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HCL not just offers you its expertise but brings to the table its vast and multi hued experience of having executed complex, full and partial lifecycle product engineering projects for fortune 500 storage companies. Today we'd like to engage you in a topic that is on the minds of Storage OEMs and technology vendors. This is nothing but distilling of HCL's experience to help IT managers map their datacenter and make appropriate decisions.



# WHITE PAPER

November 2007



## Abstract

Data Center SANs are typically built using the FC topologies though the alternate way of building a SAN using iSCSI is more cost effective. A recent entrant in the SAN industry is FCoE. FCoE enables SAN traffic to be natively transported over Ethernet networks. The standardization work for FCoE is in progress. The products are expected to be available mid 2009, on top of 10 Gigabit Ethernet.

The question here is, for achieving I/O consolidation and cost reduction, should data center designers wait for FCoE, or migrate to iSCSI immediately?

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## Introduction to FC SANs

Fibre Channel is a highly reliable Gigabit interconnect technology. FC includes robust and mature protocols to meet data integrity and performance requirements in both Mainframe and Open systems environments.

FC SAN constitutes of

- 1) Host Bus Adapter (HBA): This unit resides on the Host computer which requires storage connectivity.
- 2) Switches and Directors: Devices which interconnect the Host systems and storage.
- 3) FC Storage

Depending on the organizational requirements, FC SAN can be implemented in different ways. In the simplest topology, a single switch can be used to connect the available hosts to the storage. This will not have high reliability as there is a single point of failure. A more highly reliable setup is possible by using multiple core directors connected to each other for redundancy with the hosts and storage devices connected to the directors using the edge switches. Figure-1 illustrates a large and reliable data center SAN.

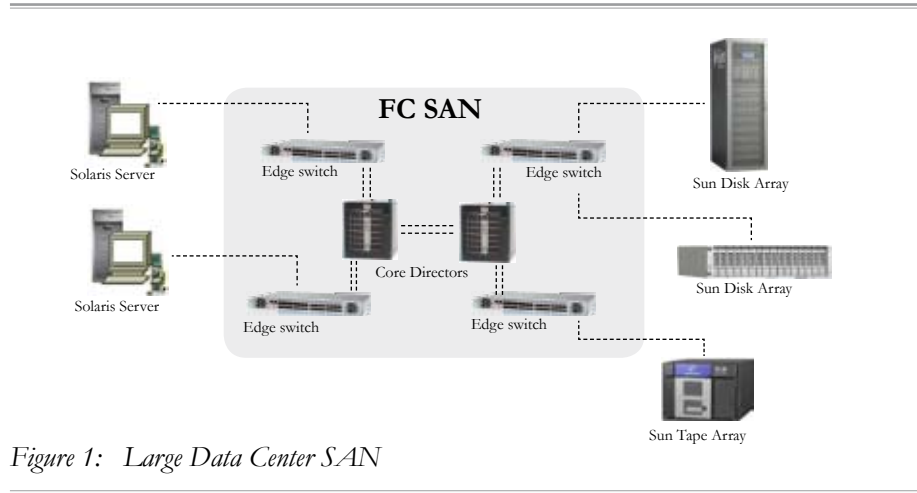


Figure 1: Large Data Center SAN

## Introduction to iSCSI SANs

iSCSI SANs connect servers with storage targets over the TCP/IP network . Using iSCSI, it is possible to connect to storage devices which are connected to the Local SAN as well as the devices connected across a WAN. iSCSI runs over existing Ethernet networks and at variable bandwidths: Ethernet, Fast Ethernet, OC-3 or OC-12 , Gigabit Ethernet or 10 Gigabit Ethernet.

iSCSI SANs are cost-effective. Existing network infrastructure can be utilized for iSCSI SAN implementation. Unlike FC, no new infrastructure is needed for data traffic. Existing Ethernet or Gigabit Ethernet cards can be used to run iSCSI Initiators. Existing Layer 2 Ethernet Switches and Layer 3 Routers can be used for switching and Routing the Traffic. Different priorities can be achieved using different VLANs. iSCSI can render better quality of service and ensure dedicated bandwidth for applications by using COS (tagged header) and DSCP (IP header).

