CISCO SYSTEMS

CISCO
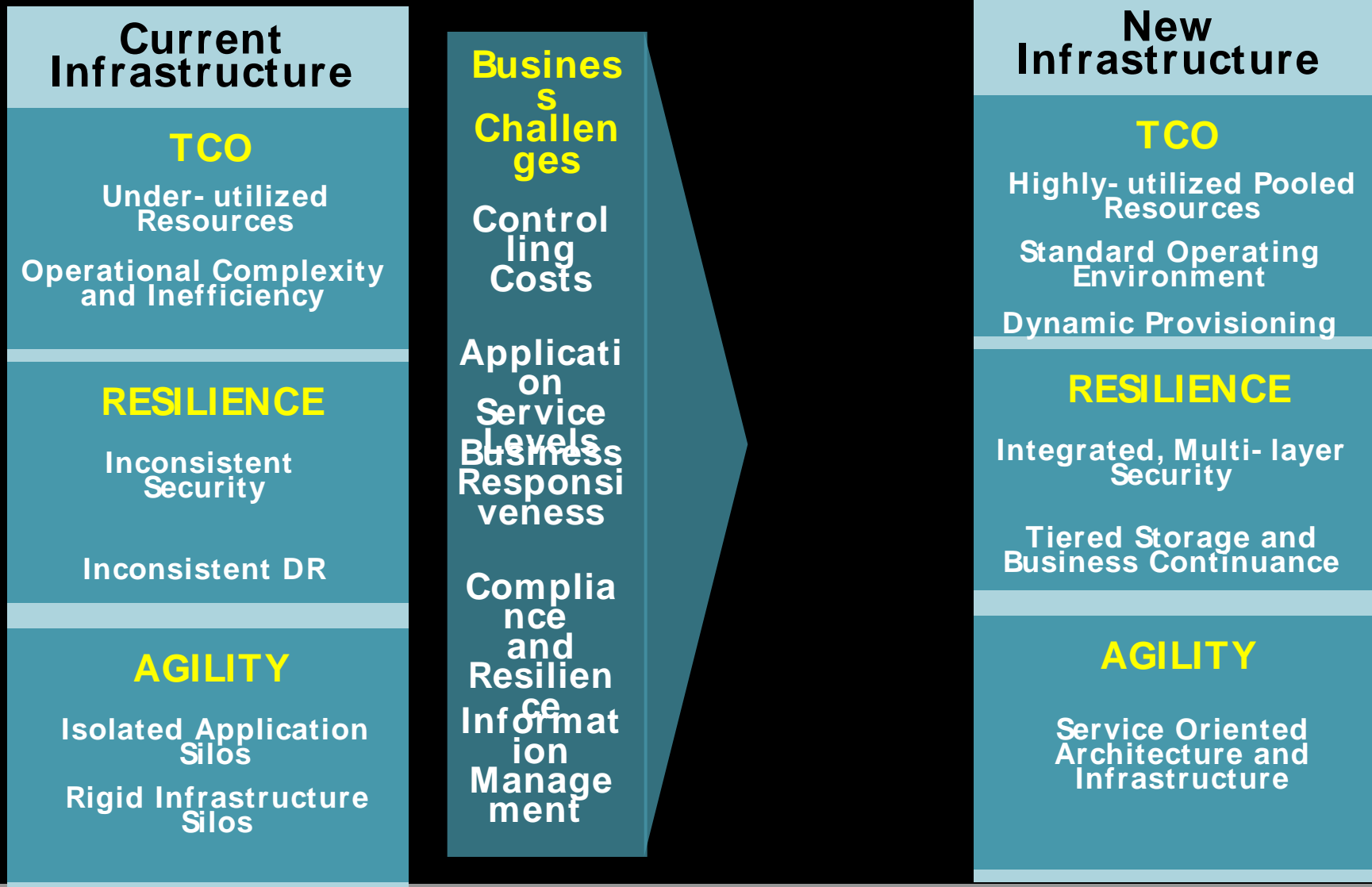# DATA CENTER NETWORKING ARCHITECTURE

A STRATEGIC NETWORKING FOUNDATION FOR THE NEW DATA CENTER
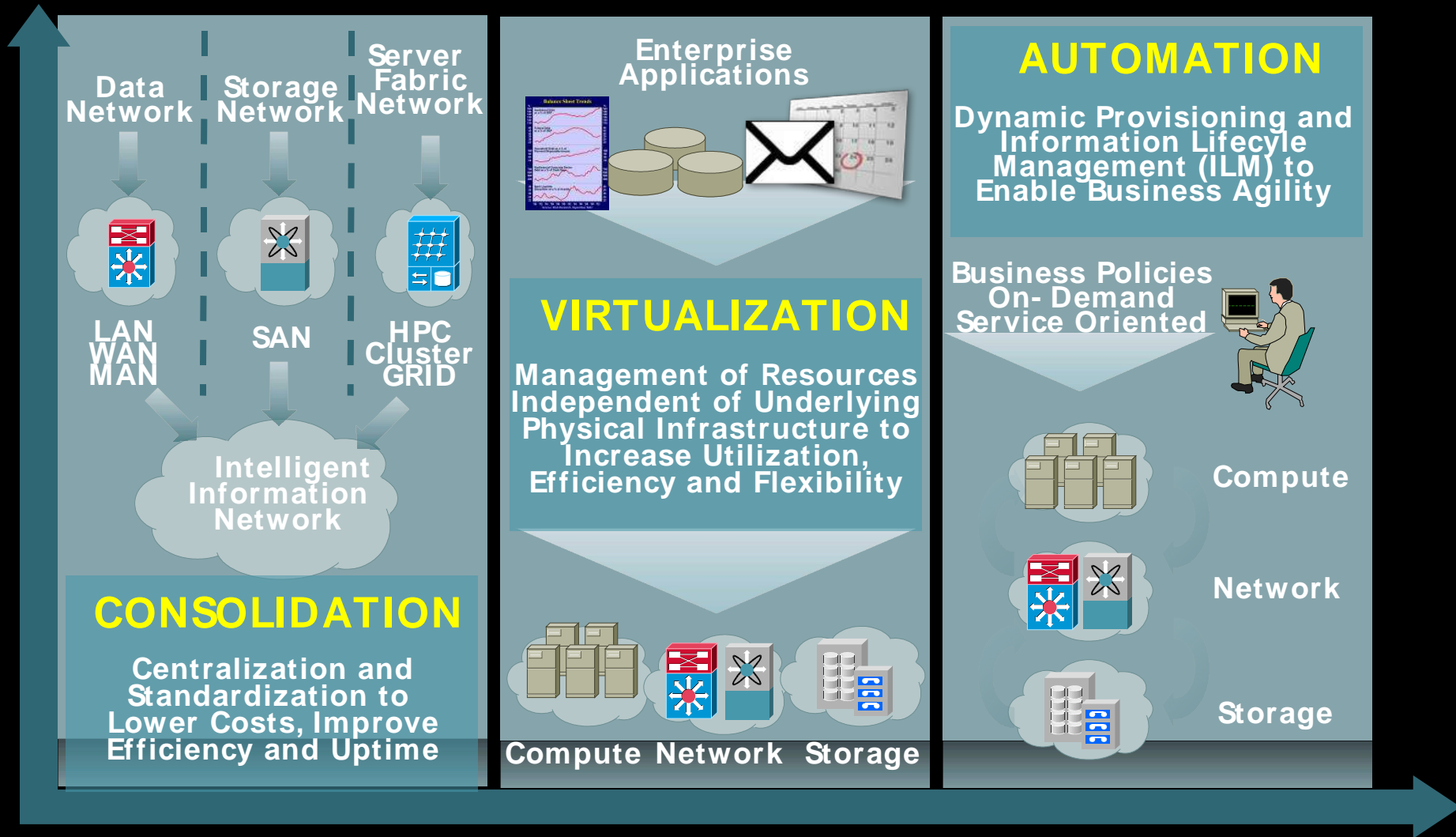
Ulrich Hamm uhamm@cisco.com

Data Center Team

Agenda

- **Data Center Challenges and Trends**
- **Cisco Data Center Networking Architecture**
- **Addressing Key Data Center Challenges**
- **Summary**
- **Cisco on Cisco**

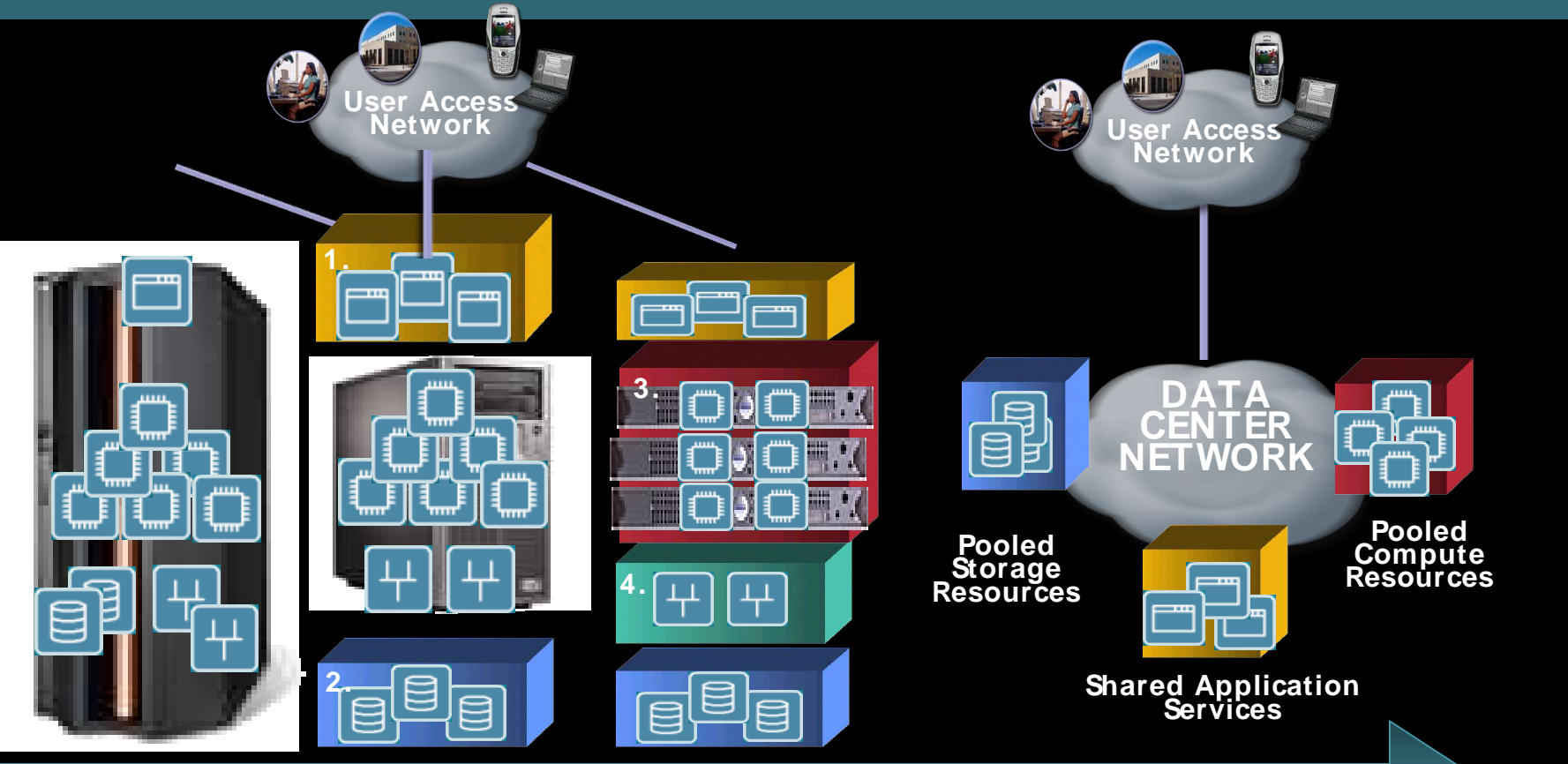# Key Data Center Infrastructure Challenges and Trends

