Fast Ethernet Deployment Guide

A Strategic Briefing for

Network Decision Makers

Network Technology from Intel

Bay Networks™

The Merged Company of SynOptics and Wellfleet

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 work-group 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 bus, such as PCI or EISA. 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).

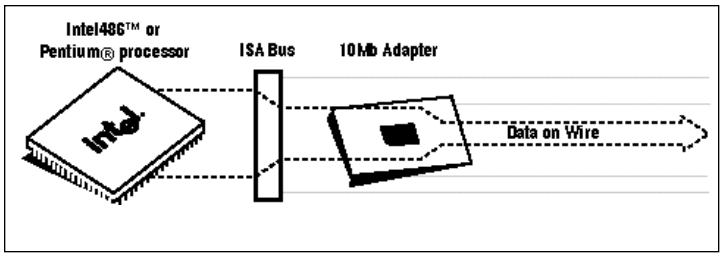

Figure 1: 10Mbps Ethernet connections are becoming a bottleneck.

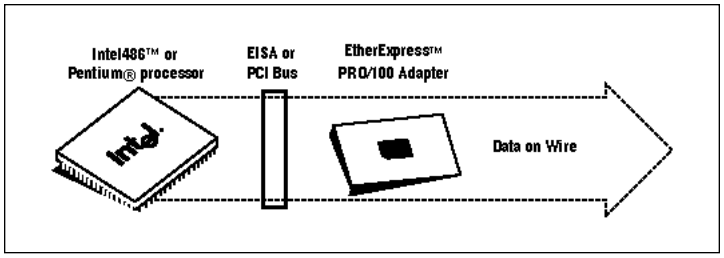

Figure 2: 100Mbps Fast Ethernet connection moves high volumes of data to/from the network without bottlenecks.

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.

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 and Bay Networks, formed the Fast Ethernet Alliance in July 1993. This cooperative effort now includes over 50 vendors representing all major categories of networking equipment, including adapters, hubs, bridges, routers, switches, and management tools. As its nameimplies, 100BASE-T Fast Ethernet is an extension of the proven 10BASE-T Ethernet standard. Today, 100BASE-T is being standardized by the IEEE 802.3 committee, 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.

Time and Money Savings 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 workgroups and new, bandwidth-intensive applications.

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 server of a shared 10Mbps

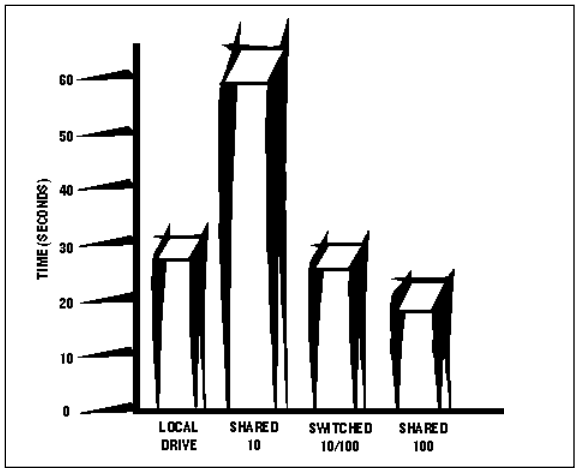

Figure 4: Application benchmark results.

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.

	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.

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 5.)

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.

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.

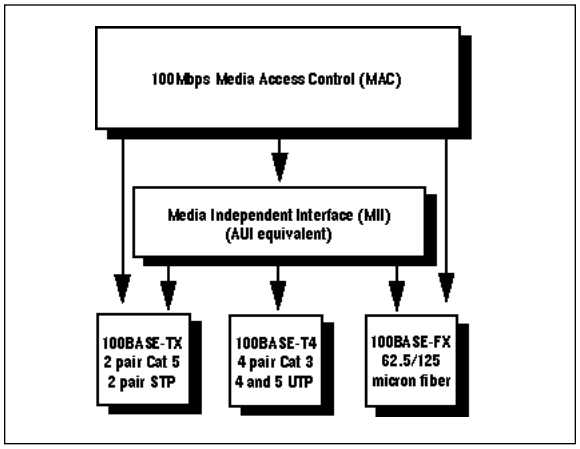

Figure 5: 100BASE-T cabling support.

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 10BaseFX 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. Switched hubs, such as Bay Networks' LattisSwitch™, are concentrators which 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 on the same segment.

