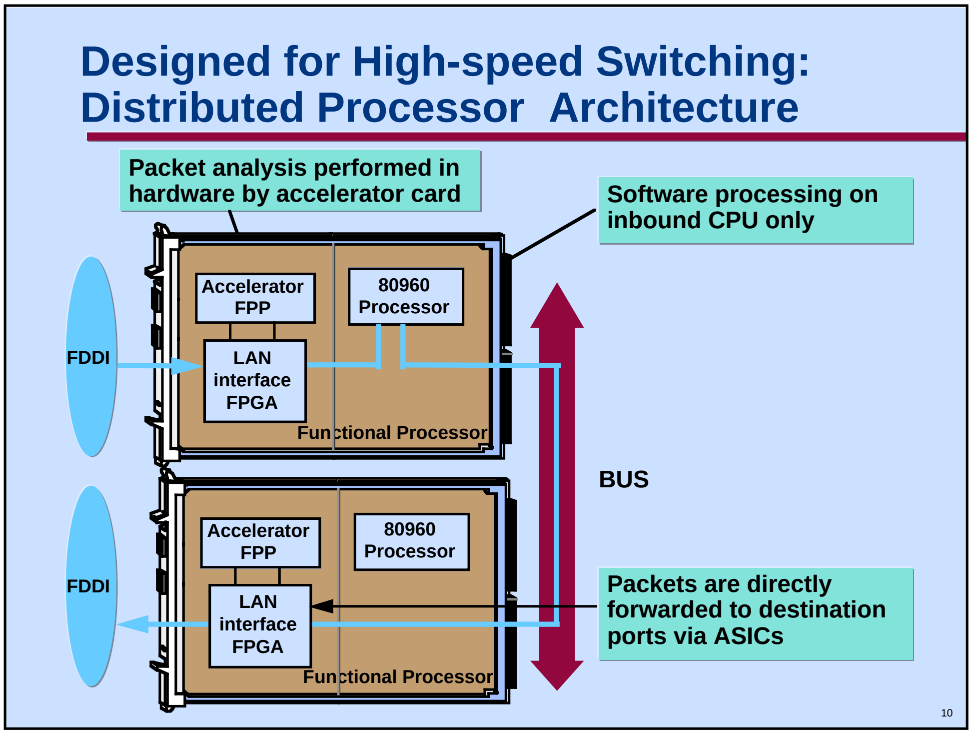
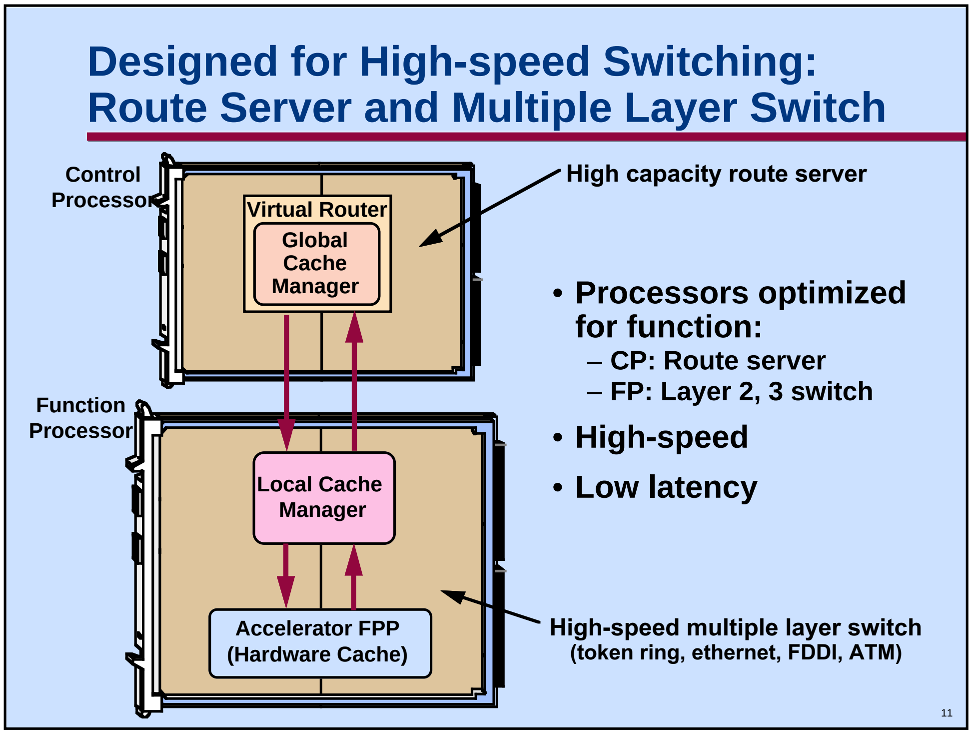


Passport's parallel multi-processor architecture is designed for high-speed campus applications. Each processor runs independently, providing a high degree of parallelism. Each processor makes extensive use of custom application specific integrated circuits (ASICs) to provide high levels of performance and functionality.

Each Passport functional processor (FP) card contains a RISC processor and custom application-specific integrated circuits (ASICs) to maximize throughput. FPs which support LAN media connections (ethernet, token ring and FDDI), also have custom integrated circuits, implemented using field-programmable gate array (FPGA) technology, to interface to the LAN media and provide additional hardware assists (FPP) for high-speed packet routing operations.

For most packets, only a few steps are needed on the FPP to make routing decisions as the packet enters the Passport switch, and the hardware handles all further switching across the backplane to the correct output port on another FP.

Passport is unique in providing this level of hardware-based switching and routing to achieve high performance.

