3D SAN Audit – The Most Effective Methodology to Assess Your Infrastructure

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Introduction

Proactive administration is the key point of effective storage management, offering many advantages in regard to OPEX reduction and time saving. The main requirement for proactive management is understanding what happens in your storage infrastructure. It isn’t just monitoring hardware and software current state. Rather, it is a regular, deep analysis of all aspects which helps to find hidden or potential problems and predict evolution of the infrastructure as a whole.

A storage area network (SAN) is one of the most important subsystems of a storage complex and a significant component of Private Cloud infrastructure. That’s why an accurate SAN audit has to be a regular and essential procedure within data center administration.

During actual assessments in finance, telecom, and transport companies, I developed a very effective methodology to examine a SAN infrastructure. This methodology uses a multidimensional 3D approach that helps to investigate all important characteristics of the SAN in detail. The SAN audit example of ABC Company points on the most typical problems you may discover during a project and provides a general roadmap for real assessment implementation.

This article is useful to architects and administrators responsible for SAN development and management.

Data collection and pre-processing

There are four main methods of data collection which can be applied:

1. Interviews with technical specialists and managers responsible for storage and SAN administration and development
2. Use of special data collection tools
3. Use of monitoring and management tools
4. Use of internal switch commands

All these methods are described in detail below.

Interviews

Live interviews are very important because of the significant information (e. g. historical infrastructure development or reasons of specific solutions choice) you cannot get otherwise.

Table 1 provides a typical general questionnaire for an interview.

ID	Question
Sites and communication channels	
GENDC1	How many sites do you have? How many server rooms are there on each site (only with equipment connected to SAN)?
GENDC2	What are the main roles of each data center (main /reserve/test, what else)?
GENDC3	What are the distances between sites (cables distance)?
GENDC4	What are the distances between server rooms on each site (cables distance)?
GENDC5	Which and how many communication channels do you have between sites?
GENDC6	If needed, do you have financial and physical resources to get additional channels between sites? If yes, which and how many? How long will it take to get them?
SAN infrastructure	
GENSN1	Do you have a Visio drawing or other diagram of the SAN infrastructure? If so, can you provide a copy?
GENSN2	Which SAN platforms do you use (FC-switch and router vendors)?
GENSN3	If multiple SAN platforms, why do you use different platforms?
GENSN4	If SAN development was implemented during formal projects, can you provide a copy of the project descriptions and final results?
GENSN5	What SAN configuration information do you have? Can you provide a copy of documents and spreadsheets?
GENSN6	Do you have detailed connectivity information (end-device to switch port)? If so, can you provide a copy?
GENSN7	Do you have detailed cable labeling information (FC cable label to end-device HBA port)? If so, can you provide a copy?
GENSN8	Do you have a cable labeling formalized rule? If so, please describe it.
GENSN9	Do you have a strict rule to label each cable? If so, does everybody follow this rule?
GENSN10	What software do you use for SAN management and monitoring? Are you happy with it?
GENSN11	What are your biggest pain points in SAN administration and provisioning? Why?
GENSN12	Which company is responsible for support of FC switches?
GENSN13	How many new servers HBAs were connected to SAN during the last 3 years?
GENSN14	How many servers HBA are you going to connect to SAN within the next 3 years?

Storage	
GENDA1	Do you have a Visio drawing or other diagram of disk array connectivity? If so, can you provide a copy?
GENDA2	Which storage platforms do you use?
GENDA3	If multiple platforms, why do you use different platforms?
GENDA4	Do you use iSCSI storage devices? If yes, why? Which models?
GENDA5	Do you use NAS storage devices? If yes, which models?
GENDA6	What remote replication solutions between storage devices do you use?
GENDA7	Please describe your specific requirements for remote replication solutions (in a SAN configuration perspective).
GENDA8	Do you have any specific requirements for data availability (in a SAN configuration perspective)? If so, please describe.
GENDA9	Do you use any special appliances for storage virtualization? If so, what appliances do you use?
GENDA10	Which company is responsible for storage support?
GENDA11	What are your biggest pain points in the administration and provisioning of storage devices? Why?
GENDA12	Will you reach storage device scalability limits during the next 3 years (capacity, performance)?
GENDA13	How many additional storage ports were implemented during the last 3 years?
GENDA14	Will you implement new storage devices within the next 3 years? If so, please estimate the number of additional FC-ports?
Backup and archiving	
GENBU1	Which tape or disk libraries do you use?
GENBU2	Which backup software do you use? If you use more than one type of backup software, why?
GENBU3	Do you have a Visio drawing or other diagram of backup configuration? If so, can you provide a copy to the EMC consultant?
GENBU4	Do you use LAN-free backup? If so, how many servers directly back up data over SAN?
GENBU5	Do you use server-free backup? If so, how many storage devices directly back up data to tape or disk libraries over SAN?
GENBU6	Do you use any special appliances for data archiving? If so, what appliance do you use?
GENBU7	Do you have any specific requirements for data backup and archiving (in SAN configuration perspective)? If so, please describe.
GENBU8	What are the biggest pain points in backup or restore? Why?
GENBU9	Which company is responsible for support of backup devices?
GENBU10	Will you reach backup and archiving device scalability limits during the next 3 years (capacity, performance)?
GENBU11	How many additional tape and disk libraries ports were implemented during the last 3 years?
GENBU12	Will you implement new backup and archiving devices during the next 3 years? If so, please estimate the number of additional FC-ports?
Security	
GENSE1	Do you use SAN-level encryption? If so, please describe.
GENSE2	Do you use default logins (admin) for access to FC-switches and routers?
GENSE3	Do you use default password (password) for access to FC-switches and routers?
GENSE4	How frequently do you change your passwords for access to FC-switches and routers?
GENSE5	Do you use role-based access control?
GENSE6	Did you configure switch authentication and authorization using the Microsoft Active Directory service?
GENSE7	Do you use password strength and expiration policies?
GENSE8	Do you regularly audit configuration of FC-switches from a security perspective? If so how often?

GENSE9	Do you have any specific requirements and rules for access to SAN management resources or components of infrastructure? If so, please describe.
GENSE10	Do you use encrypted protocols to get access to FC-switches?
Personnel	
GENPR1	Total number of full time employees (FTE) participating in administration and support of: -FC switches -disk arrays and NAS devices -backup and archiving devices Are these persons the same?
GENPR2	Do you have an education plan accepted by the management? How often do your FTEs get training on FC-switches, storage, and backup administration?

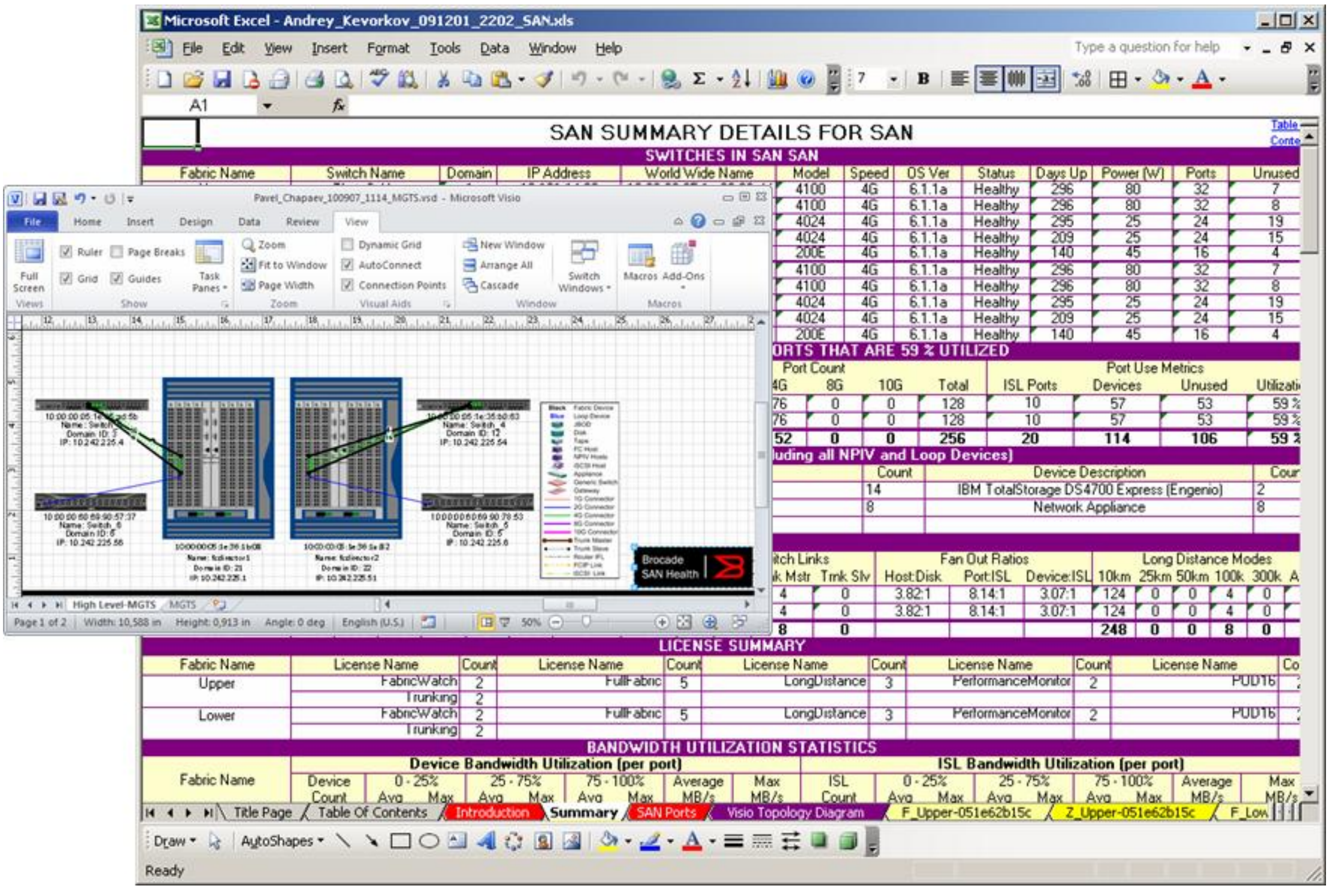
Table 1 General questionnaire

Questions about pain points are very important and help to obtain the information that you'll never receive another way. Investigate such points deeply and certainly try to give the customer some improvement recommendations.

Special collection tools

Today, Brocade SANhealth is the most powerful collection and analysis tool. Available for free, SANhealth version 3.2 supports both Brocade and Cisco MDS switches.

To process output *.BSH* files, you have to send them to the Brocade site. In the response email, you receive an Excel spreadsheet with detailed information about SAN configuration and a topology diagram in Visio format. Brocade SANhealth professional utility helps to compare SAN states in different periods of time.



