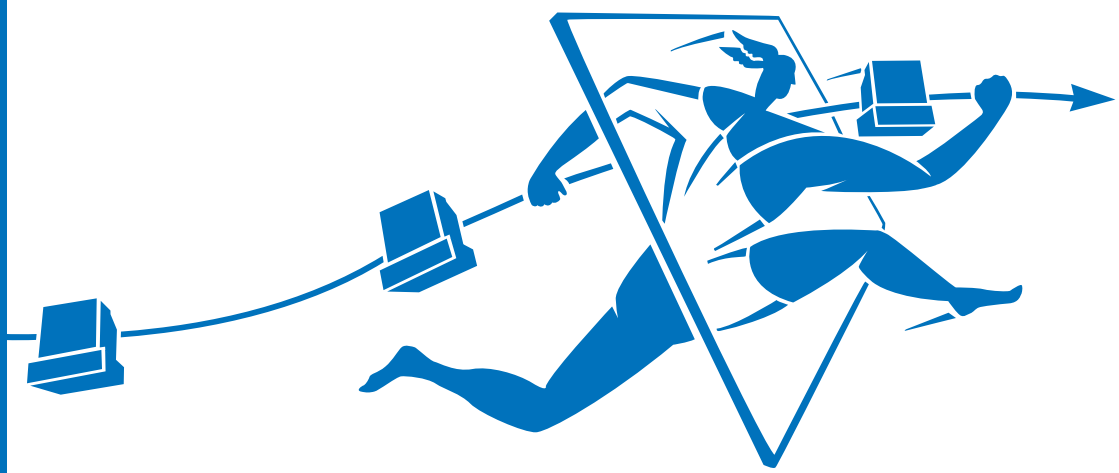
Faster Simpler NETWORKS

Intel Adaptive Technology
Optimizing Network Performance

Intel Networking Information Series

For today's networking professionals who need fast, concise information to help them understand new technologies that can make their networks more efficient and cost-effective.



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Executive Summary

In today's fast-paced and competitive business environment, companies need their PC networks to be as efficient and cost-effective as possible. Network decision-makers need to know how to build their networks with reliable, interoperable and easy-to-use products. And, to make informed decisions, network managers need to understand new and evolving technologies, how to exploit those technologies and what benefits they can expect those technologies to deliver.

This document discusses Adaptive Technology, developed by Intel Corporation to help preserve your company's IT investment by optimizing network performance. When incorporated into networking products, Adaptive Technology delivers two key benefits – it optimizes performance in existing network environments, and it allows the products to adapt to future changes, ensuring continued peak performance without costly hardware upgrades.

Today, initial implementations of Adaptive Technology optimize the network performance of Intel adapters and switches. These products and other networking solutions capitalize on Intel's silicon design strengths and PC expertise – a unique blend that lets companies take advantage of the latest Intel silicon solutions, thus matching PC and network performance.

Adaptive Technology: Optimizing Network Performance

Introduced by Intel in 1996, Adaptive Technology is a solution that optimizes product performance for your network environment. The performance optimization is achieved in different ways for different products.

For example, in Intel EtherExpress™ PRO/100 PCI LAN Adapters, Adaptive Technology allows the silicon microcode to be dynamically updated, thus automatically adjusting to most network operating system environments. The benefit to users is that their adapter is tuned to their specific networking needs, ensuring peak network performance. Adaptive Technology also offers the advantage of inherent flexibility: Network managers can keep pace with many changes to network operating systems and applications without incurring the expense and trouble of swapping out network adapters.

Intel has applied a similar approach to switching silicon in its family of Express Switches. In this implementation, Adaptive Technology optimizes switch performance by dynamically assigning the optimal switching mode for each port. This provides two similar benefits to the adapter implementation: dynamic adjustment of switch performance based on users' network environments, and protection against future changes to network traffic content and flow.

Optimizing Performance with Adapters

The development of Adaptive Technology marked an industry first and a new level of investment protection for networks. Available for Intel PCI Ethernet Adapters since May 1996, Adaptive Technology increases adapter capabilities and optimizes adapter silicon for specific network operating environments without incurring the cost of typical hardware upgrades.

Adaptive Technology optimizes the performance of Intel adapters in two ways:

- *Dynamically adjusting adapter performance based on existing network conditions at time of installation*
- *Adapting to new network conditions on an ongoing basis, thus maintaining peak network performance as the computing environment changes*

Companies find this innovative approach appealing because operating systems, PCs and networks tend to change over time. Adaptive Technology lets adapters evolve along with those network changes by means of a simple software upgrade that physically updates the adapter for new capabilities. Because companies no longer need to swap out adapters to stay abreast of ever-changing technologies, they stand to realize a noticeable reduction in the cost of business computing.