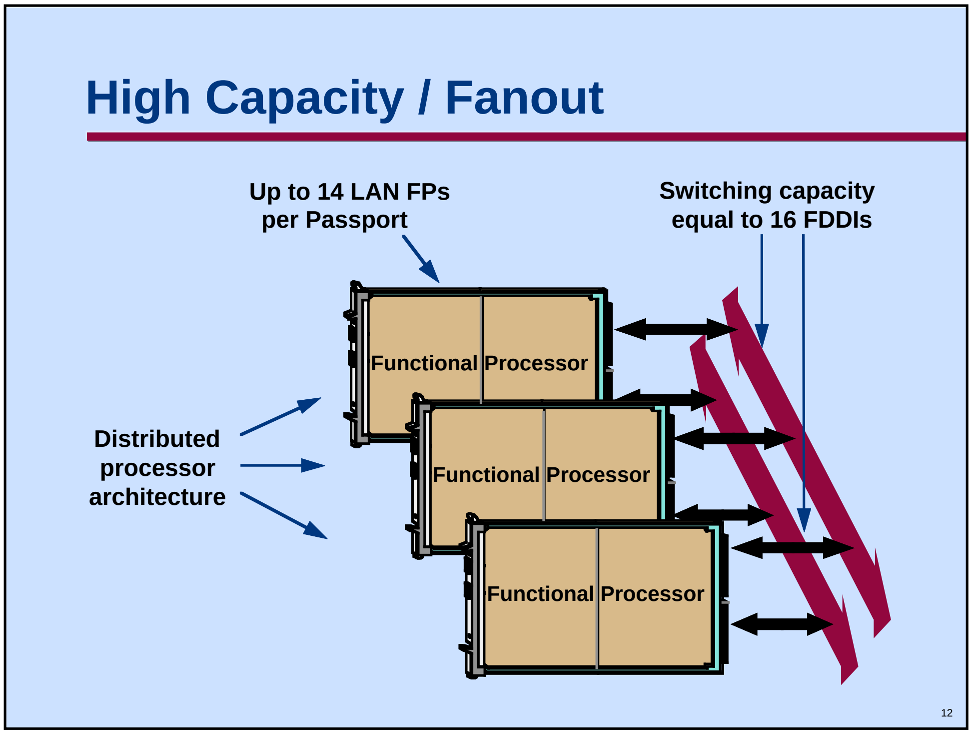


To minimize latency, routing, bridging and switching functions are split between processors. The control processor (CP) is designed as a high capacity route server, providing global routing and filtering services. The functional processor (FP) is designed as a high-speed layer 2 and 3 switch with local caches and tables to minimize its dependency on the CP. An example of how the two work together to minimize latency follows.

A packet arrives at the interface of the Functional Processor. If the destination address is known to the fast packet processor (the FPP holds the addresses of the most used destinations), the appropriate headers and trailers are added, and the packet is forwarded directly to the output queue of the destination FP.

If the FPP does not know the packet’s destination, it calls the local cache manager (LCM), which also resides on the FP. The LCM holds the forwarding tables for the FP which is its current knowledge of the network topology. Once the destination is determined, the packet is forwarded to the output queue of the destination FP, and the LCM updates the FPP as required. In both cases above, CP access was not required.

If the LCM is not aware of the destination, it calls the global cache manager (GCM) on the CP to help resolve the address. Once the destination is determined, the packet is appended with the appropriate headers and trailers, then forwarded. The GCM maintains the complete network topology, updates the LCM, and does this for all protocols an the network.

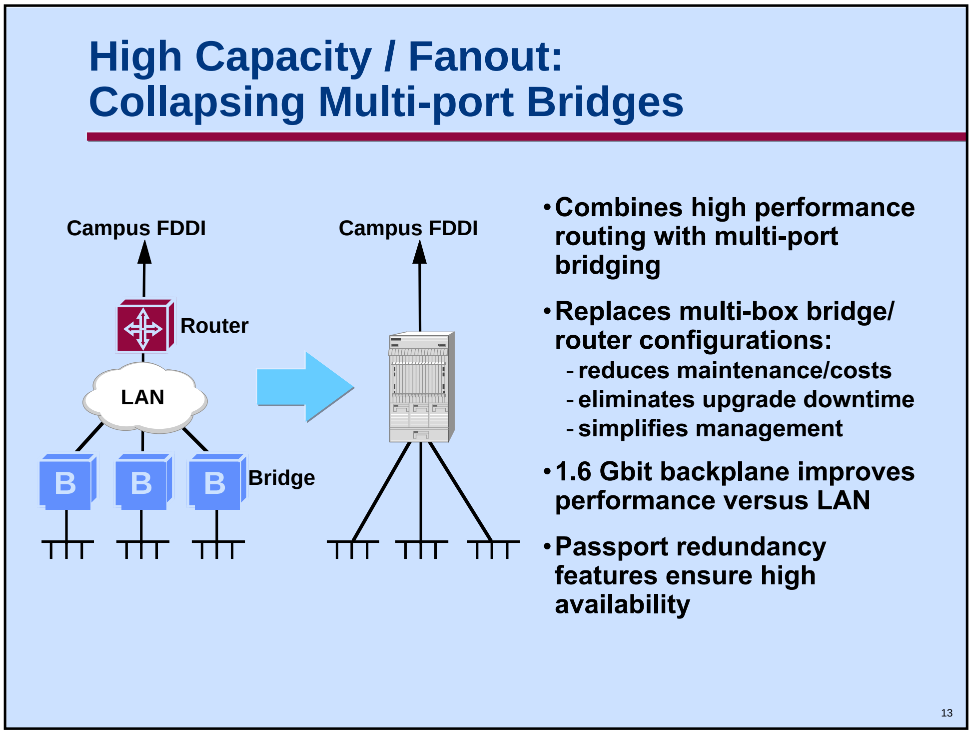


High fanout:

- Up to 14 FPs per Passport
  = 84 ethernets
  = 14 FDDIs
  = 64 token rings
  = 112 T1s/E1s

High capacity:

- Switching over dual load shared buses
- Switching capacity equal to 16 FDDIs
- Distributed processor architecture maintains high performance levels as fanout increases

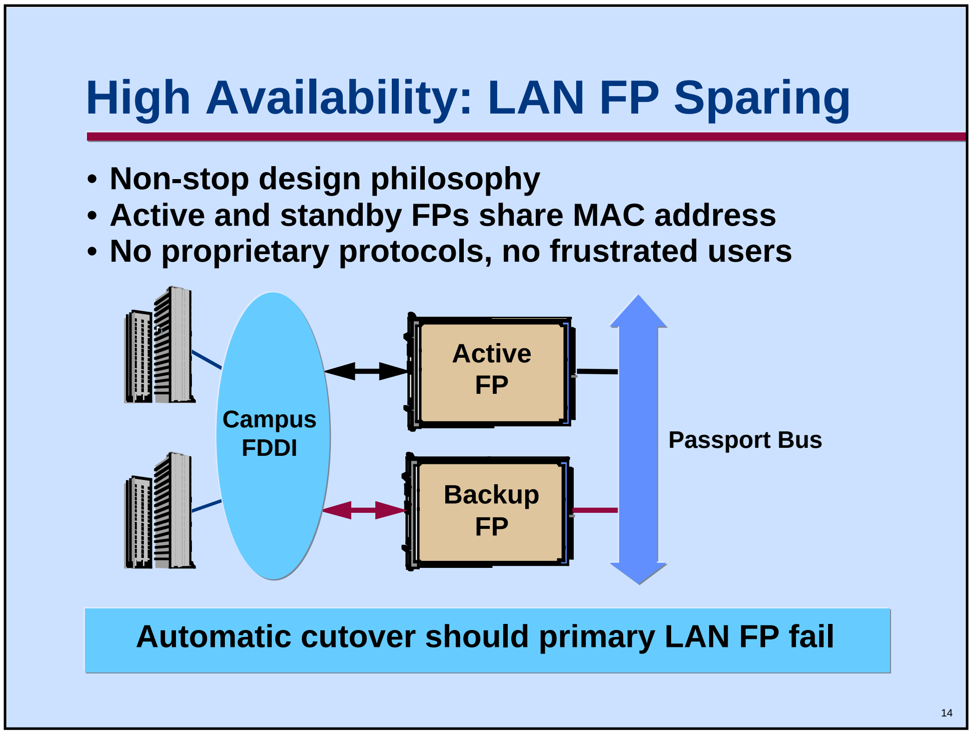


Cluster bridging combines the capabilities of a multi-port bridge and a router in one Passport switch. Normally, packets are routed unless their network protocol is unknown or unroutable—in which case they are bridged (i.e. forwarded according to layer 2 information).

