SUN TRUNKING 1.2

901 San Antonio Road, Palo Alto, California, 94303 U.S.A.

Table of Contents

INTRODUCTION

Over the past decade, dramatic changes have taken place in the office computing environment. Yesterday's image of groups of workers laboring in isolation has given way to a new era of collaboration as an increasing number of users access and share data across corporate and Internet networks.

As networks have become more powerful, the complexity and sophistication of the data they carry has also increased. The availability of powerful workstations, personal computers, and the internet has triggered development of a new generation of multimedia, groupware, imaging, and database applications that dramatically enhance user productivity. Today, the business world is experiencing a networking revolution that is profoundly changing the way that people and companies do business.

But with network growth comes problems. Today, corporate local area networks (LANs) are feeling the impact as more users and powerful applications threaten to overwhelm network capacity. Recently, Gigabit Ethernet (1000Base-T) and Fast Ethernet (100Base-T) have emerged to provide some relief to networks feeling the strain of increased traffic. However, as more devices running at Gigabit Ethernet and Fast Ethernet speeds are added, administrators find that they require a corresponding increase in backbone capacity.

What today's organization requires is a bandwidth-enhancement technology that provides the power demanded by complex technical and commercial applications, yet preserves investments in network technology. Many are turning to bandwidth-enhancement technologies like trunking as the solution to network congestion.

Sun Trunking™ 1.2, a new high-speed networking solution from Sun Microsystems™, builds upon Gigabit Ethernet and Fast Ethernet technology to provide a dramatic increase in network performance. Using Sun Trunking 1.2, enterprises have the ability to aggregate multiple Gigabit Ethernet and Fast Ethernet links into a single link to establish a scalable "fat pipe" to carry higher data rates than any single Ethernet link can accommodate. Because Sun Trunking 1.2 leverages Ethernet technology, network managers who deploy Sun Trunking 1.2 in their networks retain the capability to seamlessly and safely migrate to other ultra high-speed Ethernet technology in the future.

SUN™ - A HISTORY OF NETWORKING LEADERSHIP & A COMMITMENT TO NEW TECHNOLOGY

Sun has been instrumental in the development of state-of-the art networked systems for over 12 years. During that time, it has consistently delivered robust, flexible and powerful network technology based upon industry standards such as Ethernet, TCP/IP and the ISO OSI model, and numerous other important technologies.

Sun has long been a pioneer in network computing, and is widely recognized as having one of the most innovative and proven network computing solutions. Each Sun product - from the hardware to the system software - is designed to be "network-aware." With the introduction of its new family of high-performance Ultra™ desktops, Sun Microsystems was the first platform vendor in the industry to offer 10/100 Mbps Ethernet *directly on the system board*.

Sun was also among the first to support Gigabit Ethernet through its membership in the Gigabit Ethernet Alliance, playing an active role in the development of the IEEE standards for 1000Base-T Ethernet.

SUN & THIRD PARTY NETWORK INTERFACES AND MANAGEMENT PRODUCTS

Sun also leads the industry in third-party solutions. With over 12,000 independent applications and hundreds of third-party hardware products available for Sun platforms, Sun boasts one of the industry's widest range of networking interfaces. Sun and third-party vendor solutions include Gigabit Ethernet, Fast Ethernet, Quad FastEthernet™, FDDI, Token Ring, and high-speed serial products. Other networking solutions available from Sun include the powerful line of Solstice™ administration, security, PC integration, and network management tools. Third-party products available on Sun also provide support for Novell and many other network topologies and protocols.

Now, the growing acceptance of Gigabit Ethernet creates a clear requirement for higher-level performance at the server and backbone level. This technical brief introduces Sun Trunking 1.2, presents an overview of applications driving the need for increased network performance, and provides an overview of Sun Trunking 1.2 technology.