With Adaptive Technology, the adapter self-tunes to match the tough performance demands of sophisticated operating systems and applications. This offers performance benefits in the following environments:

- ***Network operating systems:*** *Microsoft Windows NT* and Novell NetWare**
- ***Operating systems:*** *Microsoft Windows* 95, Microsoft Windows NT*
- ***Heavy-traffic networks***

Adapter Implementation

By enabling silicon-level upgrades, Adaptive Technology clearly differentiates Intel adapters from adapters manufactured by other vendors. Intel's recognized expertise in silicon makes this distinctive approach possible.

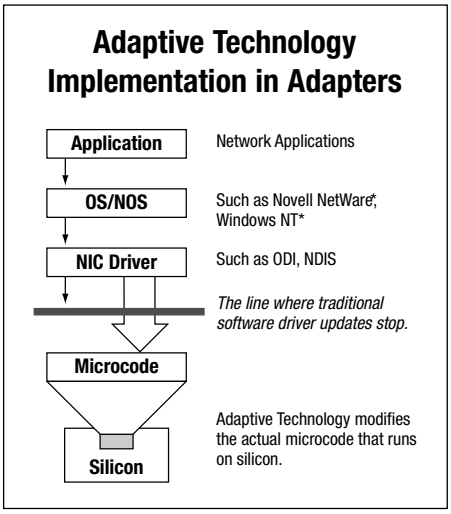

Fig. 1: *Adaptive Technology software downloads go beyond the adapter driver in the software hierarchy to alter the actual silicon microcode on the Ethernet controller.*

Adaptive Technology works by modifying the actual microcode that runs on adapter silicon. The implementation for Intel adapters is simple yet elegant: Adaptive Technology employs the known and reliable driver update mechanism to alter the reloadable microcode on Intel 82557 and 82558 Ethernet controllers, which are the foundation of Intel PCI-based adapters. This easy and convenient software update tunes the adapter for maximum throughput and minimum CPU utilization and enables the device to adapt to the nuances of various operating environments.

The adapter silicon is modified when the new software driver with updated microcode is loaded, ensuring no run-time effects. Since Adaptive Technology is a simple software upgrade, it offers another advantage: if necessary, the modifications to microcode can be easily reversed (Figure 1).

To optimize performance in Windows NT, Windows 95 and NetWare environments, an Adaptive Technology-enabled adapter intelligently analyzes the resident NOS, then automatically adjusts performance accordingly.

Adaptive Technology further optimizes performance in heavy-traffic environments through a feature called collision reduction. This powerful feature allows the adapter to intelligently monitor network traffic patterns, then dynamically increase or decrease the spacing between packet transmissions depending on the level of congestion. By continually tuning itself to accommodate fluctuating traffic levels, the adapter minimizes packet collisions and increases overall network performance. The collision reduction feature is ideal for heavily loaded networks, especially environments that experience the increased demands of 32-bit operating systems such as Windows 95, Windows NT and NetWare 4.1, LAN switching, high-performance systems and bandwidth-intensive applications.

Intel issues customized Adaptive Technology software upgrades for Windows and NetWare environments and their companion drivers via its site on the World Wide Web and its BBS. Companies can license and download them at no cost on the Web at http://www.intel.com/network or http://support.intel.com.

Adapter Performance Benefits

Companies can expect to achieve immediate benefits in increased performance by deploying Adaptive Technology-enabled adapters. For example, tests conducted by Intel indicate that the first Adaptive Technology upgrade can provide the following throughput gains[1] without increasing CPU utilization:

- *3 to 5 percent for NetWare environments*
- *5 to 20 percent for Windows NT environments (Figure 2)*
- *5 to 15 percent for heavily loaded Fast Ethernet networks*

[1] *The actual amount of throughput increase will depend on network loading.*

Optimizing Performance with Switches

Adaptive Technology brings a distinctive silicon advantage to the design of Intel Express Switches. When applied to switches, Adaptive Technology ensures optimal throughput by dynamically assigning the best switching mode of each port based on the level of network traffic. This optimization maximizes throughput, improves network stability, enhances productivity and extends the overall life of a company's networking products.

Adaptive Technology optimizes the performance of Intel Express Switches in two ways:

- *Adjusting switch performance on a per-port basis according to network traffic conditions*
- *Adapting to new network conditions on an ongoing basis, thereby preserving a company's investment in switches as traffic content and flow changes*

Thus, companies are assured that the switch they purchase today will not become obsolete or less effective in response to changes in network environments that ultimately affect network traffic.

