Intel Fast Ethernet Lan Guide

(Intel Corporation)

Introduction

With 100BASE-T Fast Ethernet, high bandwidth performance can be seamlessly integrated into existing 10BASE-T Ethernet installations to deliver 100Mbps (megabits-per-second) bandwidth when and where it's needed. To help customers plan Fast Ethernet implementations, this paper provides:

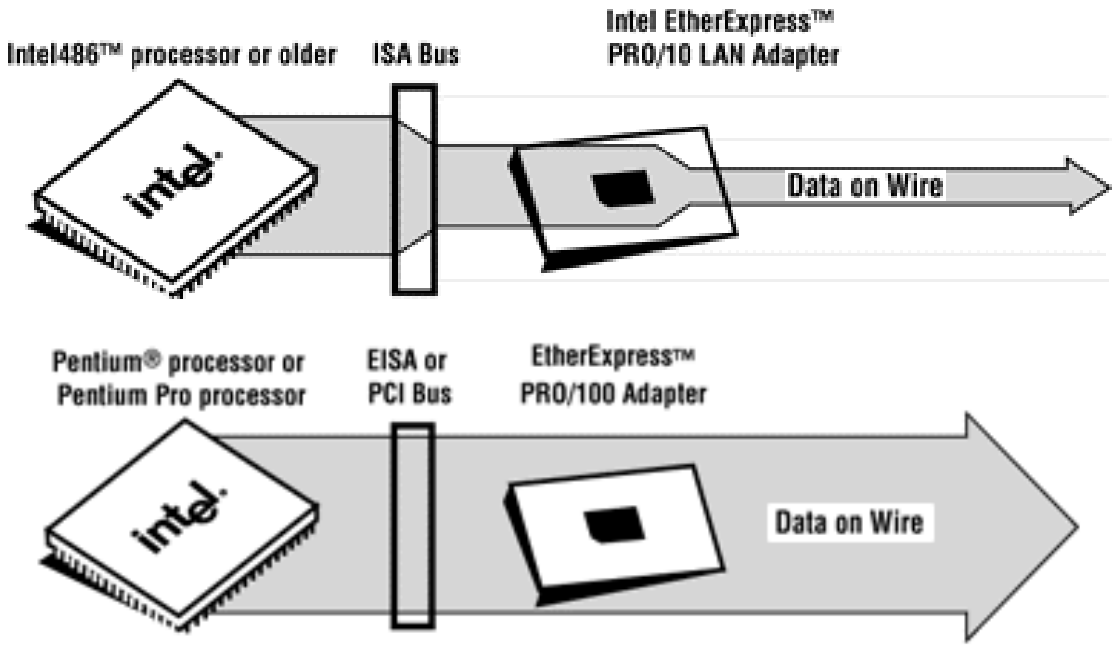
- An introduction to Fast Ethernet.
- Explanations of the Fast Ethernet specifications.
- Benchmark information.
- Steps for deploying Fast Ethernet.

The rapid advances in microprocessor and personal computer technology have brought increasingly powerful desktop computers and applications into everyday use. Many computers purchased today are powered by Pentium and Pentium Pro processors, usually coupled with a high performance 32-bit PCI bus. At the same time, Local Area Networks (LANs) are increasingly becoming strategic elements of corporations. LANs are more and more critical in the work environment, and users need the same high performance across the network as they have on their desktop PCs.

However, in the case of Ethernet, the available bandwidth for data transmission has remained constant at 10Mbps since its introduction in the early 1970's. This 10Mbps bandwidth is already inadequate for many environments; it will become even more of a bottleneck with the growing volumes of data generated by more powerful desktop PCs, applications, and more network users.

The use of Fast Ethernet, together with the 32-bit PCI bus architecture, extends the power of high performance desktop PCs onto the LAN (See Figure 1). With a wide data path from the processor onto the network wire, communicating on the network is no longer a bottleneck to productivity.

Figure 1
100BASE-T Fast Ethernet: a Natural Evolution from 10BASE-T Ethernet



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10BaseT LANS are becoming a bottleneck. 100BaseT Fast Ethernet Connections Move High Volumes of Data To and From the Network Without Bottlenecks.

To expedite development of a Fast Ethernet standard, Intel and a group of leading networking companies formed the Fast Ethernet Alliance in July, 1993. This cooperative effort included over 50 vendors representing all major categories of networking equipment, including adapters, hubs, bridges, switches, routers and management tools. As its name implies, Fast Ethernet is an extension of the proven Ethernet standard and is therefore easily integrated into existing Ethernet networks.

Fast Ethernet was officially adopted in June 1995, by the IEEE 802.3 committee, the group responsible for all Ethernet standards. The standardization and multi-vendor support guarantees a broad range of high-performance, low-cost Fast Ethernet products, ensuring that Fast Ethernet is a leading price/performance solution among high-speed networking alternatives.

