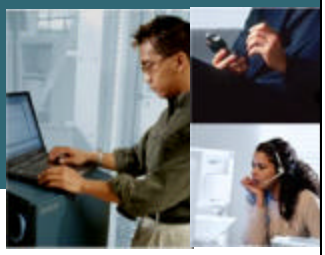
Cisco Storage Networking – Redefining Data Center Scalability



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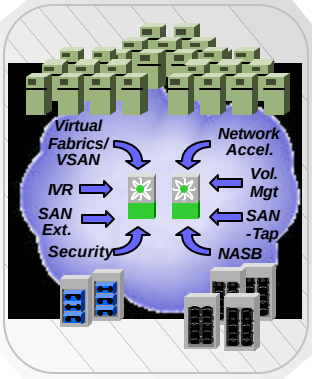
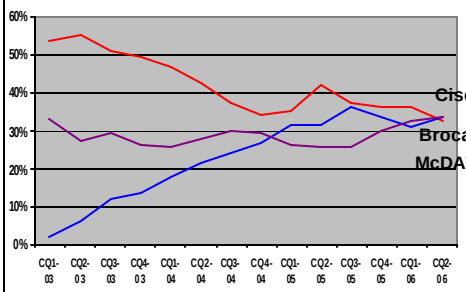
Data Center Trends
Large-scale Physical and Virtual Consolidation

- **IT Requirement**
  - Significant cost reduction – paradigm shift
  - Support for tiered storage environments and ILM strategies
  - BC/DR across a broad range of applications
  - Rapidly respond to changing business conditions
- **Enabling technologies**
  - Ultra-scalable directors (400+ ports) w/ virtual fabric (VSAN) *plus* integrated routing (IVR)
  - Network-hosted volume management; high density storage subsystems
  - Scalable servers and server virtualization techniques
- **Benefits**
  - Dramatic simplification of storage environment
  - Greatly improved service levels
  - Significant reduction in downtime, management expense and TCO

Large Scale Physical, Virtual Consolidation



Quantitative Market Data



Cisco 33.6%

Brocade 33.3%

McDATA 32.9%

Source: Dell'Oro Group – August 2006

Capturing Share

- Consistent Product Set
- Effective Go-to-Market Strategy
- Advanced Services for Migration
- Data-Center Approach

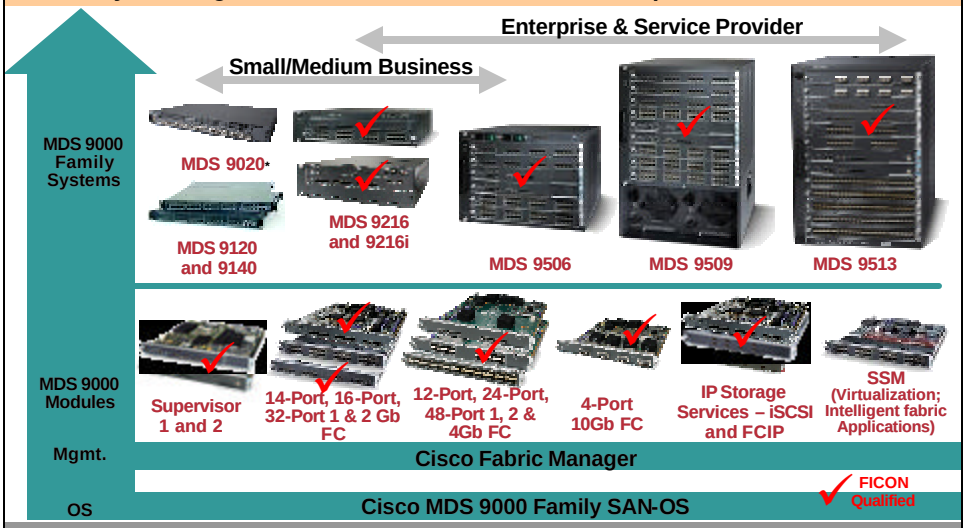
Executing on a Strategy

- Virtual Fabrics & Fabric Routing
- Intelligent Fabric Applications
- Security and Management
- Performance and Scale

MDS 9000 Fabric Switch Positioning

Cisco positioned to extend reach all market segments

Industry-Leading Investment Protection Across a Comprehensive Product Line



* FabricWare OS

Cisco MDS 9000 FICON Advantages

- Industry leading scalability up to 528 ports
- FICON feature supported on both director-class and fabric-class switches
  - Full FC-SB2 and FC-SB3 Compliance
- Enhanced Consolidation and DR/BC Support
  - Advanced Cascading
  - ISL Port Channeling
  - Traffic Management
- Most secure VSAN-based Intermix Support
- Integrated Remote Extension
- Advanced Management Options- including CUP
- N_Port ID Virtualization

MDS 9500
Modular Directors

MDS 9200
Flexible Configuration Series

Introducing the Cisco MDS 9513 – Redefining Data Center Scalability

- **Ultra-scalable**
  - Up to 528 1/2/4-Gbps FC ports
  - 1/2/4-Gbps and 10-Gbps in a single system
- **Best in class availability**
  - Dual active/active crossbar architecture
  - In event of failure, a single crossbar will supply full system bandwidth
- **Extensible architecture for investment protection**
  - Accepts all existing MDS 9000 Family modules

MDS 9513

Supervisor-2
Module

Introducing the Cisco MDS 9513 – Redefining Data Center Scalability

- **VSANs and integrated Inter-VSAN Routing**
  - Port-level granularity of VSANs and IVR
  - IVR integrated into port-level hardware – no need for external routing devices
- **Secure, Integrated SAN extension**
  - FCIP with hardware-based encryption and compression
  - CWDM support
- **Application hosting and acceleration**
  - Network hosted volume management, non-disruptive data migration
  - Network Accelerated Backup, SAN-Tap

