

10 Gigabit Ethernet Technology Brief

WHITE PAPER

The 10 Gigabit Ethernet Standard

In June 2002, the IEEE standard for 10 Gigabit Ethernet, IEEE Std 802.3ae- 2002, was unanimously approved by the IEEE Standards Association (IEEE-SA) Standards Board. With the ratification of the IEEE 802.3ae specification, enterprises can now confidently deploy 10 Gigabit Ethernet in their corporate backbones, data centers and server farms to support high-bandwidth mission-critical applications.

Positioned as a high-speed, unifying technology for networking applications in LANs, MANs, and WANs, 10 Gigabit Ethernet offers high bandwidth, reliability, and ease of installation. Because 10 Gigabit Ethernet is still fundamentally Ethernet, it leverages existing IT staff expertise, management tools and architecture. It is within the enterprise Local Area Network (LAN) that 3Com will be positioning its 10 Gigabit Ethernet solutions.

Technology Overview

IEEE Std 802.3ae-2002 defines the operation of the 802.3 Media Access Control (MAC) at 10Gbps for full duplex operation only, while preserving the 802.3 frame format, including minimum/maximum frame size.

There are two different physical layer (PHY) families. The LAN PHY uses simple encoding mechanisms to transmit data on dark fiber and dark wavelengths. The WAN PHY adds a Synchronous Optical Network / Synchronous Digital Hierarchy (SONET/SDH) framing sublayer to utilize SONET/SDH as the Layer 1 transport.

The physical media supported includes both copper and fiber cabling. For copper, the recently approved twin-axial copper cabling (10GBASE-CX4) specification supports a maximum of 15m (49 feet). Fiber cabling, on the other hand, supports multiple derivatives of the standard related to the different optical types required for the various WAN and LAN applications. The typical 10GbE LAN optical standards can be summarized as follows:

- 10GBASE-LR (10km over single-mode)
- 10GBASE-ER (40km over single-mode)
- 10GBASE-SR (26m over FDDI-grade multi-mode)
- 10GBASE-LX4 (300m over FDDI-grade multi-mode)

Table 1 summarizes the options supported, and distances achieved, depending on the grade of fiber.

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TABLE 1: Fiber Distances Supported in IEEE 802.3ae 10 GbE

FIBER	62.5 MMF		50 MMF			SMF
MH*km	160	200	400	500	2000	-
SR 850 nm	26m	32m	66m	82m	300m	-
LX4 1310 nm	300m@500Mhz*km	240m	300m	-	10km	
LR 1310 nm	-	-	-	-	-	10km
ER 1550 nm	-	-	-	-	-	40km

TABLE 2: Copper 10-Gbps Technologies and the Relative Distances Achieved

COPPER	CABLE	DISTANCE
CX4	twinax	28 m
10GBASE-T	Cat 5 - 7	30 - 100 m

10 Gigabit Technology and Applications

The advent of intelligent Gigabit Ethernet multilayer switches has transformed LAN designs. Core network technologies are rapidly shifting to Gigabit Ethernet, with the next step for the enterprise being the move to a multi-gigabit bandwidth network with backbone and server connections supporting up to 10 Gbps. Although some companies have released products that support 10 Gbps, including 3Com, large-scale implementation of 10 Gigabit thus far has been slow. But shipments are accelerating, with 7,300 10Gbps ports in 2003, and 15,600 ports in the first half of 2004 having been shipped according to the recent Dell'Oro data.

Three main factors are contributing to this acceleration:

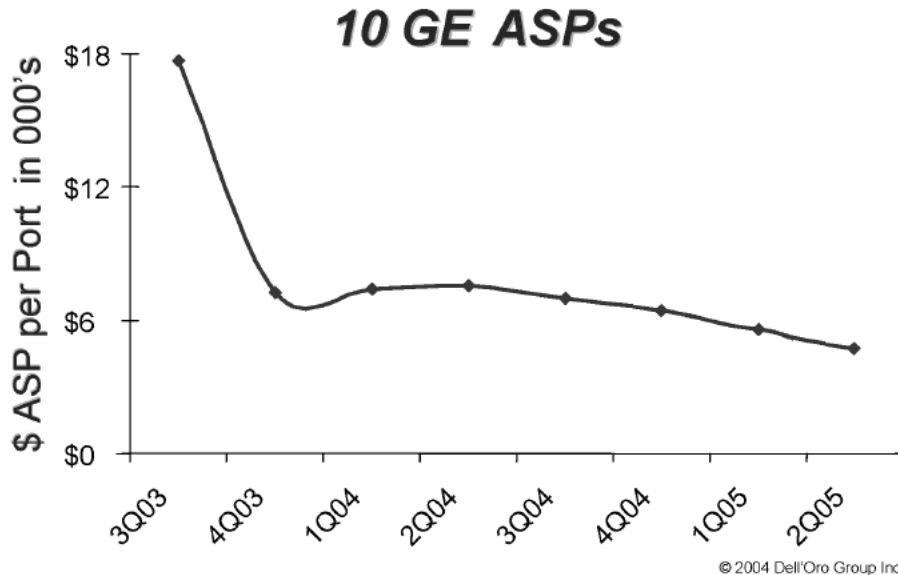
1. 10 Gigabit Ethernet pricing has come down, even beginning to cross the sub-\$1,000 level per port.