Networking in the New Millenium

Today's business world is changing at a rapid pace. Intensified competition, shorter time-to-market requirements, and efficient just-in-time manufacturing and distribution practices are just a few of the key forces driving this change. Because of the critical role that computing systems and networks play in today's business environment, it's not surprising that business success often goes to the company with the best information and the most efficient process for delivering that information. As the principal tool for business collaboration, corporate LANs are a vital resource in enabling today's enterprises to adopt competitive strategies that will carry them into the next century and beyond.

But increased reliance on corporate networks also means a corresponding increase in network traffic. Today, the number of users wanting to share and access data across enterprise networks and the Internet is increasing dramatically. Network resources are also being strained by the increasing popularity of bandwidth-intensive applications. Today, video and state-of-the-art multimedia applications, with data streams hundreds of megabytes in size, continue to proliferate across corporate LANs, gobbling up an ever-increasing amount of network bandwidth, as Table 1 illustrates.

Category	Data Types & Size	Impact on Network Traffic
Telemedicine/ Info Retrieval	¥Data les ¥100s of Megabytes to Gigabytes	¥Increased bandwidth required to move large les
Video Conferencing	¥Constant data stream ¥1.5 to 3.5 Mbps at the desktop	¥Data stream volume high ¥Class of service reservation
Internet/Intranet	¥Data les ¥100s of Megabytes to Gigabytes	¥Increased bandwidth required to move large les ¥Low transmission latency ¥Data stream volume highs
Scienti c Modeling & Engineering	¥Data les ¥100s of Megabytes to Gigabytes	¥Higher bandwidth for desktops, servers and backbone
Data Warehousing	¥Data les ¥Gigabytes to terabytes	¥Higher bandwidth for server and backbones

Table 1: Bandwidth-intensive applications are feeling the need for fast networks

ETHERNET TECHNOLOGY AND TODAY'S LANS

To provide increased support for business operations, network managers have extended corporate LANs by integrating higher performance Gigabit Ethernet and Fast Ethernet. Because they evolved from traditional Ethernet, Gigabit Ethernet and Fast Ethernet easily capitalize on the huge installed base of 10Base-T and retain compatibility with existing protocols. Today, Gigabit Ethernet and Fast Ethernet have emerged as the most convenient, cost-effective path to high-speed network performance.

But the rapid acceptance of Gigabit Ethernet and Fast Ethernet as a desktop technology presents network managers with another problem. As the number of devices entering the network at high speeds increase, network administrators now find that their network backbones lack the capacity to handle the increased traffic.

Today, some corporations with immediate needs to increase performance across network backbones are embracing Gigabit Ethernet. As Ethernet's next evolutionary leap, Gigabit Ethernet provides a raw data bandwidth of 1000 Mbps, while maintaining compatibility with the installed Ethernet base of over 70 million nodes.

Other companies who prefer to deploy high-speed networking more gradually are seeking a high-speed, standards-based technology that can supply the bandwidth relief they require today, while providing them with a seamless transition path to ultra high-speed Ethernet tomorrow.

TRUNKING: TODAY'S SAFE MIGRATION PATH TO HIGH-SPEED NETWORKING

Today, in a move to achieve highly efficient connectivity between backbones and servers, many companies are turning to trunking. Trunking is a port-aggregation technology that has long been used by the communications industry to enable a large number of users to share a small number of communications paths. More recently, network managers in the computing industry have applied trunking concepts to local area networks - bundling several links in parallel to form a single, high-speed, logical link. Until recently, these high-speed links were applied solely between pairs of switches to provide the increased throughput necessary to relieve network congestion. Now, in a natural evolution of trunking technology, Sun Microsystems, with Sun Trunking 1.2, extends trunking capability, linking switches and hosts, to dramatically reduce network latency between workgroups and network servers.

