Faster Simpler NETWORKS

Optimizing Server Throughput and Availability

An Introduction to the Advanced Features of Intel® Server Adapters

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Contents

Overview

A powerful and dependable PC network has become an essential component of productivity for most businesses. As companies deploy increasingly sophisticated and business-critical applications – such as intranet, database, groupware and video-conferencing – the cost and impact of sluggish network performance and downtime continues to escalate.

A crucial point of vulnerability is the network link to a corporate or departmental server, where a failure or bottleneck can hamper productivity for many users. Intel's line of server adapters helps to address this concern by significantly improving server throughput and availability. Three advanced features contribute toward a simple and cost-effective server solution, providing scalable bandwidth and a more dependable network link.

Intel's advanced server adapter features include:

Adapter Fault Tolerance (AFT) – *Safeguards the network link to the server with transparent backup links.*

Adaptive Load Balancing (ALB) – *Provides scalable server bandwidth in 100Mbps increments up to 400Mbps, by balancing outgoing traffic among multiple adapters.*

Fast EtherChannel* (FEC) – *Delivers scalable bandwidth in 200Mbps increments, up to 800Mbps full duplex.*

This white paper discusses the technologies underlying these advanced features. It also explains how they build on one another and how they can improve server performance.

Intel Server Adapters – support for advanced features

Intel® Server Adapter	*Application*	*AFT*	*ALB*	*FEC*
PRO/1000 Gigabit Server Adapter	High-traffic backbone servers	✓	9/98	N/A
PRO/100 Intelligent Server Adapter	High-traffic web servers	✓	✓	✓
PRO/100+ Dual Port Server Adapter	Departmental servers with limited PCI slots	✓	✓	✓
PRO/100+ Server Adapter	The economical choice for most servers	✓	✓	✓
PRO/100 Smart Server Adapter	Novell NetWare* SFTIII environments (supports Mirrored Server Links)	N/A	N/A	N/A
PRO/100 EISA Server Adapter	EISA file servers	N/A	N/A	N/A

Understanding Adapter Fault Tolerance Technology

Intel developed Adapter Fault Tolerance (AFT) technology in April '97, in response to the need for high-availability servers and maximized server uptime.

Today's network servers provide more than basic print and file services. In fact, they're used for carrying out most essential business processes – including providing reliable connections to vital applications. Server downtime not only results in a loss of productivity, but can bring business to a halt. The subsequent cost is measured in lost revenue and lost customers.

As a result, servers are becoming more and more powerful, and are a crucial component of today's PC networks.

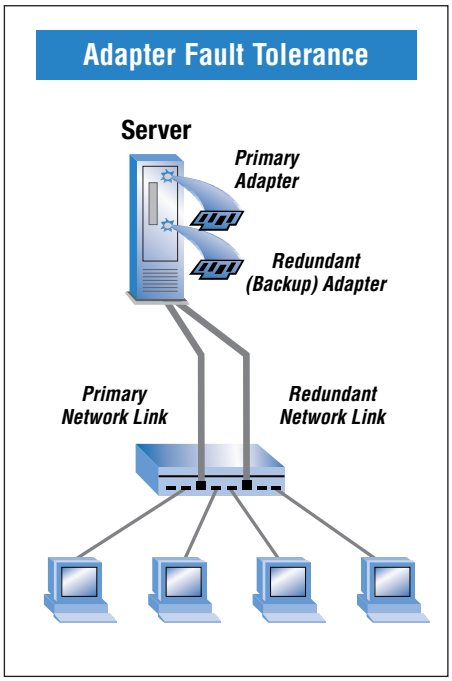

Figure 1: *If the primary network link fails, the back-up link automatically takes over, with no interruption of service. An alert is generated to notify the administrator of the failed link.*

The link from the server to the network is just as crucial. This link must be as dependable as the server itself to assure the overall reliability and availability of the network. In actual computing environments, however, failures do occur – whether they're attributed to broken or loose cables, hub or switch port faults or adapter hardware breakdown.

Adapter Fault Tolerance technology addresses these concerns. A simple, effective and fail-safe method for increasing the availability of server connections, AFT provides link recovery in a manner that's transparent to applications and users.

AFT technology works by providing redundant links from the server to the network (see Figure 1). This redundancy requires the installation of two adapters, one for the primary connection and a second for the backup connection. Assume, for example, that one of the links to a server has failed due to a disconnected cable. With AFT, the redundant link takes over within seconds and typically without users even noticing the exchange.

