Next-Generation Retail Networks

Future-Proofing and

Bullet-Proofing the

Store Network

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In today's highly competitive retail environment, real-time information access is fast becoming the retailer's most critical asset. Market and technology changes are transforming the retail enterprise into an information-rich, networked system that is differentiated on the basis of personalized services and products. Legacy "first-generation" store networks and proprietary POS systems cannot handle the challenges of this new environment. Today's retail IT organization must support new technology initiatives that achieve both cost reduction and revenue enhancement, and these initiatives are increasingly network dependent.

To meet the business needs of retailers, the next-generation enterprise store network architecture must meet the following challenges:

- *Future-proof the LAN and WAN by dynamically delivering the right amount of bandwidth performance to individual applications or users, and by cost-effectively scaling (either incrementally or by order of magnitude) when needed*
- *Bullet-proof the LAN and WAN by offering unprecedented levels of fault tolerance and network availability, particularly for mission-critical POS, pharmacy, and property management (lodging) applications*
- *Reduce the cost of network ownership while delivering comprehensive network management*

This white paper examines the driving forces behind the need for change in retail enterprise/store network architectures. It describes recent innovations in enterprise network technology—innovations that offer exciting new solutions for retail networks. It includes examples of retailers that have deployed next-generation networks using 3Com products. The paper will be of interest to retail IT professionals planning the replacement of a legacy POS system or the deployment of new multimedia kiosk systems, wireless applications, or bandwidth-hungry, WAN-based intranet, video, and voice applications.

The Business Opportunity: A New Retail Paradigm

In the past, value creation and profitability for large retail organizations has depended on how well the business was organized around merchandise and real estate. Information was centrally controlled, suppliers were driven in win/lose adversarial relationships, and retailers competed largely on the basis of price. But pervasive network infrastructure is now enabling the breakdown of traditional boundaries in the value chain between manufacturers, distributors, retailers, and customers. These changes let retail organizations create customer-focused interactions in ways that were never before possible.

In today's hyper-competitive world, the retailer's most critical assets are shifting from inventory and real estate to real-time information access. It no longer matters where the information or the applications reside. The retail enterprise is becoming an information-rich, networked system that delivers personalized services and products on an individual customer basis. Customer information is being leveraged to reveal new and overlooked business opportunities, define target market segments, support marketplace alliances, and turn customer service into a competitive advantage.

Historically, most large-format store retailers have invested heavily in distributed in-store systems for both point-of-sale (POS) and back-office functions. But the IT organization's ability to fully leverage these investments has been impeded by the cost and complexity of deploying and managing a distributed, multivendor, multiplatform store environment. Faced with relentless competitive pressures and shifting consumer lifestyles and preferences, today's retail IT organization must respond with initiatives that achieve both cost reduction and revenue enhancement.

Recent advances in software and networking technologies, together with the widespread use of the public Internet, have led to a fundamental shift in thinking about how retailers can best implement new business processes and applications. Retailers are now beginning to strategically leverage their

Acronyms and Abbreviations

ATM
Asynchronous Transfer Mode

ISDN
Integrated Services Digital Network

FDDI
Fiber Distributed Data Interface

IMA
inverse multiplexing over ATM

JPOS
Java-based point of sale

NIC
network interface card

OLE
Object Linking and Embedding

OPOS
OLE for point of sale

PBX
private branch exchange

POS
point of sale

network infrastructure, shifting from a complex, costly, and difficult-to-manage distributed database/application architecture to one that reduces complexity and cost by centralizing information resources and delivering real-time information access to the store.

In this new, network-centric paradigm, Java-based applications, together with a ubiquitous, browser-based interface, enable real-time access to data whether it resides in the store, in the corporate or regional office, or even in suppliers' systems. By deploying new applications together with more intelligent and robust networks, forward-thinking retailers are finding that they can reap substantial benefits, including:

- Enhanced business opportunities from new revenue-producing services
- Tighter integration between in-store and enterprise applications and data
- Reduced systems development time and maintenance costs
- Faster response time in a continuously changing market
- Stronger customer loyalty as a result of more consistently meeting customer needs

But yesterday's proprietary POS systems, legacy back-office applications, and aging network infrastructures won't support the applications being developed today. And the significant growth in traffic over the network infrastructure presents serious challenges to the retail IT organization. To achieve the benefits of real-time information access, store networks must deliver unprecedented performance, scalability, and reliability. Because investments in networked store systems represent the single largest network capital expenditure for retailers, the next-generation store network architecture must future-proof the enterprise against tomorrow's high-bandwidth LAN and WAN applications, bullet-proof it for maximum uptime and reliability, and equip it with effective, proactive systems management.

In this new retail world, application development cannot be effectively planned and budgeted without first understanding the network implications and requirements. This understanding will allow non-network IT professionals to assess the performance, reliability, and scalability factors so important to application success.

Today's Retail Network Profile

Most large-format stores today run on first-generation back-office LANs that connect PCs and terminals to an in-store server running UNIX, OS/2, or increasingly, Windows NT. These back-office networks typically have less than 30 nodes and are characterized by shared technologies, low bandwidth, and little or no manageability. Applications run on shared 10 Mbps Ethernet or 4/16 Mbps Token Ring hub-based workgroups. A typical store associate's edge device (POS terminal, PC workstation, or wireless handheld device) realizes at most 3 Mbps of actual bandwidth. This limited bandwidth has been sufficient to support predominantly character-mode, operations-driven applications such as inventory and labor management, and line-of-trade specific applications such as pharmacy. Customer-critical applications like POS and pharmacy typically run on dedicated servers supporting a small number of PCs or terminals to ensure adequate application performance and reliability.

Back-office LANs typically coexist with, but are distinct from, proprietary POS systems that frequently date back 8 to 12 years or more. The self-contained, legacy POS systems are limited by smaller screens, 286- or 386-based processors, and a closed architecture that limits integration of new technologies and applications and results in higher maintenance costs. POS servers are typically deployed in a redundant configuration that offers a very high degree of system availability. Both the back-office applications and the POS system use isolated data applications and repositories that make information exchange difficult at both the inter-store and intra-store levels.

Ironically, the network is often the weakest link in the legacy POS system. Given the customer-critical nature of the POS system, retailers have historically paid a premium for third-party solutions that attempt to overcome some of the inherent weaknesses in proprietary

Acronyms and Abbreviations

PSTN
public switched telephone network

RMON
Remote Monitoring

RSL
Resilient Server Link

SNA
Systems Network Architecture

SNMP
Simple Network Management Protocol

TCP/IP
Transmission Control Protocol/Internet Protocol

VLAN
virtual LAN

VLT
Virtual LAN Tagging

VOIP
voice over IP

VSAT
very small aperture terminal

POS network implementations. In addition to their reliability and cost problems, these systems often lack any real traffic monitoring or data collection capabilities for proactive management and network planning.

In the WAN, many large-format store retailers have migrated from leased lines and X.25 to VSAT and/or Frame Relay networks. But the number of client/server and browser/server applications continues to grow, drawing the retailer ever closer to the bandwidth limitations of the existing WAN infrastructure. What's worse, today's Frame Relay and VSAT networks don't dynamically allocate bandwidth among applications, so expensive voice bandwidth is generally unusable for data and video applications. This expensive "idle bandwidth" problem is becoming a key issue for those retailers that are beginning to require more data bandwidth than their frame network currently offers. Ideally, they should have the flexibility to utilize their total voice/data WAN bandwidth in the manner that best meets their overall business objectives.