Microsoft Excel - Andrey_Kevorkov_091201_2202_SAN.xls
File Edit View Insert Format Tools Data Window Help
Type a question for help
A1
Pavel_Chapaev_100907_1114_MGTS.vsd - Microsoft Visio
File Home Insert Design Data Review View
Ruler Page Breaks Grid Guides Task Panes Zoom Fit to Window Page Width Dynamic Grid AutoConnect Connection Points New Window Arrange All Cascade Switch Windows Macros Add-Ons
Full Screen Views Show Zoom Visual Aids Window Macros
Brocade SAN Health
High Level-MGTS MGTS
Page 1 of 2 Width: 10,588 in Height: 0,913 in Angle: 0 deg English (U.S.) 50%
Title Page Table Of Contents Introduction Summary SAN Ports Visio Topology Diagram F_Upper-051e62b15c Z_Upper-051e62b15c F_Low
Draw AutoShapes
Ready

SAN SUMMARY DETAILS FOR SAN

SWITCHES IN SAN SAN

Fabric Name	Switch Name	Domain	IP Address	World Wide Name	Model	Speed	OS Ver	Status	Days Up	Power (W)	Ports	Unused
					4100	4G	6.1.1a	Healthy	296	80	32	7
					4100	4G	6.1.1a	Healthy	296	80	32	8
					4024	4G	6.1.1a	Healthy	295	25	24	19
					4024	4G	6.1.1a	Healthy	209	25	24	15
					200E	4G	6.1.1a	Healthy	140	45	16	4
					4100	4G	6.1.1a	Healthy	296	80	32	7
					4100	4G	6.1.1a	Healthy	296	80	32	8
					4024	4G	6.1.1a	Healthy	295	25	24	19
					4024	4G	6.1.1a	Healthy	209	25	24	15
					200E	4G	6.1.1a	Healthy	140	45	16	4

ORTS THAT ARE 59 % UTILIZED

Port Count				Port Use Metrics			
4G	8G	10G	Total	ISL Ports	Devices	Unused	Utilizati
76	0	0	128	10	57	53	59 %
76	0	0	128	10	57	53	59 %
52	0	0	256	20	114	106	59 %

luding all NPIV and Loop Devices)

Count	Device Description	Cour
14	IBM TotalStorage DS4700 Express (Engenio)	2
8	Network Appliance	8

itch Links		Fan Out Ratios			Long Distance Modes					
k Mstr	Trnk Slv	Host:Disk	Port:ISL	Device:ISL	10km	25km	50km	100k	300k	A
4	0	3.82:1	8.14:1	3.07:1	124	0	0	4	0	
4	0	3.82:1	8.14:1	3.07:1	124	0	0	4	0	
8	0				248	0	0	8	0	

LICENSE SUMMARY

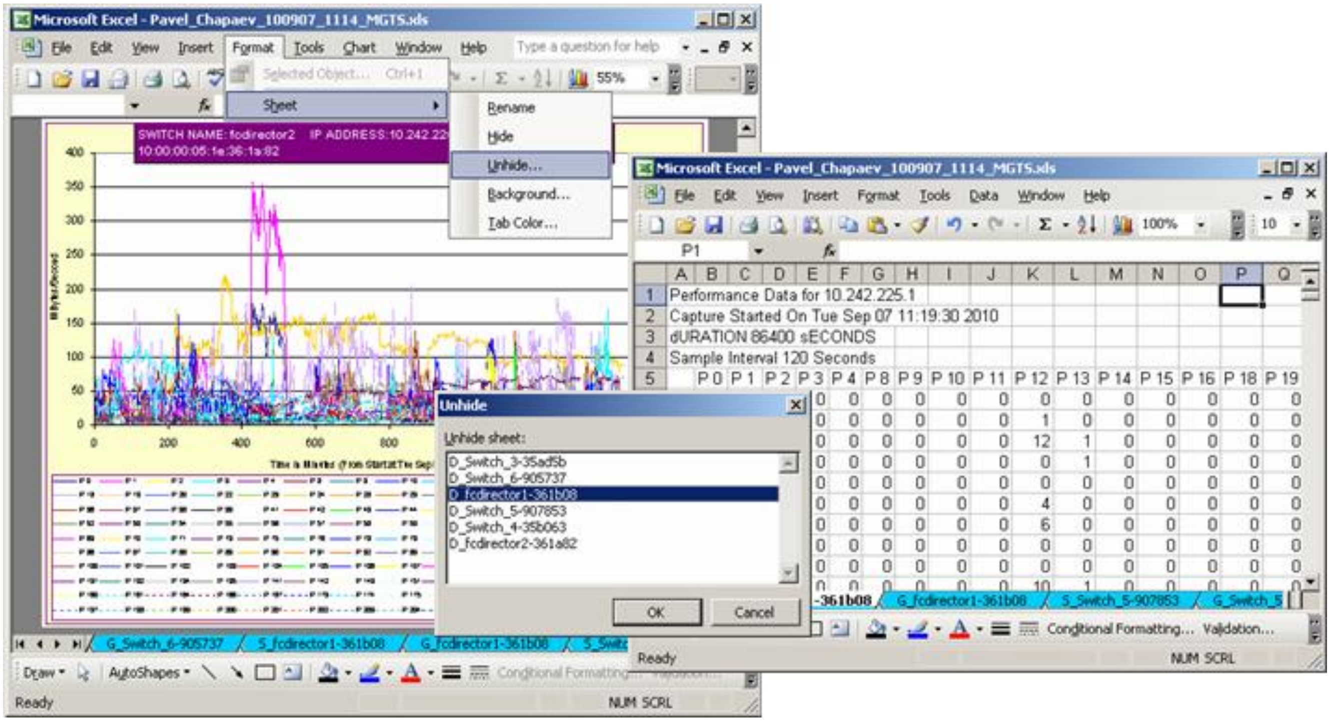
Fabric Name	License Name	Count	License Name	Count	License Name	Count	License Name	Count	License Name	Co
Upper	FabricWatch	2	FullFabric	5	LongDistance	3	PerformanceMonitor	2	PUD16	
	Trunking	2								
Lower	FabricWatch	2	FullFabric	5	LongDistance	3	PerformanceMonitor	2	PUD16	
	Trunking	2								

BANDWIDTH UTILIZATION STATISTICS

Fabric Name	Device Bandwidth Utilization (per port)									ISL Bandwidth Utilization (per port)									
	Device Count	0 - 25%		25 - 75%		75 - 100%		Average MB/s	Max MB/s	ISL Count	0 - 25%		25 - 75%		75 - 100%		Average MB/s	Max MB/s
		Avg	Max	Avg	Max	Avg	Max				Avg	Max	Avg	Max	Avg	Max		

Figure 1 Brocade SANhealth results

Performance data for all ports of each switch is already in the graphs inside the SANhealth output Excel spreadsheet. The trick is you can draw your own graphs for specific ports by using data in the hidden sheets.



Microsoft Excel - Pavel_Chapaev_100907_1114_MGTS.xls
File Edit View Insert Format Tools Chart Window Help
Type a question for help
55%
Selected Object... Ctrl+1
Sheet
Rename
Hide
Unhide...
Background...
Tab Color...
SWITCH NAME: fcdirector2 IP ADDRESS:10.242.22
10:00:00:05:1e:36:1a:82
400
350
300
250
200
150
100
50
0
0
200
400
600
800
G_Switch_6-905737 S_fcdirector1-361b08 G_fcdirector1-361b08 S_Switc
Draw AutoShapes Conditional Formatting... Validation...
Ready NUM SCRL
Microsoft Excel - Pavel_Chapaev_100907_1114_MGTS.xls
File Edit View Insert Format Tools Data Window Help
100% 10
P1
-361b08 G_fcdirector1-361b08 S_Switch_5-907853 G_Switch_5
Conditional Formatting... Validation...
Ready NUM SCRL

Unhide

Unhide sheet:

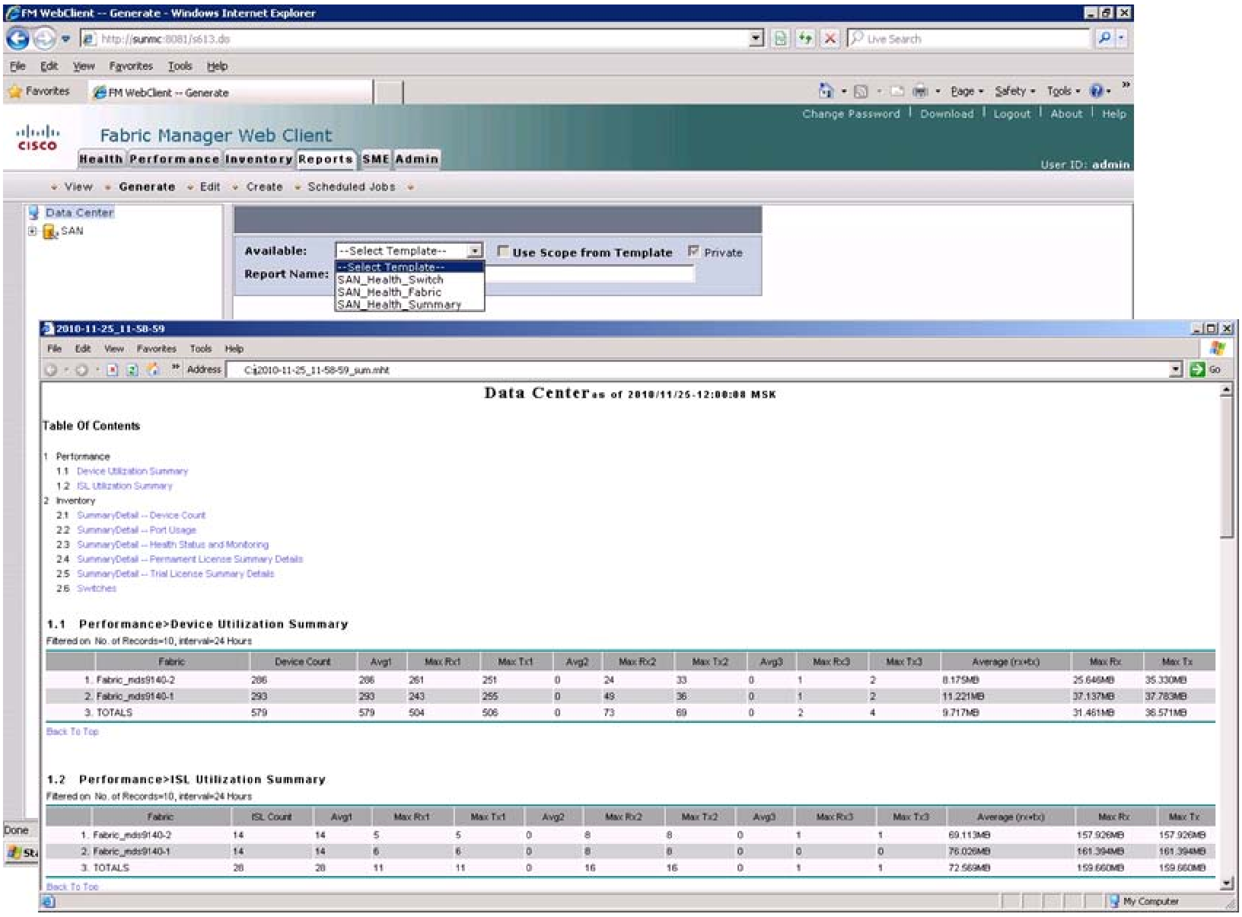
- D_Switch_3-35ad5b
- D_Switch_6-905737
- D_fcdirector1-361b08
- D_Switch_5-907853
- D_Switch_4-35b063
- D_fcdirector2-361a82

OK Cancel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Performance Data for 10.242.225.1																
2	Capture Started On Tue Sep 07 11:19:30 2010																
3	dURATION 86400 sECONDS																
4	Sample Interval 120 Seconds																
5		P 0	P 1	P 2	P 3	P 4	P 8	P 9	P 10	P 11	P 12	P 13	P 14	P 15	P 16	P 18	P 19
					0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	1	0	0	0	0	0	0
					0	0	0	0	0	0	12	1	0	0	0	0	0
					0	0	0	0	0	0	0	1	0	0	0	0	0
					0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	4	0	0	0	0	0	0
					0	0	0	0	0	0	6	0	0	0	0	0	0
					0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	10	1	0	0	0	0	0

Figure 2 How to unhide sheets with performance data

The quickest way to get the current configuration of Cisco switches is to use Cisco Fabric Manager Web Client. There is an option to create reports from one of the three available templates (SAN_Health_Switch, SAN_Health_Fabric, and SAN_Health_Summary) and save them in *html* format.


