NETWORK TECHNOLOGY INFORMATION

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Compaq Computer Corporation

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Technology Overview

Many customers currently have, or foresee having, network throughput bottlenecks due to faster server processors, new applications, and more demanding environments that require greater network data transfer rates than existing LANs can provide. As networks mature, server consolidation results in a greater number of users and more network traffic per average file server, straining the throughput capabilities of today's LANs. New data-intensive applications, such as network file server backups and synchronized voice/video, require reduced latency, as well as new levels of data transmission speed and reliability.

New, faster networking technologies are redefining LAN environments with high-speed topologies that offer data throughput of at least 100 Megabits per second (Mbps). Compaq takes the lead in 100-Mbps Ethernet with the Compaq NetFlex-3 Controller, the only network interface controller that delivers outstanding performance and complete flexibility for any Ethernet environment.

This document briefly discusses and compares 100Base-T (IEEE 802.3U) and 100VG-AnyLAN (IEEE 802.12) technologies.

NOTE: These technologies are discussed at length in the Compaq document *High-Speed Networking Technology Brief*, document number 001A/0395.

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100 BASE-T AND 100VG-ANYLAN FAST ETHERNET

According to recent studies, there is an average of over 20 users per LAN, an increase of nearly 42 percent since the early 1990s. Network applications ranging from spreadsheets and graphics to complex databases and multimedia are placing greater demands on networks than ever anticipated.

The popularity and large installed base of 10-Mb/s LANs makes it a natural springboard for faster networking technologies. Many in the networking industry are interested in leveraging from a proven successful technology. Two emerging technologies that can meet the current high networking demands are 100Base-T (IEEE 802.3U) and 100VG-AnyLAN (802.12). The maximum network bandwidth is 100,000,000 bits/sec for both 100Base-T and 100VG-AnyLAN technologies.

Compaq has chosen to support both technologies and enable the implementation of either 100Base-T or 100VG-AnyLAN. This flexibility helps maximize our customers' investments if their network requirements change.

Both 100Base-T and 100VG-AnyLAN technologies have a common goal: to provide 100-Mbps connectivity without modification to the network packet transferred on the wire. The main difference is in their approach to providing 10 times the bandwidth of the 10Base-T, without decreasing the 100-meter 10Base-T lobe length.

100Base-T Technology

The 802.3U (100Base-T) committee design approach kept 100-Mbps Ethernet as close to the original definition as possible. Therefore, the 802.3U 100-Mbps technology utilizes the Carrier Sense Multiple Access/Collision Detect (CSMA/CD) shared-media access method supported in earlier versions of Ethernet. The simplicity of this media access method might make it attractive to companies using traditional Ethernet.The challenge for developing this technology is the collision detection (CD) functionAs the bandwidth is increased times ten, the collision window is reduced to one tenth.

The 100Base-T technology can be broken down into two sub-categories, both of which Compaq has utilized in developing network interface cards:

- 100Base-T4
- 100Base-TX

How 100Base-T4 Works

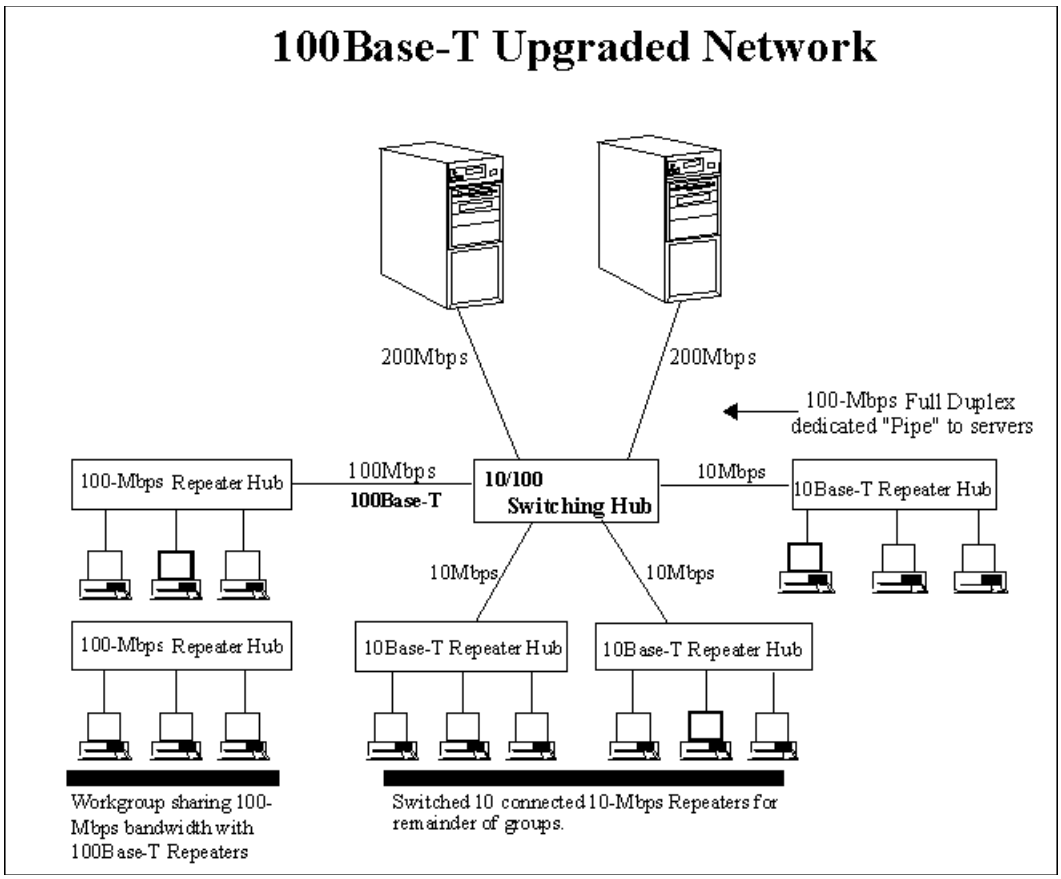
The physical layer implementation for 100Base-T4 varies significantly from the physical layer definition of 10Base-T. The 100Base-T4 achieves its speed by dividing a 100-Mbps data stream into three 33-Mbps streams. These three streams are sent over three pairs of Unshielded Twisted Pair (UTP) wire. A fourth pair of wire is used for collision detection. No data is sent on the fourth pair; instead, the hub uses it to signal a workstation when a collision occurs.

Splitting the data stream across the wires helps ensure the signal integrity while complying with FCC standards. However, because 100Base-T4 splits the data stream over four pairs of cable, full duplex is not supported. The 100Base-T4 requires 4 pair Category 3 (CAT 3) or better cabling. The total network diameter is 205 meters, which is shorter than current 10Base-T standards.

How 100Base-TX Works

The 100Base-TX is a true derivative of 10Base-T. Its 100-Mbps speed is achieved by sending the signal 10 times faster. Signal integrity is retained by shortening cable lengths and using Category type 5 (CAT 5) cabling. CAT 5 cabling increases the twist ratio of the wires to cancel the electromagnetic interference (EMI). Because 100Base-TX uses exactly the same protocol as today's Ethernet (no splitting of data streams), it supports full and half duplex mode.

A typical 802.3U (100Base-T) based implementation is shown below:

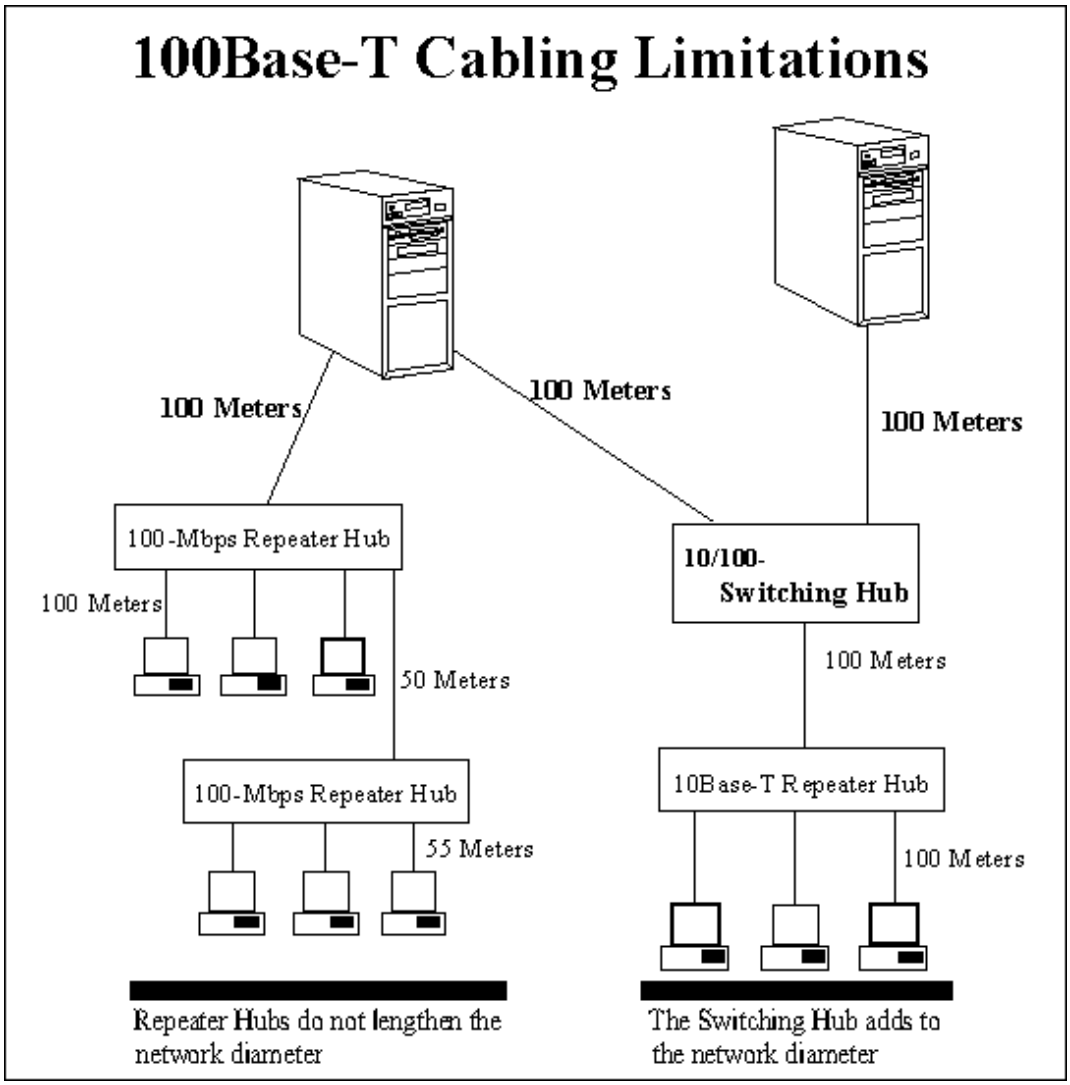


100Base-T Upgraded Network

Requirements for 100Base-TX and 100Base-T4

Both technologies support a maximum 100-meter UTP from the hub to the workstation. A total of 205 meters of cable is allowed for the end station-hub-hub-end station (referred to as the network diameter) connection. This requirement is shorter than current 10Base-T technology (2500 meters). To increase the distance, the use of switching hubs at key central locations is recommended.

A switching hub allows 100 meters of cable between stations and hubs because it stores and forwards the packets, rather than repeating them along the wire. This store and forward works as if the packet came from the switching hub itself, although none of the packet information is changed (the originator's address is still stored, rather than the switching hub address).



100Base-T Cabling Limitations

The main difference between 100Base-TX and 100Base-T4 is that different cable types are supported for each technology (see the table at the end of this document). The 100Base-T4 works with CAT 3 cabling while 100Base-TX requires higher cost CAT 5 cabling.

The two technologies (100Base-TX and 100Base-T4), must communicate through a hub that handles both types of 100Base-T or have bridges and/or routers that connect the two types of networks.

100VG-AnyLAN Technology

100VG-AnyLAN is the second emerging standard for 100Mps technology. Instead of using the technique common to today's Ethernet standard where each controller checks for a busy network, 100VG-AnyLAN uses a demand priority scheme. Demand priority works like a traffic signal; the hub logic determines which controller has access to the network. The hub polls each controller to determine if that controller has data to transmit and then allows transmission in port order.

For example, if there is a request waiting on port one and port three, all requests are of equal priority. The hub begins by servicing port one. Next, the hub checks to make sure that no new requests have come in for port two, the next in line. Assuming no requests have come in, the hub proceeds to service the request on port three.

If a request came in from ports two and four while the request at port three was being serviced, port four would be the next one serviced and then the hub would start back at port one. This "round-robin technique" allows equal access to network media.

Hub Priority

On a 100VG-AnyLAN network, priorities are also allowed. The network manager can set the priority from the hub.

In theory, every workstation could be set to high, which negates the purpose of priorities, but in a ideal network only ports using applications such as video conferencing or multimedia would be set to high. These types of applications require frequent response in real time, so they need the priority set to high.

If port one has a normal priority request and ports two and three have high priority, the hub bypasses port one and services ports two and three first.

