Service Oriented Data Center and Storage Networking
Cisco on Cisco Technology Tutorial

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Agenda

- Cisco IT Overview
- Data Center Transformation
- Services Oriented Data Center (SODC)
- SODC Technologies
- SODC Results and Lessons Learned
IT Overview

Cisco IT Governance
Cisco IT Mission

At Cisco, IT is expected to...

- Support the business strategy
- Drive productivity
- Facilitate Cisco innovation
- Showcase Cisco technology
Enable “Every” Move with IT
CEO sets the Vision, CIO enables the Vision

- Strategies
- Business Capabilities
- Operational Functionality

Growth
Experience
Productivity
Two Views

Those that view Information Technology as Strategic to their business

OR

Those that see IT as a Cost Center
Production Data Center Transformation

Overview and Issues
Cisco Data Centers

Total of 195,000 square feet of raised Data Center space at Cisco
Cisco’s Next-Gen Production Data Center

IT Enables Business Agility and Resiliency

Growth

User Experience

Business Agility

Business Resiliency

Architecture & Operational Excellence
Problem Statement

Cisco’s data centers are nearing capacity, increasing our Business Risk.

Rather than enabling the business, we are rapidly approaching a situation in which our data centers are inhibiting our agility and resiliency.
Data Center Operational Impact

- 1 hr of downtime in Customer Service = 10 hrs of impact
- 1 hr of downtime in Manufacturing = $40k-$100k impact
- No Power – No Cooling – No Space = No Innovation
- No showcasing = impact to Eng = impact to Sales!

- Business requirements increasing quarterly…
  - “No business downtime”
  - “New business models”
PDC, Opportunity Enable Every Move with IT

Architecture & Operational Excellence

SODC Architecture
Application Networking Services
VFrame Data Center
Unified Network Fabric
Critical Systems Resiliency Tracks
EA Policies for new PDC
Application Dependency Mapping
CMBD

Agility and Resiliency
PDC Site Selection
## PDC Tier

<table>
<thead>
<tr>
<th>Tier</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components</td>
<td>Need only (N)</td>
<td>N + 1</td>
<td>N + 1</td>
<td>2 (N + 1)</td>
</tr>
<tr>
<td>Delivery Paths</td>
<td>One only</td>
<td>One only</td>
<td>One active</td>
<td>Two active</td>
</tr>
<tr>
<td>Single Points of Failure</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Concurrently Maintainable</td>
<td>No</td>
<td>Components only</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Projected Availability / Downtime per Year</td>
<td>99.671% 28.8 hours</td>
<td>99.749% 22.0 hours</td>
<td>99.982% 1.6 hours</td>
<td>99.995% 0.4 hours</td>
</tr>
</tbody>
</table>

Tiering system courtesy of The Uptime Institute
PDC Site Selection Strategy
from 420 Metro Areas Down to 8, Then 1

Must-haves:
- U.S. or Canada
- Negligible environmental risk (e.g. earthquake, hurricane, tornadoes, etc.)
- Fiber service
- At least 2 long distance providers

Additional Criteria:
- Electrical power cost; long-term price stability
- Other costs: real estate, labor, taxes, govt incentives
- Proximity to existing Cisco IT operations
- Close to customers
- Availability of technical labor
- Regulatory environment
The Winner! - Richardson

Richardson, Texas

Runner-ups

Phoenix
Boulder

Tipping Points

Leverage $21M RDC9 Capital investment

Accelerate Data Center Business value by 12 months

Cisco Community and Campus

Multiple land options at optimal distances at right size

Fiber Infrastructure

Skilled IT resources
Service Oriented Data Center

Overview
Service Oriented Data Center (SODC)

SODC Target State:
Pooled Virtual Resources, Automated, Standard Services Based, Secure, Intelligent Unified Data Center Network
SODC Meeting Business Objectives

- **Enhance business agility**
  - Provisioning resources within 3 days

- **Improve business continuance**
  - Every component of SODC will be utilized and load balanced at all times.