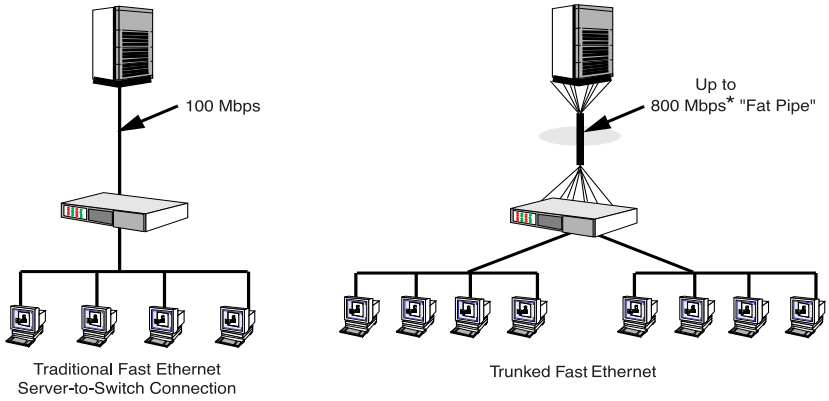

Figure 1: Trunking technology provides a dramatic increase in network performance over traditional 100 Mbps server-to-switch connections.

Figure 1 illustrates the advantages of trunking technology. On the left, a traditional Fast Ethernet link between a server and a switch provides a 100 Mbps connection that is shared equally among four clients. On the right, throughput between the server and switch is boosted to 800 Mbps* using Sun Trunking 1.2 port aggregation technology. Figure 2 illustrates the boost in throughput between server and switch when using trunking technology with Gigabit Ethernet.

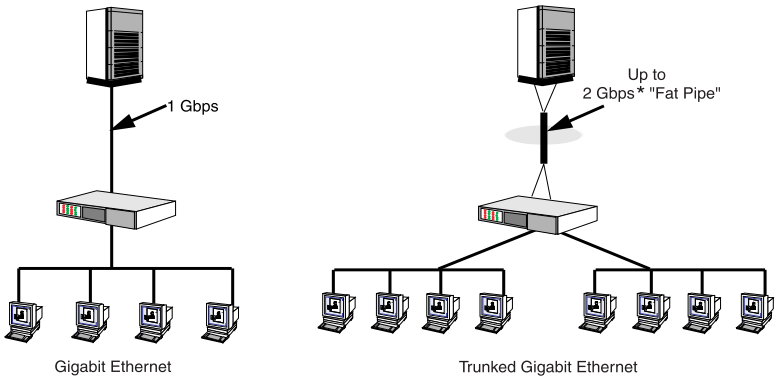

Figure 2: With trunking and Gigabit Ethernet, “fat pipe” capacity expands to 2 Gbps.*

When used in conjunction with Gigabit Ethernet and Fast Ethernet technology, trunking can provide network managers with higher bandwidth between servers, routers, and switches than any single Gigabit Ethernet or Fast Ethernet link can deliver. And because trunking products leverage Ethernet technology, they supply enterprises with substantial investment protection while providing a smooth upgrade path to ultra high-speed Ethernet.

*Theoretical maximum. Actual performance may be lower, depending on applications and system configuration.

SUN TRUNKING 1.2: A STANDARDS-BASED NETWORK SOLUTION

Sun Trunking 1.2 leverages the IEEE 802.3 Gigabit Ethernet and Fast Ethernet standards to provide a low-risk, cost-effective migration path for organizations that require increased performance at the server and backbone levels today.

Using Sun Trunking 1.2, network managers can aggregate up to two Gigabit Ethernet or eight Fast Ethernet ports in a single virtual link. Sun Trunking 1.2 provides a transparent migration path to multi-gigabit-level performance.

Sun Trunking 1.2 Components

Sun Trunking 1.2 works with Sun Gigabit Ethernet or Quad FastEthernet network interface card (NIC), combined with a trunking-capable switch.

The Gigabit Ethernet Adapter provides industry-leading performance of 1 Gbps and is fully compliant with IEEE 802.3z, the Gigabit Ethernet standard. It is available in both PCI and SBus interfaces.