Cluster bridging reverses this priority, by bridging packets within a group of LANs (a "workgroup"), and routing packets only when they are destined outside the group.

This provides protocol transparency within the group, so several different network protocols can be used easily. It also simplifies moves and changes, because a station may be moved from one LAN in the group to another without needing to change its network address.

The router function provides a firewall to allow free exchange of information within the group, while controlling what kind of information leaves or enters the group.



Functional processors may be configured with redundant “standby” FPs attached to the same media. Both FPs share the same MAC address. If the active FP should fail, the standby automatically takes over and starts accepting packets. This approach insulates the user from router failure, automatically cutting over to a duplicate backup “router” without resorting to proprietary protocols.

Agenda

- Trends in network evolution
- Magellan values: regional
  - LAN/WAN interface and protocol diversity
  - scalable platform
- Magellan values: network-wide
- Evolution to ATM

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LAN/WAN Interface and Protocol Diversity

Routing Protocols

- OSPF
- EGP
- APPN
- RIP
- Appletalk II+

Network Protocols

- TCP/IP
- IPX
- Appletalk+

WAN Protocols

- PPP
- X.25
- Frame relay (1490)
- ATM UNI (1483) +
- SMDS +

Bridging Protocols

- Transparent (802.1d)
- Translational (8209, ENET/ FDDI)
- Source route
- Source route transparent

Functional Processors

- Token ring, ethernet, FDDI
- T1/E1, T3/E3, V35/V11
- OC3/STM1+

+ Planned Capability

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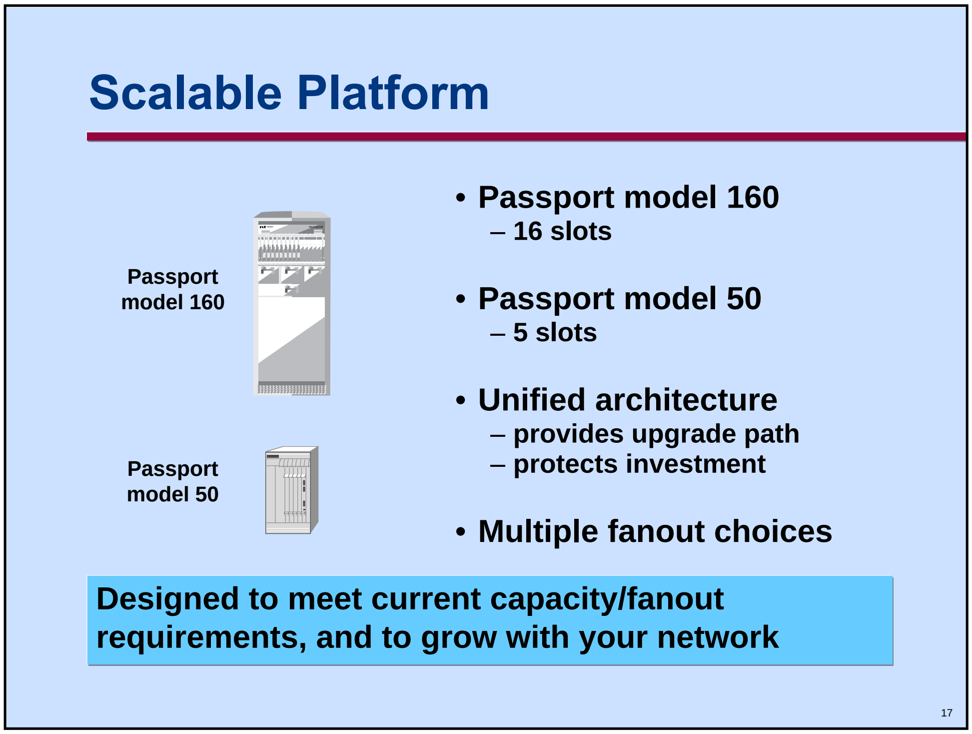
In addition to the above, the following protocols are under consideration: BGP-4, NLSP, Decnet and X.25 DDN.



With five slots, the Passport model 50 is targeted at a standard regional office. FPs are available in multiple fanout configurations (4 port versus 8 port, as well as integrated CP and FP) allowing customers to pick the most cost-effective configuration for their environment.

In addition, all Passport platforms share the same architecture so FPs are interchangeable from one Passport model to the next. This provides a cost-effective migration path that follows network growth and provides network managers with the flexibility to re-deploy network assets, as required.

Agenda

- Trends in network evolution
- Magellan values: branch
  - MAS LAN services
  - Oscar LAN services
- Magellan values: network-wide
- Evolution to ATM

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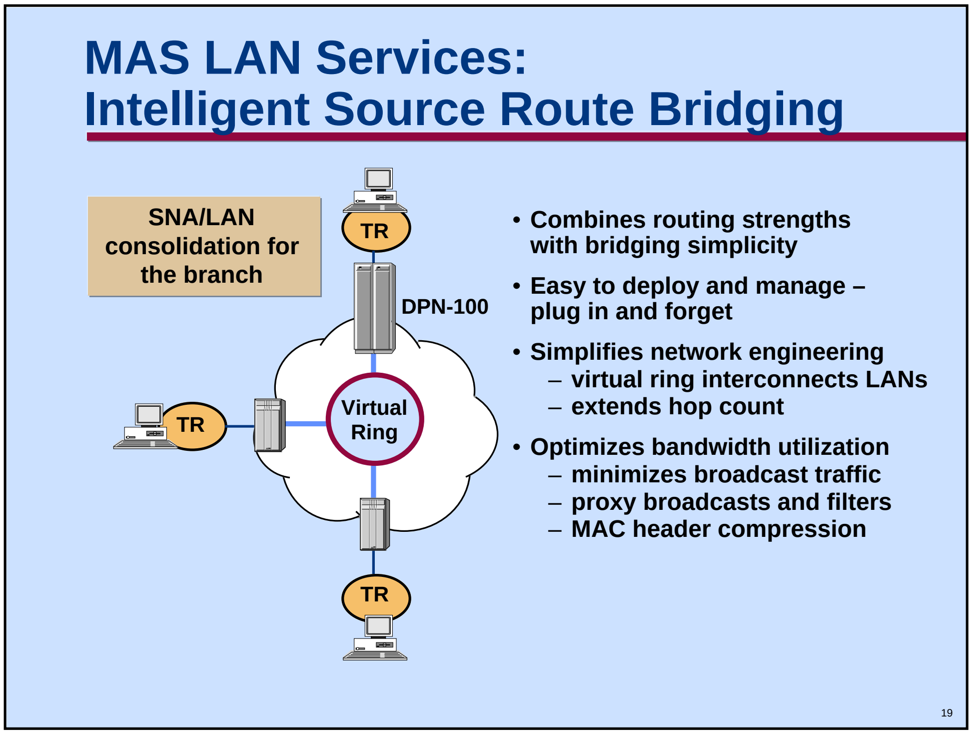
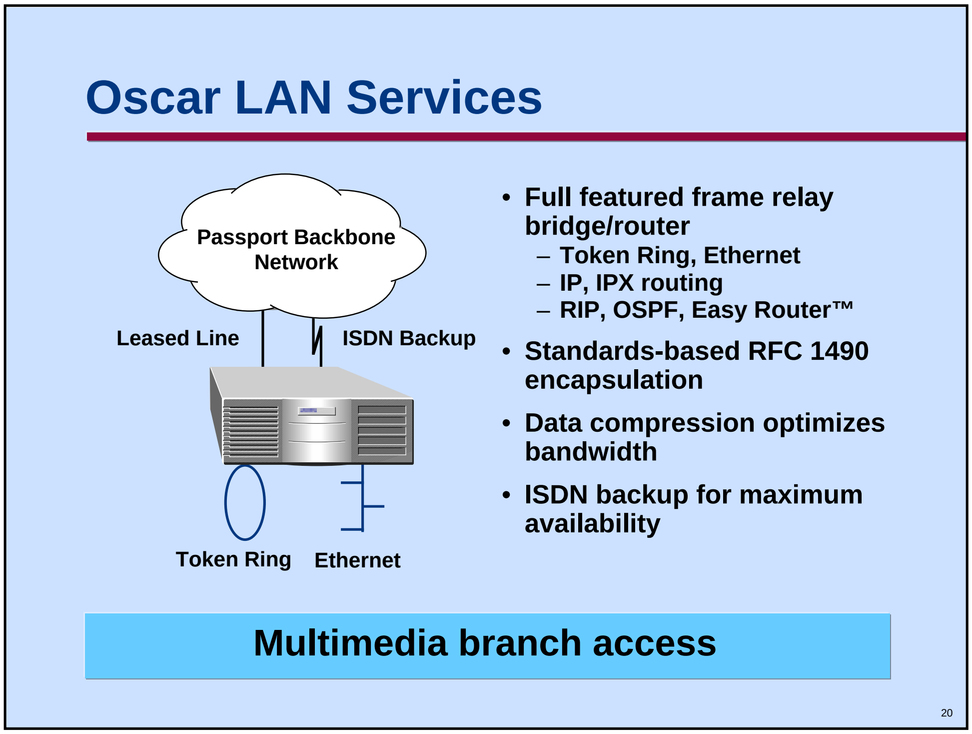