Current Infrastructure

TCO

Under- utilized Resources

Operational Complexity and Inefficiency

RESILIENCE

Inconsistent Security

Inconsistent DR

AGILITY

Isolated Application Silos

Rigid Infrastructure Silos

Business Challenges

Controlling Costs

Application Service Levels

Business Responsiveness

Compliance and Resilience

Information Management

New Infrastructure

TCO

Highly- utilized Pooled Resources

Standard Operating Environment

Dynamic Provisioning

RESILIENCE

Integrated, Multi- layer Security

Tiered Storage and Business Continuance

AGILITY

Service Oriented Architecture and Infrastructure

Evolution of the Data Center Infrastructure Phased Approach

Data Network | Storage Network | Server Fabric Network

LAN WAN MAN | SAN | HPC Cluster GRID

Intelligent Information Network

CONSOLIDATION

Centralization and Standardization to Lower Costs, Improve Efficiency and Uptime

Enterprise Applications

VIRTUALIZATION

Management of Resources Independent of Underlying Physical Infrastructure to Increase Utilization, Efficiency and Flexibility

Compute Network Storage

AUTOMATION

Dynamic Provisioning and Information Lifecyle Management (ILM) to Enable Business Agility

Business Policies On- Demand Service Oriented

Compute

Network

Storage

Infrastructure Standardization and Consolidation
Server- Centric to Service- Centric

User Access Network

1.

3.

4.

2.

DATA CENTER NETWORK

User Access Network

Pooled Storage Resources

Pooled Compute Resources

Shared Application Services

Monolithic Proprietary Compute Silos	**1. Virtual Machines** **2. Storage Networks**	**3. Compute Networks** **4. I/ O Consolidation**	**Service- Centric Model** "Pools" of standardized resources Assembled On- Demand to create "Virtual Infrastructure" out of piece- parts

I/ O **Server Processing** **Storage** **Applications**

Cisco Public

5

Consolidated Data Center
Based on an Intelligent Data Center Network Platform

- **Integrated data center technologies and services**

- **One network, many services**

- **Single point of management**

- **Resilience with Security and Stateful Redundancy**
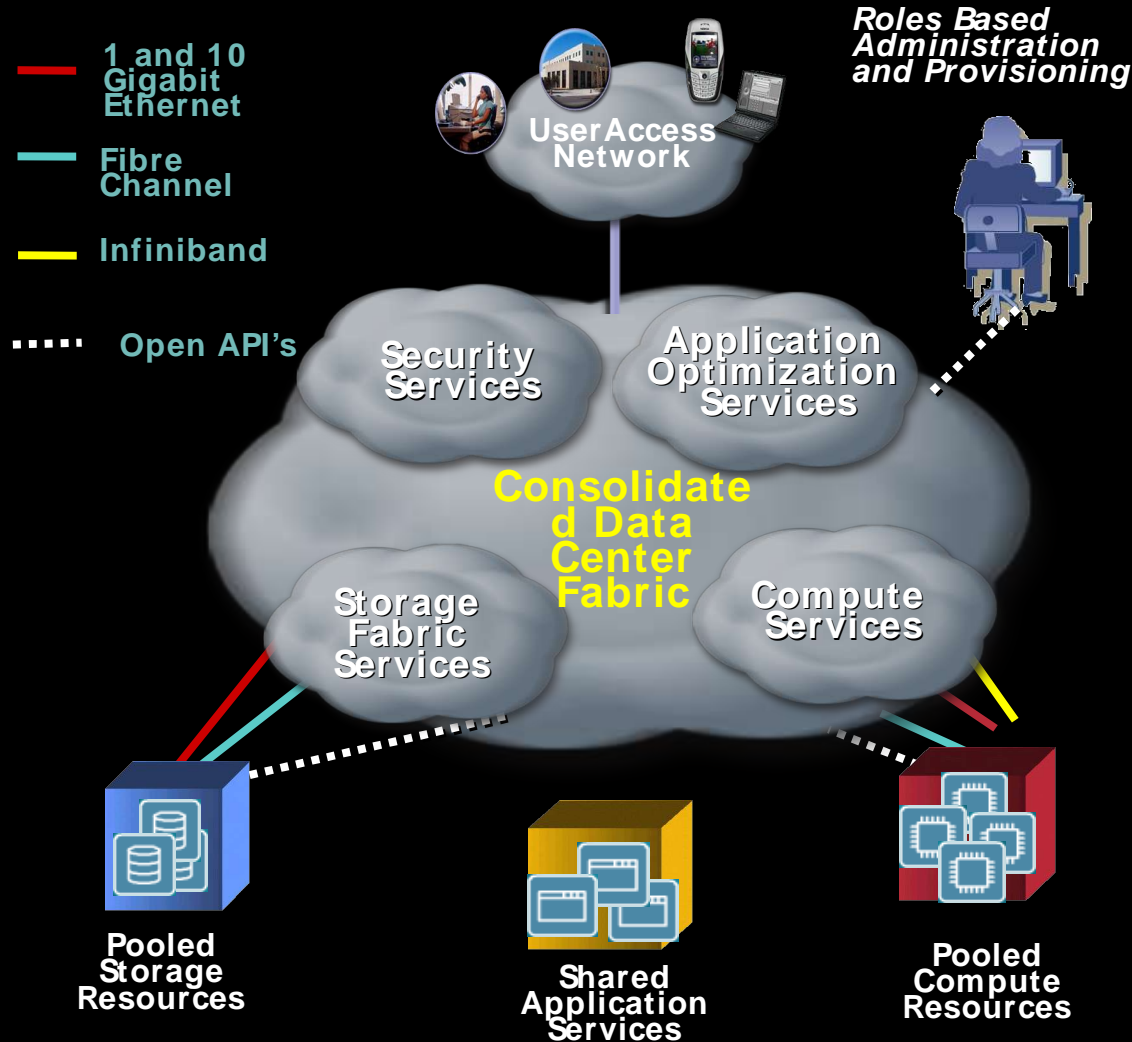
Legend:
- **1 and 10 Gigabit Ethernet**
- **Fibre Channel**
- **Infiniband**
- **Open API's**

Roles Based Administration and Provisioning

User Access Network

Security Services

Application Optimization Services

Consolidated Data Center Fabric

Storage Fabric Services

Compute Services

Pooled Storage Resources

Shared Application Services

Pooled Compute Resources

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Executing on the Data Center Network Architecture with Innovation, Partnerships and Acquisitions

Application Optimization

Wide Area File Services

Application Velocity Engine

Content Services

Data Center Services

Server Load Balancing – SSL Offload

Firewalls, Intrusion Protection, Security Agents

RDMA, Virtual I/O, Low Latency Clustering

Virtualization, Replication, Virtual Fabrics

INTERACTIVE SERVICES LAYER

NETWORKED INFRASTRUCTURE LAYER

Compute Network

Storage Network

Server Fabric	Switching	Storage Switching	Optical Transport
Topspin			
SFS Family	Catalyst Family	MDS Family	ONS Family

VFrame Virtualization and Provisioning

Fabric Manager Network Management

Data Center Network Topology

SERVER FARM NETWORK

- DDOS Guard
- Firewall Services
- Intrusion Prevention
- Server Load Balancing
- SSL Off-load
- Application Message Services

INTEGRATED NETWORK SERVICES

SERVER FABRIC NETWORK

- Grid/Utility Computing
- Server Virtualization
- Low Latency RDMA
- Virtual I/O

INTEGRATED VIRTUALIZATION SERVICES

STORAGE AREA NETWORK

- Virtual Fabrics (VSANs)
- Storage Virtualization
- Fabric Assisted Applications
- Data Replication Services

INTEGRATED STORAGE SERVICES

Catalyst 6500
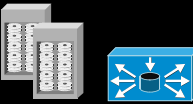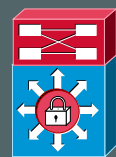
NAS   Caches

Network Attached Appliances

Gig E, 10 Gig E

EMPLOYEE / PARTNER / CUSTOMER ACCESS NETWORK

Internet
MPLS VPN
IPSEC/ SSL VPN
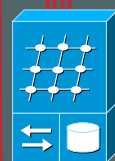
Infiniband

SFS 3000
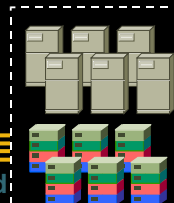
Virtual Server Clusters

Enterprise Grids

Blade Servers UNIX/ NT Servers Mainframes

DATA CENTER INTERCONNECT NETWORK

FC, FICON, iSCSI, FCIP

SONET/ SDH
xWDM
Metro Ethernet
FCIP

ONS 15000

MDS 9500

Storage & Tape Arrays

Data Center Networking Lifecycle Services

Delivering a Technology Vision and Consultancy Services to optimize current resources and plan for future network growth

Planning for Peak Network Performance to protect mission-critical application traffic

Delivering Network Investment Protection to maximize ROI

Performance Evaluation, Architecture Planning, and Skills Assessments to reduce cost and Complexity

Designing agile, resilient, scalable, and highly available networks for greater service velocity and minimal impact of outages