Fast Ethernet uses technology that has been working reliably for more than a decade. It retains the familiar CSMA/CD (Carrier Sense Multiple Access/Collision Detection) protocol, enabling data to move between Ethernet and Fast Ethernet nodes on the LAN without protocol translation and retains the same cabling support (See Figure 2). This makes it easy to integrate Fast Ethernet segments into an existing Ethernet network.

	10BaseT Ethernet	100BaseT Fast Ethernet
Speed	**10 Mbps**	**100 Mbps**
IEEE Standard	**802.3**	**802.3u**
Media Access Protocol	**CSMA/CD**	**CSMA/CD**
Topology	**Bus or Star**	**Star**
Cable Support	**Coax, UTP, or Fiber**	**UTP or Fiber**
Max Hub-to-Node Distance	**100 Meters**	**100 Meters**
Media Independent Interface	**Yes (AUI)**	**Yes (MII)**

Figure 2
10BASE-T Ethernet vs. 100BASE-T Fast Ethernet

Fast Ethernet delivers ten times the bandwidth of 10BASE-T Ethernet. An analogy will help illustrate this tenfold increase in performance. Think of switched 10Mbps Ethernet as a ten-lane freeway where the speed limit is 10 Mph (See Figure 3A) and shared 100Mbps Ethernet as a one-lane freeway where the speed limit is 100 Mph (See Figure 3B). So, even though a switched 10Mbps freeway has 10 lanes, it still takes 10 times as long to get from here to there. Taking the analogy one step further, switched 100Mbps Ethernet is then a 10-lane autobahn (See Figure 3C) where the speed limit is 100 Mph!

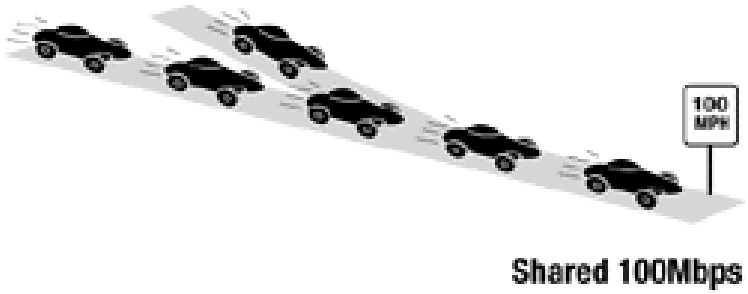

Figure 3A:

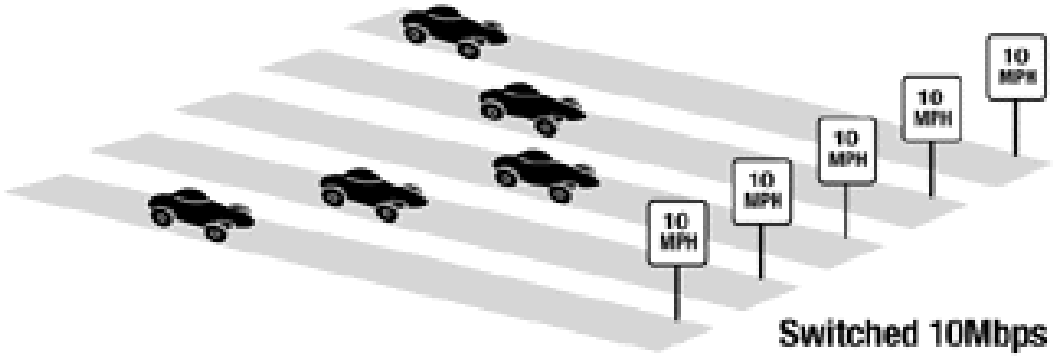

Figure 3B:

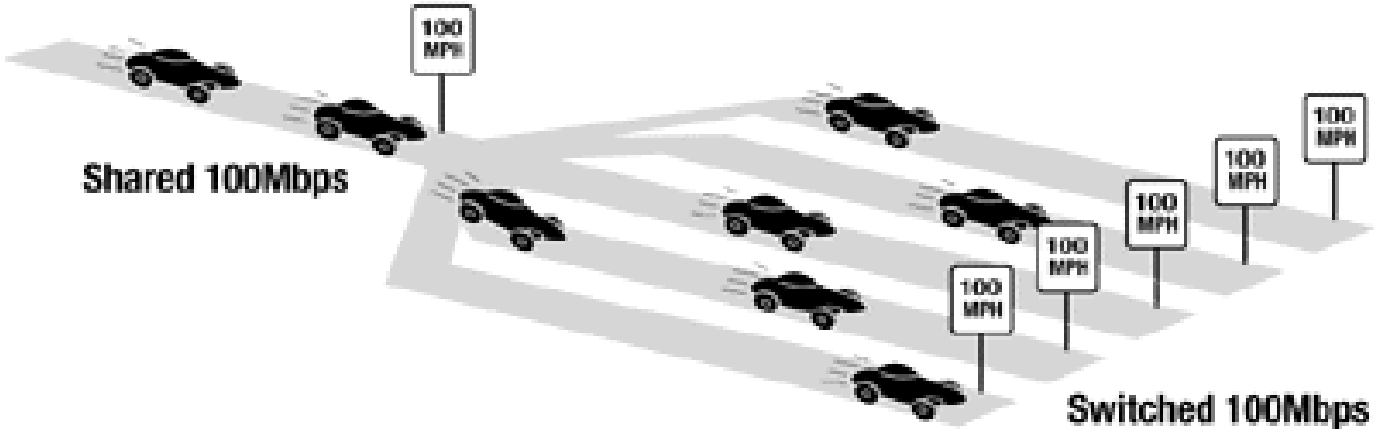

Figure 3C:

Fast Ethernet's impact on raw throughput can be judged by comparing Novell's Perform3 results in various scenarios. As shown in Figure 4, the network gets some performance benefit by moving from shared 10Mbps to switched 10Mbps (server on dedicated 100Mbps and clients on dedicated 10Mbps), but clients don't realize a tangible performance benefit until they are also connected at 100Mbps.

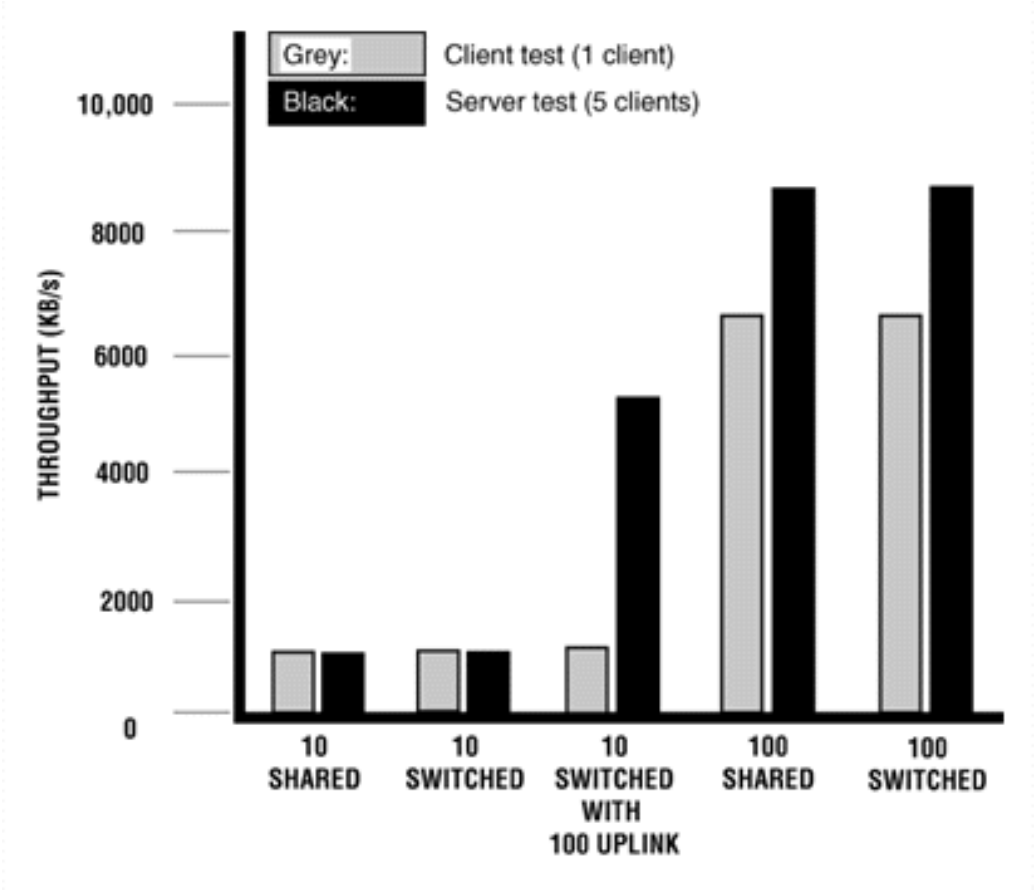

Figure 4
Novell3 Perform Results Show Real Performance Benefits In Switched and Shared 10Mbps and 100Mbps Networks.

In these tests, conducted with Intel's EtherExpress PRO/100 Adapter, average server CPU utilization was always less than 25%. This allows the file server to take advantage of the 100Mbps bandwidth while applying itself to the tasks for which it was intended: file, print and applications.

Fast Ethernet also brings real benefits to both servers and clients in terms of network load capacity. For example, a 10Mbps network running at 50% utilization can handle very few additional nodes or server-based applications. That same network traffic placed on a 100Mbps wire would have only 5% utilization leaving 95% of the bandwidth for network traffic growth.