Intel AFT technology integrates seamlessly into Novell NetWare* and Microsoft Windows NT* operating system-based servers. It is management-ready and simple to use.

Transparent Fault Recovery for high availability

The additional link that AFT establishes between the server and the network includes redundant adapter, cable and hub or switch port connections. One of the links is used for standard server network traffic; the secondary link provides backup support.

To enable advanced features in its adapters, Intel includes an intelligent software agent as part of the software driver. This agent is packaged as an intermediate driver under Windows NT and as a NetWare Loadable Module (NLM) for NetWare.

The intelligent software agent continuously monitors all the links, taking action in moments if any component of the link fails. Because the backup link immediately assumes "ownership" of all traffic going to and from the server, the failure doesn't disrupt users who are running critical applications, or otherwise interfere with ongoing network operation.

This transparent recovery ability allows technicians to take corrective measures immediately – as in the case of a disconnected cable – or to address the problem later, for example, during off-business hours. As soon as the failed link recovers, the software agent detects the recovery. This link then serves as the backup, ready to take over in the event of another failure.

Alert mechanisms for easy management

To enhance adapter manageability, AFT generates an alert whenever it detects a failure on a link, or whenever a failed link is brought online. This allows any problems with links to be fixed promptly. AFT uses operating system-based alerts for compatibility with management applications. Specifically, it generates NetWare alerts for NetWare servers and event logs for Windows NT servers.

A management application, such as Intel® LANDesk® Management Suite, can detect these alerts and trigger an appropriate action. For example, a network manager could choose to be notified of a failure via an email message, a fax or a call to his pager or cellular phone.

Intuitive interfaces for ease-of-use and setup

Standard operating system interfaces are used for NetWare, and Windows NT uses PROSet, Intel's intuitive Windows OS-based configuration utility, assuring that AFT is easy to set up and use.

How Adapter Fault Tolerance works

When two Intel server adapters are installed in a NetWare or Windows NT server, AFT allows them to function in tandem. The intelligent software agent coordinates this "adapter team," designating one adapter as primary and the other as secondary.

While the primary adapter handles the server traffic, the software agent uses the secondary adapter to monitor the primary adapter's link and connection status. The agent does so by sending out specially designated "probe packets." If a link failure occurs, these probe packets won't reach the primary adapter. The software agent, recognizing the change in status, immediately shifts traffic to the backup adapter, including MAC and network addresses. Because all configuration information is forwarded to the secondary adapter, users perceive no changes, and there is no impact on the server's operating system.

For additional information about enabling Adapter Fault Tolerance technology refer to the section titled "Configuration Considerations."

Understanding Adaptive Load Balancing Technology

Intel developed Adaptive Load Balancing (ALB) technology in January '98 to address the specific demands of high-performance environments – for example, companies that need more than 100Mbps throughput at the server to run sophisticated, bandwidth-intensive applications. Adaptive Load Balancing provides fault tolerance as well.

As more companies rely on their client/server networks for running business-critical applications, high server throughput is becoming as imperative as low downtime. In some cases, a single 100Mbps channel isn't enough, especially as new multimedia, intranet and Web-based applications drive the need for high server throughput. In such cases, a server bottleneck can slow down the entire network, hampering business and quickly incurring costs in lost productivity.

To overcome these problems, companies have taken steps to increase bandwidth and maintain high server throughput.

Drawbacks to the traditional method of resolving server bottlenecks

In the past, if a server threatened to become a bottleneck, a network manager typically segmented the network into two subnetworks by installing an additional network interface card (NIC) in the server. With segmentation, the traffic load is cut in half, usually alleviating congestion.

However, this older approach poses some problems, including additional overhead and the need to reassign IP addresses and remap the network. Segmentation also typically requires additional hardware, such as switches or routers. And, balancing traffic on the two segments can be extremely difficult, usually requiring repeated reconfiguration. Figure 2 illustrates the network segmentation approach.

A better method: aggregating bandwidth across multiple adapters

Adaptive Load Balancing offers a simpler and better way to move more data faster through the server. This innovative Intel technology increases throughput by balancing data transmission across multiple adapters. Essentially, each additional adapter adds another 100Mbps link, or channel. Adaptive Load Balancing also delivers the same fault tolerance benefits as Intel AFT technology, because if one link fails, the other(s) continue to assure network connectivity.