Deploying best practice configurations for easier manageability of networks

SAN Network Architecture Assessment

DNS Design Knowledge Transfer and Mentoring

HTTP Performance Analysis

MDS Subject Matter Expert (SME) Service

SAN Extension Support

Optical Infrastructure Remote Deployment Support
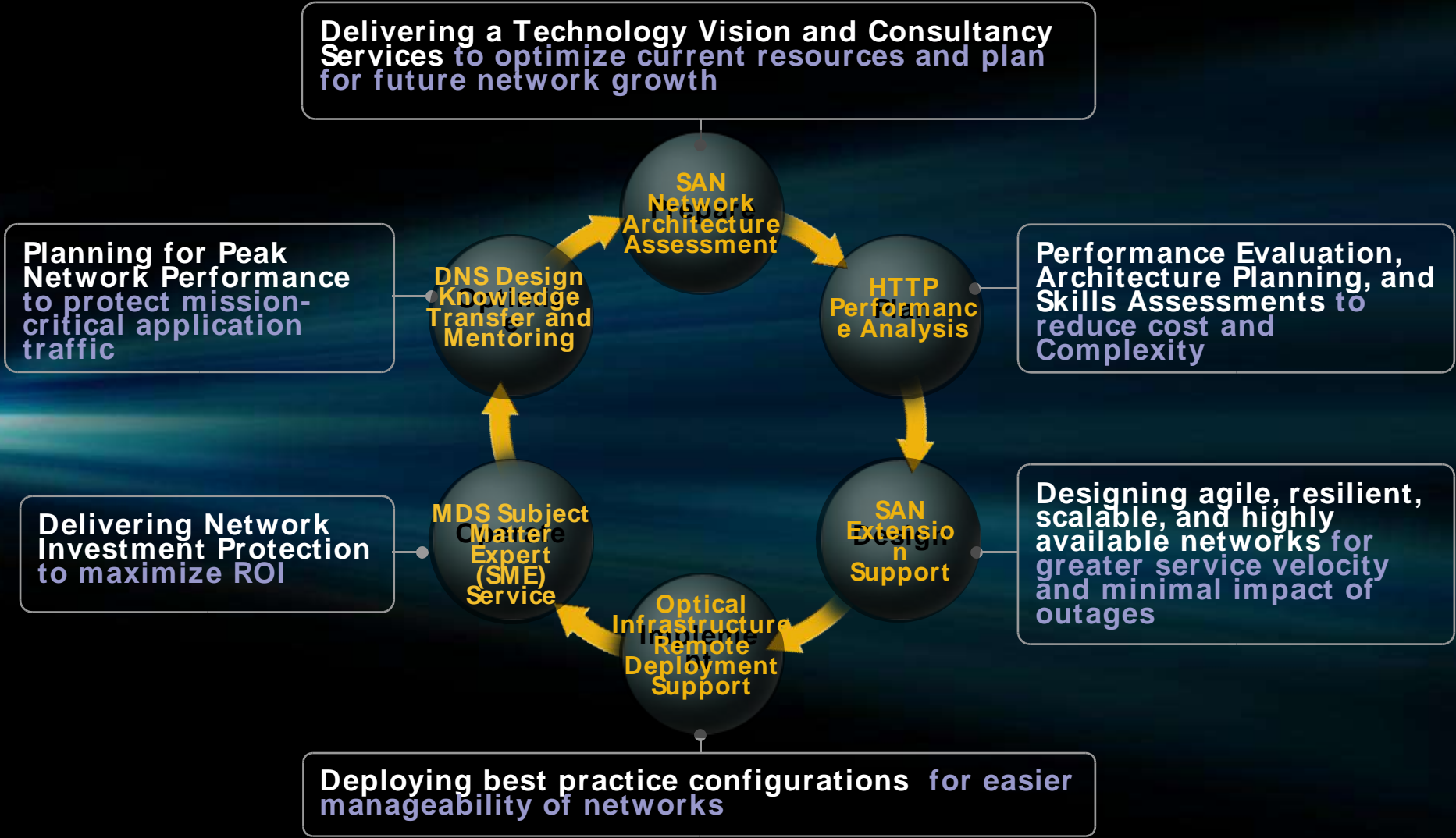
Ease Deployment, Reduce Risk, Improve Resilience with Data Center Networking Design Best Practices

www.cisco.com/ go/ datacenter

Cisco Data Center Network Architecture
Backed by Key Partners

EMC²
where information lives

Reducing Cost and Complexity Through Information Lifecycle Management

- Storage consolidation—MDS 9000
- Storage virtualization—EMC Invista
- Business continuance—ONS 15000
- File server consolidation— WAFS and Celerra

IBM

Enabling Business Transformation to an On- Demand Operating Environment

- Server consolidation—Infiniband and GE Switch—Blade center
- Storage consolidation— virtualization engine
- End- to- end provisioning—IBM Tivoli provisioning manager
- Server optimization— e- workload manager

hp ® invent

Protecting Against Outages with a Disaster Tolerant Framework

- Remote data replication—FCIP
- Synchronous data replication DWDM
- Server consolidation—GE and Infiniband Switch for Blade server
- Storage consolidation—MDS 9000

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Addressing Key Data Center Challenges
Cost, Resilience and Flexibility

- **Storage Consolidation and Virtualization**
- **Proliferation of Server I/O Connections**
- **File Server Proliferation in Branches**
- **Cost Effective High Performance Computing**
- **Business Continuance and Compliance**
- **Web Application Performance Challenges**
- **Data Center Virtualization**

Challenge:
Storage and SAN Island Proliferation

Island A
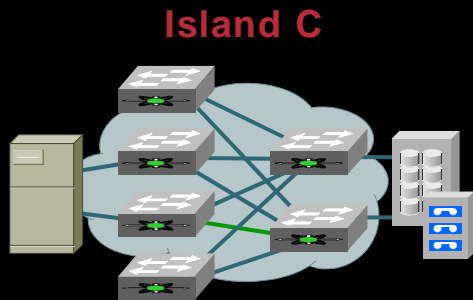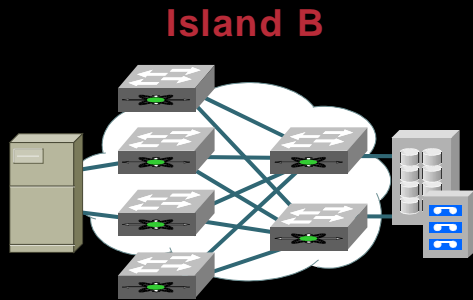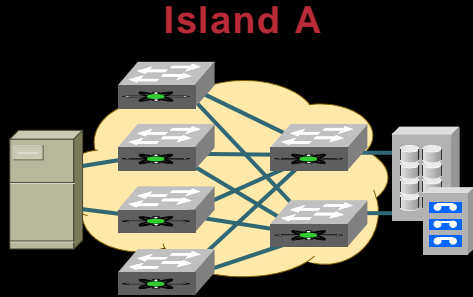
Island B

Island C

Cost

- **Extra ports ($$) due to dedicated ISLs**

- **Extra Administrators ($$) to manage extra switches**

- **Extra time ($$) to expand existing islands**

Flexibility

- **Cannot move ports from one island to another**

- **Extra time to provision new SAN island – complete new infrastructure**

Data Center Network Architecture Solution: Storage *Consolidation and Virtualization*

Blade Servers UNIX/ NT Servers Mainframes

FC, FICON, iSCSI, FCIP

MDS 9500

Virtualization Engine

API

Storage & Tape Arrays
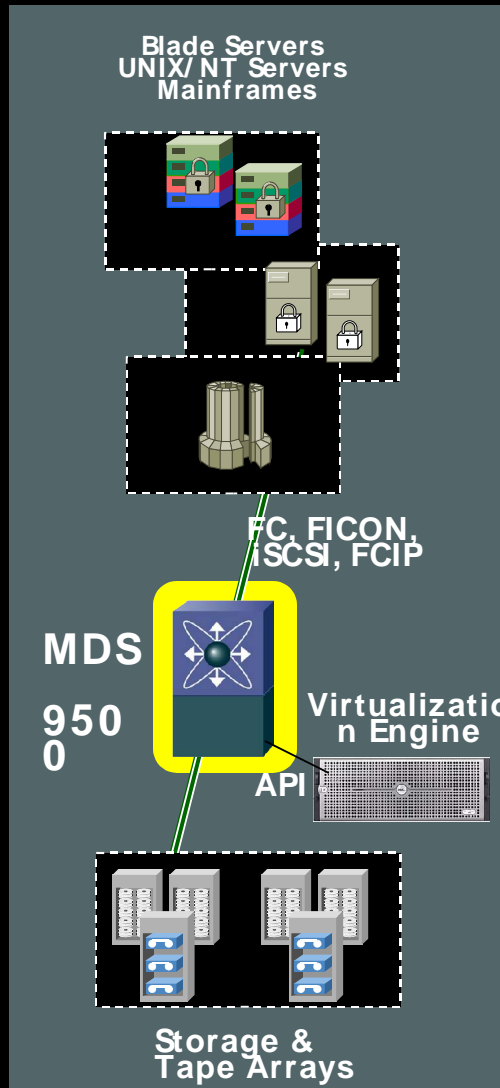
Mission- Critical Availability

- **Fully- redundant platform (MDS 9500)**
- **Non- disruptive software upgrades**
- **Stateful switchovers**
- **Fault- Isolation with VSANs**

Virtualization Platform

- **Provides standard- based API to 3rd party virtualization engines**
- **Enhances performance and transparency by hosting virtualization in the fabric**

Scalability and Density

- **1.44 Tbps switching bandwidth**
- **224 FC ports in 14RU (MDS 9509)**
- **10G Ready**
- **VSANs and Inter- VSAN Routing (IVR)**

Heterogeneous Fabrics

- **Interoperability with legacy switches**
- **Inter- VSAN Routing (IVR)**
- **Native- mode interop. with legacy switches**

Troubleshooting

- **Embedded FC Analyzer**
- **FC Ping and FC Traceroute**
- **Remote SPAN (RSPAN)**
- **Hot- spot analysis**

Multi- protocol Connectivity

- **Integrated FC, FCIP, FICON, iSCSI**
- **Common set of features**
- **Unified provisioning and management**

Storage Consolidation - Reduced Cost
Cisco- on- Cisco - Increasing Storage Effectiveness

Costs (y-axis)

