3com

10 Gigabit Ethernet Technology Brief
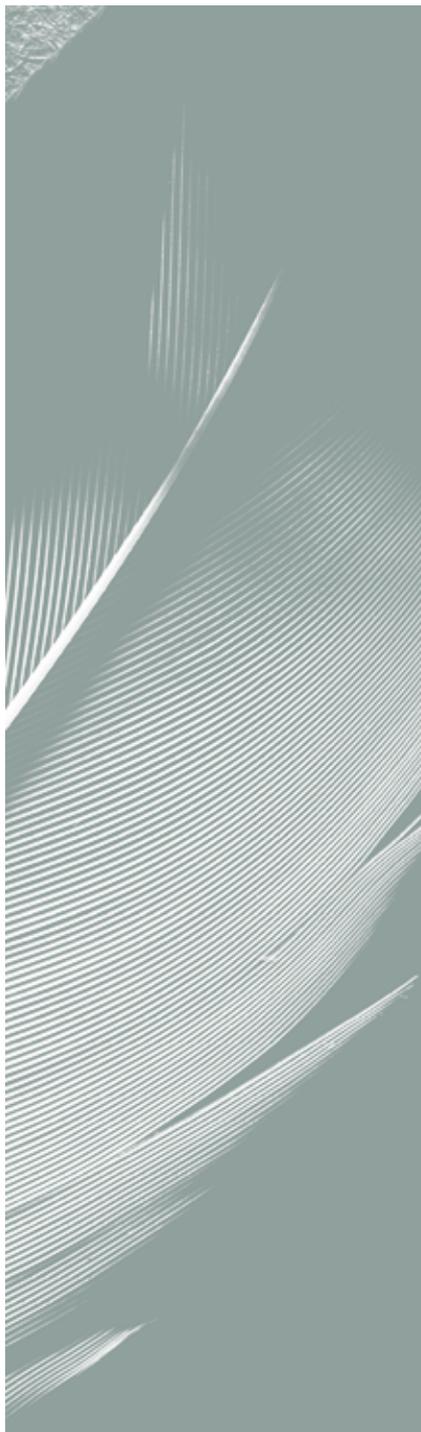
The 10 Gigabit Ethernet Standard

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

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

Table 1: Distances Supported in 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

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, large-scale implementation of 10 Gigabit Ethernet in enterprise LANs has thus far been slow, with approximately 300 ports having been shipped as of Q3CY03, according to the latest Dell'Oro data. Two main factors are contributing to this situation:

1. 10 Gigabit Ethernet ports are not priced for widespread enterprise deployment
2. Few application drivers are available

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. Given that 10 Gigabit Ethernet prices are currently around $35K to $70K per port, users are paying a significant premium in comparison to the cost of 10 equivalent 1 Gigabit ports. This disparity can make Link Aggregation much more appealing as an intermediate solution.

Figure 1 illustrates current forecasts by the Dell'Oro group as to when 10 Gigabit Ethernet prices will begin to drop.
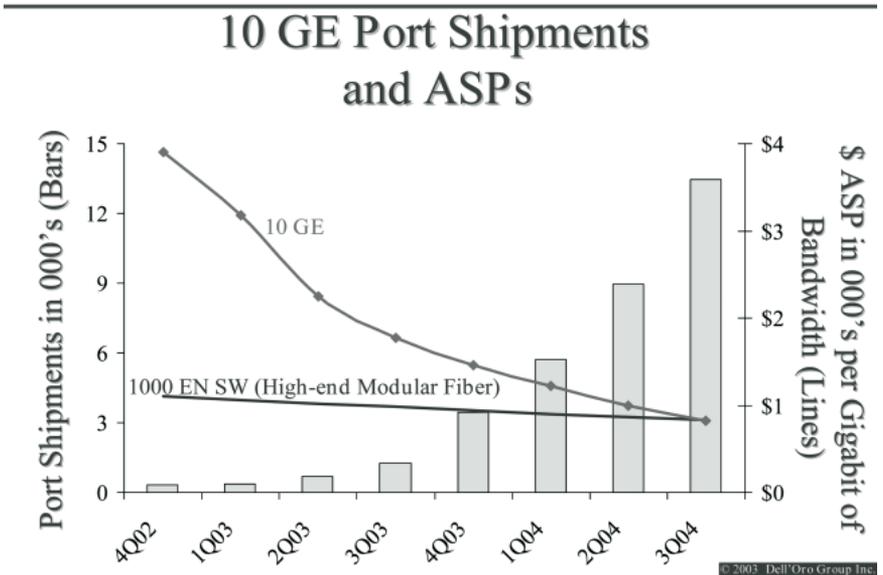

Figure 1. 10 Gigabit Ethernet Port Shipments and Average Selling Prices

There are two driving forces that can change this in the years to come. The first is a drop in the price of 10 Gigabit products and the second is the widespread adoption of Gigabit to the desktop.

