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CONTENTS

Compaq 100 Mbit/sec Ethernet Technology

New, faster networking technologies are redefining LAN environments with high-speed topologies that offer data throughput of at least 100 megabits per second (Mbit/sec or Mb/s). One of the most compelling alternatives, 100 Mb/s Ethernet, offers customers the lowest-cost, most easily implemented path to fast networking, while keeping the door open for upgrades to even faster technology. This white paper provides an in-depth explanation of 100 Mb/s Ethernet and describes the benefits the Compaq NetFlex-3 network interface controller brings to both 10 Mb/s and 100 Mb/s Ethernet LANs.

FAST NETWORKING TECHNOLOGY

Many customers currently have, or foresee having, network throughput bottlenecks due to new applications and more demanding environments that require greater network data transfer rates than existing LANs can provide. Server consolidation, a growing trend, results in a greater number of users and more network traffic per server, straining the throughput capabilities of today's LANs. New data-intensive applications like backup over the network and synchronized voice/video require reduced latency, or transmission time, as well as new levels of data transmission speed and reliability.

Customers who wish to increase their network throughput face the sometimes confusing choice between Asynchronous Transfer Mode (ATM), Fiber Distributed Data Interface (FDDI) and two competing 100 Mb/s Ethernet implementations, 100Base-T and 100VG-AnyLAN. ATM, FDDI and 100 Mb/s Ethernet all provide higher bandwidth, but 100 Mb/s Ethernet has several advantages for LAN implementations today.

ATM

ATM began as a Wide Area Network (WAN) technology that transmits data at up to 2 gigabits per second (Gb/s) using cells, instead of frames, to send data. Cell relay improves switching speed and data throughput by breaking data packets up into smaller packages than those transmitted using Ethernet, Token Ring or FDDI frames. In addition, ATM provides a collisionless, point-to-point connection between nodes, further improving data throughput. ATM is maturing as a LAN technology, with emerging support for unshielded twisted pair (UTP) cabling, in addition to fiber optics.

Currently ATM technology is not widely accepted as a LAN technology because equipment, software and cabling are still too costly to provide a practical alternative for most desktop connections. One issue delaying acceptance for LAN implementations is that ATM requires LAN Emulation, a developing technology, to connect with existing LAN segments. LAN Emulation translates cell relay packets into the frame types supported by Ethernet and Token Ring. Another issue is that ATM network maintenance techniques are still developing and are not yet supported by most network operating systems (NOSs). As the technology matures and software support improves, industry analysts expect ATM to become an important LAN technology.

FDDI

FDDI transmits data at up to 100 Mb/s over fiber optic cable or data-grade UTP, also known as Copper Distributed Data Interface (CDDI.) FDDI borrows the collisionless token passing access method used by Token Ring networks and implements it on a dual ring configuration. Instead of a single connection between network nodes, FDDI supports two "rings" of cable with servers, hubs and routers connected to both rings. If the primary FDDI ring fails, the secondary ring continues to service the network, bypassing the failed section of the primary ring. FDDI is primarily a niche market today, because of its high cost per node and wiring requirements. FDDI uses different frame types, network management software, and maintenance techniques from 10 Mb/s Ethernet. Most customers would need to rewire their network to use FDDI in a LAN, but it is a robust technology for corporate backbones.

100 MBIT/SEC ETHERNET

The popularity of 10 Mb/s Ethernet makes it a natural springboard for faster Ethernet technologies. Two emerging 100 Mb/s Ethernet technologies are now available, each with its own group of supporters: 100Base-T, which is proposed as IEEE 802.3u, and 100VG-AnyLAN, proposed as IEEE 802.12. These two solutions are similar in their goal to provide 100 Mb/s Ethernet connectivity without modification to the Ethernet frame type. The main difference between them is their approach to providing 10 times the bandwidth of 10Base-T. Because 100 Mb/s Ethernet is a direct outgrowth of 10 Mb/s Ethernet, its cost per node is low since it requires less customer rewiring for installation and it leverages the synergy with existing management software. All popular NOSs support 100 Mb/s Ethernet, allowing network administrators to use the same management software currently running on their 10 Mb/s Ethernet LANs.

Implementing 100 Mb/s Ethernet requires replacing network adapters and hubs with 100 Mb/s Ethernet equipment, but does not require changes to the network operating system and network management utilities. Both FDDI and ATM require new software environments in addition to new hardware. Among those supporting 100 Mb/s Ethernet, Compaq is currently the only computer manufacturer who supports both 100Base-T and 100VG-AnyLAN, offering customers the flexibility to choose the topology that best fits their networking needs.