To demonstrate the response time offered by Fast Ethernet for clients in everyday Windows 3.1 operating system-based environments, a test was run in which a client PC opened and closed Microsoft Word* 6.0, Excel 5.0, and PowerPoint 4.0 from various sources.

As shown in Figure 5, the test took 36 seconds when the applications resided on the client's hard disk, and almost twice that long when the applications resided on the file server of a shared 10Mbps

LAN. With the file server running on a switched (dedicated) 100Mbps connection port and the client running on a switched 10Mbps connection, the same test took 35 seconds, similar to the local hard drive.

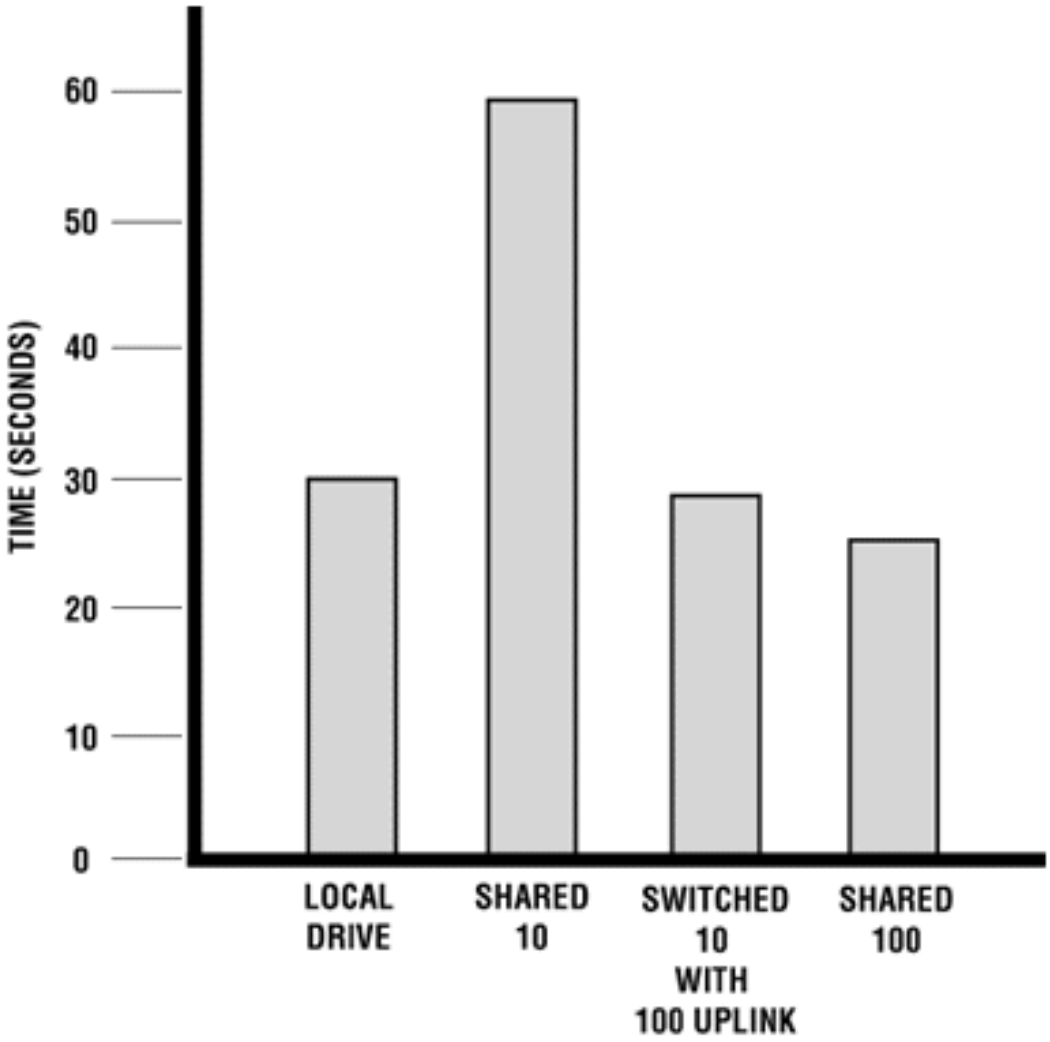

Figure 5
Application Benchmark Results

When both servers and clients were connected at 100Mbps, the test took only 24 seconds faster than even a local hard drive. With this level of performance, Fast Ethernet becomes an enabling technology, allowing corporations to do what is not feasible with 10Mbps Ethernet today.

100BASE-T Fast Ethernet Design Guidelines

Cabling and Connector Requirements

Since 100BASE-T supports multiple media types, the same cabling technology already installed for a 10BASE-T network can typically be used. Specifically, the 100BASE-T standard includes three media specifications: 100BASE-TX, 100BASE-T4 and 100BASE-FX. (See Figure 6.)