- **Reduce Costs**
  - The SODC model will optimally manage the infrastructure to meet user, application, and business needs
SODC Design Phases

- **Consolidate**
  - Optimize Data Center Resources
  - Increase Resource Utilization

- **Virtualize**
  - Virtual Resource Pools
  - Increase Availability and Agility

- **Automate**
  - Adaptive Orchestration
  - Rapid Delivery of Services
### Data Center Evolution

<table>
<thead>
<tr>
<th>Component</th>
<th>Legacy Data Center</th>
<th>Consolidated Data Center</th>
<th>Virtual Data Center</th>
<th>Service Oriented Data Center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compute</strong></td>
<td>- 4 Tier Silos</td>
<td>- Standardization</td>
<td>- Server Repurposing</td>
<td>- Infrastructure Aligned to Application Services</td>
</tr>
<tr>
<td></td>
<td>- Heterogeneous OS</td>
<td>- Virtual Machines</td>
<td>- VM Mobility</td>
<td>- Policy Based Management</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>- Storage Silos</td>
<td>- SANs, VSANs</td>
<td>- Storage Virtualization</td>
<td>- Intelligent Data Management</td>
</tr>
<tr>
<td></td>
<td>- Low Utilization</td>
<td>- Tiered Storage</td>
<td></td>
<td>- Tiered Recovery</td>
</tr>
<tr>
<td><strong>Network</strong></td>
<td>- IP Connectivity</td>
<td>- Consolidated Network Services</td>
<td>- Virtualized Network Services</td>
<td>- Usage and SLA-based Funding Model</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>- Perimeter Security</td>
<td>- Secure Each Application Tier</td>
<td>- Virtual Firewalls</td>
<td></td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>- Application Silos</td>
<td>- Consolidate, Centralize</td>
<td>- Optimization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Distributed</td>
<td></td>
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</tr>
</tbody>
</table>

- **2004:** Consolidation Phase
- **2005:** Virtualization Phase
- **2006 - 2007:** Automation Phase
- **2008 - 2010:** Automation Phase
Service Oriented Data Center Technologies

Servers
SODC Server Landscape

- 11,953 virtual/physical servers
- 12,853 Applications
- 325 Production Databases

Source: Cisco IT, June 2007
SODC Server Virtualization

- **Data Center Server Consolidation**
  - Improve Operational Agility
  - Lower Data Center Operating Expense

- **Increase Utilization of Physical Servers**
  - Optimize TCO
  - Improve Data Center Capacity Management

- **Reduce Service Provisioning Times**
  - Rapid deployment of Operational Environments

- **Increase Operational Efficiencies**
  - Ease Support of Environments
  - Reduce Planned and Unplanned downtime
Server Virtualization Considerations

- **Support Model**
  Support Model must drive operational objectives
  Managed by core SODC Team

- **Risk vs. Virtualization Targets**
  ISV’s Support?
  Reduced Risk = Reduced Potential Savings

- **Keep Clients In Mind**
  Minimize Impact of Migrating to Virtual Servers
  Platespin, VM Converter Software is Crucial

- **Communicate VMware Strategy and Direction**
  Success Depends on Leadership Support
SODC VMware Architecture
SODC Server Virtualization Highlights

- **New Virtual Machine Deployments**
  - Reducing New Servers Deployed in Data Centers
  - **No** Limits on Supported Apps
    - Support Third-Party and Custom Built Apps in VMware Farms
    - Drive Clients to VMware by Working with Vendors
  - Target **2,500** New VMs by August 30, 2007

- **Server OS and App Migrations**
  - Focusing on Legacy x86 Hardware
  - Reduce Maintenance Costs
  - Leverage **Platespin/VM Converter** Software For Migrations
    - Linux and Windows Migrations
    - Minimizes Client Impact – **No** App Reinstall
  - Migrate a Physical Server to a Virtual Server in Less Than 4 Hours
  - Target **350** Server Decomms/Migrations August 30, 2007
SODC Server Virtualization Metrics

- Improved Productivity and Increased App Availability
- 95+% Of VMs Delivered Under 3 Days
- 14 VMs Per ESX Server
- 2500 Total Virtual Machines Today
- Over $14 M in Savings And Cost Reduction To Date
Service Oriented Data Center Technologies

