The New Ethernet

New advancements in Ethernet technology are changing the way to work, connect and communicate

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Executive Summary

Over 20 years ago, Intel helped co-develop the technology that changed how people share information. Today, Ethernet remains the universal technology of choice in enterprise LANs. With the explosion of Internet Protocol (IP) traffic and sophisticated applications driving the demand for greater bandwidth inside and outside the enterprise, Intel is helping the industry take Ethernet to greater speeds and performance in the LAN, as well as extend Ethernet into new market segments including wireless, storage and metro area networking.

Advancements in Ethernet technology are at the center of today's transitions to:

- Gigabit speeds in the enterprise
- Wireless networking
- Networked storage
- Ethernet in the metropolitan area network

This paper provides information on these trends, why they are happening and, most important, how to benefit from these transitions as the demand for faster and more efficient network infrastructure increases.

The Growth of Ethernet

Standards Evolution

To understand the Ethernet phenomenon, it is helpful to briefly consider the evolution of the standard since the early 1980s (Figure 1).

Invented by Dr. Robert Metcalfe and co-developed by Intel, Digital and Xerox (see sidebar on the origin of Ethernet, Figure 2), Ethernet has become the most commonly used LAN technology worldwide. Today, more than 85% of LANs are Ethernet-based according to International Data Corporation (IDC, 2000). Gigabit Ethernet has evolved from the original 10 Mbps Ethernet and 100 Mbps Fast Ethernet standards. In addition, a 10 Gigabit standard is already under development, supported by the IEEE and the 10 Gigabit Ethernet Alliance, with the adoption of the 10 Gigabit standard expected in the first half of 2002.

Central to the success of Ethernet is the fact that Ethernet standards, over the last 20 years, have advanced along with networking requirements. This progression of standards provides a clear and straightforward migration path with the explosion of IP traffic and sophisticated applications driving the demand for greater bandwidth inside and outside the enterprise.

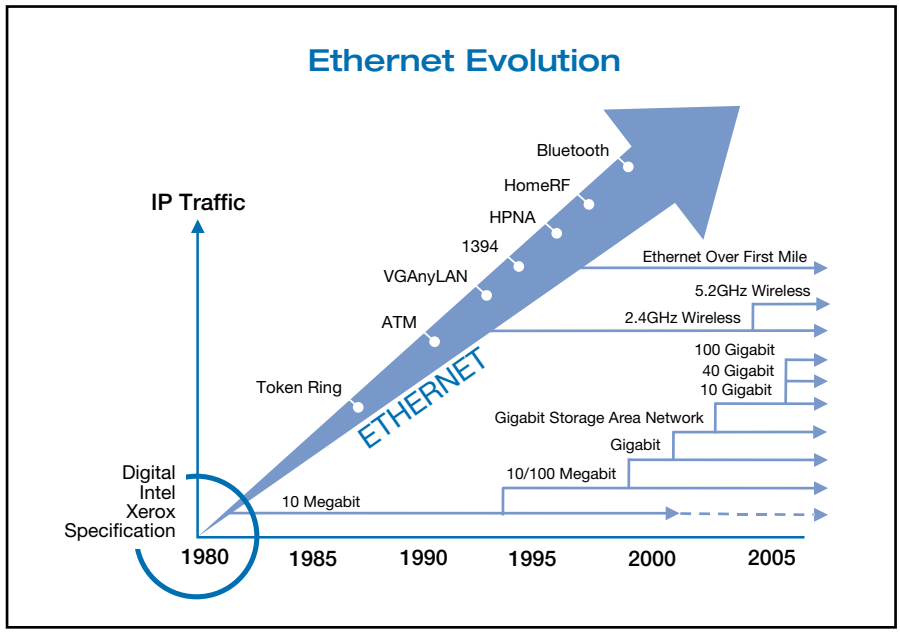

Figure 1

A Time of Critical Transitions

Today, several significant industry events are occurring that center on Ethernet as a key technology. These include:

- The transition to Gigabit line speeds in the enterprise LAN.
- The transition to wireless networking for mobile computing in the enterprise, small to medium sized businesses, and the adoption of wireless home networking.
- The transition to a networked storage approach in the corporate enterprise and small to medium sized businesses.
- The transition to 10 Gigabit line speeds in the enterprise and, even more significantly, into the metropolitan area network.

