Fast Ethernet Overview

With 100Base-T Fast Ethernet, high bandwidth performance can be seamlessly integrated into existing 10Base-T installations to deliver 100Mbps bandwidth where and when 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, and scenarios for workgroup and enterprise Fast Ethernet deployment.

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® processors, usually coupled with a high performance 32-bit PCI bus. At the same time, Local Area Networks (LANs) are becoming increasingly strategic elements of corporations. LANs are more and more critical in the work environment, and users are needing the same high performance across the network as on their desktop PCs.

However, in the case of Ethernet, the available bandwidth for data transmission has remained constant at 10 megabits-per-second (Mbps) 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 computing PCs, applications, and more network users (Figure 1).

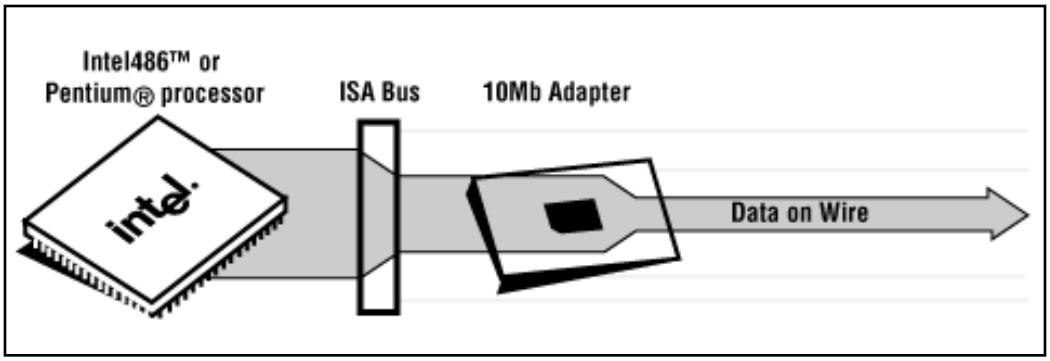

Figure 1: 10Mbps Ethernet connections are becoming a bottleneck.

The use of 100Mbps Fast Ethernet, together with the 32-bit PCI or EISA bus architectures, extends the power of high performance desktop PCs onto the LAN (Figure 2). With a wide data path all the way from the processor onto the network wire, communicating on the network is no longer a bottleneck to productivity.

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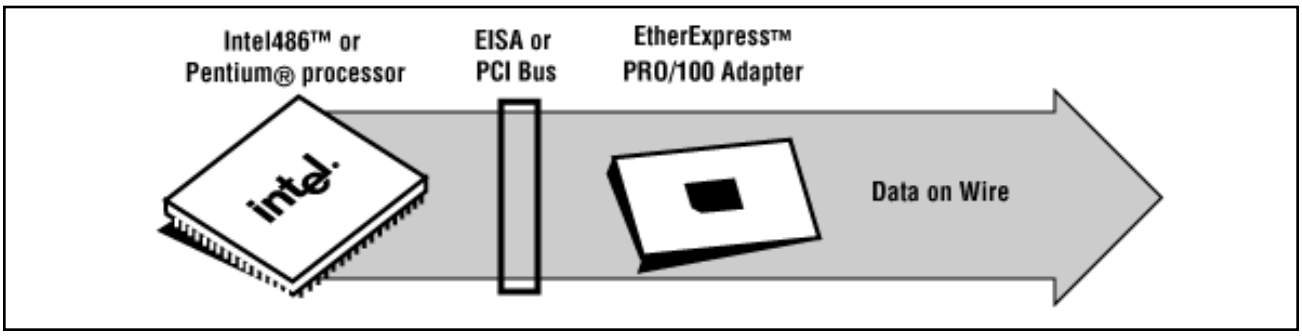

Figure 2: 100Mbps Fast Ethernet connection moves high volumes of data to/from the network without bottlenecks.

100Base-T Fast Ethernet: a Natural Evolution from 10Base-T

To expedite development of a 100Base-T Fast Ethernet standard, a group of leading networking companies, including Intel formed the Fast Ethernet Alliance in July 1993. This cooperative effort now includes over 100 vendors representing all major categories of networking equipment, including adapters, hubs, bridges, routers, switches, and management tools. As its name implies, 100Base-T Fast Ethernet is an extension of the proven 10Base-T Ethernet standard. 100Base-T became a standard by the IEEE 802.3 commit-tee, the group responsible for all Ethernet standards including 10Base-T. The standardization and multi-vendor support guarantees a broad range of high-performance, low-cost Fast Ethernet products, ensuring that 100Base-T is the best price/performance solution among high-speed networking alternatives.

