



## **Network Switching — Technology, Strategy and Products**

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## **Network Switching Overview**

High-performance client/server applications and interactive multimedia services are just some of the increasingly popular styles of computing that are placing new demands and driving higher bandwidth requirements on the networks that support them.

This document examines the issues facing network managers, how network switches are evolving to address those issues, and how Digital is leading the way with innovative switching products.

### **Factors Affecting Network Performance**

Switching, which has emerged in recent years as a result of a fundamental shift in the networking landscape, is affecting a broad range of organizations and enterprises.

With the availability of ever more powerful computing capabilities at the desktop and the cost of this power getting lower every day, the use of PCs and workstations has proliferated rapidly. Along with the growing use of desktop devices, the increasing need of users to gain access to and share information and resources has resulted in the spread of client/server networks. In addition, more powerful applications — with graphics, images, video, and audio — have not only broadened the forms of information available through the network, but also expanded the use of this information.

While desktop, network, and application capabilities continue to grow, enterprises — in response to increasing competitive pressures — are pushing the limits of their networks. The drive is for more — and more complete — information, available to the appropriate people anywhere in the enterprise, all presented at the desktop with the least delay. As more users, more software, and more data travel the network, the network load increases, doubling every year.

Many organizations have responded to increasing network load by migrating from shared LANs to segmented LANs to switched LANs. Previously, the choices most organizations faced were to redesign their networks using the technology in place, to employ higher-speed technology in the existing network configuration, or to implement a combination of the two strategies. Today, the most cost-effective solution is to integrate switches into an existing network while providing quick access to the network backbone.

### **Switching at Different Levels in the Organization**

Switching permits organizations to meet the network performance demands of their users and applications. For example, by incorporating switches into an existing LAN, network managers can increase network throughput without altering network infrastructure. In this way, switches help preserve network investments as needs change. Requirements for switches vary, however, based on where in the network they are used.

At the desktop, for instance, users typically need to maximize performance at minimal cost. For users involved in data-intensive activities — such as frequent database queries that may result in large file transfers to the desktop — a network manager will want to “personalize” the bandwidth available to users. Desktop switching will provide these power users with an “express lane,” so they are not contending with other less aggressive applications and effectively dragging down the whole network. The solution is high-speed, low-cost switching.

When we look at the departmental level, the issues become traffic control and security, or “firewalling.” Here, bandwidth-demanding desktops need to be segmented into manageable entities to ensure each user has access to all the information and resources needed — but nothing extraneous or classified. Consider a medical imaging application, which places very high load on the network and requires full protection of patient information. By grouping users according to need and implementing switches between the groups, a network manager can deliver the necessary bandwidth, while protecting privileged data. To achieve firewalling and gain greater control over the traffic, protocol or address filtering is required. Ideally, the switch could combine the security and functionality of a router, while retaining the performance capabilities originally sought from a switching solution.

Moving out to the enterprise as a whole, switching takes on yet a different challenge. Here, departmental workgroups must be interconnected to ensure quick access to information, communications, and resources among the aggregated groups. Bandwidth becomes a primary concern, along with performance and availability. Financial services provides a good example, where users of a campus backbone share common financial databases, real-time applications, and servers. Enterprise switching provides the essential high-speed link between department LANs for optimal network responsiveness and high availability required in this transaction-intensive environment. Here at the heart of the network, the network manager will also look for scalability and redundancy to permit growth and ensure availability, since the increasing load from each desktop and each department compounds significantly as it travels through the entire enterprise.

### **Virtual LANs for the Virtual Organization**

The role of switching leads beyond the physical bounds of traditional organizations, as networks evolve to meet the needs of a more distributed, mobile workforce. Telecommuters, independent consultants, or other widely dispersed individuals may now be brought together on a project or ad hoc basis forming “virtual” organizations. This phenomenon raises new concerns for network managers struggling to maintain performance and security, while handling the increased cost and burden of network adds, moves and changes. These concerns can be minimized, if not eliminated, over time by incorporating virtual LANs into the network environment.

Virtual LANs enable the logical connection of physically separated individuals or workgroups onto a common software-based LAN or “express lane.” Virtual LAN capability allows a network manager to optimize performance, ensure proper levels of security, and dynamically adapt to many network changes — all critical to users in a virtual organization that may link resources and environments from all corners of the globe.

Five technology enablers are needed to deploy virtual LANs. A software-configurable backplane is required to deliver multi-gigabit performance across multiple technologies. Configuration switching, required to group users on a common LAN for security and traffic optimization, and LAN switching, needed to deliver high-speed switching interconnects to users across multiple LAN segments, provide a critical foundation for defining the virtual LAN. And a software-based management tool provides the necessary capabilities to manage the relationships among ports, users, and devices on the virtual network. Network monitoring is also needed to study traffic patterns and thus optimize network utilization.