ISRB is a bridge/router in that it overcomes the limitations of traditional bridges. It dynamically interconnects token ring LANs (which view the Magellan backbone as a virtual token ring LAN), extending hop count and allocating bandwidth as required. Unlike traditional bridges which do not provide traffic and flow control functions, ISRB provides committed information and burst rate capabilities that reign in bursty LAN traffic.

ISRB allows network administrators to control which users, protocols and servers are allowed on the network by filtering on token ring number, MAC and SAP. Proxy agents stop identical SAP, RIP and NetBIOS broadcasts from traversing the WAN, while MAC header compression reduces overhead by up to 80%.

The above features serve to stop bandwidth-insensitive LAN traffic from crippling the WAN, an all too common occurrence when a large number of LANs are connected over relatively low-speed links. Although ISRB provides capabilities typically found in routers, it shares the any-to-any connectivity, and the easy-to-deploy and manage nature of bridges, without the complexity or overhead of routing.



Two versions of Oscar will support either a direct token ring or an ethernet LAN connection. Oscar will support full routing of LAN protocols including IP, IPX, Appletalk and Decnet. In addition Oscar will support an "access routing" protocol to simplify branch configuration and minimize network link utilization.

Additional bandwidth savings can be realized through Oscar’s data compression service, while support for a backup ISDN link ensures mission critical applications keep running should to the primary link fail.

Agenda

- Trends in network evolution
- Magellan values: campus, regional, branch
- **Magellan values: network-wide**
  - simplified network engineering
  - security and firewalls
  - bandwidth management and COS
- Evolution to ATM

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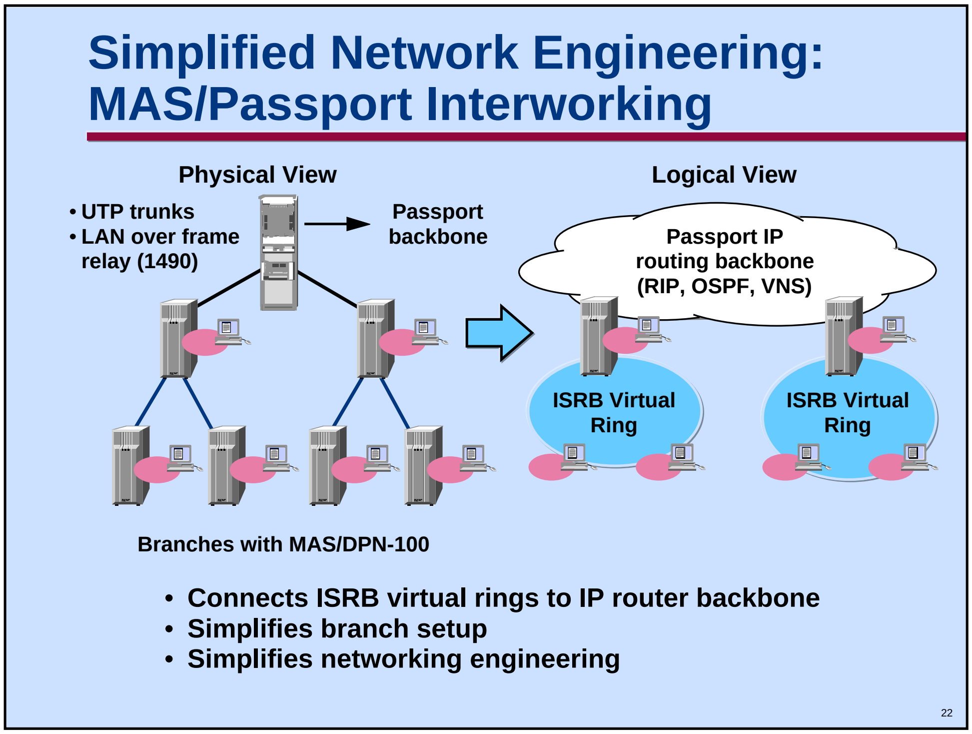


