



Technical Brief

NVIDIA Gigabit Ethernet
The Performance Leader



A Giant Leap in Performance

Gigabit Ethernet is going mainstream. Prices are dropping dramatically, and major market players have joined the game. Like the transition during the 1990s from the standard 10 megabits per second (Mbps) Ethernet to 100 Mbps Fast Ethernet, 1,000 Mbps Ethernet—or Gigabit Ethernet—delivers an impressive tenfold improvement in network bandwidth. The impact of this Ethernet evolution will be significant for desktops because today's PCs host a new generation of applications and take on many new roles.

This paper details the transition from Fast Ethernet to Gigabit Ethernet on the desktop PC. The applications that benefit most from the increased throughput are described for home and business computing environments; the last section describes the specifics of the NVIDIA Gigabit Ethernet solution, and outlines the difference between alternative Gigabit Ethernet solutions and the high-speed, native NVIDIA implementation.

By providing a dedicated Gigabit Ethernet port and integrating the Media Access Control (MAC) technology into the high-performance NVIDIA nForce™ media and communications processors (MCPs), NVIDIA delivers the industry's fastest Gigabit Ethernet desktop solution.

What Is Gigabit Ethernet?

Gigabit Ethernet looks just like Fast Ethernet. It uses the same Category 5 (also known as CAT5) cables and operates over the same network infrastructure. What distinguishes Gigabit Ethernet from its predecessor is the throughput: Fast Ethernet delivers up to 100 Mbps of throughput, but Gigabit Ethernet delivers significantly more—up to 1,000 Mbps, or 1 gigabit per second (Gbps).

From Fast Ethernet to Gigabit Ethernet

Fast Ethernet cannot satisfy the current demands for bandwidth on the desktop. The need for more bandwidth stems from these industry trends:

- ❑ Bandwidth-hungry applications
Real-time software upgrades and network-based backups tax today's networks in homes, enterprises, and small businesses. Enterprise infrastructures must host all corporate applications including data, voice, video, and network-based storage. Gigabit Ethernet can integrate these previously disparate enterprise networks into a common network infrastructure.
- ❑ Faster platforms
Because of their faster processors and larger amounts of memory, the newest PCs can generate and push data onto the network more quickly.
- ❑ Network expansion
More users are networked, so network-based applications continue to proliferate in today's computing environments.
- ❑ Intelligent devices on the network
Network traffic will increase because of data from faster PCs, plus emerging intelligent devices and appliances (such as PDAs and IP phones).

Why Do You Need It Now?

Even though entire networks will be upgraded gradually, new Gigabit Ethernet-enabled desktop computers should be purchased today because the new networking technology offers these benefits:

- ❑ Affordability
Gigabit Ethernet prices are dropping rapidly. In home environments, consumers save by avoiding difficult-to-install add-ons, and protect their investments by lengthening the lifespan of their computer. For the enterprise and small businesses, it is much cheaper to purchase PCs with built-in Gigabit Ethernet rather than upgrade later—which typically requires service by an IT person.
- ❑ Compatible cabling
A new PC with Gigabit Ethernet can be attached to an existing network without cabling upgrades or other infrastructure modifications. When the network is upgraded, the PC auto-negotiates its speed to take advantage of the available bandwidth.
- ❑ Backward and forward compatibility
Fast Ethernet and Gigabit Ethernet computers can coexist on the same networks. Gigabit Ethernet network infrastructure can support both Fast Ethernet and Gigabit Ethernet desktops, so the move to Gigabit Ethernet can be gradual—one desktop and network component at a time.

- Application transparency

As soon as the network infrastructure is upgraded, existing (and future) applications benefit from the tenfold boost in throughput delivered over Gigabit Ethernet networks.

Although the move from Ethernet to Fast Ethernet spanned six years, industry experts anticipate a much faster transition to Gigabit Ethernet. Many networks are already upgrading to Gigabit Ethernet, plus Gigabit Ethernet technology is the basis for all new network infrastructures deployed today. Buying desktops with Gigabit Ethernet capabilities protects current investments and lengthens the useful life of the platforms.

Consumer Benefits

Several trends make Gigabit Ethernet a critical technology for in-home computing:

- Multimedia

Graphics and multimedia files are commonplace on desktops. But, the larger the file, the longer the downloading/uploading times. Gigabit Ethernet handles the increasingly large files, and speeds up any operation that involves moving data over a network (Figure 1).