#### **Switching Technology**

There are two types of switching that network managers may employ — configuration switching and LAN switching — which optimize network performance, simplify network management, ensure security, and provide the essential foundation for virtual LANs.

#### **Configuration Switching**

Configuration switching is a software-based solution that enables network managers to maximize available network bandwidth at the desktop and workgroup levels. It is a method of grouping individual users according to job function or organizational relationships, using software to define the logical links rather than physically moving cables from one port to another. For example, a user in the marketing workgroup LAN is working on a project with a user in engineering. While the user resides on a separate LAN, configuration switching enables them to work on their own private LAN — a “virtual” LAN. In this way, the network manager can construct secure, independent workgroups based on job function and easily move, add, or change users in those workgroups as needed. Since adds, moves, and changes are achieved through software, management of even complex virtual networks is easy and cost-effective.

Configuration switching made possible by the use of port-switching devices allows the network manager to change network traffic lanes by switching users or segments from one port to another. Through software, the network manager creates the “express lane” between users with a common need to communicate. Independent workgroups that have been constructed using port-switching devices can be interconnected to individual LAN segments using a software configurable backplane. By extending this approach throughout an enterprise, the network manager can build switched virtual LANs among multiple hub-based workgroups across a campus backbone.

#### **LAN Switching**

LAN switching provides the physical connections among users and LAN segments to switch data packets from one segment to another. Packet switching is achieved using either “cut-through” or “store-and-forward” switch technology.

Based on specific switching algorithms, store-and-forward switches process the data packets passing through them, validating that they have accurately received the bits comprising the packets. A store-and-forward switch waits to receive an entire packet off the network link, verifies that it has received the data without error, processes its destination address and only then forwards the packet to the appropriate network.

The key advantage of store-and-forward switches is that their use guarantees the integrity of the packets passing through. The store-and-forward switch detects bad or incomplete “runt” packets and does not propagate them to other networks. IEEE 802.1-compliant store-and-forward devices provide additional capabilities. For example, these full-function devices can also support redundant paths to ensure network availability and can connect dissimilar networks, such as Token Ring and FDDI — distinctive benefits in today’s hybrid networking environments.

Cut-through switches, on the other hand, do not attempt to validate the data in the packets passing through them. A cut-through switch begins retransmitting a packet as soon as it reads its destination address — even before it has received the entire packet. Because cut-through switches evaluate only the destination address on each packet passing through, their latency, which is the delay before a packet is transmitted, is typically very low.

The effectiveness of cut-through and store-and-forward switching methods varies with the networks technologies on which they are deployed. Ethernet is a collision-oriented approach to transmitting data on a network. If two stations attempt to transmit on an Ethernet network at the same time, a collision occurs. Collisions result in “runt” packets and do not contain any useful or complete user data.

When cut-through switches are used to switch Ethernet traffic, the network manager must consider both the integrity of data packets, as well as the performance capabilities of the switch. Runt packets will occur more frequently, since a cut-through switch only examines the destination address and forwards the packet immediately. Moreover, cut-through switches typically have less memory, which prevents them from providing adequate performance on heavily loaded Ethernet networks. Cut-through switches are simply not designed to perform store-and-forward functions, and will likely lose packets due to their minimal buffer size.

In contrast, store-and-forward switches are often a better alternative for Ethernet networks because they can detect and reject runt packets, and because they typically carry more robust memory buffers.

FDDI networks are based on a timed-token passing dual ring scheme. Because collisions do not occur in these networks, cut-through switching can be used effectively to improve network performance.

### Digital's Switching Strategy

Digital implements both configuration switching and LAN switching to offer customers a choice when selecting the best switching solution for their requirements.

Digital's switching strategy is to :

- Deliver a full range of high-performance switching products — across desktops, departments and enterprise networks backbones
- Implement store-and-forward and cut-through switches to ensure that customers have the network building blocks they need
- Offer high-performance switching engines across key networking technologies — such as Ethernet, FDDI, and ATM
- Build standards-based switching platforms ensuring data integrity, interoperability, low latency, and redundancy
- Integrate switching, routing, and hub functionality to offer a graceful migration path to ATM
- Provide a single, easy-to-use graphical SNMP management application on multiple platforms

Digital's leadership in switching technology has evolved from the company's twenty-plus years of network experience and numerous technical contributions in product innovation and standards development, including: the invention of peer-to-peer networking; the co-development of Ethernet; and the development of the Spanning Tree algorithm, used in bridges and IEEE 802.1-compliant devices. Digital was also the first company to develop and manufacture a true store-and-forward device, the LAN Bridge 100.

