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Network Digest

Mission-critical insights for managers of mission-critical systems

Executive Summary

Technology Choices, Business Decisions

The Art and Science of Migrating to Switched Networks

Local area network congestion has reached a critical point for most organizations. The growing number of users, size of files, popularity of the Internet, and the myriad of bandwidth-intensive applications, such as video conferencing, have contributed to an unprecedented demand for network services.

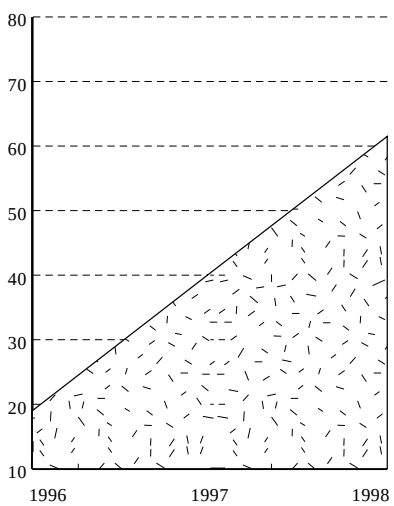
A variety of advanced networking technologies provide the increased capacity required to ease the bandwidth crunch. However, most require a lengthy period of infrastructure rebuilding, which the typical organization can't afford. Migrating a shared medium environment to a switched approach is the fastest solution to the network crunch.

High-performance switches support Ethernet, as well as Fast Ethernet, FDDI, ATM, IP, and other advanced networking protocols. In addition to being relatively easy to implement, switches also offer a lower capital cost approach than routers to increased network capacity. Furthermore, switches enable lower-cost network management.

This edition of *Network Digest* synthesizes information from vendors and analysts about the types of switches, a migration path to implement the devices, and some advice on cost justification.

Switched LAN Stampede

% of network ports



Source: Business Research Group

Technology Choices, Business Decisions

The Art And Science of Migrating to Switched Networks

By Gerald Lazar and Larry Marion

Ten years ago, a 10 Kbyte WordPerfect file represented a lot of writing on someone's part. And transmitting that file represented a major job for the corporate network.

Today, it's not uncommon for desktop users to transmit 1 Mbyte files. "There's far more graphical content in almost everything," says Mary Petrosky, an analyst in the San Mateo, Calif., office of the Burton Group. "People routinely E-mail presentation files that can exceed 1.5 Mbytes."

Confronting the Problems

Network managers face a fundamental challenge: Although the size of a typical word processing, spreadsheet, or presentation file has grown, network capabilities have struggled to keep pace. During the past decade, the power of desktop applications has jumped from 8- to 16- to 32-bit, tremendously expanding the size of each file. Furthermore, users are routinely transmitting compound documents (annotated with notes and audio comments) and files attached to electronic-mail messages, further exacerbating the networking load.

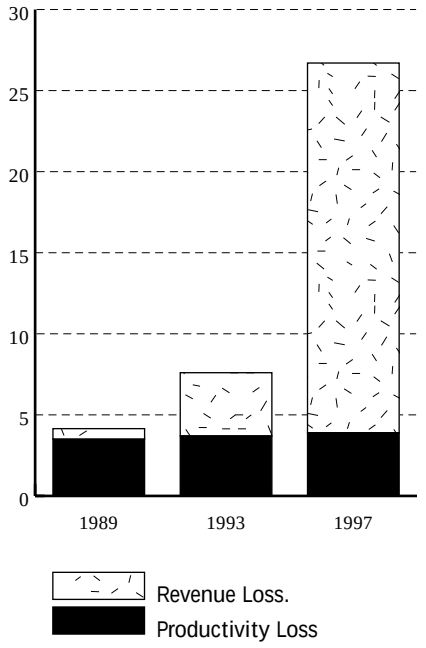
Other formidable issues confront today's network manager. There are many more users on the network than ever before—each demanding more bandwidth and faster response time. Today networks are used for mission-critical business applications. In such an environment, businesses can't afford a 5-second delay, much less a total network breakdown. These pressures are forcing network managers to take a long, hard look at the network's infrastructure.

Some of the increased pressure on LAN performance is simply the result of more users. As recently as 1992, only 19% of business personal computers were linked to a local area network, according to the 1997 Software Market Survey by Sentry Research Services, in Westborough, Mass. Today 84% of business PCs are tied to a local area network, according to Sentry, which predicts the business PC-LAN connection will reach 92% in 1998.