Storage
Cisco Data Center Storage Landscape

- Over 7.8 PB of “raw” storage, Overall Growth Rate: FY’02=69%, FY’03=32%, FY’04=50%, FY’05=58%, FY’06=29%, FY’07=52%
- Elimination of all external direct attached storage, focus now on reduction of internal server storage (via remote boot)
SODC Storage Architecture consolidation

Timeline

2001  2002  2003  2004

Phase 1: Originally scheduled for 1 year (2001)

Phase 2: Predicted to take 18–24 months
Planned to begin in 2002
Start delayed for 12 months

Phase 3: Predicted to take 12–18 months
Originally planned to begin in 2004

“Logical” Cisco Business Functions
*Multiple Datacenters (campus/metro)

“Physical” Cisco Business Functions
SODC Storage Architecture consolidation

Multiple Datacenters (Campus/Metro/Global)

Timeline

2004

Phase 4:
Originally scheduled to begin in 2005

2005

Phase 5:
Predicted to take 12—18 months (2005-2006).
Cisco IT SODC Storage Architecture

- Hosts
- Global Storage Fabric
- Physical Storage Arrays

IP WAN Services

Metro Optical Network

Platinum
Gold
Silver
Bronze

Remote DC
Data Center 1
Data Center n
Two Halls, Hall one holds; 2 storage rows and 8 Zones with two pods per zone.
Pods planning on supporting vframe farms of over 200 hosts.
This is not enough storage infrastructure to hold current storage capacity.
San design has to be flexible to leverage additional storage arrays anywhere.
Hall one and Hall two interconnected via DWM and Native Fibre

Edge Switches port channeled back to both switches in core for additional reliability

Switches based on 9513 chassis and configured into three different types
SODC Storage Results

- Managed storage per FTE increased from 25 TB to 600 Terabytes over past 5 years

- Total Cost of Ownership reduced from .21/MB to .001/MB over past 6 years

- Overall utilization increased from 20% to 67% over past 5 years

- $69 Million in cost avoidance over past 4 fiscal years ($9M in FY04, $14M in FY05, $27M in FY06, $19M in FY07)
Service Oriented Data Center Technologies

Network
Mode of Operation Choices

- **Active-Standby**
  - Same as today
  - Doesn’t work well today
  - Only critical apps
  - Idle hardware
  - Different configuration in both DCs
  - Min infra complexity
  - Med apps complexity

- **Active-Active-Hybrid**
  - Similar to other customers solutions
  - Majority of apps
  - Identical configuration in both DCs
  - Not specific to vendor
  - Best Cisco on Cisco
  - Med infra complexity
  - Min apps complexity

- **Active-Active**
  - Used by financial institutions (E.g. metro clusters, multi-master data)
  - Majority of apps
  - Vendor specific
  - High infra complexity
  - High apps complexity
Cisco IT Active/Active-Hybrid Data Center

**Network**
- Using DNS, users are directed to GSS
- GSS load balances users across both DC #1 & #2
- ACE selects the optimal server to forward request between DC servers

**Note:**
Production infrastructure (network, hosts, infrastructure) configuration is identical in both DCs

---

**Normal operations**
- Web and app server are processing requests in both DCs
- Transaction logs are applied to remote DB

**Failure Scenario**
- Last transaction logs applied
- Apps DB connection timeout and reconnect
- No runtime apps changes required

**Note:**
In the physical implementation active DBs will be distribution across both DCs
Continuous Availability with Disaster Recovery

www.cisco.com

Non Cisco DNS Service

External User

DC 2

GSS

ACE

Web Server (Load Balanced)
Active

App Server (Load Balanced)
Active

Database Server (Local Cluster)
Standby

Storage

Replication Sync Async

DC 1

GSS

ACE

Web Server (Load Balanced)
Active

App Server (Load Balanced)
Active

Database Server (Local Cluster)
Active

Storage

Replication Async

Remote DC

GSS

ACE

Web Server (Load Balanced)
StActive or Quick Ship

App Server (Load Balanced)
StActive or Quick Ship

Database Server (Local Cluster)
Warm Standby

Storage

Replication Async

HA VFrame Data Center Cluster
SODC Orchestration

ISM Framework

SODC POD

OS and App Images

Network Pool

Server Pool

Storage Pool

Virtual Service Template

Virtual Network Services

VLANs

Virtual LUNs

VSANs

Cisco VFRAME Data Center Orchestration

Specific resources selected from PODs
Network Services Provisioned
VLANs, VSANs configured
SAN is zoned
Servers get booted with assigned image – Remote Images
Application(s) are started
Traffic into logical network turned “on”
Failover of Services - Resiliency
SODC Network POD Architecture