With ALB technology, there's no longer a need to segment the network if the server link becomes a bottleneck. Instead, a network manager can eliminate the bottleneck quickly and easily by installing two Intel server adapters in the server and configuring Adaptive Load Balancing. This method requires no client configuration, and clients don't have to be routed to communicate with each other. Moreover, traffic is balanced among all server adapters. Figure 3 illustrates the ALB approach.

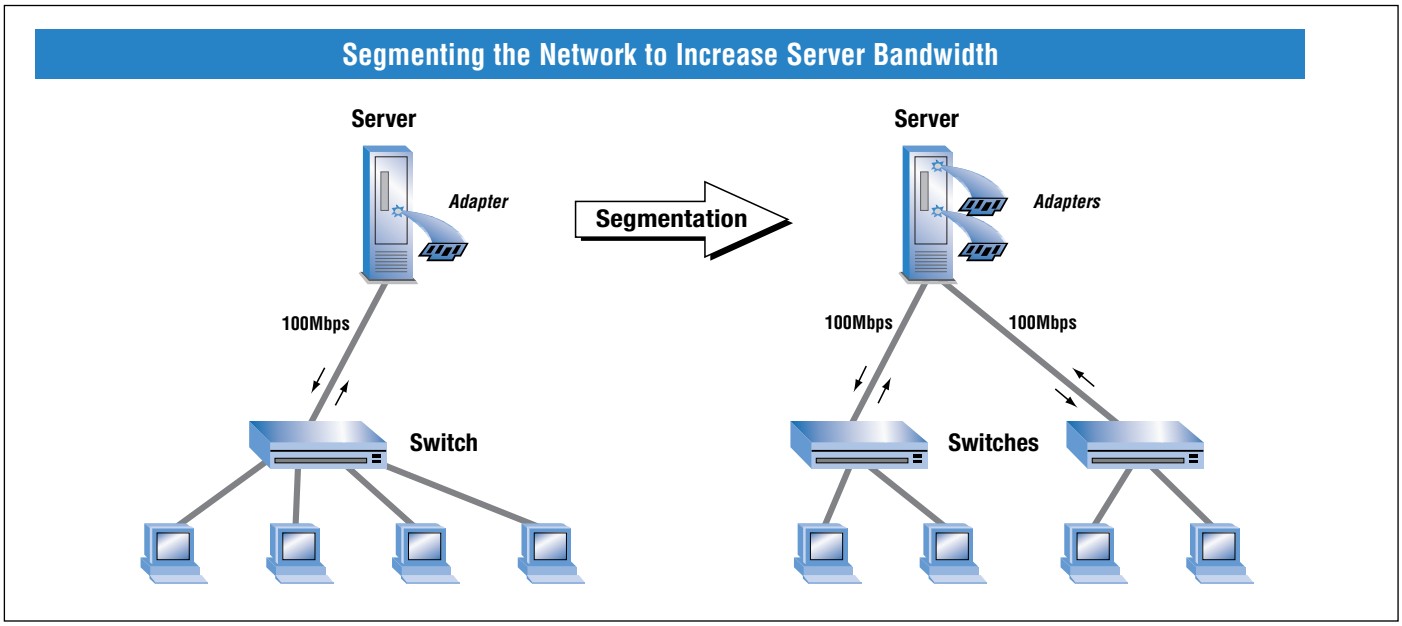

Figure 2: *Segmentation increases server bandwidth, but typically requires additional hardware and considerable management overhead. It may also require repeated reconfiguration to balance the traffic load.*

How Adaptive Load Balancing works

As many as four Intel server connections can be configured to work together as an Adaptive Load Balancing "team." All of the adapters in a team must be connected to a switch, and the team is assigned a single network address. (Adaptive Load Balancing is designed to work with any switch, whereas AFT works with either a hub or a switch.)

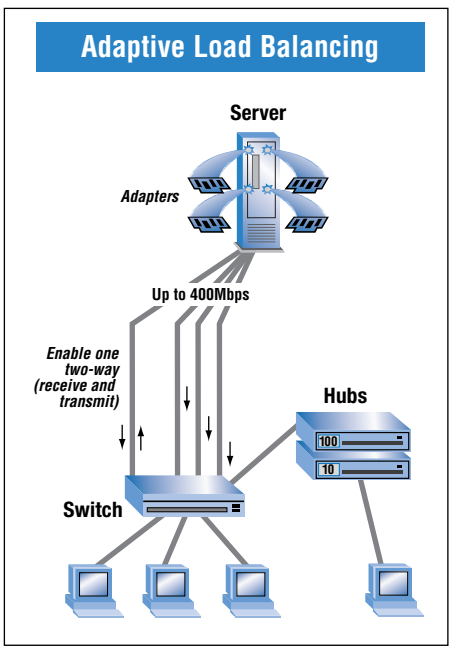

Figure 3: *With Adaptive Load Balancing, all traffic traveling from the server is automatically balanced between up to four links. This assures fast throughput with no need to restructure or reconfigure the network.*