FM WebClient -- Generate - Windows Internet Explorer
http://sunmc:8081/s613.do
Live Search
File Edit View Favorites Tools Help
Favorites
FM WebClient -- Generate
Page Safety Tools
Change Password | Download | Logout | About | Help
cisco
Fabric Manager Web Client
Health Performance Inventory Reports SME Admin
User ID: admin
View Generate Edit Create Scheduled Jobs
Data Center
SAN
2010-11-25_11-58-59
File Edit View Favorites Tools Help
Address
Go
Done
My Computer

Available: --Select Template--

☐ Use Scope from Template ☑ Private

Report Name:

--Select Template--
SAN_Health_Switch
SAN_Health_Fabric
SAN_Health_Summary

Address: C:\2010-11-25_11-58-59_sum.mht

Data Center as of 2010/11/25-12:00:08 MSK

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2 Inventory
2.1 SummaryDetail -- Device Count
2.2 SummaryDetail -- Port Usage
2.3 SummaryDetail -- Health Status and Monitoring
2.4 SummaryDetail -- Permanent License Summary Details
2.5 SummaryDetail -- Trial License Summary Details
2.6 Switches

1.1 Performance>Device Utilization Summary

Filtered on No. of Records=10, interval=24 Hours

	Fabric	Device Count	Avg1	Max Rx1	Max Tx1	Avg2	Max Rx2	Max Tx2	Avg3	Max Rx3	Max Tx3	Average (rx+tx)	Max Rx	Max Tx
1.	Fabric_mds9140-2	286	286	261	251	0	24	33	0	1	2	8.175MB	25.646MB	35.330MB
2.	Fabric_mds9140-1	293	293	243	255	0	49	36	0	1	2	11.221MB	37.137MB	37.783MB
3.	TOTALS	579	579	504	506	0	73	69	0	2	4	9.717MB	31.461MB	36.571MB

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1.2 Performance>ISL Utilization Summary

Filtered on No. of Records=10, interval=24 Hours

	Fabric	ISL Count	Avg1	Max Rx1	Max Tx1	Avg2	Max Rx2	Max Tx2	Avg3	Max Rx3	Max Tx3	Average (rx+tx)	Max Rx	Max Tx
1.	Fabric_mds9140-2	14	14	5	5	0	8	8	0	1	1	69.113MB	157.926MB	157.926MB
2.	Fabric_mds9140-1	14	14	6	6	0	8	8	0	0	0	76.026MB	161.394MB	161.394MB
3.	TOTALS	28	28	11	11	0	16	16	0	1	1	72.569MB	159.660MB	159.660MB

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Figure 3 Cisco Fabric Manager Web Client reports

Monitoring and management tools

An alternate way to perform detailed information capture is to use centralized SAN and storage management products already implemented in the customer’s infrastructure such as Brocade DCFM (Data Center Fabric Manager), HP StorageWorks, IBM Tivoli Storage Productivity Center, or EMC ControlCenter® SAN Manager.

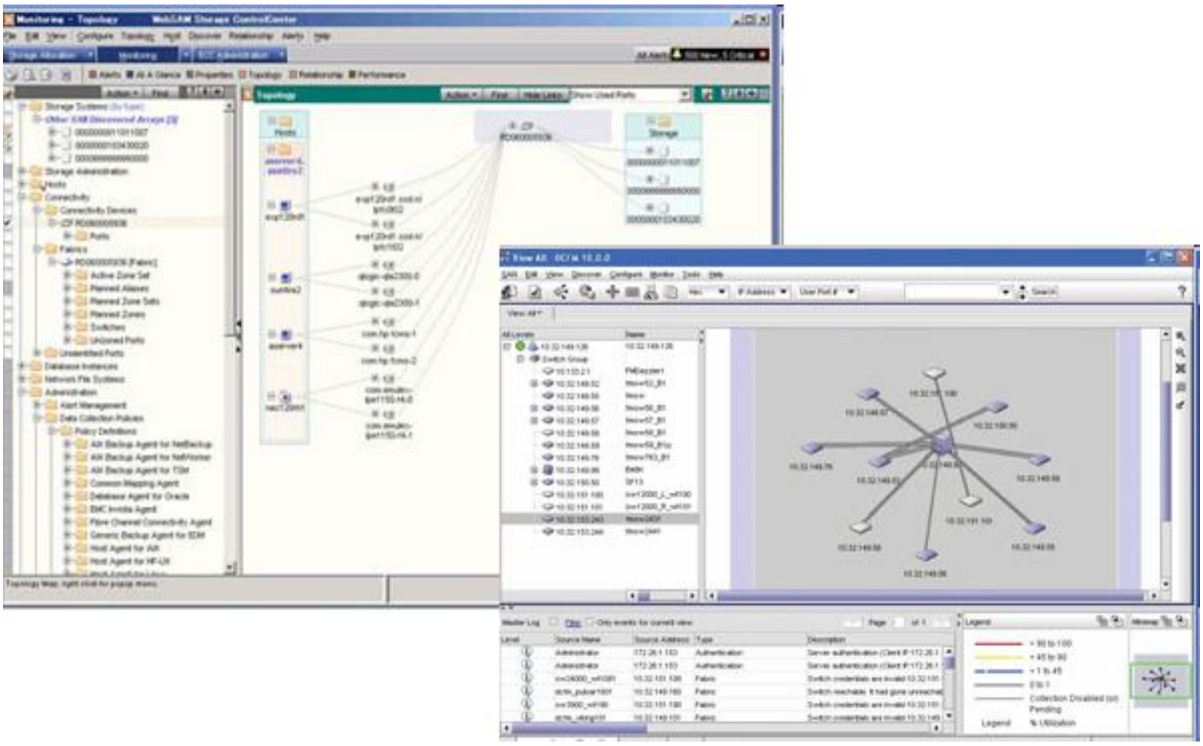
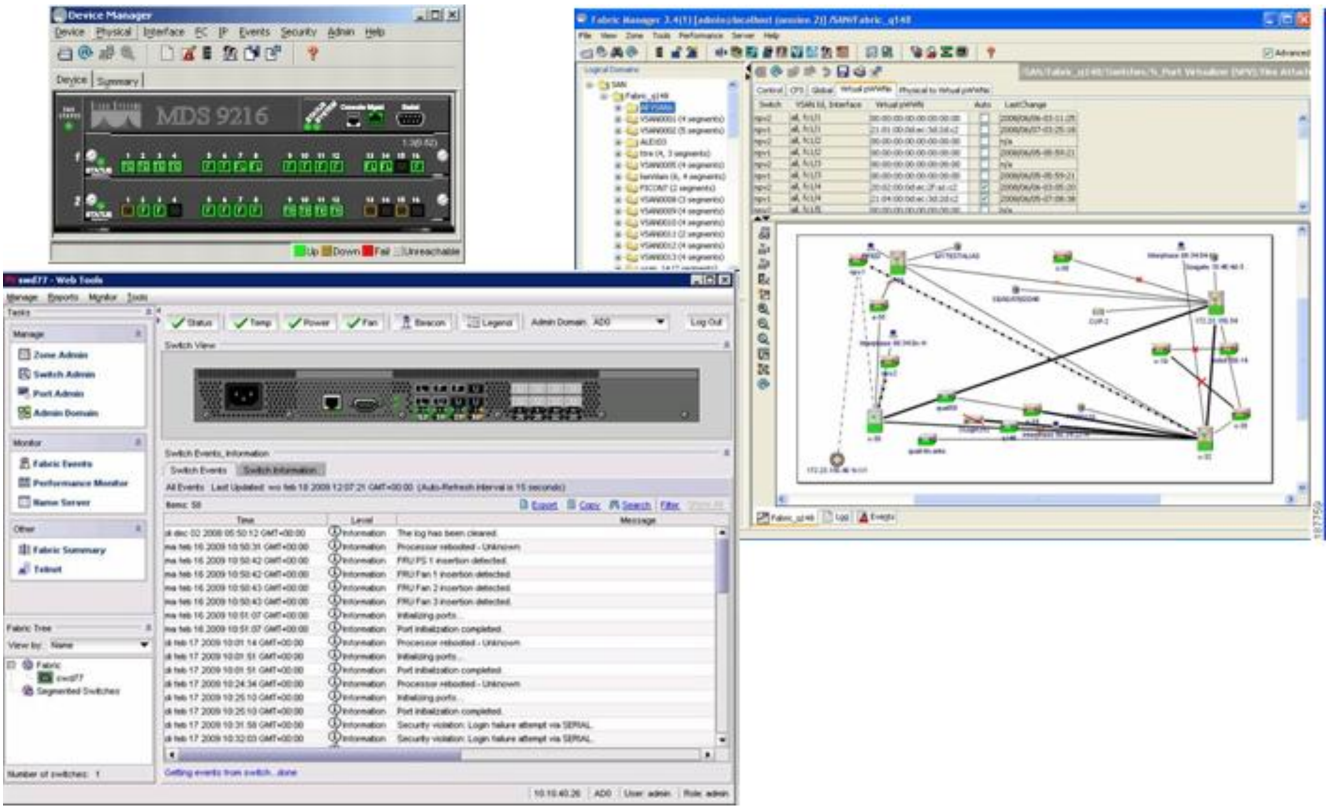


Figure 4 EMC ControlCenter and Brocade DCFM

You can receive the information about switch configuration, component health, and connectivity topology screenshots from Cisco Device and Fabric managers and Brocade Web tools. However, this method of collection is less preferable because it requires manual work for data export and takes more time and advance preparation of all required information checklists.



