iSCSI Design and Implementation

Recuerde siempre:

- Apagar su teléfono móvil/pager, o usar el modo “silencioso”.

- Completar la evaluación de esta sesión y entregarla a los asistentes de sala.

- Ser puntual para asistir a todas las actividades de entrenamiento, almuerzos y eventos sociales para un desarrollo óptimo de la agenda.

- Completar la evaluación general incluida en su mochila y entregarla el miércoles 8 de Junio en los mostradores de registración. Al entregarla recibirá un regalo recordatorio del evento.

iSCSI Storage Network Design

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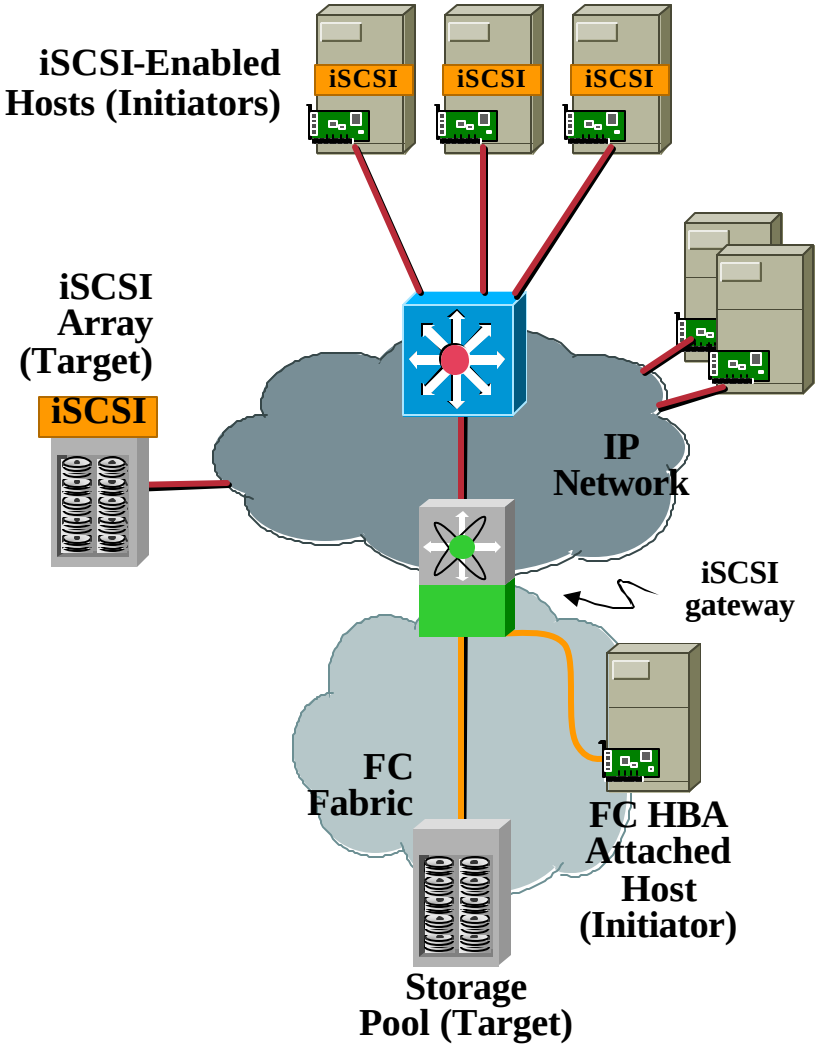
- **IT Challenges that iSCSI Helps to Solve**
- **iSCSI Concepts**
- **iSCSI Integrations and Design Elements**
- **End to End HA Design**
- **iSCSI Client Performance**
- **iSCSI Network Security**
- **Managing the iSCSI Network**

IT Challenges and Solutions

- **Inside enterprise data centers**
  - **40%-70% annual data growth rate**
  - **As much as 80% of data are isolated**
  - **SAN islands**
- **Challenges that the IT professionals face**
  - **Meet the high reliability, availability, security and performance demand at low operational cost**
  - **Growing unused disk and management (including backup) in DAS**
- **Storage consolidations => better efficiency**
  - **DAS to SAN migration**
  - **Server consolidation**
- **SAN extension => data protection**
  - **Host to storage**
  - **Storage to storage**

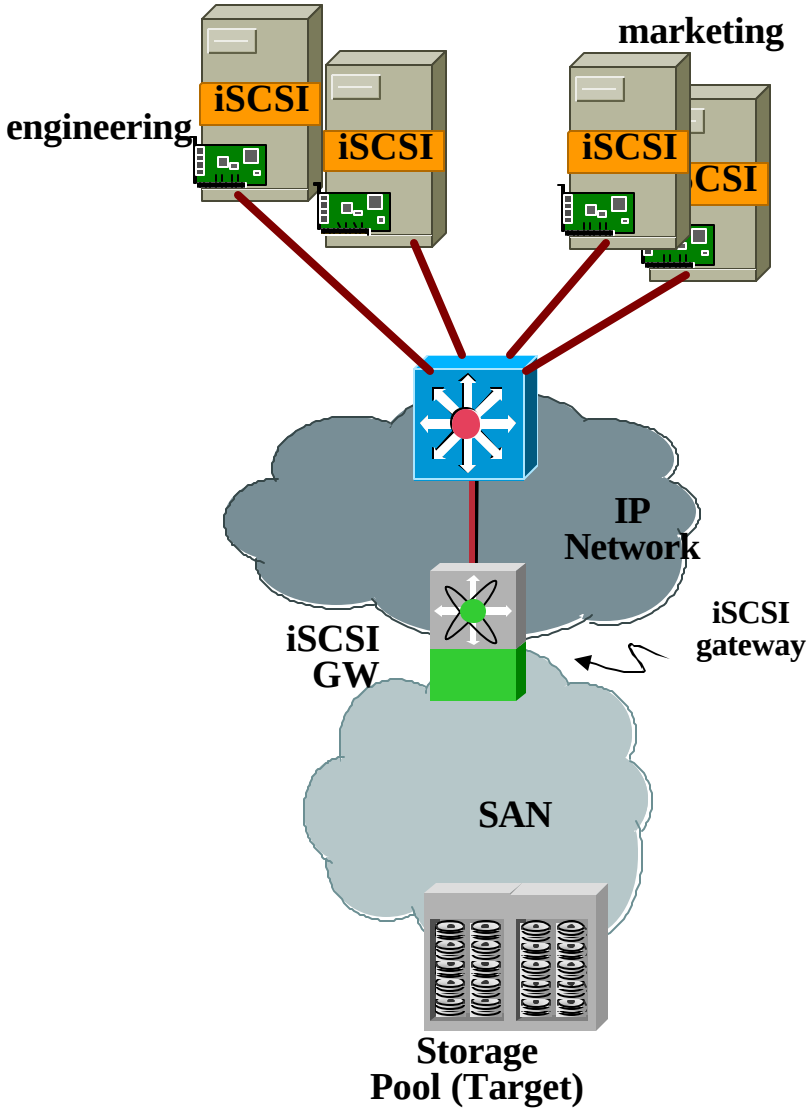
iSCSI for Storage Consolidation

- New trend: consolidation
- Storage consolidation promotes storage resource and data sharing, efficiency and simplicity
- Server consolidation centralizes computing resource and system management
- iSCSI is an enabling technology
  - IP access to open systems iSCSI array
  - iSCSI initiator with iSCSI driver or iSCSI HBA resides on Ethernet network accessing FC attached storage



iSCSI for Remote Host Access

- **Data protection requires enterprise to deploy geographic distributed data centers with data replication function**
  - **SAN extension**
  - **iSCSI remote host access**
- **iSCSI hosts can access to consolidated storage without theoretical limitation on distance via TCP/IP network (though distance should be considered when design with iSCSI)**
- **Remote host backup to the centralized storage protects user data beyond normal means**



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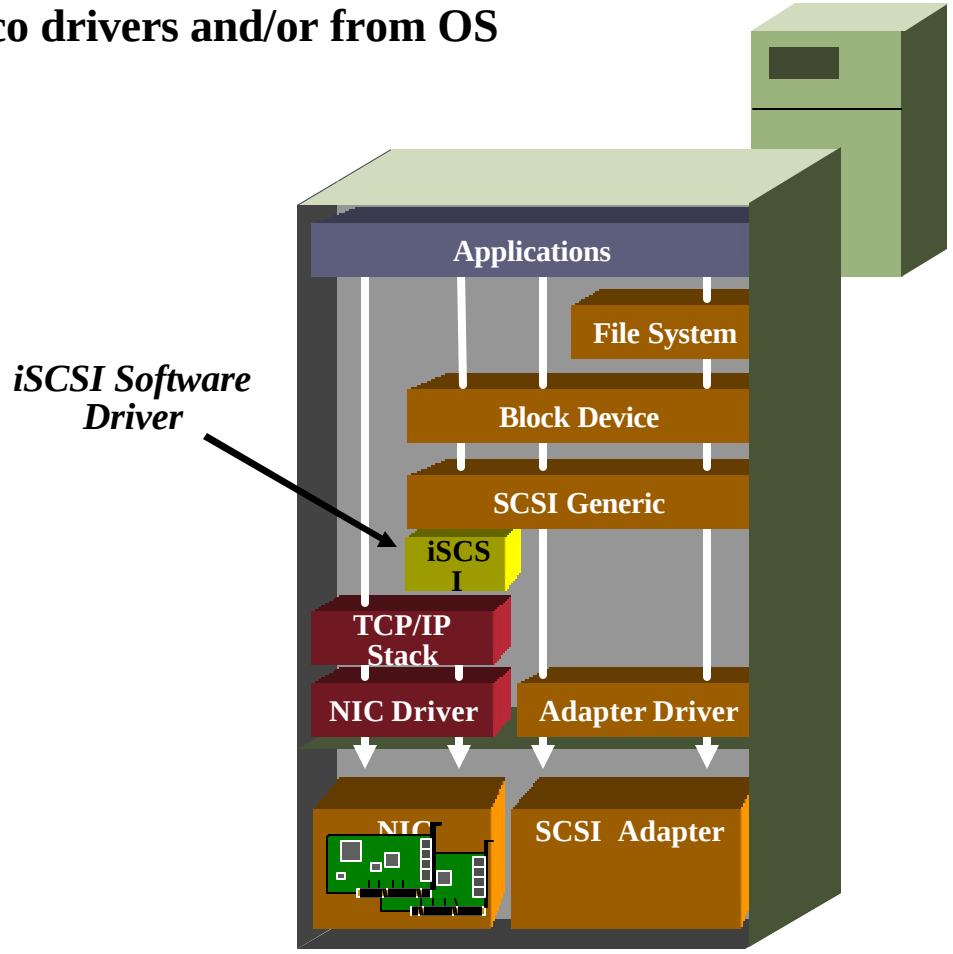
What Is iSCSI?

- A SCSI transport protocol that operates over TCP
  - –Encapsulates SCSI CDBs (operational commands: e.g. read or write) and data into TCP/IP byte-streams (defined by SAM-2—SCSI Architecture Model 2)
  - –Allows IP hosts to access IP based SCSI targets (either natively or via iSCSI to FC router)
- Standards status
  - –RFC 3720 on iSCSI
  - –Collection of RFCs describing iSCSI
    - •RFC 3347 – iSCSI Requirements
    - •RFC 3721 – iSCSI Naming and Discover
    - •RFC 3723 – iSCSI Security
- Broad industry support
  - –Server vendors now publishing own supported iSCSI drivers
  - –Native iSCSI storage arrays now appearing

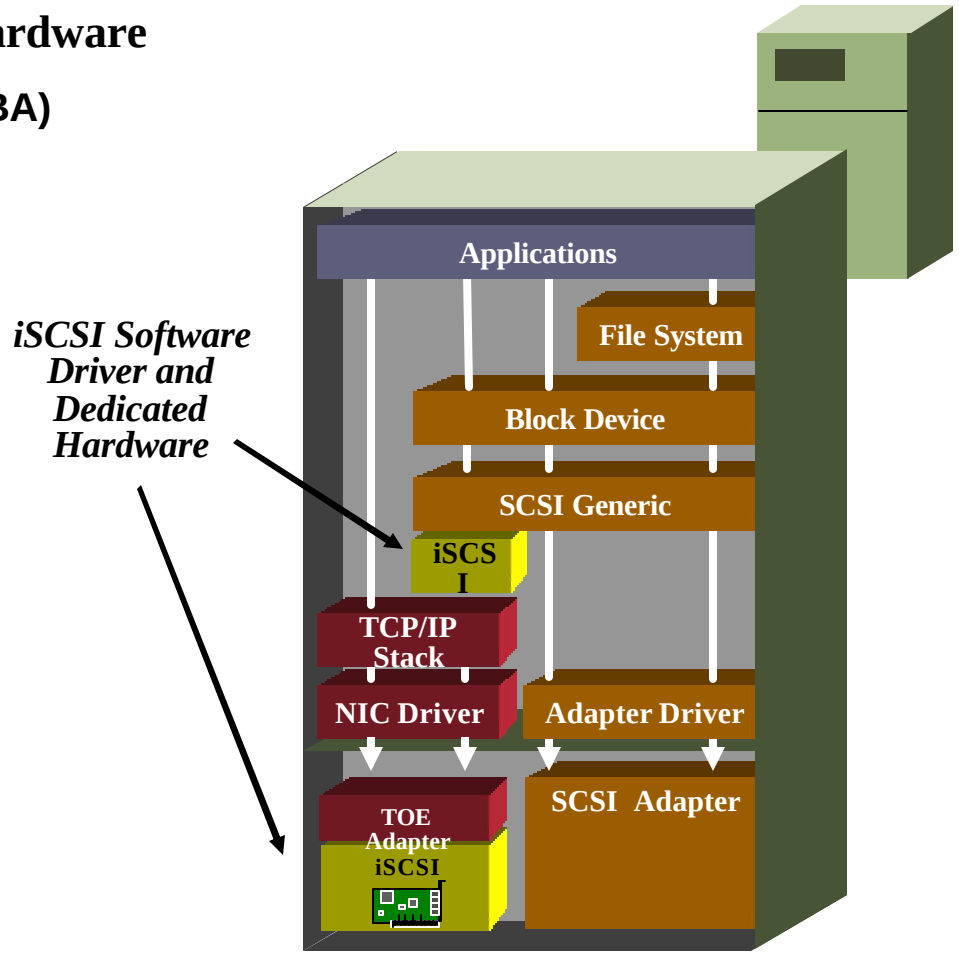
The Basic iSCSI Model with Software Only

- **iSCSI is a network service enabled through the use of an iSCSI software driver**
- **Many operating systems supported via Cisco drivers and/or from OS vendor**
  - **Cisco provides full driver suite**
    - **Solaris**
    - **Linux – based on 2.6 kernel**
    - **Win 2000**
    - **Windows XP Pro**
    - **WinNT 4.0**
    - **HP/UX**
    - **AIX**
  - **OS vendors support native iSCSI drivers**
    - **Windows *native* Win 2000, XP, 2003 support**
    - **HP *native* HP/UX support**
    - **IBM *native* AIX support**
    - **Novell Netware *native* support**

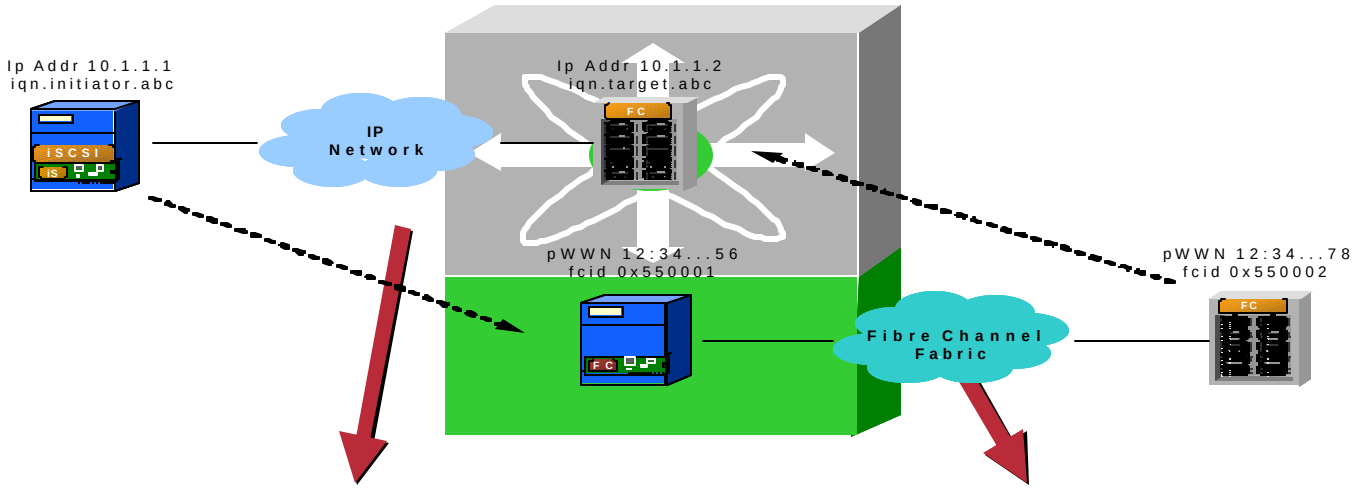


The Basic iSCSI Model with TOE

- **Hardware implementation of iSCSI within specialized NIC (1Gb and 100Mb available)**
- **Offloads TCP and iSCSI processing into hardware**
  - **Full Offload: iSCSI & TCP offload (iSCSI HBA)**
  - **Partial Offload: TCP offload only (TOE)**
- **Relieves host CPU from iSCSI and TCP processing**
- **Does not necessarily increase performance, only if CPU strapped**
- **Wire-rate iSCSI performance**
- **Not absolutely required to build iSCSI solutions**