As the figure shows, prices for 10 Gigabit products are forecast to be comparable with Gigabit Ethernet prices near the end of 2004. It is at this point that we believe enterprise LAN customers will consider 10 Gigabit Ethernet products sufficiently affordable for widespread deployment.

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 an increase in the copper installation of Gigabit in Q3CY03. It is this increase that we believe to be the beginning of en-masse deployment of gigabit to the desktop:
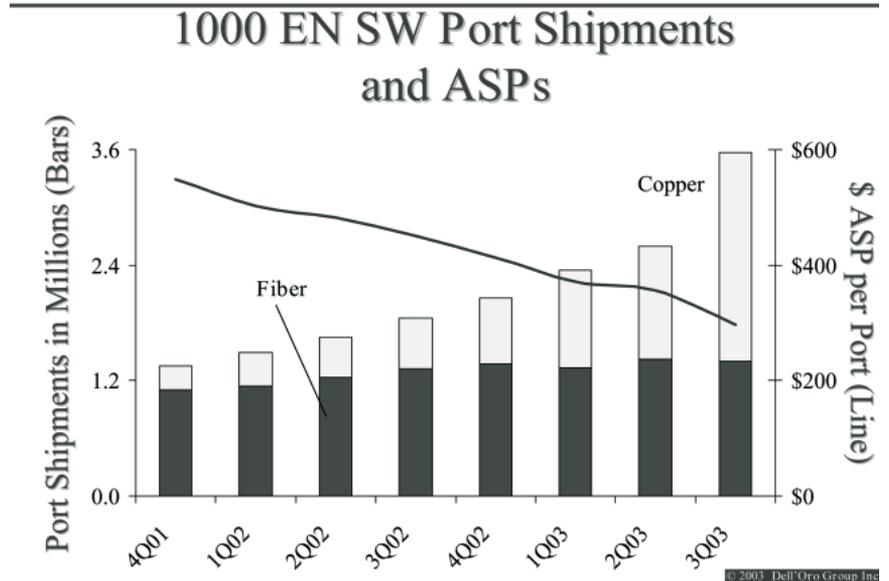

Figure 2. Gigabit Ethernet Switch Port Shipments and Average Selling Prices

3Com 10 Gigabit Ethernet Strategy

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

3Com plans to target the following key applications:

• 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 is for LAN backbone connectivity that 3Com plans to release its first 10GbE product, a single-port 10Gbps module for its multilayer core modular family, the Switch 7700, in the second half of 2004.

Workgroup Aggregation Switch Uplink
With the dramatic drop in the price of Gigabit network interface cards (NICs), over time, they are expected to become the de facto standard connection for desktop PCs in the larger enterprise. Similarly, as the price per port drops for Gigabit Ethernet stackable switches, enterprises will upgrade wiring closet switches to Gigabit. Initially the focus will be 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.

As the number of desktop Gigabit users increases, so will performance requirements for the uplink. This demand will initially be satisfied by trunked Gigabit, but when 10 Gigabit Ethernet uplinks reach an acceptable price (approximately equal to the price of a four-port Gigabit trunk, or $4,000 at today's prices) they will become the natural successor to Gigabit links. In addition to the performance benefit of 10 Gigabit Ethernet, enterprises will also be attracted to the installation cost savings they can realize by running a single 10 Gigabit Ethernet link.

The majority of enterprises have installed multi-mode fiber in the risers that link the data center to the wiring closets. Therefore the ideal technology for this application will be 10GBASE-LX4, which provides a 10 Gigabit Ethernet link over FDDI-grade multi-mode fiber over distances up to 300 m.

As the technology matures and the pricing gets to a point for mass deployment, 3Com intends to release in the second half of 2004 a new generation of desktop switches that will fully support 10 Gigabit Ethernet modules serving as high-speed uplinks back into the LAN backbone.

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

IEEE Std 802.3ae-2002 10 Gigabit Ethernet 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.

As a market leader in Gigabit Ethernet switches, 3Com is committed to the development of products that support 10 Gbps transmission rates to address enterprise customer infrastructure requirements.

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