Business Requirements for the Next-Generation Retail Network

The growing number and diversity of store applications being deployed today, both in the in-store LAN and the enterprise WAN, are driving the need for greater network performance, scalability, reliability, and management (Figure 1). The need to integrate both the in-store LAN and the enterprise WAN into a

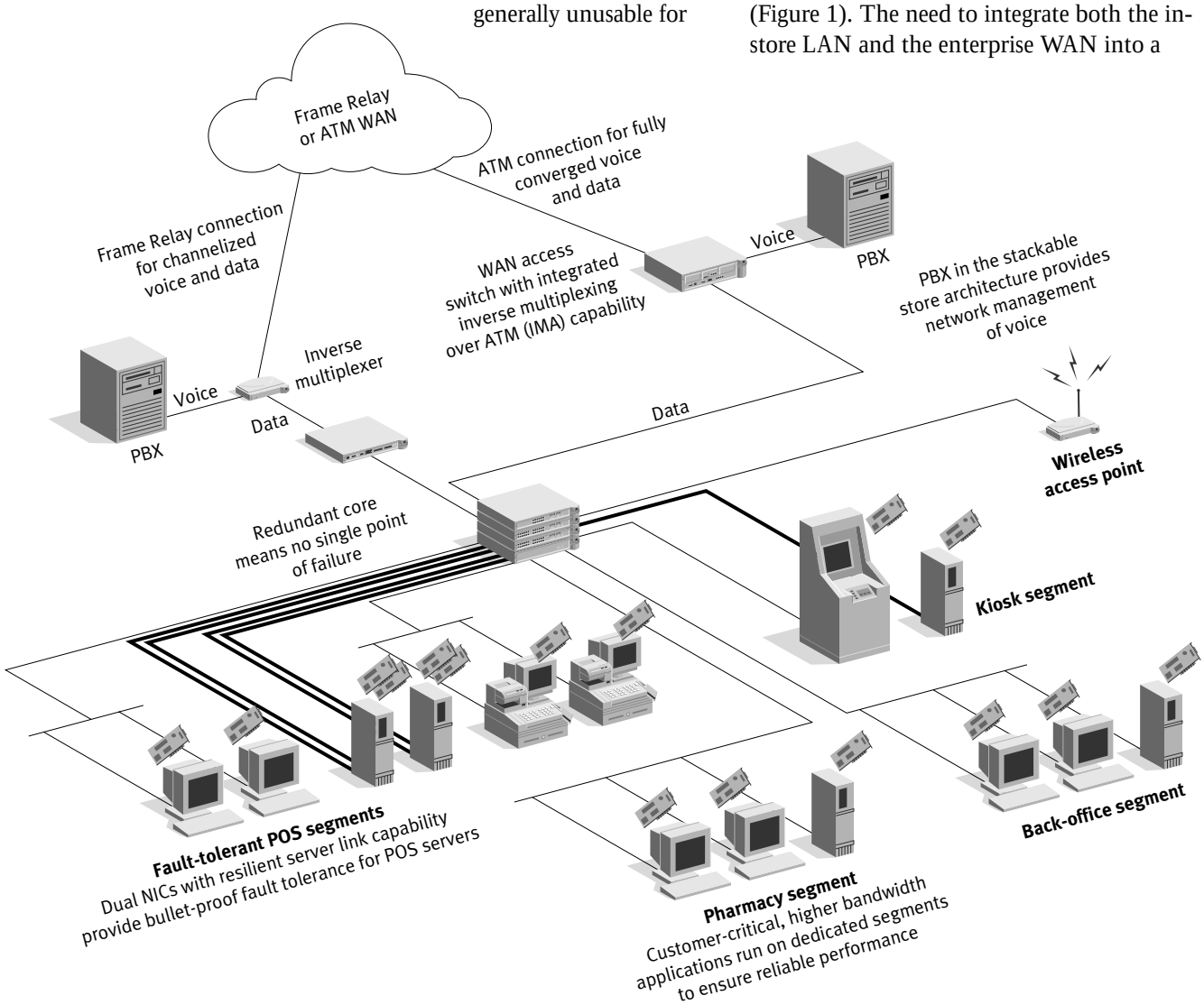

Figure 1. *Next-Generation Enterprise Store Network*

single, cohesive enterprise architecture capable of supporting this diverse set of applications is driving the re-engineering of the retail information infrastructure. In the process, the nature of the store network itself is being fundamentally redefined. Four basic changes present dramatic new challenges to the retail IT organization:

- The shift to a database/application architecture that centralizes information resources while delivering real-time information access to the store creates completely new traffic flows over the corporate backbone and enterprise WAN. With the use of a browser interface, enterprise applications such as human resources, data warehouse/decision support, and e-mail are now available online to store associates. Legacy back-office and POS workgroup traffic flows were predictable and mostly confined within the workgroup segment. The open networked computing model gives users immediate, browser-based access to data located anywhere on the enterprise network, making traffic patterns highly unpredictable.
- New bandwidth-hungry applications are beginning to be deployed, including voice-over-IP (VOIP)–enabled telephones and multimedia kiosks in the LAN, and video-based security, training, and collaborative applications over the WAN. To handle these applications, the WAN and LAN infrastructures must be capable of giving appropriate priority to diverse traffic types—including data, voice, and video—in order to make the most cost-effective use of bandwidth resources.
- The massive growth in network scale as legacy POS systems residing on a separate, proprietary network are replaced with Ethernet-based, open POS systems and combined with multimedia kiosks and the back-office store LAN. For example, a department store Ethernet network can easily grow from 30 nodes in the back office to more than 200 nodes when POS terminals and servers are included. Even a typical supermarket or discount store with a back-office LAN consisting of one server and ten PCs or terminal workstations can quickly expand to three servers and 40 nodes with a integrated network.The next-generation store network must be capable of scaling to support an increasing number of interconnections as well as increased bandwidth demands.
- Supporting an ever-growing number of stores and applications brings complexity and an increased workload that can overwhelm an IT organization. A next-generation network solution must provide a way to centralize network management of both voice and data while curtailing telecommunication costs.

Yesterday's first-generation shared Ethernet/Token Ring LANs and channelized VSAT/Frame Relay WANs cannot effectively address tomorrow's emerging application requirements. More intelligent networks—capable of supporting this more diverse set of store applications and network traffic and designed with scalability, application performance, and availability in mind—are critical for this new store environment.

To meet the business needs of retailers, the next-generation enterprise store network architecture must meet the following challenges:

- Future-proof the LAN and WAN by dynamically delivering the right amount of bandwidth performance to individual applications or users, and by cost-effectively scaling (either incrementally or by orders of magnitude) when needed
- Bullet-proof the LAN and WAN by offering unprecedented levels of fault tolerance and network availability
- Reduce the cost of network ownership while delivering comprehensive network management

The following sections of this white paper describe these requirements in more detail and introduce innovative 3Com solutions.

Challenge #1: Future-Proofing the Store LAN

Today's demanding store environment, characterized by large-scale deployment of new mission-critical, bandwidth-hungry applications, requires far greater bandwidth and network intelligence. Yesterday's first-generation store

networks simply don't provide these capabilities. Designing in scalability means developing a future-proofed network solution that allows a retailer to cost-effectively increase network performance as application demands dictate, and varying bandwidth allocation depending on individual application requirements. In addition, the network must be able to support the growth in network nodes as new devices and users are added or new networking paradigms such as intranets are introduced.

In addition, the increase in the number of store networked applications and the emerging convergence applications such as voice-over-IP (VOIP), video-based security, multimedia kiosks, and computer-based training make it more critical to manage store network performance on an application-specific basis. In a next-generation network, much more intelligence must be built into the network—from the network interface card (NIC) to the edge/core switches.

The network solution must achieve these scalability and bandwidth management goals:

- Support back-office, POS, kiosk, and voice functions within a common network architecture
- Vary bandwidth to cost-effectively ensure performance on a per-application basis
- Cost-effectively and smoothly scale network performance to meet future application requirements and network growth

Two Views of Scaling Store Network Performance: Near-Term vs. Long-Term

Application performance in a networked environment is limited by three network-specific factors. First, typical shared Ethernet networks deliver closer to 3–5 Mbps performance than 10 Mbps. Second, too many network devices may have to share the limited bandwidth of a single LAN segment. Third, a high-performance network device or application such as a POS server or multimedia kiosk, which may require 100 Mbps of bandwidth, may be limited to the standard 10 Mbps. In all cases, poor application performance is the result. The challenge is to build in the flexibility to cost-effectively scale performance as needed over time. Nowhere is the scalability challenge more pronounced than in the replacement of legacy POS systems with new Ethernet-networked POS systems.