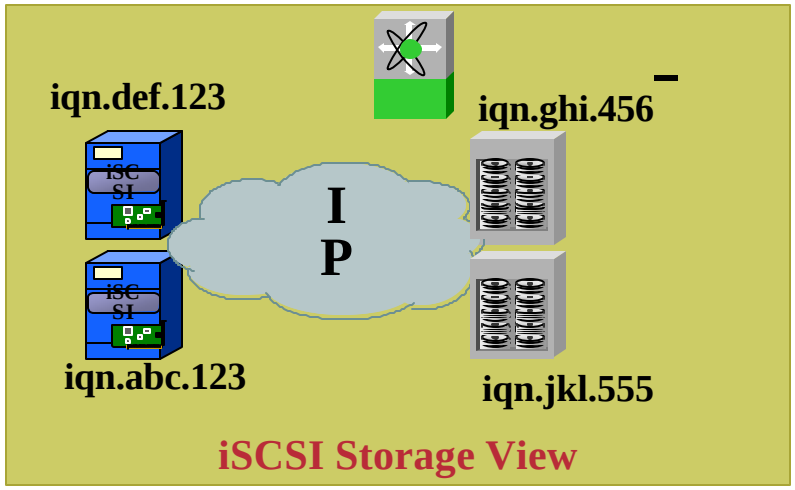


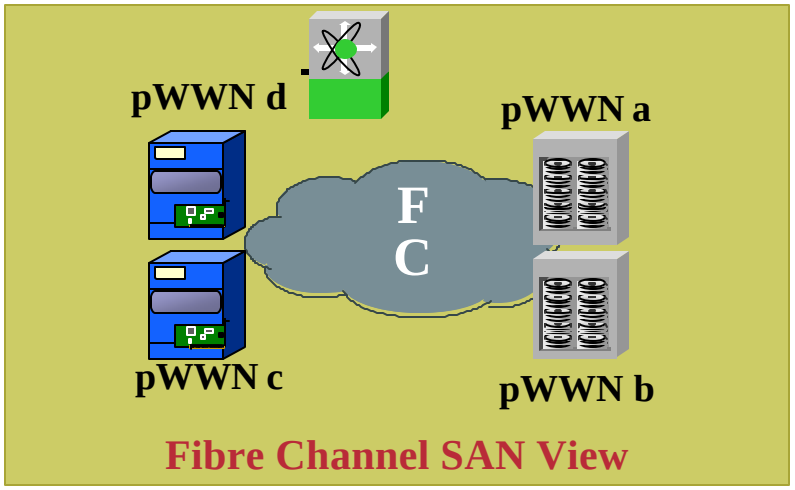
iSCSI gateway function on Cisco MDS



FC Targets Presented as iSCSI Targets

iSCSI Initiators Presented as FC Initiators





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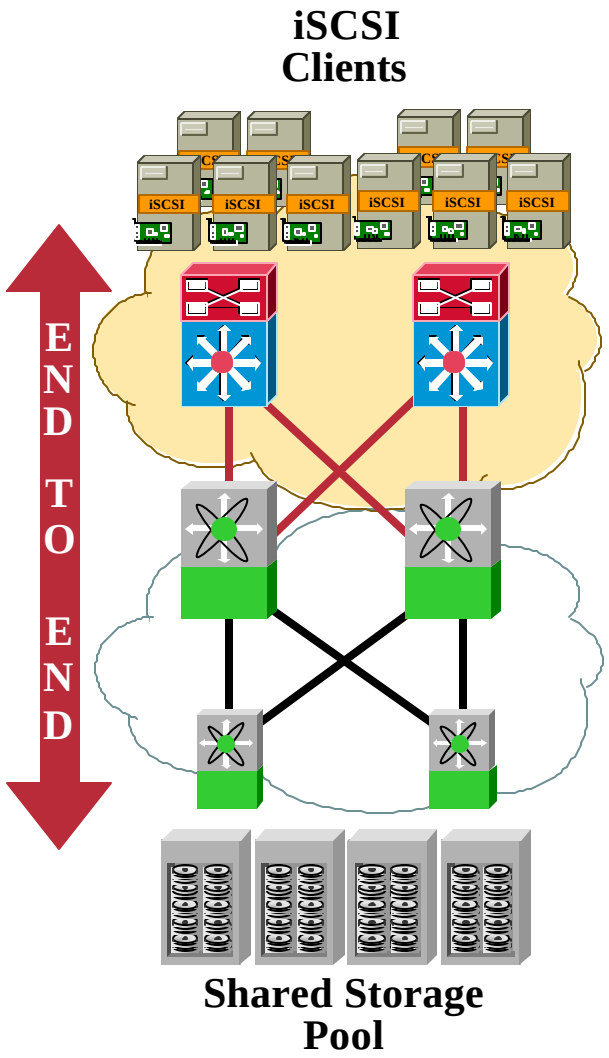
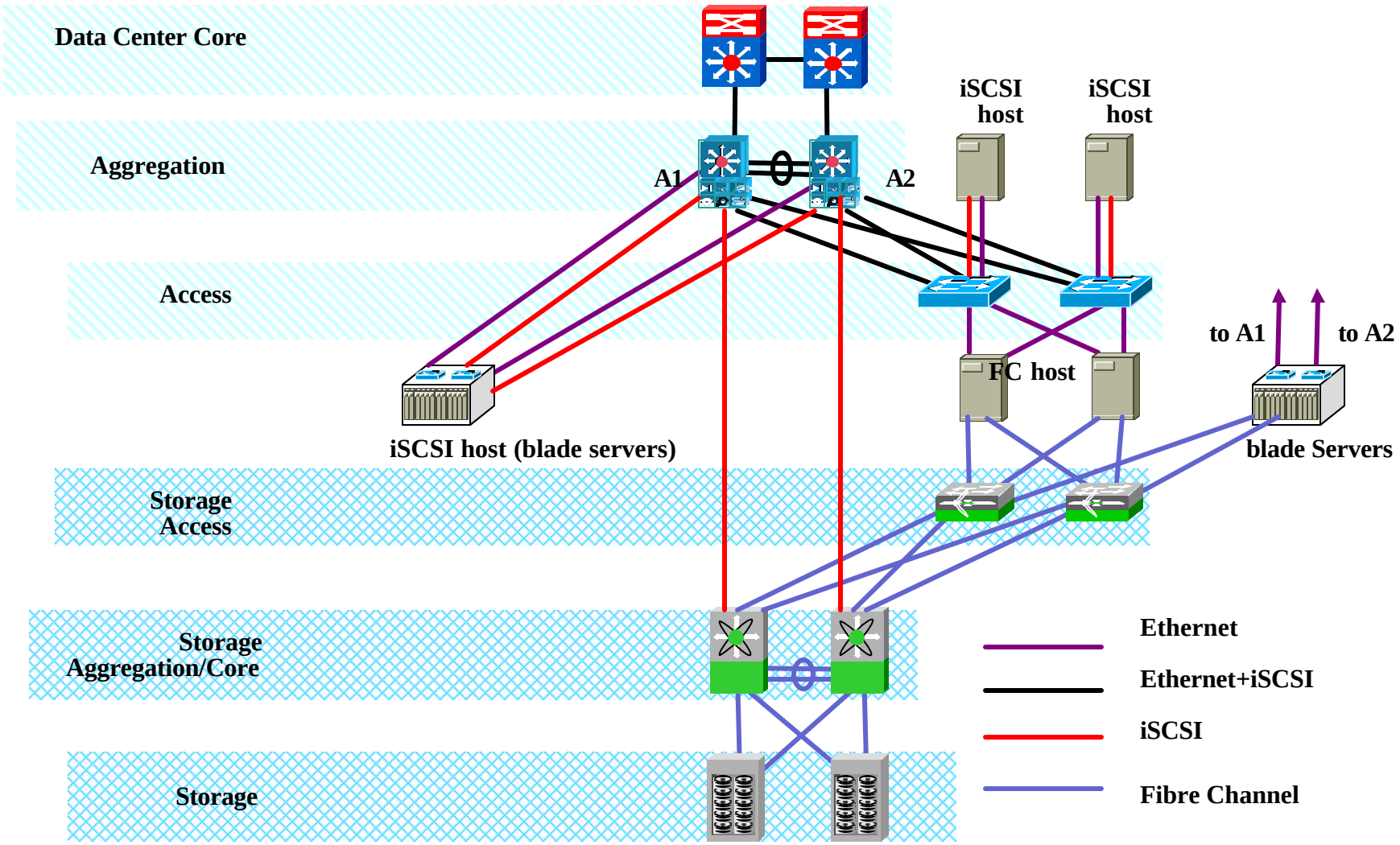
Build An Enterprise iSCSI Fabric

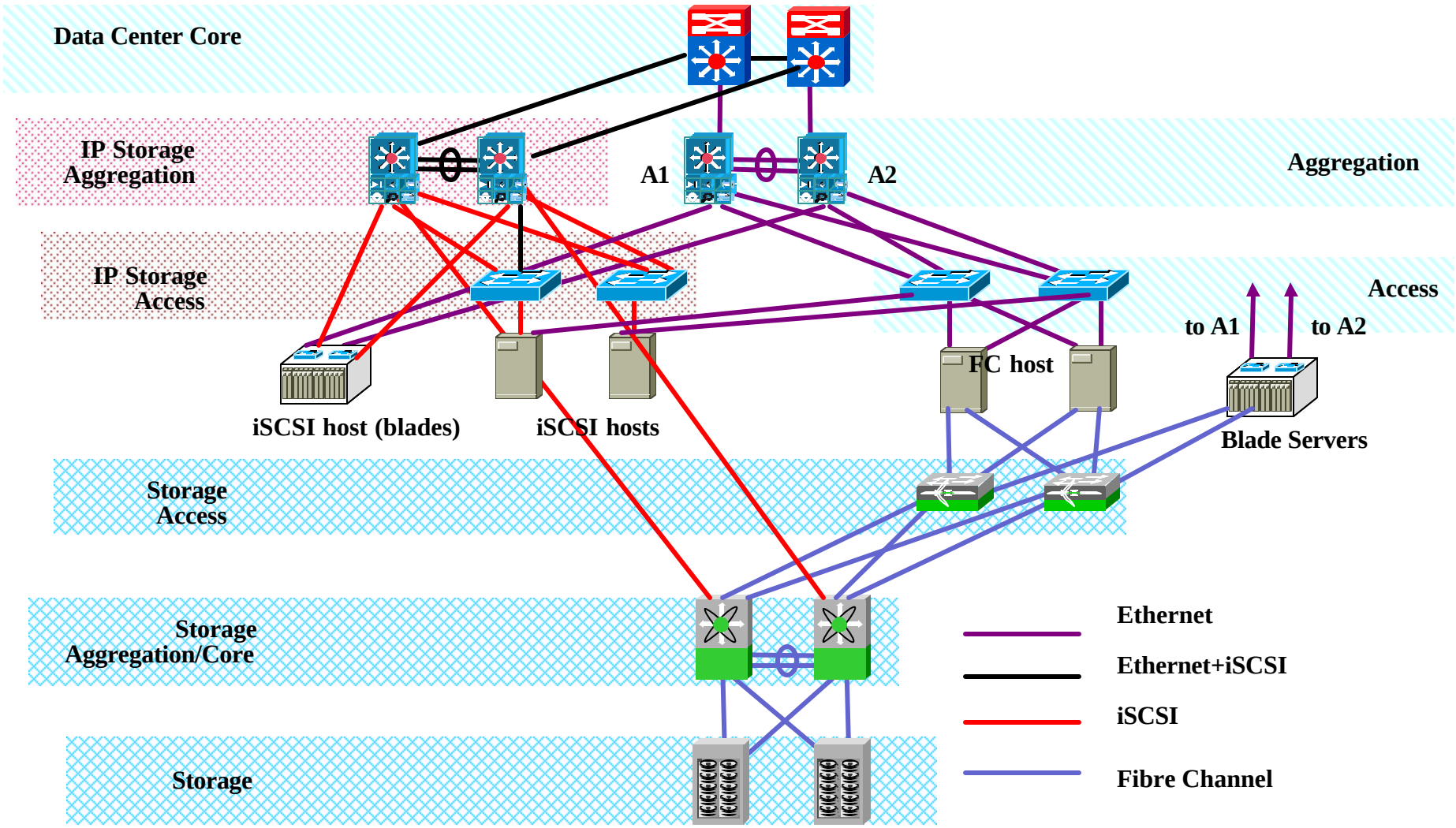
- **iSCSI fabric scalability**
  - **iSCSI proxy initiator**
  - **iSNS**
- **iSCSI fabric availability**
  - **Etherchannel**
  - **VRRP**
- **iSCSI fabric security**
  - **Authentication and binding**
  - **IPSec VPN**
- **iSCSI fabric manageability**
  - **iSCSI identity and management**
  - **Unified management tool**



