Introduction to iSCSI

Version 1.0, March 2002

Authored by:
Caroline Larson, Intel
Eric Yeh, Hewlett Packard Co.
Venu Mannem, Adaptec, Inc.
Herman Chao, QLogic Corp.

Introduction to iSCSI

As Ethernet begins to enter into the Storage world a new protocol has been getting a lot of attention. The Internet Small Computer Systems Interface or iSCSI, is an end-to-end protocol for transporting storage I/O block data over an IP network. The protocol is used on servers (initiators), storage devices (targets), and protocol transfer gateway devices. iSCSI uses standard Ethernet switches and routers to move the data from server to storage. It also enables IP and Ethernet infrastructure to be used for expanding access to SAN storage and extending SAN connectivity across any distance. The technology is based on SCSI commands used in storage traffic today and IP protocols for networking.

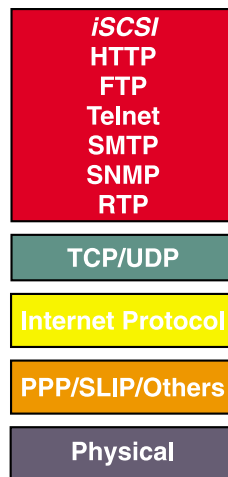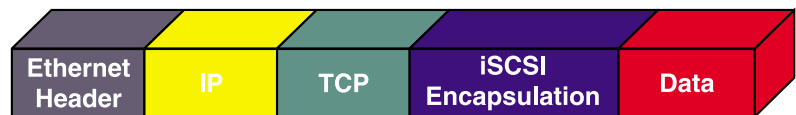**Figure 1. iSCSI Layers within the OSI Model**

iSCSI HTTP FTP Telnet SMTP SNMP RTP
TCP/UDP
Internet Protocol
PPP/SLIP/Others
Physical

Figure 2. iSCSI Packet Configuration

Ethernet Header	IP	TCP	iSCSI Encapsulation	Data

Leveraging the Best from Storage and Networking

iSCSI builds on the two most widely used protocols from the storage and the networking worlds. From the storage side, iSCSI uses the SCSI command set, the core storage commands used throughout all storage configurations.

On the networking side, iSCSI uses IP and Ethernet, which are the basis for most corporate networks, and uses in metropolitan and wide area networks is increasing as well. With almost 30 years of research, development and integration, IP networks provide the utmost in manageability, interoperability and cost-effectiveness.

Industry Forums

IEEE:

The IEEE is the Institute of Electrical and Electronics Engineers, Inc. helps advance global prosperity by promoting the engineering process of creating, developing, integrating, sharing, and applying knowledge about electrical and information technologies and sciences for the benefit of humanity and the profession. Under the IEEE is a Standards Association that reviews and approves submitted projects for standards approval. The 10GbE technology fall under the 802.3 organization, the group that specifically developments standardization for the Ethernet technology. The proposed standard within the IEEE for 10GbE is 802.3ae.

SNIA:

The Storage Networking Industry Association (SNIA) is the point of cohesion for developers of storage and networking products in addition to system integrators, application vendors, and service. SNIA is broken down into subgroups including SNIA technical council and forums, SNIA work groups, SNIA technology labs, and SNIA conferencing. Inside the SNIA forum there is a dedicated forum to IP Storage with a mission to market and promote standards-based block storage networking solutions using IP networks. Inside the IP Storage is a deeper sub layer group that is solely dedicated to iSCSI. The mission of the iSCSI subgroup, named "iSCSI Group" is to market and promote iSCSI as a standard for transporting block storage data over Internet Protocol (IP) networks.

IETF:

The Internet Engineering Task Force (IETF) is an open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. The actual technical work of the IETF is done in its working groups, which are organized by topic into several areas (e.g., routing, transport, security, etc.). The IP Storage (ips) work group is where the this group will define the approach of encapsulating existing protocols, such as SCSI and Fibre Channel, in an IP-based transport or transports. The group will focus on the transport or transports and related issues (e.g., security, naming, discovery, and configuration), as opposed to modifying existing protocols. Standards for the protocols to be encapsulated are controlled by other standards organizations (e.g., T10 [SCSI] and T11 [Fibre Channel]).

10GbE enabling iSCSI

As the demand for bandwidth is increasing for storage and networking applications, Gigabit Ethernet technology provides the right path, however to make these applications mainstream, 10GbE is needed.

- A 10 Gigabit Ethernet network will have the capabilities to provide solutions for unified storage and networking applications. With networking applications requiring gigabits of throughput and the terabits of storage transactions, existing gigabit networks will max out, however 10GbE will be able to sustain lower latencies and high performance needed for these applications.