Ubiquitous access to the LAN is being driven in part by the Internet. Many companies rely on an intranet for corporate-wide applications and the dissemination of information, which has sharply increased bandwidth demand. The crazy quilt combination of text, graphics, sound, and video can create huge and unpredictable demands on networks, which are straining just to keep up with current demand. Yet the Internet is whetting appetites for more-sophisticated transmissions, such as video conferencing, distance learning, and collaborative computing—while network bottlenecks keep companies from even considering these newer technologies.

The Cost of Failure

As LANs grow in importance, the annual cost of downtime soars. The figures depict the impact on an organization with 1,000 employees ($ millions).



Source: Infonetics Research

Reversing the 80/20 Rule

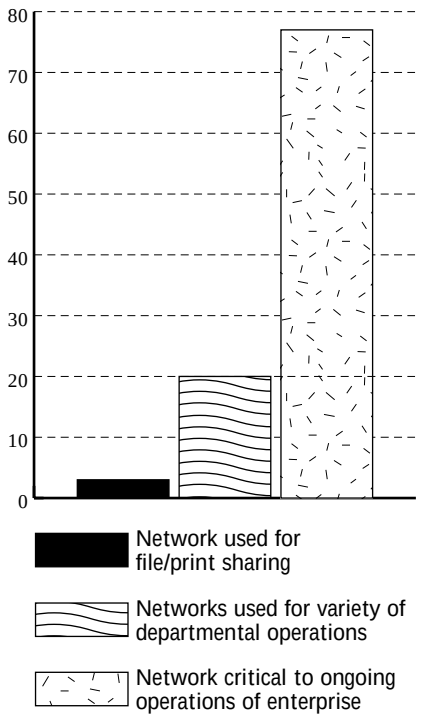
These new applications have dramatically shifted traffic flow on networks. Dataquest, a market research firm in San Jose, Calif., says that the traditional 80/20 rule has become inverted. In the past, 80% of network traffic stayed in the workgroup and only 20% was traffic to and from the server. Today 80% of the network traffic makes it up to the server and only 20% stays local. Architecture shifts, too, have increased the amount of server-to-server transactions. The drive toward network computers (NC), desktop devices with a minimum of computing power, will put an even greater strain on network capacities—these "thin clients" need to contact the server continuously, not only to download the initial application but also for applets that change fonts or create tables.

Given the increasing dependence on the network and network servers, users are becoming less tolerant of LAN downtime and deteriorating response time. At a clothing retailer, for example, operators taking telephone orders typically interact with the corporate database and with the database of an outside credit card company. When demand on the system is high (just after a catalog mailing, for example), response time slows. A delay of a second or two is irritating, but a delay of 15 seconds or more means the retailer risks losing the customer entirely. "The network has become a key part of how a company does business," says Petrosky. "Not many of us could live without it."

That opinion is backed by surveys conducted by the International Data Corp., a market research firm in Framingham, Mass. Almost 75% of network managers consider their networks to be critical to their company's operations (see chart, "The Rise of Mission-Critical Networks," this page). And downtime will cost plenty, too. Network failures will cost the average company with more than 1,000 employees $26 million this year in lost productivity and revenue, according to Infonetics Research Inc., in San Jose, Calif. (see chart, "The Cost of Failure," page 2).

The Rise of Mission-Critical Networks

Most local area networks are critical to ongoing operations, according to a survey of IS managers asked to describe the role of LANs in their enterprise (% of LANs, 1997).



Source: International Data Corp.

Clearly, network managers have to provide more capacity and higher reliability. But because the networks have become critical to the company, managers can't just yank everything out and start over (much as they might like to). Installing higher capacity cables or a new higher speed, additional bandwidth architecture might resolve the problem in six months, but business' craving for bandwidth must be assuaged today.

Assessing Alternatives

The 10 Mbps Ethernet network was fine 10 years ago but is inadequate today as a shared network or backbone technology. Corporate networks have more users with more information to exchange and no patience to wait. In other words, corporate networks need greater capacity, improved performance, and better throughput. Fortunately, a number of technologies provide greater data rates and effective throughput. Although 38% of large and midsize companies were using advanced networking technologies last year, more than 70% planned to upgrade, according to surveys by Sentry Research (see chart, "Switching and Fast Ethernet Gain Interest," page 4).

Here's a summary of the advanced networking technologies now available:

FAST ETHERNET: Providing data transmission at up to 100 Mbps while using the same framing structure and MAC address system as 10 Mbps Ethernet, Fast Ethernet has become the de facto standard for new installations. "At the desktop, it's become a no-brainer," says David Passmore, president of market researcher Decisys Inc. in Sterling, Va. "With price wars, street prices for 100 Mbps network interface cards are $70 each. At that price, why put in anything BUT Fast Ethernet cards?" Fast Ethernet cards are not displacing installed desktop Ethernet cards because the PCs themselves only have a three-year useful life.