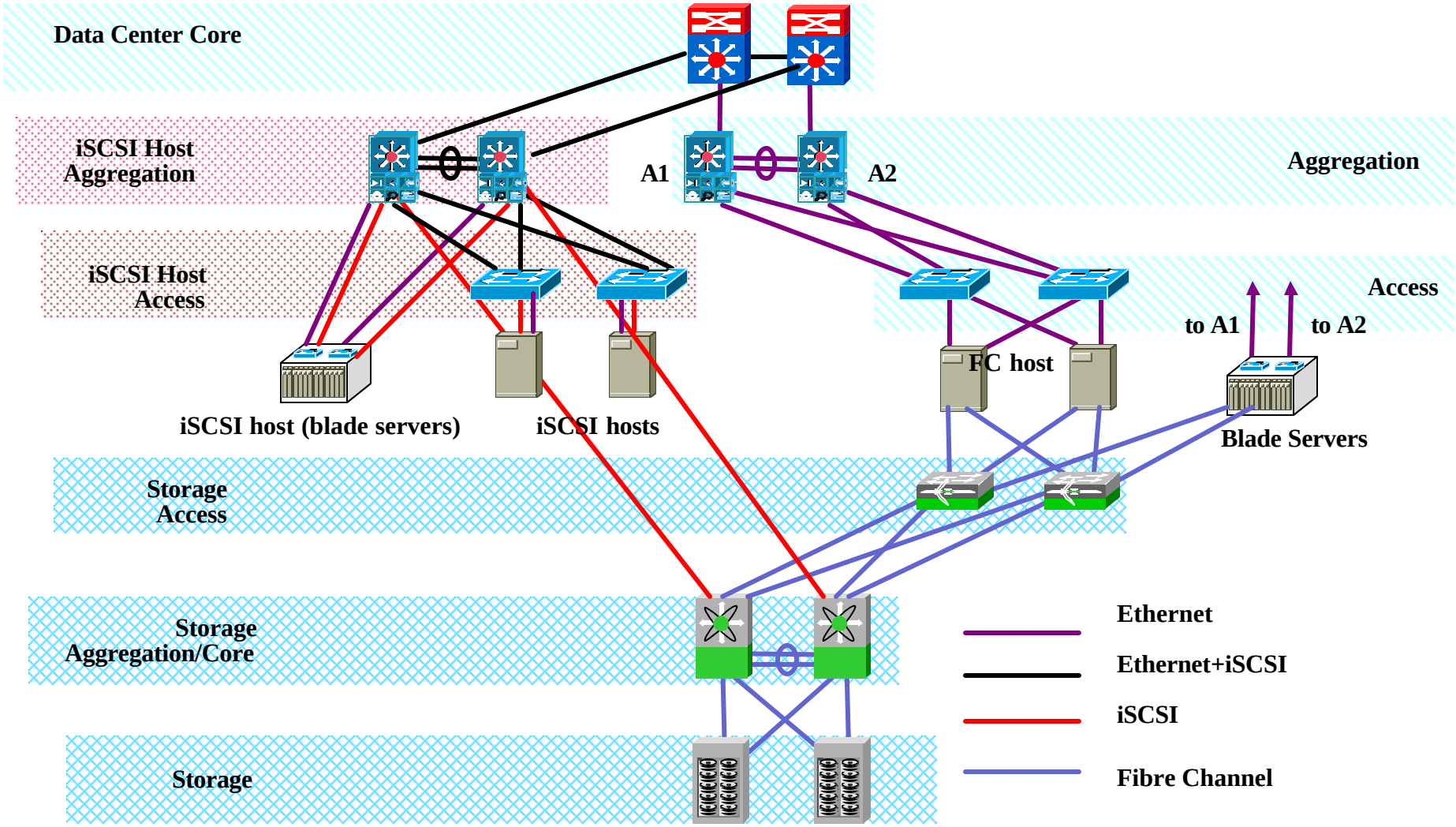
Shared Logical IP Network



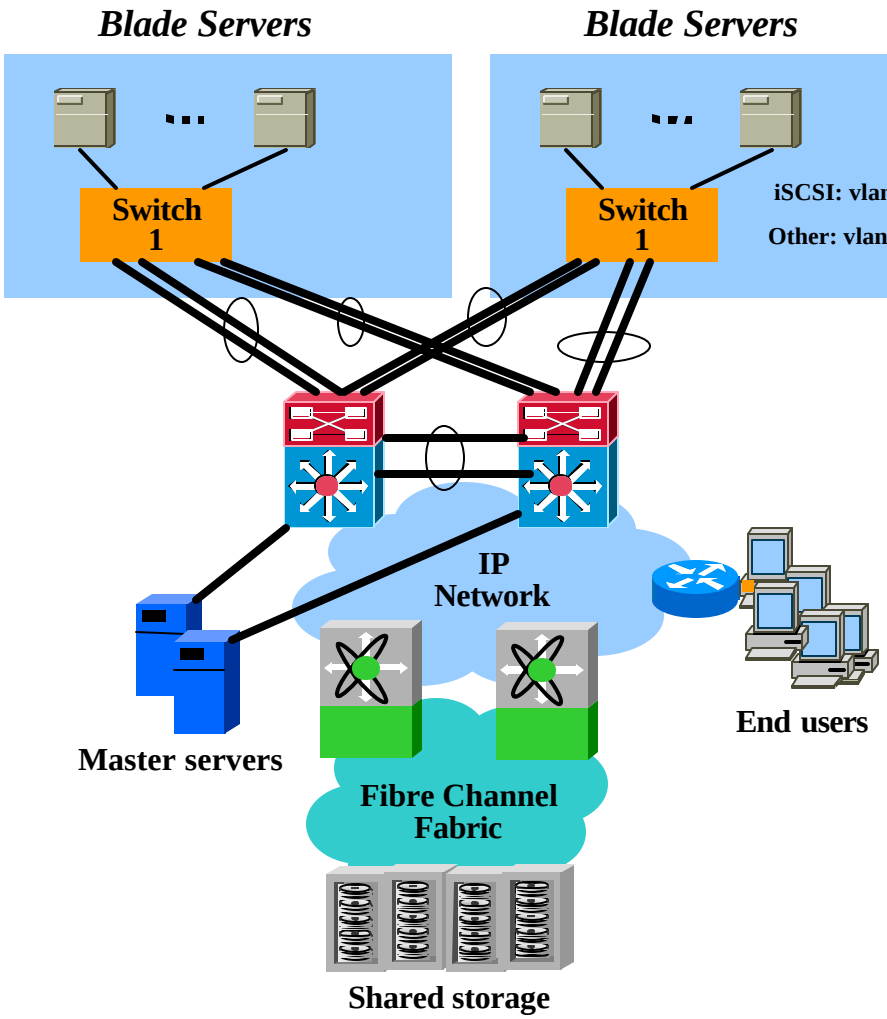
Dedicated IP Storage Layer



Dedicated iSCSI Host Services Layer

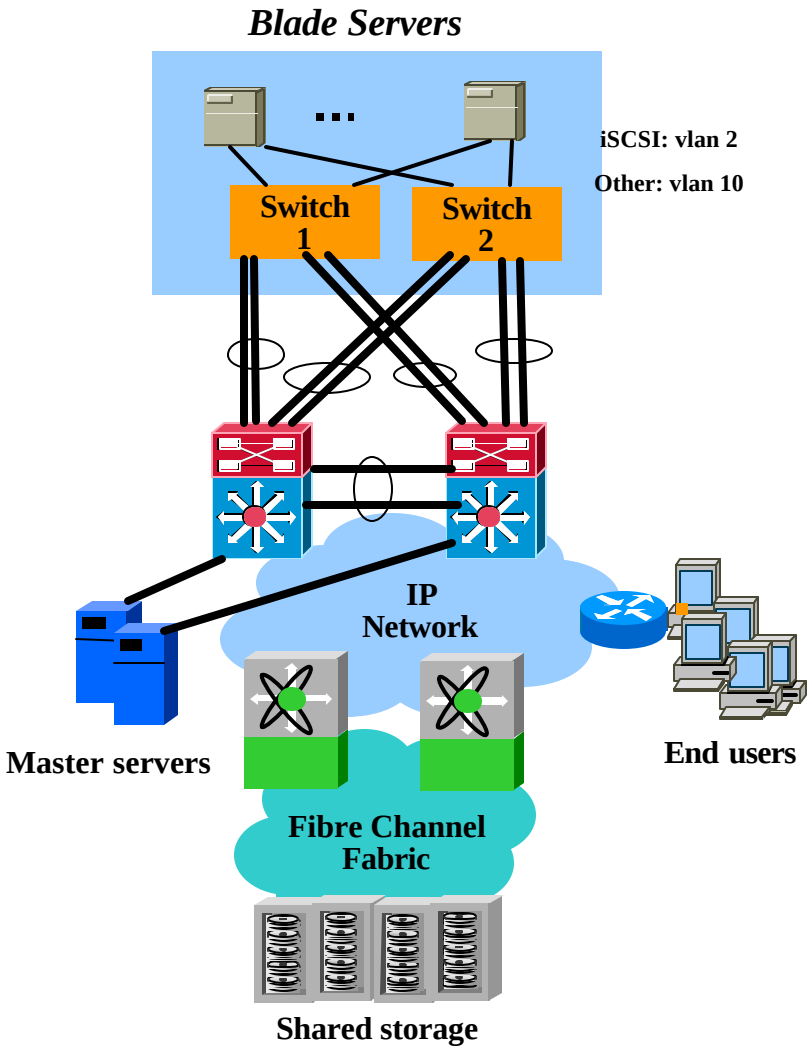


Storage Single NIC Design
iSCSI Integration with Blade Servers



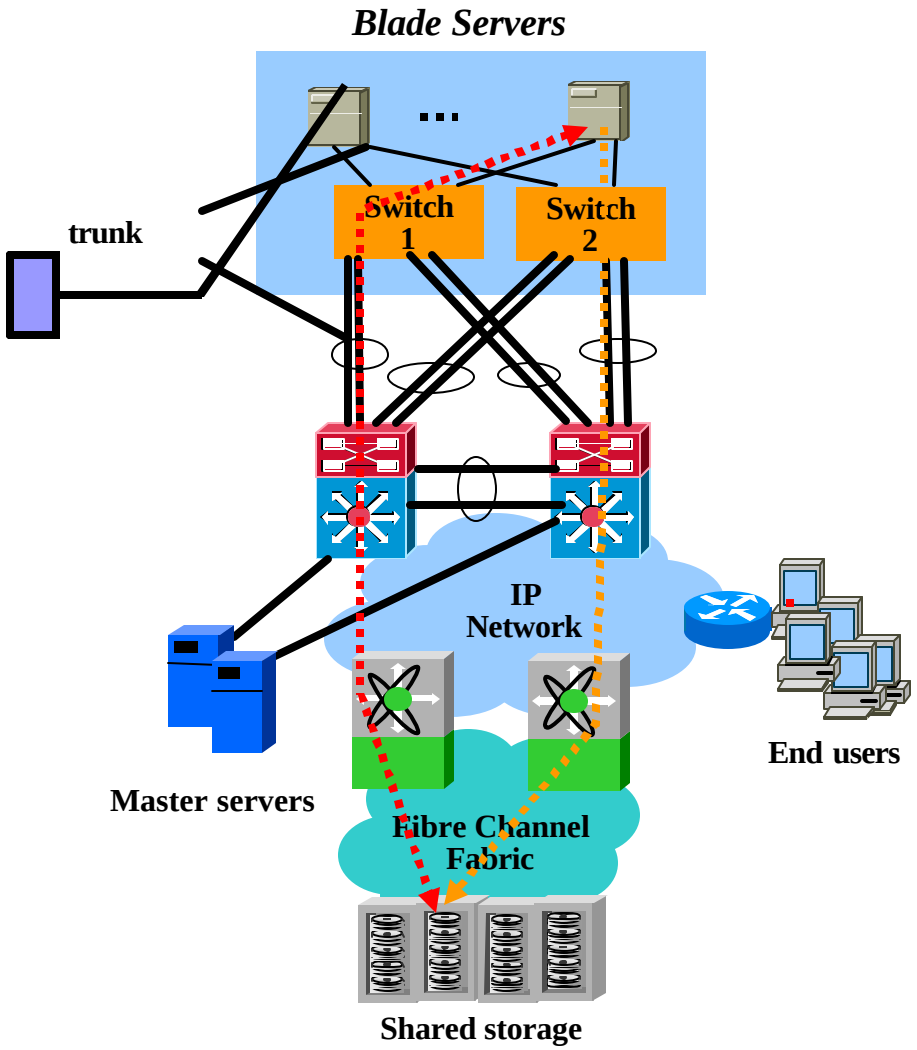
- One NIC card, one integrated switch to be used per chassis
- iSCSI and other IP traffic share the same link
- Separate VLAN for iSCSI and other IP traffic
- Implement QoS to prioritize iSCSI traffic
- Ease of management for blades
- HA and load balancing achieved via multiple deployment of blades and/or external service modules in Catalyst 6k

Two NIC Design
iSCSI Integration with Blade Servers



- Two NIC cards and both integrated Ethernet switches
- iSCSI takes one NIC, other IP traffic share the second NIC – dedicated NIC card for iSCSI
- Server load balancing for HA
- QoS can be implemented on trunk port

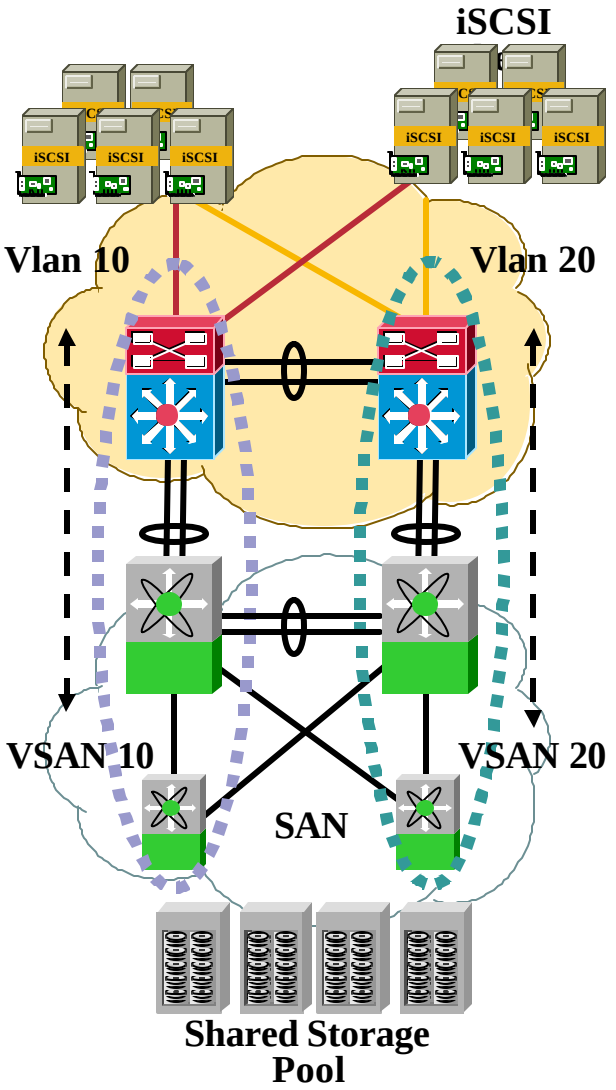
Two NIC Design (cont)
iSCSI Integration with Blade Servers



- **Two NIC cards and both integrated Ethernet switches**
  - ✓ **iSCSI and other IP traffic share the same NICs**
- **iSCSI and other IP traffic share the link**
- **802.1q trunks on both inter-switch links and server-switch links**
- **NIC teaming for HA on top of server load balancing**

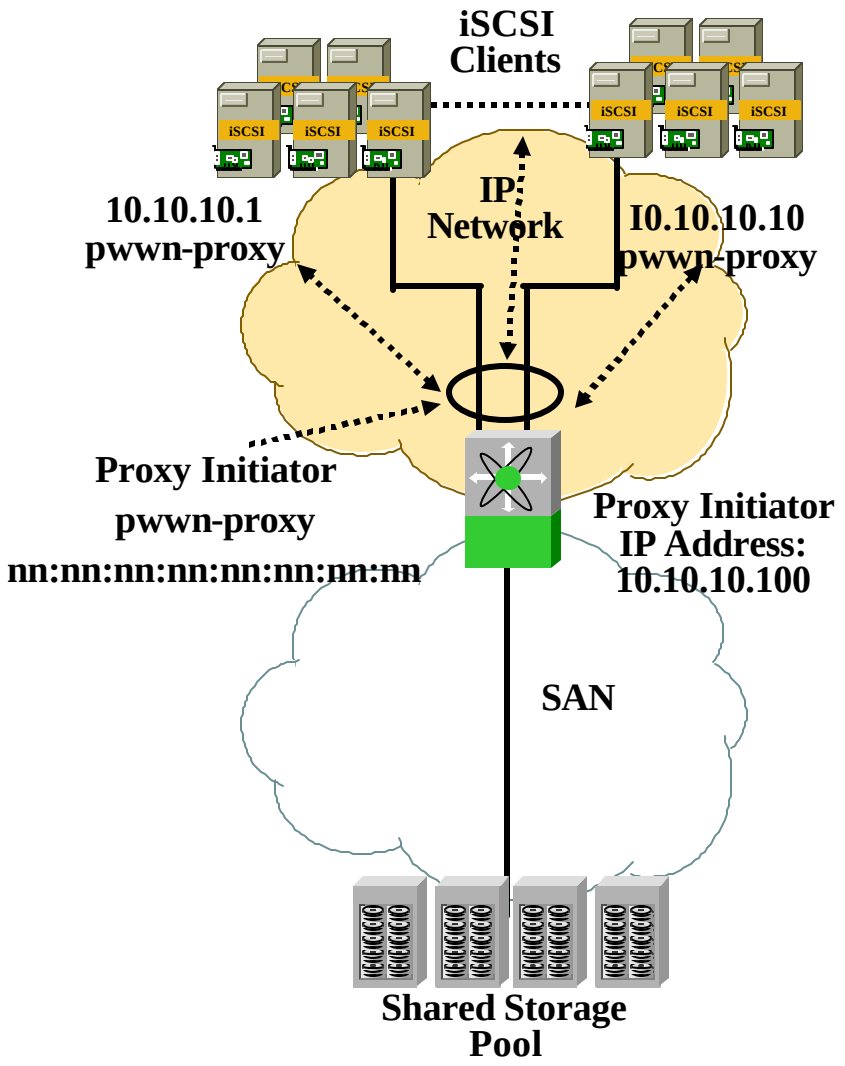
VLAN and VSAN Mapping: Best Practice Design

- **Vsan and vlan share the same tag**
- **VSAN membership**
  - **iSCSI hosts**
  - **FC port**
- **VLAN termination**
  - **Sub-interface**
- **VLAN and VSAN mapping advantages**
  - **Management**
  - **Troubleshooting**



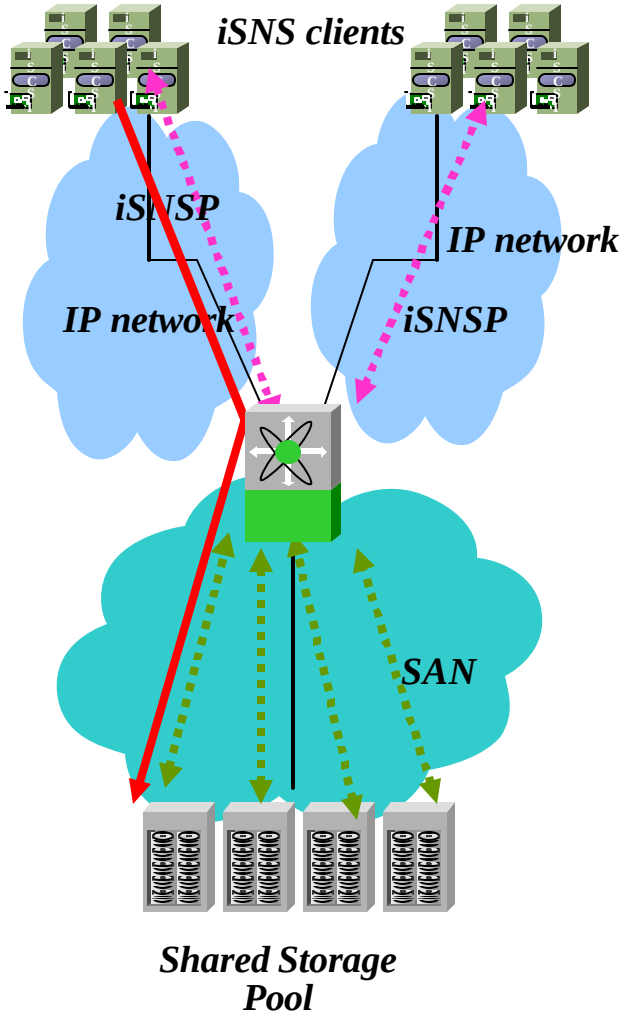
Proxy Initiator

- **Transparent mode—default**
  - **Array provides LUN mapping**
- **Proxy initiator**
  - **One pWWN to represent multiple iscsi initiators for scalability**
  - **Less entries in the FC Name Server**
  - **Ease management of zoning**
  - **Useful in file system clustering applications**
  - **Recommend to use MDS to perform LUN mapping**