There are two scalability strategies that retailers can adopt today, depending on their time orientation, budget, and the aggressiveness of their application deployment plans. The first strategy takes a shorter-term or more moderate application view. It begins with the deployment of an adequate yet moderate amount of bandwidth today, with the assumption that, in three to five years, network bandwidth may need to grow to support new applications. Taking advantage of recent network innovations such as the segmented Ethernet hub, which collapses a switch and hub into a single network product, retailers for the first time can cost-effectively deploy a switched backbone at the store network core with shared Ethernet to the edge. This approach requires less investment up front, but will require incremental investment sooner, when more bandwidth-intensive applications are deployed.

The second strategy takes a longer-term or more aggressive application view. It deploys more network bandwidth in the beginning, either due to aggressive application deployment plans, or to ensure that no further network investment will be needed as new applications are implemented over the next several years. The switched network infrastructure will take the company much further into the future, but the initial investment is greater. This approach typically uses a combination of Ethernet switches and segmented Ethernet hubs, depending on the mix of applications and their performance requirements.

Which strategy is right for any particular organization depends on the pace and timing of planned application growth, the nature of the applications themselves, and the budget that senior management is prepared to commit up front to its store technology deployment. In either strategy, a future-proofed solution depends on designing a store network based on a stackable architecture that can easily scale and be reconfigured based on changing application requirements.

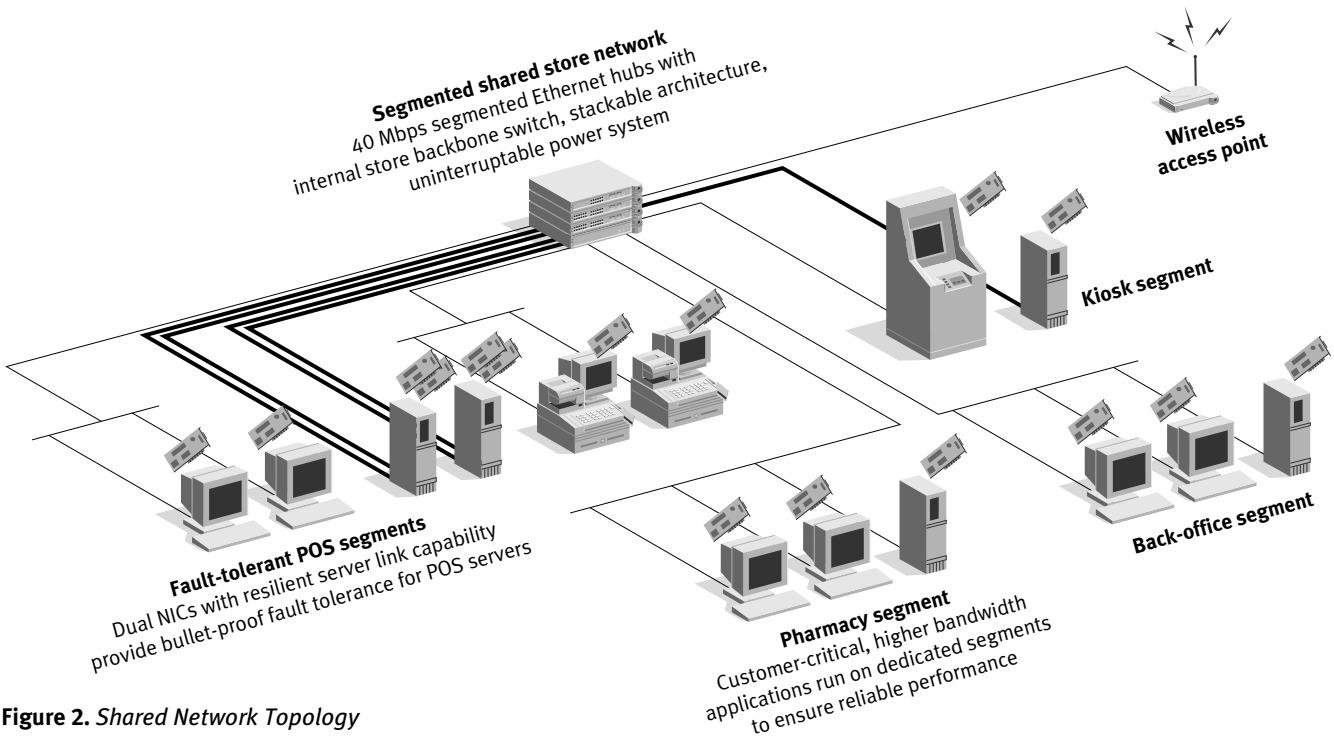

Figure 2. *Shared Network Topology*

Strategy 1: Shared Network Architecture

The successful near-term solution prioritizes bandwidth needs in a shared Ethernet environment, addressing the most pressing application needs first, while leaving room for future growth. This scenario assumes that application deployment plans are not aggressive for the next few years and that the applications deployed initially are not bandwidth-intensive in nature.

The ideal solution maximizes network performance cost effectively today within the constraints of a shared Ethernet environment, yet provides an easy path for adding more LAN segments and higher performance switched Ethernet ports in the future. This requires the right interplay of all network components including NICs, shared ports with a switched backbone, and a stackable architecture. Let's examine recent innovations in these network components to better understand how they integrate into an optimized shared network solution (Figure 2).

Scalable NICs. The link connecting network devices can quickly become a performance bottleneck. From a NIC perspective, future-proofing the network means installing auto-sensing 10/100 Ethernet NICs with Parallel Tasking® performance into all networked devices, including POS terminals, servers, electronic scales, customer service and store management workstations, and wireless gateways. Innovative 10/100 NICs support the devices at the edge on shared or switched 10 Mbps networks today, but when new applications requiring higher bandwidth are deployed, they automatically make the jump to 100 Mbps performance. 3Com's Parallel Tasking NIC architecture, not unlike multiprocessor servers, significantly increases overall network performance by allowing multiple tasks such as receiving and transmitting to occur simultaneously. NICs with Parallel Tasking performance not only maximize application performance today, but by extracting the maximum performance possible from shared Ethernet, they extend the life of the shared network investment by as much as two years.

Segmented Hubs with Fast Ethernet Downlink. In the Ethernet price/performance spectrum, a segmented hub sits between a hub and

a switch. A segmented hub offers four innovative features that are ideally suited to the retail store environment:

- It collapses an otherwise separate switch and four LAN segments into a single Ethernet hub, reducing cost and protecting application performance. For the first time, most large-format store retailers can cost-effectively deploy a switched backbone at the store network core with shared Ethernet to the edge. This switched backbone solution supporting LAN segmentation has previously been the province of only the largest stores.
- It delivers a total of 40 Mbps shared among 24 ports, letting store applications achieve far greater performance than was possible with first-generation, 10 Mbps shared Ethernet hubs. Segmenting a shared Ethernet network reduces the number of users per segment, which increases the average bandwidth available to each user and makes the network more responsive. The integrated switch in the hub speeds traffic between segments and avoids the heavy incremental cost of purchasing a separate switch. Each segment can be dedicated to a specific user group or application profile. For example, one segment can be configured for a pharmacy application, a second for back-office applications such as inventory and labor management, and the third and fourth segments for POS. This segmented architecture prevents a kiosk or back-office application from "stealing" bandwidth from the POS application. Each segment has its own bandwidth, and the IT organization can determine bandwidth allocation based on application priorities.

American Stores' Shared Segmented LAN

Supermarket giant American Stores, based in Salt Lake City, Utah, has installed a shared segmented architecture to create highly integrated store networks. SuperStack® II PS hubs, installed in more than 1,700 drugstores and supermarkets, give retailers a cost-effective, flexible way to intelligently allocate bandwidth to meet pharmacy and back-office application requirements. Both the main store server and the pharmacy server are connected to 100 Mbps ports for optimal server performance, while the PCs and other end devices supporting the pharmacists, store management, and associates are connected to 10 Mbps ports.