- $600
- $500
- $400
- $300
- $200
- $100
- $0

X-axis: 2002, 2003, 2004, 2005

W/ O MDS- 9500 Operations

With MDS Operations

W/ O MDS 9500 Assets

With MDS 9500 Assets
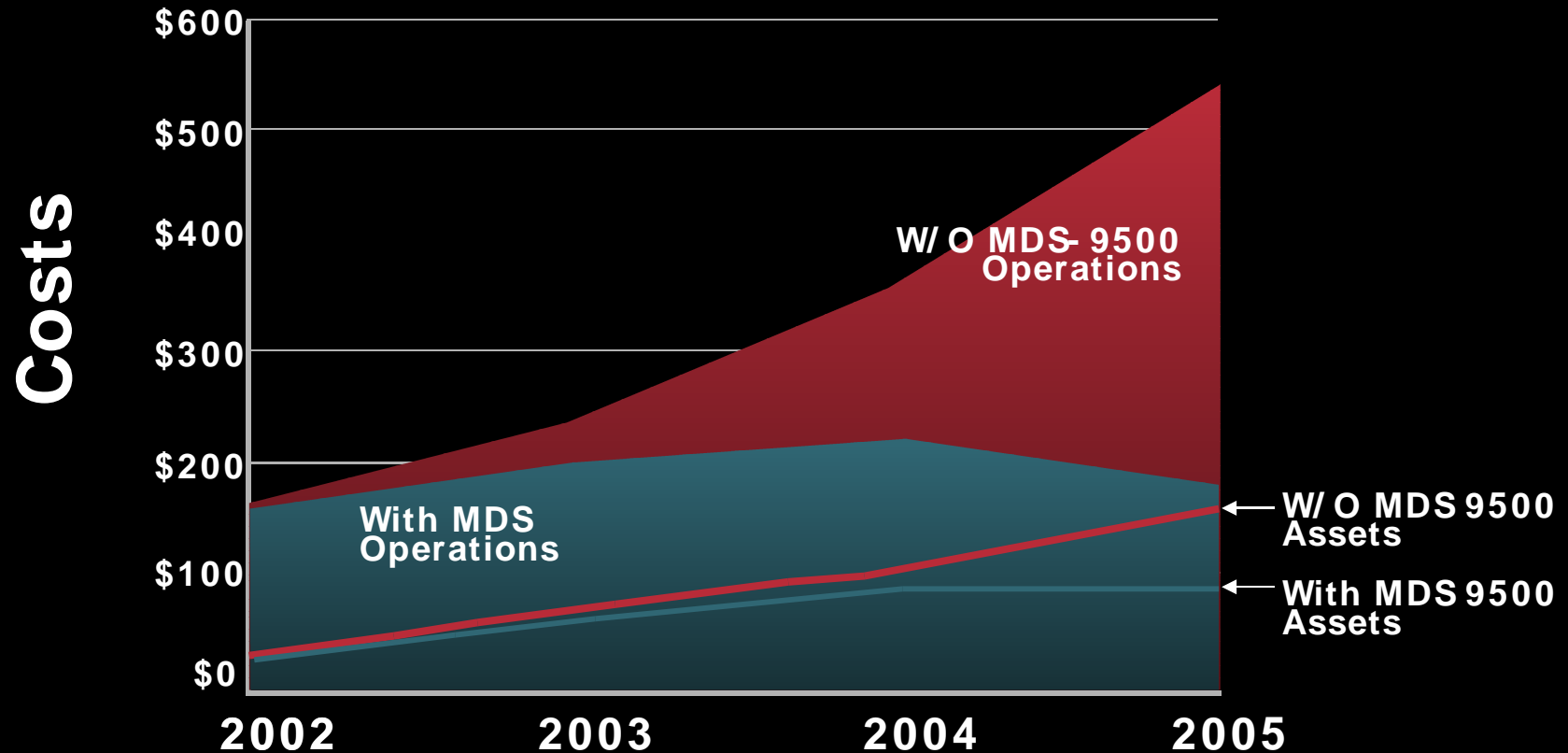
Based on 20c/ MB TCO – Gartner

Challenge:
Proliferation of Server I/O Connections

Campus/ WAN/ VPN

Catalyst 6500

LAN

GbE

CLUSTER

FC

MDS 9500

Systems Administrator

SAN
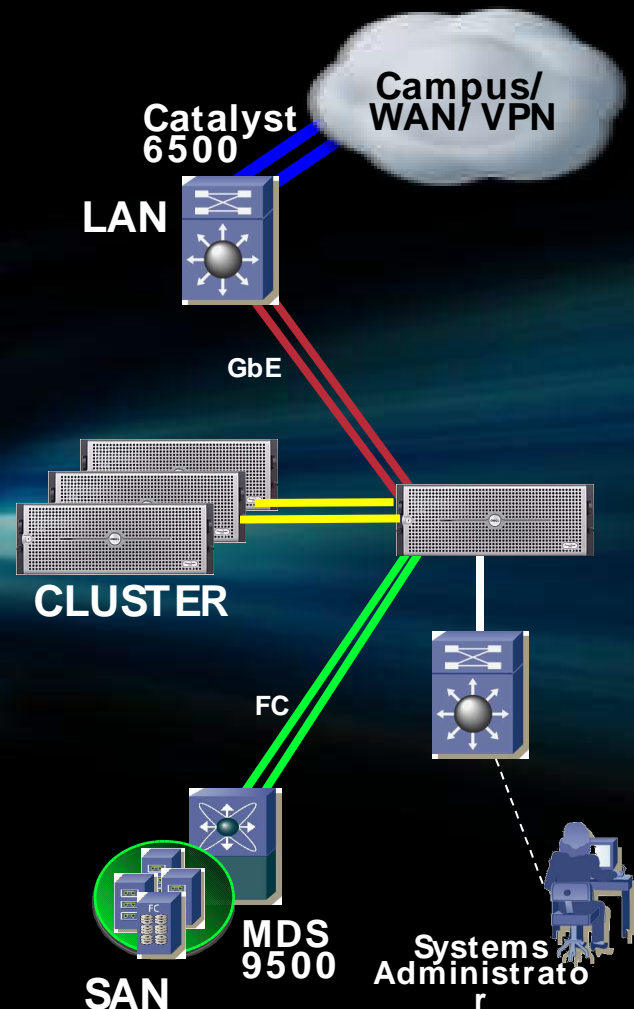
Cost

- **High TCO of traditional server I/O model**

- **Costly NICs & HBAs**

Resilience

- **Downtime dealing with frequent change**

- **Cabling bulk interferes with cooling**

Flexibility

- **Server, cable. I/O changes are complicated**

- **Not enough I/O slots to allow use of 1RU servers or blade servers**

Data Center Network Architecture Solution: *Consolidation of Server I/O Connections*

Campus/ WAN/ VPN

Catalyst 6500

GbE

CLUSTER

SFS 3000

Consolidated 5 connections into 1 and 2+ RUs to 1 RU

FC

VFrame Provisioning

Systems Administrator

MDS 9500

SAN
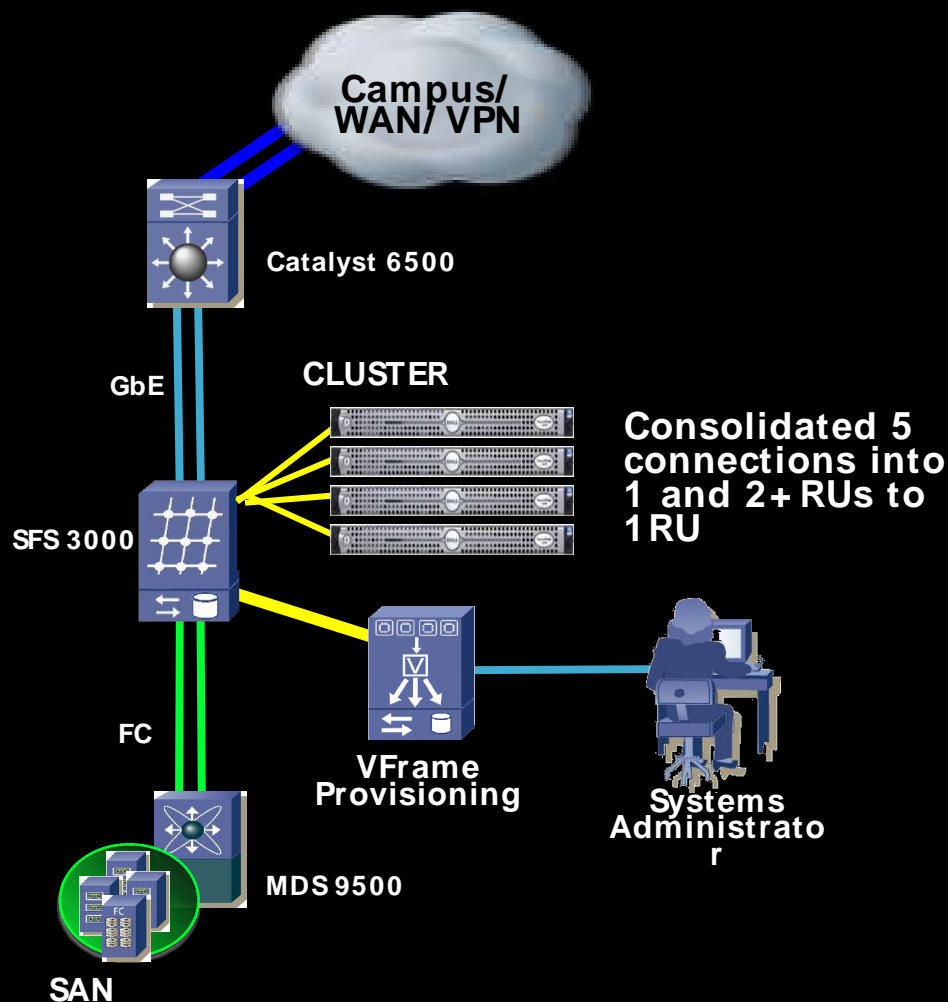
Lower Cost

- **Consolidate LAN, SAN and Clustering traffic over a single transport**

Improved Resilience

- **Reduced complexity results in higher availability**
- **Changes no longer require downtime**

Increased Flexibility

- **Provision servers and I/O connectivity on- demand**

Cisco Public

Case Study: Media Company
Immediate ROI from MFIO

Before Cisco

Fibre Channel Switches
(SAN Connectivity)

Ethernet Switches
(LAN Connectivity and
Clustering)