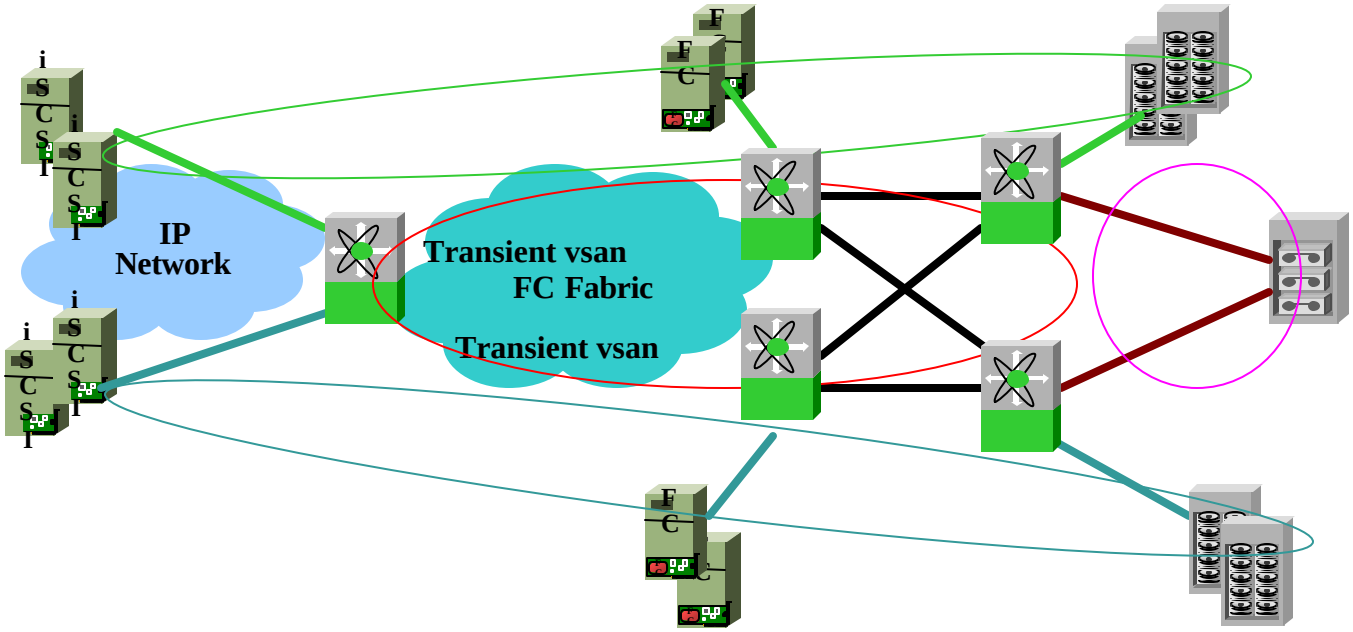


Internet Storage Name Service (iSNS)

- **iSNS**
  - Storage resource discovery: register/deregister/query
  - Automatic login control service: access control
  - State change: notification service
  - Light weigh protocol on top of TCP(iSNSP)
- **Design with iSNS**
  - iSNS server support on MDS 9000 or external servers
  - Dynamic discovery for large scale deployment
  - Centralized access control management for both iSCSI and FC devices
  - Seamless integration with FC name service
  - VSAN identity is preserved through iSNS interaction with FC NS server on MDS – advantage over MS or Linux iSNS servers

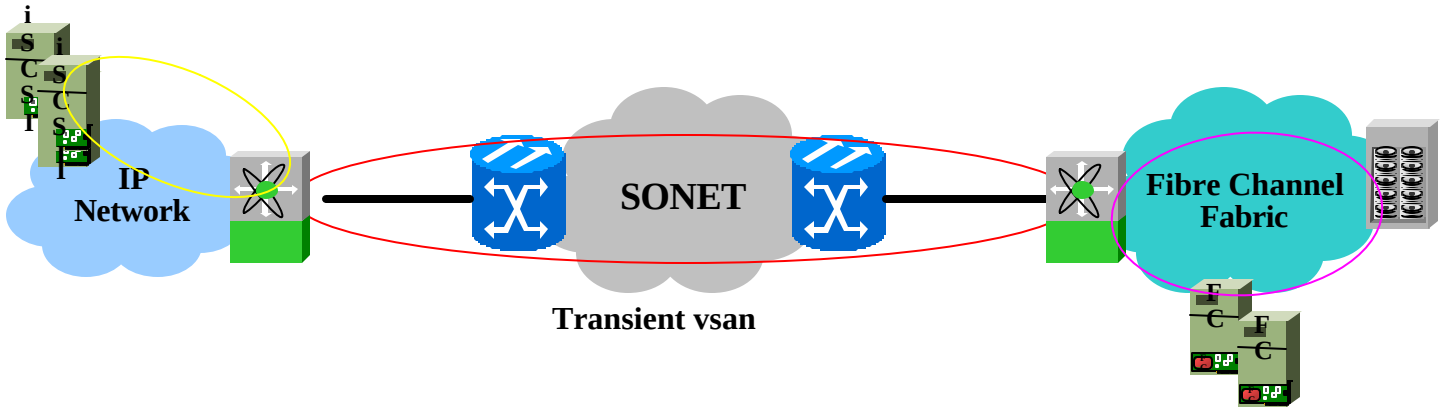


IVR Deployment Scenarios (1)



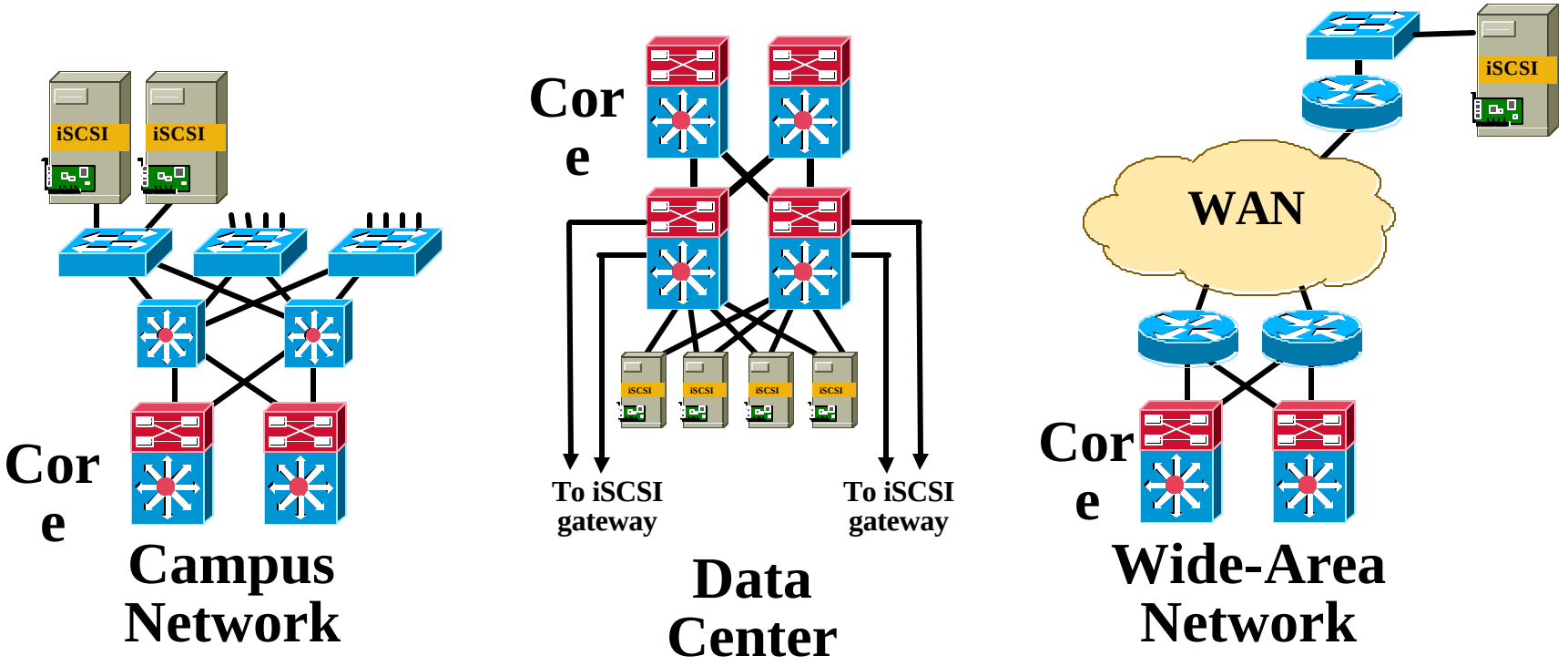
- **Departmental segregation**
- **Consistent in handling both FC and iSCSI servers**

IVR Deployment Scenarios (2)



- **iSCSI Remote Access**
- **Isolate problems in Transient VSAN**
- **No impact to the FC SAN because of the WAN issue**

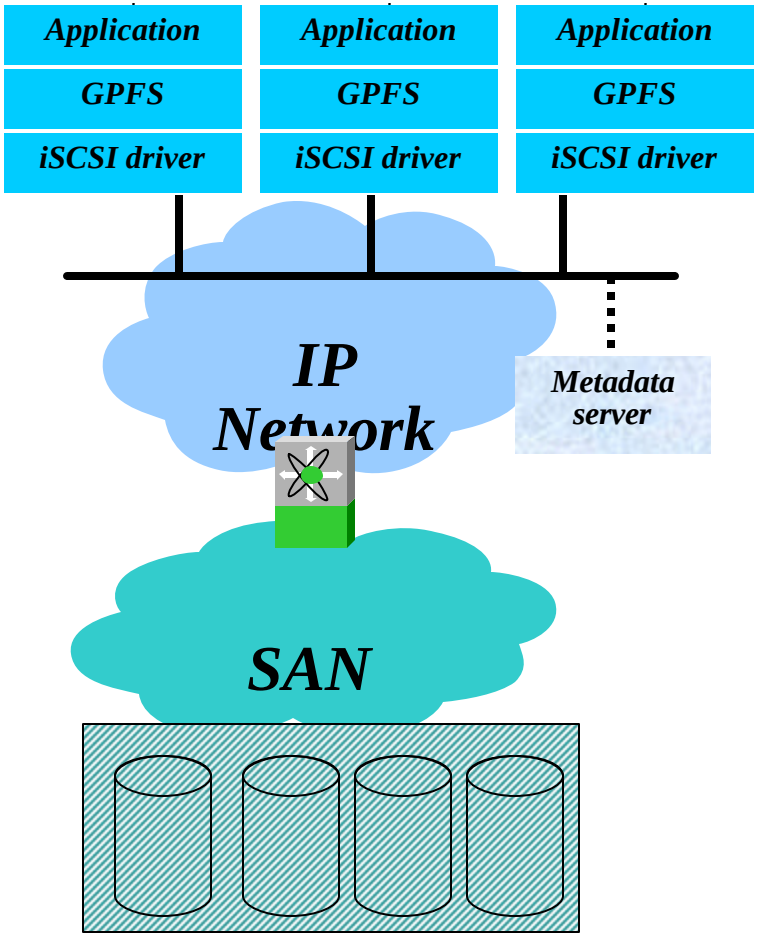
QoS for iSCSI: Best Practice Design for Convergence Network



- Delay and jitter
- Oversubscription design concept
- Bandwidth estimation – know the bottleneck
  - Aggregation point, WAN link
- DSCP on iSCSI GE interface
- Other QoS techniques on IP network: Traffic Shaping, Congestion Management (queuing) and CAR

Clustered File Systems in iSCSI Environment

- **File sharing provided by NFS or NAS Filers -- performance bottleneck?**
- **iSCSI provides high performance block level access – lack of file sharing**
- **Shared-disk (Clustered) File System**
  - **Allows sharing of file blocks via a shared clustered file system**
  - **Allows block level sharing of files with a meta dedicated file access control mechanism**
  - **Same physical device can be used via Fibre channel as well as iSCSI**



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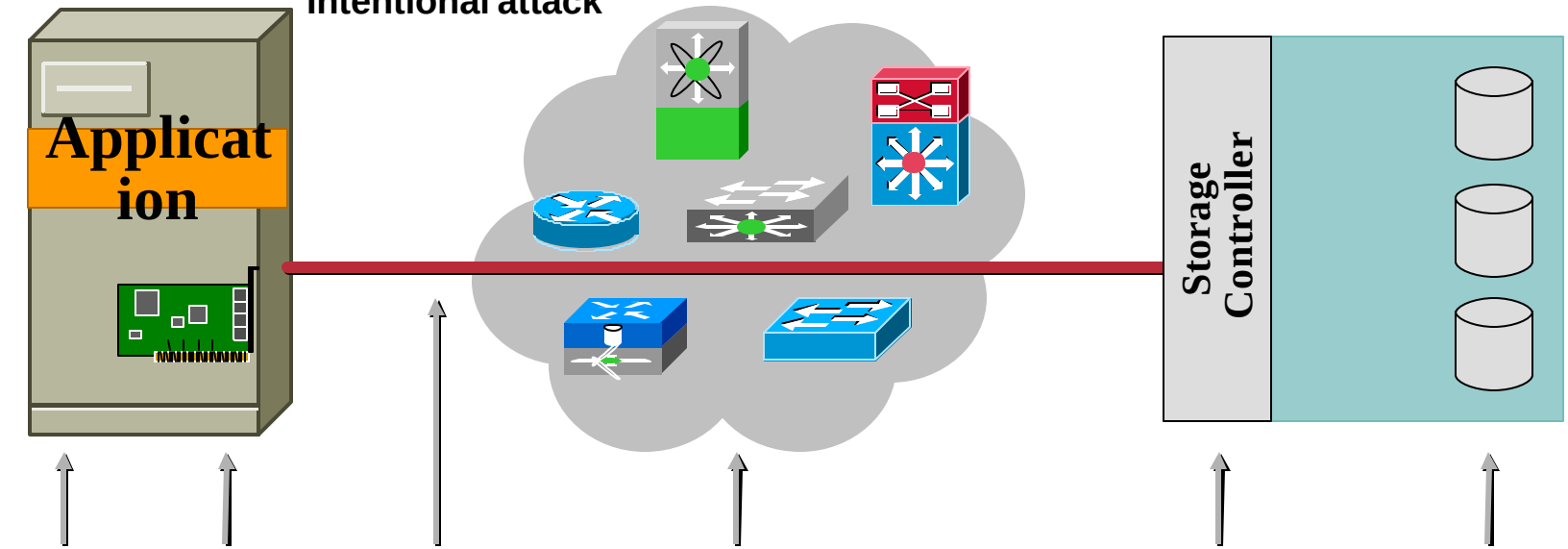
What Can Fail in a Storage Network?

- **Failure causes:**
  - **Hardware, software, or cable failures**
  - **Mis-configuration or upgrades**
  - **Intentional attack**



Host Failure

NIC or HBA Failure

Link Failure

Network Failure (Software, Hardware, Links, etc)

Controller or Interface Failure

Disk Failure

Host to iSCSI fabric connectivity

iSCSI fabric connectivity

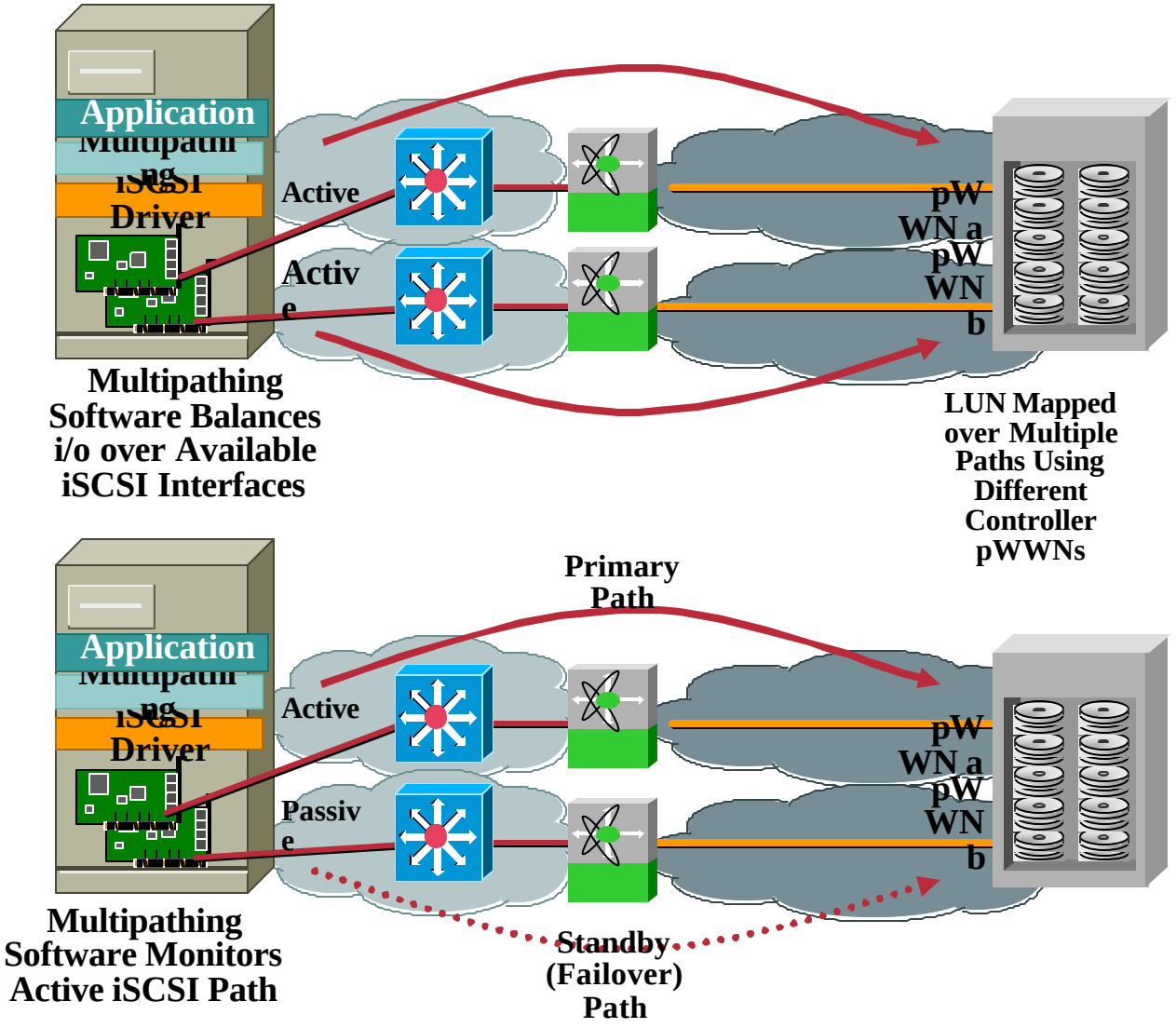
Storage to iSCSI fabric connectivity

iSCSI High Availability Approaches

Components	HA Options	Characteristics
iSCSI Host to Fabric	Multipathing software	Transparent failover, act/act, act/std, software cost
	MPIO	Integrated better with OS, require storage driver
	NIC teaming	Fast, application level retransmission, free
iSCSI Fabric	Etherchannel	Stateful failover, single point of failure possible
	VRRP	Fast, application level retrans., span multiple cards
Storage to Fabric	Multipathing software	Act/act, act/std, software cost
	PWWN aliasing/trespassing	Act/passive with support of trespassing