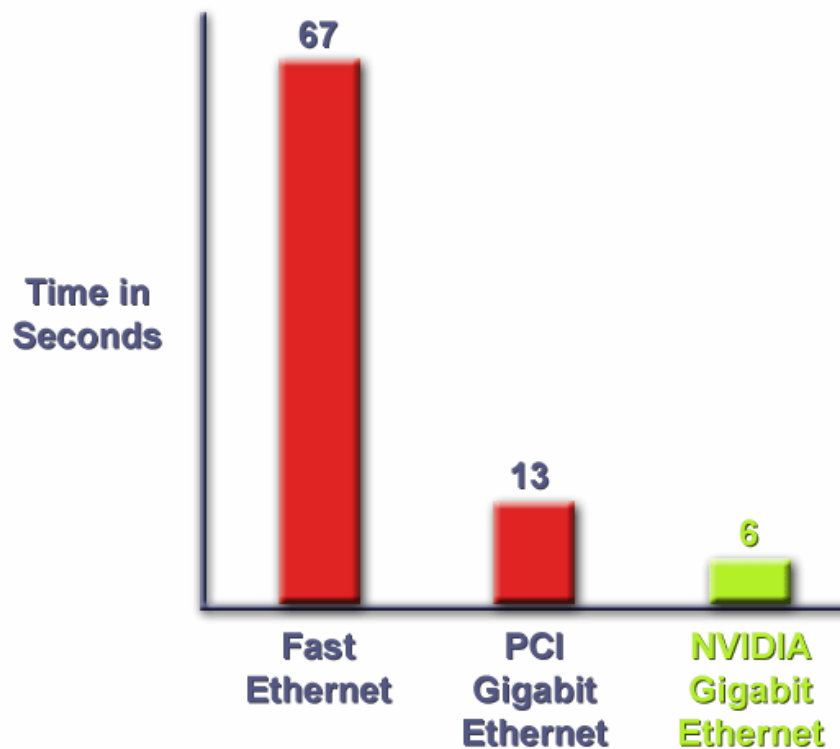


Figure 1. Download Time for an Average Movie (810MB) Using Fast Ethernet, PCI-Based Ethernet, and NVIDIA's Gigabit Ethernet Solution (Less Time Is Better)

- File Sharing
File sharing between computers can be accelerated with the tenfold increase in throughput offered by Gigabit Ethernet. Digital videos and photographs, music, computer games, and text files with lots of graphics are just some examples of the large files that are becoming common in the home.
- Longer desktop lifespan
Consumers usually keep their desktop systems longer compared to corporate environments. Gigabit Ethernet protects PC investments by ensuring throughput levels that can meet demands for increased traffic, broadband connections, and large file sizes.

Most home users are taking advantage of multimedia capabilities or sharing files. Users who are not yet using these capabilities, but anticipate they might, should opt for built-in Gigabit Ethernet now to avoid the inconvenience of purchasing and installing an upgrade later.

Enterprise Benefits

The rationale for choosing Gigabit Ethernet over Fast Ethernet is simple: Corporations want faster performance for affordable costs. Regardless of the upgrade schedule for the entire infrastructure, every enterprise or small business can immediately benefit by specifying that all new desktop computer purchases include Gigabit Ethernet technology.

These are some of the benefits for today's businesses:

- Faster data transfers
Everyone deals with larger software and file assets today, especially those working in CAD/CAM and storage markets, and professionals who deal with imaging, video editing, and graphic design. Anyone handling huge files will save time with Gigabit Ethernet. Gigabit throughput levels mean that even a file in excess of 500MB can be downloaded or uploaded in 15 to 20 seconds.
- Improved productivity and responsiveness
Network-based collaborative efforts are the norm for today's enterprises. Sharing information and keeping entire teams synchronized and informed translates into shorter project cycles and faster results. Faster network performance means more effective information sharing.
 - Teams can communicate new ideas and changes rapidly. For teams supporting customers, client requests can be addressed quickly.
 - E-mail applications run faster over the high-speed links.
 - Printing reports and files takes less time.
 - Database records can be accessed faster, doubling or even tripling the application performance compared to Fast Ethernet.
 - Gigabit Ethernet throughput levels support emerging video conferencing and voice over IP (VoIP) applications, and will be essential for future collaborative applications, such as distance learning and video on demand (VOD) downloads.

- ❑ High-speed storage solutions

Most businesses employ a networked approach for content management. Two storage architectures are common; either way, high-bandwidth access to storage resources directly affects application performance and user experience at each desktop.

 - Dedicated high-end storage networks use high-speed Fiber Channel. Servers typically require high-speed technologies, like iSCSI, over dedicated storage networks.
 - Distributed storage solutions use the corporate backbone and available LAN infrastructures to optimize performance. Some enterprises distribute data storage over the backbone network to locate content nearest the user.
- ❑ Accelerated backups and system management tools

Gigabit Ethernet on the desktop can support network-based backups at speeds equivalent to a local hard drive. You can back up a gigabyte of data in seconds, compared to minutes using a Fast Ethernet link. Similarly, desktop management and recovery tools execute significantly faster with Gigabit Ethernet.
- ❑ Less overhead for security

Encrypted transmissions increase network overhead, reducing the payload capacity of each data frame. When the transmission speed is increased, the loss of capacity is more than offset by Gigabit Ethernet's tenfold speed boost—which means Gigabit Ethernet provides the bandwidth needed for secure, high-speed transmissions.
- ❑ Reclaimed network and server capacity

By achieving a tenfold increase in bandwidth over existing wiring and infrastructure, enterprises can extend the life of, and fully utilize, the existing infrastructure.