In addition, Digital has more than six years of experience with high-performance switch-based networking for both FDDI and ATM networks. This includes GIGAswitch/FDDI, the industry's fastest FDDI switch, and GIGAswitch/ATM for unprecedented performance, low latency, and high availability in ATM networks. In fact, the GIGAswitch/FDDI was recently named Data Communications' "Hot Product of the Year" for 1994 and won *R&D Magazine's* "R&D 100" award for technological leadership while the GIGAswitch/ATM made the "Short List" of *Network World's Buyer's Guide* issue.

### Digital's Switching Product Family

Digital's switching product strategy brings the benefits of high-performance switching to a range of network applications on a variety of levels — the desktop, the department, and the enterprise.

Digital's switches can connect multiple high-performance personal computers, workstations, and servers on a single LAN, as well as interconnect multiple desktop and departmental LANs into a high-performance corporate backbone. Digital combines data integrity with high performance to bring industry-leading price/ performance to its switching family.

### Digital's Three x Three Switching

Switching at every level in the network

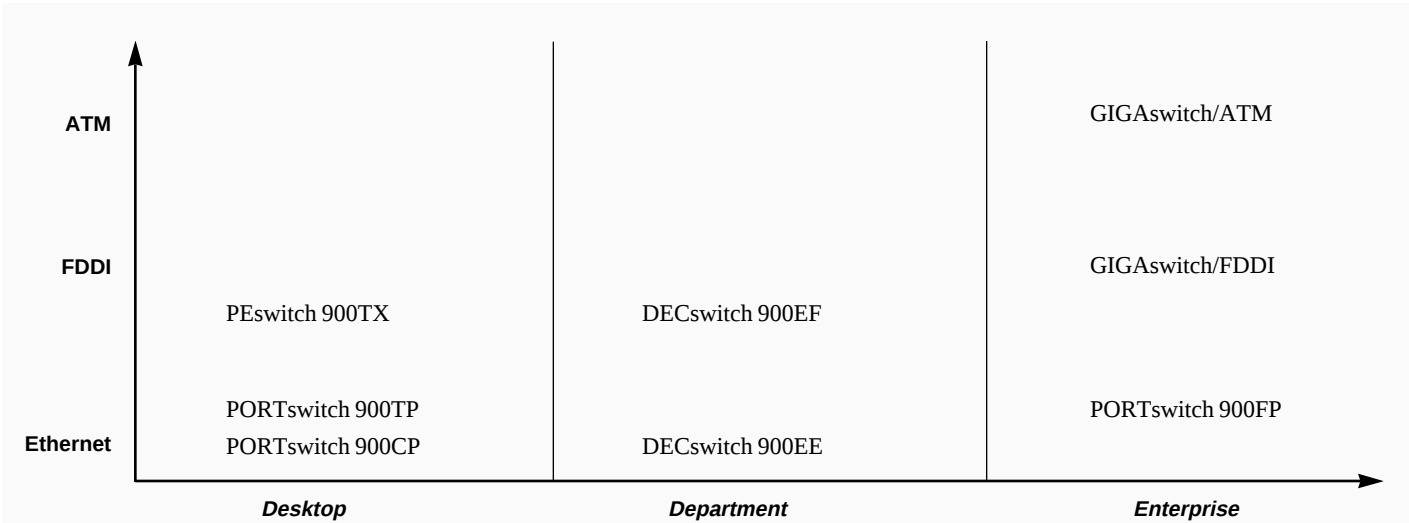


Figure 1. Digital's Switching Product Family

### **Per Port Switching for Flexible Workgroups**

To enable configuration switching and to provide the foundation for switched virtual LANs, Digital offers the port-switching devices for desktops, workgroups and enterprise backbones. The PORTswitch 900TP provides up to 32 10BaseT ports for as many as six Ethernet LAN segments. The PORTswitch 900CP supports up to 16 ThinWire ports across up to six individual Ethernet LAN segments and the PORTswitch 900FP for 12 per-pair port switching. All PORTswitch products provide per port security, and as members of the DEChub family operate and are managed as stackables and snap in the DEChub 900 MultiSwitch. The PORTswitch 900TP and PORTswitch 900FP also support redundant links for high network availability. All three PORTswitch products fully support software manipulation using Digital's HUBwatch management software to group and switch ports from one Ethernet LAN segment to another.

### **Low-Cost, High-Performance Desktop Switches**

The PEs switch 900TX meets the needs of bandwidth-hungry desktops. This true store-and-forward switch expands available bandwidth through dedicated Ethernet switching at desktop prices. The PEs switch 900TX provides excellent performance and low latency. The unit also provides robust, high-performance network connections that maintain packet integrity, while delivering full IEEE-compliant 802.1 Ethernet-to-FDDI translation and IP fragmentation.

The PEs switch 900TX permits a choice of upgrades for desktop performance connections at a cost that is significantly lower than other high-speed technologies. This approach minimizes user disruption, changes to cabling infrastructure and replacement costs of new system adapters, drivers and software.