Advances in the Quality of Service (QoS), along with technologies such as DiffServ* and MPLS (Multiple Protocol Label Switching), are able to provide a high degree of predictability and service for Ethernet users without excessive complexity and cost.

Ethernet's popularity as an attractive solution for packet-based networking is based on the following critical requirements:

- Scalable performance
- Scalable distance to meet any need from short-range LAN applications (100m) to Metro Area Networks (40km+)
- Low cost
- Flexibility and interoperability
- Ease of use and administration

Origins of Ethernet

Dr. Robert Metcalfe invented Ethernet at the Xerox Palo Alto Research Center (PARC) in Palo Alto, California. Figure 2 shows his original sketch. A development team headed by Dr. Metcalfe created a system that operated at almost 3 Mbps and connected approximately 100 computers. A few years later, Xerox, Digital Equipment Corporation and Intel Corporation formed an alliance to develop 10 Mbps Ethernet networking and published a "Blue Book Standard" for Ethernet. The IEEE subsequently used it as a basis for the 802.3 standard.

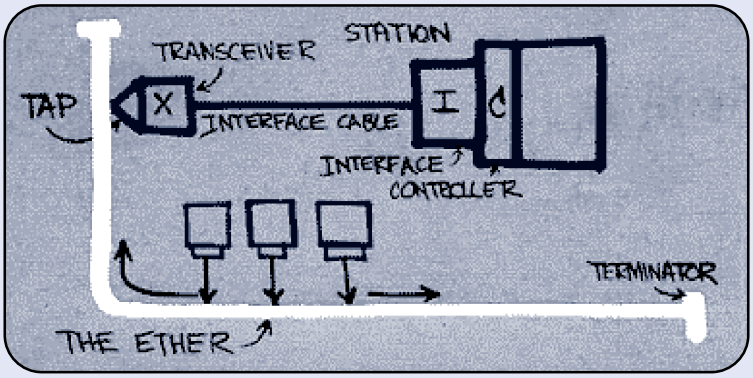

Figure 2

Ethernet in all of its forms supports these requirements very effectively, making it an ideal choice for current and evolving networks. The following sections provide more information about each of the critical transitions now taking place in Ethernet technology.

Transition 1: Gigabit Ethernet in the Enterprise

Sophisticated applications and more powerful PCs are continually driving network traffic to new levels, with the result that critical connections no longer have enough bandwidth. At one time, for example, desktop processing and connectivity were considered adequate if the user could simultaneously open Microsoft Word* and an Excel* spreadsheet. The kind of visually rich multi-tasking that is routine today, such as exchanging graphic designs while talking on an Internet phone line, were not part of the equation.

As applications became more bandwidth intensive, 10Mbps desktops migrated to 100 Mbps. This trend greatly accelerated when the cost of dual-speed 10/100 Mbps Ethernet connections approached the cost of regular Ethernet. Network managers could build 100 Mbps capability into their new PCs at the time of purchase and avoid the higher costs of retrofitting these desktops in the future.

The industry is now in a similar circumstance with Gigabit Ethernet connections. Servers are already specified today with Gigabit Ethernet for increased performance. At the desktop, shrinking price deltas are ramping the growth of Gigabit and continuing a now-familiar pattern as 10/100/1000Mbps Ethernet begins to replace 10/100 Mbps (Figure 3).

By deploying 10/100/1000 Mbps capable desktops, IT managers can maintain full compatibility with today's infrastructure, and provide future proofing for their client purchases. It is estimated that by the middle of 2002, over 50% of worldwide NIC revenues will come from Gigabit Ethernet products (Cahners In-Stat, 2001).