100Base-T

The 100Base-T design utilizes the Carrier Sense Multiple Access/Collision Detect (CSMA/CD) shared media access method supported by 10Base-T, leveraging existing 10 Mb/s Ethernet as much as possible. CSMA/CD allows all network nodes simultaneous access to the network. If more than one data packet is transmitted at a time, the packets collide. 100Base-T adapters monitor the network for collisions and, if one occurs, the adapter waits for a random time period and then resends the data packets. Because it uses the same protocol, wiring, and management software as 10Base-T, 100Base-T is easily implemented as a low-cost LAN technology with minimal changes to the network environment.

100Base-T technology can be broken down into three different topologies, with different data transmission schemes and different cabling requirements:

- 100Base-TX
- 100Base-T4
- 100Base-FX

100Base-TX

100Base-TX is a derivative of 10Base-T that achieves 100-Mb/s speed by sending the signal 10 times faster over two pairs of UTP cable. To retain signal integrity at this high data transmission speed, 100Base-TX requires data-grade, Category 5, UTP cabling. Because 100Base-TX uses exactly the same transport method as 10 Mb/s Ethernet, it supports either half- or full-duplex operation. Full-duplex mode requires a switching hub and allows the network adapter to transmit and receive simultaneously, for data throughput of up to 200 Mb/s.

100Base-T4

100Base-T4 achieves its 100 Mb/s speed by using three wire pairs to transmit data, while using the fourth pair of an RJ-45 connection for collision detection. Splitting the data stream into multiple wire pairs ensures signal integrity on either data-grade (CAT 5) or voice-grade, Category 3 (CAT 3) cable. Because of its transmission scheme, 100Base-T4 does not support full-duplex operation.

100Base-FX

100Base-FX implements 100 Mb/s Ethernet over one pair (two strands) of 62.5/125 micron fiber optic cable, using the CSMA/CD access method. With a switching hub, 100Base-FX supports full-duplex performance for data throughput of up to 200 Mb/s.

Implementing 100Base-T Networks

100Base-T networks require a slightly different implementation from 10Base-T networks because new hubs and different wiring configurations are necessary. 10Base-T hubs are incapable of sending or receiving data packets at 100 Mb/s, so a 100Base-T network requires a 100Base-T hub. Both 100Base-TX and 100Base-T4 support a maximum lobe length, the distance from the hub to the workstation, of 100 meters of UTP. 100Base-T UTP implementations support up to 205 meters of cable in network diameter, the farthest-node-to-farthest-node distance, which is a fraction of the 2,500 meter diameter supported by 10Base-T. Because 100Base-T sends signals 10 times faster than 10Base-T, the collision window, the time during which the network can detect a collision between packets, is reduced to one-tenth the size of the 10Base-T collision window. For proper collision detection, the 100Base-T network diameter must be one-tenth the 10Base-T network diameter.

In a repeater environment, 100Base-T only allows a single layer of cascaded hubs. Switching hubs may increase the network diameter for 100Base-T LANs by buffering data packets. Each port can be connected to a separate LAN segment, each with a maximum segment diameter of 205 meters thereby increasing the overall diameter of a 100Base-T network.

100Base-FX supports considerably larger networks because fiber optic cable has fewer distance limitations than copper wiring. Half-duplex 100Base-FX networks support 400 meters maximum lobe length and network diameter, while a full-duplex link supports a lobe length of 2 kilometers. Network diameter for a 100Base-FX network depends on the deployment of half- and full-duplex segments, as well as the mix of fiber optic and UTP segments serviced by the same 100Base-T/FX hub. In networks wired entirely for full-duplex, the network diameter is virtually unlimited. In networks that include both 100Base-FX and UTP 100Base-T serviced by the same hub, the network diameter is constrained by the individual network configuration.

Figure 1 illustrates a typical 100Base-T network:

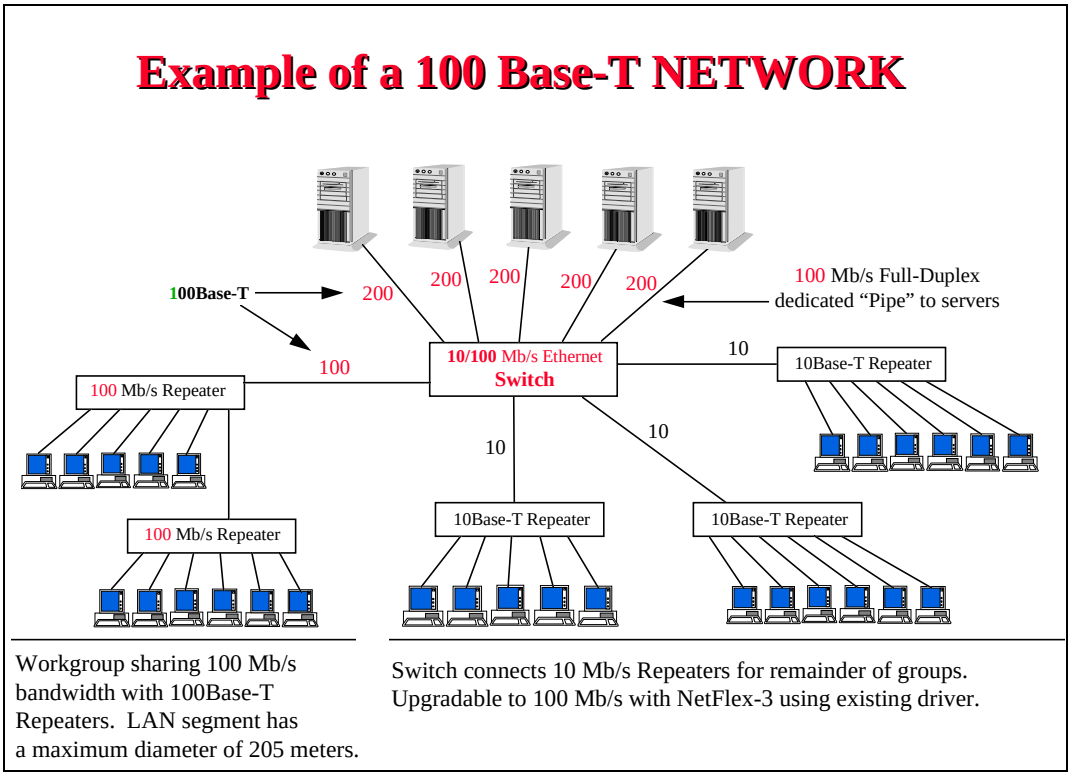

Figure 1

100Base-T Wiring Requirements

Not only do 100Base-TX and 100Base-T4 use different data transmission schemes, but they also have different cabling requirements. As noted above, 100Base-TX requires data-grade (CAT 5) UTP while 100Base-T4 operates over either data-grade or voice-grade (CAT 3) cable.

Some office buildings have CAT 5 wiring, but do not have CAT 5 accessories, wall outlets and wiring closet punch-down blocks. 100Base-TX requires CAT 5 wall outlets and punch-down blocks meeting specifications EIA/TIA 568A or EIA/TIA 568B for proper operation. When wiring a 100Base-TX network, check to make sure that the wire pairing for all accessories meets specifications.

Existing CAT 3 wiring may not have all four wire pairs available for network use. In many CAT 3 wiring schemes, two pairs are used for the network while the other two pairs are used for phones, modems, etc. 100Base-T4 will not operate without connection to all four wire pairs.

100VG-AnyLAN

100VG-AnyLAN is a 100 Mb/s Ethernet technology currently in competition with 100Base-T. Instead of leveraging Ethernet signaling, 100VG-AnyLAN uses a demand priority scheme to transmit data. Demand priority works like a traffic signal--the hub determines which adapter has access to the network and allows only one port to transmit data at a time, in port order. The demand priority access method can also assign a higher transmission priority to servers and selected workstations, allowing them to send and receive data before other nodes on the network. Priorities are set by the network administrator or by the node device driver. Although network operating systems do not yet support the prioritization of individual data packets, 100VG-AnyLAN allows assigning each packet a separate priority. Time-sensitive transmissions, like synchronized voice/video, particularly benefit from the increased speed and reliability provided by the demand priority access method.

100VG-AnyLAN transmits data at 100 Mb/s using four pairs of either voice-grade or data-grade UTP. All four pairs are used at one time to either transmit or receive data. Because of this signal transmission scheme, 100VG-AnyLAN does not support full-duplex operation. 100VG-AnyLAN is a suitable medium-sized backbone technology because it supports up to 2,500 meters in network diameter.

Implementing 100VG-AnyLAN Networks

100VG-AnyLAN operates over four pairs of either voice-grade (CAT 3) or data-grade (CAT 4 or 5) cable. To operate properly over data-grade cable, 100VG-AnyLAN requires wall outlets and wiring closet punch-down blocks meeting specifications EIA/TIA 568A or EIA/TIA 568B.

100VG-AnyLAN supports up to three layers of hubs. The root hub controls overall request servicing on the network, while subordinate hubs function as ports on the root hub. When the root hub receives a request from another hub, it passes control of the network to the subordinate hub. The subordinate hub services its own requests in port order before returning control to the root hub. Then the root hub continues to process requests on its own ports. 100VG-AnyLAN supports a maximum lobe length of 100 meters.