The segmented, intelligent stackable hub contains four discrete Ethernet segments, increasing the available bandwidth within the next-generation Ethernet hub from 10 Mbps to 40 Mbps. Due to multiple LAN segments, the back-office applications cannot interfere with the performance of the pharmacy application. For maximum flexibility, any of the ports can be assigned to any of the four Ethernet segments. Multimedia kiosks—supporting American Stores' customer loyalty program—or high-demand servers can be located on a dedicated segment to ensure bandwidth availability at the lowest possible cost. Less-demanding applications share bandwidth, but have the ability to draw on additional bandwidth when needed during peak traffic times through the hub's Automatic Load Balancing feature. The integrated switch in the SuperStack II PS Hub 50 switches traffic between each of the four LAN segments. In addition, an optional high-speed module can be plugged into the SuperStack II PS Hub 50 for a Fast Ethernet connection to the backbone.

Servers and workstations are equipped with 3Com EtherLink® 10/100 Mbps PCI NICs. The intelligence designed into 3Com's EtherLink 10/100 cards automatically senses the network backbone wire speed, while patented Parallel Tasking II architecture increases application performance by processing multiple network functions in parallel and delivering a continuous data stream from the network wire to the host.

- It can dynamically allocate bandwidth to meet user demand by configuring the hub to load-balance automatically at a preset time or whenever a threshold is exceeded.
- It supports 100 Mbps Fast Ethernet for either a downlink to other network core devices or for high-speed connectivity to store servers. Since server traffic is many times greater than most edge devices, this once again optimizes overall store application performance.

When application demands require more bandwidth than segmented hubs can provide, the hubs can be replaced with stackable switches. Each POS terminal or back-office PC can be connected directly to a dedicated 10 Mbps port on a hybrid Ethernet switch, while POS servers or multimedia kiosks can be connected to a dedicated 100 Mbps Ethernet port for maximum performance. Putting this into perspective, a 24-port Ethernet switch delivers 240 Mbps of bandwidth compared to a 10 Mbps first-generation Ethernet hub or the newer segmented Ethernet hub, which delivers an aggregate total of 40 Mbps.

Stackable Store Network Architecture. Scalability means being able to add functionality and performance in a modular fashion through new network products such as additional hubs, switches, or routers without sacrificing initial network investment and while maintaining a highly integrated network architecture. A stackable (vs. chassis-based) architecture, with its relatively low initial investment and incremental growth path, is very cost effective for an in-store network. Stackable architectures also offer a high degree of manageability, reliability, and integration, maximizing centralized management and minimizing downtime. This cost effective configuration lets retailers pay for only as much bandwidth as today's applications require, adding bandwidth easily in the future as needed.

Summary: Shared Network Architecture. Scalability in a shared Ethernet store architecture is accomplished through:

1. Auto-sensing 10/100 Ethernet NICs with Parallel Tasking architecture, which significantly increase POS terminal and client/server performance
2. Segmented hubs, which flexibly allocate bandwidth (aggregated 40 Mbps) per LAN segment within a single unit and use automatic load balancing to dynamically adjust bandwidth as needed without sacrificing application performance
3. Stackable architecture, which permits modular, economical expansion without sacrificing network integration

Strategy 2: Switched Network Architecture

Very large store architectures, typically deployed by hypermarkets and some department stores, have historically combined a high-performance network backbone, multiple Ethernet switches for LAN segmentation purposes, and shared Ethernet hubs, which typically were more cost effective in delivering connectivity to the POS terminals and servers. The network backbones, initially deployed with Fiber Distributed Data Interface (FDDI), have begun to migrate to Asynchronous Transfer Mode (ATM) for faster performance and expanded scalability.

However, the recent plummeting cost of switched Ethernet has enabled large-format store retailers to consider dedicated (not shared) bandwidth to the POS terminal and servers, increasing application performance while future-proofing their POS investment for many years to come. While this architecture may deliver more bandwidth than is required by some POS applications today, other in-store applications such as multimedia kiosks do require the bandwidth. And with the development of more multimedia and graphics-based applications, it is only a matter of time before switched 10 Mbps and even switched 100 Mbps bandwidth will be a requirement. With switched Ethernet to the POS terminal and servers, a newly deployed POS system can be expected to perform adequately for at least eight to ten years.

The ideal solution maximizes network performance cost-effectively today by delivering the right combination of dedicated (switched) 10 Mbps and 100 Mbps bandwidth to the network edge devices, and

Carnival Cruise Lines' Integrated Switched "Store" LAN

Carnival Cruise Lines, based in Miami, Florida, has integrated a range of value-added guest services into its onboard POS terminals, extending their capabilities far beyond the traditional point of sale. Interactive TV, instant credit card authorization in casinos, automatic teller machine (ATM) transactions, and virtual reality games offer passengers a new level of luxury, entertainment, and convenience. These services, however, demand a high level of bandwidth availability and network intelligence. 3Com EtherLink 10/100 NICs are installed in more than 80 POS terminals and servers. With Dynamic*Access*® software, including standards-based flow control and traffic prioritization capabilities, 3Com EtherLink XL NICs work actively with 3Com switches to regulate and optimize data transfer and prioritize mission-critical and latency-sensitive multimedia applications.

To supply the needed bandwidth, each POS terminal connects to a dedicated SuperStack II workgroup switch, which in turn connects to a CoreBuilder 7000 ATM backbone switch. The redundant network configuration affords a level high of fault tolerance to minimize the impact of at-sea electrical storms. In the event of a switch port going down due to electrical problems, the remaining POS terminals, each operating on its own dedicated port, remain unaffected.

supports VOIP, private branch exchange (PBX) integration, video, and other emerging convergence-related applications. But greater bandwidth is just the beginning. Perhaps more important, the intelligence required for more advanced network functions comes from the interplay between the NIC and the switch. Let's examine the components of a switched store network—including NICs, switched workgroups and backbone, and a stackable architecture—that provide the performance and intelligent control to support emerging applications (Figure 3).

Scalable NICs. As in the shared Ethernet scenario, 10/100 NICs deliver dedicated 10 Mbps Ethernet today, while paving the way for the inevitable migration to switched 100 Mbps Fast Ethernet in the future. While autosensing NICs and Parallel Tasking architecture play an important role in this scenario, far more crucial is the advanced functionality that an intelligent switched network provides.

Much of the advanced functionality in a switched store network involves the interplay of the intelligence designed into the NIC and the switch. In the switched environment, the NIC becomes an active, intelligent component of the network. It is imperative that the NIC be equipped with the intelligence to support standards-based flow control and traffic prioritization features that work with switches to regulate and optimize data transfer and to prioritize mission-critical and latency-sensitive multimedia applications. For an application developer working on a bandwidth-hungry store application, understanding the bandwidth available for that application, and the relative priority of other applications, is key to determining how the application will actually perform. For example, a multimedia kiosk has more demanding bandwidth requirements than a POS terminal, but given its mission-critical nature, POS should always receive the highest prioritization, and never be impacted by other applications' use of network resources.

High-Speed Workgroup Switches. To upgrade a shared workgroup to a high-performance switched workgroup, each POS or back-office PC can be connected directly to a 10 Mbps port on a 10/100 Ethernet switch, while POS servers can be connected to a 100 Mbps port for maximum performance. Autosensing 10/100 switches simplify migration by eliminating labor-intensive reconfiguration tasks because each port automatically connects at the speed of the attached device. This mini-