Quad FastEthernet combines 100 Mbps performance with the density of four high-speed 10/100 auto-negotiating Ethernet ports. Conforming to 100Base-T, the Quad FastEthernet card is a compatible extension of the existing IEEE 802.3u standard.

Sun Trunking 1.2 software provides a number of sophisticated link aggregation features. Sun Trunking 1.2 supports load balancing that distributes traffic - including unicast, broadcast, and multicast - evenly across the aggregated links. In the event of a link failure, Sun Trunking 1.2 automatically redistributes loads across the remaining links without user intervention.

Sun Trunking 1.2 Technology

Because Sun Trunking 1.2 leverages Ethernet technology, this chapter discusses Gigabit Ethernet and Fast Ethernet and provides an overview of their component structure and technology. This chapter also discusses the features and benefits of Sun Trunking 1.2 and provides some typical implementation scenarios.

GIGABIT ETHERNET

Gigabit Ethernet has emerged as an easy and inexpensive solution for networks straining under the weight of increased network traffic. Gigabit Ethernet consists of the following component specifications: the Media Access Control (MAC) layer, the Gigabit Media Independent Interface (GMII), and Physical Layers supporting the most widely used cabling types. Each of these components was designed to preserve compatibility with 10/100 Mbps Ethernet and existing installations.

Media Access Control

The Media Access Control (MAC) layer is fundamental to the structure of both Gigabit Ethernet and Fast Ethernet networks. As its name implies, this layer arbitrates transmissions between all nodes attached to the network. Gigabit Ethernet's MAC layer supports both full- and half-duplex operation. The MAC layer relies on the CSMA/CD algorithm for collision detection and recovery.

Gigabit Ethernet simply increases the speed at which data is transmitted by a factor of ten over Fast Ethernet. The access method, packet format, packet length, error control, back-off algorithm, and management information remain unchanged. This provides that all network services and protocols written for 10- and 100-Mbps Ethernet networks work unchanged over Gigabit Ethernet.

Gigabit Media Independent Interface (GMII)

The Gigabit Media Independent Interface (GMII) is a synchronous digital interface carrying unencoded data over separate transmit and receive paths. The GMII connects the Media Access Control function to various Gigabit Ethernet physical layer components in an interoperable fashion.

The GMII offers several features for high-bandwidth networking:

- Independent paths for transmitting and receiving data
- Supports IEEE specifications for full-duplex operation
- Multivendor interoperability

- Enables compatibility between system and physical layer ASICs supplied by different vendors
- Simple resource management
- Two-wire serial management interface for query and control of physical resources
- Backwards compatibility

Physical Layers

Initial implementations of Gigabit Ethernet will support physical layers that are based on Fibre Channel technology, including 8B/10B encoding/decoding for the PCS sub-layer, the Serializer/Deserializer (SERDES) technology enhanced to run at 1.25 Gbps, and existing fiber-optic components.

The physical media and link distances supported by Gigabit Ethernet are:

- Short wavelength laser (850 -nm)
  - 300 m over 62.5 micron MMF
  - 550 m over 50 micron MMF
- Long wavelength laser (1300-nm)
  - 550 m over 62.5 and 50 micron MMF
  - 3000 m over 9 micron SMF
- Copper media
  - 25 m over Twinax cable
  - 100 m over four pairs of Cat-5 UTP (utilizing a complex encoding scheme).

In the future, it is anticipated that Gigabit Ethernet will operate over unshielded twisted-pair (UTP) wiring.

Because of its similarities to Ethernet, Gigabit Ethernet is easily implemented in existing networks. Network managers can combine Gigabit Ethernet with other low- or high-bandwidth technologies to structure the environment best suited to their requirements. For example, Gigabit Ethernet can be implemented as a high-speed 1000 Mbps connection to file servers, a backbone interconnect technology between 10/100 switches, or as an upgrade path to future high-performance desktop computers.