Figure 2 illustrates a typical 100VG-AnyLAN network:

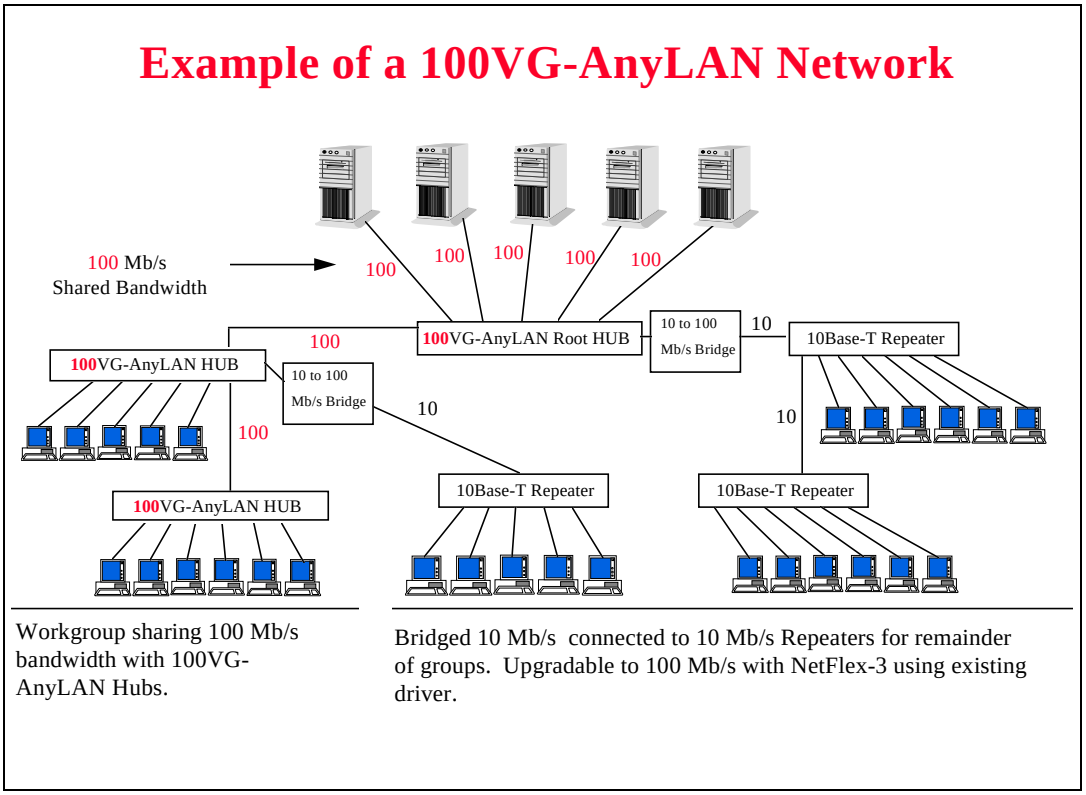

Figure 2

CHOOSING A 100 MBIT/SEC ETHERNET TOPOLOGY

Both 100Base-T and 100VG-AnyLAN offer unique advantages for LAN implementations. Customers do not have to choose a single 100 Mb/s technology for all of their LANs; different LANs at the same company will benefit most from using different 100 Mb/s Ethernet solutions depending on LAN configuration and applications. Below are benefits and issues to consider when choosing a 100 Mb/s Ethernet topology.

Benefits of 100Base-T

100Base-T is best suited for low-cost LANs that carry bursty traffic:

- Leverages existing Information Technology (IT) expertise: most IT departments are already familiar with 10Base-T Ethernet software and management, enabling customers to easily incorporate this new technology into their existing networks.
- Full-duplex operation: 100Base-TX supports full-duplex capability for data throughput of up to 200 Mb/s.

Benefits of 100Base-FX

100Base-FX benefits wide-spread LANs for which the cost of wiring fiber optic cable is outweighed by the increased lobe length:

- Lobe length: 100Base-FX delivers the longest maximum lobe length available for Ethernet LANs. The maximum lobe lengths are 400 meters for half-duplex segments and 2 kilometers for full-duplex implementations.
- Increased network diameter: fiber optic cabling and repeaters allow 100Base-FX networks to span network diameters in the multiple kilometers. Network configurations incorporating UTP segments or half-duplex 100Base-FX constrain network diameter, depending on the particular configuration.