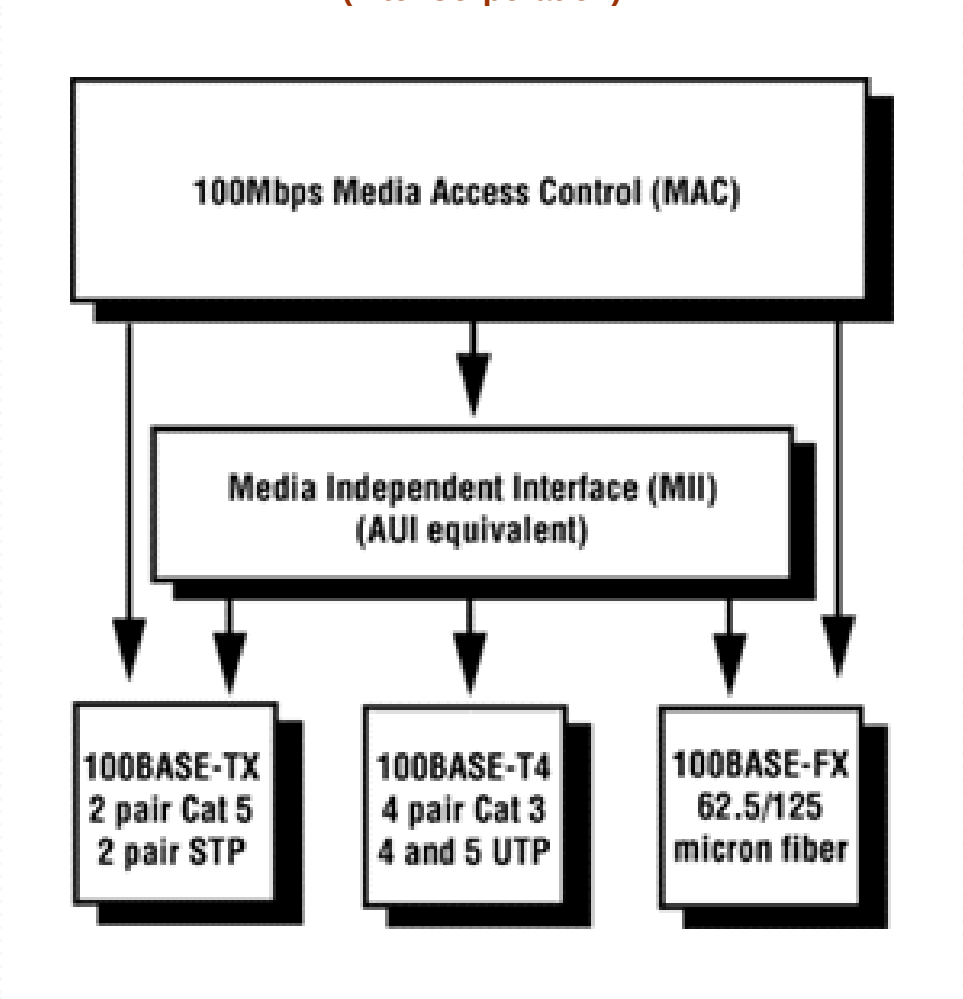

Figure 6
100BASE-T Cabling Support

The 100BASE-TX specification supports 100Mbps transmission over two pairs of Category 5 unshielded twisted pair (UTP, used in most new buildings and LAN segments today) or Category 5 shielded twisted pair (STP) wire.

The 100BASE-TX UTP RJ-45 connector is exactly the same as that used by 10BASE-T, where the RJ-45 links two pairs of wires. For 100BASE-TX operation, the punch down blocks in the wiring closet must be Category 5 certified. 100BASE-TX also specifies the traditional DB-9 connector for STP wiring.

The 100BASE-T4 media specification supports a 100Mbps data rate over four pairs of Category 3, 4 or 5 UTP wiring. This scheme uses a signaling technology in which three wires are used for transmission and the fourth wire is used for collision detection. Because 100BASE-T4 can use Category 3, it enables migration to 100BASE-T performance for many companies without rewiring.

100BASE-T4 also uses the RJ-45 connector wired the same way as for 10BASE-T. The two connections in the RJ-45 which are not used for 10BASE-T are used to connect the third and fourth

pairs of wires which are required for 100BASE-T4. Even though 10BASE-T uses only two pairs of wires, most Category 3 installations have a total of four pairs available.

The 100BASE-FX media specification defines 100Mbps operation over two strands of 62.5/125 micron fiber. Fiber optic media transmits over greater distances than UTP, which is particularly useful for connections between bridges, routers and switches on a Fast Ethernet backbone. 100BASE-FX connectors are the same MIC, ST or SC fiber connectors defined for FDDI and 10BASE-FX networks.