Switch Events, Information

All Events Last Updated: wo feb 18 2009 12:07:21 GMT+00:00 (Auto-Refresh interval is 15 seconds)

Items: 58

Time	Level	Message
di dec 02 2008 05:50:12 GMT+00:00	Information	The log has been cleared.
ma feb 16 2009 10:50:31 GMT+00:00	Information	Processor rebooted - Unknown
ma feb 16 2009 10:50:42 GMT+00:00	Information	FRU PS 1 insertion detected.
ma feb 16 2009 10:50:42 GMT+00:00	Information	FRU Fan 1 insertion detected.
ma feb 16 2009 10:50:43 GMT+00:00	Information	FRU Fan 2 insertion detected.
ma feb 16 2009 10:50:43 GMT+00:00	Information	FRU Fan 3 insertion detected.
ma feb 16 2009 10:51:07 GMT+00:00	Information	Initializing ports...
ma feb 16 2009 10:51:07 GMT+00:00	Information	Port initialization completed.
di feb 17 2009 10:01:14 GMT+00:00	Information	Processor rebooted - Unknown
di feb 17 2009 10:01:51 GMT+00:00	Information	Initializing ports...
di feb 17 2009 10:01:51 GMT+00:00	Information	Port initialization completed.
di feb 17 2009 10:24:34 GMT+00:00	Information	Processor rebooted - Unknown
di feb 17 2009 10:25:10 GMT+00:00	Information	Initializing ports...
di feb 17 2009 10:25:10 GMT+00:00	Information	Port initialization completed.
di feb 17 2009 10:31:58 GMT+00:00	Information	Security violation: Login failure attempt via SERIAL.
di feb 17 2009 10:32:03 GMT+00:00	Information	Security violation: Login failure attempt via SERIAL.

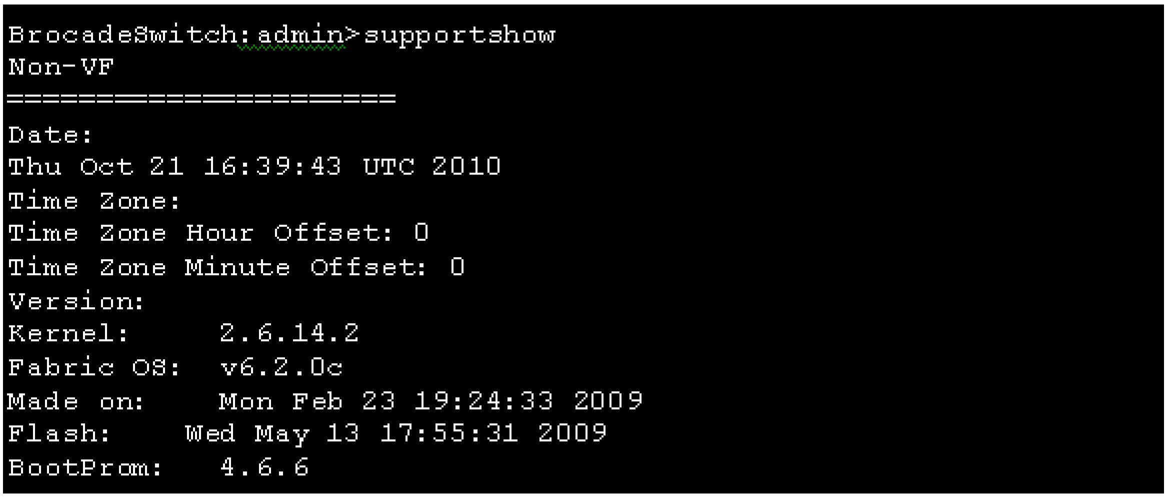
Getting events from switch...done

10.10.40.26 | AD0 | User: admin | Role: admin

Figure 5 Cisco Device and Fabric manager, Brocade Web tools

Internal switch commands

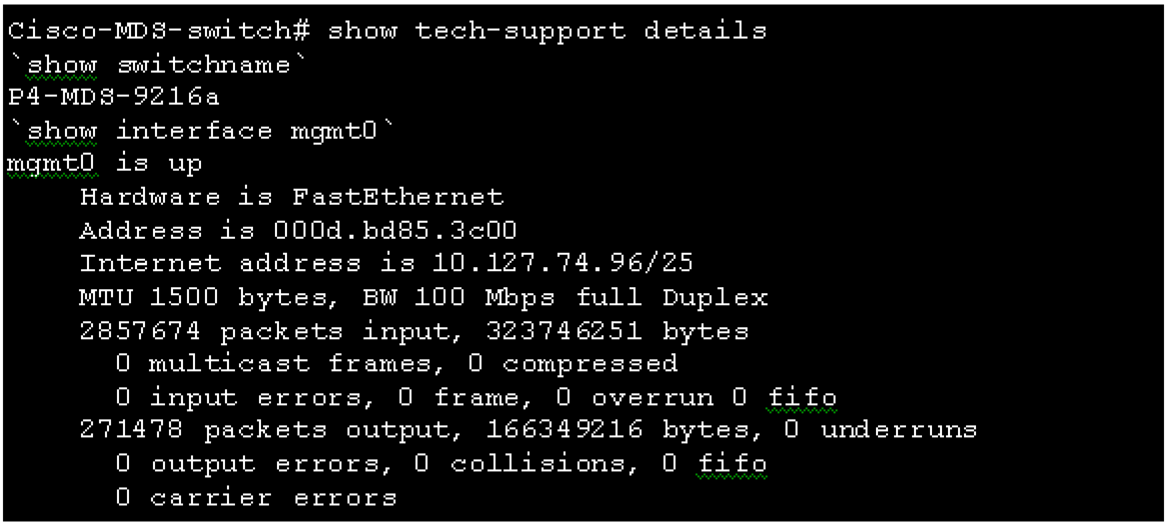
In Brocade switches you need to use *supportsave* or *supportshow all* commands from telnet/ssh session or click *Tasks > Technical Support Information > Capture SupportSave / SupportShow* in DCFM.



```
BrocadeSwitch:admin>supportshow
Non-VF
======================
Date:
Thu Oct 21 16:39:43 UTC 2010
Time Zone:
Time Zone Hour Offset: 0
Time Zone Minute Offset: 0
Version:
Kernel:     2.6.14.2
Fabric OS:  v6.2.0c
Made on:    Mon Feb 23 19:24:33 2009
Flash:     Wed May 13 17:55:31 2009
BootProm:   4.6.6
```

Figure 6 supportshow command output

For Cisco, use *show tech-support details* or *tac-pac* CLI commands or click *Tools > Show Tech Support* in Fabric Manager.

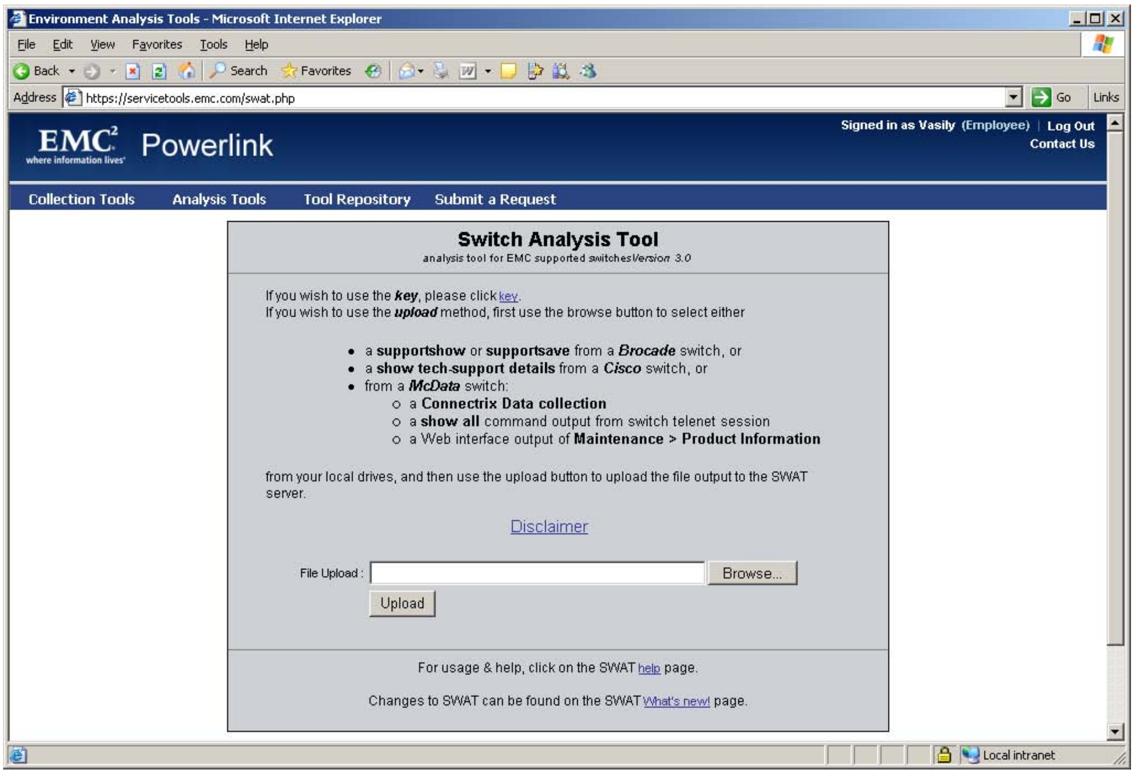


```
Cisco-MDS-switch# show tech-support details
`show switchname`
P4-MDS-9216a
`show interface mgmt0`
mgmt0 is up
    Hardware is FastEthernet
    Address is 000d.bd85.3c00
    Internet address is 10.127.74.96/25
    MTU 1500 bytes, BW 100 Mbps full Duplex
    2857674 packets input, 323746251 bytes
      0 multicast frames, 0 compressed
      0 input errors, 0 frame, 0 overrun 0 fifo
    271478 packets output, 166349216 bytes, 0 underruns
      0 output errors, 0 collisions, 0 fifo
      0 carrier errors
```

Figure 7 show tech-support command output

The main advantage of this data collection method is that you receive the most detailed information about configuration and in case of problems, you may analyze logs and send trace dumps to technical support. The disadvantage is that the output is in text or raw internal format and requires additional pre-processing for later analysis.

For pre-processing purposes, EMC employees and partners can use the SWAT (Switch Analysis Tool) utility.


Environment Analysis Tools - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address https://servicetools.emc.com/swat.php
Go Links
EMC² where information lives® Powerlink
Signed in as Vasily (Employee) | Log Out
Contact Us
Collection Tools Analysis Tools Tool Repository Submit a Request

Switch Analysis Tool

analysis tool for EMC supported switchesVersion 3.0

If you wish to use the ***key***, please click key.
If you wish to use the ***upload*** method, first use the browse button to select either

- a **supportshow** or **supportsave** from a ***Brocade*** switch, or
- a **show tech-support details** from a ***Cisco*** switch, or
- from a ***McData*** switch:
  - a **Connectrix Data collection**
  - a **show all** command output from switch telenet session
  - a Web interface output of **Maintenance > Product Information**

from your local drives, and then use the upload button to upload the file output to the SWAT server.