As with Adapter Fault Tolerance, an intelligent, adaptive agent is included with the software driver. To coordinate ALB, this agent dynamically manages the server adapter team and evenly distributes the load among them by constantly analyzing the traffic flow from the server. Thus, all traffic sent from the server is balanced across the server adapters. (One channel within an ALB team carries traffic to and from the server. The others carry traffic from the server only.) This load balancing of server transmissions assures that all users enjoy the same network response from the server.

By taking advantage of Adaptive Load Balancing, a four link configuration can yield an aggregate throughput of approximately 400Mbps.

For additional information about enabling Adaptive Load Balancing technology in Intel server adapters, refer to the section titled "Configuration Considerations."

Understanding Fast EtherChannel* Technology

Fast EtherChannel* (FEC) technology was developed by Cisco Systems to address high-end needs for scalable bandwidth as companies deploy throughput-intensive applications such as Web browsing and intranet applications. Fast EtherChannel technology also offers a reliable and resilient high-speed solution to the challenge of deploying increasingly mission-critical applications on client/server networks.

Fast EtherChannel, which supports all the benefits and solutions provided by Adapter Fault Tolerance and Adaptive Load Balancing, provides bandwidth scalability through link aggregation.

In a server environment, Fast EtherChannel technology is similar to Adaptive Load Balancing in that

it provides fault tolerance and load balancing across multiple adapters. The addition of an FEC-enabled switch will offer the added advantage of balancing traffic loads in both directions – boosting throughput for data both from and to the server.

A Fast EtherChannel configuration is ideally suited to environments that rely on state-of-the-art Intel architecture systems for such applications as enterprise servers, Web servers, intranet servers and high-end graphics imaging and rendering servers.

Eliminating server bottlenecks

As with Adaptive Load Balancing, Fast EtherChannel technology resolves server throughput bottlenecks by allowing multiple adapters to share the traffic load. Also like ALB, a single network address is assigned to the collection of adapters that constitute a Fast EtherChannel team. The intelligent Adaptive agent balances traffic transmitted across all adapters connected in a Fast EtherChannel team; the switch balances the traffic that is received at the server.

This model offers an ideal solution for computing environments that run in full-duplex Fast Ethernet mode. Figure 4 illustrates a typical Fast EtherChannel configuration.

Scalability for today and tomorrow

Fast EtherChannel resolves the current needs of companies for whom 100Mbps Fast Ethernet performance is insufficient by delivering scalable bandwidth in increments of 200Mbps to 800Mbps at full duplex.

Fast EtherChannel is also compelling technology for future-proofing. Because it is a standards-based technology (IEEE 802.3-compliant), Fast EtherChannel paves the way for a seamless evolution to Gigabit Ethernet (1,000Mbps) capacity and subsequent industry-standard technologies.

How Fast EtherChannel works

Fast EtherChannel is a trunking technology that groups multiple full-duplex Fast Ethernet network connections to achieve fault-tolerant high-speed links. One Fast EtherChannel switch can connect two, three or four Fast Ethernet server adapters, supporting an aggregate available bandwidth of as much as 800Mbps at full duplex.

Because Fast EtherChannel load balancing is integrated with the switch architecture, high throughput can be maintained as links are added to a channel. Thus, the gain in bandwidth imposes no latency penalty or degradation of performance.

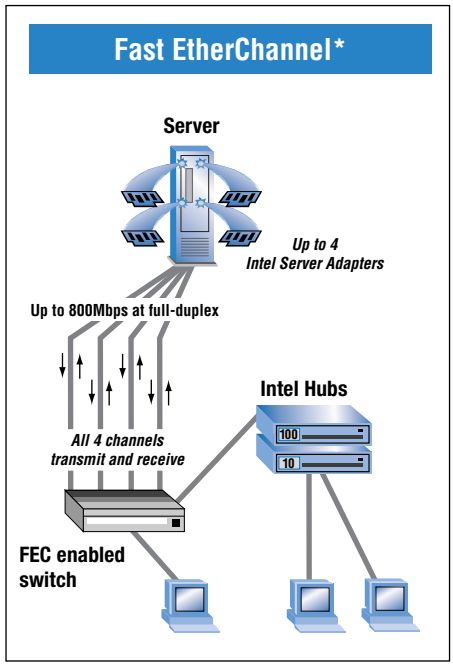

Figure 4: *With Fast EtherChannel,* traffic traveling to the server as well as from the server is automatically balanced between as many as four Intel adapters.*

Redundant parallel data paths help ensure resiliency within a Fast EtherChannel connection. If one link in a channel fails, the intelligent agent automatically redirects traffic to the remaining links transparently and without user intervention.