150 Servers

Storage Arrays

Corporate LANs
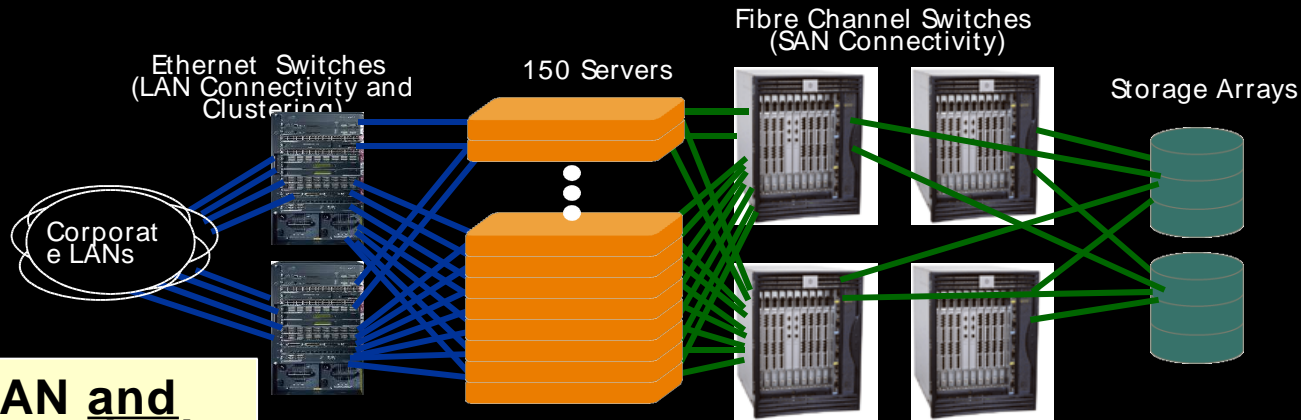
150 LAN and SAN Attached Nodes

With Cisco

150 Servers

Cisco 7000 Server Switches

Cisco 3000 Server Switches

Storage Arrays

Corporate LANs
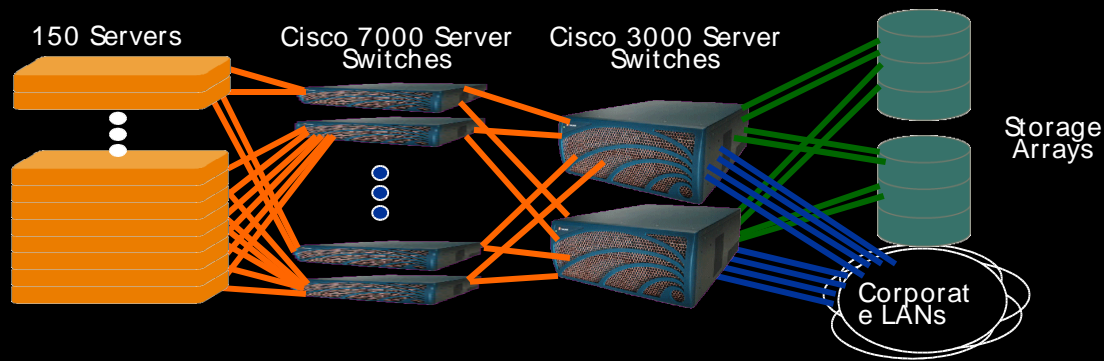
Total Cisco Savings = $329,101 or 48%

Challenge:
Distribution of File Servers at Branches

WAN/ VPN Network

File Storage Distributed

Network Attached Storage Filers

Storage Arrays

Administrator

Tape Arrays

File Storage in the Data Center

Local File & Print Server and Backup

Files

Administrator

Branch Office
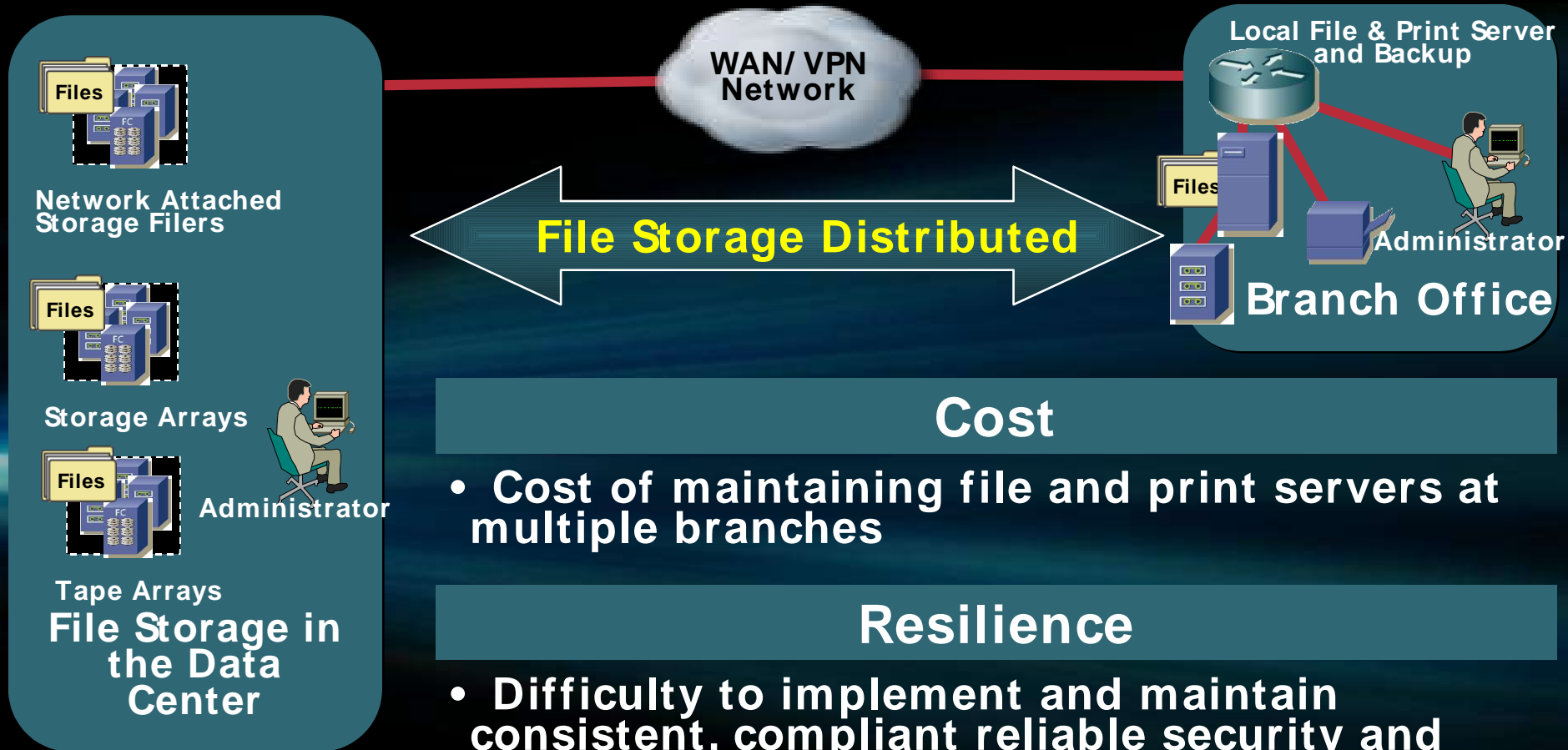
Cost

- **Cost of maintaining file and print servers at multiple branches**

Resilience

- **Difficulty to implement and maintain consistent, compliant reliable security and back up practices**

Flexibility

- **Expansion requires system replacement**

Data Center Network Architecture Solution: Wide Area File Services

Core File Engine

Files

Network Attached Storage Filers

Files

Storage Arrays

Files

Administrator

Tape Arrays

File Storage in the Data Center

WAN/ VPN Network

LAN Speeds for Remote Files

Local File & Print Server

Files

Administrator

Branch Office

Lower Cost

- **Consolidate files on scalable, centralized NAS**
- **Centralize file administration**

Improved Resilience

- **Consistent, compliant security and business continuance best practices**

Improved Flexibility

- **Dynamic provisioning of additional storage**
- **Universal access to information**

Challenge:
Business Continuance and Compliance

Telecommuter

Rem ote Branch

WAN/ VPN Network

Server Network

Applications

Storage Network

Data Storage

Consolidated Data Center
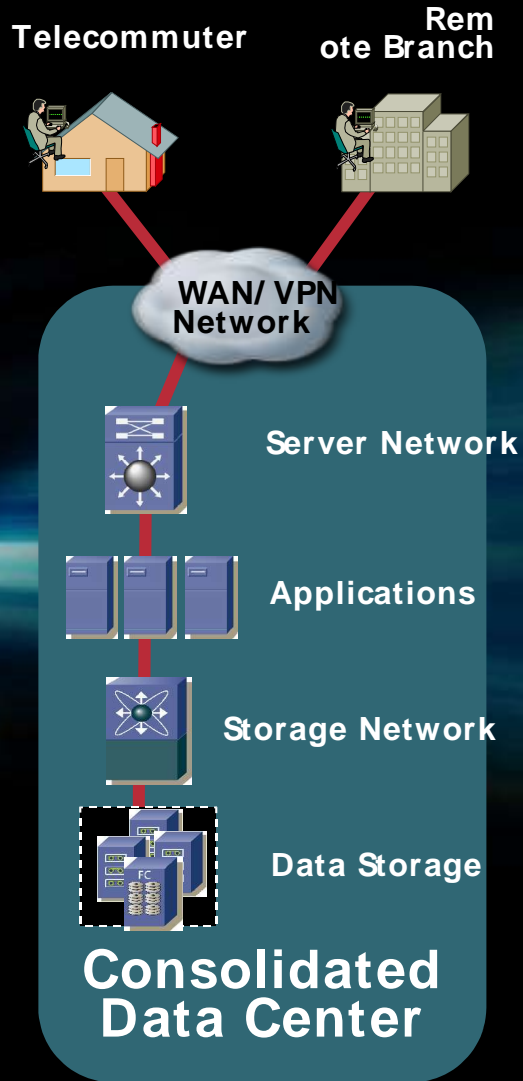
Requirements

- Compliance with regulations
- Increased business impact of downtime
- Lower RPO and RTO needs
- Traditional disaster recovery/ backup solutions are insufficient

Cost

- Traditional business continuance solutions are costly.
- Cost of interconnecting data centers
- Cost of scaling solutions to support increases in data and number of systems

Data Center Network Architecture Solution:
Comprehensive Business Continuance Networking