Of course, if after servicing port three, high-priority requests continue to come from port two and three, station one again is bypassed. Normal requests will continue to be bypassed until that request has been waiting 200-300 ms (depending upon the configuration of the hub timer).

Once the timer has expired:

- The hub completes the processing of the current high-priority request.
- The hub changes the priority of the request on port one from normal to high.
- The hub again polls all ports and determines, using the port order, which port should be processed next.

In the example above, the hub would finish the request from port two, complete the outstanding request from port three and then service the request waiting at port one. This handling of priorities guarantees that a maximum settable delay will not be exceeded.

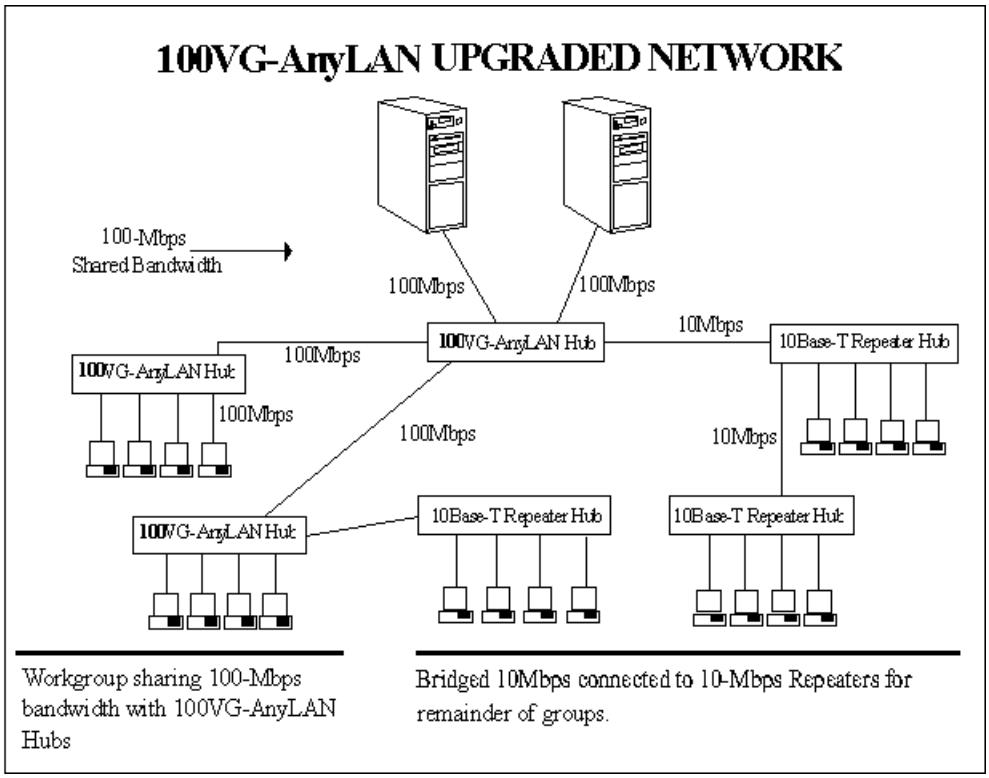
The network manager, through network management software, should ensure that a high number of users are not all configuring systems to send packets marked as high-priority. The network manager can configure each hub to treat packets from a particular port as normal, regardless of request priority assigned locally by the driver.

In the future, application technology and operating system technology will advance so that applications can set priority. This means that only requests from a particular application will be high priority and other requests from that port will be normal priority. However, today's network interface architectures allow only a single data stream, preventing the drivers from dynamically splitting data into high and low priority streams.

Hub Layers

Up to three hierarchical (cascaded) layers of hubs are allowed in a 100VG-AnyLAN network. The root hub (first-level hub) controls which request is being serviced. When the root hub receives a request from another hub, it passes control of the network to the second-level hub. The second-level hub services its requests in port order. The root hub continues to process all requests from the second-level hub before it continues servicing the third port on its own hub.

A typical 100VG-AnyLAN configuration is shown below:



100VG-AnyLAN Upgraded Network

ADVANTAGES AND DISADVANTAGES OF 100BASE-T AND 100VG-ANYLAN TECHNOLOGY

100Base-T Advantages

The following list contains some positive considerations with using 100Base-T technology.

- Inexpensive 100-Mbps Technology - Expected to become an inexpensive 100-Mbps solution that integrates well into many installed Ethernet bridged and routed networks.
- Leverage existing expertise - Familiarity with Ethernet should enable customers to incorporate this new technology easily into their existing networks.

100VG-AnyLAN Advantages

The following list contains some positive considerations with using 100VG-AnyLAN technology.