MDS 9513

Supervisor-2 Module

SAN-OS 3.0 – Key Software Enhancements

- **Port Bandwidth Reservation**
  - Flexibility to assign bandwidth on a per port basis (1G, 2G and 4G FC)
  - Dedicated and shared bandwidth modes
- **IP Protocol Version 6 (IPv6)**
  - IPv6 protocol support for OOB Management port, iSCSI/FCIP ports
- **McData Interop Mode**
  - Flexibility to interoperate with McDATA switches without enabling McDATA Open Fabric mode
- **FICON Tape Acceleration for Disaster Recovery**
  - Minimize the impact of latency and distance on the performance of FICON Tape applications
  - Beta customers testing now.
- **Security Enhancements**
  - Digital Certificates and MS-CHAP protocol

MDS 9513 Industry Leading Port Density

MDS 9509

Up to 336 Ports
14 RU Form Factor
18.8” Deep

MDS 9513

Up to 528 Ports
14 RU Form Factor
28” Deep

MDS 9513
Rear View

Dual Power (6000w)
Fabric Cards

New Generation 2 Fibre Channel Modules

Four modules address key SAN consolidation requirements

- 12-Port 1/2/4Gbps FC Module DS-X9112

  Full-rate 4Gbps performance for ISLs and highest performance server and tape applications

- 24-Port 1/2/4Gbps FC Module DS-X9124

  Full-rate 2Gbps performance for enterprise storage connect and high performance server applications

- 48-Port 1/2/4Gbps FC Module DS-X9148

  Shared bandwidth 2Gbps performance for mainstream server applications

- 4-Port 10Gbps FC Module DS-X9704

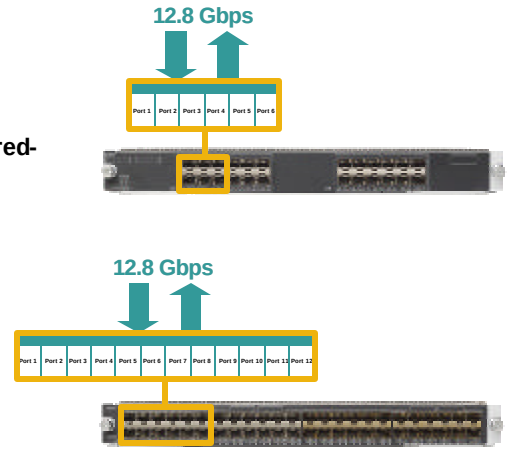
  Full-rate 10Gbps performance for ISL consolidation and high bandwidth Metro connect

Maximum subscription ratio with all ports active

	1 Gbps	2 Gbps	4 Gbps	10 Gbps
DS-X9112 12-Port	1:1	1:1	1:1	N/A
DS-X9124 24-Port	1:1	1:1	2:1	N/A
DS-X9148 48-Port	1:1	2:1	4:1	N/A
DS-X9704 4-Port	N/A	N/A	N/A	1:1

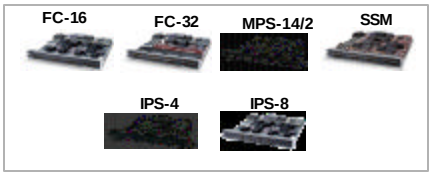
New 24-Port and 48-Port FC Switching
Module - Shared-Mode Port Groups

- FC ports operate in either:
  - Dedicated-mode
  - Shared-mode
- Dedicated-mode ports get bandwidth allocation
- Port Groups distribute backplane bandwidth to shared-mode front panel ports
- Each port group shares 12.8 Gbps
- 12-Port FC Module:
  - No port groups
- 24-Port FC Module:
  - 4 x 6-port port groups
- 48-Port FC Module:
  - 4 x 12-port port groups

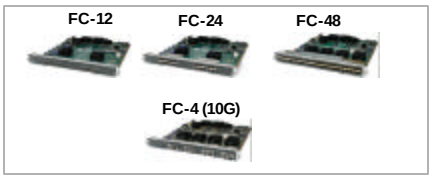


Investment Protection –
Extensible Architecture For Ease of Migration

Existing Switching Modules (1/2G FC, IPS)

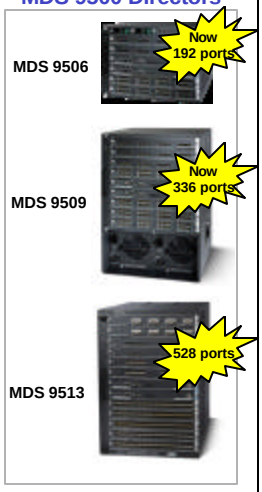


New Switching Modules (1/2/4/10G FC)



- Switching modules are forward & backward compatible*
- Common OS with consistent features

MDS 9500 Directors



* All switching modules compatible with MDS 9216A, 9216i 9506, 9509 and 9513

MDS 9216i – Multilayer Fabric Switch and Multi-Protocol Services Module

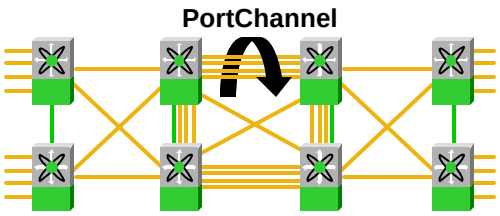
- FC/FICON/FCIP/iSCSI capable fabric switch
  - 14 FC ports + 2 IP ports
  - Expansion slot for MDS 9000 Family modules
- Optimized for SAN extension
  - FCIP enhancements
    - Compression – Bandwidth optimized
    - Encryption – IPsec
    - FCIP Write and Tape Acceleration
  - FC over DWDM/CWDM/SONET/SDH enhancements
    - Extended distance capability
    - 255 buffer credits per FC port
    - Up to 3500 buffer credits on a single FC port (Extended Credits)
- Low cost SANs via iSCSI
  - IP ports support both iSCSI and FCIP (including FICON over IP)
  - Line rate performance for server aggregation
- FICON Qualified