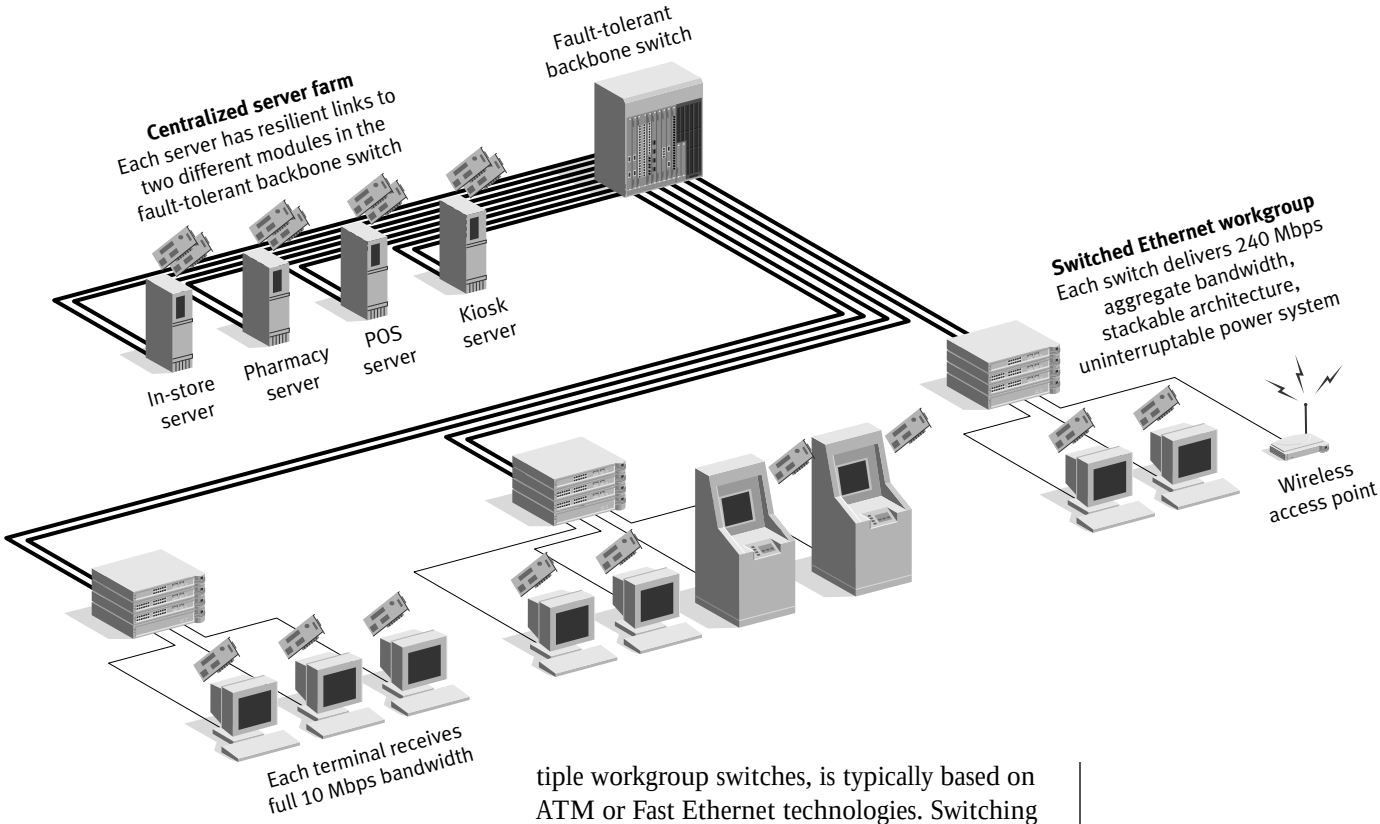

Figure 3. *Switched Network Topology*

mizes the time, effort, and cost associated with upgrading network performance and greatly future-proofs the investment in new store network architecture.

There are several benefits to implementing a switched Ethernet architecture. For the largest-format retail stores—where POS terminals exceed 100 per store—the sheer number of POS terminals dictates a highly segmented LAN architecture. LAN segmentation provides separate collision domains for different store applications so that one application doesn't affect the performance of others. For example, regardless of how much bandwidth a multimedia kiosk application might demand, it should not be able to steal bandwidth from other LAN segments where POS or other applications reside.

Flexible Backbone Switches. At the core of a next-generation store network is a high-performance backbone. This store network backbone, supporting the integration of multiple workgroup switches, is typically based on ATM or Fast Ethernet technologies. Switching features such as low latency packet forwarding and sophisticated bandwidth allocation and bandwidth reservation capabilities give different types of traffic—data, multimedia, voice, and video—different levels of service according to policies developed by the IT group.

Switching also enables IT managers to set up virtual LANs (VLANs) that can increase configuration flexibility and security within the network by creating separate, flexible, location- and topology-independent groups of workstations that communicate as if on a common physical LAN.

Stackable Store Network Architecture. As described in the shared solution, a stackable architecture lets the retailer grow the network incrementally as needed. UNIX servers like the IBM RS/6000 or HP9000 families have been largely deployed as in-store processors due to their ability to cost-effectively scale in performance through the addition of more and faster processors, expanded memory, and disc storage, avoiding a costly and disruptive box swap. Likewise, the SuperStack II store network architecture is an integrated networked

system that can expand with the addition of hubs/switches/routers as needed in modular and highly cost-effective fashion. Stackable architectures also offer a high degree of manageability, reliability, and integration.

Summary: Switched Ethernet Architecture. Scalability in a switched Ethernet store architecture is accomplished through:

1. Auto-sensing 10/100 Ethernet NICs with Parallel Tasking architecture, which significantly increase POS terminal and client/server performance
2. Ethernet switches, which segment the LAN backbone and support multiple VLANs
3. A high-speed store network backbone capable of supporting multiple technologies (ATM, Fast Ethernet, etc.) for greater LAN segmentation, performance, and support for future convergence-related applications
4. Stackable architecture that permits economical, incremental expansion without sacrificing network integration

Challenge #2: Future-Proofing the Store WAN

The WAN is also undergoing radical transformation. As integrated applications tie corporate headquarters, distribution centers, stores, and suppliers more closely together, the need for bandwidth grows significantly. Today, most large-format store chains have deployed Frame Relay–based WANs to connect their stores into an enterprise network. This solution often involves an expensive local loop from the local telco provider to access the Frame Relay network. Some chains also operate parallel satellite networks to provide the bandwidth required to support video broadcasts out to their stores for sales associate training and enterprise communications. Many chains now recognize that it is only a matter of time before applications running over the WAN will outgrow these traditional solutions.

ATM-Based WANs Scale to Meet Capacity Demands

To address the rapidly growing bandwidth needs in the WAN, retailers are beginning to turn to a new solution that offers far greater data bandwidth management without a substantial increase in telco charges. This innovative and exciting WAN solution combines voice, data, and video over a single T1 connection using ATM technology. While many retailers have already turned to ATM in their

Kinko's High-Performance Switched Store Network

Kinko's is basing its future on customers using services supported by its switched in-store networks. In addition to high-quality, high-volume copy services, the company's chain of 850 business service centers is gearing up to provide traveling business people with all the business functions they're used to in their own offices. From the ability to print large digital documents, to Internet access, to the ability to access their own corporate intranets in a secure environment, Kinko's new switched store network will allow it to create a "virtual office" for business travelers in need.

Eager to proceed with its external products and services plan, Kinko's has moved aggressively to install 3Com SuperStack II Ethernet/Fast Ethernet switches in its stores. With 10 Mbps of dedicated bandwidth to each PC, printer, and high-performance output device in the store—a total of 240 Mbps of bandwidth in each store—Kinko's can easily handle multiple megabit-size print jobs without slowing down other network traffic.

Kinko's is replacing its older-generation POS hubs with 3Com OfficeConnect® eight-port hubs. These hubs link directly into the switches, creating a single, integrated store network architecture. The abundance of bandwidth in the switched store network ensures that demanding virtual office applications won't steal bandwidth from the POS system.

Station Casinos' Future-Proofed ATM LAN/WAN

Station Casinos (STN), the ninth largest gaming company in the U.S., chose to standardize a new ATM network on 3Com systems at its four Las Vegas hotel/casinos. The fully switched, 2,000-user LAN and WAN, utilizing 3Com PathBuilder™ S600 WAN access switches, enables STN to provide multimedia feeds to all four casinos, supporting not only high-bandwidth video applications, but also voice services currently executed using costly voice-only T1 circuits.

The network will support a range of new applications designed to provide enhanced customer services at the four casinos, including multimedia touch-screen Redemption Center kiosks. The kiosks provide videos of STN services and accommodations, and let customers redeem and exchange casino points for purchases at retail stores and restaurants. The 3Com network also expedites customer checkout at STN hotels, restaurants, and shops via the integrated POS solution. A Data Slot Accounting System monitors all 15,000 casino slots and video machines. And the multimedia LAN/WAN provides video conferencing for employees at geographically dispersed sites.

To support this mission-critical, multimedia computing environment, STN needed to centralize its information using a stable, redundant, high-speed LAN/WAN connecting all four Las Vegas properties and their associated restaurants and stores. STN's casino LANs are each based on a CoreBuilder™ 7000HD ATM switch with redundant switching engines, dual power supplies, and a 5 Gbps backplane. The backbone CoreBuilder 7000 switches have redundant 155 Mbps ATM full-duplex fiber connections to one another, providing redundant paths in case of link or switch failure.