Intel Adaptive Technology can choose from among three switching modes to forward data packets in the most efficient way possible: store-and-forward, fragment-free and cut-through. This flexibility and automatic configuration results in better performance and time savings for a network administrator, helping reduce the cost of business computing.

Switch Implementation

Intel Express Switches with Adaptive Technology automatically select the optimal mode on a per-port basis. This adaptability capitalizes on the advantages of the three forwarding modes, which are described as follows:

- *Store-and-forward mode buffers data until the entire packet is received and checked for errors. This prevents corrupted packets from propagating throughout the network but increases switching latency.*
- *Fragment-free mode filters out most error packets but doesn't necessarily prevent the propagation of errors throughout the network. It offers faster switching speeds and lower latency than store-and-forward mode.*
- *Cut-through mode does not filter errors; it switches packets at the highest throughput and imposes the least forwarding delay.*

Intel Express Switches start out using the cut-through mode to achieve the highest performance possible. If the error levels on any given port reach a certain threshold, the switching silicon automatically changes that port's switching mode to the best (and safest) forwarding mode, depending on the type of error. This sensing process is repeated independently for each port, making performance on the entire switch truly optimal – without requiring human intervention (Figure 3).

To accomplish this optimization, the switching silicon uses a combination of per-port Remote Monitoring (RMON) management counters and fast internal state machines to determine the amount and type of errors, in real time, at each port. This information allows the switch's Adaptive Technology capability to achieve the best balance of performance and data integrity at each port, without affecting the overall switch forwarding rate and performance.

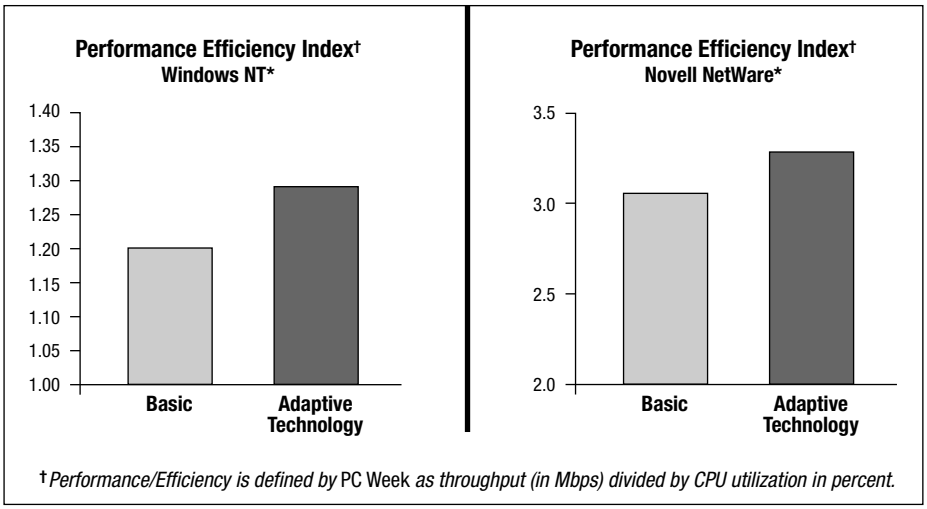

Fig. 2: *Adaptive Technology increased throughput by as much as 20 percent in performance tests conducted by Intel.*

Conclusion: Optimizing Performance While Protecting Your Investment

Intel is committed to delivering technologies that help companies build and maintain faster, simpler networks. Intel continues to lead the way in this initiative by exercising its silicon expertise to come up with a long-term strategy for optimizing performance, easily and without the costs of hardware upgrades.

Adaptive Technology adds a new level of investment protection to networking. Adaptive Technology-enabled adapters let companies take advantage of the latest Intel advancements in silicon design and performance technology – minus the drawback of high support and service costs. Adaptive Technology-enabled switches prolong their value to companies by automatically adjusting to ever-changing network conditions.

Product Support for Adaptive Technology

Intel offers a range of high-performance adapters and switches that feature Adaptive Technology. Adaptive Technology is instrumented today in the following products.