 - The faster throughput reclaims bandwidth and allows new applications and users to be added, and existing users also see immediate performance improvements. These new applications, such as network-based storage, can translate into cost savings across an entire enterprise.
 - With the faster links, desktops connect with servers for shorter periods of time. This reduces the number of active connections on servers and eliminates bottlenecks during peak times, such as the start of the day when everyone is downloading e-mail.
- ❑ Forward-compatible infrastructure

Applications and users continually demand more performance and throughput. Gigabit Ethernet provides the headroom required to keep up with the increases in demand.

NVIDIA Gigabit Ethernet Architecture

What It Does

The NVIDIA Gigabit Ethernet technology platforms deliver optimized throughput and minimized overhead. Two architectural features set NVIDIA apart from the competition: the dedicated, high-speed Gigabit Ethernet port, and the integration of the Gigabit Ethernet MAC component with the NVIDIA nForce chip-level solution.

Most desktops supported Ethernet and Fast Ethernet adapters over the PCI bus (Figure 2). For these previous-generation Ethernet solutions, the PCI bus was able to deliver enough bandwidth for the network connection, even when the bus was shared with other high-speed devices. However, these connections did not exceed the maximum bandwidth of the bus.

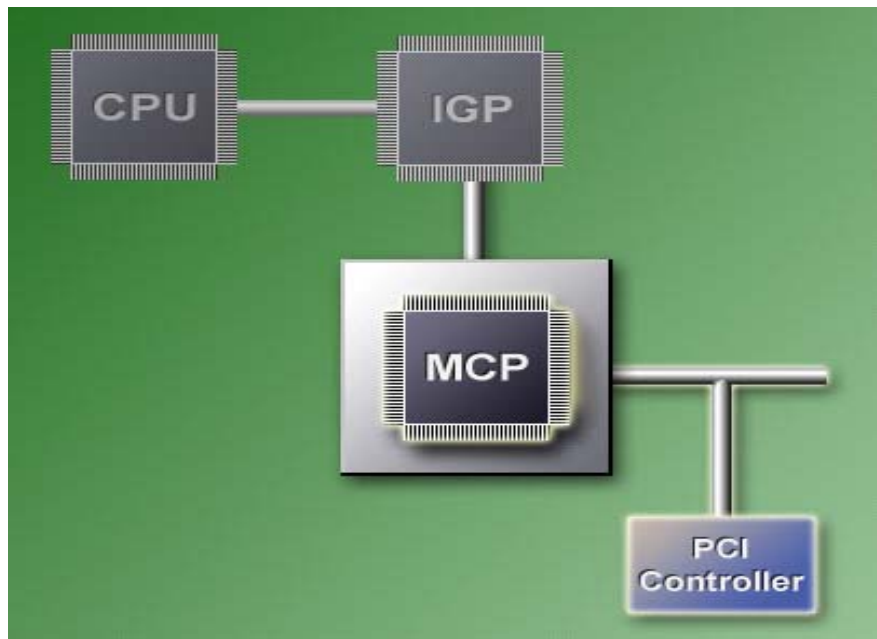


Figure 2. Ethernet and Fast Ethernet Adapters Were Usually Supported over the PCI Bus. These Connections Did Not Exceed the Maximum Bandwidth of the Bus.

With the advent of new streaming devices and Gigabit Ethernet technology, this is no longer the case. Only Gigabit Ethernet can operate at 1Gbps, exceeding the maximum throughput of the PCI bus. Gigabit Ethernet cannot operate at its full potential if limited to the PCI bus bandwidth level, and would also be severely affected if it shared the PCI bus with other high-speed devices.

Although NVIDIA is not the only solution provider to move Gigabit Ethernet off the PCI bus, it provides the fastest pathway for Gigabit Ethernet.

Features

The commercial-grade NVIDIA nForce solutions (Figure 3) integrate proven third-generation NVIDIA MAC technology and provide the following features.

Dedicated Connection

The native chip-level NVIDIA MAC solution takes advantage of a dedicated port for Gigabit Ethernet. This approach eliminates any bus contention problems, and achieves throughput levels that are unmatched by any competitive offerings.