Actually, all Fast Ethernet cards are dual-speed ports, able

to function at 10 or 100 Mbps, allowing the network to continue to operate as a 10 Mbps environment until migration to a faster environment can begin.

Although the higher speed Ethernet standards are still evolving, Fast Ethernet is still Ethernet, a stable and revered environment that has successfully resisted the inroads of trendier networking protocols for more than a decade. Given Fast Ethernet's heritage, there's almost no new training required of network support staff or the users themselves. However, all the criticisms of Ethernet are still valid, too: It's a collision-based solution and can't transmit data more than 100 meters without a repeater, and so on.

FDDI: The fiber distributed data interface is an alternative 100 Mbps data communications strategy. After more than a decade of use as a backbone protocol, it's firmly entrenched as a networking scheme. "FDDI is the best pure backbone technology out there," notes Skip MacAskill, a senior analyst with the Gartner Group IT consulting firm in Stamford, Conn. Nearly 50% of large corporations use FDDI, according to Sage Research Inc., in Natick, Mass.

FDDI's reliability and maturity make it a good bet for mission-critical applications. The attributes of the FDDI architecture—token based, predictable, not constrained by Ethernet distance limitations, and featuring auto rerouting of packets for fault tolerance—make it particularly useful for backbone applications. The FDDI customer can scale the backbone without taking on the risk of a new technology or losing all the inherent reliability features. Network administrators trying to add capacity to existing installations will be adding FDDI capabilities well into the next century.

ATM: The asynchronous transfer mode protocol can propel data at up to 622 Mbps and beyond for backbones and wide area network transmissions. ATM has quality of service mechanisms that allow the use of a single network for voice, video, and data, with guaranteed bandwidth providing smooth, no-jitter video transmission.

Expect to see ATM backbones in almost half of all large Fortune 1000 networks in the next couple of years. A survey last year by the Business Research Group (BRG), a market research firm in Newton, Mass., found that 42% of network managers said they would use ATM in their backbone LAN within the next two years.

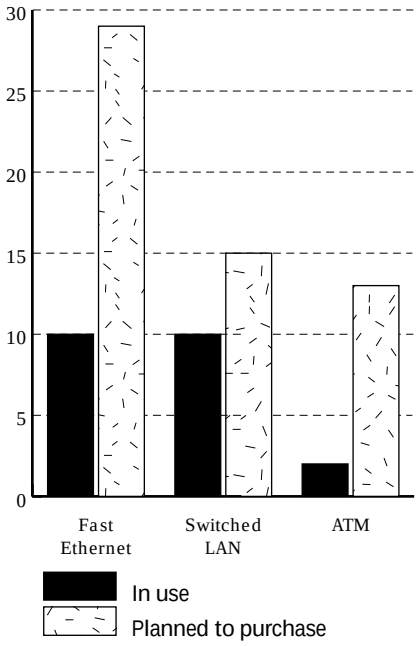
ATM technology holds promise for the longer term, too. It uses a cell-based delivery system, which is well-suited to a multimedia networking environment. In addition, ATM's ability to regulate data rates based on need makes it a flexible environment not only for multimedia but for all networking environments in which mission-critical applications may need to be given priority.

Gigabit Ethernet: It may be fast, but the 1000 Mbps technology is still evolving. Several vendors, large and small, have introduced Gigabit Ethernet hardware. Large organizations will begin experimenting with the technology over the next year or two. But the high price—several thousand dollars per port—and the lack of an approved standard, mean that 1000 Mbps won't be routine as a high speed backbone until the year 2000.

Gigabit Ethernet still suffers from limitations that preclude more widespread use. The current cost can be up to five times that of a Fast Ethernet; and Gigabit Ethernet currently has an effective range of only about 25 meters, making it a limited backbone technology. And the technology may actually be too fast for some applications, "It would be like trying to drink water out of a fire hose," says Passmore.

Switching and Fast Ethernet Gain Interest

A survey of almost 300 network managers early last year found strong interest in switching and 100 mbps Ethernet. Gigabit Ethernet has, subsequent to the survey, attracted considerable interest (percentage of respondents).