Access Network

Blade Servers
UNIX/NT Servers
Mainframes

Metro / Wide Data Center Interconnect Network

MDS 9500

Storage & Tape Arrays

DWDM Network

ONS 155X0 154xx

SONET/SDH

ONS 15454

7X00

IP WAN

Blade Servers
UNIX/NT Servers
Mainframes

MDS 9500

Storage & Tape Arrays

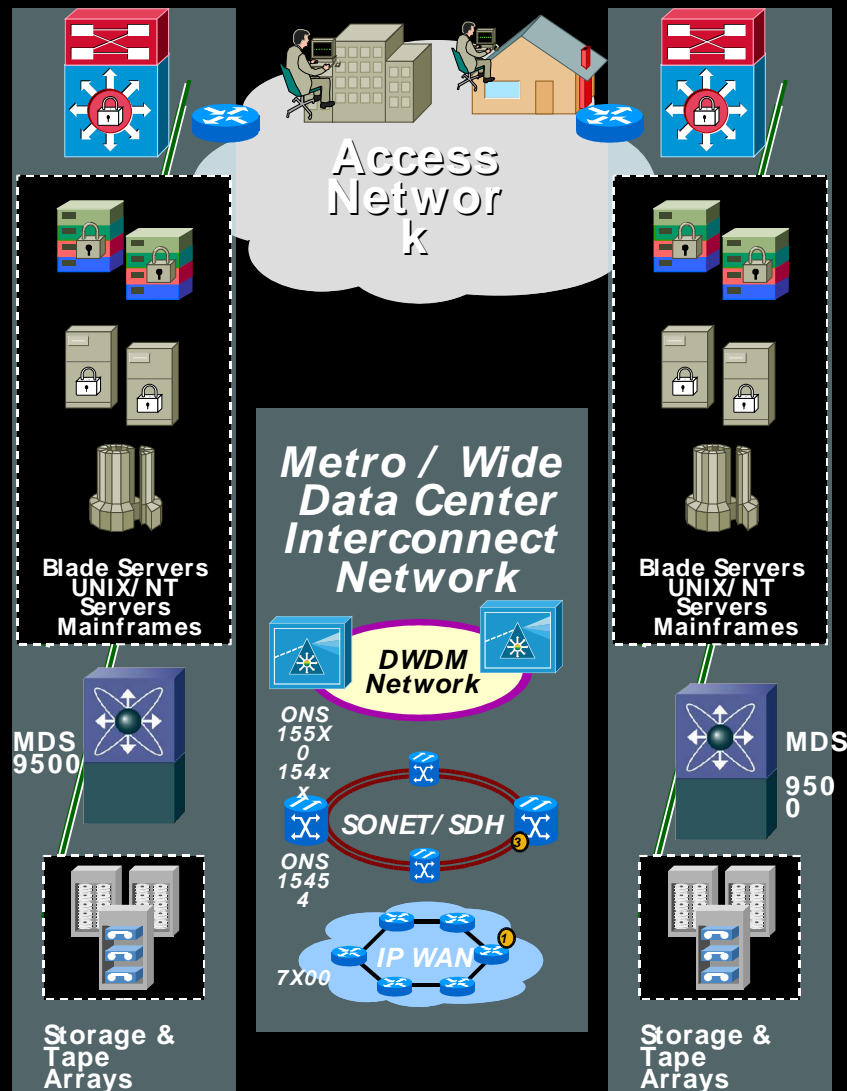## Broad Application Support

- Asynch / Synch Replication, Backup, Point in Time Copy
- Multi- vendor Support: EMC, HP, HDS, IBM, Appliances
- 3rd Party Appliance Support: SANTap
- Network Assisted Serverless Backup

Optimized SAN Extension

- Multi- protocol Transport: FCIP, DWDM, Sonet/ SDH
- Distance / Application Optimization: Write and Tape Acceleration
- Security: FCIP Encryption and FC- SP Auth
- WAN Utilization: Compression and Large BB Buffers Credits
- Availability: VSANs and Inter VSAN Routing
- Availability: VSANs and Inter VSAN Routing

Continuous Access

- Global Site Selector
- VPN – IPSec, SSL, MPLS
- Optimized Exit Routing

Cisco Public

Long Distance Business Continuance

Asynchronous replication through HDS TrueCopy over FCIP

London

Paris

SAN 1

SAN 3

Approx 650km

Cisco 7600

SDH Ring
OC-48

ONS 15454

SAN 2

SAN 4

Amsterdam
Approx 1500km

Cisco MDS 9509 w/ IPS
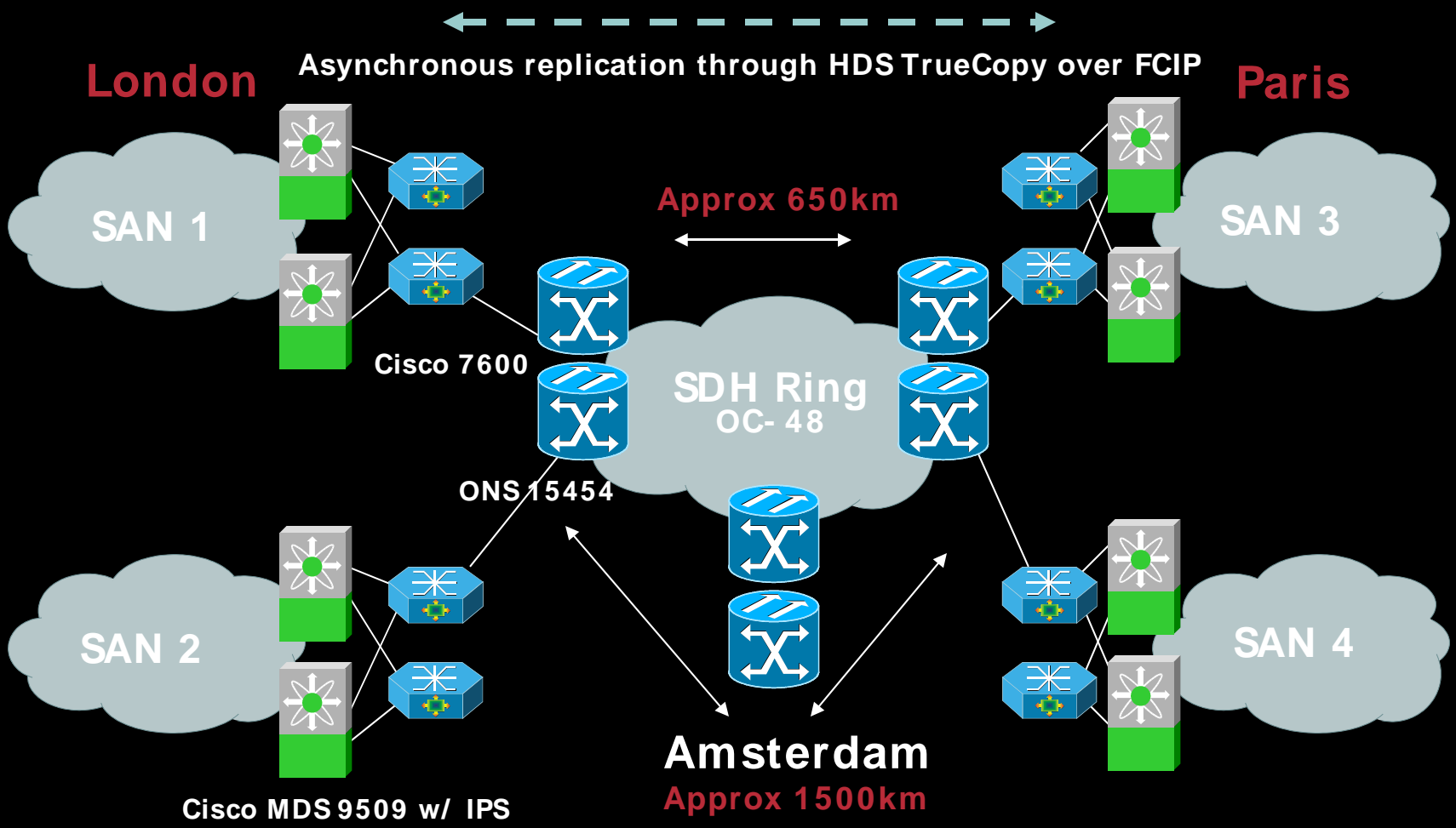
Challenge:
Cost Effective High Performance Computing

Catalyst 6500

Research HPC
- Universities
- Research Labs
- Dept of Energy
- Dept of Defense
- Federal / Intelligence

Enterprise HPC
- Auto Design
- Drug Research
- Oil Explotation
- Aerospace Design
- "On- Demand" HPC

Proprietary Supercomputer

Cost

- **High cost of proprietary supercomputer hardware**
- **Requirement for specialized application development**
- **Lack of pay as you grow capabilities**
- **Increased low- cost option with higher performance x86 / Linux servers**

Data Center Networking Architecture Solution:
Standard- based Server Fabric Switching

Server Fabric Switching

Catalyst 6500

SFS- 7000

Low- Latency Cluster Interconnect

Research HPC
- Universities
- Research Labs
- Dept of Energy
- Dept of Defense
- Federal / Intelligence