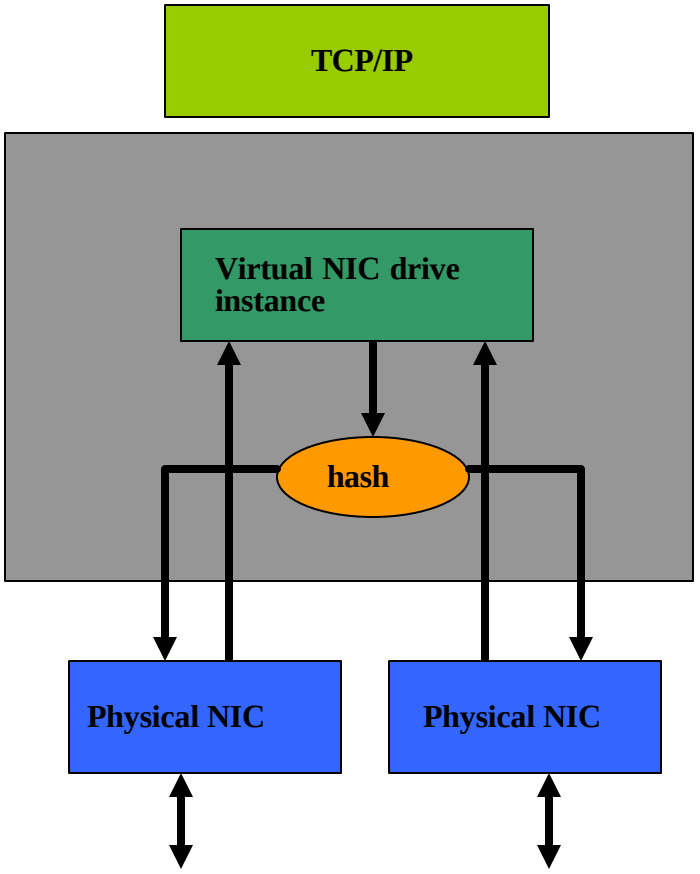
Software Multipathing Variations

- **The same as hosts with FC HBAs**
- **Active/Active: balanced i/o over both paths**
- **Active/Passive: i/o over primary path—switches to standby path upon failure**
- **A/A or A/P will vary by vendor implementation and storage type**



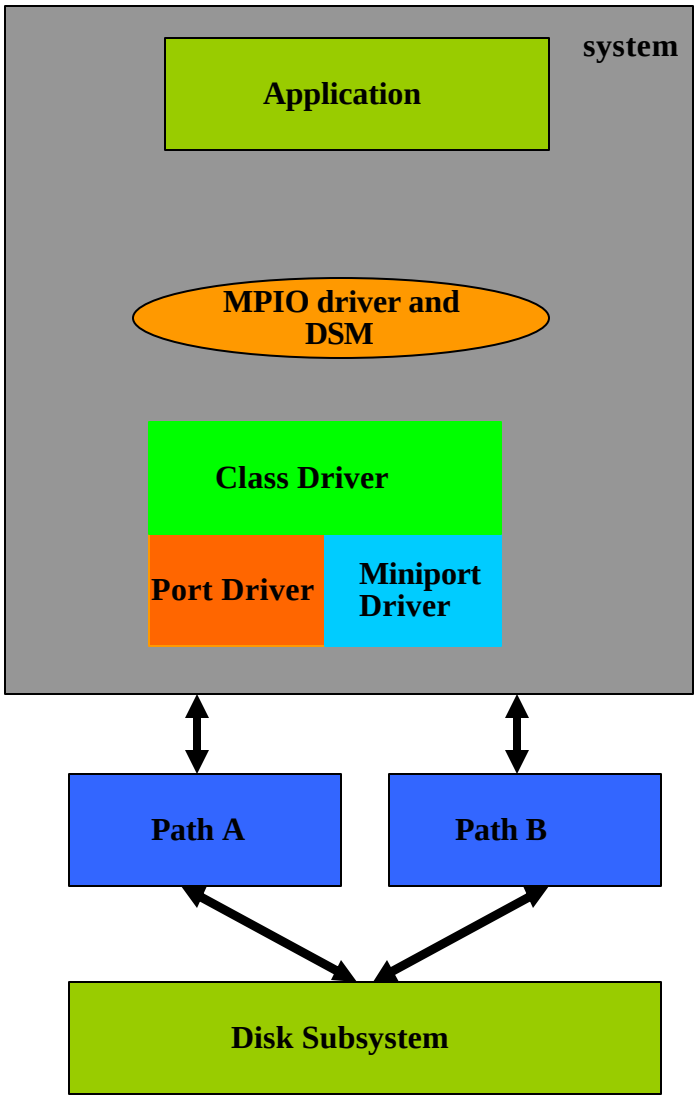
NIC Teaming for Hosts

- **Group of two or more physical NICs into a single logical network device**
- **Benefits of NIC teaming**
  - **Load Balancing**
  - **Fault Tolerance**
- **How does it work?**
  - **Virtual NIC instance uses the MAC address of the first NIC in the team**
  - **NIC cards in one team share the same layer three ip address**
  - **There can be two or multiple NICs in one team**
  - **Inbound and Outbound LB**
  - **Trunking possible**



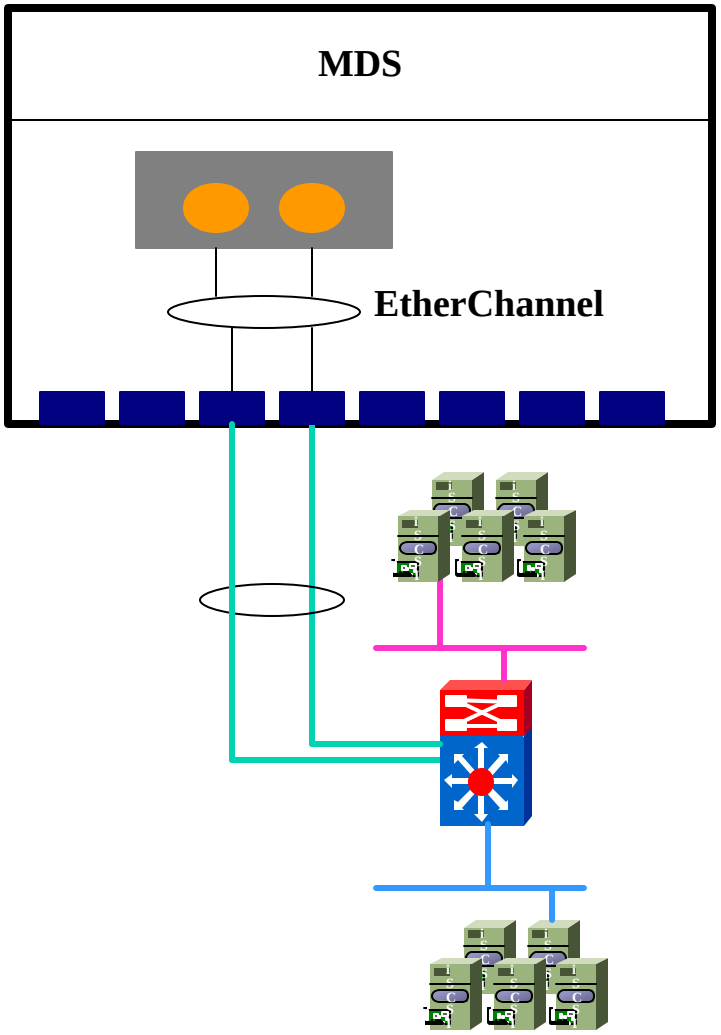
Microsoft Multipath IO (MPIO)

- **Operating system based multipathing solution**
  - **Tight integration with MS Windows**
- **Two Components**
  - **MPIO driver package (the port filter driver, the disk-driver replacement and the bus driver)**
  - **DSM (Disk specific module)**
- **How does it work?**
  - **MPIO driver works with various drivers and DSM to provide multipath functionality**
  - **Device discovery using unique hardware ID**
  - **Dynamic Load Balancing based on policy set on DSM**



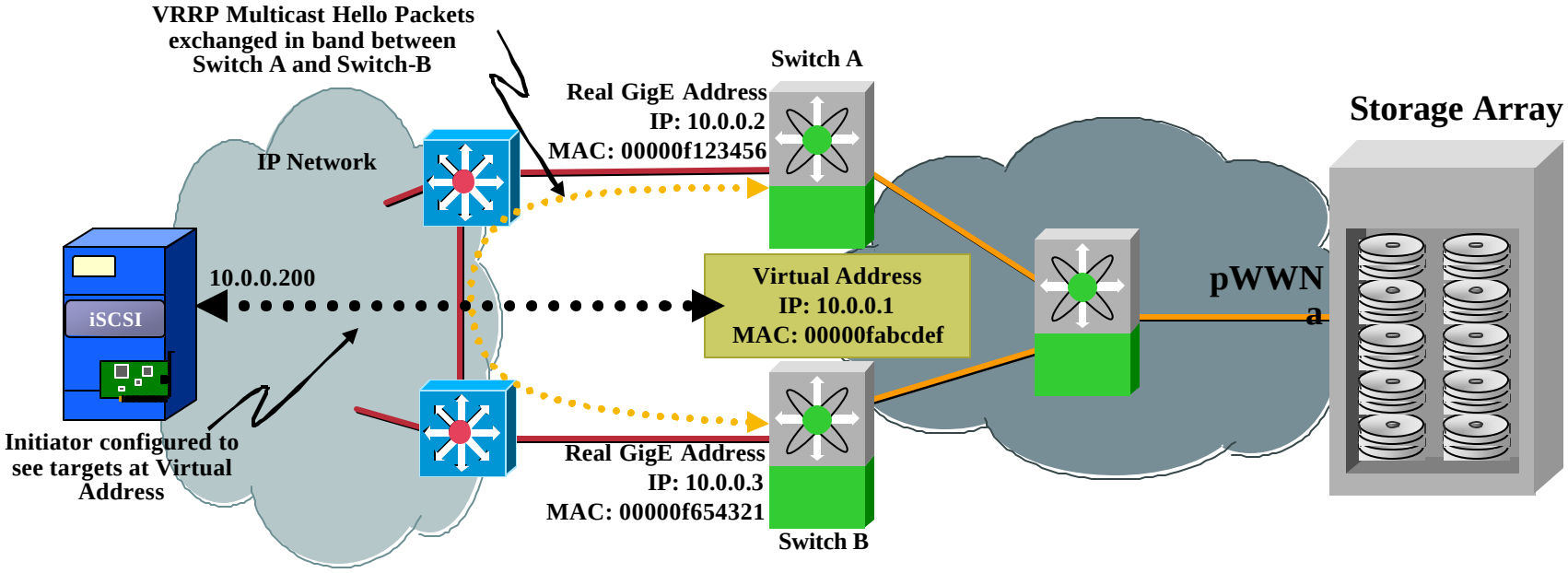
Gigabit EtherChannel

- **EtherChannel on MDS IPS**
  - Group multiple GE links for larger bandwidth
  - Static Configuration
  - Two adjacent GEs on the same chip on the same channel
- **Design with EtherChannel**
  - Bandwidth: not quite 2G with small number of iSCSI initiators
  - Load balancing: hash and based on (src ip, src port, dest ip, dest port and protocol
  - Layer 3 etherchannel – ip address on port channel interface
  - Recommend for HA or with large number of iSCSI initiators



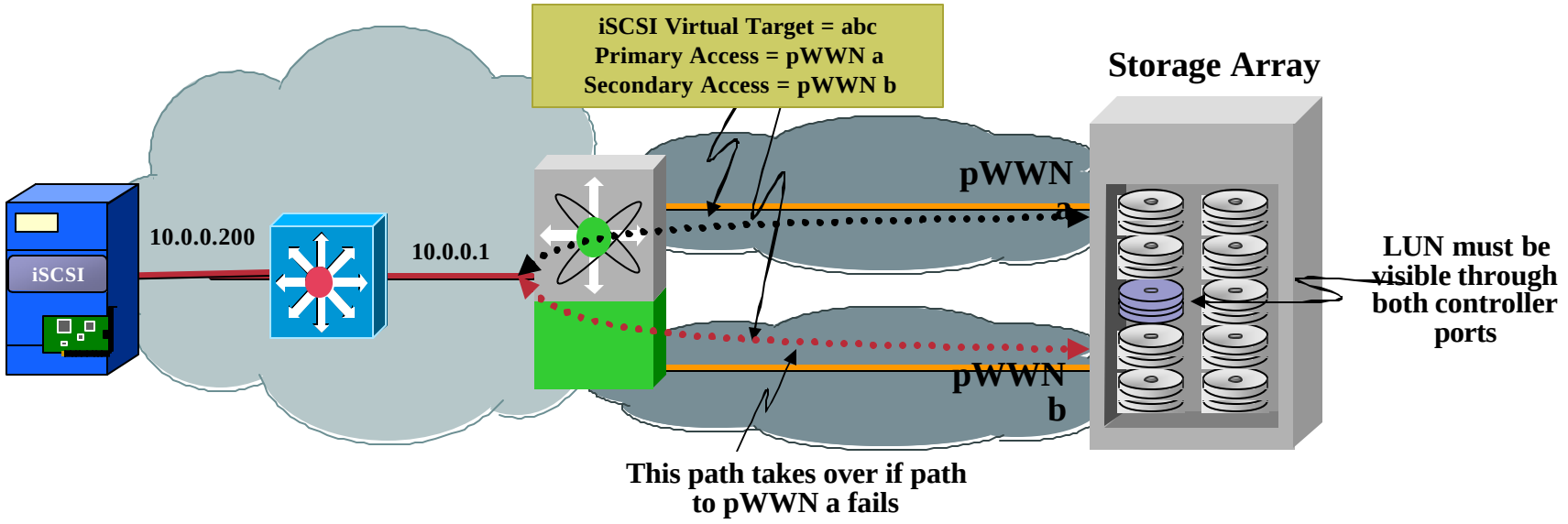
MDS 9000 VRRP

- **RFC 2338 for VRRP over Ethernet**
- **Protects Ethernet port, card or switch failure**
- **Alternate port, card or switch assumes configuration of failed port/card/switch**
  - **Maintains same virtual IP and MAC addresses**
  - **Same storage mappings (target WWPN and LUNs)**
  - **Up to 256 instances, 3-10 seconds failover**
- **iSCSI sessions terminated and reestablished (state not retained)**



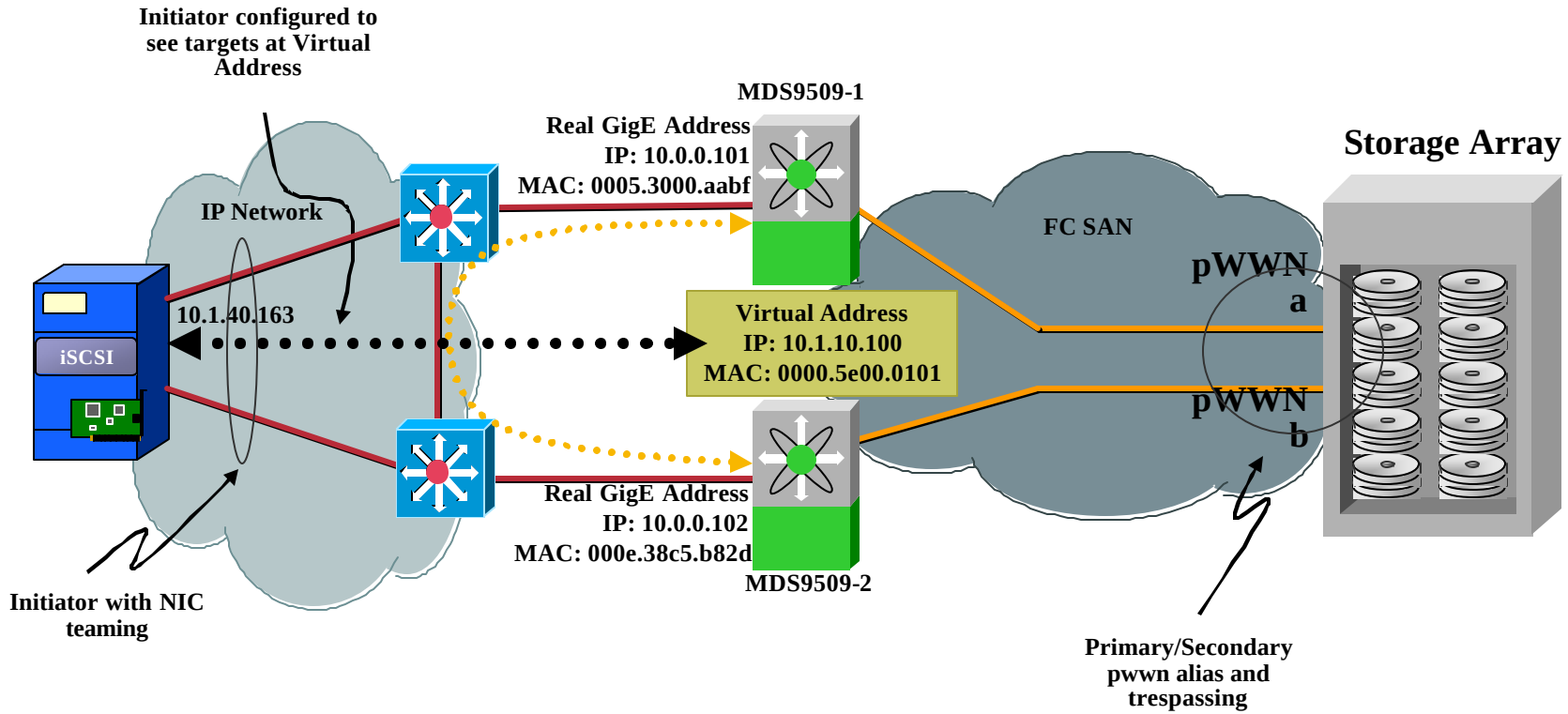
PWWN Aliasing & Trespass

- **Trespass and its main function: move to the passive port when trespass command is detected**
- **Not every array uses it**
- **Protects against FC port/fabric failure, or storage array controller/port failure**
- **Available for statically imported iSCSI targets**
- **Controller ports can be active/active or active/passive**
  - **Secondary path will only take over if primary path fails**
- **LUNs must be visible over both ports (e.g. pWWN a and pWWN b)**