For additional information about enabling Fast EtherChannel technology in Intel server adapters, refer to the following section, "Configuration Considerations."

Configuration Considerations

A single driver provides the agent for Adapter Fault Tolerance, Adaptive Load Balancing and Fast EtherChannel. How the agent is configured in a particular environment determines which of the advanced features is enabled. Note that only one of the technologies can be configured at a time within an adapter team. For example, a company could choose Adapter Fault Tolerance (AFT), Adaptive Load Balancing (which includes AFT benefits), or Fast EtherChannel (which also includes AFT). A company can also configure the Intel PRO/100+ Single or Dual Port Server Adapters with the Intel® 82558 Onboard LAN Component. This enables AFT, ALB or FEC to be configured using fewer PCI slots.

The table in Figure 5 shows support for Adapter Fault Tolerance, Adaptive Load Balancing and Fast EtherChannel for various OS environments.

A Reliable, Flexible and Easy-to-Use Solution

Adapter Fault Tolerance, Adaptive Load Balancing and Fast EtherChannel technologies make the Intel server adapter family an ideal solution for fast network connectivity with enhanced availability. And, because the advanced features are evolutionary in nature, companies can choose to configure the adapter software for the technology best suited to the demands of their server environment (See Figure 6).

The three key attributes of Intel's PRO/100 Server Adapter product line solution are availability, flexibility and ease of use.

Availability

The advanced features integrated in Intel server adapters provide an effective solution for improving the availability of server links and increasing bandwidth. Affordable Intel architecture servers, enabled with Adapter Fault Tolerance, Adaptive Load Balancing or Fast EtherChannel, can provide high-availability capabilities and load balancing at a fraction of the cost of specialized server hardware and other expensive infrastructure components.

	Intel® PRO/100 Intelligent Server Adapter Intel PRO/100+ Dual Port Server Adapter Intel PRO/100+ Server Adapter			Intel PRO/1000 Gigabit Server Adapter	
Server Operating System	**AFT**	**ALB**	**FEC†**	**AFT**	**ALB**
NetWare* 4.11	yes	yes	yes	9/98	9/98
Windows NT 4.0	yes	yes	yes	yes	9/98
† Requires a switch that supports Fast EtherChannel*					

Figure 5. *Availability of Adapter Fault Tolerance (AFT), Adaptive Load Balancing (ALB) and Fast EtherChannel* (FEC) for various OS environments.*

Advanced Feature	Connection Requirements	Benefit
Adapter Fault Tolerance	■ When connected to any hub or switch	■ Transparent, backup network connections for high server availability
Adaptive Load Balancing	■ When connected to any switch	■ Transparent, backup network connections for high server availability ■ Load balancing of traffic sent from the server for increased throughput
Fast EtherChannel*	■ When connected to a switch that supports Fast EtherChannel*	■ Transparent, backup network connections for high server availability ■ Load balancing of traffic sent from the server for increased throughput ■ Load balancing of traffic sent to the server from the switch, for as much as 800Mbps aggregate throughput

Figure 6. *By configuring the adapter software for Adapter Fault Tolerance, Adaptive Load Balancing or Fast EtherChannel,* each company can select the level of support needed for their particular server environment.*

For more information on Cisco switches supporting FEC see http://www.cisco.com

Flexibility

The advanced features in Intel server adapters are designed to fit the way people work. The technologies discussed in this paper support the most widely used network operating systems, including Novell NetWare 4.11 and Windows NT 4.0, as well as popular network protocols such as TCP/IP and IPX. Intel will continue to support future releases of NetWare and Windows NT. This broad support means virtually all users can take advantage of these advanced features.

Ease of use

Adapter Fault Tolerance, Adaptive Load Balancing and Fast EtherChannel technologies were designed around the comments and most frequent requests of system administrators and OEMs. By supporting these advanced features in Intel server adapters, Intel has ensured that the adapters are easier for companies to configure, use and manage.

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