Disclaimer

File Upload : Browse...

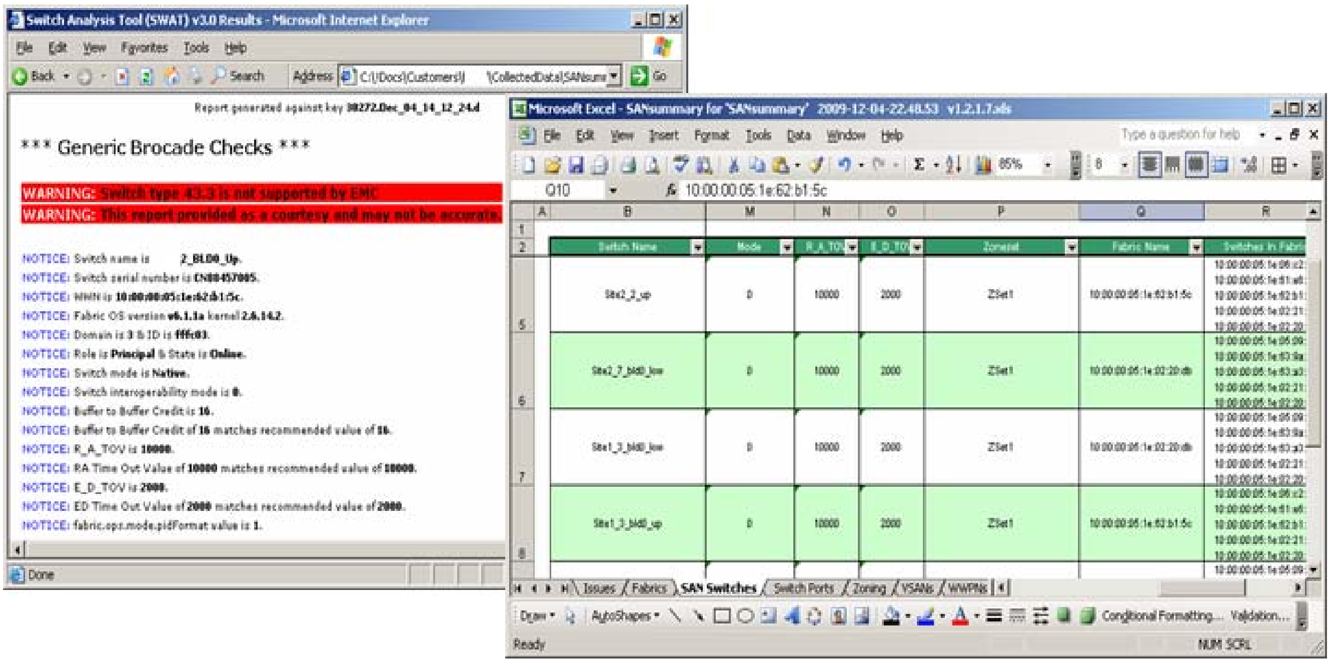
Upload

For usage & help, click on the SWAT help page.

Changes to SWAT can be found on the SWAT What's new! page.

Figure 8 EMC SWAT

Results in *html* format can be viewed in a web-browser and received by email. SANsummary utility, available on *one.emc.com***,** helps transform SWAT output to Excel spreadsheet format.


Switch Analysis Tool (SWAT) v3.0 Results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Address C:\|Docs\Customers\| \CollectedData\SANsum Go

Report generated against key **30272.Dec_04_14_12_24.d**

*** Generic Brocade Checks ***

WARNING: Switch type 43.3 is not supported by EMC
WARNING: This report provided as a courtesy and may not be accurate.

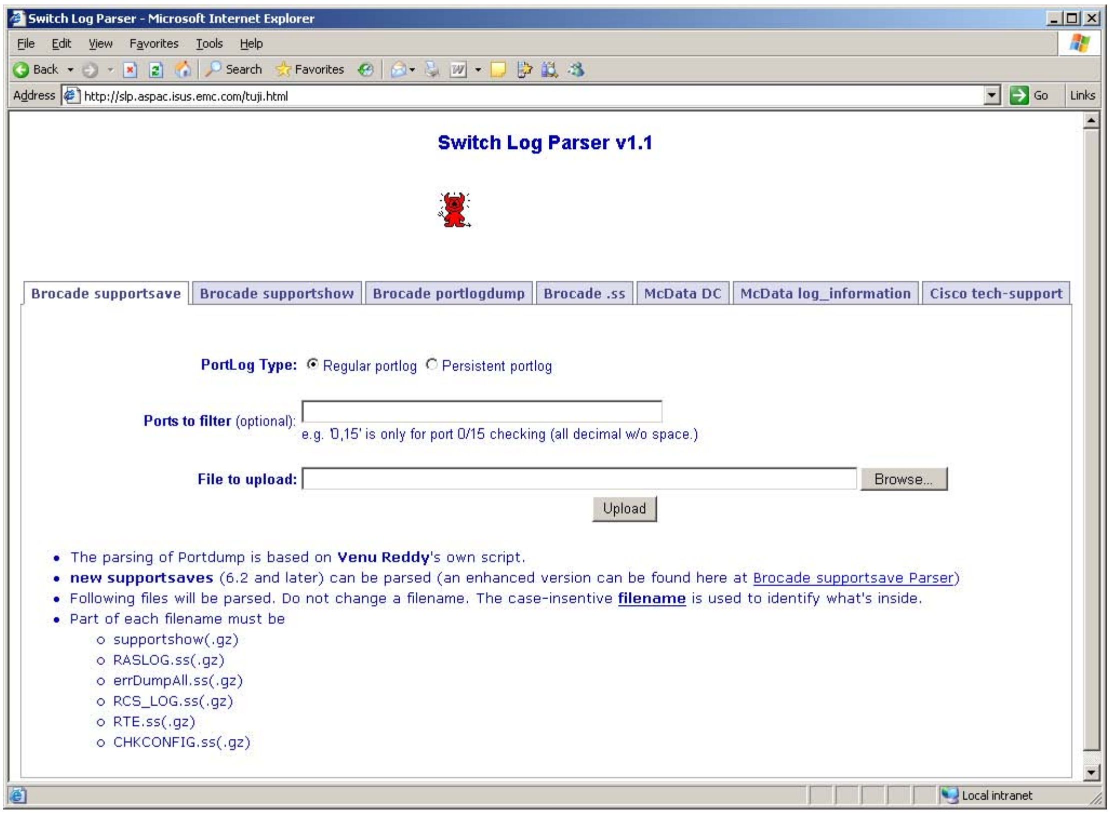
NOTICE: Switch name is **2_BLD0_Up**.
NOTICE: Switch serial number is **CN00457005**.
NOTICE: WWN is **10:00:00:05:1e:62:b1:5c**.
NOTICE: Fabric OS version **v6.1.1a** kernel **2.6.14.2**.
NOTICE: Domain is **3** & ID is **fffc03**.
NOTICE: Role is **Principal** & State is **Online**.
NOTICE: Switch mode is **Native**.
NOTICE: Switch interoperability mode is **0**.
NOTICE: Buffer to Buffer Credit is **16**.
NOTICE: Buffer to Buffer Credit of **16** matches recommended value of **16**.
NOTICE: R_A_TOV is **10000**.
NOTICE: RA Time Out Value of **10000** matches recommended value of **10000**.
NOTICE: E_D_TOV is **2000**.
NOTICE: ED Time Out Value of **2000** matches recommended value of **2000**.
NOTICE: fabric.ops.mode.pidFormat value is **1**.

Done
Microsoft Excel - SANsummary for 'SANsummary' 2009-12-04-22.48.53 v1.2.1.7.xls
File Edit View Insert Format Tools Data Window Help
Type a question for help
85%
Q10
10:00:00:05:1e:62:b1:5c
Issues Fabrics SAN Switches Switch Ports Zoning VSANs WWPNs
Draw AutoShapes Conditional Formatting... Validation...
Ready NUM SCRL

Switch Name	Mode	R_A_TOV	E_D_TOV	Zoneset	Fabric Name	Switches in Fabri
Site2_2_up	0	10000	2000	ZSet1	10:00:00:05:1e:62:b1:5c	10:00:00:05:1e:06:c2 10:00:00:05:1e:51:a6 10:00:00:05:1e:62:b1 10:00:00:05:1e:02:21 10:00:00:05:1e:02:20
Site2_7_bld0_low	0	10000	2000	ZSet1	10:00:00:05:1e:02:20:db	10:00:00:05:1e:05:09 10:00:00:05:1e:63:9a 10:00:00:05:1e:63:a3 10:00:00:05:1e:02:21 10:00:00:05:1e:02:20
Site1_3_bld0_low	0	10000	2000	ZSet1	10:00:00:05:1e:02:20:db	10:00:00:05:1e:05:09 10:00:00:05:1e:63:9a 10:00:00:05:1e:63:a3 10:00:00:05:1e:02:21 10:00:00:05:1e:02:20
Site1_3_bld0_up	0	10000	2000	ZSet1	10:00:00:05:1e:62:b1:5c	10:00:00:05:1e:06:c2 10:00:00:05:1e:51:a6 10:00:00:05:1e:62:b1 10:00:00:05:1e:02:21 10:00:00:05:1e:02:20

Figure 9 EMC SWAT and SANsummary results

EMC employees can also use the Switch Log Parser utility. It can analyze not only *show tech-support* and *supportshow* data but also Brocade *portlogdumps* and engineering *.ss* files.


Switch Log Parser - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://slp.aspac.isus.emc.com/tuji.html
Go Links
Local intranet

Switch Log Parser v1.1

Brocade supportsave | Brocade supportshow | Brocade portlogdump | Brocade .ss | McData DC | McData log_information | Cisco tech-support

PortLog Type: ● Regular portlog ○ Persistent portlog

Ports to filter (optional):
e.g. '0,15' is only for port 0/15 checking (all decimal w/o space.)

File to upload: Browse...

Upload

- The parsing of Portdump is based on **Venu Reddy**'s own script.
- **new supportsaves** (6.2 and later) can be parsed (an enhanced version can be found here at Brocade supportsave Parser)
- Following files will be parsed. Do not change a filename. The case-insentive **filename** is used to identify what's inside.
- Part of each filename must be
  - supportshow(.gz)
  - RASLOG.ss(.gz)
  - errDumpAll.ss(.gz)
  - RCS_LOG.ss(.gz)
  - RTE.ss(.gz)
  - CHKCONFIG.ss(.gz)

Figure 10 Switch Log Parser

Since collected data has to be accurate and up-to-date you should carefully check information consistency and correctness during processing. In arguable cases, cross-check from different sources is required.