Very little training is needed for TCP/IP administrators. The existing Fibre Channel targets can be used with iSCSI initiators. With the help of an iSCSI to FC gateway, the iSCSI hosts can connect to the existing FC storage devices. For enhanced security in iSCSI, IPSec can be used to encrypt data traffic.

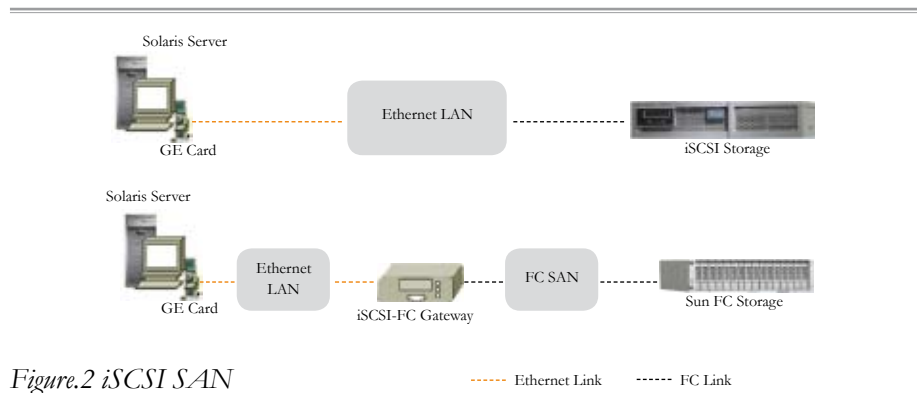


Figure.2 iSCSI SAN



## Fibre Channel over Ethernet (FCoE)

FCoE enables SAN traffic to be natively transported over Ethernet networks while protecting the investment customers have made into the FC SAN. FCoE is an emerging standard which provides a direct mapping of Fibre Channel over Ethernet. FCoE standards body includes all the major SAN vendors such as Brocade, Cisco, EMC, Emulex, IBM, Intel and Sun. The first products supporting FCoE are expected to be available early 2009, on 10 Gig Ethernet. FCoE HBAs (10G Ethernet adaptor) can be connected to an FCoE switch and the FCoE switch can connect to an existing FC fabric. Figure-3 illustrates how FCoE hosts can connect to existing FC fabrics.

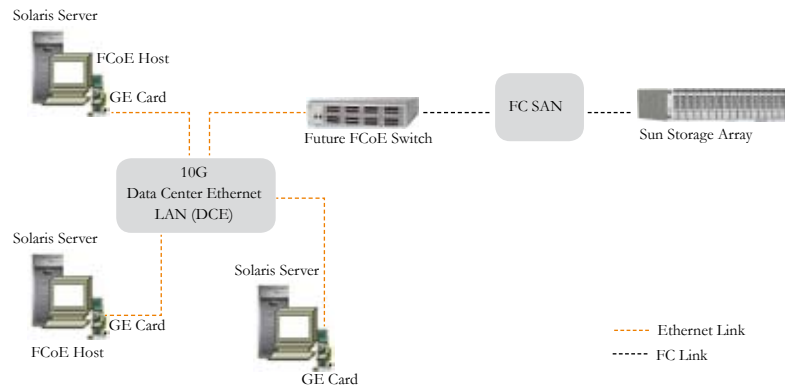


Figure-3 FCoE Hosts connecting to existing FC fabrics

For enabling FCoE functionality, the existing Ethernet should provide the following features:

1. Support for PAUSE: The PAUSE mechanism ensures that Ethernet is reliable. The receiving end sends a PAUSE frame if its buffers are full. On receiving PAUSE, the sender stops sending frames, thus preventing packet loss due to buffer overflow.
2. Jumbo Frame Support: Jumbo frame support enables avoiding fragmentation and reassembly of FC Frames (2K Bytes) into 1500 bytes of Ethernet Frames. Increasing frame size reduces the Number of Frame transmission for a given block of data and consequently reduces retransmissions less number of main CPU Interrupts and therefore reduces Overheads.
3. Priority processing and packet scheduling: Priority based packet scheduling mechanism ensures that high priority traffic does not get affected by lower priority traffic.