- Interchangeability and Interoperability of equipment. Currently the Fiber Channel model is not optimized for connectivity of multiple vendor devices. With 802.3 standards based products, Ethernet has continued to provide solutions that can connect systems for multiple vendors allowing for a better cost model and a variety of vendors to chose from for the end user.

- Consolidation of SAN & NAS markets.

- Ability to connect Fiber Channel SAN islands through IP, a link greater than the gigabit interfaces in the SAN islands is required.

Advantages of iSCSI SANs

- Familiar network technology and management
  - Reduces training and staff costs

- Proven transport infrastructure
  - Increases reliability

- Transition from 1 Gigabit Ethernet to 10-Gigabit Ethernet and Beyond
  - Protects investment with simplified performance upgrades

- Scalability over long distances
  - Enables remote data replication and disaster recovery

- Brings Ethernet economics to storage
  - Enables lower total cost of ownership

Building iSCSI SANs with 10GbE

Data Center Approach

An iSCSI SAN is a perfect choice for a user interested in moving to networked storage. Using the same block level SCSI commands as direct attach storage, iSCSI provides compatibility with user applications such as file systems, databases, and web serving. Similarly, since iSCSI runs on ubiquitous and familiar IP networks, there is no need to learn a new networking infrastructure to realize SAN benefits. To build an iSCSI storage network in a data center, iSCSI host bus adapters can be used in servers, along with iSCSI storage devices and a combination of switches and routers.

An iSCSI SAN is an optimal choice for a user interested in moving to IP Storage. iSCSI is like one more application to the network protocol stack. So, iSCSI is not only compatible with the existing networking architecture but also maintains the same block level SCSI commands. This capability allows IT staff to transition from the direct attached storage (DAS) model to iSCSI SAN model. By adding the storage traffic to the existing network, IT staff doesn't need any additional training to manage the networks for IP Storage.

In a typical data center the servers updates/retrieves the data from the storage devices located remotely at gigabit speeds. Consolidated storage serves multiple servers at the same time. In the same environment, network traffic is processed at gigabit speeds. IT staff has a challenging task to support growing needs of storage and network requirements. Though gigabit networks are being deployed widely, it cannot solve all the problems. Storage networks have low latency and high bandwidth requirements

iSCSI at 10 Gigabit Ethernet is the answer to these requirements. 10GbE provides a smooth transition for the existing storage networking infrastructure to higher speeds. Applications like synchronous mirroring demand low latency and file serving needs high bandwidth. By using a host bus adapter (HBA), which supports both the network protocols and the iSCSI protocols, both SAN and NAS can be environments can be consolidated. 10GbE networks facilitate the high band-width and low latency required in this environment, thereby resulting improved application response time.
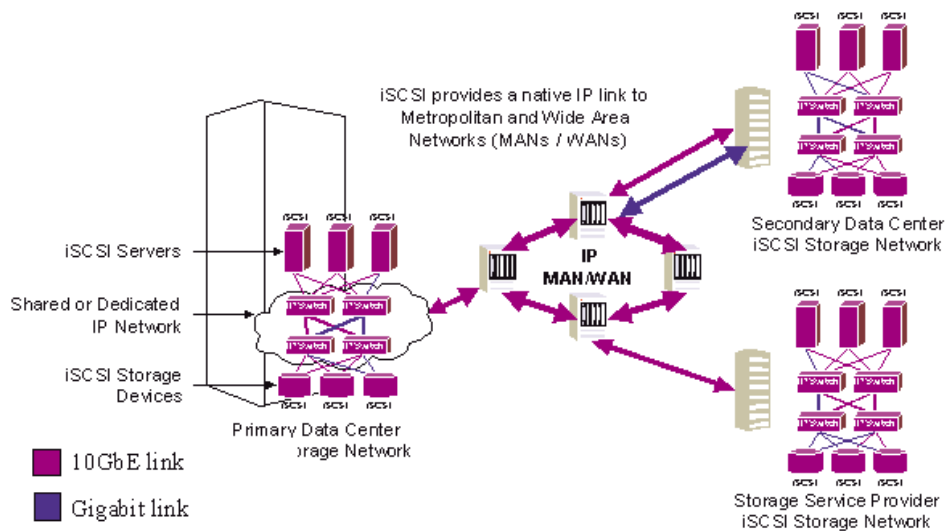
Data Center Applications

- Server and storage consolidation
  With a networked storage infrastructure, customers can link multiple storage devices to multiple servers allowing for better resource utilization, ease of storage management, and simpler expansion of the storage infrastructure

- Accelerated Backup Operations
  Backup operations previously restricted to operating across traditional IP LANs at the file level can now operate across IP Storage networks at the block level. This shift facilitates faster backup times, and provides customers the flexibility to use shared or dedicated IP networks for storage operations

- Seamless Remote Site Access and Storage Outsourcing
  With the storage network based on IP, customers can easily enable remote access to secondary sites across metropolitan or wide area IP networks. The remote sites can be used for off-site backup, clustering or mirroring replication. Additionally, customers can choose to link to storage service providers for storage outsourcing applications such as storage-on-demand.