Data analysis

Analysis methodology is based on SAN Maturity Model. This model enables maturity levels of SAN administration areas to be visualized and develop specific recommendations for their optimization. It investigates SAN in 3D-perspective of the most important factors:

- Architecture
- Physical state
- Fault-tolerance
- Configuration
- Performance
- Management
- Security
- Operations

All factors depend on many characteristics which have from two to four state variants. Each state has a cost between zero and three. Characteristics' values are defined by cost of only those variants applicable to the current state. Whole factor value is calculated by the average of all characteristics.

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
4		**Factor Architecture value**	-	0,5	-	2,5
4.1		**Characteristic 1**		**1**		**2**
4.1.1	0	*value 1*				
4.1.2	1	*value 2*	**X**	1		
4.1.3	2	*value 3*			**X**	2
4.1.4	3	*value 4*				
4.2		**Characteristic 2**		**0**		**3**
4.2.1	0	*value 1*	**X**	0		
4.2.2	1,5	*value 2*				
4.2.3	3	*value 3*			**X**	3

Table 2 Factor maturity level calculation

Methodology requires investigation of both "as is" and "to do" states. Using this approach directs attention to the difference between the current situation and the target state to which a customer should tend during next 2-3 years.

Factors	Current state	Target state
Architecture	2,3	2,8
Physical state	1,8	2,7
Fault-tolerance	2,0	2,6
Configuration	0,8	3,0
Performance	1,7	2,1
Management	1,0	2,0
Operations	1,4	2,0
Security	2,0	2,3

Table 3 Current and target maturity levels

Values of all factors are shown in the Maturity Spider Diagram. Gaps between green and red diagrams show each factor's maturity level and visualize how far current and target states of SAN are from each other.

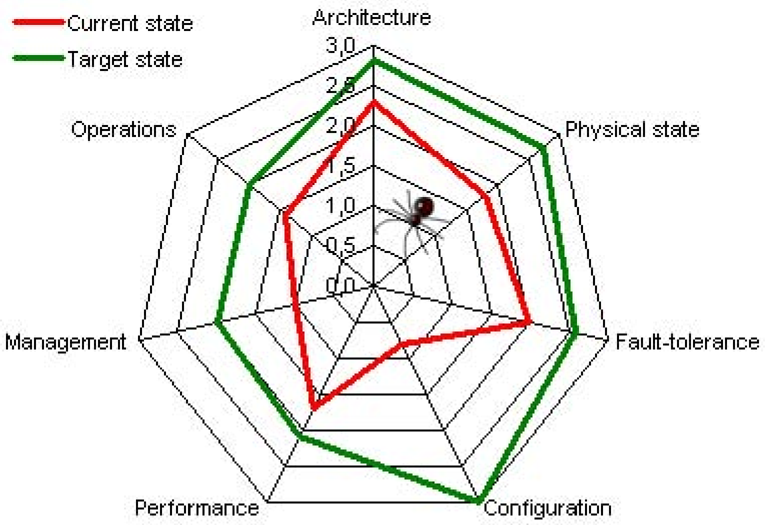


Figure 11 SAN Maturity diagram

Recommendation development is made with severity level consideration of weaknesses and problems discovered during analysis.

Severity	Description
High	Critical problems or defects which require special attention and urgent actions are found
Medium	Non-critical problems or defects which don't require urgent actions are found
Low	General optimization possibilities are found

Table 4 Recommendation severity levels

Improvement recommendations for specific problems are given with a list of required resources and estimation of their implementation difficulty.

Implementation level	Description
High	Implementation with significant risks and/or high expenses
Medium	Implementation with medium risks and medium or low expenses
Low	Minimum of implementation's risks without direct expenses

Table 5 Recommendation implementation level

SAN audit in ABC Company

This section will focus on how to use described methodology and emphasize the most typical points you can discover during a live SAN audit.

ABC is an artificial company combined from several real projects which the author implemented in the last two years. Of course, the actual assessment report has more details and is much bigger.

In the text below, you'll find special signs:

✓ finding follows the best practices and vendors recommendations

✗ finding points out some current or potential problems

✦ general comment or recommendation

Architecture

Topology

✗ ABC SAN topology doesn't fit any of the standard topologies recommended by EMC. This leads to serious scalability restrictions and low level of availability and potential problems with performance.

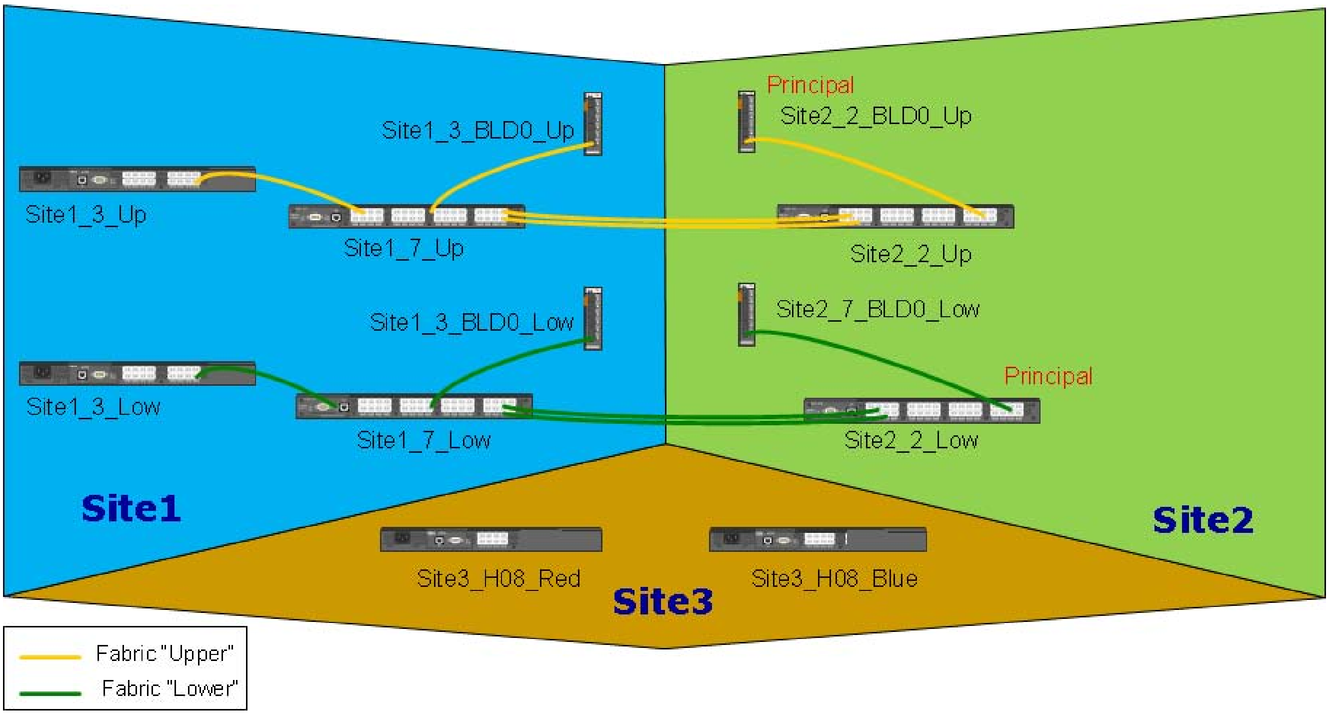


Figure 12 Current topology

✓ Redundant Upper and Lower fabrics are topologically symmetric and physically isolated.

✗ Switches Site3_H08_Red and Site3_H08_Blue are not connected to the fabrics.

Remote sites

✓ ISLs (Inter-Switch Links) between Site1 and Site2 are configured on four dark optics links.

✓ There is a possibility to rent several dark optic channels between Site1 - Site3 and also Site2 - Site3. This is good from the perspective of Site3 integration in the SAN.