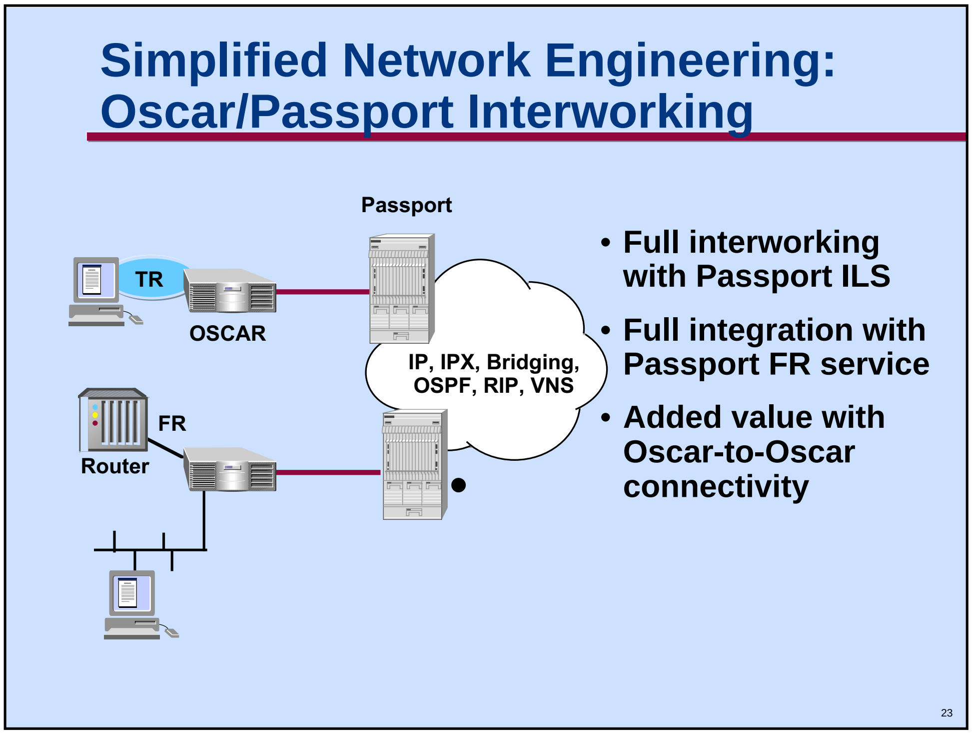
While ISRB is optimized to provide LAN interconnection for regional user communities, it does not scale to large networks. ISRB user communities can be interconnected via a Passport IP backbone which can also provide the basis for corporate-wide, IP-based client/server applications.

ISRB interoperates with Passport by encapsulating token ring frames using the RFC 1490 bridged frame relay format and feeding those frames to the interLAN switching (ILS) module on Passport through a Magellan VC (see diagram below):

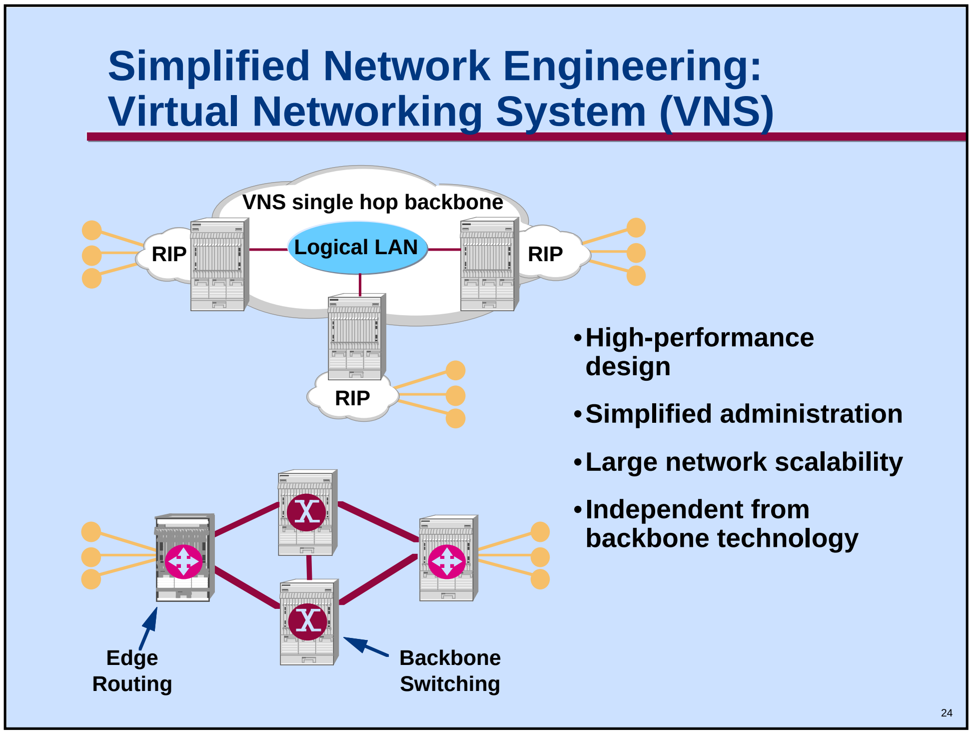
UTP	Magellan VC	1490 Bridged Header	Token Ring Frame

To Passport, each ISRB virtual ring appears as a logically attached LAN. To IP hosts on an ISRB virtual ring, the Passport backbone appears as a default or local router.

This approach simplifies network engineering and minimizes WAN traffic by greatly reducing the number of routers required in the network. WAN traffic between ISRB/ Passport link is minimized via implementation of ISRB filters.



- Full interworking with Passport interLAN switching (ILS)
  - full featured bridge/routing
  - 1490 encapsulation
  - multiple backbone routing options
- Full integration with Passport frame relay service
  - Prioritization on ingress/tandem/egress
  - Frame relay PVC backup resiliency
- Oscar-to-Oscar value added:
  - compression for optimal bandwidth utilization
  - Easy Router™ simplifies network engineering for small router networks



Passport's virtual networking system (VNS) is designed to simplify network engineering while reducing latency associated with backbone transit.

High performance design

- Single "hop" to peer routers
- Minimal processing in tandem/backbone nodes—edge routing, backbone switching
- Reduced route table size and processing in access hubs and routers

Simplified administration

- Backbone appears as logical LAN to peer routers with all nodes one hop away
- Each logical LAN is automatically and dynamically configured. Network administrators simply configure endpoint to belong to logical LAN—no need to maintain complex PVC mesh
- Single, intelligent routing protocol in backbone

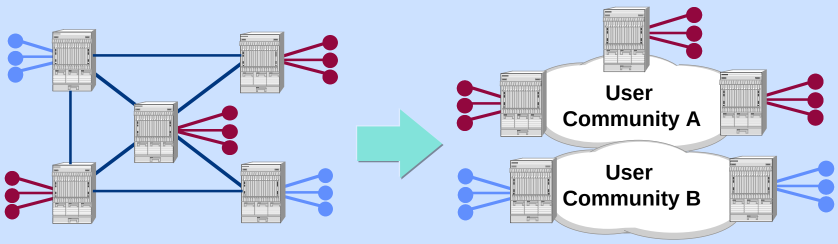
Large network scalability

- Logical LAN unicast/multicast facility minimizes WAN chatter
- Extends scalability of RIP by creating two-tier routing protocol hierarchy

Independent from backbone technology

- VNS is supported over backbones that support one or more of the following: frame/cell, ATM PVC and ATM SVC. This protocol transparency ensures smooth transition of backbone technologies from the standpoint of LAN interconnection, and is unique in the industry

Simplified Network Engineering: Virtual Networking System



- **Multiple logical networks over same backbone**
- **Traffic separation for:**
  - multiple internal networks
  - class of service offerings
  - security