MDS Licensing Summary

Package/SAN-OS	1.1.x	1.2.x	1.3.x	2.0.x	2.1	3.0
Standard Package	All features included in SAN-OS Releases, including Cisco Fabric Manager and Device Manager (FM/DM), except those features explicitly listed in the licensed packages FCP, iSCSI, Fabric Manager, VSANs, Zoning, FCC, Virtual Output Queuing, Diagnostics (SPAN, RSPAN etc.), SNMPv3, SSH, SFTP, RBAC, Radius, High Availability, Port Channels, RMON, Call Home, TACACS+, FDMI, SMI-S (XML-CIM), iSNS Client, iSNS server, WWN based, IPS ACLs, N_Port ID Virtualization, etc.					
SAN Extension over IP (FCIP) Package	FCIP Protocol		FCIP Software Compression FCIP Write Acceleration	FCIP IVR FCIP Hardware Compression (14/2) FCIP Tape Acceleration SAN Extension Tuner		
Enterprise Package		LUN-Zoning Read-only zones Port Security VSAN Roles	FC-SP Host/Switch Authentication QOS Inter-VSAN Routing	QoS aware zones Extended Credits IPSEC for iSCSI & FCIP (Encryption on MPS 14/2)	FC Fast Write	
Fabric Manager Server Package			Historical Performance Monitoring Continuous Health & Event Monitoring Centralized Management	Web-based operational view Threshold Monitoring for Performance Management		
Mainframe Package			FICON w/CUP Intermixing VSANs Switch Cascading Fabric Binding			Mainframe Tape Acceleration
Storage Services Enabler Package			Veritas VSFN Enabler (1.3.5 only)	Veritas VSFN Enabler	SANTap FAIS Based Apps NASB	

MDS 9000 FICON Cascading Enhancements - PortChannels

- Aggregation of up to 16 physical links into a single PortChannel (logical ISL)
- Up to 64Gb/s per Port Channel (4Gb ISLs)
- PortChannel member ports can reside on any port on multiple line cards for enhanced availability
- Hardware-based intelligent load distribution
- Used in conjunction with FSPF routing

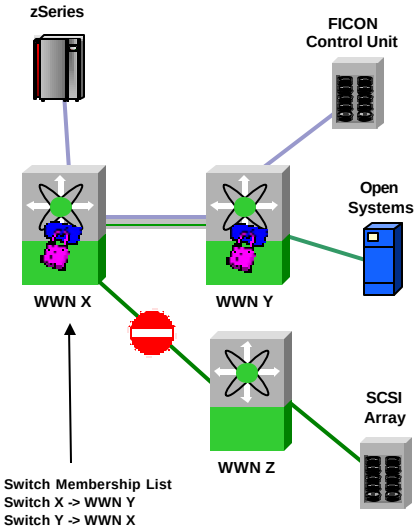


PortChannels optimize use of the fabric

- ✓ Increased ISL utilization
- ✓ Reduced ISL cost
- ✓ Increased ISL availability

Fabric Binding for Enhanced Cascading Security

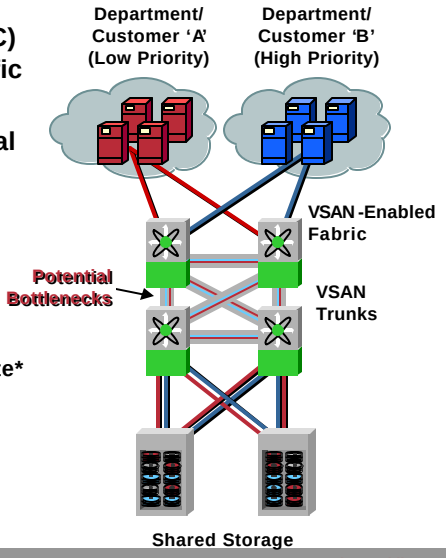
- Two Switches / One Hop
- Based on Switch WWNs
- Only authorized switches can connect to a secure fabric
  - Unauthorized switches result in attachment port being placed in 'Invalid Attachment' state
  - Query Security Attributes and Exchange Security Attributes ensure compliance
- Predictable error recovery
- Requires Insistent (static) Domain IDs



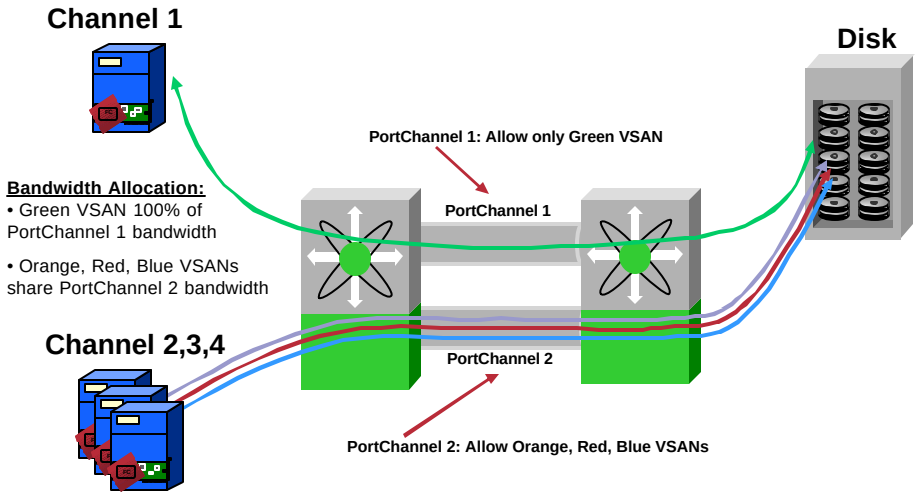
Cascading Enhancements Advanced Traffic Management