Open Interface

NVIDIA nForce solutions provide an industry-standard Reduced Gigabit Media Independent Interface (RGMI) for attachment of the 1000BASE-T Gigabit Ethernet PHY. The open, nonproprietary interface lets system designers interface the NVIDIA solution to Ethernet PHY from a variety of vendors. Consumers and enterprises all benefit from a broad range of competitive PHY offerings.

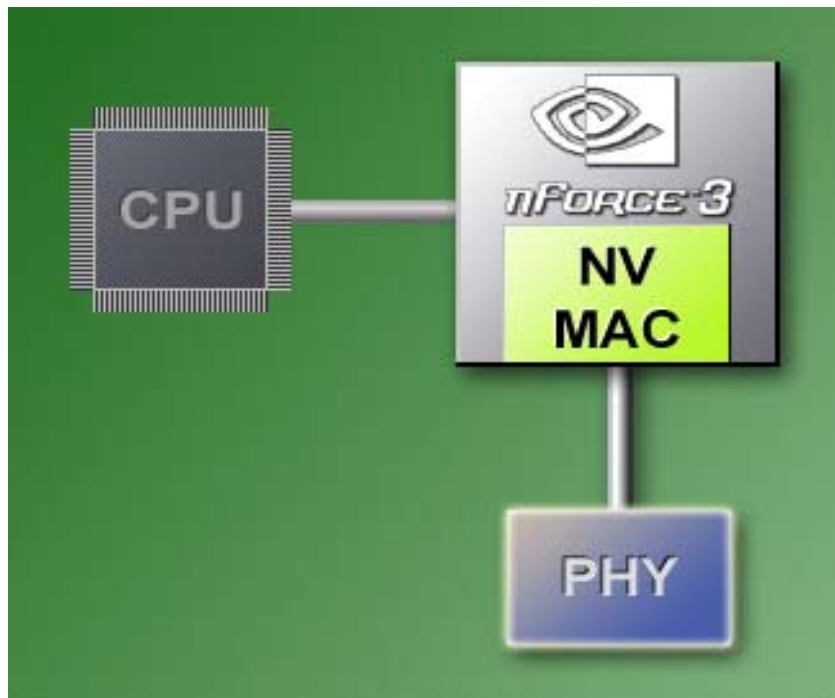


Figure 3. NVIDIA Gigabit Ethernet: A Dedicated Connection and Open Interface

Throughput Optimization

The NVIDIA Gigabit Ethernet port operates at a speed designed to accommodate the maximum Gigabit Ethernet transfer rate. The optimized port design, combined with other design features that minimize CPU overhead for Gigabit Ethernet transfers, enables NVIDIA to deliver the fastest Gigabit Ethernet desktop solution today.

Optimized Design

The integrated Gigabit Ethernet native to the NVIDIA nForce solution includes an optimized design with appropriate hooks into all the system hardware and NVIDIA software. Compared to completely external Gigabit Ethernet offerings, the NVIDIA solution ensures that upgrades and enhancements incorporate changes to the appropriate part of the complete datapath.

Forward-Compatible Design

The NVIDIA implementation of task offloads—such as Internet Protocol (IP), Transmission Control Protocol (TCP), and User Datagram Protocol (UDP)—incorporates support for IPv6, as well as Internet Protocol version 4 (IPv4). This forward-looking design ensures a forward-compatible system as the standards evolve.

Conclusion

Desktops can be purchased today with built-in Gigabit Ethernet capability. Complete cabling compatibility and interoperability with the previous generations of Ethernet and Fast Ethernet platforms make it an easy decision, especially considering the cost savings and conveniences that result from avoiding future desktop upgrades. However, all Gigabit Ethernet solutions are not created equal.

The NVIDIA solution, developed by a world-class networking team, offers major advantages over the competition.

Architecture

The NVIDIA MAC is integrated in core-logic, and offers the advantages of busless design, while making Ethernet appear as a PCI device at the system level. The NVIDIA design also provides large memory bandwidth with very low latencies. This native Gigabit Ethernet MAC is the fastest Gigabit Ethernet solution in the market, performing within a fraction of the theoretical maximum throughput for 1000BASE-T.

Performance

The highly optimized NVIDIA MAC driver uses the NVIDIA Unified Driver Architecture (UDA) and best-in-class techniques to achieve maximum performance. The driver offers user-selectable preset tuning for optimizing raw throughput and CPU efficiency.

User Interface

The full-featured Ethernet implementation is fully manageable by a user interface and command line interface (drewCLI) network management suite. Customizing the driver behavior through the user interface is user-friendly. Plus, it's comprehensive—it simplifies the settings for more than 80 Ethernet parameters.

Full-Featured Ethernet

The NVIDIA driver exposes a full set of standard Ethernet features, which includes supporting all defined Microsoft Windows task offloads (IP, TCP, and UDP checksum offloads, plus TCP large send).



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