Data Center Distribution GW

Shared Network Services

Data Center Distribution Layer

10 Gig

6500 Series

CAT 4948

1RU

CAT 4948
Service Oriented Data Center Technologies

Wide Area Application Services
ANS

Big Picture

Customer

Internet

Information

AMS

DMZ

DC

SJC

DMZ

DC

PDC1

DMZ

PDC2

DMZ

PDC1

PDC2

Extranet Partner

FSO

Server

Application Control Engine (ACE)

ACE Appliance

Wide-Area Application Services (WAAS)

Global Site Selector (GSS)

Application Content and Networking System (ACNS)

Application Networking Services
Content Switching
What Is it?

- **Server Farm (SF)**
  “Group of one or more servers with nearly identical configuration and providing equal functionality”

- **Server Load Balancing (SLB)**
  “Distribution of data connections across servers in a single serverfarm, such that the overall capacity and availability increase (typically at Layer 3–4)”

- **Content Switching (CS)**
  “Intelligent distribution of data requests across servers in different serverfarms, such that the appropriate serverfarm is used and the overall capacity, availability and/or functionality increase (up to Layer 7)”
Content Switching

Why Do We Need it?

- **High Availability (HA)**
  Required for mission-critical applications
  Achieved through load-balancing, health monitoring (reactive), server maintenance (proactive)

- **Functionality**
  Flexible back-end infrastructure while keeping user-friendly URL’s through URL load-balancing, manipulation and redirection
  Example: retain the paradigm

- **Cache control**
  Manual and proactive control of cache-logic on Content Engine

- **Security**
  Provides limited Denial-of-Server (DoS) protection
  Facilitates SSL Offload though SSL Service Module or ACE
The www.cisco.com Paradigm

- Separate the user interface (front-end) from the special-purpose server farms (back-end)
- Domain Name System (DNS) resolves the vanity name to a Virtual IP address hosted on a content switch
Symmetric Acceleration (Now)

- Based on the Wide Area Application Services (WAAS) technology
- Enabler for NAS Consolidation
- WAN savings
  Experienced 40-60% savings (volume) in lab PoC
  Capacity plan impact: from 68kbps (20 kbps for apps) to 60 kbps (12 kbps for apps)
- Acceleration for Emerging Markets
- Architecture
  Core (or “Server Edge”) and Edge (or “Client Edge”)
  Transparent at Layer3-4 (WCCP)
  Inter-DC traffic not in initial wave
WAAS Bandwidth Savings

- Similar to ACNS, but now for *all* TCP protocols
- Enabler for additional consolidation and virtualization
- Target: lower standard from 68 kbps/user to 60 kbps/user
  Net Cost Avoidance is $3M - $7M (3 year horizon, WAN + NAS consolidation)

* Note: ACNS also reduces Video streaming and CIFS for laptop re-imaging
WAAS Acceleration Metrics

- Potential productivity increase of est. $21M (3 year horizon)

![Graph showing WAAS acceleration metrics](image)

- Before WAAS
- After WAAS - Initial
- After WAAS - Subsequent

Note: ANS Test Environment: 256Kbps BW and 150ms latency
3MB PowerPoint file used in document downloads
* Note: Benefit is variable depending on transaction characteristics
** Note: Validated at Moscow and Sao Paulo POC sites
Asymmetric Centralized Acceleration

- **Web Acceleration**
  Modify HTTP context and payload
- **Reverse Proxy Cache model**
- **Source IP will change**
  Impact to downstream applications
  Problem already encountered for URL site selection
  Need a common strategy
Service Oriented Data Center Results and Lessons Learned

Cisco IT Best Practices
Cisco IT Data Center Lessons Learned

Build Foundation with Business Vision

Organization and Process

Buy in from Critical Stakeholders

Evolve to Service Aligned Organization

Reengineer Operational Practices

IT “Cost Model”

Executive Support
Q and A
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