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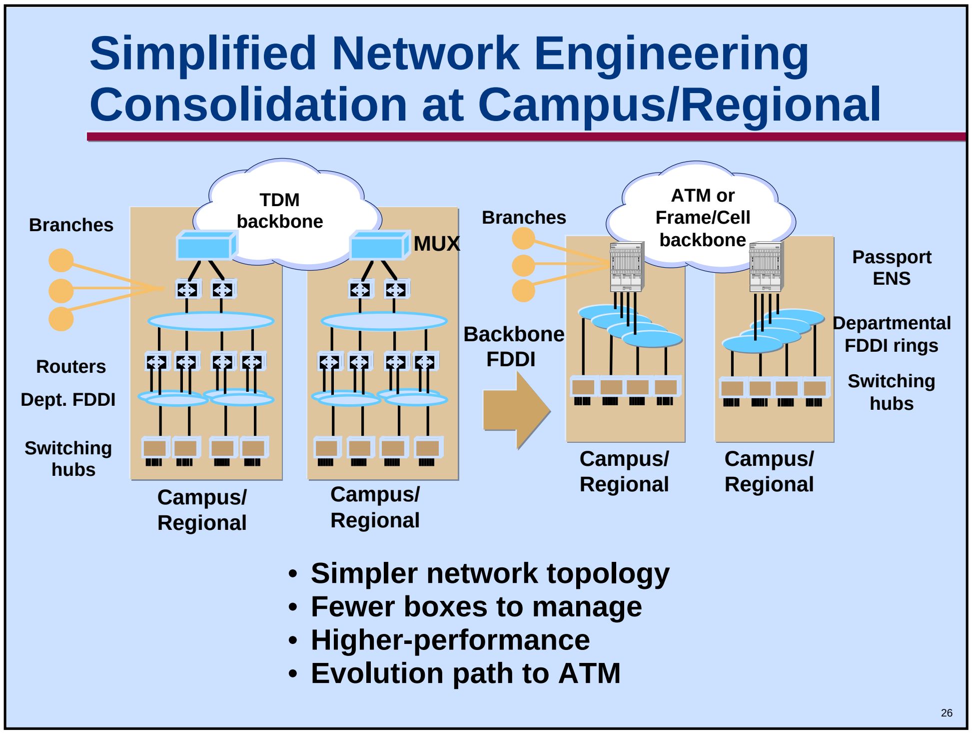
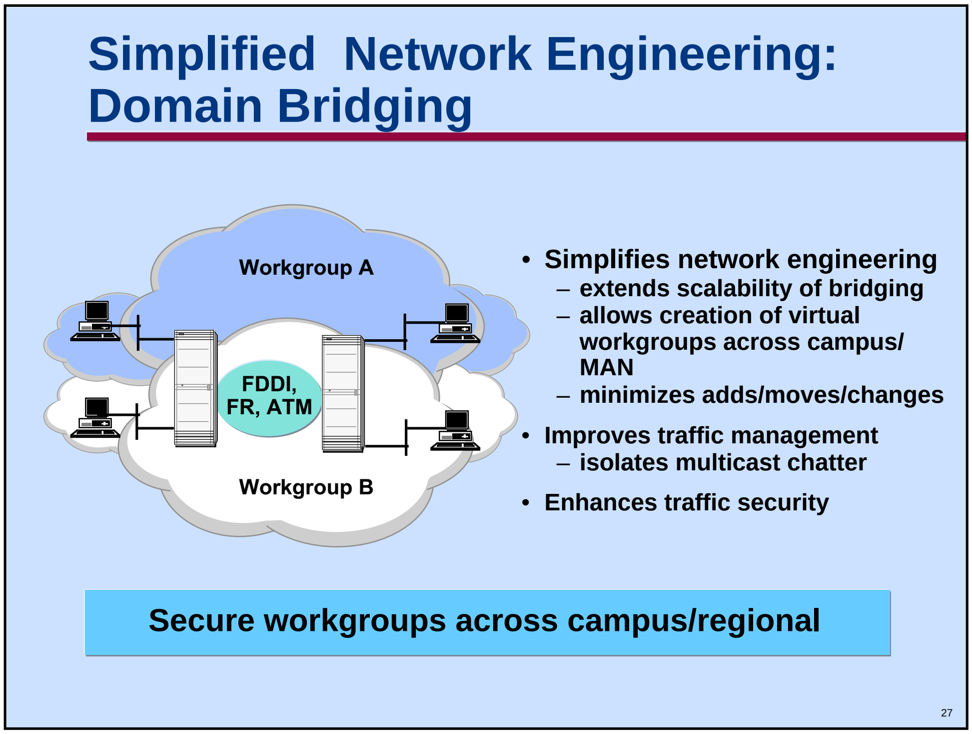
VNS also allows a single physical network to be partitioned into multiple logical networks. Each logical network is a wholly separate instance of VNS to ensure secure partitioning.

Application scenarios include corporations with multiple subsidiaries, government organizations with multiple, independent agencies, etc. These organizations wish to provide separate networks to their subsidiaries while maintaining the economies of scale provided by a single physical network.

Since each trunk can be configured to support specific instances of VNS, network administrators can decide which Passport links can be utilized by each user community. This partitioning allows for class of service offerings, with higher-speed links reserved for user communities with mission critical network applications.



Passport's high capacity and fanout characteristics allow network managers to collapse multiple boxes in in-building/campus and large regional environments into one or more Passports. This consolidation simplifies network management in that there are fewer boxes to support and manage, and simplifies network engineering in that there are fewer peer routers in the network topology. Consolidation also improves performance by minimizing routing latency and provides a clear migration path to a switched ATM environment.



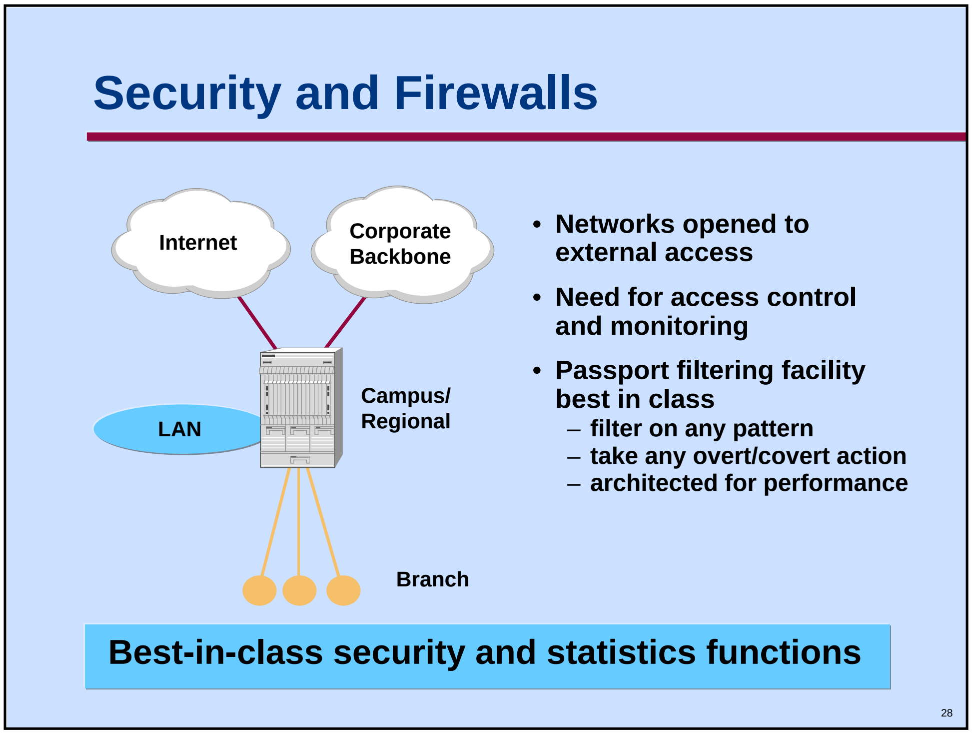
Domain bridging allows the formation of logical workgroups across a campus/regional network.