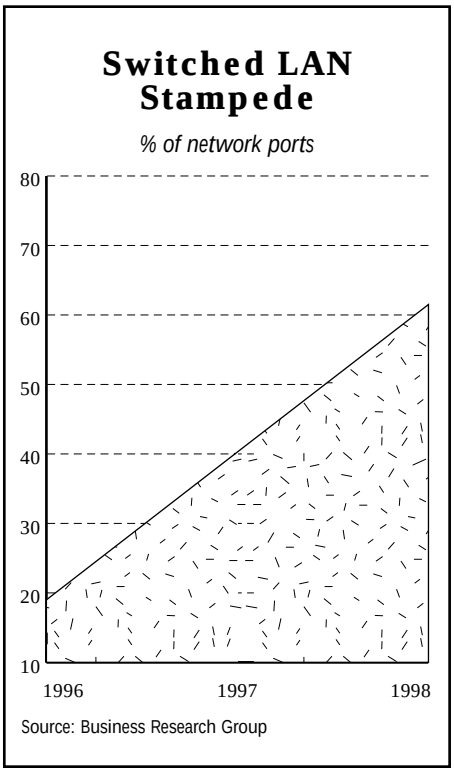
Source: Sentry Research Services, 1996 Enterprise Network Management Report

Comparative Analysis

Each of these technologies has its strengths and weaknesses. Some people worry about the learning curve associated with using ATM technology. And ATM hardware still costs at least three times as much as comparable gear for Fast Ethernet, according to the Dell'Oro Group, a market research firm in Portola Valley, Calif. Dataquest and Dell'Oro agree that the cost gap between ATM and Fast Ethernet will shrink significantly by 2000. However, ATM's quality of

service capabilities and greater suitability for multimedia and other advanced video applications make it and FDDI the preferred protocol for backbone connection.

As for Gigabit Ethernet, although the draft standard was approved in early 1997, the final version won't be approved until 1998, and it will take several years before market demand drives down prices to commodity levels. Even then there will be a large gap: Dell'Oro predicts that the per-user cost of Gigabit Ethernet may be almost double the cost of Fast Ethernet in 2000. Although 155 Mbps ATM is currently cheaper than Gigabit Ethernet, prices of the newer technology will fall faster during the next several years. So by 2000, Gigabit Ethernet is expected to be roughly 20% less expensive than ATM, according to Dell'Oro forecasts.



The faster throughput of ATM and Gigabit Ethernet will drive more organizations to take advantage of the newer technologies. Dataquest predicts an 82% compound annual growth rate of ATM system shipments from 1996 through 2000. Fast Ethernet shipments are expected to plateau, beginning next year.

The Switched Solution

To satisfy user demand for immediate bandwidth relief and to overcome some inherent weaknesses of a shared-media, router-based environments, many network managers are adding switches to their mix. Data switching is per-port segmentation of the LAN or WAN, as opposed to users or devices sharing the same physical setting.

Switches multiply bandwidth by the number of ports provided. Because bandwidth is dedicated, four switched Ethernet ports provide four times the throughput of a shared media network. Although there is a practical limit to the multiplication effect, switching provides the most bang for the buck when dramatic increases in network capacity are demanded in a short time frame.

Switches function as multiport bridges, which means they provide a dedicated amount of bandwidth for each user. The addition of a single switch can improve available bandwidth on a LAN by an order of magnitude or more, depending on the number of concurrent users.

In a LAN environment, "the clear plus is that you have a collision-free environment," says Kevin Tolly, president and CEO of the Tolly Group consulting firm in Manasquan, N.J. "By having a collision domain of one—you—you can't collide with anybody else."

Switches can be used with virtually any network technology and can be placed at various points within the network, as well. Although switches can improve performance throughout a network, network managers are more likely to first use switches in the campus backbone. After improving throughput at the server farm, network managers deploy switches to increase desktop capacity; later switching may be incorporated across the wide area network, according to a study by BRG. In fact, more than 60% of all installed network ports will be switched ports by next year, predicts BRG (see chart, "Switched LAN Stampede," this page).

Several different technologies fall under the rather broad umbrella of LAN switching. Segment switches are used instead of routers to tie Ethernet LANs together. Desktop switches can be used to replace shared media LAN hubs to provide more user throughput of the basic 10 Mbps Ethernet environment. Half of large organizations polled by BRG have installed switches to boost the performance of their Ethernet LANs and backbones. And backbone switches can take the place of routers in network cores. (Backbone switches tend to have more high-speed ports than workgroup switches and typically feature Fast Ethernet, FDDI, ATM, or other high-speed protocols).

A new switching technology adds routing capabilities to a switch. These switches (known as Layer 3 or IP switches) can move IP traffic between network segments. The Layer 3 switches can replace routers for some routing applications, providing intersubnet routing at speeds far faster than that of a standard router. IP switches provide network managers the ability to configure virtual LANs (VLANs) at a fraction of the cost of a router.