Benefits of 100VG-AnyLAN

100VG-AnyLAN is the ideal choice for low-cost, repeater-based LANs and LANs running time-sensitive applications, such as synchronized voice/video or multimedia applications. Its primary benefits are:

- Large network diameter: 100VG-AnyLAN allows the same network diameter as 10Base-T, 2,500 meters distance between the farthest nodes.
- Collisionless access method: 100VG-AnyLAN networks transmit a single packet at a time, avoiding the collisions that can disrupt time-sensitive applications and providing excellent performance under heavy traffic-load conditions.
- Demand prioritization: the demand priority access method improves network performance by servicing servers and selected clients first, before other network traffic.

Issues

The following considerations are important in choosing a 100 Mb/s Ethernet topology:

- Applications: 100VG-AnyLAN uses a demand priority access method that allows servers and selected workstations to have higher priority over other network nodes in sending data. This access method improves network performance when transmitting time-sensitive data like synchronized voice/video. 100Base-TX supports full-duplex operation, for data throughput of up to 200 Mb/s. Servers and data-intensive applications particularly benefit from this increase in bandwidth.
- Required network radius: 100Base-T UTP networks allow a smaller network diameter than 100VG-AnyLAN implementations, making them less suitable when nodes are located at a distance. 100Base-FX networks offer greater maximum lobe length and network diameter, but at a greater cost for buildings not wired with fiber optic cable.
- Cabling requirements: 100Base-TX requires CAT 5 cabling and accessories. 100Base-T4 and 100VG-AnyLAN implementations require all four pairs of CAT 3 wire. 100Base-FX requires costly fiber optic cable.

The table below summarizes the various Ethernet topologies.

Ethernet Topology Comparison					
	10Base-T	**100Base-TX**	**100Base-T4**	**100Base-FX**	**100VG-AnyLAN**
Cables Supported	2 pairs Cat 3 or 5 UTP	2 pairs Cat 5 UTP STP	4 pairs Cat 3, 4, or 5 UTP STP	1 pair (2 strands) 62.5/125 micron fiber optic cable	4 pairs Cat 3, 4, or 5 UTP STP
Network Diameter	2500 meters	205 meters	205 meters	Half-duplex: 400 meters Full-duplex: depends on network configuration	2500 meters
Lobe Length	100 meters	100 meters	100 meters	Half-duplex: 400 meters Full-duplex: 2,000 meters	100 meters
Connector	RJ-45	RJ-45	RJ-45	MIC, ST or SC fiber connections	RJ-45
Maximum data throughput	Half-duplex: 10 Mb/s Full-duplex: 20 Mb/s	Half-duplex: 100 Mb/s Full-duplex: 200 Mb/s	100 Mb/s	Half-duplex: 100 Mb/s Full-duplex: 200 Mb/s	100 Mb/s
Repeater Layers	Up to three	One	One	One	Up to three
Switching Hub	Optional	Recommended	Not Yet Available	Optional	Not Yet Available

COMPAQ NETFLEX-3 CONTROLLERS

The new Compaq NetFlex-3 Controller supports a standard 10Base-T/10Base-2 physical layer and allows upgrades to either 100Base-TX or 100VG-AnyLAN with the addition of inexpensive optional upgrade modules. Figure 3 illustrates the NetFlex-3 modular design.

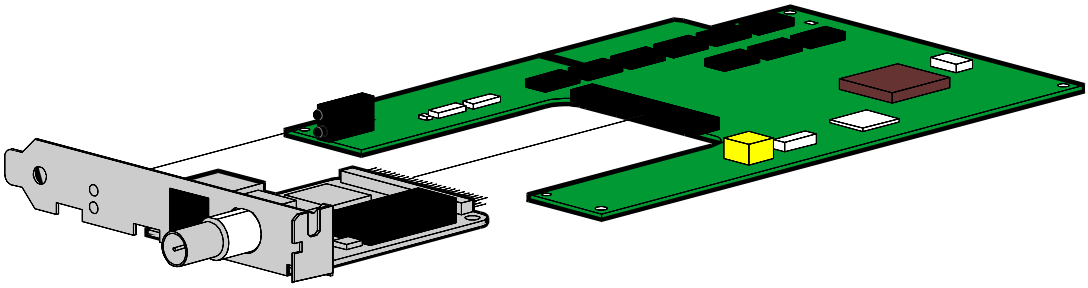

Figure 3

NetFlex-3 Features

- Standard configuration supports 10Base-T and 10Base-2 operation (IEEE 802.3)
    - RJ-45 and BNC connectors
- Texas Instruments (TI) ThunderLAN chip
    - Adaptive Performance Optimization (APO) automatically adjusts the data buffer (FIFO) for dynamic I/O bus availability
- Modular design for easy upgrades to 100Base-TX and 100VG-AnyLAN
    - Optional 10/100Base-TX UTP Module
    - Optional 100VG-AnyLAN UTP Module
    - Compaq Media Independent Interface (MII) provides direct physical connection to any of the NetFlex-3 modules
- All configurations use the same Compaq auto-sensing device driver for your NOS
- Full-duplex capability when configured for 10Base-T or 100Base-TX
- Choice of EISA and PCI versions
    - NetFlex-3/E: 32-bit EISA bus-master performance
    - NetFlex-3/P: 32-bit PCI bus-master performance
- Separate LEDs for monitoring network linkage and controller activity
- Both hardware and software drivers are fully tested for quality, compatibility and interoperability