Enterprise HPC
- Auto Design
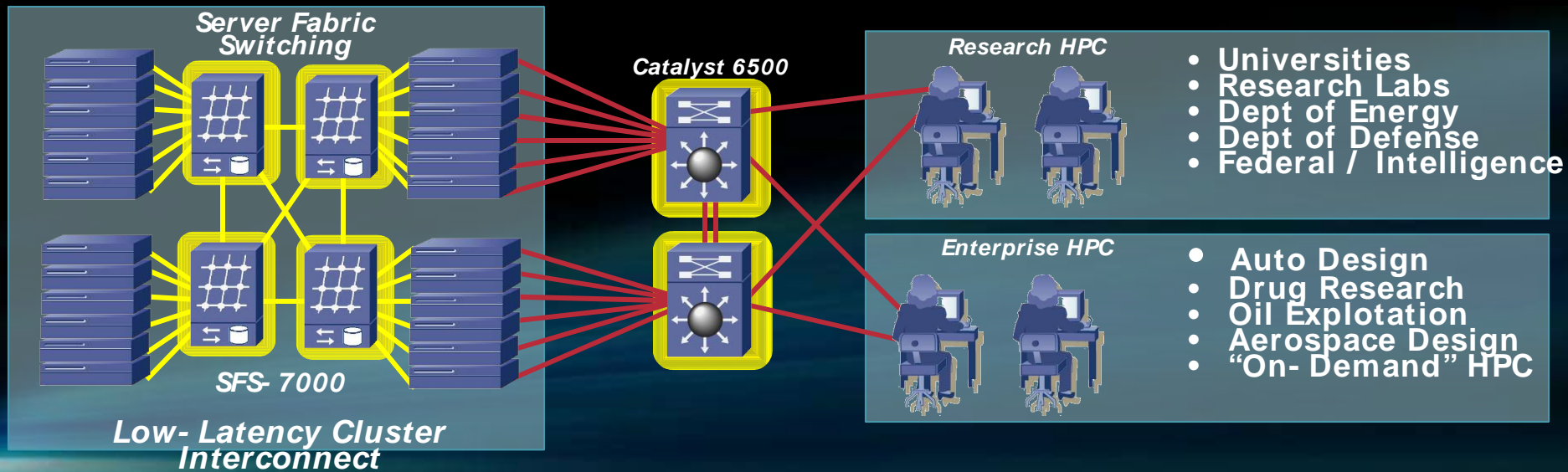- Drug Research
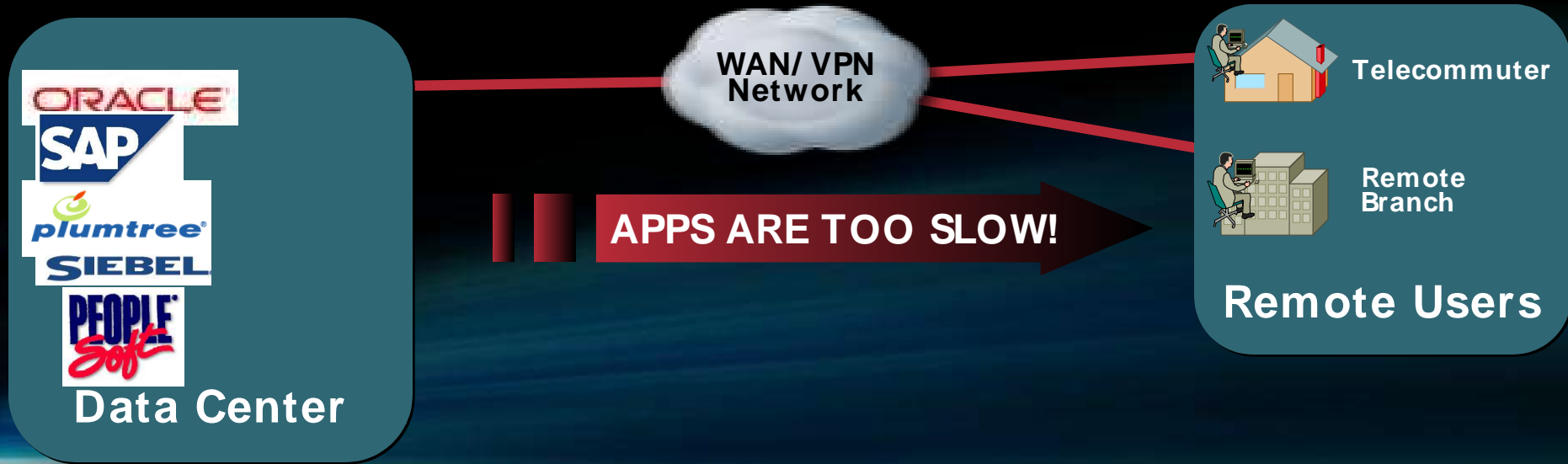- Oil Explotation
- Aerospace Design
- "On- Demand" HPC

Lower Cost High Performance Computing

- High performance, low latency, low cost interconnect - Infiniband
- Proven scalability to 4000 nodes
- Standard- based
- Servers transparently replaced for continuous operation
- Prove interoperability with major server vendors

Challenge:
Consistent Performance of Web Applications

ORACLE
SAP
plumtree®
SIEBEL
PEOPLE Soft®

Data Center

WAN/ VPN Network

APPS ARE TOO SLOW!

Telecommuter

Remote Branch

Remote Users

Performance

- **Remote user challenges for HTTP-based Enterprise Applications**

- **Increased graphic content requires more bandwidth**

Data Center Networking Architecture Solution:
Performance Acceleration with Wide Area Application Services

AVS - 3100

WAN/ VPN Network

Telecommuter

Remote Branch

2x - 5x Faster Application Delivery!
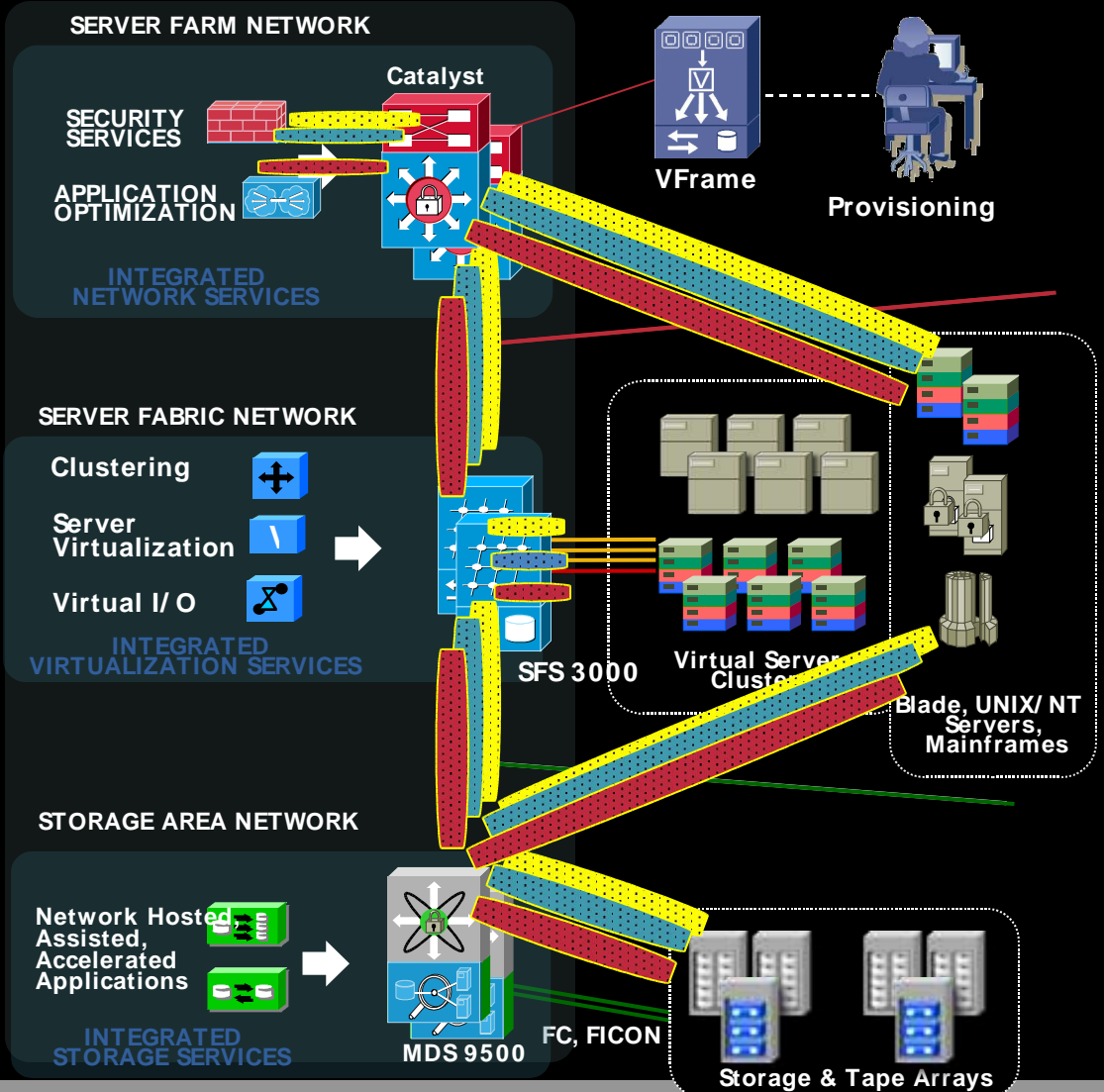
Remote Users

Data Center
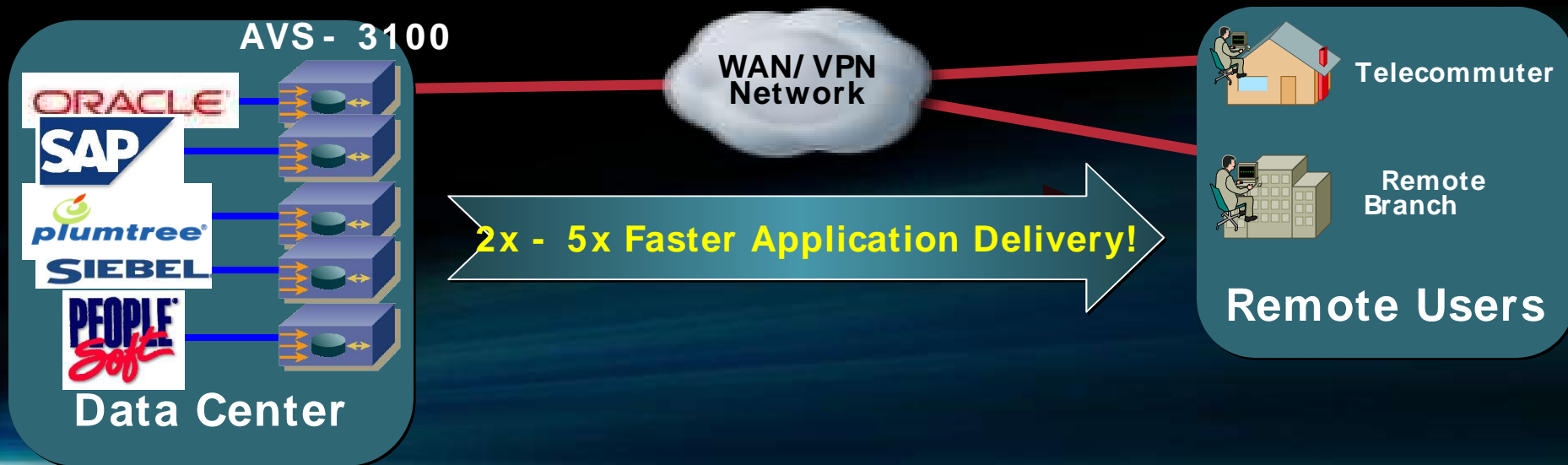
Improved Performance

- **Dramatically reduces the amount of information sent to the client from the central site.**

- **Dynamically Caches, Transforms Content, Compresses Content, and Secures the Web With Full- Proxy Functionality.**

Enabling the Virtualized Data Center
Virtualizing Server, Storage and Network Infrastructure

SERVER FARM NETWORK

Catalyst

SECURITY SERVICES

APPLICATION OPTIMIZATION

INTEGRATED NETWORK SERVICES

VFrame

Provisioning

SERVER FABRIC NETWORK

Clustering

Server Virtualization

Virtual I/O

INTEGRATED VIRTUALIZATION SERVICES

SFS 3000

Virtual Server Cluster

Blade, UNIX/NT Servers, Mainframes

STORAGE AREA NETWORK

Network Hosted Assisted, Accelerated Applications

INTEGRATED STORAGE SERVICES

MDS 9500

FC, FICON

Storage & Tape Arrays

Pooled Storage Resources

Compute Virtualization

- **Infiniband Switching**
- **Server I/O Virtualization**
- **Policy-based Server Virtualization – VFrame**