100BASE-T also includes a media-independent interface (MII) specification. MII defines a standard interface between the CSMA/CD MAC layer and any of the three media specifications mentioned above. The MII defines a 40-pin connector that can support external transceivers, much like the AUI connector for 10Mbps Ethernet.

The main difference in media support between traditional 10Mbps Ethernet and Fast Ethernet is that 100BASE-T doesn't support coaxial cabling. This is largely because companies have moved away from coax for new installations and distance limitations on coax will not support the speeds of 100BASE-T.

Types of Hubs and Switches

The topology guidelines for 100BASE-T have different implications for network design based on whether switches or shared hubs are used.

Shared hubs are concentrators where the bandwidth is shared among all connected nodes. For example, a 100BASE-T hub provides a total of 100Mbps bandwidth which will be shared among all nodes connected to it. Shared hubs do not filter packets or regenerate signals, and all nodes on a shared hub typically operate at the same speed (either 10 or 100Mbps).

A special type of shared hub is the Intel Express 10/100 Stackable Hub which offers 10/100Mbps capabilities. This feature allows you to move your desktops to Fast Ethernet now or later. The Express 10/100 Stackable Hub comes in 12- and 24-port versions that stack up to eight units high. With a maximum of 180 managed ports or 192 unmanaged ports, Express 10/100 Stackable Hubs satisfy the needs of everything from small LANs to large, managed networks. Stackable hubs are very important to 100BASE-T deployment because of their scalability and high port densities.

In contrast, 10/100Mbps workgroup switches provide dedicated bandwidth to each connected node. For example, an Intel Express 10/100 Fast Ethernet Switch provides 10Mbps or 100Mbps dedicated bandwidth to each device connected to it. Thanks to this technology, switches can be designed to accommodate some ports running at 10Mbps and some ports running at 100Mbps.

The main purpose of a workgroup switch is to help boost performance on a portion of the network, such as a floor in a building, or a particular functional group such as accounting or marketing. Workgroup switches improve performance on two fronts: They help segment the local LAN so there are fewer users per segment, and they give the server its own dedicated segment.

Using the Intel Express 100FX Switch to provide dedicated switched connections to the Express 10/100 Fast Ethernet Switches and Express 10/100 Stackable Hubs allows companies to extend Fast Ethernet capabilities to additional network segments, floors of buildings and campus environments, easily and cost-effectively. New clients, servers, workgroups and bandwidth-intensive applications can be added seamlessly as business needs dictate.

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Intel Express Switches are a comprehensive family of Ethernet and Fast Ethernet switching products that provide a complete, end-to-end solution for campus-wide networks. Combined with Express 10/100 Stackable Hubs, they deliver a full range of cost-effective solutions from the desktop through the entire network.

Five Rules for Network Topology

Since 100BASE-T Fast Ethernet is an extension of 10BASE-T, it is governed by many of the same network topology rules and is implemented in a star topology. The ISO 11801 cabling standard also applies to Fast Ethernet implementation.

There are five standard rules for network topology that apply to the deployment of Fast Ethernet and are largely concerned with network diameters:

RULE 1: All UTP cables are no longer than 100 meters.

RULE 2: Repeater placement should be planned in "wiring closets."

- Class I: Use one repeater between any two nodes. (A stack of Class I repeaters is ONE repeater {higher port density} No repeater hops allowed).

- Class II: Use a maximum of two repeaters between any two nodes. (One repeater hop of 5 meters maximum is allowed).

RULE 3: A hub connected to a switch with UTP cable should not exceed 100 meters.

RULE 4: A hub connected to a switch with fiber cable should not exceed 160 meters.

RULE 5: A switch connected to a switch at full-duplex with fiber cable should not exceed 2 kilometers. (A switch-to-switch connection using MultiMode (MM) Fiber cable can be up to 2 kilometers).

Just as in 10BASE-T networks, there is virtually no practical limit to the size of a 100BASE-T network.

Deploying Fast Ethernet

STEP 1: Preparing for Fast Ethernet

The easy, cost-effective way to prepare for 100Mbps is to install Intel EtherExpress PRO/100 Adapters in all of your Intel Pentium, Pentium Pro and Pentium II processor-based clients and servers (See Figure 8). Use EtherExpress PRO/100 Server Adapters for your high-end Intel Pentium and Pentium Pro processor-based servers, such as application servers or PC-based routers. And utilize EtherExpress PRO/100 Mobile Adapters for Pentium processor-based portable PCs. These adapters ensure the flexibility to operate at 10Mbps or 100Mbps or initially move to 100Mbps when the time is right. And with Intel 10/100Mbps adapters at under $89 U.S. SRP there is no cost differential between this option and the price of a regular 10Mbps adapter today.