Superior 10 Mb/s Ethernet Performance

In industry-standard Perform3 network benchmarking tests, the NetFlex-3 10Base-T standard configuration delivers faster data throughput and lower processor utilization than other NICs, optimizing user response time and freeing the processor for other tasks. The combination of the ThunderLAN chip, co-developed by TI and Compaq, and the Compaq device drivers produce optimal 10 Mb/s Ethernet performance. For the joint development of the ThunderLAN architecture, Compaq worked with TI on design of the ThunderLAN chip to incorporate performance-enhancing features, such as Adaptive Performance Optimization (APO.) The development partnership brings together Compaq's in-depth system engineering capability and extensive relationships with NOS vendors, particularly Novell and Microsoft, with TI's protocol processing expertise.

ThunderLAN architecture employs a PCI chip-level interface to speed data throughput and a patent-pending feature, APO, to guarantee optimal performance for unique server configurations. To deliver maximum data throughput, APO automatically senses the bandwidth demands on the system I/O bus and adjusts the NetFlex-3 dynamic data buffer accordingly. APO accomplishes this task by continuously monitoring how much bandwidth other peripherals on the system I/O bus require for data transfer and how long it takes NetFlex-3 to arbitrate for the I/O bus. Then APO adjusts the NetFlex-3 dynamic FIFO to modify the amount of data transferred and the frequency of bus arbitration. For example, if NetFlex-3 is one of four peripherals on the EISA bus, APO increases the FIFO layer depth and transmits data packets less frequently. If, in contrast, NetFlex-3 is the only device on the bus, APO decreases the FIFO and transmits data more frequently. Third-party NICs are designed for the average server, with static system performance parameters, and cannot adapt to the demands unique configurations place on network controller performance.

Network performance also depends on device drivers. Compaq designed the NetFlex-3 drivers to support all popular network and client operating systems, leveraging partnerships with software vendors Novell and Microsoft. The drivers automatically sense which 10 Mb/s or 100 Mb/s NetFlex-3 module is attached to the controller and adjust operation accordingly.

Modular Architecture Facilitates 100 Mb/s Upgrades

The NetFlex-3 modular architecture offers customers new levels of flexibility in choosing an Ethernet topology because it supports 10Base-T/10Base-2, 100Base-TX and 100VG-AnyLAN. The NetFlex-3 modular design does not lock customers into a single technology, like adapters that support only one 100 Mb/s Ethernet topology. It allows customers to deploy 10 Mb/s Ethernet today and see over time which 100 Mb/s standard best fits their needs.

Customers upgrade NetFlex-3 to 100 Mb/s Ethernet by removing the standard 10Base-T UTP/BNC Module and installing an optional 100 Mb/s upgrade module that plugs directly into the controller. Upgrading requires no changes to switch or jumper settings and no driver upgrades. For a particular operating system, the same device driver automatically senses which module is attached and adjusts operation accordingly, without requiring software updates or changes.

The ThunderLAN chip facilitates upgrades because it includes an embedded MII that provides a direct, non-proprietary connection to 10Base-T/10Base-2, 100Base-TX and 100VG-AnyLAN topologies. The MII allows NetFlex-3 customers to enjoy unimpeded data throughput for any supported Ethernet topology, on any network that employs industry-standard cabling. Because the

MII supports both 10 Mb/s and 100 Mb/s Ethernet configurations, customers are free to choose the speed and topology that best meet their needs without changing their cabling or connectors.

Reliability

Compaq systems engineers were involved in developing the ThunderLAN chip to ensure optimal integration and reliability in high-performance systems. In addition, over 120,000 hours of compatibility, interoperability and quality assurance testing, using industry-standard tests and benchmarks, guarantee both hardware and driver reliability at either 10 Mb/s or 100 Mb/s operation. Both the design integration and depth of testing set NetFlex-3 apart from competitive NICs that are designed, built and tested for average performance in the average system. Compaq performance testing tunes NetFlex-3 hardware and drivers to deliver faster data throughput and lower processor utilization than competitors for overall better system performance. Interoperability testing conducted by the University of New Hampshire guarantees NetFlex-3 compliance with IEEE standards and operation in multi-vendor networks.