iSCSI HA Design – end to end

- **Take advantage of what IP and IPS have to offer**
- **Low cost with many options**
- **Design and implementation can be complex**



iSCSI HA—Dual Fabric Design

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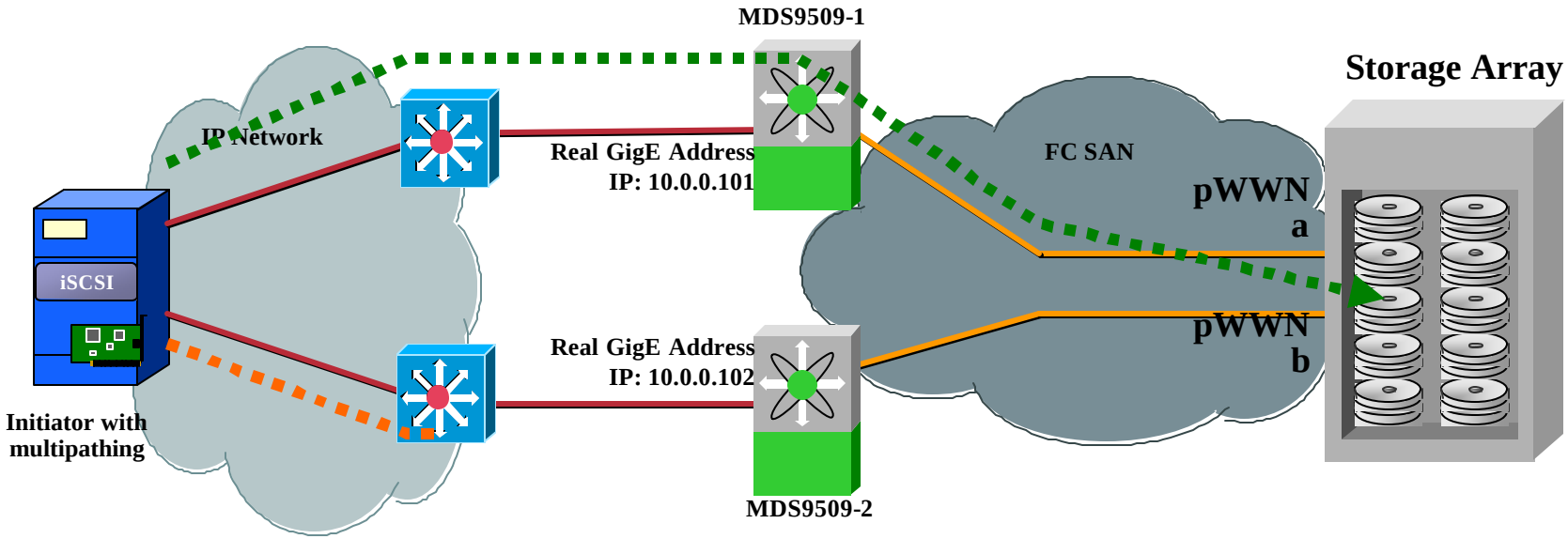
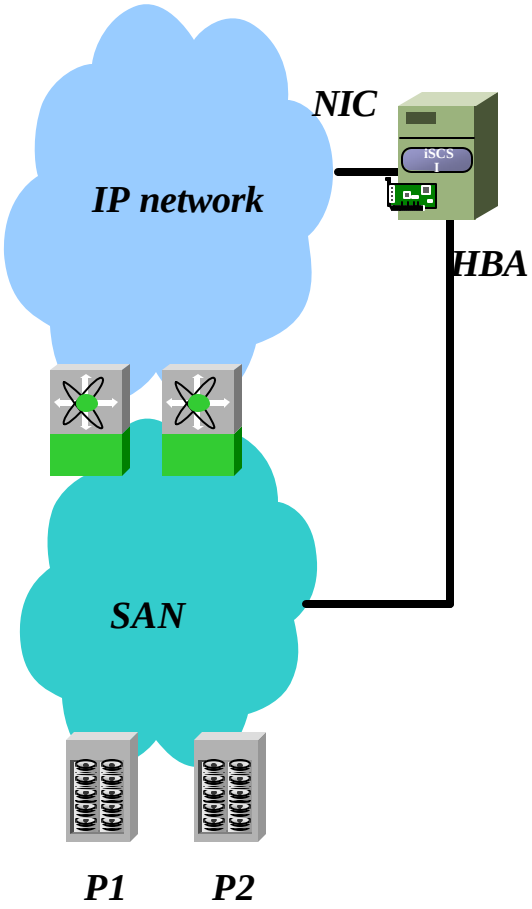
- **Mirroring what is done in FC world – dual fabric**
- **Multipathing software required**
- **Simple design, very stable**
- **Costly**



iSCSI HA -- Backup to FC



- **FC and iSCSI transports work in active/active or active/standby mode**
- **Possible improvement on performance and reliability compare to iSCSI only solution with slightly higher cost**
- **Multipathing software applies as in iSCSI only or FC only scenarios**

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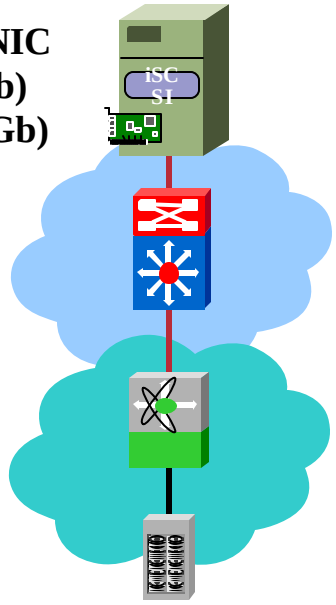
iSCSI Performance – What's Expected?

- **The following test results set out to compare iSCSI with and without a TOE against Fibre Channel**
- **It is expected that the iSCSI stack will consume some CPU resources**
  - **However, sweet-spot for iSCSI may not drive excessive I/O bandwidth**
  - **CPU power is relatively inexpensive**
  - **Can always use TOE if necessary**
- **Results will vary – distance (latency) will also affect results**
- **All tests were conducted with IOMeter running against raw disks**

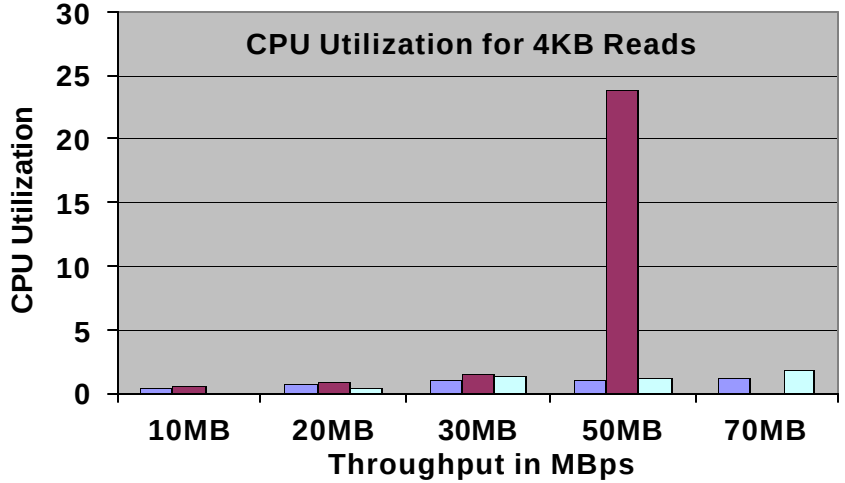
IBM Dual 2.66GHz Xeon Server
1 GB of RAM
Windows 2000 Adv Server SP4

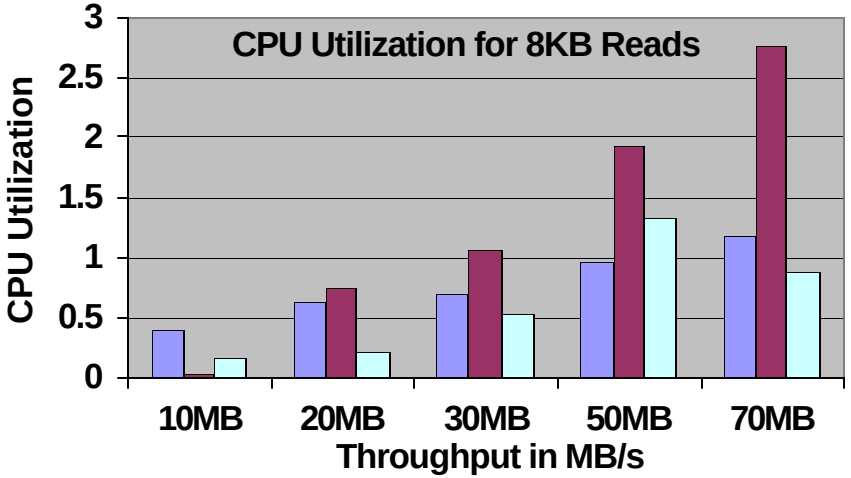
Intel (82546EB) 1Gb NIC
Emulex HBA (@ 1Gb)
Alacritech TOE (@ 1Gb)

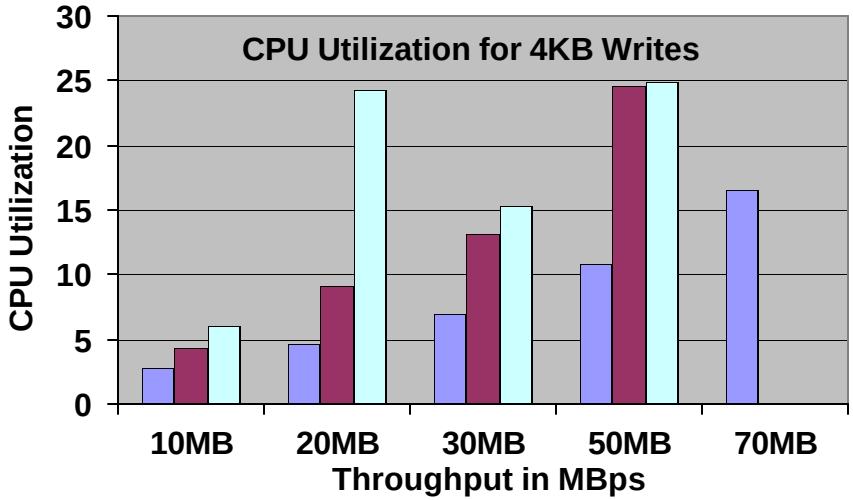


2 Gb Fibre Channel
JBOD

iSCSI Performance Results (no latency)







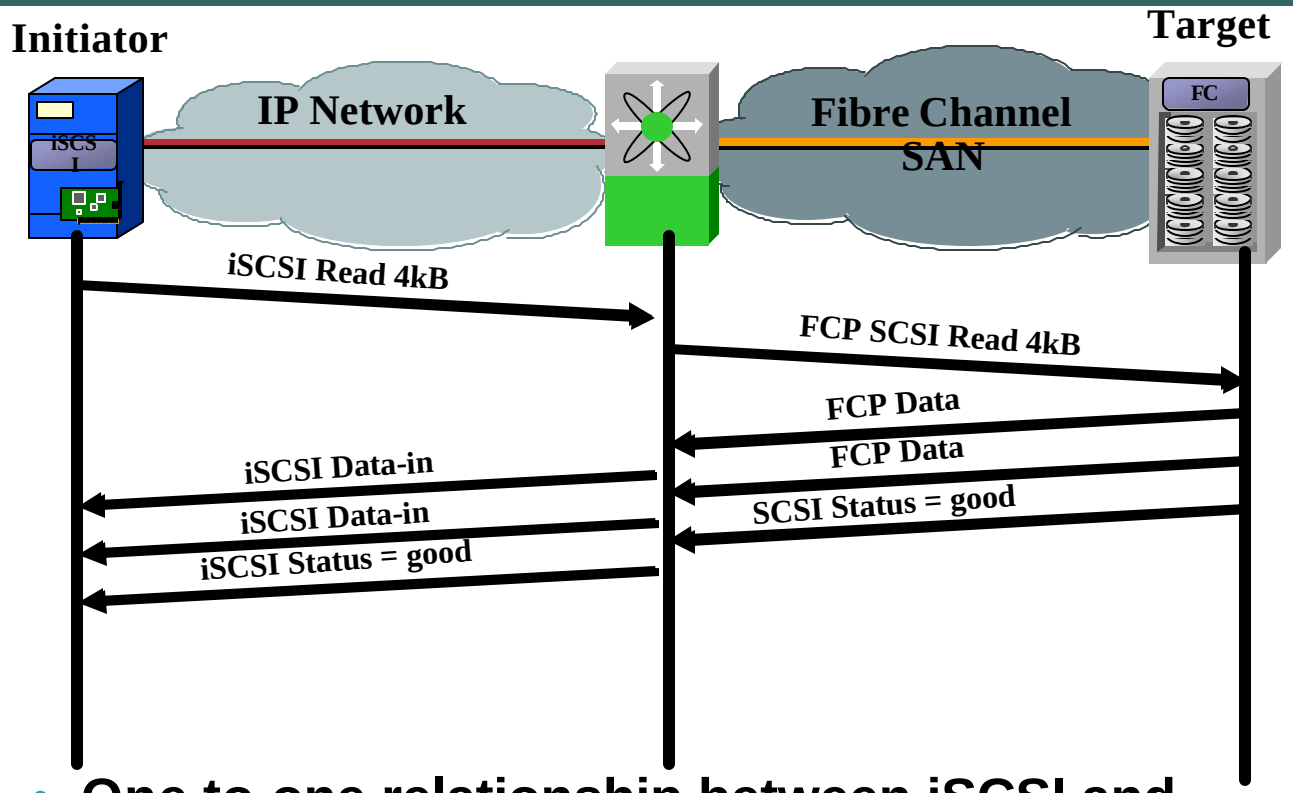
Fibre Channel (@ 1Gb) *Gigabit Ethernet (@ 1Gb)* *Gigabit Ethernet TOE (@ 1Gb)*

Test to Measure CPU Utilization Based on Varied I/O Loads

Performance Objectives and Determining Factors

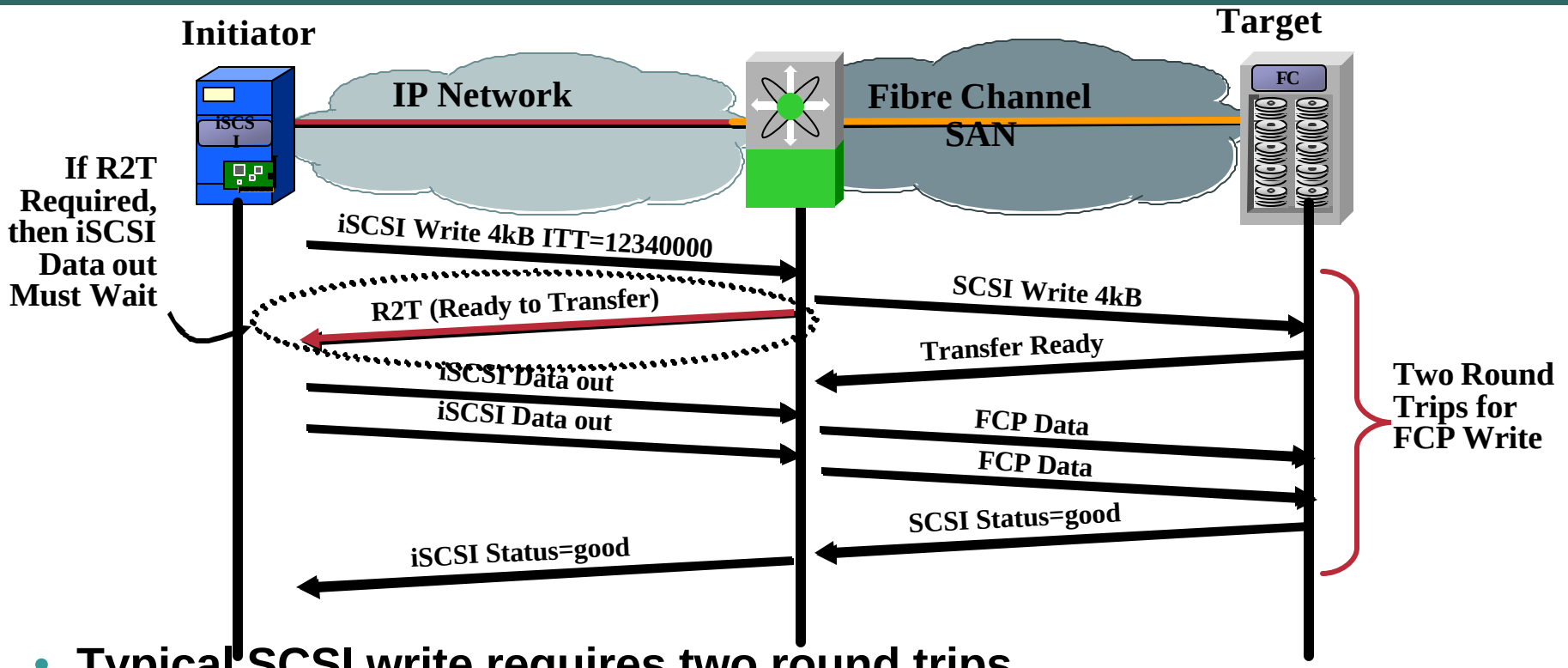
- **Understand performance objectives**
  - Number of users
  - IO intensive: IOPS and Throughput
  - Acceptable response time
- **Factors impact performance**
  - System resources (cpu, memory, bus architecture)
  - Storage resources (RPM, cache, RAID level)
  - Network equipment/gateway
  - Available IP network bandwidth (especially in WAN)
  - Distance between iSCSI initiators and targets
  - TCP implementation and configuration
  - I/O block size

iSCSI Read



- One-to-one relationship between iSCSI and FCP frames
- Single round trip between Initiator and Target to retrieve data