Switches solve a variety of network performance problems. Overwhelmingly, LAN planners are installing switches rather than routers, according to the IT consultants at the Forrester Research firm, in Cambridge, Mass., because

they provide inexpensive and flexible bandwidth. Campus backbone switches can relieve bottlenecks across server connections, as well as between networks.

Switches have some limitations, too. They can't perform the packet identification that routers do routinely. (However, that's changing as vendors introduce switches with Layer 3 capability.) And switches are faster than routers because they don't have to perform the security and management functions of routers. Indeed, most observers contend that routers will still play a role at the edges of the local area network, as internal traffic goes to WANs and back again. Connecting to the Internet and a metropolitan area network via a backbone requires a high-speed solution, however. Multigigabit routers are becoming available—capable of transmitting millions of packets per second—and they may allow network managers to retain their current architecture a bit longer. But they're an expensive and risky answer to a problem, compared with migration to a switched environment.

Switching allows network designers to place existing routers more effectively, moving them to the edge of the network for security, WAN access, and firewalling. Eventually, some vendors say, you'll be ale to replace those routers with intelligent high-speed switches, although other vendors maintain that mainframe routers—high performance mulitport routers—will be able to administer a large number of LAN switches.

Furthermore, switching requires a different management approach. "It's the dark side of switching," says consultant Tolly. In a shared environment, network managers can figure out what's going on by capturing frames. To follow what's going on in a switched environment, you need a mirror port—a switch sends a copy of all the frames moving from one port to another, where they can be examined. "That means you need to have that capability within the switch, and that means a more expensive piece of hardware," Tolly explains.

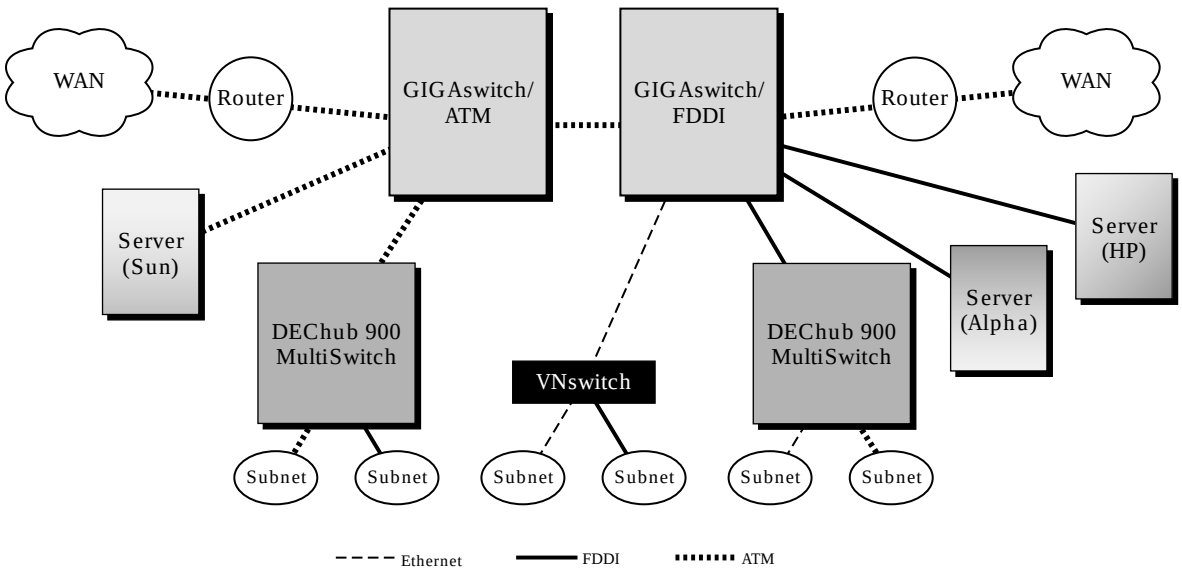
Migration Path

Because today's networks are increasingly mission-critical, one can't shut down a shared resource system for a couple of weeks to install a modern switched network. Fortunately, that isn't necessary. A well thought out migration plan for a switched network usually includes a staged approach.

Several factors should be taken into account as you plan your migration to a switched network. Obviously, the first consideration is to make sure there is connectivity between the old network and the new. Unless you can replace an entire network overnight, there will be an interval during which some will be on the old network architecture, some on the new. Make

Multiprotocol Switches for the Enterprise

Switches from Digital Equipment Corp., for example, can link FDDI, ATM, and Ethernet devices across the enterprise.