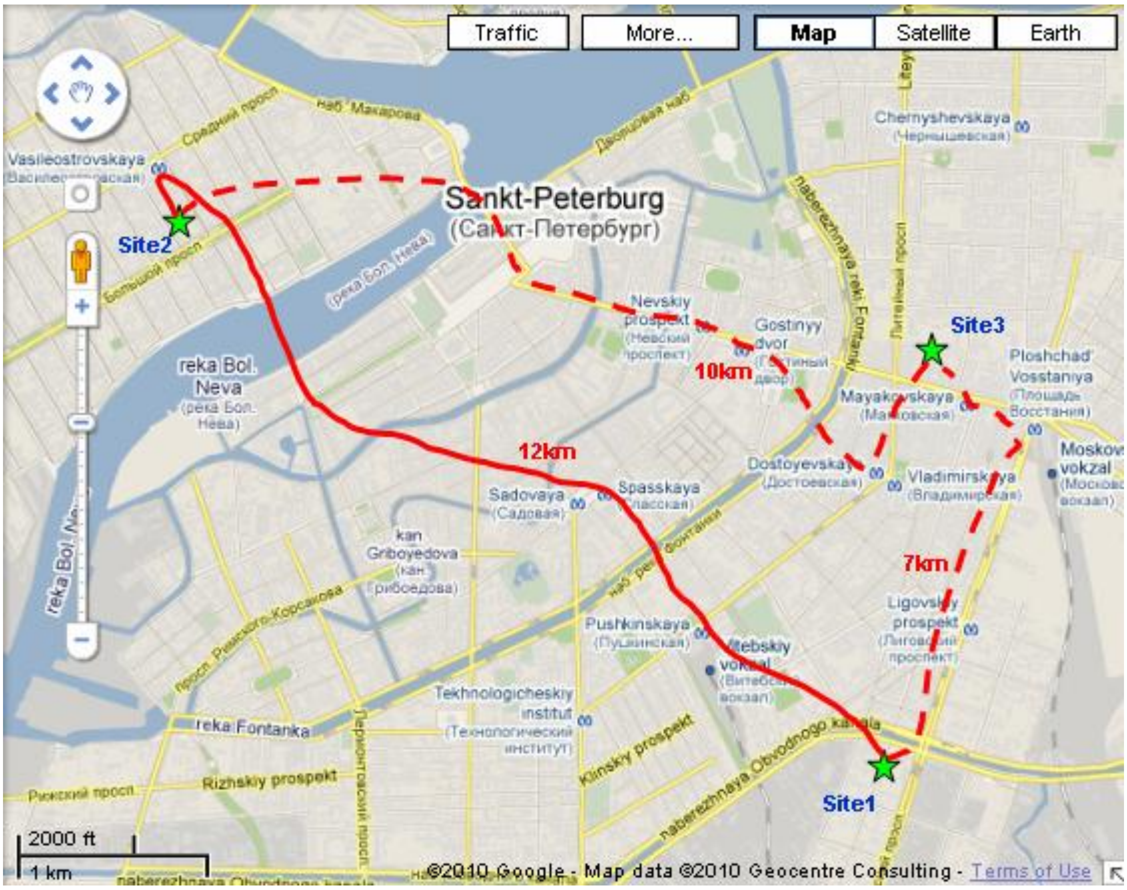


Figure 13 Physical links between sites

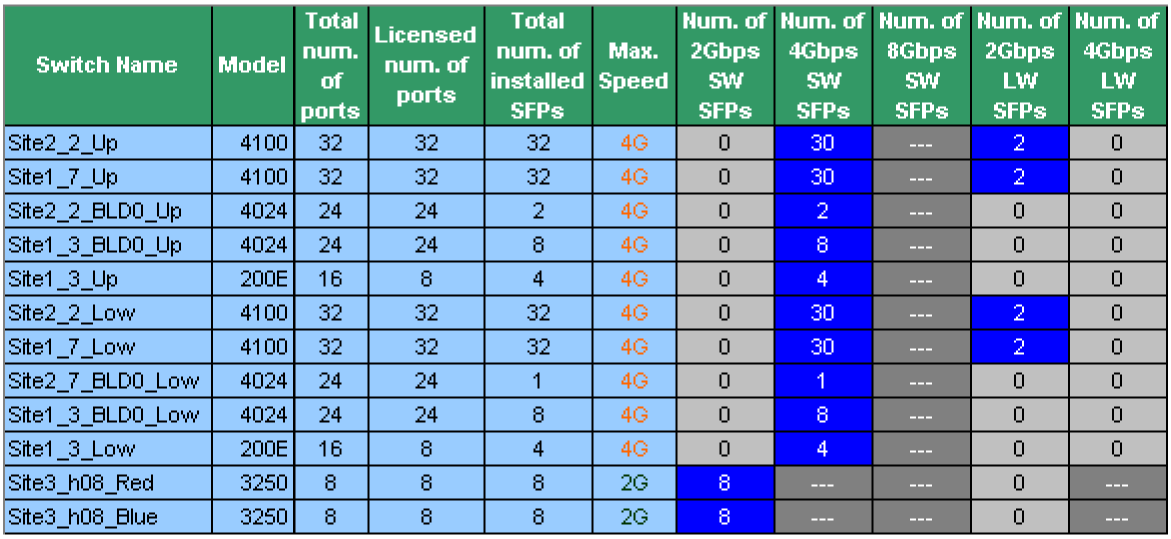
✦ New remote site is currently under IT management consideration. New site should be connected to the SAN during the next 10 months. Distance to Site1 and Site2 will be less than 15km.

Heterogeneity

✓ SAN based on Brocade switches only (IBM and HP OEMs).

Scalability

Table 6 describes SFPs configuration.



Switch Name	Model	Total num. of ports	Licensed num. of ports	Total num. of installed SFPs	Max. Speed	Num. of 2Gbps SW SFPs	Num. of 4Gbps SW SFPs	Num. of 8Gbps SW SFPs	Num. of 2Gbps LW SFPs	Num. of 4Gbps LW SFPs
Site2_2_Up	4100	32	32	32	4G	0	30	---	2	0
Site1_7_Up	4100	32	32	32	4G	0	30	---	2	0
Site2_2_BLD0_Up	4024	24	24	2	4G	0	2	---	0	0
Site1_3_BLD0_Up	4024	24	24	8	4G	0	8	---	0	0
Site1_3_Up	200E	16	8	4	4G	0	4	---	0	0
Site2_2_Low	4100	32	32	32	4G	0	30	---	2	0
Site1_7_Low	4100	32	32	32	4G	0	30	---	2	0
Site2_7_BLD0_Low	4024	24	24	1	4G	0	1	---	0	0
Site1_3_BLD0_Low	4024	24	24	8	4G	0	8	---	0	0
Site1_3_Low	200E	16	8	4	4G	0	4	---	0	0
Site3_h08_Red	3250	8	8	8	2G	8	---	---	0	---
Site3_h08_Blue	3250	8	8	8	2G	8	---	---	0	---

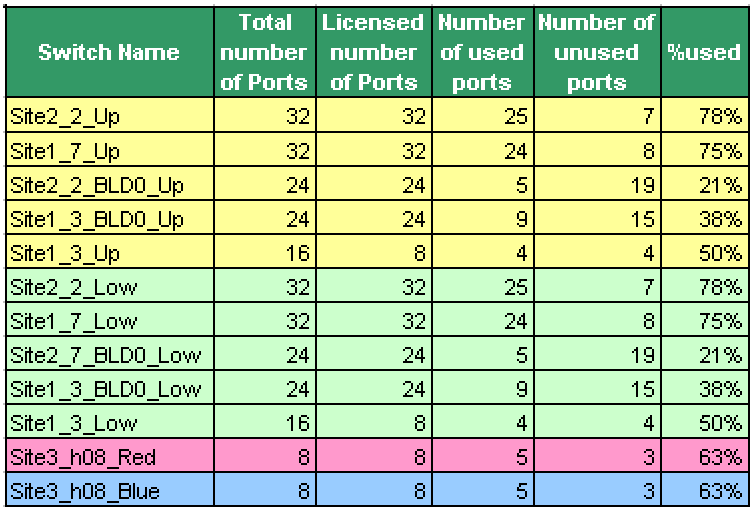
Table 6 SFPs configuration

✦ To install additional SFPs to switches Site1_3_Up and Site1_3_Low, POD (Ports On Demand), license is required.

Ports utilization metric (percent used) is calculated by formula:

$$\%used = \frac{\mathbf{NumberOfPorts}_{Used}}{\mathbf{NumberOfPorts}_{Licensed}} * 100\%$$

✓ Average ports utilization <63 percent. Maximum switch ports utilization 78 percent.



Switch Name	Total number of Ports	Licensed number of Ports	Number of used ports	Number of unused ports	%used
Site2_2_Up	32	32	25	7	78%
Site1_7_Up	32	32	24	8	75%
Site2_2_BLD0_Up	24	24	5	19	21%
Site1_3_BLD0_Up	24	24	9	15	38%
Site1_3_Up	16	8	4	4	50%
Site2_2_Low	32	32	25	7	78%
Site1_7_Low	32	32	24	8	75%
Site2_7_BLD0_Low	24	24	5	19	21%
Site1_3_BLD0_Low	24	24	9	15	38%
Site1_3_Low	16	8	4	4	50%
Site3_h08_Red	8	8	5	3	63%
Site3_h08_Blue	8	8	5	3	63%

Table 7 Ports utilization

✗ Site1_3_Up and Site1_3_Low each have only 4 used ports. Site3_h08_Red and Site3_h08_Blue each have only 5 used ports.

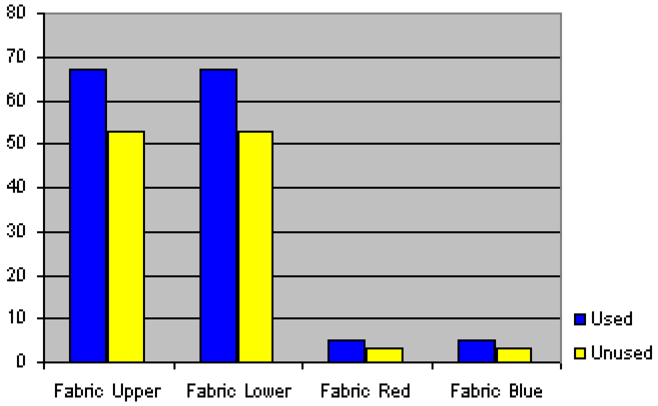


Table 8 Number of used and unused ports in each fabric

✓ Historical data of SAN growth was analyzed. Growth potential was calculated on the basis of future extrapolation of number of used and available ports. SAN is very scalable in terms of new devices on Site1 and Site2 connection.

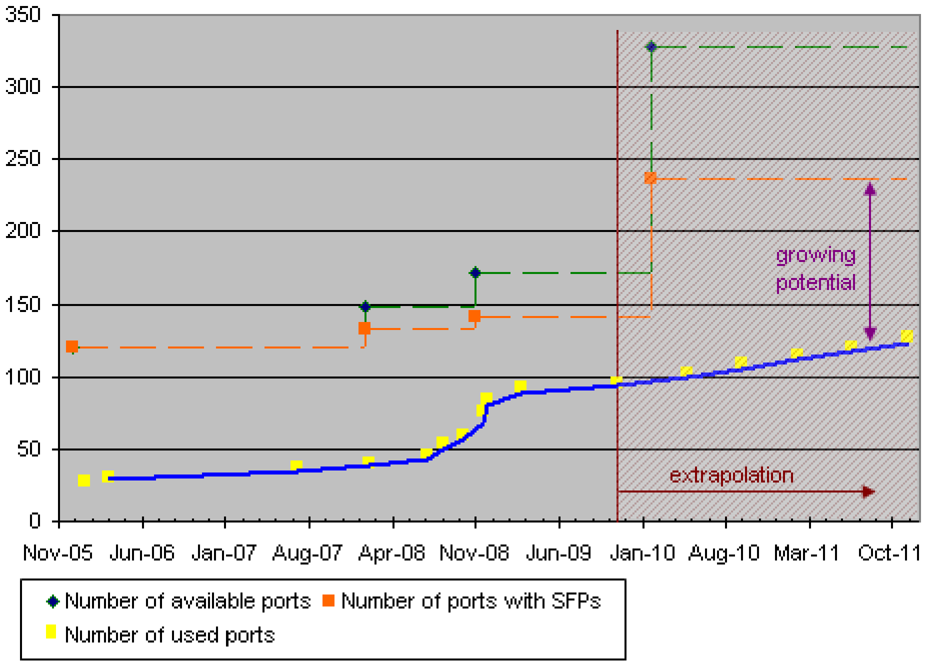


Figure 14 Extrapolation of number of used and available ports

Architecture recommendations

№	Architecture problem description and recommendations			
A1	**Severity**	High	**Description**	Current topology doesn't fit any of standard topologies recommended by EMC. Switches Site3_H08_Red and Site3_H08_Blue are not connected to the fabrics
	Recommendation	Consider two target core-edge topologies described below		
	Implementation level	High	**Resources**	Detailed design and additional switches and ISLs

Table 9 Architecture recommendations

Recommended target topologies are shown in Figures 15 and 16.