GLOSSARY

TERM	DEFINITION
802.3	IEEE standard specification for 10Base-T Ethernet.
802.3u	Proposed IEEE standard specification for 100Base-T Ethernet. Developed and championed by the Fast Ethernet Alliance, 802.3u covers 100Base-TX, 100Base-T4 and 100Base-FX topologies.
802.12	Proposed IEEE standard specification for 100VG-AnyLAN. Developed and championed by the 100VG-AnyLAN Forum.
10Base-2	One of the 10 Mb/s Ethernet topologies defined by IEEE specification 802.3. 10Base-2 networks use CSMA/CD and transmit data at 10 Mb/s using coaxial cable.
10Base-T	One of the 10 Mb/s Ethernet topologies defined by IEEE specification 802.3. 10Base-T networks use CSMA/CD and transmit data at 10 Mb/s using two pairs of CAT 3, 4 or 5 UTP.
10 Mb/s Ethernet	10Base-2 and 10Base-T Ethernet, IEEE standard 802.3.
100Base-FX	One of the 100 Mb/s Ethernet topologies, using one pair of 62.5/125 micron fiber optic cable. CSMA/CD access method.
100Base-T	The 100 Mb/s Ethernet topologies developed by the Fast Ethernet Alliance. Encompasses 100Base-TX, 100Base-T4 and 100Base-FX.
100Base-T4	One of the 100 Mb/s Ethernet topologies, using four pairs of category 3, 4 or 5 UTP, or STP. CSMA/CD access method.
100Base-TX	One of the 100 Mb/s Ethernet topologies, using two pairs of category 5 UTP or STP. CSMA/CD access method.
100 Mb/s Ethernet	100Base-T, IEEE standard 802.3u, or 100VG-AnyLAN, IEEE standard 802.12.
100VG-AnyLAN	Formerly called 100Base-VG. One of the 100 Mb/s Ethernet topologies using four pairs of category 3, 4 or 5 UTP or STP. Demand priority access method.
Adaptive Performance Optimization	APO. The patent-pending feature of the ThunderLAN chip that manages the network controller FIFO. APO dynamically adjusts the FIFO depth to meet system I/O bus availability, delivering maximum data throughput.

GLOSSARY (continued)

TERM	DEFINITION
Asynchronous Transfer Mode	ATM. A collisionless, fast networking technology that uses fixed size cell frames to transmit data at up to 2 Gb/s.
ATM	See Asynchronous Transfer Mode
Bandwidth	The data throughput capability of a network topology.
BNC Connector	British Naval Connector. Used for connecting 10Base-2 (Thinnet) networks.
Carrier Sense Multiple Access with Collision Detection	CSMA/CD. The access method used by 10 Mb/s Ethernet and 100Base-T to monitor the network for signal transmissions, send a data packet when the wire is clear, and resend after a random time in the event of a packet collision.
CAT	See Category of Cable.
CAT 3	See Category Type 3 Cable
CAT 4	See Category Type 4 Cable
CAT 5	See Category Type 5 Cable
Category of Cable	CAT. The standards organizations rate UTP cable based on electrical characteristics. Voice-grade cable is category 3. Data-grade cable falls into categories 4 and 5.
Category 3 Cable	Voice-grade UTP cable used for digital telephones and LANs.
Category 4 Cable	Data-grade UTP cable used for LANs.
Category 5 Cable	The top grade of data-grade UTP cable used for LANs.
CDDI	Copper Distributed Data Interface. The FDDI implementation that operates over four pairs of data-grade (CAT 5) UTP.
Cell Relay	A method for packaging and transmitting data through carrier services that uses 53-byte cells. Cell relay allows faster data throughput and switching than does frame relay. ATM uses cell relay.
CSMA/CD	See Carrier Sense Multiple Access with Collision Detection.