Interface cards in each ATM switch provide 100 Mbps Fast Ethernet links to servers and mainframes at each casino, as well as to SuperStack II Ethernet/Fast Ethernet switches for dedicated 10 Mbps connections to desktops and local devices.

corporate data centers for increased bandwidth and to support LAN-based convergence applications, nowhere is the use of ATM more promising than in the WAN. Retailers that have already deployed ATM as a WAN backbone between regional sites include Target Stores, Station Casinos, and Boots plc. The next step is the deployment of ATM-based services out to the stores.

For some retailers, the Frame Relay T1 line into the retail store network is inverse multiplexed to separate, static data and voice channels, providing a first-generation convergence solution. In contrast, ATM services provisioned by the carrier deliver a single "fat pipe" or channel. The retailer determines how much bandwidth to allocate to each application based on policies rather than having bandwidth preset by the carrier. The dynamic voice-data ATM network offers significant cost savings. For example, voice channels typically far exceed the bandwidth of the data network. This huge amount of untapped bandwidth can be dedicated entirely to data and video traffic when voice traffic drops off at night. During the day, IT can intelligently utilize the "idle" voice bandwidth for data, as application requirements dictate (Figure 4 on page 14). And ATM's Quality of Service (QoS) capability ensures that latency-sensitive multimedia applications get the bandwidth and delivery priority they need to deliver crisp audio and smooth video images.

ATM is being adopted as a WAN technology at differing rates throughout the world, largely depending upon the aggressiveness of carriers in different geographies. WAN access switches based on an open architecture support Frame Relay–based WANs today while providing a migration path to ATM without hardware replacement. It is widely believed that the U.S. market, with its highly competitive carrier environment, will see the most rapid rate of adoption.

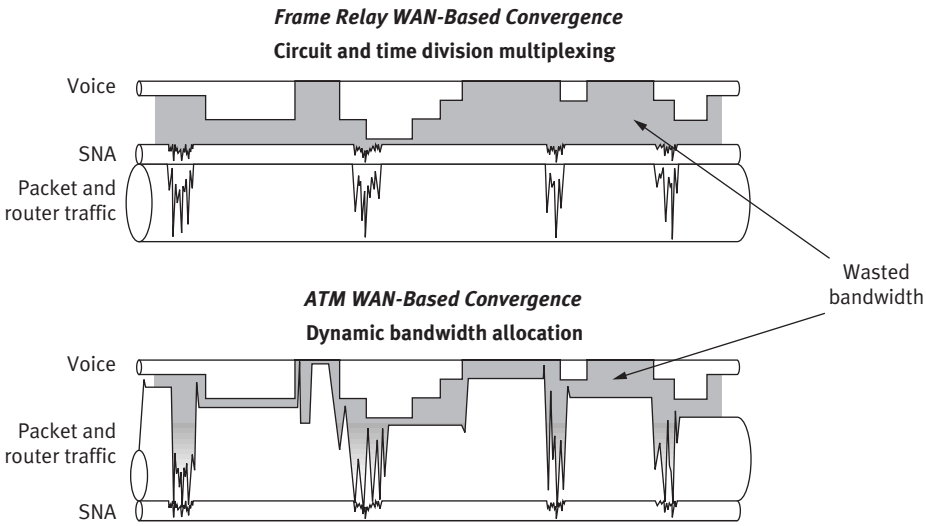

Figure 4. *ATM-Based Networking Supports Dynamic Allocation of Bandwidth*

ATM Features Suit Retail Network Needs

ATM is a standards-based, widely available, long-distance carrier–provisioned service. In contrast, ISDN is a local carrier-provided service. Difficult, inconsistent local telco provisioning policies and widely varying state tariffs made ISDN in North America a management nightmare for the regional or national retail chains that deployed it. And ISDN's time-based cost model makes it undesirable for continuous connections. ATM greatly lessens tariff and provisioning complexity for retailers. Since long-haul carriers' internal infrastructures are already based on ATM, little additional investment is required to offer it "the last mile" to the stores. And because ATM is a permanent circuit like Frame Relay, it is not time sensitive, so monthly telco costs remain constant regardless of monthly usage.

The intelligent utilization of bandwidth made possible by policy-based ATM networking, together with the easier provisioning of these new ATM services, radically alter a retailer's ability to cost-effectively support new store applications for competitive advantage. These include video conferencing for collaboration, video-based security surveillance, distance learning, and a growing number of Web-based applications such as data warehouse access, human resources, e-mail, gift registry, and special orders.

Challenge #3: Bullet-Proofing the LAN and WAN

To be viable for the store environment, next-generation store networks require a highly reliable architecture where downtime is either zero or minimal and problems are quickly resolved. For a network to be completely bullet-proof, fault-tolerant capabilities must be designed into every critical component on the network, from the POS servers at the network edge to core Ethernet hubs and switches, WAN links, and remote office systems. High-transaction POS environments in particular require a completely fault-tolerant network solution with no single point of failure.

The level of robustness required in a system component is directly related to its effect on the network if it fails. It's not surprising then, that the closer a component is to the network core, the more critical its fault-tolerant and resiliency features become. Fault-tolerant strategies include built-in redundancy of key components, alternative power sources in case of equipment power supply failure or building "brownouts," and redundant data paths in case of LAN or WAN link failures.

Fault tolerance is also a critical requirement for the WAN, as was painfully evident in a recent outage of AT&T's U.S. Frame Relay network. Most large-format retailers with permanent leased, satellite, or Frame Relay–based WAN circuits require a backup

solution to ensure that electronic payments and other customer-critical applications are not interrupted, even when the primary WAN circuit or router fails.

Fault Tolerance at the LAN Edge

Each POS terminal is typically configured with a single NIC, because a single POS terminal failure is not considered catastrophic given the high terminal population in large-format stores. However, a POS server failure is another matter. Retailers have long recognized the benefits of dual POS servers, where the second server is configured as a hot standby to the primary server and instantaneously takes over operation should the primary server fail. In this way, system availability is ensured—provided the network connection doesn't fail. Up until now, however, a network link failure could render even the most fault-tolerant server configuration useless. And for retailers with a single POS server or a collapsed ISP/POS server configuration, the health of the network is even more critical to POS uptime.

A recent innovation in next-generation server NICs takes fault tolerance a quantum leap forward. A new fault-tolerant capability, Resilient Server Link (RSL), features a "standby" NIC that automatically provides access through a secondary link if the primary hub or switch link fails for any reason. In addition, if the POS server or the network causes a driver to become corrupted, "self-healing" drivers in the NICs can monitor, detect, and recover from fault conditions. These innovative solutions bring unprecedented levels of fault tolerance to networked POS systems.

The degree of fault tolerance designed into the store network, then, is a function of which network products are deployed, together with how the network is architected. The key point is that varying degrees of availability and fault tolerance can be designed into the store network architecture—it doesn't have to be an all-or-nothing situation (Figure 5). For example, POS requires a greater investment in fault-tolerant design than back-office applications. For POS, redundant server links comprised of one or two tightly integrated pairs of NICs residing in the POS servers together with a redundant Ethernet core made up of two Ethernet hubs or switches, each internally equipped with dual power supplies and other redundant components, creates the ultimate