In the context of domains, there are two types of ports on Passport:

- **Access ports** can belong to one (and only one) domain and hence can only carry traffic associated with its domain
- **Backbone ports** can belong to multiple domains and can carry traffic associated with all domains

The port types allow a bridged network to be split into a set of independent logical LANs across a common backbone

Each independent logical LAN can maintain its own spanning tree thus isolating it from topology perturbations in the other co-resident LANs, and enhancing traffic security.



Access control and monitoring capabilities are required to stop external intruders from entering the corporate network and to limit external access for local users. The need for these firewalls has been mandated by current trends to open corporate networks to external access through file sharing with a partner corporation, or via a hookup to the Internet. A single, popular web site can easily swamp bandwidth and bring a network to a crawl.

Security gateways are best implemented at centralized locations with network switches that have the capacity and performance to filter frames from a large number of remote users. As such, Nortel has focussed on providing best-in-class filtering and security capabilities on Passport as follows:

Routing
- Count number of packets between any source and destination
- Collect user-specified statistics by source and destination
- Permit/restrict connectivity between source and destination
- Take overt or covert actions based on packet content and address
- Perform type of service routing based on packet content

Bridging
- Selectively bridge packets based on type and content
- Separate bridged traffic into distinct bridging domains
- Disallow broadcasting by port
- Disable learning by port (static tables)
- Perform translational bridging of IPX frames adapting header to next hop media

Security
- Generate and check network layer extended security options per DNSIX
- Generate and check basic security options in IP packets per RFC 1108
- Filter tables loaded on each FP to minimize latency

Bandwidth Management and COS

- SNA/LAN/voice consolidation
- Dynamic bandwidth allocation
- Multiple Priority System
- End-to-end prioritization
- Congestion management and avoidance

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At the core of all Magellan products that support network consolidation are sophisticated bandwidth management and prioritization capabilities. These provide optimal bandwidth utilization while ensuring the integrity of delay sensitive traffic in the face of bursty LAN traffic, and are collectively referred to as the Magellan Multiple Priority System (MPS).

Where most other vendors' prioritization schemes apply only at the network edge, MPS provides end-to-end COS. MPS mappings apply at the edge of the network to resolve contention for bandwidth-limited branch links, at tandem nodes where switches must prioritize traffic in a manner that minimizes latency for delay sensitive traffic, and at the egress of the backbone network where an edge switch must again resolve contention for the bandwidth limited branch link.

The Magellan frame relay service also provides congestion management features such as CIR throttling that slows down the rate at which data enters the backbone network at times of congestion.

Agenda

- Trends in network evolution
- Magellan values: campus, regional, branch
- Magellan values: network-wide
- **Evolution to ATM**
  - **in-building/campus**
  - **campus/WAN**

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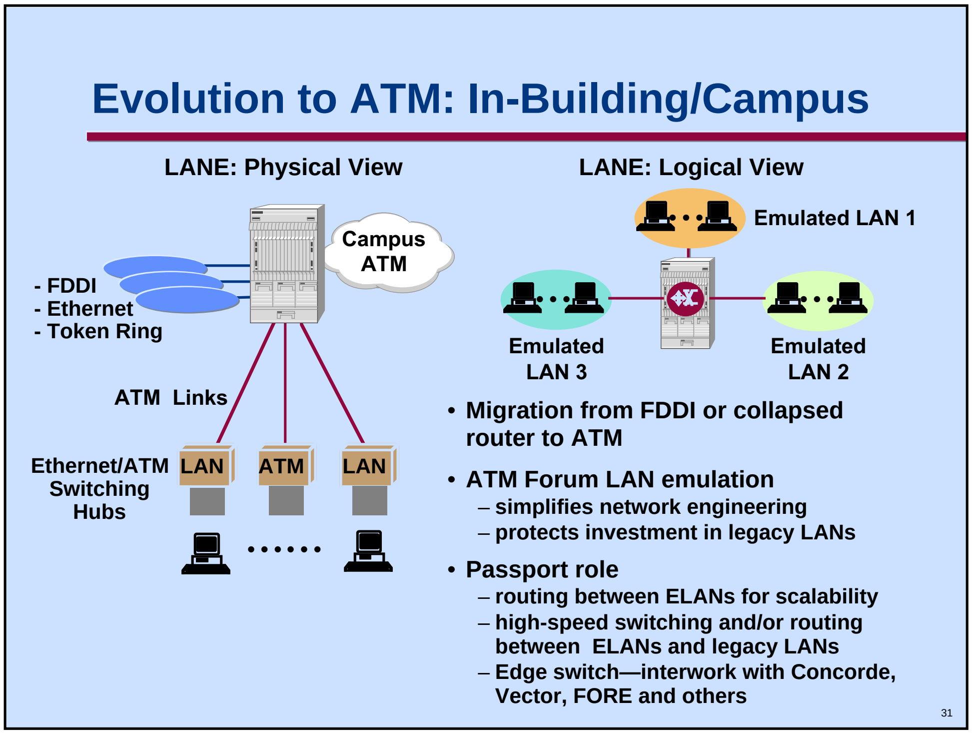


For corporations implementing ATM to the desktop, the LAN emulation (LANE) standard enhances their investment in legacy LAN software and equipment by defining how ATM devices can emulate legacy LAN services across an ATM network. LANE supports connectivity between LAN-LAN, LAN-ATM and ATM-ATM end stations. Essentially a layer 2 switching protocol (i.e. bridging), it also defines support for legacy bridging standards such as source route and transparent bridging. LANE can be implemented in ATM switches, routers, bridges or dedicated workstations. LANE will be implemented on Passport in two phases.