Intel EtherExpress™ Adapters
Unlike traditional silicon designs, Adaptive Technology enables Intel adapters to optimize network performance in new environments that weren't originally designed into the controller chip. Adaptive Technology is a key feature in these adapters:

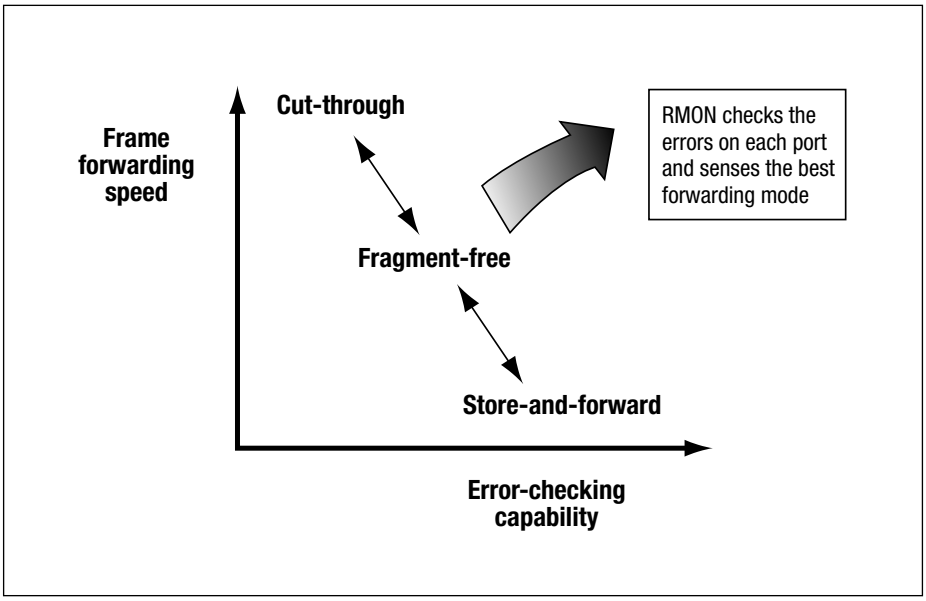

Fig. 3: *Adaptive Technology automatically chooses the optimal forwarding mode based on real-time RMON information to maximize throughput and uptime.*

- ***Intel EtherExpress PRO/100+ PCI LAN Adapter.*** *A 10/100Mbps Ethernet adapter with advanced features, such as an innovative single chip design, Adapter Fault Tolerance and a powerful new driver suite. Designed for server and client PCs connected via 10BASE-T/100BASE-TX Category 5 wiring and 10BASE-T/100BASE-T4 Category 3 wiring.*
- ***Intel EtherExpress PRO/100 PCI LAN Adapter.*** *A 10/100Mbps Ethernet adapter designed for server and client PCs. Available with support for either 10BASE-T/100BASE-T4 Category 3 wiring or 10BASE-T/100BASE-TX Category 5 wiring.*
- ***Intel EtherExpress PRO/100 Server Adapter.*** *A 10/100Mbps Ethernet adapter designed to boost server responsiveness and improve network traffic flow with Adapter Fault Tolerance and support for Cisco ISL VLANs.*
- ***Intel EtherExpress PRO/10+ PCI LAN Adapter.*** *A high-performance 10Mbps Ethernet adapter designed for Intel486™ and Pentium® processor-based servers and clients.*

Intel Express Switches

Intel Express Switches relieve the bandwidth bottlenecks caused by deploying networks of higher-performance PCs that use increasingly powerful applications. Adaptive Technology is a key feature in the following switches:

- ***Intel Express 100FX Switch****. An eight-port Fast Ethernet fiber switch for optimizing the performance of 100Mbps networks campus-wide.*
- ***Intel Express 10 Switch+.*** *A 24-port segment switch designed to upgrade the performance of existing 10Mbps Ethernet networks.*
- ***Intel Express 10 Switch.*** *A 24-port desktop switch for maximizing the performance of existing 10Mbps Ethernet networks.*

Future Product Support for Adaptive Technology

Intel intends to stay at the leading edge of networking technology by releasing new versions of Adaptive Technology. Future versions will offer additional capabilities to customers, and extend the technology to more users. This strategy promises new convenience as well as superior performance.

For More Information

Visit Intel on the World Wide Web at http://www.intel.com/network/ for more information on Adaptive Technology, LAN adapters, switches and other high-performance Intel networking solutions.

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† modem settings: 8-N-1, up to 14.4Kbps

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NOTE: Call our FaxBack service and order document #9089 for a current list of phone numbers.

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Support information for Intel Brand products is available on the Internet for downloading by Anonymous FTP and for viewing or downloading on the World Wide Web.

World Wide Web address (URL)

Corporate: http://www.intel.com

Customer Support: http://support.intel.com

Intel FTP Server hostname: ftp.intel.com

File directory location: /pub/PCandNetworkSupport

For FTP Server access instructions, order document #9051

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