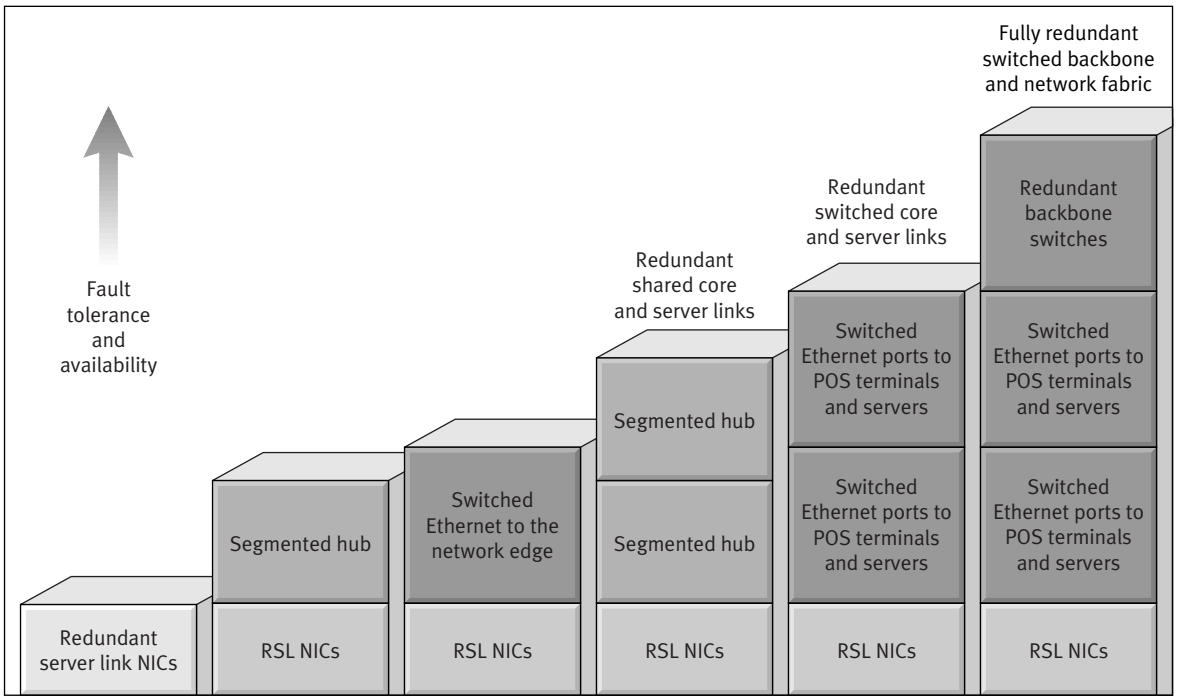

Figure 5. *Degrees of Store Network Availability and Fault Tolerance*

Marks & Spencer's Fault-Tolerant LAN Network

Marks & Spencer is an upscale department store chain with more than 320 stores located throughout Europe. Known as a technology leader in its market, Marks & Spencer has designed a networked POS solution that offers not only exceptional performance, but also the most fault-tolerant network capabilities ever deployed in a retail store. This retailer's bullet-proofed solution employs a Fast Ethernet backbone switch, with multiple Ethernet switches providing dedicated 10 Mbps Ethernet directly to each POS terminal for a total of 240 Mbps aggregate bandwidth per switch. This fully switched architecture delivers the bandwidth required to support Marks & Spencer's applications well into the next decade.

Dedicated segment architecture ensures high-bandwidth availability and guarantees that a single port failure affects only one POS terminal. The retailer also uses next-generation Fast Ethernet Server NICs in its POS servers. The dual-board NIC operates in tandem. If the primary NIC link fails for any reason, the secondary NIC automatically takes control, keeping the POS server available to all connected switches, and subsequently all POS terminals, on the network. Marks & Spencer installed two pairs of redundantly configured Server NICs in each POS server (four total), connecting each POS server to two different switches to eliminate any single point of failure. And in the event of any single component problem, 3Com's Transcend® network management software automatically sends a sophisticated RMON2 alert that provides the technical staff with detailed information for problem determination and resolution.

Finally, the NICs' Virtual LAN Tagging (VLT) feature—when used in conjunction with 3Com VLAN-enabled switches—allows network resources to be shared by as many as 16 VLANs, increasing configuration flexibility and security within the network. The Ethernet NICs embedded in the new ICL POS terminals are also designed with 3Com's award-winning Parallel Tasking II performance and Dynamic*Access* software capabilities to ensure fast, efficient processing in high-traffic environments for even the most demanding applications.

fault-tolerant solution. Utilizing LAN segmentation ensures that other in-store applications don't impair POS performance by robbing the POS application of precious bandwidth. But this level of fault-tolerant investment may not be warranted for all in-store applications.

Fault Tolerance at the Heart of the Store LAN

System resilience and robustness must be designed in on many levels. Stackable hub and switch system redundancy features deliver one layer of fault tolerance. For example, redundant management modules safeguard against any interruption of management if one unit in the stack goes off-line. When equipped with a hot-swap cascade unit, a hub or switch can be removed from anywhere in the stack without disrupting the operation of the rest of the stack. Optional redundant and uninterruptible power systems protect against internal and external power failures, ensuring constant power to the stack. These power systems can be managed and monitored remotely at a central site. The automatic resilient links feature found in some stackable hubs and switches automatically and continuously monitors the health of primary and backup ports, switching over to the backup path in milliseconds should a signal fail on a primary connection.

In addition to device-level fault tolerance, retail store networks also require bullet-proofing at the network core. Hub and switch network configurations can provide an additional level of fault tolerance. Switches provide inherent protection because each POS terminal has its own dedicated switched port, so that a single port failure affects only one POS terminal. POS servers and terminals can also be connected to either single or multiple hubs or switches, depending on the desired degree of network availability. For example, some

retailers, including Carnival Cruise, The Home Depot, Marks & Spencer, and Carrefour, have deployed networked POS designs that ensure that no single point of failure exists within their POS environment. By deploying multiple Ethernet hubs or switches along with multiple NICs per POS server, these store networks have significantly higher degrees of fault tolerance than their legacy dual POS server configurations. Given the extremely high transaction volume in many store environments, this capability is considered essential for effective store operation and top-quality customer service.

Fault Tolerance at the WAN Interface

As retailers deploy online customer service applications that travel throughout the enterprise and beyond into the supply chain, LAN resiliency is only one part of the solution. To guarantee the highest availability over WAN links, many retailers use both a primary and backup WAN link strategy. In case of link failure on a primary link, calls are quickly rerouted over a backup, alternate technology network.

An ideal bullet-proofing strategy for the retail enterprise WAN is to have a backup, dial-up WAN infrastructure in place based on either ISDN or analog modems in-store communicating to a highly scalable, ultra-high port density remote access switch on the host end. In this solution, the dial-up WAN is automatically engaged when the primary Frame Relay circuit or router fails. Achieving this degree of primary and backup WAN infrastructure is considerably easier when both ends of the solution—in-store modems and HQ-based remote access WAN switches—are manufactured by the same vendor.

Multiprotocol routers support connectivity between store networks and the central site with flexible WAN connectivity options supporting primary and secondary WAN links.

Challenge #4: Reducing Cost of Ownership While Improving Network Support

For large-format retailers, the ongoing costs of monitoring the network and keeping it performing at peak levels far outpace initial equipment costs. According to a recent study, the total network cost of ownership breaks down into the following percentages:

- Capital equipment purchase outlay (approximately 23 percent)
- Support staff costs to implement, operate, and administer the network (approximately 36 percent)
- Maintenance, cabling, and leased line costs (approximately 41 percent)

Wal-Mart's Fault-Tolerant Wide Area Network

With more than 3,000 stores, 300,000 employees, and $120 billion in sales, Wal-Mart is by far the world's largest retailer. Wal-Mart deployed a fault-tolerant enterprise WAN solution to ensure uninterrupted availability of credit authorization and other customer-critical applications.

Like many other large-format retailers, Wal-Mart has a Frame Relay WAN connecting all its stores into an enterprise infrastructure. To avoid downtime from a circuit, router, or telco network failure, Wal-Mart installed multiple 3Com Total Control™ remote access concentrators that connect to a 3Com Courier™ modem in each store. This high-density, highly scalable concentrator, used by America Online and more than 1,000 other Internet service providers, enables retailers to set up, support, and manage a wide mix of primary and secondary WAN technologies. Based on a future-proofed design, these modems can be upgraded to V.90 56 Kbps technology through a simple software download into flash memory. Using the full capabilities of the Total Control platform to extend access beyond the store, remote users and mobile professionals such as buyers and regional/district store managers can access e-mail and database applications through the robust dial-up ISDN or analog network infrastructure.