- Lower-cost hubs compared to the switching hubs recommended and used with 100Base-T technology.
- Provides an easier migration path from Token Ring networks than 100Base-T technology because 100VG-AnyLAN is able to use Token Ring (802.5) frame formats.
- 100VG-AnyLAN is deterministic - the longest maximum time it will take to send a packet on a network can be calculated.

100Base-T Disadvantages

A few considerations to take in account before setting up your 100Base-T network.

There is a smaller network radius with 100Base-T networks than with 100VG-AnyLAN if you are using repeater hubs instead of the more expensive switching hubs.

- Shared bandwidth, non-priority solution- Many end stations contend for the 100-Mbps on an equal (non-priority) basis. Network applications and servers can consume large quantities of bandwidth and starve other end systems contending for bandwidth. It is important for network designers to understand how the network will be used and to manage its growth to avoid this type of problem.
- Fragmented Frames - Network administrators using current network analyzer products will see a lot of fragmented frames. Collision fragments are not normally received by 10Base-T analyzers because the collisions occur much earlier in the frame. However, these collision fragments might be seen with 100Base-T analyzers due to the higher speed and extended preamble of each frame.

100VG-AnyLAN Disadvantages

A point to consider before setting up your 100VG-AnyLAN network.

Total throughput of 100VG-AnyLAN cannot exceed 100-Mbps. With 100Base-T and efficient switching hubs, it is possible to reach higher throughputs.

HALF AND FULL DUPLEX ETHERNET SUPPORT

Half duplex network transmission is typical and allows simultaneous one-way transmission between nodes while eliminating collisions. Full duplex is an enhancement that allows simultaneous two-way transmission between nodes while eliminating collisions. Full duplex transmission increases performance and efficiency by doubling the bandwidth of 10Base-T cabling to 20 Mbps or 200 Mbps for 100Base-T cabling.

Under the Windows NT 3.5x environment, the 10/100 TX PCI UTP Controller, the 10T PCI UTP Controller, and the entire Family of Compaq NetFlex-3/Netelligent Controllers support full duplex operation. Make sure that all Ethernet interfaces, such as your hub, allow and are configured for full duplex support. Refer to your hub documentation for more information.

To enable full duplex Ethernet operation with the Compaq NetFlex and NetFlex-2 Controllers, the controller must be configured by running the Compaq System Configuration Utility v2.25 or greater and selecting the *Full Duplex* operation. Full duplex is supported on 10Base-T networks.

To enable full duplex operation on the NetFlex-3/Netelligent, use the Network Control Panel to configure the NetFlex-3/Netelligent Controller and select the *Full Duplex* option in the *Media Speed* drop down list. The *NETFLX3.SYS* driver currently supports full duplex operation when used with the 10Base-T UTP/BNC module or the 10 T PCI UTP and 10/100 TX PCI UTP controllers.

WHICH TECHNOLOGY TO CHOOSE?

Compaq has developed two different network interface cards (NICs); one that is compatible with EISA slots and one for PCI slots. Both the EISA base and PCI base controllers can be used with interchangeable modules for 10Base-T, 100Base-TX, 100Base-T4, or 100VG-AnyLAN. Each of the modules (or daughter boards) slide into the base boards. A common driver is used for all configurations.

Chose an upgrade module based on whether the 100Base-T or 100VG-AnyLAN technology meets your networking needs. Here are some differences to consider when choosing a Compaq EISA or PCI controller:

100BASE-T

	10Base-T	100Base-TX	100Base-T4	100VG-AnyLAN
Cables Supported	Cat 3,5 UTP 2 or 4 pairs	2 pairs-Cat 5 UTP	4 pairs over Cat 3,4,5 UTP	4 pairs over Cat 3,4,5 UTP
Network Diameter	2500 meters	205 meters	205 meters	205 meters
Lobe Length	100M	100M	100M	100M
RJ45	YES	YES	YES	YES
Thinnet (10Base-2)	YES	NO	NO	NO
Full Duplex	YES	YES*	NO	NO
Maximum throughput	10 Mbps or 20 Mbps full duplex	100 Mbps or 200 Mbps full duplex	100 Mbps	100 Mbps
Switching Hub	Optional	Recommended	Recommended	Not Available Yet

* Only supported with the 10/100 TX PCI UTP controller.

SUMMARY

Compaq Netelligent Controllers provide leading-edge network technology with good performance gains. This paper has provided a brief summary of the 100Base-T and 100VG-AnyLAN technologies.