TECHNOLOGY BRIEF

October 14, 1997

Compaq Computer
Corporation

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Strategic Direction for Compaq Fibre Channel-Attached Storage

EXECUTIVE SUMMARY

As performance of processors and peripherals improves and companies increasingly move to distributed architectures while consolidating servers, high-speed and data intensive network applications (such as transaction processing, decision support, data warehousing, image-based document systems, geophysical mapping, and multimedia) are proliferating. Interconnects between servers and the I/O devices they support have become a management bottleneck. Current interconnects require that I/O devices be located within very close proximity to servers. This limited transmission distance is inadequate for mirrored data sites. A further restriction is the number of I/O devices that can be attached to systems.

New interconnect technology is needed to overcome current I/O and physical limitations and to meet future demands. Nowhere is this need more critical than in the storage subsystem.

This technology brief addresses recent computing trends and customer issues with current storage technology. It provides an overview of Fibre Channel technology and explains why Compaq's strategic direction for high-performance and high-capacity external storage is based on Fibre Channel.

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NOTICE

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STORAGE TRENDS AND CUSTOMER ISSUES

Today storage needs are expanding more rapidly than ever before. Customers are demanding improved storage solutions. Driving their demands are these new trends in enterprise computing:

- the explosion of the Internet
- the need to keep more information on-line
- the need to collect, scan, and track decision support information
- consolidation of servers
- movement of PC Servers into business critical applications
- the growing complexity of applications with more graphics, video, and sound to be stored

Key storage issues for enterprise customers include their current and future needs for distributed storage in conjunction with improved network storage management; increased connectivity and capacity, plus dynamic expansion capabilities; high performance, availability, and reliability; investment protection; and reduced cost of ownership.

Small Computer System Interface (SCSI) technology has carried the storage industry forward for many years. Inherent I/O and physical limitations, however, now prevent SCSI technology from satisfying the expanding needs of enterprise storage.

Although SCSI will remain an important part of data storage solutions for some time, a new interconnect technology must propel future growth of enterprise storage. This technology brief explains why Compaq believes Fibre Channel is the right interconnect technology for building future storage solutions.

TERMINOLOGY AND CONVENTIONS

In this document the term *fibre* (international spelling) refers to a communication medium consisting of either copper or fiber optics. The term *Fibre Channel* is capitalized in accordance with the convention set by the governing standards committee.

COMPAQ'S STRATEGIC DIRECTION FOR EXTERNAL STORAGE

Compaq's strategic direction for high-performance and high-capacity external storage is based on Fibre Channel technology because it provides the means to satisfy all the enterprise storage needs identified above. Fibre Channel is a key technology for the high-speed storage interconnect (that is, processor-to-storage and storage-to-storage communications) and for the serial drive interface (high-performance disk systems). It provides opportunity for the integration of primary and secondary storage as well as for shared storage among multiple servers.

Compaq also has a strong interest in Gigabit Ethernet and Tandem ServerNet. Gigabit Ethernet is a high-speed extension to Ethernet. It leverages the physical level and the encoding used in Fibre Channel. Gigabit Ethernet and Fibre Channel are complementary. Gigabit Ethernet provides the high-speed local area network, while Fibre Channel provides the high-speed storage area network. A Fibre Channel storage area network allows a client attached to a specific processor to access data in any storage device within the storage area network because all storage devices are accessible to all processors.

Compaq is developing ServerNet, on the other hand, as the server node-to-server node interconnect within Compaq clusters because ServerNet features very low latency in server node-to-server node communications. Current implementations of ServerNet use a copper interface. Future implementations will use fiber and leverage the physical level and encoding of Fibre Channel, as does Gigabit Ethernet.

Commonality of architecture at the physical level of these three technologies promotes the use of common parts and allows the use of the same infrastructure for Fibre Channel, Gigabit Ethernet, and ServerNet.

WHAT IS FIBRE CHANNEL?

Fibre Channel is the general name of an integrated set of standards being developed by committees accredited by the American National Standards Institute (ANSI). This set of standards defines new protocols for flexible information transfer. Fibre Channel is an industry standard interconnect and high-performance serial I/O protocol that is media independent and supports simultaneous transfer of many different protocols.