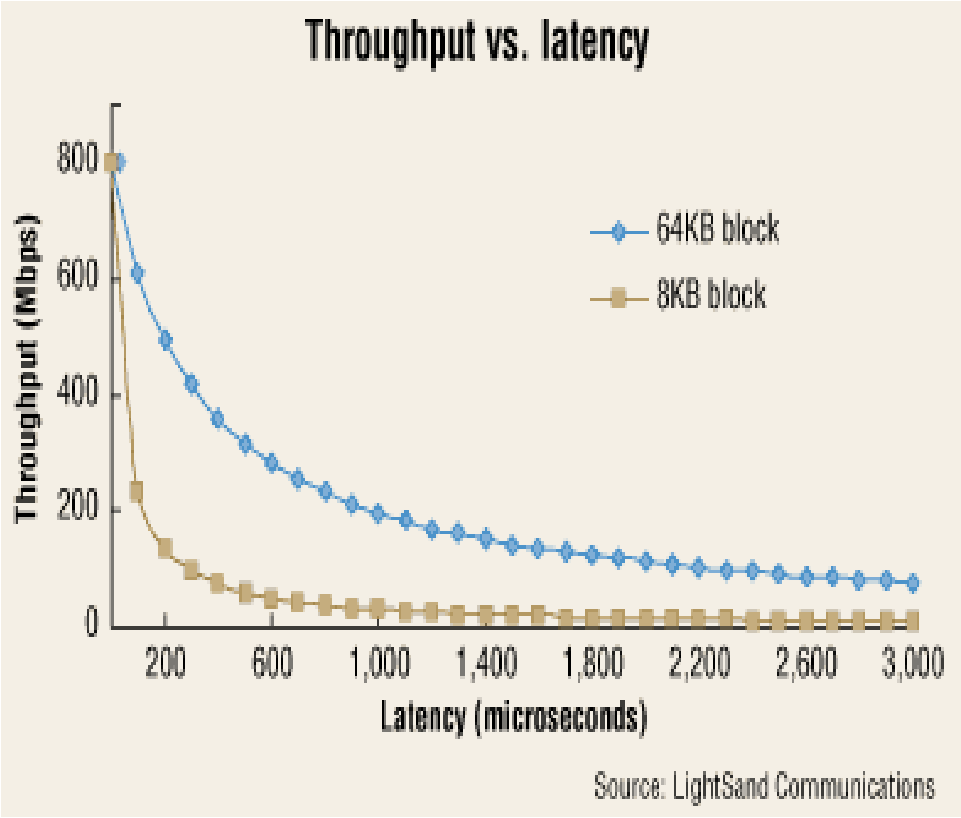
iSCSI Write



- **Typical SCSI write requires two round trips**
  - **Must wait for "Transfer Ready" before sending data**
- **iSCSI Initiator and Target may negotiate "Initial R2T = no" during login ("solicited" data)**
  - **iSCSI data out can follow SCSI write**

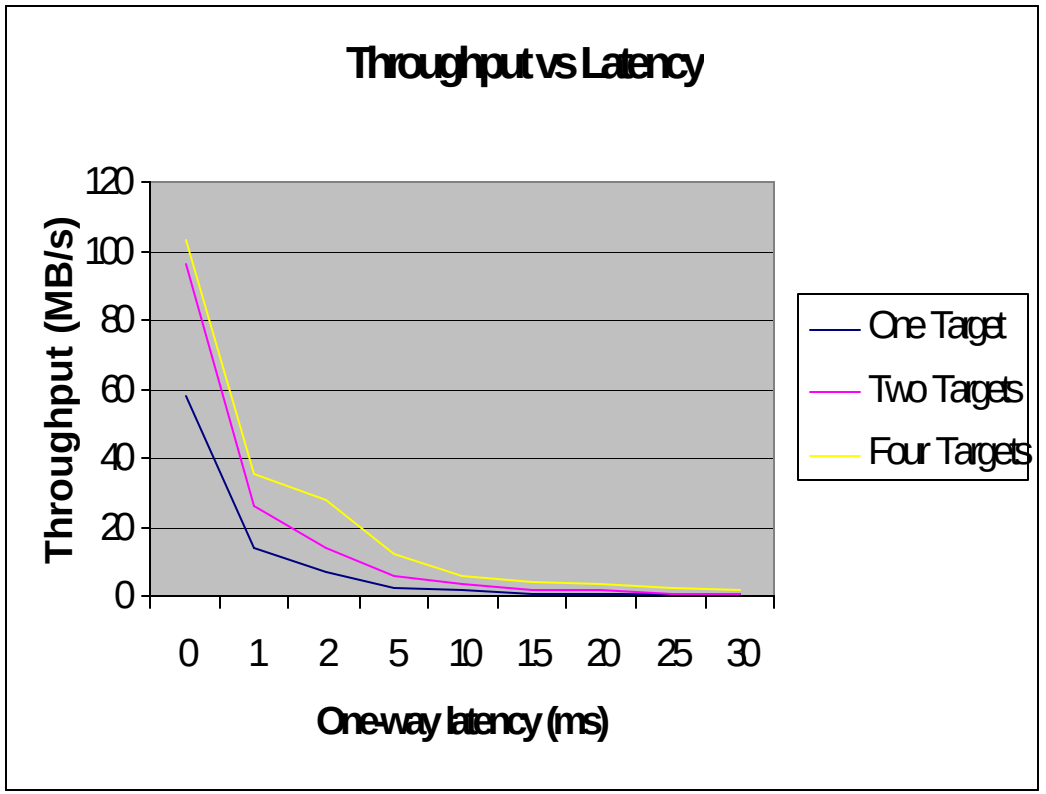
Throughput in iSCSI

- **SCSI controls data movement**
- **Latency impact on throughput**
  - **Throughput is calculated: Total data transmitted / end to end latency**
  - **Factors contribute to latency: equipment, protocol, distance**
  - **The larger the distance, the longer the latency – 1ms/100 miles**
- **Maximize the throughput**
  - **Manage the distance: as short as possible**
  - **TCP impacts iSCSI throughput**



Latency Impact on Throughput

- **Test is done with single outstanding IO**
- **Actual outstanding IOs depending on applications**
- **Latency reduces possible maximum throughput**
- **Increase total throughput of iSCSI network using fan-out, multiple targets, and increase outstanding IOs**
- **Consider iSCSI target over long distance as secondary storage**



Network: Best-Practice Design

- **TCP/IP stack for IPS of MDS**

  Configurable congestion window size and slow start thresh hold (decided by max and min bandwidth parameters)

  TCP Window Scale option (RFC 1323) – use multiple of 65k window size to keep the pipe full

  Enable SACK (default, RFC 2018) – allows fast retransmit and fast recovery when multiple packets loss happens

- **Other things related to TCP/IP**

  Avoid lossy network or use Qos to prioritize iSCSI traffic

  Enable jumbo-frame support end to end -- reduce overhead and improve efficiency

  Use TCP send buffer on IPS

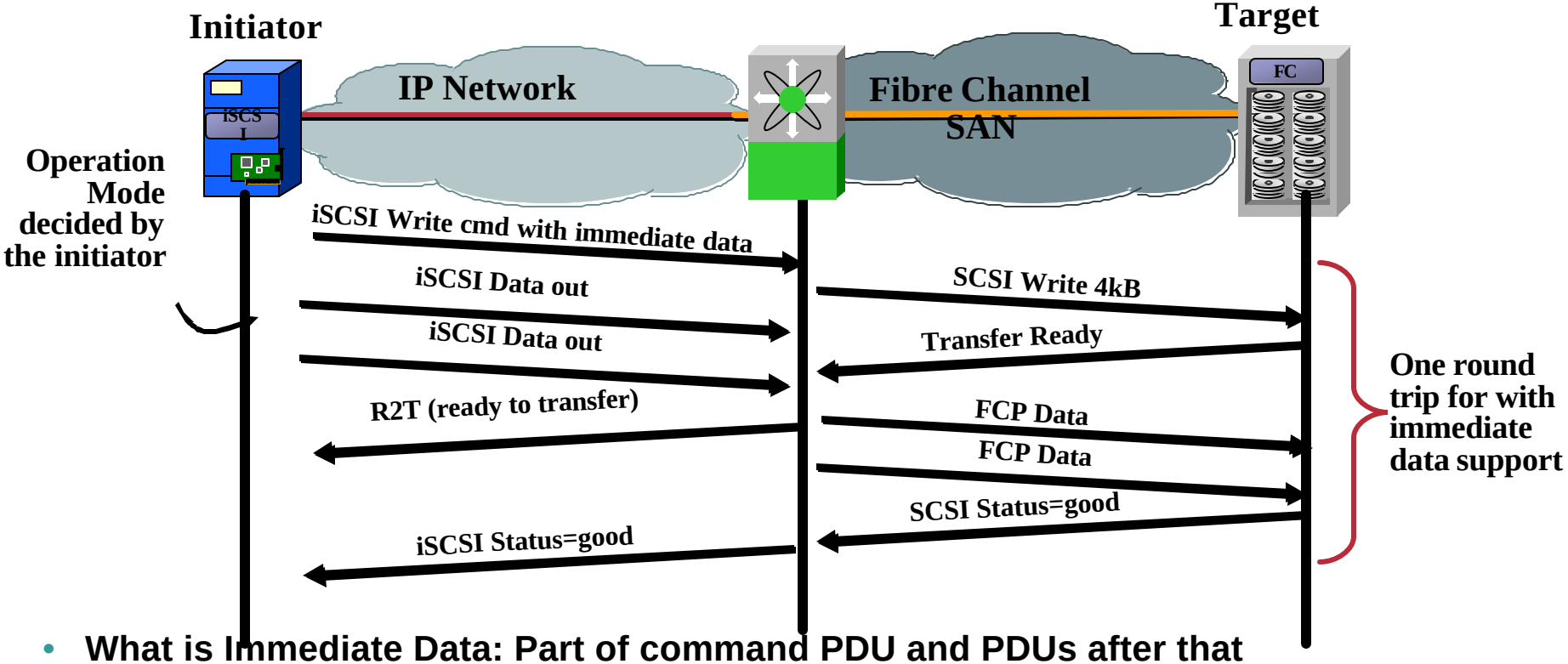
Network: Best-Practice Design (continue)

- **Performance is usually I/O bounded, iSCSI normally is not the bottleneck**
- **RAID-level implementation on disk array**
  - **General performance of one disk with 10000 RPMs (streaming and random IO, IOPS)**
  - **In database design, put user and temporary table space in different disks**
- **Block size of the IO – what is it and how is it monitored?**
  - **Client IO, Apps IO, File IO, OS IO and disk IO**
  - **Make the IO size multiple of the block size of the individual disks**
- **Increase I/O block size to 64KBytes – generally, the larger the block size, the larger the throughput**
- **The types of applications that best suite for iSCSI are the one with small to medium IOPS and large throughput**

Network: Best-Practice Design (continue)

- **Use TOE cards on systems with high CPU utilizations**
- **System memory helps when architecture is predefined**
- **Store-and-forward mode in MDS (no iSCSI CRC) – recommended for good performance with long distance**
- **Pass-through mode in MDS – recommended to improve response time**
- **Fan-out ratio consideration – what is it and how to find out the best fan-out ratio for your environment? 4-25:1**

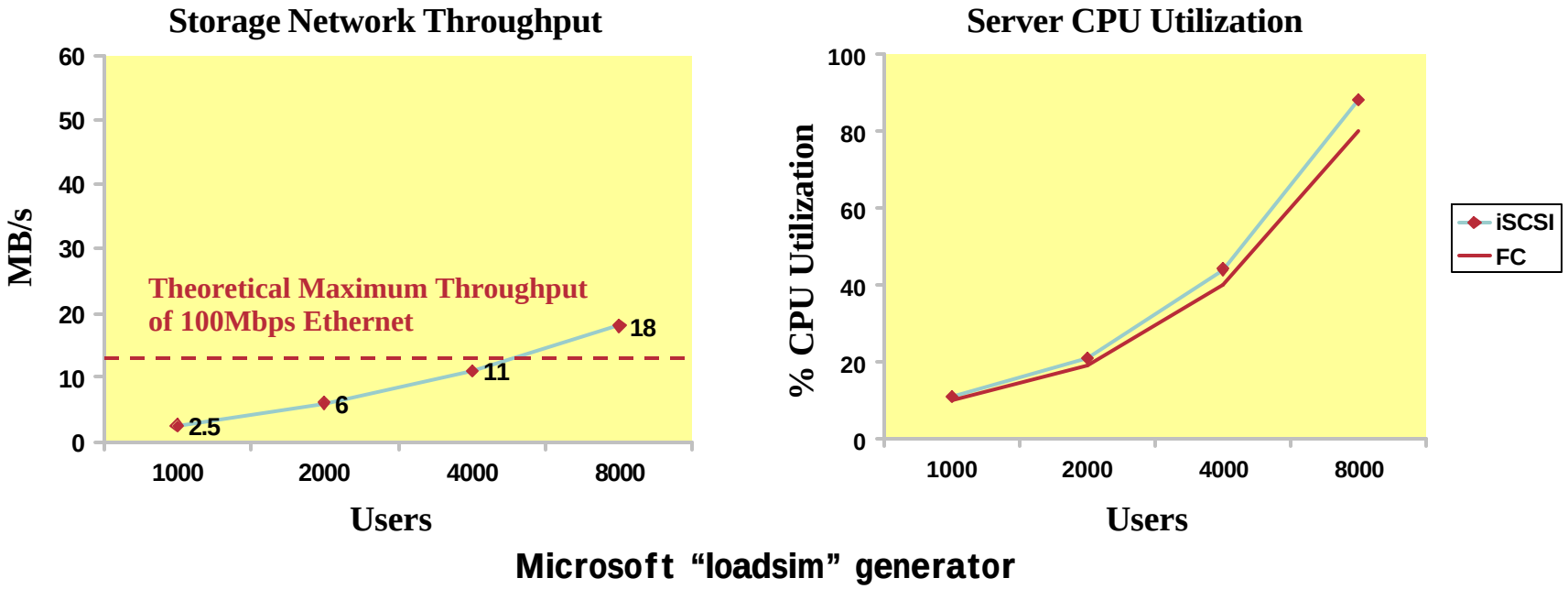
iSCSI Immediate Data – Improve Write Perf



- What is Immediate Data: Part of command PDU and PDUs after that
- Negotiation Parameters : Initial R2T (yes) and Immediate Data (yes) by default – in SAN OS 2.1
- Buffer to insure that “Burst Length” specified in Transfer Ready is met “Initial R2T = no” during login (“solicited” data)
- Performance Improvement: shorten IO processing time and reduce bandwidth

Microsoft Exchange 2000 iSCSI Test

- **Rapidly emerging as the application choice for messaging and collaboration**
- **Requires a large volume of storage, but little throughput**
- **Minimal CPU utilization difference between iSCSI software drivers and Fibre Channel HBAs**



iSCSI Storage Network Design

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- **IT Challenges that iSCSI Helps to Solve**
- **iSCSI Concepts**
- **iSCSI Integrations and Design Elements**
- **End to End HA Design**
- **iSCSI Client Performance**
- **iSCSI Network Security**
- **Managing the iSCSI Network**