100Base-T Fast Ethernet leverages 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 10Base-T and 100Base-T nodes on the LAN without protocol translation (Figure 3). This makes it easy to integrate 100BASE-T segments into an existing 10Base-T network.

Benefits from Fast Ethernet

Deploying Fast Ethernet brings real benefits to both servers and clients in terms of throughput as well as network load capacity. For example, a 10Mbps network running at 50% percent utilization can handle very few additional nodes and server-based applications without additional complexity. That same network traffic placed on a 100Mbps wire would represent only 5% utilization leaving 95% of the bandwidth for additional

	10Base-T	**100Base-T**
Speed	10Mbps	100Mbps
IEEE Standard	802.3	802.3
Media Access Protocol	CSMA/CD	CSMA/CD
Topology	Bus or star	Star
Cable support	Coax, UTP, fiber	UTP, fiber
Max hub-to-node distance	100 meters	100 meters
Media independent interface	Yes (AUI)	Yes (MII)

Figure 3: 10Base-T Ethernet vs. 100Base-T Fast Ethernet

workgroups and new, bandwidth-intensive applications, such as Windows NT* and Windows* 95.

Fast Ethernet Server Response Time

Fast Ethernet not only provides additional network load capability, it also improves response time for clients in everyday Windows* 3.1-based environments. To demonstrate this, 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 4, 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 ser-ver of a shared 10Mbps LAN. With the file server running on a switched (dedicated) 100Mbps hub port and the client running on a switched 10Mbps connection, the same test took 35 seconds, similar to the local hard drive.

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: run applications from the server.