Development of the Fibre Channel standards began in 1988. These standards are being developed to meet several objectives:

- to keep pace with increasing host processor performance
- to keep pace with growing data-intensive applications
- to provide a practical and inexpensive means for high-speed transfer of large amounts of data
- to ensure the integrity of data
- to support multiple physical interface alternatives
- to provide a common interface for all data traffic
- to provide a means of transmitting data with very low error rates
- to separate logical protocol from physical interface, allowing transport of multiple protocols over the same interface
- to allow simultaneous transfer of many different protocols over the same interface

Channel and Network Functions

In business computing there are two basic protocols for device communication: channels and networks. A channel is an interface between a host computer and I/O peripherals such as tape drives, disks, and printers. The host system has knowledge of all the peripheral devices attached to it, so this is a structured, predictable, hardware-intensive environment with relatively low software overhead.

A network, on the other hand, comprises distributed devices that may include mainframes, workstations, and file servers. A network has its own protocol and is an unstructured environment because almost any device in the network can communicate with any other device at any time (peer-to-peer communication). This environment has more overhead than a channel because more software support is required to verify access permission, set up sessions, and route transactions correctly.

Fibre Channel is superior as a traditional channel for attaching storage devices in a robust fashion. The use of fiber optics for the transmission media provides for extremely low error rates. Fibre Channel incorporates both a powerful encoding scheme and a strong cyclic redundancy check (CRC) on each message frame, ensuring data integrity. Fibre Channel uses a topology (either a loop or a switch) to provide connectivity. The capability to provide scalable connectivity and the peer-to-peer basis of the Fibre Channel architecture are the key enablers for networking. Fibre

Channel is now the only standard that can perform both the traditional channel and network functions simultaneously on the same port.

Interconnect Topologies

Fibre Channel nodes each have one or more ports that enable external communication. Each port uses two fibres, one for outgoing information and the other for incoming information. The pair of fibres is called a *link*. All the components that connect ports comprise an interconnect topology.

Various topologies are used to provide connectivity between Fibre Channel ports. The two basic topologies used today are Fibre Channel Arbitrated Loop (FC-AL) and the fabric switch. Both are illustrated in Figure 1.

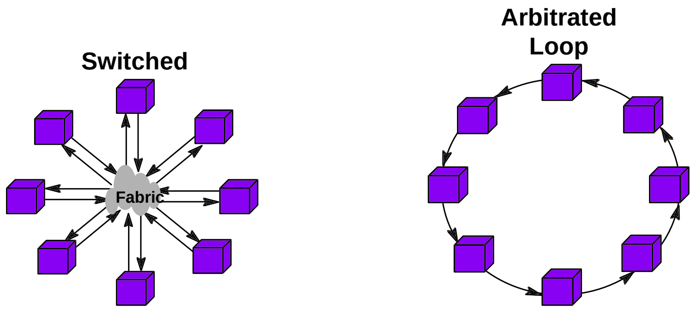

Figure 1. Simplified depiction of non-blocking cross-point switch topology and of FC-AL topology

A fabric switch allows multiple pairs of nodes to communicate with each other simultaneously. Therefore, as more nodes are added, the aggregate data throughput capability can increase incrementally. A fabric switch requires a cross-point switching function and the intelligence to make the connections. A pair of transceivers is required to form the link between the attaching port and the port on the switch. These transceivers add to the cost of the switch.

The Fibre Channel Arbitrated Loop is a serial interface that creates logical point-to-point connections between ports with the minimum number of transceivers and without a centralized switching function. FC-AL therefore provides a lower cost solution. The bandwidth of a Fibre Channel loop is shared by all ports on the loop. A single pair of ports on the loop communicates at one time, while the other ports on the loop act as repeaters.

Hubs are useful in configuring the Arbitrated Loop. A hub contains several ports that are internally connected in a loop. Each port is fitted with a port bypass switch to maintain the continuity of the loop should a controller or device attached to the port be powered off or malfunction. A hub port can be given the ability to accept either electrical or optical input. This capability is useful in configuration. For instance, if it were desirable to locate the hub and controllers some distance from the server, an optical connection (long wave or short wave) could be used between the server and hub while copper connections could be used between the hub and controllers. Hubs can be cascaded to provide additional ports for more connectivity.

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