- Forward Congestion Control (FCC) mechanism can throttle back traffic at its origin
- Virtual Output Queuing for optimal crossbar performance
- Oversubscription Enhancements
  - Round Robin Fairness
  - Assured Fairness
  - Port Bandwidth Reservation
    - Allows any port to act as line rate*

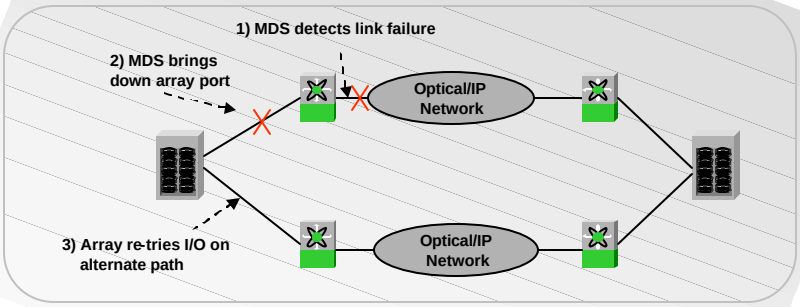
* Requires second generation modules



Industry-First Traffic Management using VSANs and PortChannels

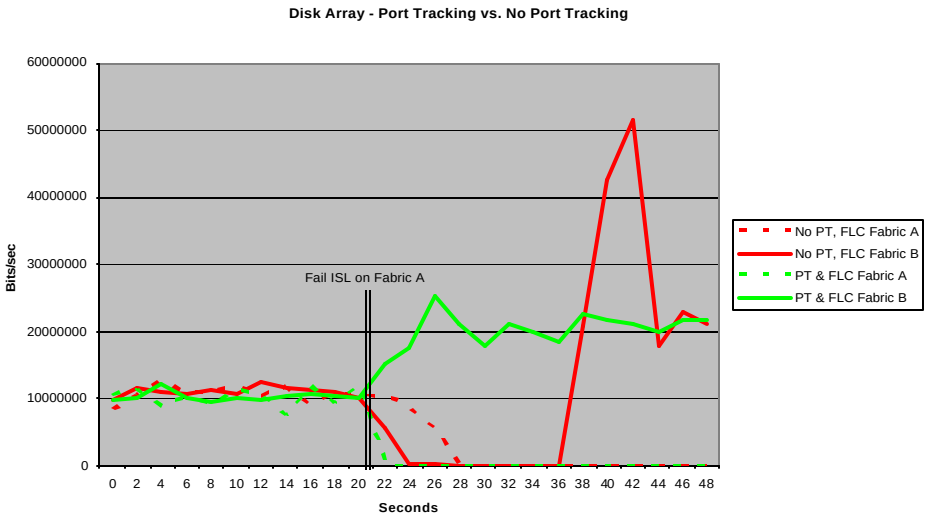


PortTrack for Resilient SAN Extension Solutions



- Arrays recover from a link failure via I/O timeouts. However, this can take several seconds or longer
- MDS PortTrack addresses this by monitoring the WAN/MAN link and if it detects a failure, it will bring down the corresponding link connected to the array
- The array after detecting a link failure will re-direct the I/O to another link without waiting for the I/O to timeout

Example of Port Tracking Benefit

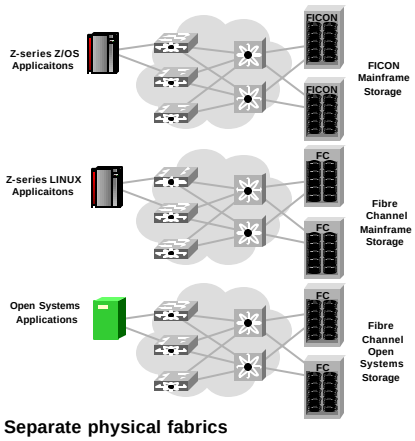


Intermixing in the MDS Switches / Directors

- **Consolidate Open and Mainframe platforms and subsets of those platforms on a single physical infrastructure**
- **Consolidate DR / Business Continuity platforms**
  - Intermix FICON, FCP and FCIP in the same physical infrastructure using separate VSANs
  - Build and Maintain *Hardware* isolation from fabric events or operator error
    - Separate services maintained per VSAN (separate name service, zone service, FSPF, RSCN, BF, RCF, etc.)
  - VSANs can be managed with Role Based Access Controls
    - Mainframe users can be safely isolated from other users
  - Allow dynamic provisioning and resizing of virtualized fabrics
  - Statistics may be gathered per VSAN

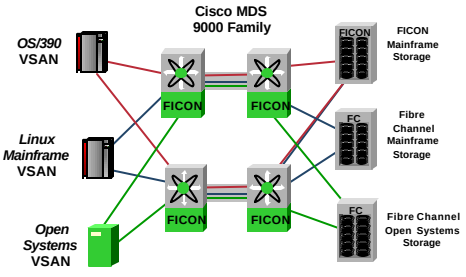
FICON Intermixing with VSANs

Application / Department based SAN Islands



- **Separate physical fabrics**
- **Over-provisioning ports on each island**
- **High number of switches to manage**

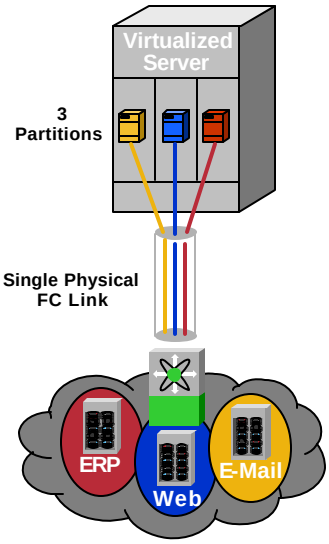
Collapsed Fabric with VSANs



- **Clean partitioning of different operating environments**
- **Significantly more stable and manageable than current zoning & best practices approach**