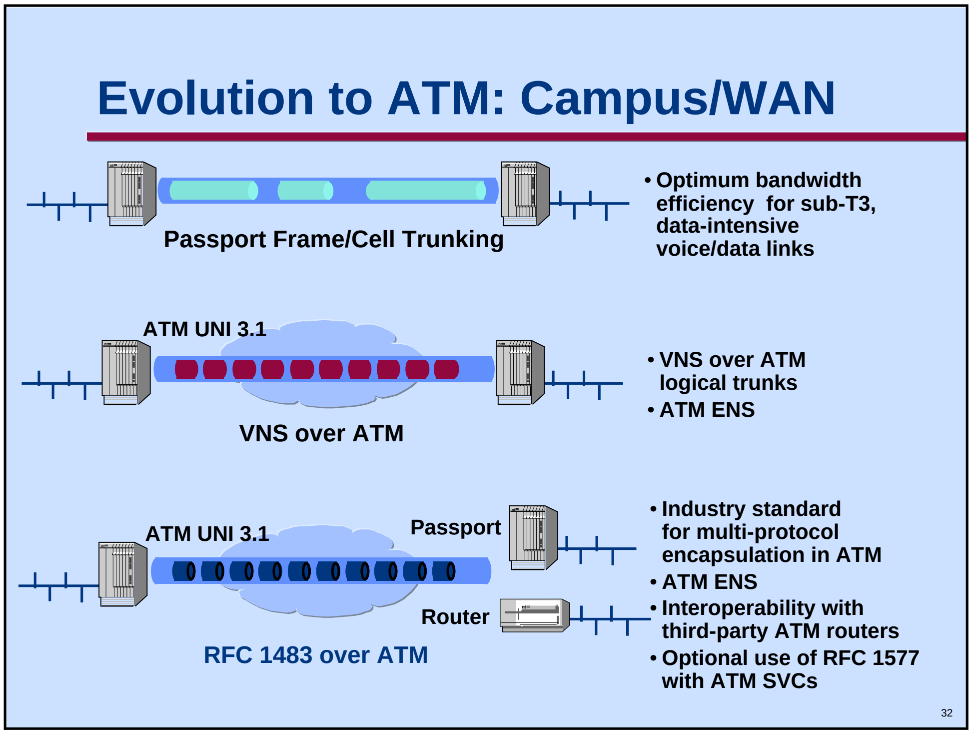
In the first phase, only the LAN emulation client (LEC) will be supported; LANE server functions will be provided by deployed devices such as ATM switches or hubs. In this scenario, Passport will:

a) provide routing and bridging functions to interconnect ATM-emulated LANs (ELANs) with legacy LANs (token ring, ethernet, FDDI)

b) route between local or remote ELANs to alleviate large network scalability problems associated with LANE

c) provide the ATM fabric required to implement LANE (i.e. in conjunction with Magellan and FORE ATM switches and switching hubs)

LAN emulation server components will be added in the second phase. This will allow Passport to fully implement ELAN services, even if no additional ELAN servers are deployed in the network.



Virtual Networking System (VNS)

VNS resolves many of the problems to be addressed by the ATM Forum in its multi-protocol over ATM (MPOA) effort. Although not a generally available standard, VNS provides added value in that it is available today (MPOA may take up to two years to hit the marketplace), and that it works transparently over frame/cell, ATM PVC and SVC networks. Customers can implement VNS and migrate to MPOA once it is generally available in LAN/ATM products.

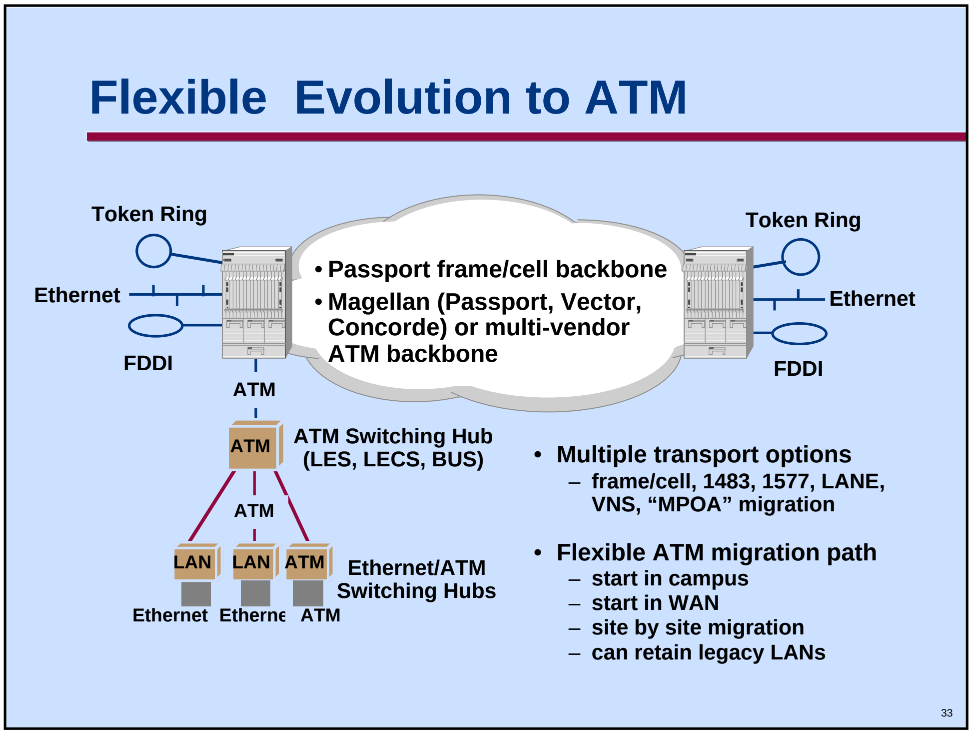
RFC 1483

Support for RFCs 1483 and 1577 will allow Passport to interconnect LANs by bridging or routing over ATM switched virtual circuits (SVCs) or ATM permanent virtual circuits (PVCs). The ATM virtual circuits will serve as logical replacements for private or switched lines.

RFC 1483 defines encapsulation techniques for transporting various types of data over ATM, setting the stage for multi-vendor interoperability over ATM. RFC 1483 will allow Passport to interconnect LANs over ATM for via industry standard bridging and routing protocols.

When routing IP over ATM PVCs, the inverse ARP protocol is used to build the ATM-to-IP translation table. When ATM SVCs are available, this table must be provisioned manually, or replaced by an ARP server as per RFC 1577.

RFC 1577 describes the functionality of the address resolution protocol (ARP) and route servers that help in the dynamic route discovery and configuration of IP routers or workstations connected using ATM SVCs.


Flexible Evolution to ATM
Token Ring
Ethernet
FDDI
ATM
• Passport frame/cell backbone
• Magellan (Passport, Vector, Concorde) or multi-vendor ATM backbone
Token Ring
Ethernet
FDDI
ATM
ATM Switching Hub (LES, LECS, BUS)
ATM
LAN
LAN
ATM
Ethernet/ATM Switching Hubs
Ethernet
ATM
• Multiple transport options
– frame/cell, 1483, 1577, LANE, VNS, "MPOA" migration
• Flexible ATM migration path
– start in campus
– start in WAN
– site by site migration
– can retain legacy LANs
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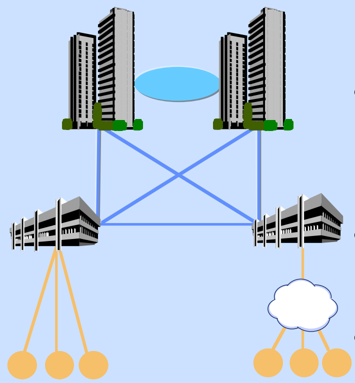
Summary



Magellan InterLAN products

- **Optimized for campus, regional, and branch applications**
- **Synergistic, network-wide solutions**
- **Flexible ATM evolution path**

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More information included in related workshops:

• DPN-100 ISRB Engineering and Scalability Guidelines	Gary Palmer
• Magellan Access Solutions	Adrian Hatcher
• LAN Applications on Passport	Rob Tomkins
• Multimedia Branch Access Solutions	Richard Mayer