2. Gigabit-to-the-desktop installations are forcing core network upgrades to keep pace.
3. With more ports shipped, there are more uses for 10 Gbps connections.

10 Gbps Price Drop

Price reductions for 10 Gigabit products are a major influence in the adoption of 10 Gigabit in the LAN. Consider that when 10 Mbps, 100 Mbps, and 1000 Mbps switches were first introduced, they were priced at a discount relative to the equivalent bandwidth in lower-speed ports. When 10 Gigabit Ethernet prices were up to \$70K per port, users were paying a significant premium in comparison to the cost of 10 equivalent 1 Gigabit ports. This disparity made Link Aggregation much more appealing as an intermediate solution. With the price coming down, 10 Gbps connections are a much more appealing solution.

FIGURE 1: shows the actual and forecasted trend related to 10 Gigabit Ethernet prices and ports shipped, according to the Dell'Oro Group (Aug 04).



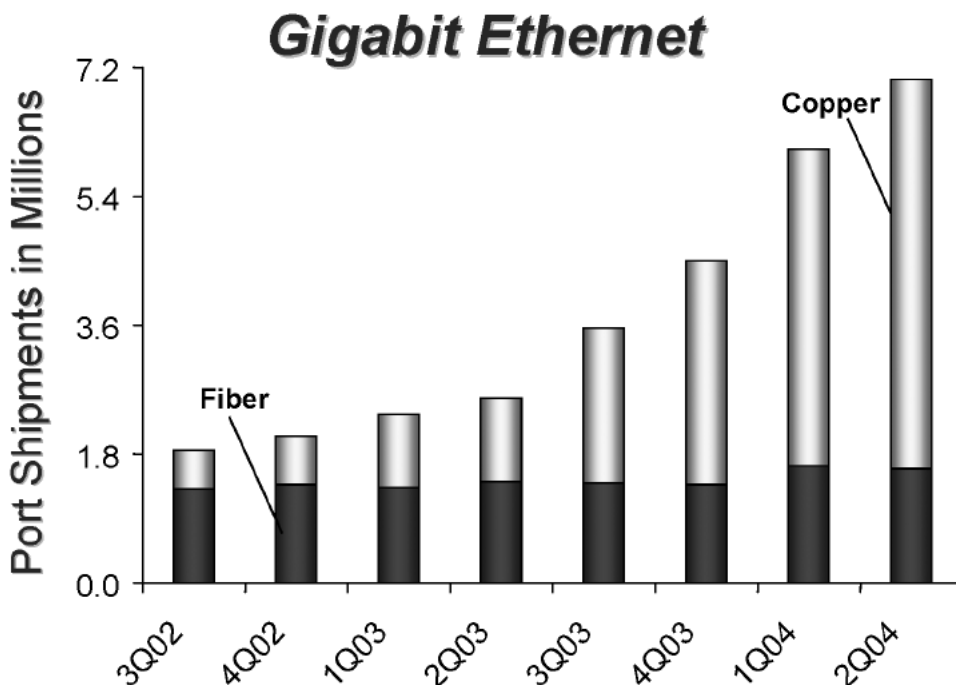
The Move to Gigabit to the Desktop

The deployment of Gigabit to the desktop will be driven primarily by a drop in the price per Gigabit port followed by the installation of high-bandwidth applications on servers and workstations. Once either or both of these events occur, there will be a need for a high port density Gigabit

Ethernet aggregator that supports 10 Gbps uplinks back to the core of the network.

Figure 2 shows Dell’Oro Group forecasting the increasing shipment of Gigabit connections as Gigabit-to-the-desktop increases.

FIGURE 2: Gigabit Ethernet Switch Port Shipments



3Com 10 Gigabit Ethernet Strategy

In November, 2004, 3Com introduced its first 10-Gbps modules for its key core and Gigabit-to-the-desktop switch lines. The 3Com Switch 7700 chassis-based family supports a single-port 10-Gbps module. The 3Com SuperStack 3 Switch 3870 is the industry's first stackable Gigabit-to-the-desktop switch with a built-in 10-Gbps expansion slot.

3Com has the strongest Gigabit Ethernet product portfolio in the industry with Gigabit over fiber and copper NICs for servers and desktops, Gigabit uplinks on 10/100 switches (all media), managed and unmanaged Gigabit switches, stackable multilayer Gigabit switches, and modular multilayer Gigabit switches.

Strong investments in next-generation Gigabit ASIC technology and highavailability Gigabit switching, Gigabit

to the desktop, and 10 Gigabit Ethernet are key components of 3Com's switching roadmap.