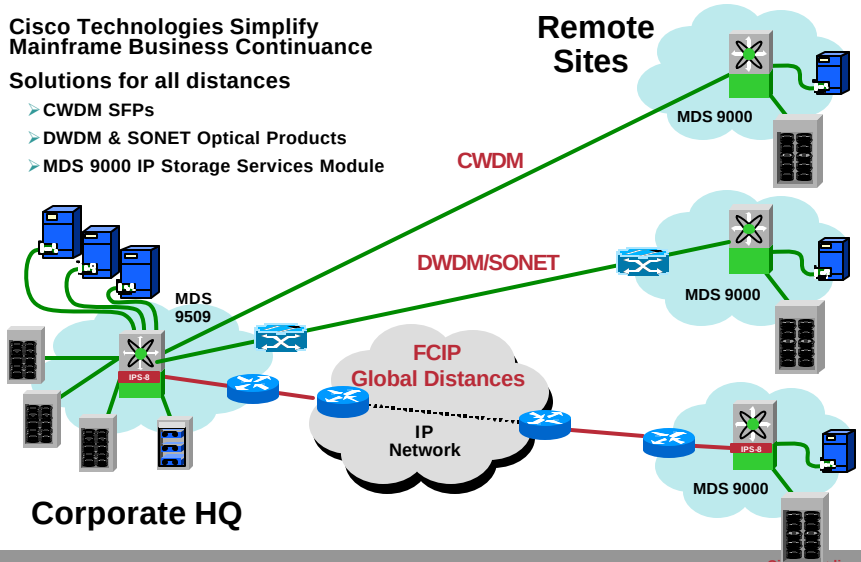
SAN-OS: N-Port ID Virtualization (NPIV)

- NPIV is standards-based (T11)
- Allows HBA port sharing between server partitions or virtual machines (VM)
- Separate fabric log-in by server partitions or VM enables application level
  - Zoning
  - Security
  - Traffic mgmt (e.g. QoS)



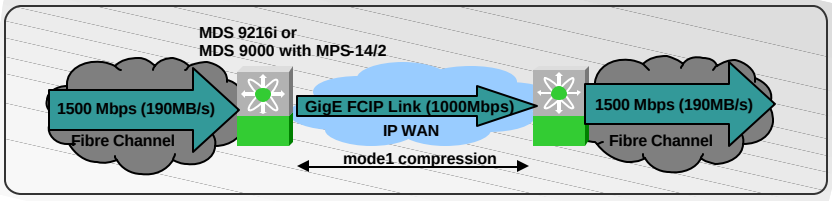
Flexible Remote Access and Replication Using Integrated FICON over FCIP

- Cisco Technologies Simplify Mainframe Business Continuance
- Solutions for all distances
  - CWDM SFPs
  - DWDM & SONET Optical Products
  - MDS 9000 IP Storage Services Module



Integrated FCIP Compression

- Compression lowers WAN costs - more throughput with less bandwidth
- MPS-14/2 card and MDS 9216i offers Hardware Compression
  - Up to 190MB/s of Fibre Channel throughput over single GigE (2:1 compression)
- Compression Ratio depends on data stream
- Three Compression Modes - choose appropriate Mode for WAN Link
  - Mode1: WAN up to 1000Mbps – compression up to 9:1
  - Mode2: WAN up to 25Mbps – compression up to 30:1
  - Mode3: WAN up to 10Mbps – compression up to 33:1

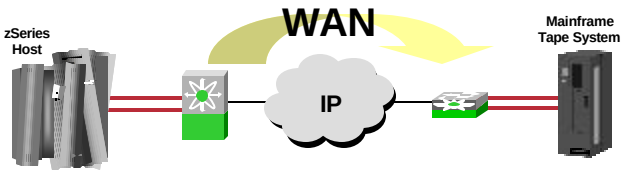


DR / Business Continuance in the MDS Switches / Directors

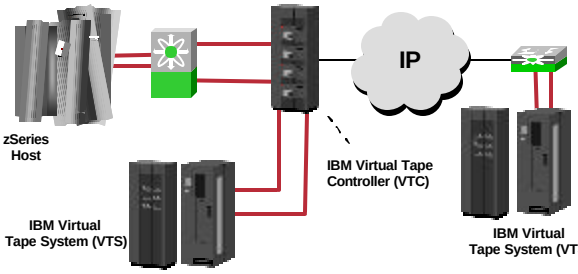
- **Supported DR / BC Extension Functions**
  - XRC over IP – 200km
  - XRC over xWDM or SONET – 200km
  - FC based replication over FCIP or xWDM or SONET
    - Eg. Global Mirror, SRDF, TrueCopy, etc.
    - Sync – 200km
    - Async – Unlimited Distance (based on required performance)
  - VTS and PtP VTS or STK VSM over FCIP or xWDM or SONET
    - Distance – 100km (BETA Sites in test today with 3.0 Code
  - Open Systems Tape – any distance with Tape Acceleration feature

Largest Buffer to Buffer Credit Allocation for longer distance over fiber
255 BB Credits per Port on 16 port line modules.
Up to 3500 BB Credits on MSM and 9216i.