In contrast, shared hubs are concentrators which provide a maximum bandwidth to be shared among all connected nodes. For example, a 100BASE-T hub from Bay Networks 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.

The Bay Networks 100BASE-T stackable shared hubs are a type of hub which, when connected to one another, act like one large hub on the network. So when six stackable shared hubs with eight ports each are connected together, they act on the network as though there is one shared hub with forty-eight ports.

100BASE-T Topology Guidelines

Since 100BASE-T Fast Ethernet is an extension of 10BASE-T, it is 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 shared hubs, such as those available from Bay Networks, can be used extensively to design a network as large as necessary. Each set of stackable shared hubs can be used to connect on the order of 100 nodes (the exact number depends on the hub model used), and switched hubs can be used almost limitlessly because they regenerate every signal that comes their way. Figure 6 shows a sample large network design using Bay Networks' stackable shared 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.

Workgroup Fast Ethernet Deployment

The evolutionary nature of 100BASE-T Fast Ethernet permits a phased approach to deploying 100BASE-T LANs. The performance advantages of 100BASE-T technology can be integrated into an existing 10BASE-T LAN on an "as needed" basis to alleviate bottlenecks on the way toward widespread deployment. The following overview provides one sample migration scenario for the workgroup LAN and clearly outlines three steps for moving an existing 10Mbps LAN to 100Mbps performance using 100BASE-T Fast Ethernet.

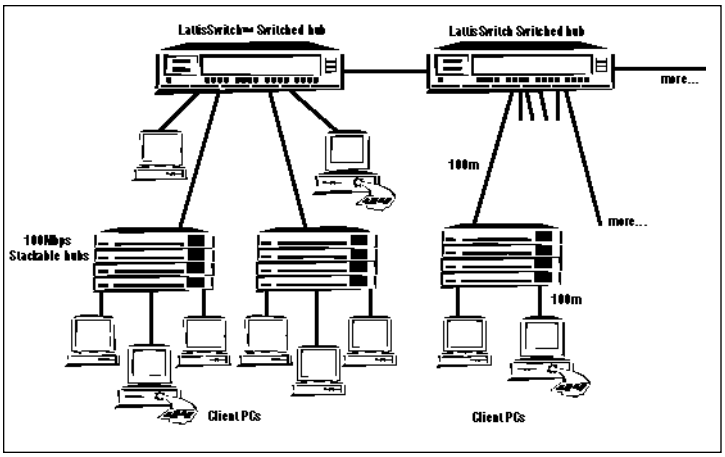

Figure 6: Network diameter can be easily extended using switched hubs.

Step 1: Overnight Performance Increase with a Future

The first step is to install Intel's EtherExpress PRO/100 Adapters in the server, and deploy a LattisSwitch switching hub for dedicated, 100Mbps server connections. Existing 10BASE-T hubs and, if necessary, router ports, are linked to 10Mbps ports on the LattisSwitch (Figure 7).

Dedicating a switched 100Mbps link to the server is the most effective way to relieve the server bottleneck. Shared media connectivity solutions are limited in their ability to support the usually large amounts of server traffic. In addition, the switch can front-end an existing router for more efficient

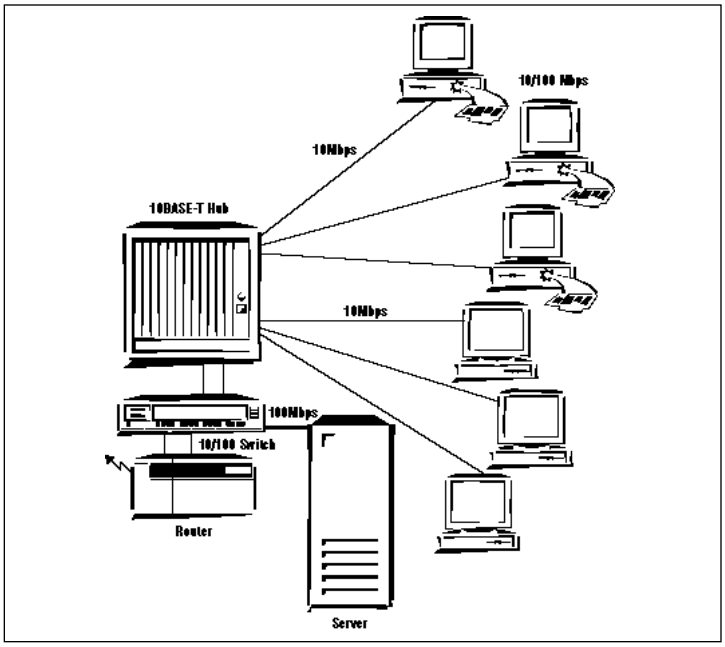

Figure 7: Overnight performance increase.