FAST ETHERNET

The Fast Ethernet architecture allows scaleable performance up to 100 Mbps, meaning that higher throughput of the workstation at the sending or receiving end directly translates into more performance through the network. With a Fast Ethernet connec-

tion, users can finally tap into the network I/O performance of their high-end workstations and servers.

Fast Ethernet has similar network components as Gigabit Ethernet: the Media Access Control (MAC) layers, the Media Independent Interface (MII), and the Physical Layers. Please refer to the Gigabit Ethernet section for details.

SUN TRUNKING 1.2 - FEATURES AND BENEFITS

Sun Trunking 1.2 is a link aggregation technology that enables network managers to group up to two full-duplex Gigabit Ethernet or eight Fast Ethernet links (ports) to obtain higher performance between servers and network backbones. Figure 3 illustrates how Sun Trunking 1.2 technology works. In the illustration, two individual links between a switch and a server are aggregated into one high speed logical link to create a "fat pipe" to relieve congestion in a dedicated area of a network.

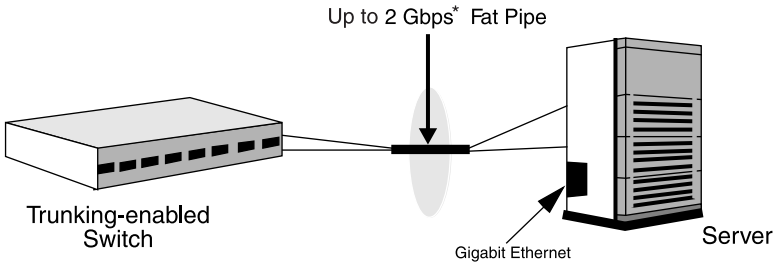

Figure 3: With Sun Trunking 1.2, two Gigabit Ethernet ports can be assigned to a port trunk

In addition to providing a dramatic increase in network performance, Sun Trunking 1.2 maximizes network reliability through its load balancing and redundancy features.

Load Balancing and Redundancy

Load balancing is a critical factor in achieving optimal performance in any trunking implementation. As the term implies, load balancing distributes traffic evenly across aggregated links, providing higher performance and redundant parallel paths.

Sun Trunking 1.2's load balancing software also provides fault tolerance and failure recovery capability. All traffic is evenly distributed across the aggregated links. If a link is unplugged, damaged, or fails, the Sun Trunking 1.2 software automatically removes the failed link from the port grouping and redistributes the load across the remaining links, without user intervention.

*Theoretical maximum. Actual performance may be lower, depending on applications and system configuration.

IMPLEMENTATION SCENARIOS

Trunking technology can be used to improve the performance and management of a workgroup network in a number of ways. This section presents some likely scenarios for implementing Sun Trunking 1.2 functionality in a network backbone.

Server-to-Switch

Because server-to-switch links are common in many technical and commercial environments, aggregating these links to improve access to applications and file servers is a likely implementation scenario. Figure 4 illustrates a connection between a server and a switch, and shows a trunk with four segments. The switch is connected to nine clients, and to an Ethernet hub that is connected to three additional clients. Under this configuration, the server could be another type of equipment, such as a router, printer, or high-performance workstation.