Expanding iSCSI Storage Networks to Metro and Wide Area Networks

Enabling storage over long distances is essential to remote site backup or implementing robust disaster recovery applications. The rapid adoption and expansion of IP data on the Internet has proven the viability of using IP across long distance wide area networks. Although it is expected that initial deployments of iSCSI will use private networks, with the use of IP's security infrastructure (such as IPSec and SSL to provide authentication and privacy) it will be possible to use public networks for wide area iSCSI storage traffic as well.

10 Gigabit Ethernet provides the necessary network links, reliability, and bandwidth for carrying large amounts of storage data over both private and public IP networks covering varying distances. To meet the distance objectives of MAN/WAN storage deployments the IEEE 802.3ae Task Force specifies the 1550nm serial transceiver to maintain the support of 40 Kilometer links over single mode fiber that Gigabit Ethernet has already been successful in deploying. 10GbE also specifies a variety of optical transceivers that support distances including 300 and 10,000 meters over single and multi-mode fiber. The 10GbE standard additionally specifies a WAN PHY to facilitate compatibility with the existing WAN network. The WAN PHY supports the same distances and optical transceivers as the LAN PHY specification. The 10 Gigabit Ethernet WAN PHY supports connections to existing and future installations of SONET/SDH (Synchronous Optical Network/ Synchronous Digital Hierarchy) circuit-switched telephony access equipment by including a simplified SONET/SDH framer. The ubiquity of Ethernet and provisions made in the 10GigE Standard, make 10GbE the ideal choice for supporting iSCSI storage networks in metro and wide area networks.

10GbE iSCSI Storage Networks with 10GbE

Conclusion

iSCSI represents a dramatic shift in the storage networking landscape. iSCSI will expand the market for networked storage by giving IT managers another alternative to direct attached storage that delivers the advantages of networked storage. IP storage networks take advantage of IP networking knowledge in IT departments and use existing network management and tools for LANs, MANs and WANs today. Riding the IP wave of technology development and enhancements like the introduction of 10 Gigabit Ethernet, iSCSI provides a logical unified infrastructure development path for corporations and service providers alike. Thank you to SNIA for provided content.

Appendix

Today's storage market offers three common options: Direct Attached Storage (DAS), Network Attached Storage (NAS), and Storage Area Networks (SAN).

Direct Attached Storage (DAS)

Direct Attached Storage (DAS) has been the common method of attaching mass storage to servers and LANs. In its simplest form, DAS consists of a disk drive attached directly to a server. Data is transferred through SCSI (Small Computer System Interface) commands, the most common means of I/O communication between a computer and a hard drive. SCSI transfers data as blocks, which are the low-level, granular units used on storage devices.

There are a number of disadvantages to the Direct Attached Storage approach, including Cost of Ownership, manageability and scalability. In particular, in order to grow storage capacity, enterprises had to buy more servers.

These shortcomings drove enterprises to look for alternative storage approaches.

Network Attached Storage (NAS)

NAS is used for file-based storage. NAS devices are attached directly to the Local Area Network (LAN) and storage traffic travels across the LAN.

The NAS devices provide file system support as well as access and control permission, along with an access point to configure the storage subsystem.

Since it is a familiar technology, network attached storage can easily be managed by an organization's existing IT staff. Little if any training in storage management is required, saving IT costs. Another benefit is flexibility, since the storage unit(s) can easily be attached at any point in the network. However, this is not a highly scalable option. .

Storage Area Network (SAN)

SANs are dedicated networks that connect servers to storage devices and transport storage traffic without burdening the enterprise LAN. See figure 1 for a typical SAN. Several factors help make SANs attractive, including performance, reliability, availability, scalability. Without centralized management, redundant copies of files can rapidly consume disk space, while multiple versions of files cause reconciliation problems. In the absence of mature management tools, servers with high-demand applications and often-used data can become overloaded, while others sit relatively idle. SANs help eliminate these problems. The dedicated SAN improves the efficiency of the LAN by offloading the constant stream of storage traffic.