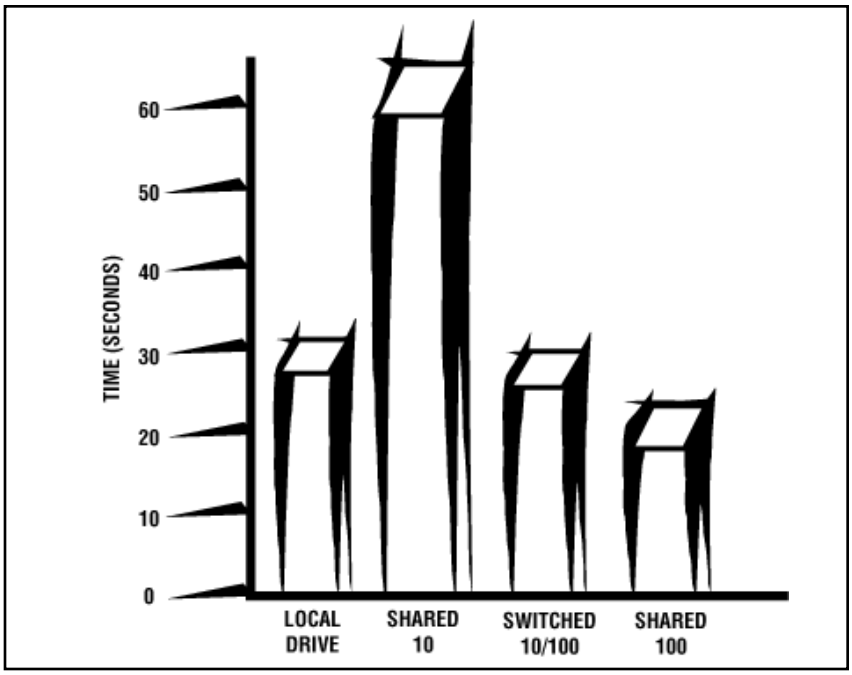

Figure 4: Application benchmark results

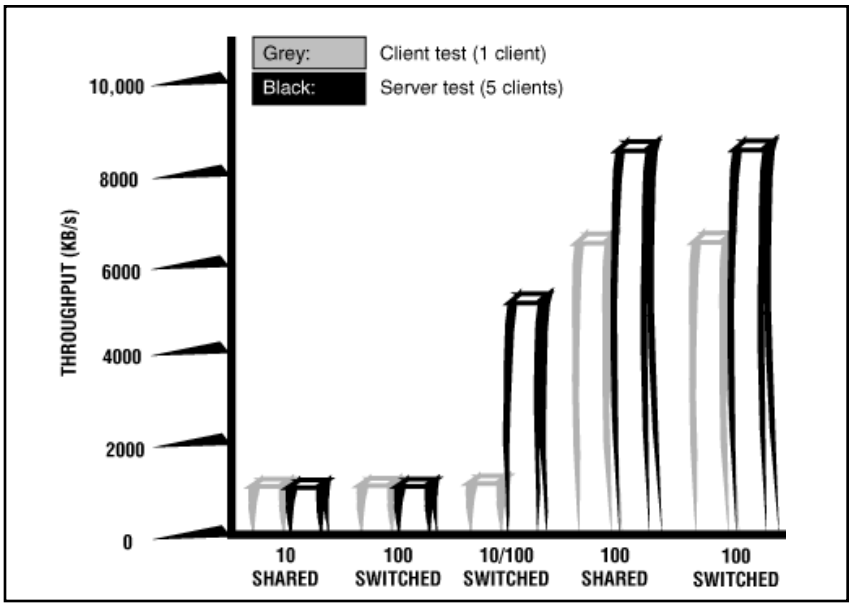

Figure 5: Novell Perform3 results show real performance benefits in switched and shared 100Mbps networks.

Fast Ethernet Throughput

Fast Ethernet's impact on raw throughput can be judged by comparing Novell's Perform3 results in various scenarios. As shown in Figure 5, the network gets some performance benefit by moving from shared 10Mbps to switched 10/100 (server on dedicated 100Mbps and clients on dedicated

10Mbps), but clients don't get any benefit until they are also connected at 100Mbps.

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

100BASE-T 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.)

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 1 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.

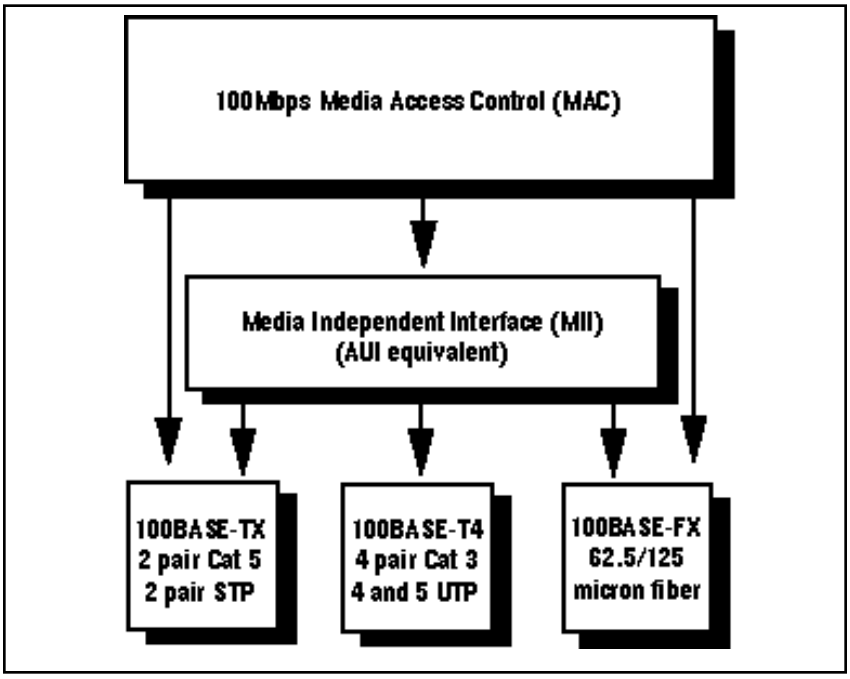

Figure 6: 100BASE-T cabling support

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 uses Category 3 (the most popular wiring for existing LANs), 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 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. It also 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.

Switched Hubs, Shared Hubs, and Stackable Shared Hubs

The topology guidelines for 100BASE-T have different implications for network design based on whether switched hubs or shared hubs are used. 100 Mbps switched hubs provide dedicated bandwidth to each connected node. For example, a 100Mbps switched hub with 16 ports provides a dedicated 100Mbps pipe to each of the sixteen ports (for a total of 1600Mbps throughput through the hub). In addition, a switched hub completely regenerates each signal before sending it on, and filters packets, sending them only to their destination address. Thanks to this technology, switched hubs can be designed to accommodate nodes running at 10Mbps and nodes running at 100Mbps.

In contrast, shared hubs are concentrators which provide a maximum bandwidth to be 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 must operate at the same speed (either 10 or 100Mbps). Shared hubs tend to be less expensive than switched hubs.