Source: Digital Equipment Corp.

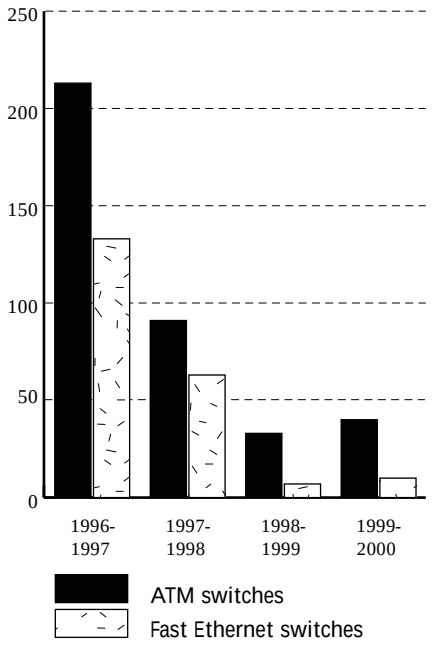
sure the two can interact seamlessly.

You'll also have to make sure that equipment from different vendors work together. Switches are fairly easy to use together. They're designed around industry standards and are interoperable virtually by definition. But network management software often relies on parts of the switch design not covered by industry standards to gather information about the network. Any manager who wants to tightly integrate network management capabilities will be better off buying gear from one vendor.

You'll also need to pursue a homogeneous networking approach if you have any interest in virtual LAN technology. As their name implies, VLANs are a way of segmenting a network by function, not by location. Among other advantages, VLANs create a broadcast domain and keep broadcasts within the appropriate LAN, preventing them from being propagated across the wider network environment. VLAN schemes are still proprietary, however, so if they're important to your migration plan, you'd be better off buying all your boxes from the same vendor.

ATM Paces Switch Growth

(% change in annual shipments, thousands of ports)



Source: Dataquest

Consider how you're going to connect to wide area networks. ATM switches may someday replace routers in WAN links—they're superior to routers in this environment because they can manage voice, video, and data on the same line. Networks are generally flattening out, according to Forrester Research. Companies are adding switches rather than routers to enable Inter- and intranet traffic.

It's the router's Layer 3 capabilities that have kept it an integral part of network architecture. But switch vendors have begun introducing switches that incorporate some Layer 3 services. The switches take advantage of the fact that TCP/IP is becoming the predominant network protocol. Routers tend to be fairly slow partly because of the amount of processing they have do to successfully identify a data packet. But if the network is IP-based, it doesn't need full router capability, just the ability to handle IP. This reasoning led to the development of the IP switch. This Layer 3 switch can detect longer data flows and establish a switched virtual connection. IP switching combines the speed of today's switches with the intelligence of routing software. Many IP switches can route or switch dynamically. Long-lived data flows are switched; short-lived flows are routed.

Among the many switch vendors, there are a half a dozen ways of implementing Level 3 intelligence on a switch, including peer-to-peer multilayer mapping, IP switching, and IP address learning. Some of these, such as IP switching, have been implemented on current products. For example, Digital Equipment's Gigaswitch/IP Solution combines IP routing and ATM hardware. It is a transparent replacement for backbone routers.

According to Forrester Research, IP switches will stimulate the need for network services management. Network managers will have to be able to set prioritization, grant bandwidth reservations, and perform other functions. At the same time, backbone switches may well provide VLAN and packet filtering that will need managing.

"The issue isn't really network management," says Decisys' Passmore. LAN managers "have little problem with the plumbing at this point. The real issue is managing applications and other software." The more heterogeneous the network, however, the more difficult network management is. That means the network manager may have to be ready to sacrifice hard-won vendor independence in return for greater control of the network.

Virtually all vendors recommend a phased-in approach to network migration. Rather than making a sweeping, often cataclysmic change to an entire network simultaneously, the phased-in approach recommends making incremental changes throughout the organization and getting those changes stabilized before moving on to the next step.

A variety of recommended switch migration paths are available. One approach is to incorporate LAN switches into the workgroup wiring closet and follow that by adding ATM switches to the backbone. Another approach advocates increased LAN segmentation, followed by virtual workgroups, then enhanced backbone capabilities. For many reasons, however, we believe the following phased-in approach should be considered:

The cost of adding switches to an existing LAN can be relatively moderate.

1. *Add switching capabilities to the network backbone.* This increases backbone capability in preparation for a deluge of data from LANs.

2. *Increase LAN segmentation.* Smaller LANs are easier to monitor and control, an important issue as throughput increases.