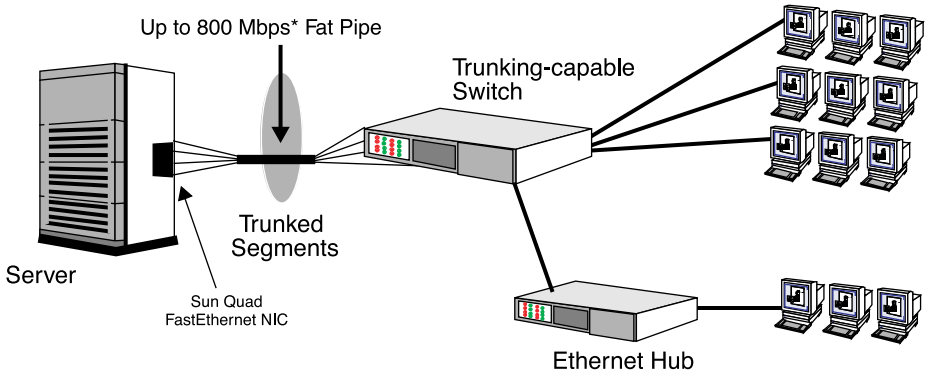

Figure 4: Server-to-switch trunk

Server-to-Server

Upgrading server-to-server links is another likely scenario. Applications such as data warehousing and data distribution demand the frequent movement of large amounts of data between servers, and providing its unimpeded movement is important. Figure 5 illustrates how trunks can be employed between a pair of servers to achieve this goal.

*Theoretical maximum. Actual performance may be lower, depending on applications and system configuration.

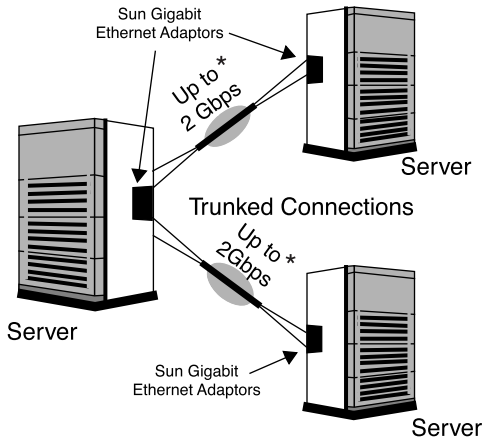

Figure 5: Server-to-server trunks

Full Integration

Figure 6 illustrates a full-integration configuration that utilizes a trunking switch, a legacy switch, and a router. This scenario demonstrates the transparency of Sun Trunking 1.2, and shows how it can be easily integrated into established computing environments. In this configuration, two ports are trunked together to provide up to 2 Gbps* full duplex transmission to a trunking switch. A third port is used to connect to a legacy switch at 10 Mbps. The remaining port is used to connect at 10/100 Mbps to a router, providing access to the wide area network.

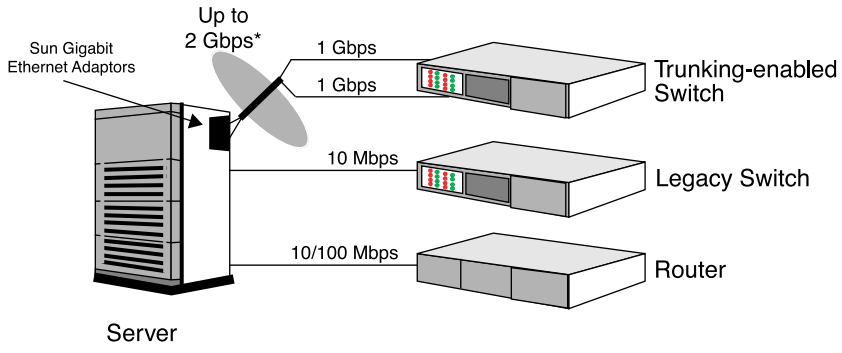

Figure 6: Full-integration configuration

*Theoretical maximum. Actual performance may be lower, depending on applications and system configuration.

Sun and Networking Solutions

Each Sun product - from the hardware to the system software - is designed to be "network-aware." With the introduction of its new family of high-performance Ultra desktops, Sun Microsystems has become one of the first platform vendors in the industry to offer 10/100 Mbps Ethernet directly on the system board. Sun has long been a pioneer in network computing, and is widely recognized as having one of the most innovative and proven network computing solutions.