Figure 7

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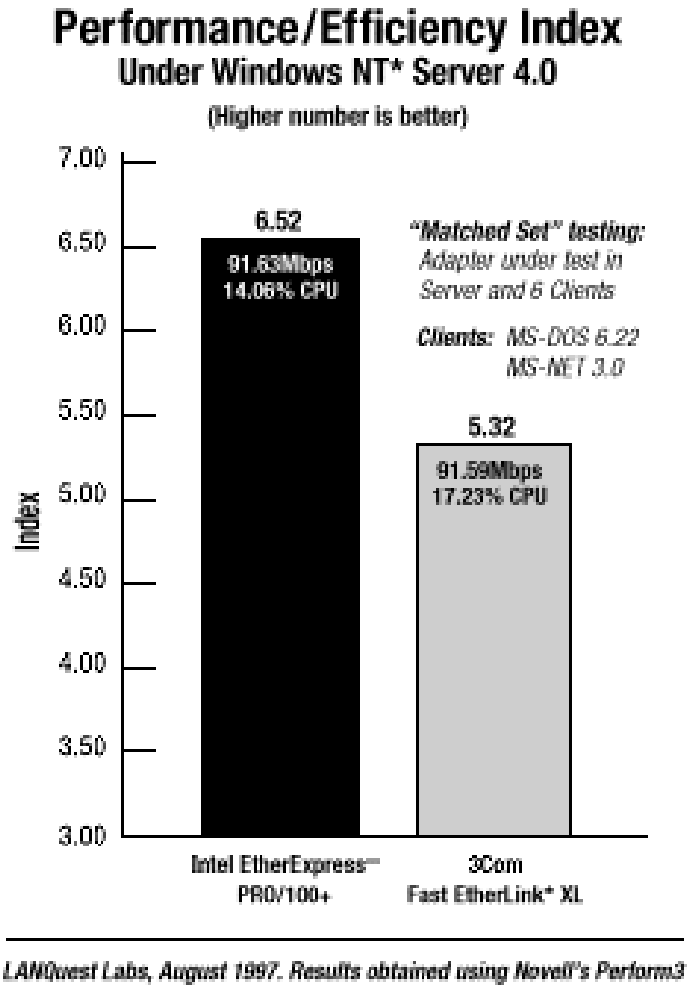
Intel EtherExpress PRO/100+ Performance



Because the EtherExpress PRO/100 family of adapters combines low CPU utilization with high network throughput over both Ethernet and Fast Ethernet, they are the best choice for your ultimate migration to Fast Ethernet (See Figure 7). With EtherExpress PRO/100 Adapters in your client PCs, EtherExpress PRO/100 Mobile Adapters in your portable PCs, and EtherExpress PRO/100 Server Adapters in your servers, you'll have increased network performance today and be well prepared for tomorrow's networks and applications.

To prepare your network for 100Mbps printing connectivity, Intel NetportExpress™ PRO/100 Print Servers provide 10/100Mbps connectivity. They’re a high-performance, centrally managed and reliable solution for connecting new and existing printers to your network. Additionally, Intel now offers 10/100Mbps hubs and switches that will allow you to install and run at 10Mbps (or 100Mbps) today and turn on 100Mbps later. These 10/100Mbps products are less expensive and simpler to deploy than buying a 10Mbps hub or switch today and a 100Mbps hub or switch tomorrow.