4. FCoE implements Per priority PAUSE: Use of the Ethernet flow control (PAUSE mechanism) on a per priority basis and providing dedicated band width for selective class of traffic.
5. Discovery and capability exchange protocol to exchange capabilities between sender and receiver.

The enhanced Ethernet which satisfies these five requirements is called Data Center Ethernet (DCE).

An FCoE switch is a DCE switch which has FC switch functionalities. In an Ethernet network where DCE and non-DCE switches exist, an FCoE HBA can connect only to a DCE or FCoE switch. Figure-4 shows valid and invalid attachments in FCoE

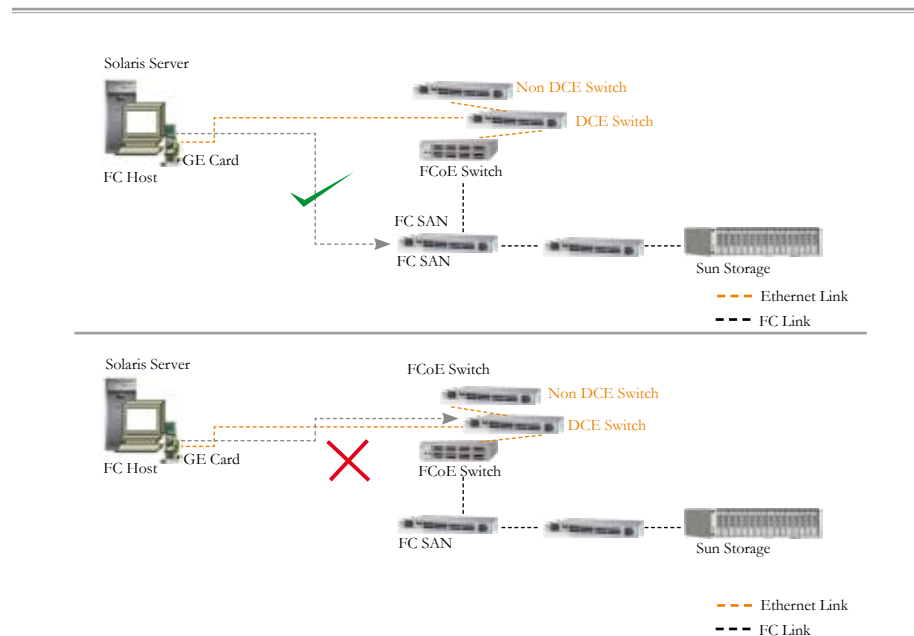


Figure-4: Valid and Invalid attachments in FCoE

## Future Trends with FCoE

FC switch vendors are likely to get into FCoE space by building FCoE switches. Popular FC switch/director vendors such as Brocade and Cisco are members of the standards body.

FC HBA makers and Ethernet NIC vendors are likely to get into FCoE by making FCoE HBAs. Emulex, QLogic and Intel are members of the standards body.

FC target makers could get into FCoE space by building FCoE targets. HDS and IBM are members of the standards body.



QLogic, Network Appliance and Nuova Systems are demonstrating the industry's first converged network with Fibre Channel Over Ethernet (FCoE) technology in SNW October 2007.

## Design Considerations for a SAN

Before considering whether to migrate to FCoE in the long run, or not, let us first see the design considerations an administrator should have in mind while upgrading SAN.