FICON VTS and Tape Acceleration over IP Topologies



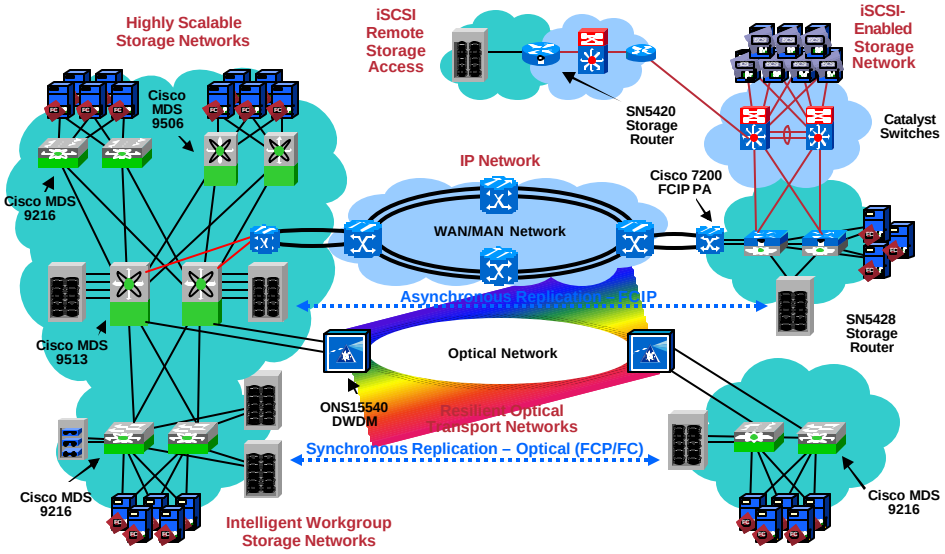
Extending the distance between the host and tape



Extending VTS Peer to Peer with IP between the VTC and the VTS

- Emulates IBM Tape Command Handshakes
- Reduced I/O Latency
- Enables Greatly Extended Backup Distance
- Support for IBM VTS PtP, 3490 Tape
- STK VSM4
- SAN OS 3.0

Cisco's End-to-End Storage Solutions



Managing FICON Directors

Cisco MDS 9000 FICON Management Options

Simplifies Management of Switches, Fabrics and Intermix

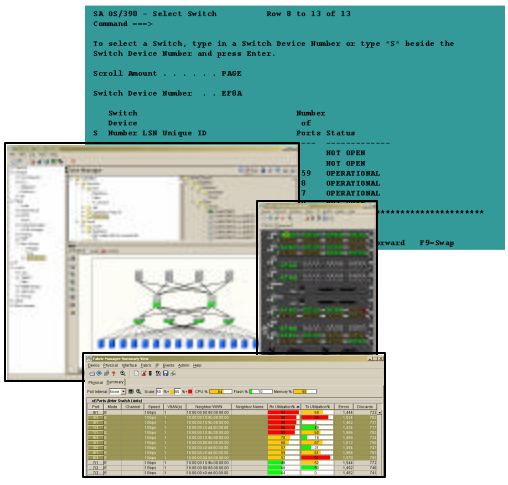
IBM SA for I/O Ops

- Full CUP Support

Cisco Fabric Manager

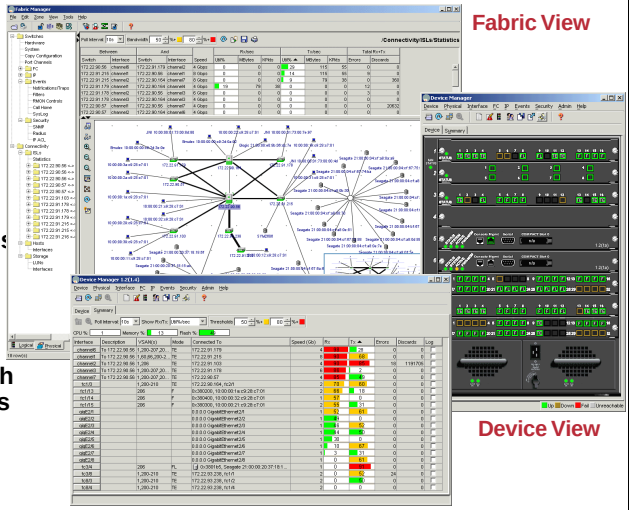
- Switch-embedded Java-based Application
- Discovery and Topology Mapping
- Multiple Views
  - Fabric View, Device View, Summary View
- Configuration
- Monitoring and Alerts
- Network Diagnostics
- Security
  - SNMPv3, SSH, RBAC

Cisco SAN-OS CLI



Cisco Fabric Manager
Simplifies Management of Multiple Switches and Fabrics

- Switch- embedded Java Application
  - Installed and updated automatically by Java Web Start
  - Runs on Windows, Solaris, Linux workstations or laptops
- Discovers FC fabric and visualizes network topology, VSANs, Zones
- Enables rapid multi-switch configuration and analysis



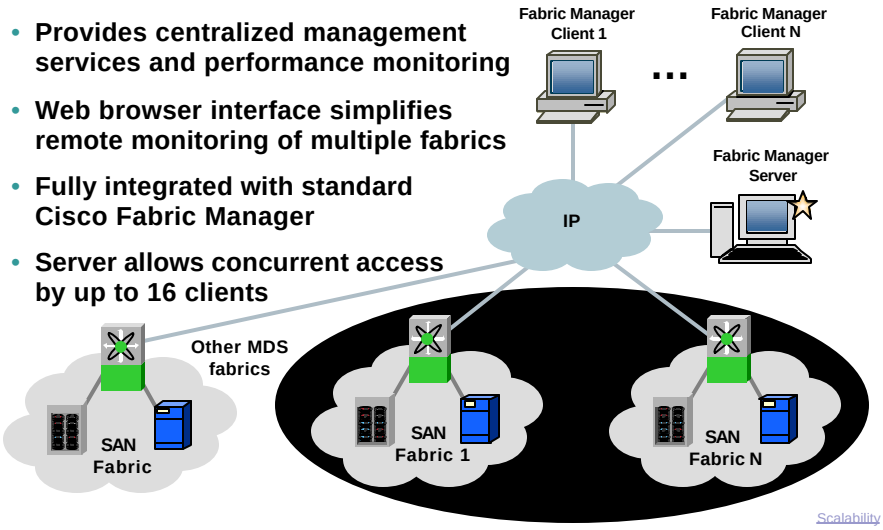
Fabric View

Device View

Summary View

Cisco Fabric Manager Server (FMS)