Stackable hubs, such as the Intel Express Stackable Hub, can be used as a single shared repeater or can be stacked up to six units high. When stacked, they act like one large hub on the network. So when six stackable hubs with eight ports each are stacked together, they act as one shared hub with forty-eight ports. Stackable hubs are very important to 100BASE-T deployment because of their scalability and high port densities.

100BASE-T Topology Guidelines

Since 100BASE-T Fast Ethernet is an extension of 10BASE-T, it is

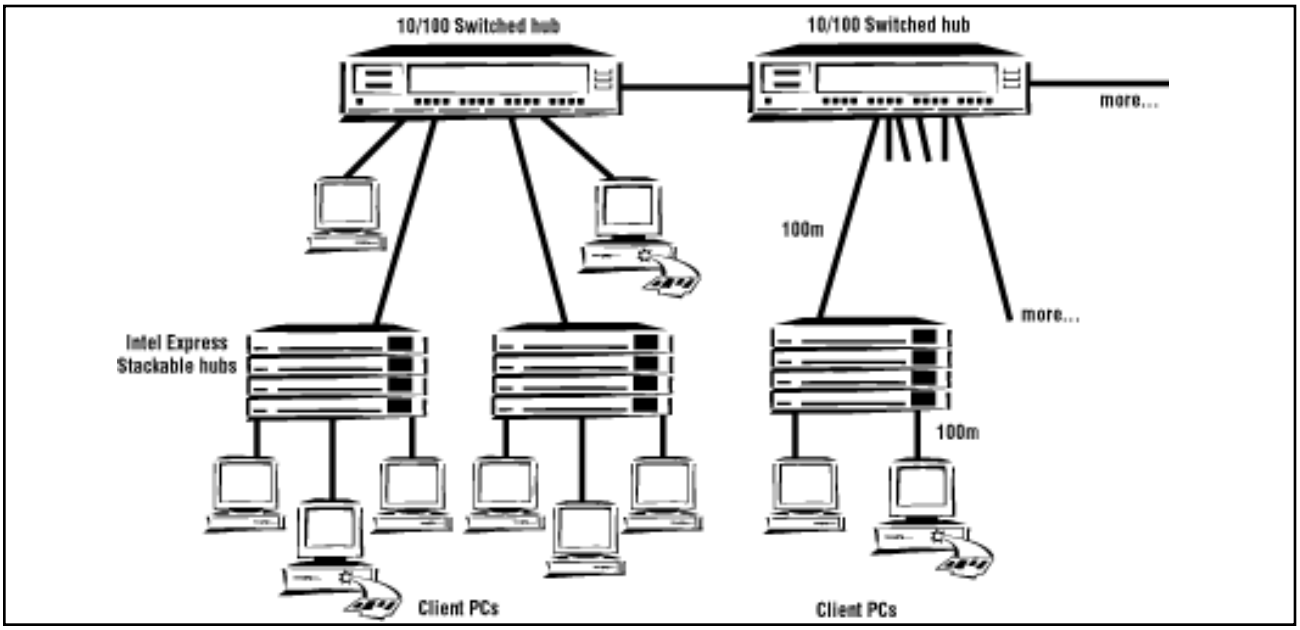

Figure 7: Network diameter can be easily extended using switched hubs.

governed by many of the same network topology rules. 100BASE-T is implemented in a star topology like 10BASE-T, and the ISO 11801 cabling standard applies. The standard imposes a 100-meter maximum wire length from the hub to the network interface card as follows:

- From the NIC to the wall socket—5 meters
- From the wall socket to the wiring closet—90 meters
- From the wiring closet to the hub—5 meters

As in 10BASE-T networks today, there is virtually no practical limit to the size of a 100BASE-T network. Switched hubs and stackable hubs can be used extensively to design a network as large as necessary. Each set of stackable hubs up to 132 managed nodes and switched hubs can be used almost limitlessly because they regenerate every signal that comes their way. Figure 7 shows a sample large network design using Intel Express stackable hubs and switched hubs. Summarized, the new design guidelines that govern 100BASE-T deployment are:

- As in 10BASE-T, network diameter is unrestricted when using switched or stackable shared hubs. (In a purely shared environment, the maximum network diameter is 205 meters.)
- A maximum 250-meter fiber run or 100-meter UTP run can be used from a shared hub to a server or to a switch.
- A 2 km, full-duplex fiber run can be used between two DTE ports, such as bridges, routers or switches.

Product support numbers

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