The first factor to account for is I/O consolidation. If separate networks are used for the LAN and storage traffic, it can consume a larger number of adaptors, cables, network equipments and managing software. Once I/O consolidation is implemented, the needed number of network components will become at least half the original number. This will reduce the equipment investment and rack space required to house the equipment. If the primary objective of the administrator is to obtain I/O consolidation, iSCSI offers it right now. The existing network infrastructure can be used for storage traffic also. One drawback of this would be reduced storage throughput because of the LAN traffic. The throughput can be improved by using VLANs and configuring QoS/Diffserv for each category of traffic. Once FCoE is available, FCoE will provide the I/O consolidation.

The second factor is the bandwidth and performance needed by the applications. iSCSI uses up a lot of CPU processing. With 10Gigabit Ethernet the CPU overhead further increases significantly as the CPU has to process more packets in the same time interval. With FCoE, CPU overheads will be very less as there is the CPU processing needed is very little.

In 10G iSCSI environment, the load on the TCP offload engine will increase considerably. High end TOE will be required for line rate performance for iSCSI. FCoE does not require TOE and hence will scale better to increase in line rate compared to iSCSI. High throughput demanding applications like OLTP transactions and video streaming will benefit from FCoE implementation. Per priority PAUSE based QoS supported by FCoE can be used to ensure bandwidth availability for high priority data transfer. Figure-5 illustrates the use of PAUSE to prioritize traffic.

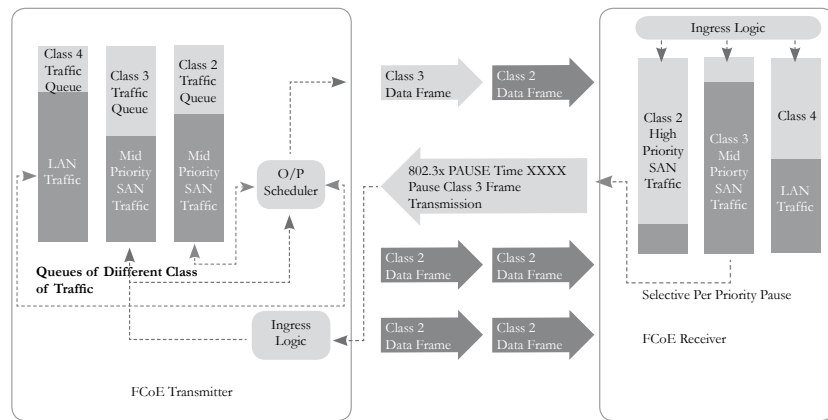


Figure-5 Use of PAUSE frames to prioritize traffic

The third consideration an administrator should have in mind is the cost of the SAN implementation. iSCSI provides the cheapest solution as it does not require a separate network for storage (like FC). No special HBAs are required for iSCSI deployment. The existing networks cards act as HBAs in case of iSCSI. iSCSI software stacks are available freely in Solaris, Windows and Linux environments. A high performance iSCSI SAN will be a bit more expensive as it requires powerful TCP offload Engines to reduce the CPU overhead. For achieving better performance a separate GE network can be implemented. This will still be less expensive than the FC fabric. A FCoE SAN would be more expensive than iSCSI SAN because a dedicated FCoE switch is needed.

The fourth consideration the administrator should have is the management of the SAN. FCoE will provide the same view as the FC. So the current FC administrators can manage the FCoE networks with out any special training. However, separate tools need to be used to manage Ethernet traffic. And administrators need to have both FC and Ethernet management knowledge. Many of the existing SAN management applications support iSCSI. The traffic monitoring tools available currently supports iSCSI.

## Recommendations for new data centers

New data centers can choose Fibre channel:

- If the performance is of utmost important and cost is not a factor in the SAN implementation. By using small switches instead of Directors, the cost can be minimized, but still it would be more expensive than iSCSI. The cost of expansion also will become higher.



- If the application is IO intensive. Fibre Chanel SANs can later migrate to FCoE. This will bring additional benefits like I/O consolidation and lower management costs to upgrade. For migration, existing FC knowledge as well as the same management tools can continue being used. FC concepts and practices can be applied to FCoE directly.