3Com targets these key applications with our 10-Gbps switch offerings:

- LAN backbone connectivity
- Workgroup aggregation switch uplinks
- Server aggregator uplinks

LAN Backbone Connectivity

The interconnection of switches in the data center is the first application where we see 10GbE being implemented. As the requirements on the core of the network increase with the proliferation of gigabit to the desktop and high bandwidth applications, there is a need to increase the speed capabilities at the heart of the network.

In campus environments such as Universities and multi-site companies, there is typically a distribution switch layer within each building. This layer aggregates the wiring closet switches and any local servers within the building. The distribution switch is then connected over a single mode fiber link to the building in which the data center is located. Single mode fiber is usually installed between the buildings, as the buildings are typically many hundreds of meters apart.

As Gigabit is deployed to the desktop, this link is a potential performance bottleneck. Although performance and availability can be improved by using trunked Gigabit links, the laying of any additional cabling may be prohibitively expensive. In situations where there is only a single link between buildings, a 10GbE uplink based on the 10GBASE-LR standard becomes an attractive alternative to Gigabit trunking.

It has been for LAN backbone connectivity that 3Com has released its first 10-Gigabit Ethernet switch offering, a single-port 10Gbps module for its multilayer core modular family, the Switch 7700.

Increasingly, Gigabit ports are shipping as standard in PCs, laptops and servers. At the same time, the price per port has dramatically dropped for Gigabit Ethernet stackable switches. These factors are shifting the balance for those considering new or upgraded workgroup connections, making it increasingly common that Gigabit-to-the-desktop is the logical, future-proof solution to put in place. Initially the focus was on users who need high performance (for example, CAD and graphics workstations), but as prices fall and data throughput needs increase, Gigabit deployment will become more widespread.

10-Gigabit Ethernet Transceivers

Easing the adoption of 10Gbps interfaces by switch vendors is the introduction of 10Gbps transceivers. These provide the media connectivity—whether various flavors of fiber or copper—for a port in a switch module. By picking the right transceiver, the IT manager can adapt the switch port to a number of different flavors of 10Gbps fiber or copper.

Two transceiver flavors have been brought to market, a dual-technology path similar to what has happened with GBICs and SFPs for Gigabit ports. The technology called "XENPAK" was first to be commercialized. More recently, transceivers designated as "XFPs" have been introduced, tending to be both smaller and less expensive than XENPAKs.

As the number of desktop Gigabit users increases, so has the performance requirements for high-capacity uplinks. This demand was initially satisfied by trunked Gigabit, but now that 10 Gigabit Ethernet uplinks have reached an acceptable price --- less than \$1,000 per port in some cases --- they are becoming the natural successor to Gigabit links. In addition to the performance benefit of 10 Gigabit Ethernet, enterprises are also attracted to the installation cost savings they can realize by running a single 10 Gigabit Ethernet link.

To support Gigabit-to-the-desktop switches aggregating data into a core infrastructure, 3Com introduced a line of stackable 10/100/1000 switches with a built-in 10-Gbps uplink expansion slot, the industry's first. The 10-Gigabit expansion module for the SuperStack 3 Switch 3870 begins shipping in December 2004.

Server Aggregator Uplinks

The enterprise typically starts with a small number of servers running multiple applications, directly connected to the core switch via 10/100 Ethernet links. To meet the growing needs for performance and availability, the network manager adds additional servers, runs each application on a separate server or across multiple servers, and increases server performance with multiple processors and gigabit links.

Providing increased performance in the uplink from the server aggregation layer to the core switch is a key application for 10GbE. High-performance enterprise servers can now saturate a gigabit link. As the number and performance requirements of the servers connected to the server aggregation layer increases, so does the need for a high-performance uplink.

In the majority of deployments, the server aggregation switches are located in the data center, which is within 100 meters of the core switch. The network manager can choose to create the link using a 10GBASE-LX4 transceiver to address legacy FDDI-grade multi-mode fiber and 10GBASE-SR in the case of newer higher bandwidth multi-mode fiber being present.

Conclusion

The IEEE 802.3ae 10 Gigabit Ethernet Standard presents an opportunity to scale the performance of network cores to meet the increasing demands of users and applications. 3Com has been actively involved in the development of the IEEE 802.3ae 10GbE standard since its inception in March 1999.

During this time, 3Com employees not only served as editors for two Clauses of the Standard but also served as the Vice-Chair of IEEE 802.3, the parent body of the 10 Gigabit Ethernet project. In addition, 3Com is a founding member of the 10 Gigabit Ethernet Alliance, which supports the standard, promotes product interoperability, and takes part in major industry events to accelerate the adoption of 10GbE technology.

In late 2004, 3Com introduced our first 10Gbps switching modules on key modular and stackable switch families. Moving forward, 10-Gigabit Ethernet will be key to core and distribution networking in the enterprise.



3Com Corporation, Corporate Headquarters, 350 Campus Drive, Marlborough, MA 01752-3064

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