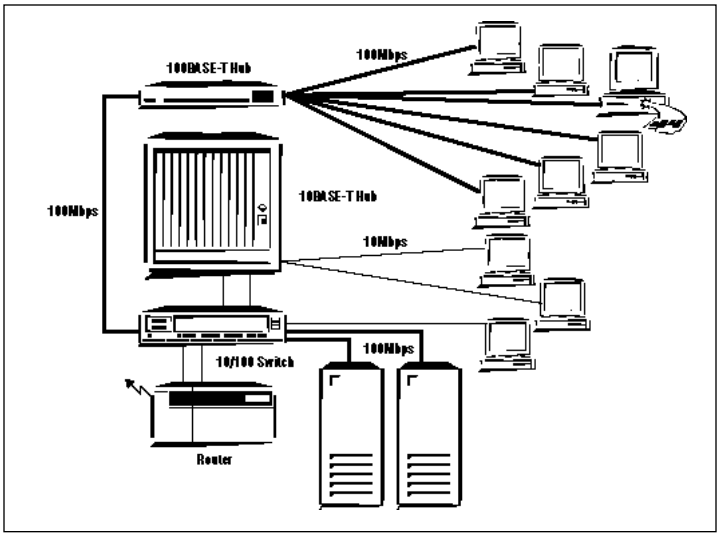

Figure 8: Empowering the desktop.

network microsegmentation. This also reduces the number of addresses required for network layer subnetting.

As the network grows, all new desktop workstations and servers should be equipped with Intel's PRO/100 adapters. Using the flexibility of this multi-speed card, these stations can operate at 10Mbps initially and have the ability to move to 100Mbps at any time.

Step 2: Empowering the Desktop, Enabling More Demanding Network Applications

Empowering desktops with 100Mbps performance is accomplished by connecting a Bay Networks 100BASE-T Fast Ethernet hub to the LattisSwitch switching hub. Then, the 100Mbps-capable desktops can be moved from 10 to 100Mbps ports (Figure 8). The Intel PRO/100 adapters in the workstations automatically detect and operate at the new higher speed, so no desktop reconfiguration is required. The transition is simple and seamless.

Meanwhile, existing 10Mbps desktops can gain additional performance by connecting to a dedicated 10Mbps port on the LattisSwitch device. Such a solution provides each desktop the equivalent of a private 10Mbps Ethernet network–with no hardware reconfiguration required.

As demands increase, additional 100BASE-T hubs can be deployed to support new 100Mbps desktops. Each new 100BASE-T hub can be connected to the LattisSwitch device which can support multiple 100Mbps connections and provide 2 gigabits per second (Gbps) of aggregate bandwidth.

Step 3: A Scalable Switched Internetwork

As more workstations transition to 100BASE-T operation, the need to internetwork at 100Mbps becomes critical. Step 3 provides for that high speed connectivity while offering a simple migration to faster, more scalable switched networks in the future.

To provide high speed network layer segmentation between 100BASE-T workgroups, Bay Networks will add 100Mbps interfaces to its Access Stack Node (ASN™) and Backbone Node (BN™) router families. By linking LattisSwitch 100BASE-T ports directly to the router, users can then route between network segments at 100Mbps, maintaining the high performance established at the desktop (Figure 9). The 100Mbps router interfaces also provide a direct path to highly scalable switched networks such as ATM.

The System 3000 and System 5000 intelligent hub product families from Bay Networks will also support 100BASE-T and ATM modules, providing a wiring closet solution for migrating to the switched internetwork architecture of the future.

Enterprise Fast Ethernet Deployment

Deploying 100BASE-T as a Backbone

Fast Ethernet is also easy to install as a new backbone, with a seamless connection to existing 10BASE-T workgroups. 100BASE-FX, the standard for Fast Ethernet over fiber, allows for 100Mbps backbone connections over standard multi-mode fiber connections of extended lengths up to 2 km. This provides a backbone with very few distance restrictions. 10/100Mbps switching hubs can provide connection and bridging services over 100BASE-T and 100BASE-FX.