New data centers can use iSCSI

- If the prime objective is to set up a SAN at the lowest cost.
- If the organizations can live with the existing iSCSI performance. The performance of the iSCSI can be further improved by using iSCSI HBA and 10G Ethernet. For this approach, all the existing monitoring tools will work. Maintenance costs will be very minimal due to the network consolidation. Trouble shooting of the TCP/ IP networking also will be easier as the skilled administrators are readily available.

## Recommendations for existing data centers

If the performance and throughput of an iSCSI based datacenter is acceptable for an organization, it can continue to use the iSCSI. Periodically the data center user can re-evaluate whether the application I/O demands have increased or not. If the I/O demands have increased considerably, FCoE can be introduced into the existing network. This can be done incrementally by introducing DCE into the network and having the new hosts as FCoE enabled.

FCoE can be deployed in existing FC data centers:

- FCoE HBAs can be used on the new servers. These servers can be connected with FCoE switch or FCoE blades of an FC director.
- By introducing new FCoE servers, the organization can benefit from the I/O consolidation and increased bandwidth.
- In case small data centers planning for a major upgrade, they can be migrated directly to FCoE. These organizations can buy an FCoE director and use FC cards on these to connect to the existing FC storage devices.

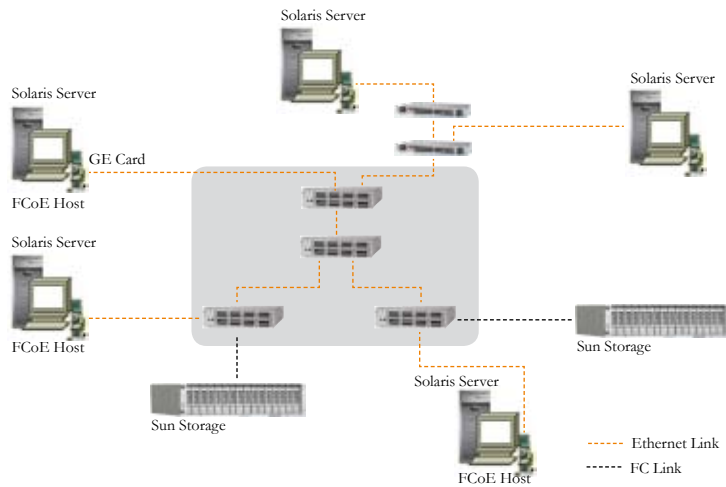


Figure-6 shows a futuristic SAN where FCoE technology is deployed end-to-end.

## Summary

Most SANs existing today are built using the FC technology. iSCSI SANs are beginning to show promise, especially in new data centers. Cost, management, bandwidth, application performance and need for I/O consolidation are key factors in design decisions for Storage area networks. New and existing data centers need to consider these factors to come up with step-by-step migration plans to FCoE.



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## **About the document**

The document compares Storage Area Network (SAN) protocols such as the futuristic Fiber Channel over Ethernet (FCOE) and the mature iSCSI on various criteria. It also provides vital recommendations for Datacenters for those who have deployed or are deploying SANs. This document is useful for IT managers, system

administrators, and network architects. It is not meant as a technical study; instead, it distills the experiences we had

with various products, so that IT managers can map their datacenter needs and make appropriate decisions backed by HCL's experience.

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HCL Technologies is one of India's leading global IT Services companies, providing software-led IT solutions, remote infrastructure management services and BPO. Having made a foray into the global IT landscape in 1999 after its IPO, HCL Technologies focuses on Transformational Outsourcing, working with clients in areas that impact and re-define the core of their business. The company leverages an extensive global offshore infrastructure and its global network of offices in 18 countries to deliver solutions across select verticals including Financial Services, Retail & Consumer, Life Sciences & Healthcare, Hi-Tech & Manufacturing, Telecom and Media & Entertainment (M&E). For the quarter ended 30<sup>th</sup> September 2007, HCL Technologies, along with its subsidiaries had last twelve months (LTM) revenue of US\$ 1.5 billion (Rs. 6363 crores) and employed 45,622 professionals. For more information, please visit [www.hcltech.com](http://www.hcltech.com).

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