Storage Virtualization

- **SAN Fabric Virtualization – VSAN**
- **Network-based virtualization – e.g EMC Invista, IBM SVC with MDS Storage Service Module**

Virtualized Network Services

- **Virtual LANs (VLANs)**
- **Virtual Firewalls**
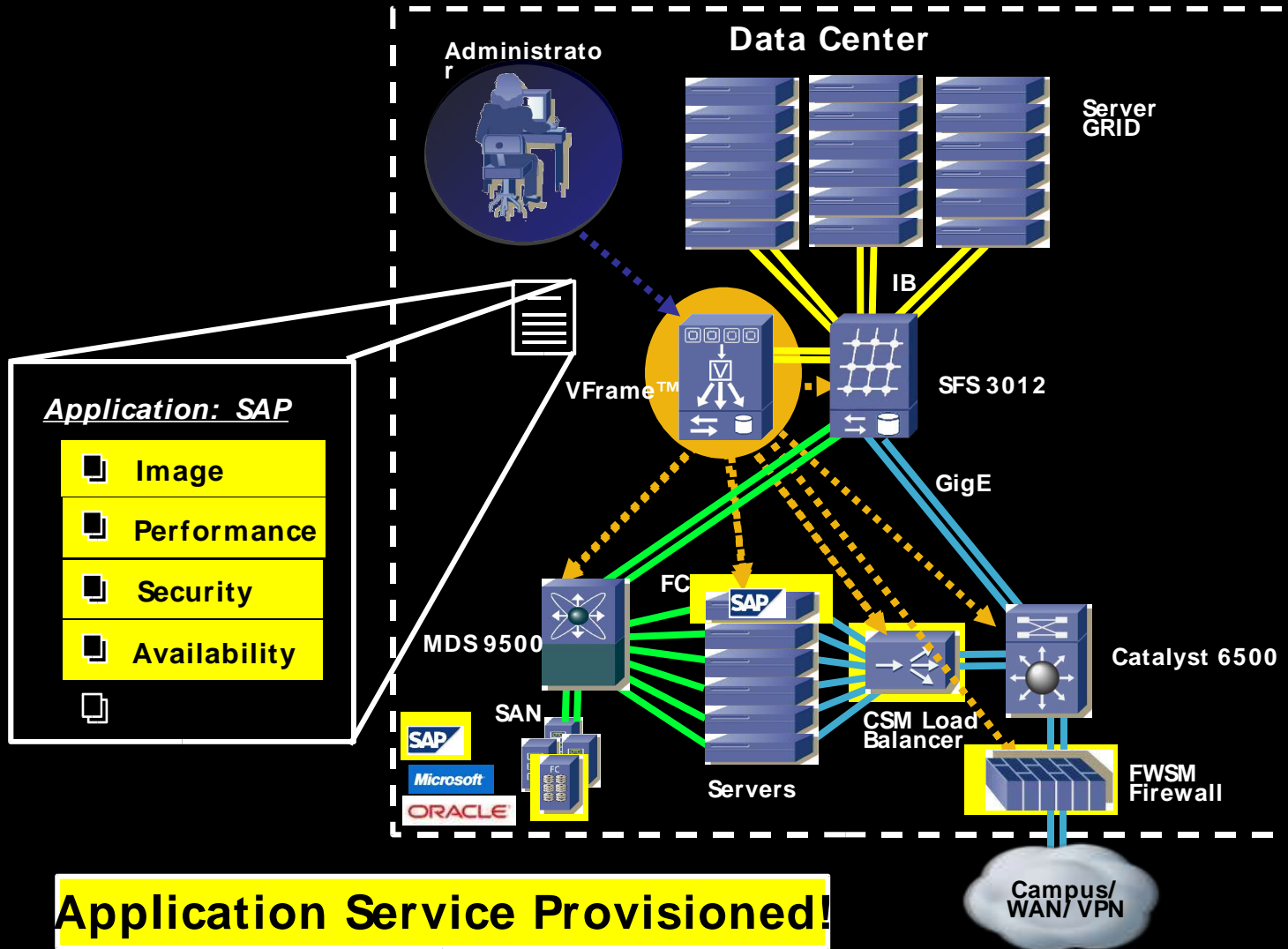- **Service Chaining and Virtualization**

Virtualized User Connectivity

- **GLB, SSL / IPSec VPN**
- **MPLS**

Virtualized DC Interconnect

- **DWDM, Sonet,**
- **InterVSAN Routing**

End-to-end Data Center Provisioning Vision
Cisco Virtualized Data Center

Administrator

Data Center

Server GRID

IB

VFrame™

SFS 3012

GigE

Application: SAP
- Image
- Performance
- Security
- Availability

FC

MDS 9500

SAP

SAN

SAP
Microsoft
ORACLE

Servers

CSM Load Balancer

Catalyst 6500

FWSM Firewall

Campus/ WAN/ VPN

Define application services and pass policy to VFrame

VFrame translates policies to actions and passes to infrastructure

VFrame identifies right App / OS Image From storage

VFrame picks server with right criteria to run application and boots server

VFrame gives new server right VLAN and LUN info so it can find/ be found by right clients and storage

VFrame provisions security policies to FWSM

VFrame provisions CSM to add new server to load balancing pool

Application Service Provisioned!

Agenda

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- **Summary**
- **Cisco on Cisco**

Summary —
Cisco Data Center Networking Architecture

Data Center Challenges

CONTROL COSTS

COMPLIANCE AND RESILIENCE

RESPONSIVENESS TO THE BUSINESS

APPLICATION SERVICES LEVELS

INFORMATION MANAGEMENT

Cisco Data Center Network Architecture Benefits

- Resource sharing and virtualization
- Enhances business continuance and security
- Flexible, scalable network
- Architectural approach
- Provides platform for 3rd party technologies
- DCN service and support
- Investment Protection
- High availability technologies, designs
- Application Optimization
- Enables Service Oriented Infrastructure (SOI)
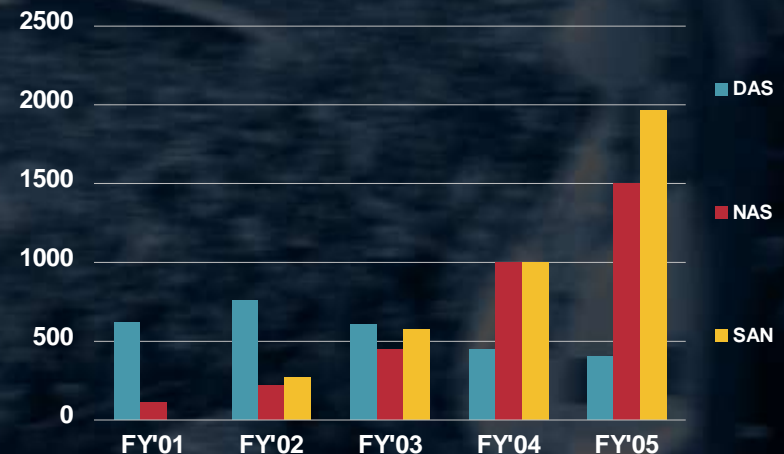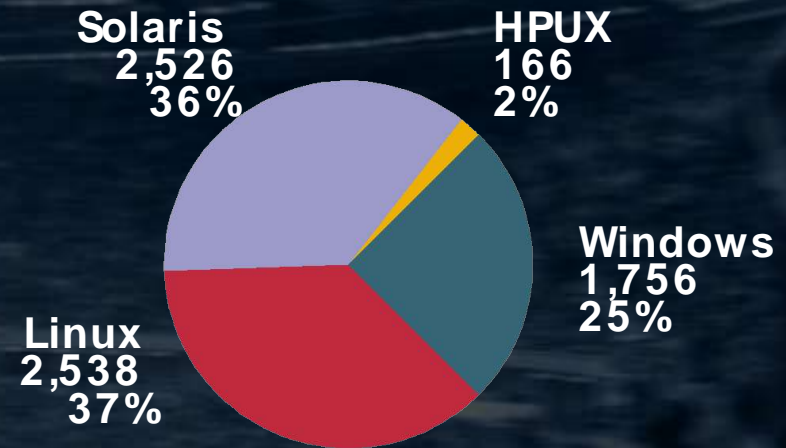- End-to-end for simpler operations

Cisco Public

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Cisco's RZ Umgebung

- **7,000 Server**

- **80 Servers per Sysadmin**

- **Server Umgebung wird weiter wachsen**

- **Heterogene Umgebung with mit diversen HW Herstellern**

- **Diverse OS Umgebungen**

- **Cisco IT unterstützt ca. 3.9 PB storage**

  Wachstums- Raten:
  FY'02=69%, FY'03=32%, FY'04=50%, FY'05=58%

Solaris
2,526
36%

HPUX
166
2%

Windows
1,756
25%

Linux
2,538
37%

DAS
NAS
SAN

2500
2000
1500
1000
500
0

FY'01   FY'02   FY'03   FY'04   FY'05

Cisco RZ Technologie Roadmap hin zu einem Service Oriented Data Center

Legacy Data Center

Service Oriented Data Center

- Mixed hosting platforms and OS's
- Infrastructures aligned to BU's
- Multiple support processes
- Disruptive changes hurt availability
- Poor resource utilization, management, agility and TCO
- Storage Consolidation to SAN islands

- Mixed hosting platforms and OS's begin move to Linux, Windows
- Multiple infrastructures aligned to BU's
- Multiple support processes
- Improved storage utilization, management, agility and TCO

- Common, x86 hosting platform
- Storage Virtualization begins
- Common processes
- Improved availability
- Improved utilization, management, agility and TCO
- Server automation begins

- Consolidated, virtual infrastructure aligned to services
- Intelligent network services
- Policy based server automation
- High availability with low cost components

| 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |

Standardisierung **Zentralisierung** **Virtualisierung** **Automation**

Ein Beispiel:
Benefits durch zentralisiertes RZ Management

Einsparungsbereiche	Jährliche Einsparungen durch zentralisiertes Management
Active directory management	$2.3 M
Active directory migration	$65.7 M
DNS/DHCP	$3.8 M
Exchange migration	$8.1 M
Unity	$6.9 M
Gesamte Kumulative Einsparungen	$86.8 M

Durch das zentrale Managen von verteilten Ressourcen erzielt Cisco signifikante Einsparungen

Cisco Public

Additional Information

http://www.cisco.com/go/datacenter