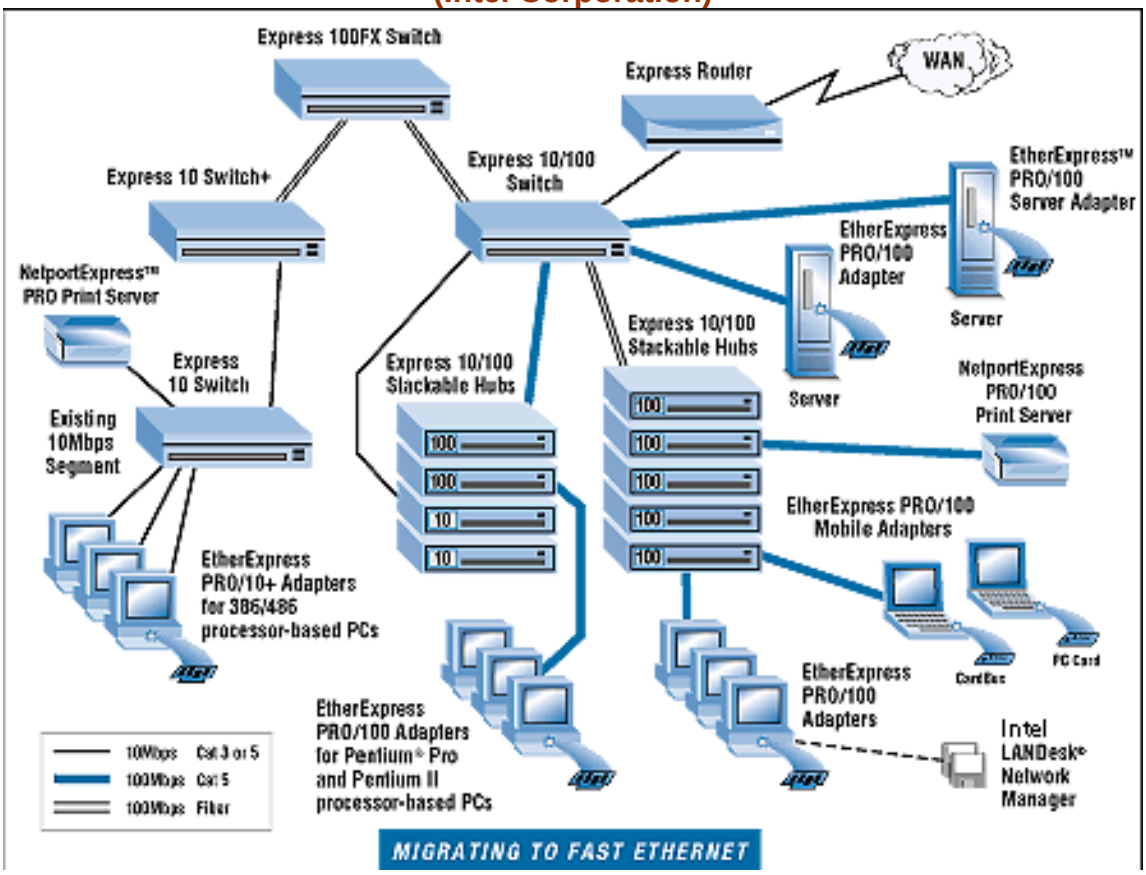


Figure 8
Migrating To Fast Ethernet

STEP 2: Turning on Fast Ethernet at the Workgroup

When you are ready for full Fast Ethernet performance, you can upgrade your Pentium processor-based PC workgroups to Fast Ethernet. First, make sure that all Pentium processor-based PCs are equipped with EtherExpress PRO/100 Adapters, portable PCs are equipped with EtherExpress PRO/100 Mobile Adapters, all servers are equipped with EtherExpress PRO/100 Server Adapters and all print servers are the NetportExpress PRO/100 Print Server. As shown in Figure 8, adding Intel Express 10/100Mbps Stackable Hubs provides 10 or 100Mbps Fast Ethernet to groups of desktops that need to run at 10Mbps today and plan to transition to 100Mbps at some point in the future. Additionally, the Intel Express 10/100 Fast Ethernet Switch will provide dedicated autosensing at 10Mbps or 100Mbps bandwidth, so that some network segments can continue to run at 10Mbps while others run at 100Mbps.

If the EtherExpress PRO/100 Adapters in any Pentium processor-based PCs previously were functioning at 10Mbps, the adapters will automatically switch over to operating at 100Mbps when they detect a connection to the Intel Express Hubs and Switches.

STEP 3: Connecting Fast Ethernet to the Campus and Beyond

As more workstations transition to Fast Ethernet it will likely become necessary to internetwork within the campus or enterprise. Fast Ethernet workgroups can be connected to the network backbone via a 100Mbps router or via the Intel Express 100FX Switch. With an Intel Express 10/100 Fast Ethernet

Switch connected to the router or Express 100FX Switch, users can route between network segments at 100Mbps, thus maintaining the high performance established with the workgroups. The Express 100FX Switch provides 100Mbps fiber connectivity to campus environments.

The 100Mbps router connection also provides a direct path to the scalable switched networks such as ATM, FDDI or Gigabit Ethernet. By choosing the appropriate router or bridge, the Fast Ethernet network can be connected to an existing FDDI campus backbone or can accommodate ATM technology on high-speed WANs.

Fast Ethernet: When and Where You Need It

Enabling your network for high-speed bandwidth needn't involve a mammoth undertaking accomplished all at once. Fast Ethernet is an extensible networking solution that can be deployed in a flexible manner, step-by-step, as your network growth warrants. A phased approach is almost always the most cost-effective way to implement a network strategy. Fast Ethernet, as an evolutionary extension of time-proven Ethernet technology, can be integrated one step at a time, when and where it's needed.

Intel is a leader in delivering 10/100Mbps for every network. With adapters, mobile adapters, server adapters hubs, switches and print servers that all run at 10Mbps or 100Mbps, you are assured that every component of your network is ready to make the move to Fast Ethernet when you are.

Additionally, Intel's PCI adapters have Adaptive Technology which allows a product's performance to be optimized for changing network conditions. Adaptive Technology maximizes performance and extends the life of Intel networking products.