The demand for Gigabit-enabled desktops is being driven by several factors, including:

- Collaborative work environments
- Routine sharing of large files
- Converged applications
- Multi-tasking, where multiple applications are open simultaneously

Recent third-party tests published by 8wire (9/25/2001) show that Gigabit at the desktop can significantly boost

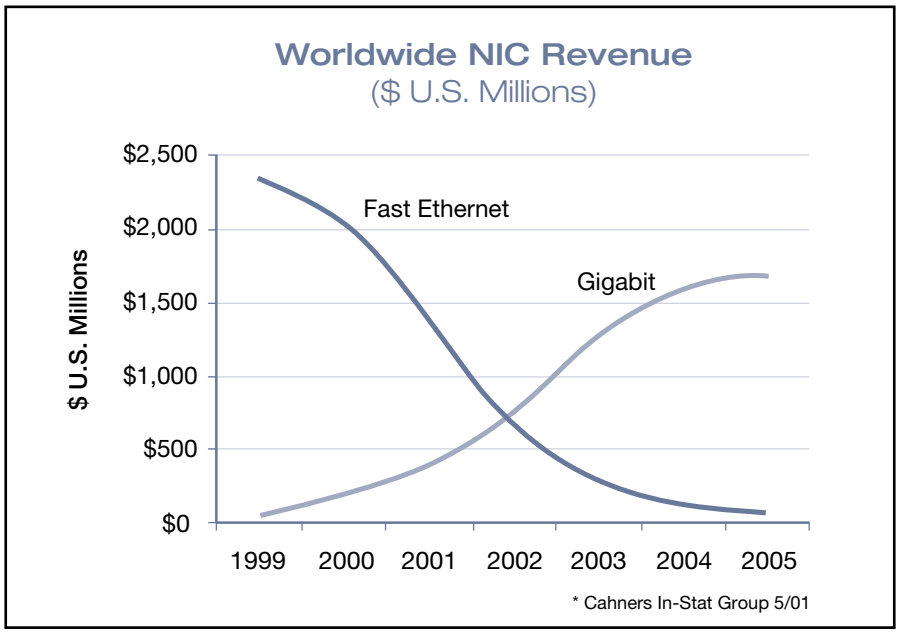

Figure 3

application performance. Testing an all-Intel, Gigabit over copper solution using mainstream applications, CSA Research was able to measure up to 47% performance gains over traditional 10/100 Mbps deployments.

As a leading supplier of Ethernet technology, Intel provides a broad range of standards-based, high-performance connectivity solutions that lower enterprise IT costs and simplify the Gigabit Ethernet transition. Compatible with existing Ethernet infrastructure, these solutions offer a reliable, flexible, scalable approach to realizing higher bandwidth.

For anyone who depends on the fast, efficient flow of information, Intel provides solutions that take Gigabit performance from the backbone to the server and ultimately to the desktop. The result: higher performance, fewer bottlenecks, greater productivity and more powerful e-Business capabilities.

Transition 2: Wireless Networking

Wireless Ethernet connectivity is a logical extension of Ethernet that is helping to fuel today's widespread movement to the "virtual" enterprise. Previously, the wireless LAN market segment was vertically focused by industry. Early adoption was limited chiefly to industries where workers needed to be mobile throughout the day – for example, the warehousing industry, where mobile workers used handheld devices for data collection and inventory management.

Over the past few years, benefits of wireless networking have become more clear, devices have become more affordable and available, and deployment of wireless LANs are becoming more prevalent. Today, wireless LANs are becoming more widely recognized as general-purpose connectivity alternatives for a broad range of business customers. Many analysts believe the wireless market segment has now reached a "critical mass" where rapid growth has commenced.

Several changes have taken place to move wireless networking from vertical market adoption to mainstream deployment:

- Standards and Increased Performance – Since its 1999 release, the IEEE 802.11 standard is the predominant standard for wireless LANS. The 802.11b high-rate standard has been adopted by almost all of today's wireless equipment vendors with data rates up to 11Mbps. The wireless evolution continues with 802.11a including increased data rates, longer reach and more robust security. 802.11a represents a new generation of wireless LANs. It is in a class of its own and promises:
  - Significantly higher data rates, up to 54 Mbps
  - Operating at comparable range and faster speeds than 802.11b

- The ability for users to perform bandwidth-intensive applications without sacrificing throughput
- Increased scalability, better interference immunity, increased data security

- Proliferation of mobile devices – A wide variety of new wireless devices are demanding access to the corporate and wide area network. The list includes laptops and desktop PCs with wireless NICs, PDAs and handheld computers with built-in radio devices, Internet access appliances and voice-over-IP phones. These devices expand the opportunity for wireless Ethernet solutions.