### **High-Performance Switches for Departments**

The new DECswitch 900 products are full-performance, store-and-forward switches for inter-LAN connectivity. They optimize network bandwidth and manage traffic by providing high-performance switching from multiple Ethernet LANs to Ethernet or FDDI backbones.

The DECswitch 900EF is an Ethernet-to-FDDI switch; it offers six Ethernet ports and one FDDI port. The DECswitch 900EE, with six Ethernet ports, offers the best price/performance of any Ethernet-to-Ethernet store-and-forward switch on the market today. These switches provide full-speed, full-function filtering and forwarding and offer a simple, firmware upgrade capability to router functionality, when downline-loaded from DOS, UNIX or VMS systems.

The DECswitch 900 products combine "full-speed" switching with standards-based, true "store-and-forward" functionality, ensuring data integrity as well as high performance.

### **Scalable Switch Configurations**

Digital has integrated the new PEs switch 900TX and the DECswitch 900 products into its leadership DEChub 900 MultiSwitch architecture — a 3+ GB/s technology-independent backplane that supports integration of Ethernet, Token Ring, FDDI, ATM, and other high-performance networking technologies. These are the only switches on the market today that can operate and be managed both as standalone switches or as modules within the DEChub 900 MultiSwitch without modifications or additional cost. This offers unmatched configuration flexibility, provides a "no-cost" migration path to powerful switch-based enterprise networks, and is a critical component for implementing virtual LANs.

### **High-Performance Enterprise Switches**

Digital's award-winning GIGAswitch/FDDI, as well as the GIGAswitch/ATM, delivers the high throughput and low latency demanded in high-performance backbone networks. GIGAswitch systems implement a patented, highly parallel switch design that supports multiple simultaneous connections between ports. This crossbar switching technology helps to make these switches among the fastest available.

The 3.6 GB/s power of the GIGAswitch/FDDI makes it the industry's fastest FDDI switch, performing, according to *R&D* magazine, "more than six times better than its nearest competitor." GIGAswitch/ATM, a 10.4 GB/s ATM small switch, reflects Digital's leadership in ATM technology, and is the only ATM switch that ensures network stability through a patented, no-loss traffic management feature, known as FLOWmaster flow control.

### **Graphical Switch Configuration/Management**

Using Digital's HUBwatch graphical management software, network managers can remotely build, configure, and manage complex networks quickly and easily — from basic connectivity to the full range of LAN and configuration switches to virtual LANs. This simple, graphical interface translates SNMP messages into illustrations of switch modules, hubs and ports. You can easily navigate through the software to configure, monitor, and control port connections and network traffic. HUBwatch provides a comprehensive set of switch management functions using simple point-and-click commands for both in-band and out-of-band management.

For configuration switching, HUBwatch provides a visual representation of the ports on a given device — such as a PORTswitch 900FP, PORTswitch 900TP, or PORTswitch 900CP — and enables a network manager to select and aggregate multiple ports into logical groups. These groups can then be pointed to individual LAN segments on the backplane of the DEChub 900 MultiSwitch.

HUBwatch is available on a choice of popular PC and workstation platforms, such as Windows, OpenVMS, and OSF/1. In addition, HUBwatch can be launched from Novell NMS, HP OpenView for Windows and POLYCENTER/NetView.

## Summary

The emerging styles of computing in the 1990s demand reliable, high-performance networks. These new switches provide the essential foundation for virtual LANs and demonstrate Digital's continued leadership in meeting these evolving needs.

Digital's family of switching products offer extremely high performance and guaranteed data integrity at an aggressive price. As customers' networking needs evolve, their networks can grow with them, scaling up from workgroup solutions to high-speed, enterprise-wide computing infrastructures, while preserving their investments.

Building on a strong tradition of technological excellence, Digital is leading the way in the networking industry today. According to revenue figures from the International Data Corporation (IDC), Dataquest, and Rising Star Research, Digital holds the number three market position in routers, hubs and LAN switching markets, and holds the number two position in FDDI products. Digital's Network Product Business has pioneered a new, converged model for networking in which hubs, routers and switches are deployed on an integrated platform. In addition, Digital's expertise in network integration services has connected more than 12 million users worldwide.

Digital Equipment Corporation is the world's leader in open client/server solutions — from personal computing to integrated worldwide information systems. Digital's scalable Alpha platforms, storage, networking, software and services, together with industry-focused solutions from business partners, help organizations compete and win in today's global marketplace.

## For more information

For more information about Digital's switching family of products and other Digital networks solutions, contact your local authorized Digital reseller or consult with a Digital sales representative. To find your nearest sales office in the United States, call 800-DIGITAL (800-344-4825).

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