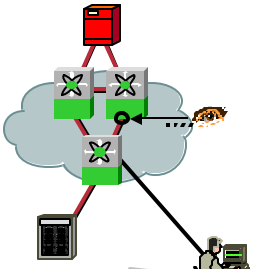
- Provides centralized management services and performance monitoring
- Web browser interface simplifies remote monitoring of multiple fabrics
- Fully integrated with standard Cisco Fabric Manager
- Server allows concurrent access by up to 16 clients

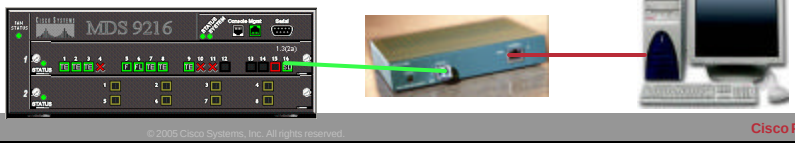


Scalability

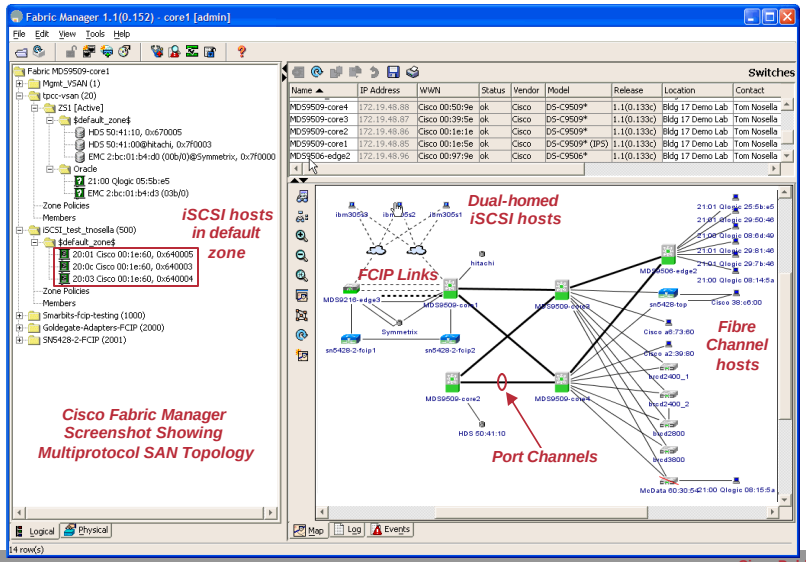
Diagnostic Tools and Serviceability

- **Cisco Fabric Analyzer: Decode and analyze Fibre Channel and SCSI protocols and send to workstation over IP**
  - **Protocol-level decodes of FC frames**
  - **Quickly diagnose protocol-level problems remotely**
- **SPAN provides the ability to intelligently capture traffic non-disruptively**
- **FC Ping provides immediate verification of connectivity, FC trace to view full path including roundtrip latency**
- **Zone merge analysis/Non-MDS Zone Migration**
- **Fabric Configuration analysis**
- **Call/Email Home**



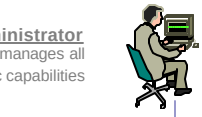


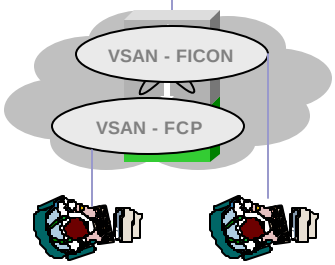
Cisco Fabric Manager - Screenshot



VSAN Based Roles

System Administrator
Configures and manages all platform-specific capabilities



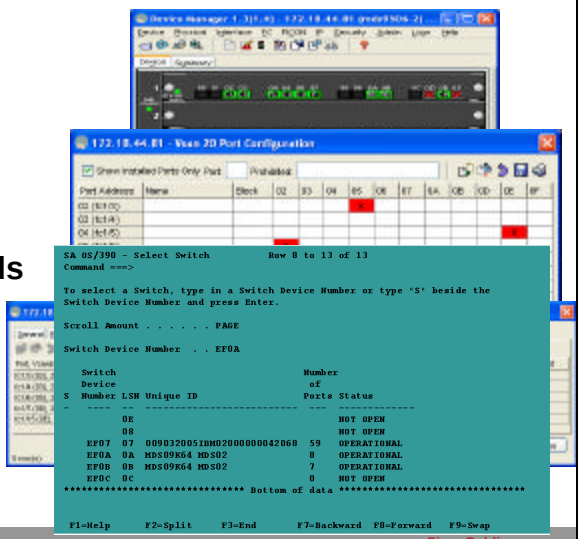


- **Enables deployment of VSANs that fit existing operational models**
  - **System-admin configures all platform-specific capabilities**
  - **VSAN-admin(s) configure and manage their own VSANs**
- **The existing "role" definition is enhanced to include VSAN(s)**

VSAN Administrators
Configure and manages only their VSANs

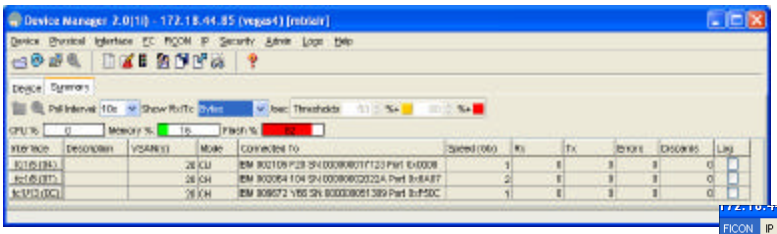
FICON Management

- **FICON Addressing**
- **Port Prohibit Matrix**
- **Node Descriptors**
- **Link Incident Records**
- **CUP Support**
- **Configuration File Management**