SUN ULTRA ENTERPRISE™ AND ULTRA HPC SERVERS

Contributing to the Sun network computing solutions is a complete line of high-performance servers. Delivering power, reliability and unprecedented value to technical and commercial users, the Sun Ultra Enterprise and Ultra HPC servers combine the latest technologies in CPU, memory, I/O and networking to deliver industry leading scalability, flexibility, and price/performance. Sun Ultra Enterprise servers can scale from one to 64 processors and support more than 20 terabytes of on-line disk storage. To support mission-critical applications, this compatible family of server systems also includes a broad set of high-availability features designed to provide maximum uptime and ease-of-maintenance.

SOLARIS™ OPERATING ENVIRONMENT

At the heart of the Sun networking solution is the Solaris networked computing environment, the world's leading UNIX operating system. Solaris provides transparent, heterogeneous networking facilities for both LANs and global enterprises. Solaris' powerful, integrated networking features include:

- Networking protocols and services (ONC+)
- Scalable, global naming services (NIS+)
- Transparent network access (NFS)

Solaris also provides the foundation for the Sun layered network management and connectivity solutions. Solstice Site Manager™ and Solstice SyMON™ enable remote administration, monitoring, and troubleshooting of LANs and WANs. Other products in the Solstice System Management family provide centralized administration, management, and security services for all types of networks.

LEGACY AND MINICOMPUTER SYSTEM CONNECTIVITY PRODUCTS

Part of the Sun success at delivering mission-critical solutions is its ability to integrate effectively with minicomputer and mainframe systems. Sun tools include SunLink SNA (for IBM SNA interface/protocol support), SunLink SNA 3270 Client and

Server products (providing 3270 terminal support), and related AS/400, remote job entry, and NetView system management protocol support.

Also available from Sun and third-parties are products that support protocols such as IBM's BSC 3270 and Digital Equipment Corporation's DECnet. The SunLink DNI and a variety of third-party network connectivity and system management products enable excellent integration of DEC and other DECnet-capable systems.

GLOBAL/REMOTE ACCESS SOLUTIONS

Open Systems Interconnection (OSI) has become a key open standard that offers diverse computing systems the potential to share resources and information across departmental, organizational, and international boundaries. SunLink OSI products include solutions that allow the exchange of information among systems from many vendors. SunLink OSI expands connections through internationally accepted ISO/OSI communication standards. SunLink OSI supports OSI protocols, from the physical to the application layer of the OSI model.

SunLink X.25 enables Solaris-based systems to act as X.25 gateways, allowing communication and resource sharing across public and private X.25 networks. SunLink X.25 includes transparent IP connectivity, enabling TCP/IP based Solaris systems to share resources and applications with other systems or LANs across X.25 networks.

Open Messaging products allow companies to use standardized products to connect people and organizations. SunLink X.400 implements the ITU-T technology for Message Handling Systems, allowing Solaris-based systems to exchange messages with systems connected to an X.400 network. SunLink X.400 supports concurrent connections over X.400, TCP/IP, Ethernet, or X.25 networks.

SunLink FTAM (File Transfer Access Method) allows Solaris-based systems to exchange files with other FTAM-based systems. It can operate simultaneously across both TCP/IP and OSI networks.

SunLink VT allows Solaris systems to establish connections with remote VT servers and/or to act as a VT server itself.

For enterprises that want to develop and implement management solutions for global telecommunication networks, Sun offers SunLink™ CMIP. SunLink, consists of the SunLink Common Management Information Protocol (CMIP), 8.1 Standard Development Environment (SDE) and SunLink CMIP 8.1 Runtime (RT). It enables organizations to cost-effectively develop and deploy advanced network management solutions.

Summary

Today, corporations are feeling the impact as more users and powerful applications threaten to overwhelm network performance. Recently, Gigabit Ethernet has emerged to provide some relief to networks overtaxed by bandwidth-hungry applications and an increased number of users. But Gigabit Ethernet's widespread deployment has triggered a need for a corresponding increase in speed in network backbones and to corporate servers.