Deploying 100BASE-T with FDDI

The major differences between FDDI and 100BASE-FX are that FDDI supports a transmission scheme and ring topology similar to Token Ring, while 100BASE-FX relies on Ethernet format packets and the star topology.

If FDDI is already installed as the backbone, then Fast Ethernet can easily be deployed to the desktop in an inexpensive and non-disruptive way. FDDI can bridge to Fast Ethernet in the same way it bridges to 10Mbps Ethernet. For instance, an FDDI ring is down-linked to a 10Mbps workgroup through an FDDI-Ethernet router. Similarly, a simple FDDI-Fast Ethernet router will enable high-speed, down-link connections to servers, workgroup shared hubs, or workgroup switches. This can be a hardware based router with FDDI and Fast Ethernet modules, or a software based router which leverages FDDI and Fast Ethernet NICs.

Deploying 100BASE-T with Asynchronous Transfer Mode (ATM)

Fast Ethernet and ATM approach the network bandwidth bottleneck from two different levels. ATM is thought of as a "tops-down" technology, penetrating the WAN connection and eventually, the enterprise and backbone. ATM offers cell-based switching of fixed length packets, generally implemented as a high-speed WAN connection over SONET* based fiber. Standards for ATM over fiber have been finalized and several vendors, including Bay Networks, have developed interoperable products.

In contrast, Fast Ethernet has developed as a "bottoms-up" high bandwidth solution for the desktop, including servers, clients, and workgroups. This is due mainly to its cost effectiveness today and easy integration into existing Ethernet environments. Fast Ethernet's dominance will be at the desktop, while ATM will become prominent on the WAN and backbone.

With ATM in the WAN, 100Mbps Fast Ethernet switches are the logical choice to increase the bandwidth to your servers, workgroups, and clients. Many clients can still be connected with 10Mbps connections, while the high-bandwidth servers and clients get dedicated or shared 100Mbps connections. WAN connectivity is provided by an ATM-to-10/100Mbps switch.

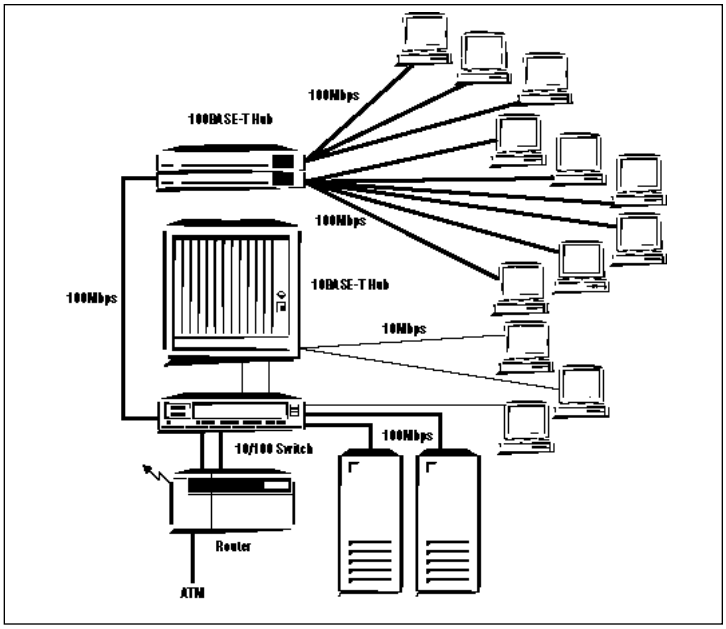

Figure 9: Scalable switched internetwork.

Fast Ethernet: 100Mbps Bandwidth, When and Where It's Needed

Fast Ethernet brings real benefits to both client and server performance, and can be deployed in a flexible, cost-effective way. And because Fast Ethernet is an evolutionary extension of the popular and proven 10BASE-T Ethernet technology, it can be integrated into an existing Ethernet environment one step at a time, when and where it's needed. Moreover, 100BASE-T architecture is easily extendible. It can be connected to an existing FDDI campus backbone, and it allows the network infrastructure to accommodate ATM at any time.

Enabling a LAN for high speed networking doesn't have to be an overhaul of mammoth proportions. Call Intel or Bay Networks for detailed information about Fast Ethernet products, or for the name of a qualified reseller near you.

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