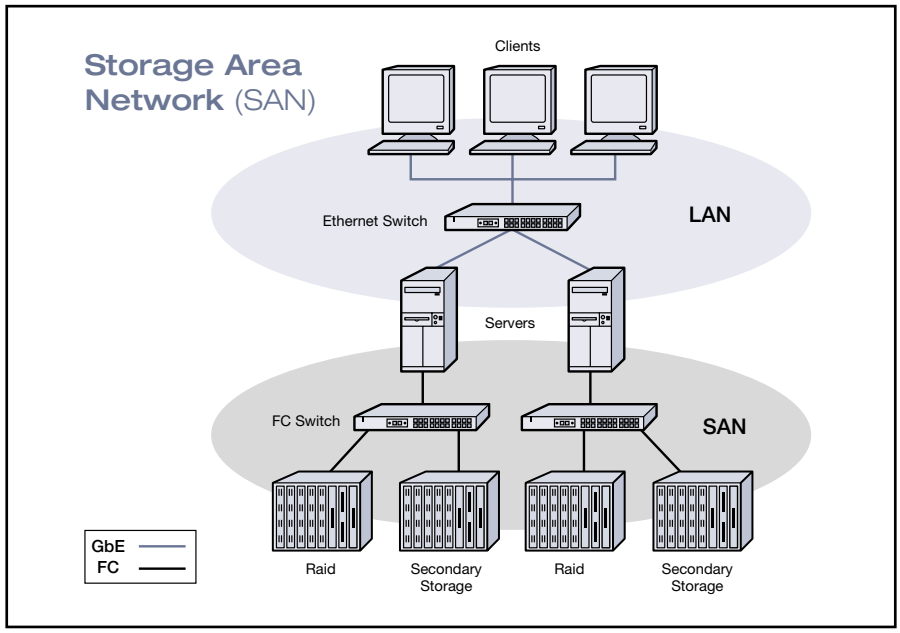

Figure 4

Today's high-performance wireless networking enables an unprecedented level of mobility and productivity to address a variety of computing needs. For example, laptop users can stay connected as they move throughout the workplace or campus, easily tapping into the resources of the wired network. Field sales people can access the corporate LAN from airport or hotel access areas, greatly increasing productivity.

Intel offers a broad selection of Ethernet solutions that provide wireless connectivity for mobile devices and maximized flexibility for new deployments. With the recently announced evolution into 802.11a products, Intel is providing increased performance for the simultaneous use of multiple bandwidth-intensive applications such as video and audio conferencing, data mining and large file transfers. The evolution of new 802.11a products brings the following advancements:

- Faster and more reliable wireless networking standard at a low cost per user — due to increased user support, with higher bandwidth per user
- Better range, with higher data rates than 802.11b at all ranges
- Over 10X the network capacity of 802.11b networks
- Interference-free transmissions
- Upgradeable to dual 802.11a/802.11b support
- Easy setup and management
- Secure network access and VPN compatible

By building on its expertise in driving wired networking transitions, Intel will extend its Ethernet leadership to provide cost-effective, high-speed connectivity and advanced capabilities for wireless networking.

Transition 3: Networked Storage

The rapid growth of email and e-commerce has combined to produce a dramatic increase in data moving across IP networks. This traffic threatens to overwhelm existing backup and storage methods, and companies are seeking to address this challenge.

As a result, major growth is projected for storage area networks (SANs) and network-attached storage (NAS) in the next few years. SANs – most of which are Fibre Channel today – together with NAS systems account for about 26% of storage systems worldwide, according to research company IDC. IDC estimates they will grow to 70% of all installations by 2005 (International Data Corp., 2001). Figure 4 shows a typical SAN configuration.