GLOSSARY **(continued)**

TERM	DEFINITION
Data-Grade Cable	UTP types 4 and 5. Used for LANs.
Demand Priority Access Method	Access method used by 100VG-AnyLAN. An intelligent hub sends data packets one at a time directly to the addressee, preventing collisions. Messages from selected ports can be assigned a higher transmission priority than ordinary network traffic.
EISA	See Extended Industry Standard Architecture.
Ethernet	Network topology defined by IEEE specification 802.3. Ethernet networks use CSMA/CD and transmit data at 10 Mb/s over various cable types.
Extended Industry Standard Architecture	A system I/O bus specification that supports 8-, 16- and 32-bit data throughput paths. Supports bus-mastering on 16- and 32-bit buses.
Fast Ethernet	Industry standard terminology for 100Base-T. Industry groups do not agree on using the term to refer to 100VG-AnyLAN; some call 100VG-AnyLAN a Fast Ethernet technology while others do not.
Fast Ethernet Alliance	FEA. Industry alliance responsible for developing IEEE specifications for 802.3u and promoting 100Base-T products.
FIFO	First-in, first-out. The data buffer in a network controller that stores data before it is transmitted over the network.
Full-duplex	10Base-T and 100Base-TX network operation using a switching hub to establish a point-to-point connection between LAN nodes that allows simultaneous sending and receiving of data packets. Full-duplex performance is twice that of half-duplex performance. A 10Base-T full-duplex network is capable of 20 Mb/s data throughput, while a full-duplex 100Base-TX network is capable of 200 Mb/s throughput.
Gb/s	Gigabits per second. Measure of data transfer rate over a network interface.
Half-Duplex	Network operation in one direction at a time only; either sending or receiving data packets, but not both at the same time.
Hub	Network equipment that connects nodes on a network segment.

GLOSSARY **(continued)**

TERM	DEFINITION
LAN	Local Area Network. Workstations/servers/peripherals physically linked together using cable or wireless technologies. A LAN provides high-speed communications capability and allows file/applications sharing.
LAN Emulation	Software required when using ATM to connect with Ethernet or Token Ring LAN segments. LAN Emulation translates the cells ATM uses for packaging data into frames that can be transmitted by Ethernet or Token Ring.
Latency	The length of time required for the NIC to access the appropriate server and receive the requested data.
Lobe Length	The hub to node distance on a network.
Mb/s or Mbit/sec	Megabits per second. Measure of data transfer rate over a network interface.
Media Independent Interface	MII. The non-proprietary connection between the ThunderLAN chip and the physical layers for 10Base-T, 100Base-TX and 100VG-AnyLAN.
MII	See Media Independent Interface
Network Diameter	The longest distance a network technology supports between nodes on the same network segment; farthest-node-to-farthest-node distance.
Network Interface Controller	NIC. A hardware expansion card that physically connects a workstation/server/peripheral to the network. The NIC acts as the communications medium and facilitates using network software.
Network Operating System	NOS. The software that manages a network. For example, NetWare, Windows NT, UNIX and OS/2 are popular NOSs.
NIC	See Network Interface Controller.
Node	A single device connected to a network. Devices may be workstations, servers, hubs, repeaters, routers, printers or other peripherals.
NOS	See Network Operating System.
Packet	Data prepared for transmission across a network.

GLOSSARY **(continued)**

TERM	DEFINITION
PCI	See Peripheral Component Interconnect.
Peripheral Component Interconnect	PCI. A system bus architecture specification designed by Intel. PCI supports 32-bit bus-mastered data transfer. Designed to support plug-and-play configuration of optional peripherals.
PHY	See Physical Layer.
Physical Layer	PHY. The portion of a network adapter that provides electrical and mechanical connections between the network controller chip set and the network cable connector.
Port	The connection point of a device on a network. Each port has an individual network address. Each network node is connected to a network port.
Punch-Down Block	The area in a building's wiring closet where individual pairs of cable are designated for particular functions. The functional designations determine which outlets in an individual office correspond to which functions. For example, voice-grade cable has 4 pairs of wire. The blue pair can be punched down for digital telephone use while the yellow pair is punched down for a departmental LAN.
Repeater	Network equipment that receives a signal, regenerates it, and re-transmits it over the network wire (often called "boosting" the signal.) Used for extending the maximum cable length supported by a network technology.
RJ-45 Connector	An eight-wire connector used for connecting digital telephones and networks running over UTP cable. 10Base-T, Token Ring and 100 Mb/s Ethernet networks may use RJ-45 connectors.
Shielded Twisted Pair	STP. Insulated 18 - 26 gauge wire used for LANs with metal shielding to protect signals from outside interference and allow longer cabling distances than those supported by UTP.
Token Ring	Network topology defined by IEEE specification 802.5. Token Ring networks use the collisionless token passing access method and transmit data at speeds of either 4 Mb/s or 16 Mb/s.
Unshielded Twisted Pair	UTP. Insulated 18 - 26 gauge wire used for LANs and telephones. UTP does not have metal shielding to protect signals from outside interference.

GLOSSARY **(continued)**

TERM	DEFINITION
UTP	See Unshielded Twisted Pair.
Voice-Grade Cable	UTP Category 3. Used for digital telephones and LANs.
WAN	Wide Area Network. A network that covers a wide geographical area.

NOTICE

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