3. *Add LAN switching.* This is where end users see their dramatic speed improvement. Each user gets a dedicated channel rather than sharing bandwidth with others on the LAN. It means an increase in capacity directly proportional to the number of users on the LAN—an increase for which the previous steps have prepared the rest of the network.

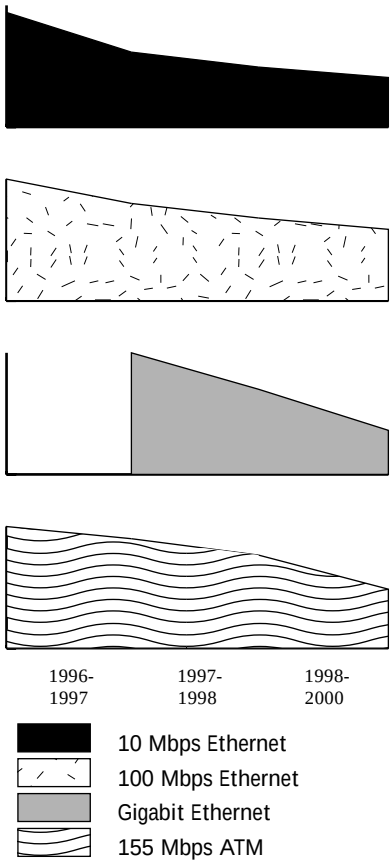
4. *Create virtual workgroups.* As noted, virtual LANs group users by function, not by location. A by-product of switching technology, VLANs can keep messages from propagating outside the user group for which they were intended.

Each phased scheme has the virtue of leaving the network operational while changes are taking place. And each step should show a concrete improvement in network performance.

Other considerations for migration schemes should include scalability (peer-to-peer multilayer mapping is aimed more at WANs than LANs, for example) and security. One should also be cautious in building a network migration plan around products that haven't yet been introduced.

Switch Costs Declining

Average decrease in end-user, per-port prices for various switch technologies from prior period



Source: Dell'Oro Group

How Much Does It Cost?

Network managers are probably already convinced that switching is the proper approach for their evolving data communications needs. But what about upper management's cost-consciousness?

The cost of adding switches to an existing LAN can be relatively moderate. However, the cost of ATM backbone switches—for example—can move into five figures, depending on the technology and number of ports. The benefits are often commensurate with the cost. Implementing an ATM backbone switch—providing 622 Mbps versus the traditional 45 Mbps (T3) backbone—can yield performance improvements that make the expense worthwhile.

Of course, companies require a firm return on investment. Analysts are united in the view that there are significant financial benefits to switching. Forrester Research and Gartner Group estimate that switching can reduce capital and administrative costs by up to 50% per port, as businesses shift away from routers to the cheaper bandwidth of switches.

Here's a summary of current costs for implementing a switched architecture for the various networking protocols:

Ethernet/Fast Ethernet: A 10/100 Mbps Ethernet switch for a workgroup starts at around $1,500, according to Gartner's MacAskill. It would have eight ports, each capable of supporting 60 to 70 users. The switch would be placed between the hub and the primary server for that workgroup and would support desktops with standard Ethernet, as well as Fast Ethernet, network interface cards. Because the cost of 10/100 network interface cards is essentially the same as for standard Ethernet NICs, installing a 10/100 switch makes the most sense today, MacAskill says. Switches for a standard 10 Mbps environment cost about 25% less than for 10/100 Mbps.

However, the lower-end switches do not provide some important features, such as management tools. A fully managed 10/100 Mbps switch solution starts at about $5,000. If the decision is made on up-front cost alone, purchase a fully managed 10 Mbps switch with 100 Mbps switched uplinks.

Backbone switches that support Fast Ethernet must be more sophisticated. Demands for fault tolerance, additional ports for access to a server farm, and other complexities drive 100 Mbps backbone switches to more than double the cost of a workgroup switch, says MacAskill. And the cost could reach $800 per port. Note that in addition to the hardware cost, a Fast

Equipment outlays are a small portion of the total cost of operating a network.

Ethernet backbone switch will require network management software that will add roughly 10% to the overall cost.

ATM: Providing ATM switching for a backbone is a significant expense. An edge device could run at least $1,000 per port, and a backbone switch starts at under $20,000. In addition, server adapter cards will cost $1,000 each. A front-edge device will be needed to convert Ethernet frames to ATM cells.

FDDI: As a mature technology, there are a variety of FDDI switches and prices. The per-port cost range is $1,500/port for a departmental link. A backbone switch starts at approximately $27,000 for four ports.