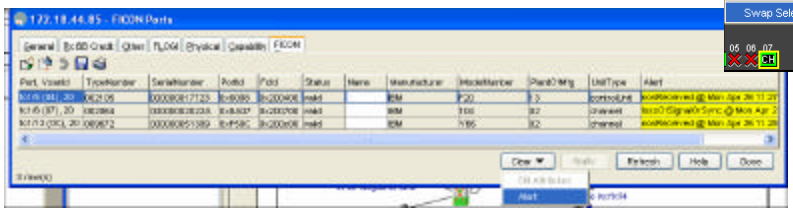


FICON Management – Discovery/Monitor

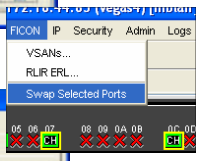
Summary View will show attached FICON CUs and CHs



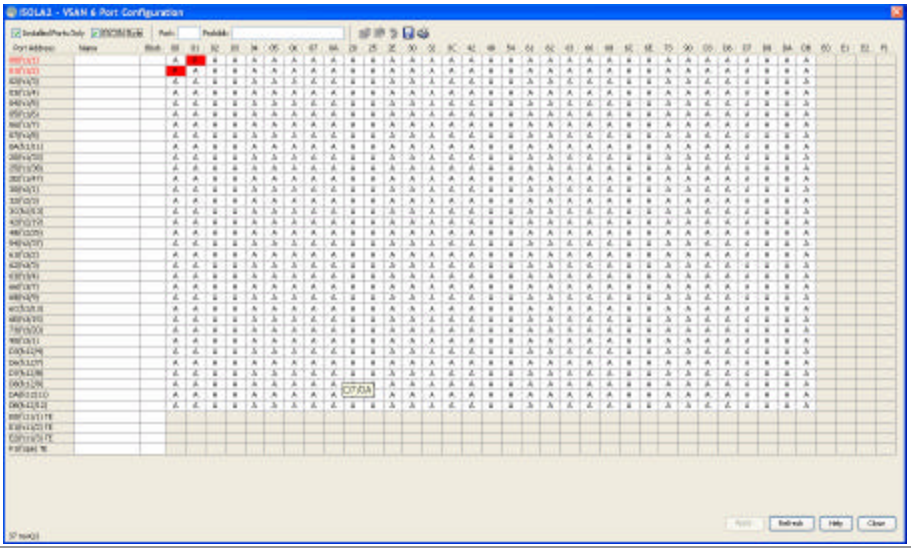
You can drill down to see more details…



Port Swap…

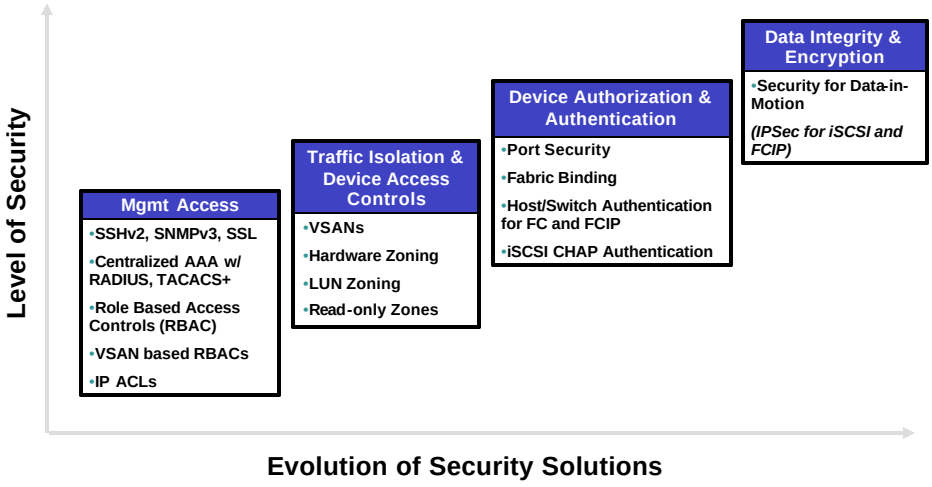


I Want my ESCON Director Back!



RESILIENT AND SECURE STORAGE NETWORKS

MDS Security Solutions



Why Cisco MDS FICON Directors?

- **Most Scalable director available**
- **Full functionality and high availability**
- **Most advanced set of FICON Director features and functionality in the market.**
- **Enhanced Traffic Intermix with VSAN segregation. Support FICON z/OS and FC (LINUX) on the same platform.**
- **DR/BC connectivity integrated into the MDS. Inter-data center connectivity via DWDM, CWDM, SONET, FCIP.**
- **Multiple methods for provisioning, monitoring and troubleshooting.**

MDS 9000 Family – Combining the Latest Technology with Unparalleled Investment Protection

- **Ultra-scalable directors up to 528 ports**
  - High density: 192, 336 and 528-port systems
  - High availability: redundant system bandwidth
  - High stability: VSANs, IVR, per VSAN fabric services
  - Advanced feature set and management tools
- **Unparalleled investment protection**
  - Seamless upgrades to 4-Gbps and 10-Gbps
  - Forward and backward compatibility
- **Integrated multiprotocol, multitransport**
  - 2-Gbps, 4-Gbps and 10-Gbps in single platform
  - Support for FICON, FCP, FCIP, iSCSI
- **Intelligent services platform**
  - Network-hosted volume management
  - Network accelerated backup and replication
  - Data migration
- **Award winning service and support**

Questions?

CISCO SYSTEMS

EMPOWERING THE
INTERNET GENERATION