Improvements are needed in today's SANs to reduce the total cost of ownership (TCO), extend distance limitations and improve interoperability. A rapidly emerging solution is a technology called iSCSI – also known as Internet SCSI or SCSI over IP. At Gigabit or 10 Gigabit Ethernet throughput, this technology can provide a high-speed, low-cost, long-distance storage solution for Web sites, service providers, enterprises and other organizations.

The iSCSI standard makes it possible to build IP-based SANs. Traditional SCSI commands and data transfers are carried on a layer above the TCP/IP layer, and iSCSI block traffic can be carried over the Ethernet protocol.

By combining SCSI, Ethernet and TCP/IP, all widely deployed technologies, Gigabit iSCSI minimizes interoperability problems. Installation and maintenance are less expensive because the ubiquitous TCP/IP protocol suite reduces the need for hiring specialized personnel. And replicated data can be far removed from the originals in order to protect against unforeseen critical data corruption or loss.

Intel is using its core competencies to deliver interoperable storage building blocks and products that reduce the equipment manufacturer's time-to-market. From the plug-and-play convenience of network-attached storage (NAS), to high-performance innovations in storage area networks (SAN) and direct attached storage (DAS), Intel is enabling the industry to meet the demand for intelligent, highly available storage anywhere on the network.

Transition 4: Ethernet in the Metro Area Network

The migration of Gigabit Ethernet to the desktop, coupled with balanced network design, will drive the need for 10 Gigabit Ethernet in servers and enterprise backbones. Likewise, optically wired buildings will require more powerful connectivity to the MAN/WAN. Unlike LANs, access links will need to operate over long-range fiber. 10 Gigabit Ethernet will address this need.

Today, with the MAN segment set to grow from $3 billion worldwide to $13 billion in 2005, 10 Gigabit Ethernet is extending from the enterprise into the heart of the new MAN architecture (Pioneer Consulting, 5/2001). Ethernet in the MAN will combine the speed and cost advantage of Ethernet with the reach and reliability of optical networks.

10 Gigabit Ethernet meets key requirements for efficient and effective high-speed networks:

- Lower cost of ownership vs. current alternative technologies
- Flexibility
- Interoperability

The time is ripe for moving the Ethernet standard into metro area networks. With its cost advantage, interoperability and easy migration to higher performance levels, 10 Gigabit Ethernet extends naturally into the metro area network.

Intel offers a wide range of standards-based 10 Gigabit components and is in development of many products that will support both 10 Gigabit Ethernet and SONET/SDH providing design flexibility and facilitating faster time-to-market for metro area network infrastructure. Intel products, released and in development, include switching silicon, optical modules, component silicon, MAC devices, SERDES transceivers, Ethernet storage adapters (HBAs) and Ethernet storage

component silicon. Compatible with existing environments, these cost-effective, flexible, multi-service solutions accelerate deployment and extend the capabilities of critical network services.

Conclusion

Intel continues to play a significant role in driving the critical transitions and trends happening in Ethernet technology. One overriding factor is the need to reduce costs.

Intel is committed to building on its market leadership and technology innovation by driving cost-effective solutions. These solutions are designed to provide higher bandwidth, easy migration and enhanced interoperability as Ethernet extends into new segments such as Gigabit Ethernet, wireless, storage and metro area networking.

Customers will benefit from this commitment through a continuous flow of new products and building blocks that offer compelling cost/performance features and benefits. Intel offers one of the broadest Ethernet portfolios in the industry. Highlights include:

- 10/100/1000 MAC/PHY and Network Interface Cards
- 10/100/1000 Switching Engines and Physical Layer Silicon
- 802.11a-based Wireless LAN Network Interface Cards and Access Points
- 10 Gigabit Ethernet solutions including multi-transport and multi-rate framers, MACs and SERDES transceivers supporting both SONET and Ethernet
- Gigabit IP Storage Adapter with TCP offload for iSCSI SANs

For More Information

For more details about Intel Ethernet products, please visit:

www.intel.com/go/Ethernet

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