Gigabit Ethernet: New product introductions each week make the Gigabit Ethernet market hard to pinpoint, but figure on a per-port cost of at least $2,000. The current range is $2,500 to $4,000, notes MacAskill.

However, networking equipment costs will continue to fall as demand and competition combine to drive down prices. MasAskill predicts that ATM costs will decline by 25% by the end of the year. Gigabit Ethernet costs will rapidly decline after the technology hits the mainstream, which MacAskill predicts will occur next year.

According to the Dell'Oro Group, the cost of the faster technologies will fall at a faster rate than the established ones (see chart, "Switching Cost Declining," page 8). For example, Dell'Oro projects that by 2000, Fast Ethernet will cost only about 74% more than 10 Mbps Ethernet—a 10-fold improvement of speed for less than twice the price. Similarly, a Gigabit Ethernet environment will offer an improvement of two orders of magnitude over 10 Mbps Ethernet for just over three times the price per port.

Gartner Group indicates that these equipment outlays are a small portion of the total cost of operating a network. According to the IT consulting firm, only 21% of the total cost of operating a networked PC environment is equipment cost. The remaining 79% is technical support, administration, and end-user operations—costs that would remain stable or decrease as a result of a migration to a switched environment.

For example, switches remove a lot of the network management complexity of routers. Configuration management and addressing issues decline or disappear. MacAskill estimates a 50% to 60% decrease in the network management requirements for a switched environment relative to a router-based architecture. However, network management personnel will need special software and training to cope with the higher speeds of a switched environment, so assume that software costs will increase by 10%.

Selling the benefits of switching should be relatively easy for network administrators. The cost savings of switching versus additional routers is compelling. The promise of immediate improvements in throughput, response times, and other end-user-oriented metrics can help sell the upgrading, especially since the time frames are relatively short. "You sell switches [to management] by promising every desktop its own private LAN," says Tolly. "You're assuring optimal network response time." The cost can be justified on improved network performance and the improvement in productivity that follows. Even in a small customer service department of a dozen users, migrating from a shared-media Ethernet network to a switched one would yield a 12-fold improvement in throughput. A 12-second response time would become a 1-second delay during peak usage. That means improved customer service at a lower cost, which could be promoted as a competitive edge.

Furthermore, demands for network bandwidth occur more frequently. Rapidly changing traffic patterns and unexpected killer applications demanded by business units can swamp a network overnight. Moving to a switched architecture is one of the few ways network administrators can keep up with demands for instant bandwidth increases. ◘

Migration Plan Tips

- ◘ Do one organizational layer at a time. Start and complete one group of units before moving to another. For example, add switching to all the backbone nodes before tackling the workgroup LANs.
- ◘ Connectivity between the old and new networks isn't an option, it is a requirement.
- ◘ Interoperability should extend to network management software as well as the hardware components
- ◘ Don't forget the WAN. Determine in advance the type of protocol that will be needed to link the switched LAN to the Internet and to other parts of the enterprise. Design your switched network to include the WAN protocol.
- ◘ Internet Protocol (Layer 3) switches can replace higher cost routers except for network edges
- ◘ Scalability—make sure the capacity of the switch product line can meet your future needs
- ◘ Security—stick with what exists and is already proven rather than vaporware

Source: *Network Digest*

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About this Report

Network Digest is a report that synthesizes analysts' research on various networking topics. The mission of *Network Digest* is to review information available from vendors and analysts and convert it into useful insights for network managers at large and midsize organizations around the world.

This edition of *Network Digest* is based on interviews and documents obtained from a variety of consulting firms and market research organizations. The authors gratefully acknowledge the cooperation of the Burton Group, Business Research Group, Dataquest, Dell'Oro Group, Decisys, Infonetics Research, International Data Corp., Sage Research, Sentry Research Services, and the Tolly Group. This edition of *Network Digest* was supported by a grant from Digital Equipment Corp.'s Network Product Business Unit, located in Littleton, Mass.

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For more information about Digital Equipment Corp.'s switch products and services, please contact the appropriate company office or Web site home page.

The telephone numbers are:

In North America: *800-859-1758*

Outside North America: *508-692-2562*

Inquiries via facsimile should be sent to: *508-392-0603*

Information requests via E-mail:

TBG@seetraenet.dec.com

The Network Products Business Unit's Web site provides a broad array of information about products and technologies.

The addresses are:

US: *http://www.networks.digital.com*

Europe: *http://www.networks.europe.digital.com*

Australia: *http://www.digital.com.au/networks/*

Japan: *http://www/dec-j.co.jp/ic/network/*

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