Clearly, effective network management significantly reduces a retailer's total cost of ownership. Store networks by definition are removed from the corporate office and the centralized technical staff. As more and more technology is deployed in retail stores, the ability to effectively monitor and manage the network remotely becomes a critical requirement. Fortunately, network management capabilities have grown considerably in the past couple of years. Network management solutions based on industry standards such as Simple Network Management Protocol (SNMP) and Remote Monitoring (RMON) allow the central support staff to log onto in-store networks remotely to diagnose and resolve problems and upgrade software and firmware when necessary.

While most routers, switches, and hubs at the core are network manageable, the greatest number of failure points occur at the edge of the network—at the POS terminals, servers, and back-office systems. Therefore, a truly comprehensive network management solution must encompass all components of the network, including the links at the edge, and must distribute intelligence throughout the network.

A relatively new but important cost-of-ownership management feature built into some NICs is the "wake-up on LAN" capability. Wake-up on LAN allows the retailer to remotely power on and off in-store POS terminals and servers, or other PCs, to cut energy costs. Boot ROMs that enable POS terminals to be booted from the networked POS server also save retailers substantial money by deploying thin POS clients and protecting against unauthorized logons and network tampering.

VLANs Simplify Network Management

In addition to reducing broadcast traffic over a switched network, VLANs can also reduce administrative costs and increase workgroup security. Large-format store retailers that spend substantial resources to handle moves and changes on their IP networks find VLANs very attractive. Since IP addresses must be manually updated in the workstations when users move to different subnets, IT departments devote considerable resources to this time-consuming process. VLANs are a solution that simplifies the labor-intensive update task. Because VLAN membership is not tied to an end device's location in the network, the end station keeps its original IP addresses and subnet membership whenever it is moved, greatly simplifying network administration.

The ability of VLANs to create firewalls also creates secure workgroup environments, especially when combined with segmented switching. Broadcast traffic on a single-user segment—for example, an in-store multimedia kiosk—is targeted only to that VLAN's users. And because the broadcast or unicast traffic does not physically traverse the segment, unauthorized users can't "listen in."

RMON and RMON2 Deliver Next-Generation Management

First-generation SNMP-based network management solutions offered limited remote store management capabilities. Remote Monitoring (RMON and RMON2) answers the need for true proactive, remote network management of a single segment or an entire network. There are typically no network technicians at store locations, so technical staff at a central site must be able to remotely monitor store network and application performance and detect and resolve network problems before

Figure 6. *RMON Reduces Management Costs*

The Case for a Single-Vendor Networked Store Solution

Most retailers today have adopted a best-of-breed philosophy in which the many components of their in-store systems—scanners, POS terminals, Windows NT–based POS servers, UNIX servers, databases, applications, electronic scales, kiosks, and other components—are manufactured by multiple vendors. At this level of systems integration, a best-of-breed approach makes complete sense. Based on industry standards such as TCP/IP, OPOS, JPOS, application software developed for portability in either C or Java, and Ethernet at the physical layer, a high degree of commonality enables the effective interoperability of multiple vendors' products.

From a networking perspective, the older, first-generation store network solutions commonly found in back-office store networks were easily built utilizing multiple vendors' products. But with today's more intelligent and more complex store networks, the multivendor approach becomes less tenable. Today's highly intelligent, advanced store networks leverage the intelligence in the NIC as an active element of the networked solution. Even a segmented hub-based network solution actively leverages the relationship between intelligent NICs and hubs to achieve advanced functionality such as automatic load balancing. A single-vendor solution also increases network availability by simplifying the problem resolution process associated with network failures. One vendor, one phone call, one escalation process, and one team of engineers ensure faster problem resolution and a more manageable solution for the retail help desk.

Adopting an end-to-end network solution from a single vendor also makes business sense. Reduced complexity translates directly into lower cost of network ownership. Integrating equipment from multiple vendors requires more skilled resources to implement and operate the network, consumes more administration time and resources, and increases training requirements—all of which adds significantly to the cost of network ownership.

Why has 3Com become the store network vendor of choice for so many major retailers? For one, choosing a vendor that offers leading price/performance and that has product leadership in key market segments and a strong overall product portfolio eliminates the concern about losing a key technological advantage in any one area. 3Com Ethernet products have won countless awards and introduced many key innovations over the years. The company is an industry leader in developing standards-based technologies that are used in more than 300,000 stores by the world's largest and most demanding retailers. 3Com network solutions are employed by major retailers across all lines of trade; they include Wal-Mart, J.C. Penney, The Home Depot, Lowes Companies, Kinko's, Sheraton, Holiday Inn, Carnival Cruise, Ross Stores, Sears Roebuck, American Stores, Shaw's Supermarkets, Wegman's Food Markets, Eckerd Drug, Nordstrom, Starbucks Coffee, Woolworths Australia, Carrefour, Marks & Spencer, Harrod's, Dixon's, Pep Boys, American Retail Group, and hundreds of others.

they threaten the health of the network and critical store systems.

In a standards-based Ethernet network, RMON agents distributed across LAN segments can collect statistical, analytical, and diagnostic data independently and non-obtrusively, forwarding them to the central site on a need-to-know basis. RMON2 moves beyond the segment level, monitoring actual network usage patterns and providing information on the health and performance of client/server applications and end-to-end communications. Together, RMON and RMON2 give network managers a complete understanding of their networks so they can optimize service to individual locations and users.

Figure 6 shows how the cost savings associated with RMON management increase as

the size of the network grows. In a distributed store network, the benefits of remote data collection are obvious, and the cost savings scale even faster than in a campus network.

Using RMON/RMON2, retail IT managers can see the effects of various applications and events on the network. For example, they can evaluate the impact of a new application on the traffic patterns coming out of each store, analyze the percentage of bandwidth used by specific applications, or isolate the cause of time-outs by time-sensitive legacy (SNA) applications. This high-level information allows retail IT managers to tune individual store networks based on application utilization and throughput requirements.

Web-Based Management Extends Access and Control

Web-based network management has become one of the most popular ease-of-use developments in recent months. Making network management tools and information available through standard Web browsers dramatically increases the accessibility of network information. Web-based management encompasses a series of fully functional tools for configuration, monitoring, troubleshooting, and analysis available through a Java-enabled browser interface. Technical support staff at a retailer's headquarters can quickly access key management data through a secured login for any store on the enterprise network from anywhere on the network, including from home or from the road.

Remote Management Reduces Management Complexity

As the scope of the enterprise network expands, a retailer's ability to manage WAN links and remote sites becomes critical to their success. 3Com Boundary Routing® architecture—a fundamental rethinking of WAN architecture—centralizes network complexity and distributes simplicity to the store. This innovation, very important to retailers, provides all the benefits of configuring a single interface, much like the central device in a collapsed backbone LAN environment, but in a large WAN network. Boundary Routing architecture transfers complexity from the in-store router to the central site router, where administrative expertise is located. As a result, the retailer does not require on-site technical staff to deploy the in-store router, and configuration changes, software upgrades, and other administrative tasks for the remote sites virtually disappear.

Boundary Routing architecture implementations that support Frame Relay, dialed lines (PSTN and ISDN), and X.25 switched media can significantly lower WAN costs. In addition, data compression, traffic prioritization, and custom filtering techniques can further lower WAN costs by using bandwidth resources more efficiently.

Conclusion

Fierce competition in the retail industry is forcing retail chains to rethink how to bring access to the resources of their enterprise into the hands of store associates to better serve their customers. Next-generation retail networks bring a wealth of information and capability to the POS and other in-store systems, enabling retailers to implement revenue-generating applications and streamline processes. This newfound capability comes at a price, however—the price of growth and increased complexity. Meeting the challenges requires a comprehensive, next-generation store network architecture that includes scalability, robust fault tolerance, intelligence-based performance, and comprehensive network management.

To obtain maximum value from their network investment, many of the world's largest retailers turn to 3Com. 3Com's next-generation, end-to-end, networked store solution encompasses intelligent NICs at the edge and intelligent, stackable hubs, switches, and routers at the core with future-proof, bullet-proof features that maximize retail flexibility while lowering cost of ownership and network overhead. A majority of the 100 largest retailers have already deployed a 3Com solution. With technological leadership in all key product areas relevant to the store environment, 3Com offers the most comprehensive POS and back-office network solution on the market. ◘

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