Secure iSCSI Network and Storage

Cisco.com

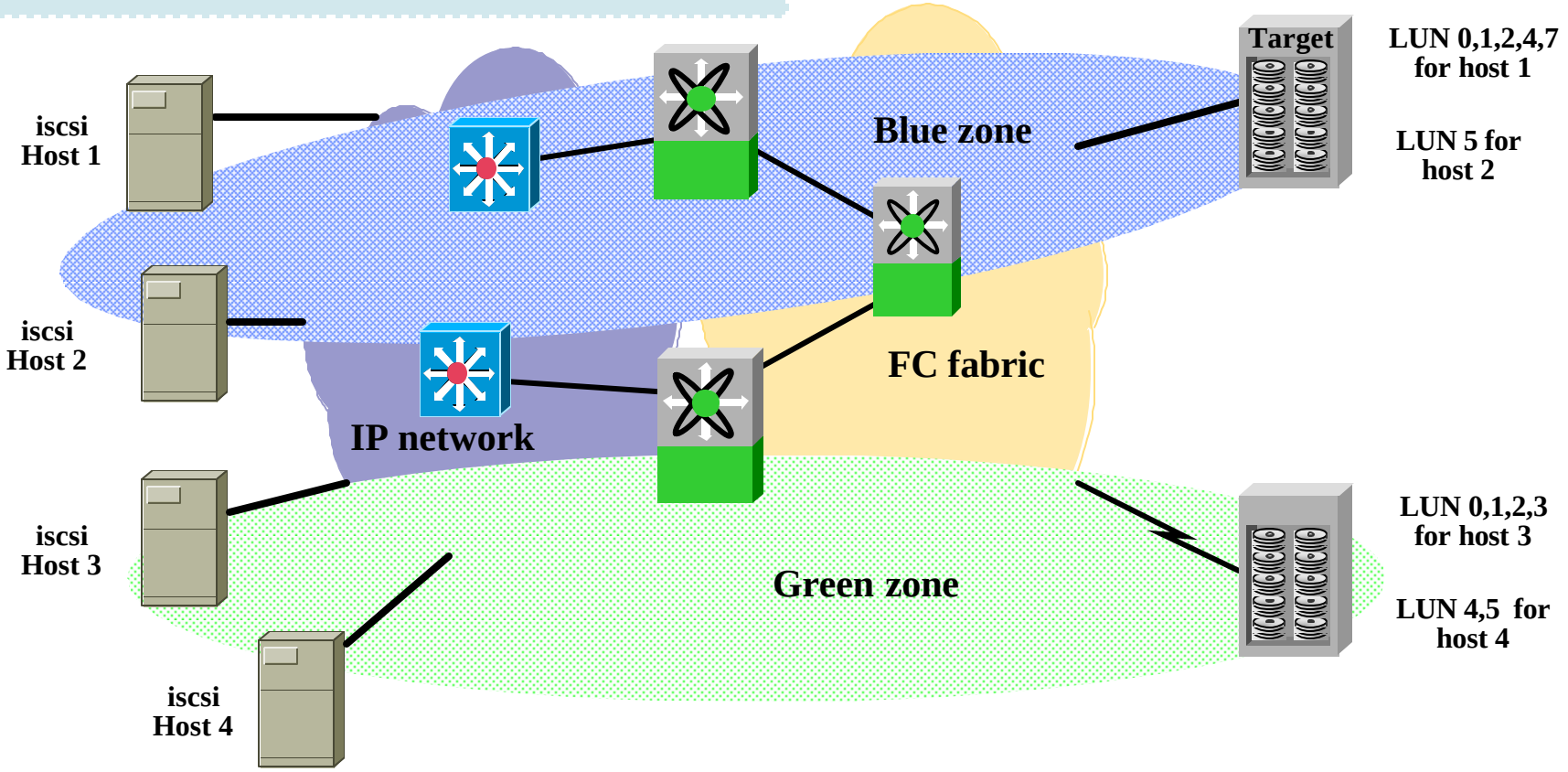
- **Average $2.7 million loss when proprietary information stolen according to CSI and FBI**
- **Intrusion and denial of service attack**
- **Where to secure**
  - **In storage—while at rest**
  - **In iSCSI network—on the wire**
- **iSCSI security components**
  - **Traditional segmentation and access control**
  - **Authentication**
  - **Emerging SAN architecture**
  - **IP network security techniques**

Traditional Storage Means

- **Zoning**
  - **Segmentation within a fabric and initial access control**
  - **Soft zoning and hard zoning**
  - **Zone members can be either iSCSI hosts ip addresses or and symbolic names**
- **LUN masking**
  - **Defining relationship between iSCSI hosts and storage devices**
  - **Detailed into LUN level**
  - **Performed at array controller**
  - **iSCSI hosts can be represented by proxy initiator in MDS**

iSCSI Zoning and LUN Masking

- **Zoning : based on IP Address or iqn name**
- **LUN Masking/Mapping**



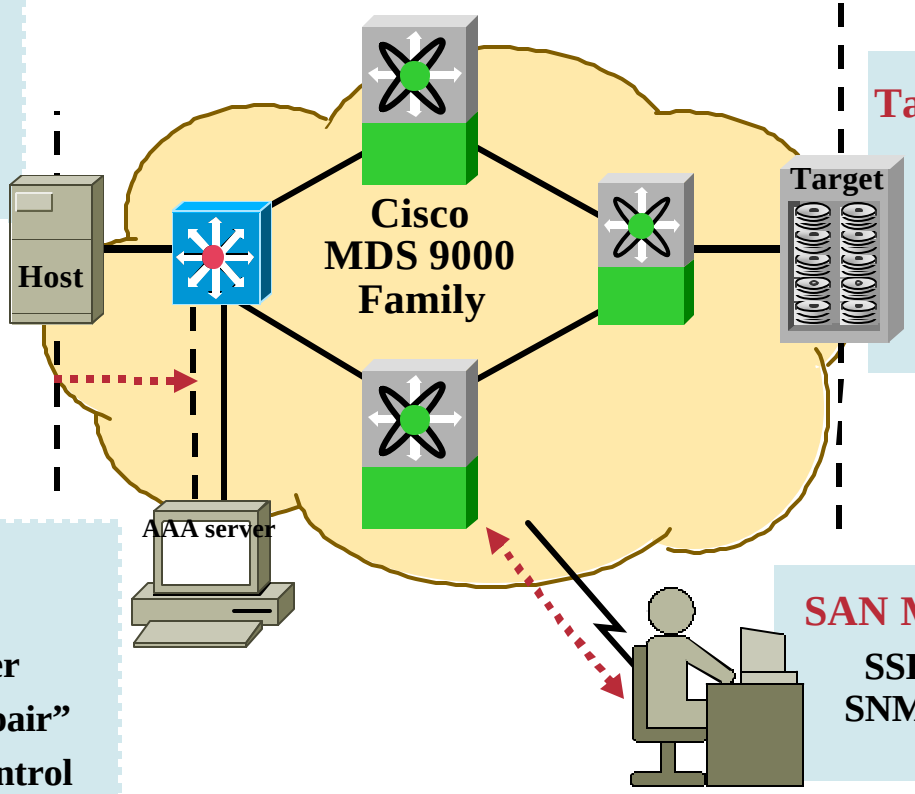
AAA iSCSI Authentication

- **Allow ONLY authenticated iSCSI initiators to access configured LUNs**
- **Two way authentication**
  - **iSCSI initiators authenticated by iSCSI targets**
  - **iSCSI targets authenticated by iSCSI initiators**
- **Choice of authentication methods**
  - **–RADIUS external server**
  - **–TACACS+ external server**
  - **–Local username database (CHAP)**
- **CHAP (Challenge Handshake Authentication Protocol) used as authentication protocol**

iSCSI Authentication

iSCSI Host authenticated to iSCSI targets

- AAA authentication
- Local authentication



Target to be authenticated to iSCSI initiators

- Optional

AAA Server

- Radius
- TACACS+ server
- Keyword “cisco-av-pair”
- Role based access control possible

SAN Management

- SSH, Radius, SNMPv3, SFTP

Emerging Secure SAN Architecture

- **Secure transport for fabric access – SNMP v3, SSH, SFTP, SSL, AAA**
- **VSAN**
  - **Partitioning SAN fabric into virtual entities**
  - **Tagging each frame by MDS to insure total isolation of each entity hence security**
  - **iSCSI port VSAN membership assign**
  - **iSCSI initiator VSAN membership assign**
- **iSCSI based access control**
  - **Access to iSCSI virtual target/LUN granted to individual iSCSI host**
  - **iSCSI LUN mapping provides more access control more granularly – at LUN level**
- **Advertisement of iSCSI virtual target**
- **Making an iSCSI zone Read-only zone – protecting the data integrity on iSCSI virtual target**
- **Role-based management access control**
  - **Apply to iSCSI related network management roles**

IPSec Overview

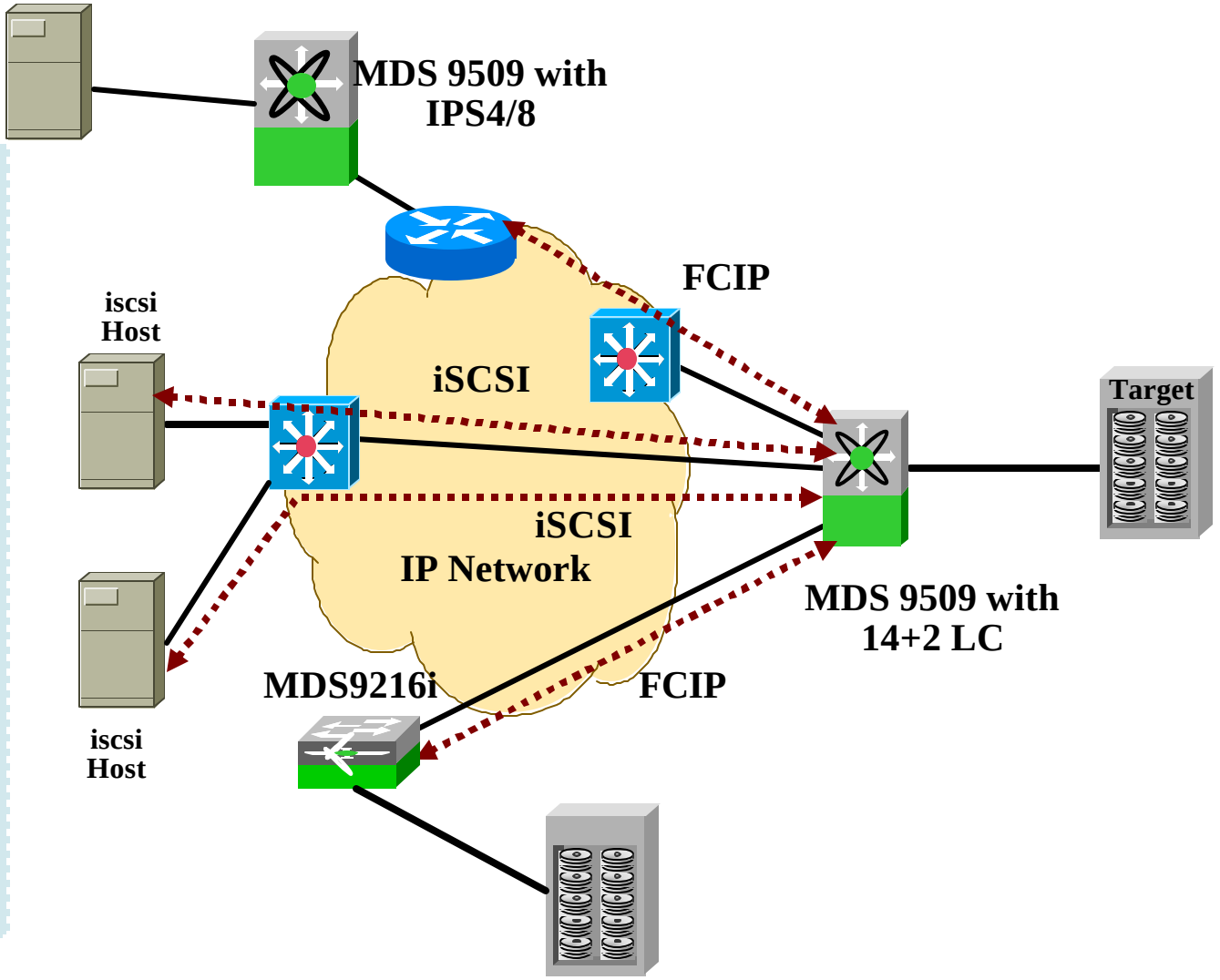
- **IPSec = AH + ESP + IKE**
  - **Securing IP traffic between two participating peers in the IP layer**
  - **Providing data confidentiality, data integrity, data origin and anti-replay protection**
- **Two major IPSec protocols**
  - **AH (Authentication Header): provide only authentication services**
  - **ESP(Encapsulating Security Payload): Provides authentication as well as encryption services**
- **Two major modes of operation**
  - **Transport mode: authenticates/encrypts only the IP payload**
  - **Tunnel mode: authenticates/encrypts the complete IP packet**
- **Key Management**
  - **Dynamic key exchange using IKE**
  - **Manual security association**

IPSec in MDS

- **IPSec used to for iSCSI and FCIP**
  - **RFC 3723 – Securing block storage protocols over IP**
- **Hardware acceleration for optimal performance**
  - **1Gps IPSec Processing**
- **Software and hardware**
  - **SAN-OS 2.0**
  - **14+2 LC and 9216i platform**
- **Supported features**
  - **IKE v1 and v2**
  - **ESP in tunnel mode**
  - **All major crypto algorithms – AES, DES & 3DES with Sha1-HMAC, MD5-HMAC and AES-XCBC-HMAC for authentication**

IPSec VPN Deployment

- iSCSI terminates on MDS, router or iSCSI hosts
- iSCSI driver IPSec self contained (ex. Microsft supports 3des and sha1)
- MTU size may increase (extra headers)
- CPU utilization on iSCSI hosts
- Other vendors may provide SOE (Security Offload Engine)



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Management: iSCSI & Fibre Channel

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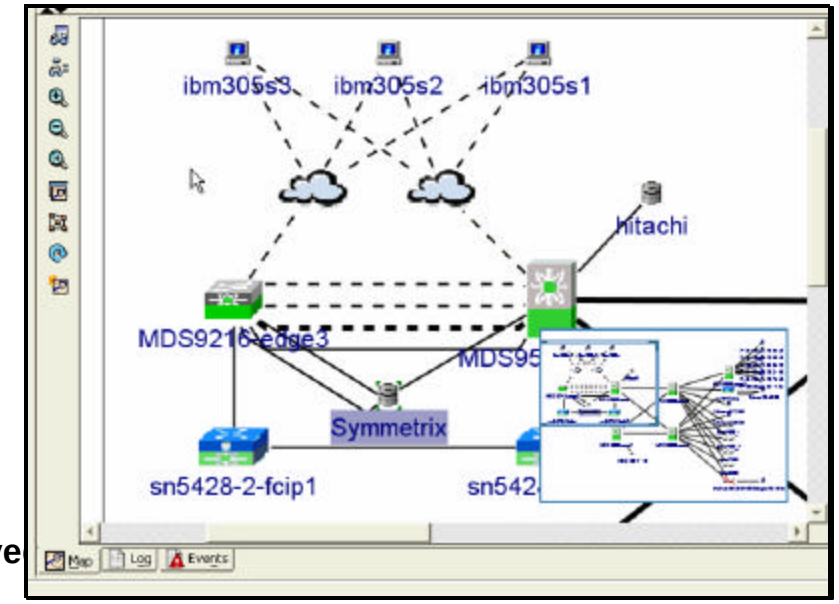
- **The Cisco Fabric Manager (CFM) with full multiprotocol management**
  - Included with each MDS 9000 switch
  - Multiprotocol topology discovery
  - Multiprotocol zoning and VSAN assignment
- **CFM maps iSCSI as 'dotted' link and Fibre Channel as 'solid' link**
  - FCIP links are also mapped as 'dotted'
- **iSCSI assigned addresses (WWNs) are kept in non-volatile configuration**
  - Can be easily extracted via TFTP, FTP, SFTP to be archive
- **Each iSCSI session can be closely monitored through CFM stats**



Cisco Fabric Manager Screenshot Showing Multiprotocol SAN Topology

Summary

- **Leverages the existing IP infrastructure**

  ---hence the intelligence, capacity and best practice design can be leveraged in the iscsi infrastructure
- **Complementary to FC yet represents a low cost transport choice**
- **Midrange applications connectivity**
- **Midrange server connectivity with Blade server integration as new system candidate**
- **Potential long distance SAN transport, recommended as backup storage when delay is high**

Reference Materials

- http://www.t10.org/
- http://www.t11.org/index.htm
- http://www.ietf.org/rfc.html **on iSCSI RFCs**
- http://www.cisco.com/en/US/products/hw/ps4159/index.html **for Storage Networking Products and related Information**

Appendix

SCSI – Small Computer System Interface

iSCSI – internet SCSI

DAS – Direct Attached Storage

FC – Fibre Channel

CDB – Command Descriptor block

R2T – Ready To Transfer

LUN – Logical Unit Number

SLP – Service Location Protocol

IQN – iSCSI Qualified Name

EUI – Extended Unique Identifier

iSNS – Internet Storage Name Service

TOE – TCP Offload Engine

SOE – Security Offload Engine

NFS – Network File System

GPFS – General Parallel File System

DMZ – Demilitarized Zone

MZ – Militarized Zone

IVR – Inter-VSAN Routing

GTS – Generic Traffic Shaping

FRTS – Frame-Relay Traffic Shaping

CAR – Committed Access Rate

PQ – Priority Queuing

CQ – Custom Queuing

FIFO – First In First Out

WFQ – Weighted Fair Queuing

DSCP – Differentiated Services Code Point

SS – Slow Start

CA – Congestion Avoidance

MWS – Maximum Window Size

SACK – Selective Acknowledgment

RPM – Rotations Per Minute

RAID – Redundant Arrays of Inexpensive Disks

DWDM – Dense Wavelength Division Multiplexing

CWDM – Coarse Wavelength Division Multiplexing

DR – Disaster Recovery

VRRP – Virtual Router Redundancy Protocol

BIOS – Basic Input/Output System

ROM – Read-only Memory

SNMP v3 – Simple Network Management Protocol, version 3

SSH – Secure Shell

SSL – Secure Socket Layer

AAA – Authentication Authorization Accounting

Radius – Remote Authentication Dial-in User Service

Appendix -- Continue

TACACS+ -- Terminal Access Controller Access Control System

RBAC – Role Based Access Control

CHAP – Challenge Handshake Authentication Protocol

IKE – Internet Key Exchange

AH – Authentication Header

ESP – Encapsulating Security Payload

MPIO – Microsoft Multipath IO

DSP – Disk Specific Module

CFM – Cisco Fabric Manager

CDM – Cisco Device Manager

SPAN – Switched Port Analyzer

MDS – Multilayer Director Switch

IPS – IP Service (module)

Q and A

Complete Your Online Session Evaluation!

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Por favor, complete el formulario de evaluación.

Muchas gracias.

Session ID: SAN – 2105

iSCSI Design and Implementation