Today, network managers are turning to proven bandwidth-enhancement technologies like trunking as the solution to network congestion. Sun Trunking 1.2 is a new high-speed link aggregation technology from Sun Microsystems that leverages 802.3 Gigabit Ethernet and Fast Ethernet technology to provide a dramatic increase in network performance. Using Sun Trunking 1.2, enterprises have the ability to establish a scaleable "fat pipe" to carry higher aggregated data rates than any single Gigabit Ethernet or Fast Ethernet link can accommodate, while retaining the capability to seamlessly and safely migrate to ultra high-speed Ethernet in the future.

HEADQUARTERS **SUN MICROSYSTEMS, INC.,** 901 SAN ANTONIO ROAD, PALO ALTO, CA 94303-4900 USA
PHONE: 650 960-1300 FAX: 650 969-9131 INTERNET: www.sun.com

THE NETWORK IS THE COMPUTER™

SALES OFFICES

AFRICA (NORTH, WEST, AND CENTRAL): +33-1-3067-4680 • **ARGENTINA:** +54-11-4317-5600 • **AUSTRALIA:** +61-2-9844-5000 • **AUSTRIA:** +43-1-60563-0 • **BELGIUM:** +32-2-716-79-11 • **BRAZIL:** +55-11-5181-8988 • **CANADA:** +905-477-6745 • **CHILE:** +56-2-372-4500 **COLOMBIA:** +571-629-2323 • **COMMONWEALTH OF INDEPENDENT STATES:** +7-502-935-8411 • **CZECH REPUBLIC:** +420-2-33-00-93-11 • **DENMARK:** +45-4556-5000 • **ESTONIA:** +372-6-308-900 • **FINLAND:** +358-9-525-561 • **FRANCE:** +33-01-30-67-50-00 • **GERMANY:** +49-89-46008-0 **GREECE:** +30-1-618-8130 • **HUNGARY:** +36-1-202-4415 • **ICELAND:** +354-563-3010 • **INDIA:** +91-80-559-9595 • **IRELAND:** +353-1-8055-666 • **ISRAEL:** +972-9-951-3465 • **ITALY:** +39-039-60551 • **JAPAN:** +81-3-5717-5000 • **KAZAKHSTAN:** +7-3272-466774 **KOREA:** +822-3469-0114 • **LATVIA:** +371-755-11-33 • **LITHUANIA:** +370-729-8468 • **LUXEMBOURG:** +352-49-11-33-1 • **MALAYSIA:** +603-264-9988 • **MEXICO:** +52-5-258-6100 • **THE NETHERLANDS:** +31-33-450-1234 • **NEW ZEALAND:** +64-4-499-2344 • **NORWAY:** +47-2202-3900 **PEOPLE'S REPUBLIC OF CHINA: BEIJING:** +86-10-6803-5588; **CHENGDU:** +86-28-619-9333; **GUANGZHOU:** +86-20-8777-9913; **HONG KONG:** +852-2802-4188; **SHANGHAI:** +86-21-6466-1228 • **POLAND:** +48-22-874-7800 • **PORTUGAL:** +351-1-412-7710 • **RUSSIA:** +7-502-935-8411 **SINGAPORE:** +65-438-1888 • **SLOVAK REPUBLIC:** +421-7-522-94-85 • **SOUTH AFRICA:** +2711-805-4305 • **SPAIN:** +34-91-596-9900 • **SWEDEN:** +46-8-623-90-00 • **SWITZERLAND:** +41-1-825-7111 • **TAIWAN:** +886-2-2514-0567 • **THAILAND:** +662-636-1555 **TURKEY:** +90-212-236-3300 • **UNITED ARAB EMIRATES:** +971-4-366-333 • **UNITED KINGDOM:** +44-1-276-20444 • **UNITED STATES:** +1-800-555-9SUN OR +1-650-960-1300 • **VENEZUELA:** +58-2-905-3800 • **WORLDWIDE HEADQUARTERS:** +1-800-555-9SUN OR +1-650-960-1300

LFC2.1 Printed in USA 07/99 DE1060-0/0K