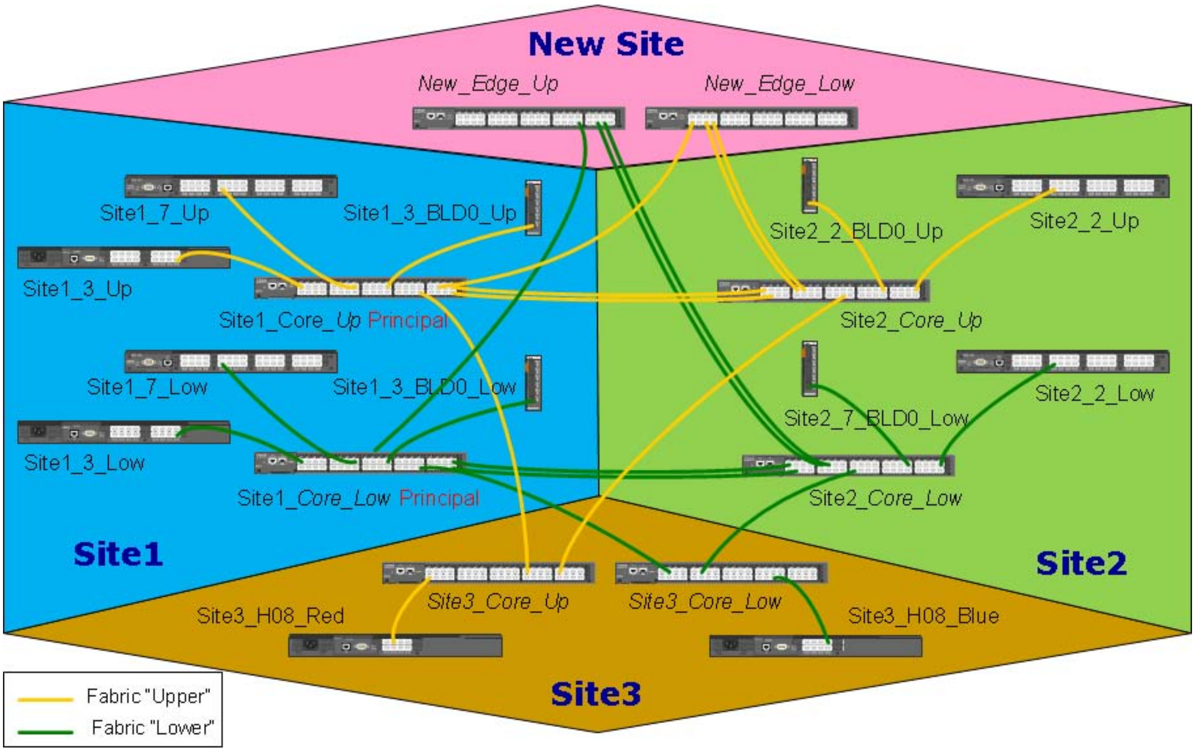


Figure 15 Target topology 1

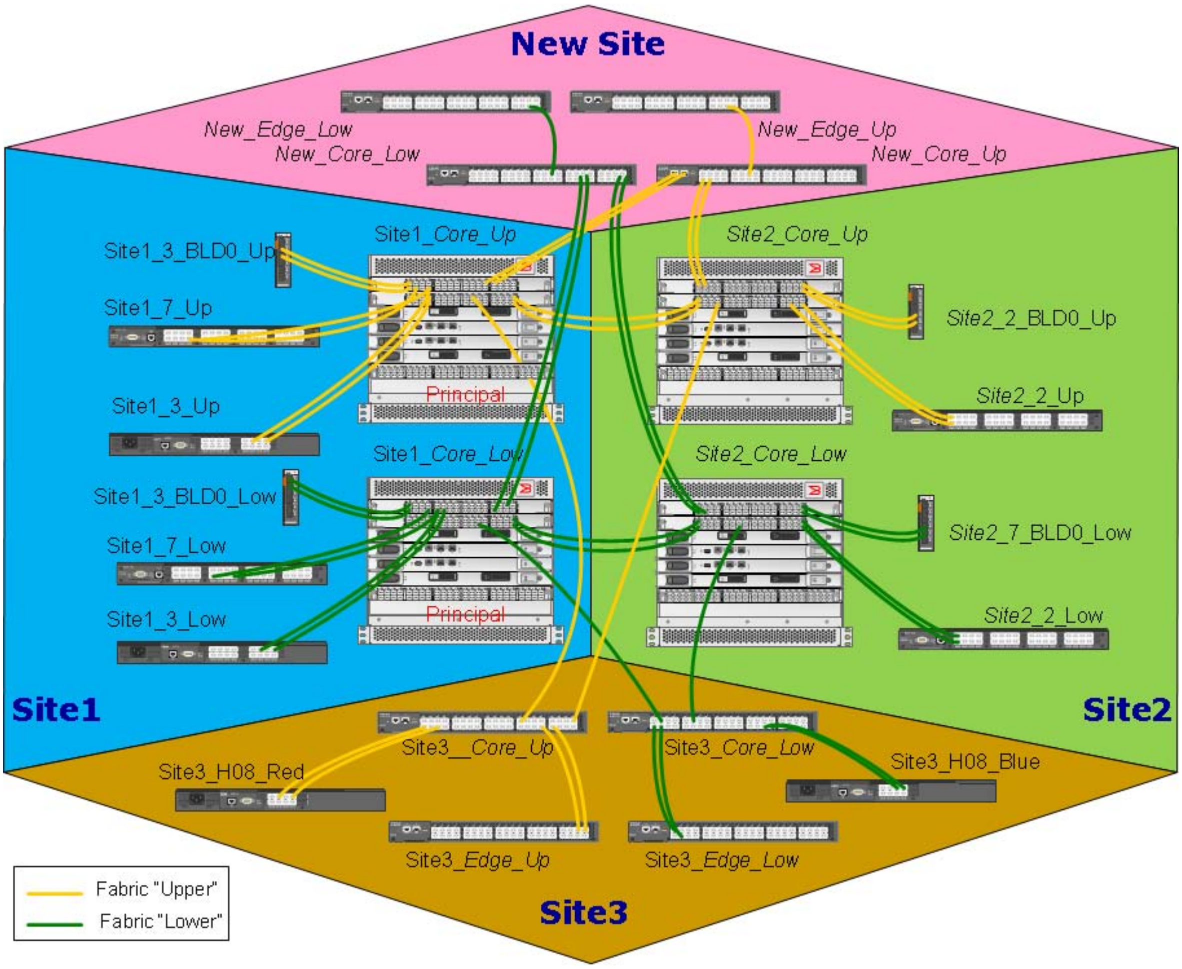


Figure 16 Target topology 2

Architecture maturity level calculation

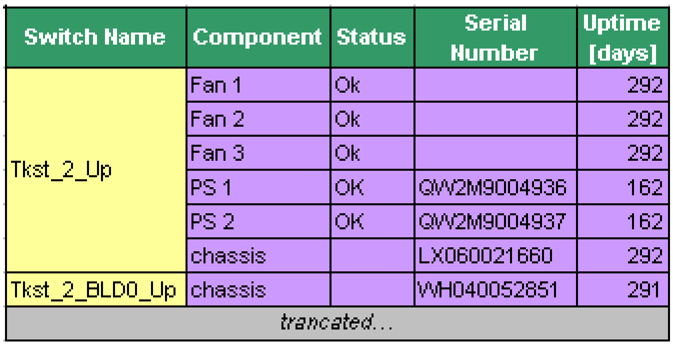
№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
1		**Factor Architecture value**	-	1,2	-	1,8
1.1		**Topology**		**0**		**3**
		Ways to organize physical connectivity between switches				
1.1.1	0	Switches are connected to each other without any rules or in long cascade (>3 switches) topology	x	0		
1.1.2	1	Switches are connected in ring or short cascade (<=3 switches) topology				
1.1.3	2	Switches are connected in full or partial mesh topology				
1.1.4	3	Switches are connected in core-edge topology			x	3
1.2		**Heterogeneity**		**3**		**3**
		Switches of different vendors in the same fabric				
1.2.1	1	Heterogeneous SAN				
1.2.2	3	Homogeneous SAN	x	3	x	3
1.3		**Unused ports**		**3**		**3**
		Number of ports available for new devices connectivity (inclusive of Port On Demand licenses)				
1.3.1	0	All ports in fabric are used or number of unused ports is not enough for the next planned device connection				
1.3.2	1	Number of unused ports enough for the next 3 years (over provisioning)				
1.3.3	2	Number of unused ports enough for the next 2 months (under provisioning)				
1.3.4	3	Number of unused ports enough for the next 1-2 years	x	3	x	3
1.4		**Logical fabric segmentation**		**0**		**0**
		Usage of Brocade MetaSAN or Cisco IVR				
1.4.1	0	Logical fabric segmentation is not used	x	0	X	0
1.4.2	3	Logical fabric segmentation is used				
1.5		**Directors in core**		**0**		**0**
		In core-edge topology, enterprise directors are used as core switches				
1.5.1	0	All core are mid-range level switches or core-edge topology is not used	x	0	x	0
1.5.2	1,5	Part of the core switches are enterprise directors				
1.5.3	3	All of the core switches are enterprise directors				

Table 10 Architecture maturity calculation

Physical state

Switches' components

✓ There are no faults in switches' components.



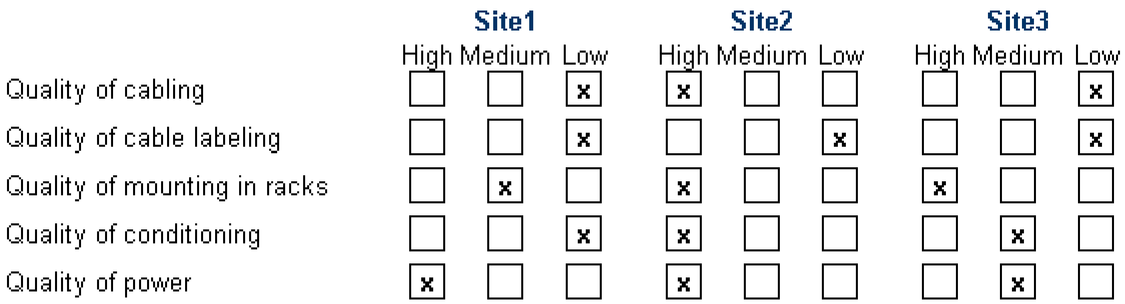
Switch Name	Component	Status	Serial Number	Uptime [days]
Tkst_2_Up	Fan 1	Ok		292
	Fan 2	Ok		292
	Fan 3	Ok		292
	PS 1	OK	QW2M9004936	162
	PS 2	OK	QW2M9004937	162
	chassis		LX060021660	292
Tkst_2_BLD0_Up	chassis		WH040052851	291
trancated...				

Table 11 Components state

Quality of power

✓ Switches on Site1 and Site2 are powered by two independent sources.

✗ Switches on Site3 are powered by an only source. Equipment is used for testing and development only.



	Site1			Site2			Site3		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Quality of cabling	☐	☐	☒	☒	☐	☐	☐	☐	☒
Quality of cable labeling	☐	☐	☒	☐	☐	☒	☐	☐	☒
Quality of mounting in racks	☐	☒	☐	☒	☐	☐	☒	☐	☐
Quality of conditioning	☐	☐	☒	☒	☐	☐	☐	☒	☐
Quality of power	☒	☐	☐	☒	☐	☐	☐	☒	☐

Figure 17 Physical state qualities

✓ During the last year, power outages were not registered.

Quality of conditioning

✗ Conditioning on Site1 doesn't have enough power. Temperature is 27°C.

Quality mounting in racks, cabling, and cable labeling

✓ On all sites, switches are mounted in cabinets.

✗ Local administrators on Site1 don't have information on where switches are located.

Quality of cabling and cable labeling

✗ On Site1 and Site3, cables are not accurately laid. They can occasionally be broken by administration personnel.

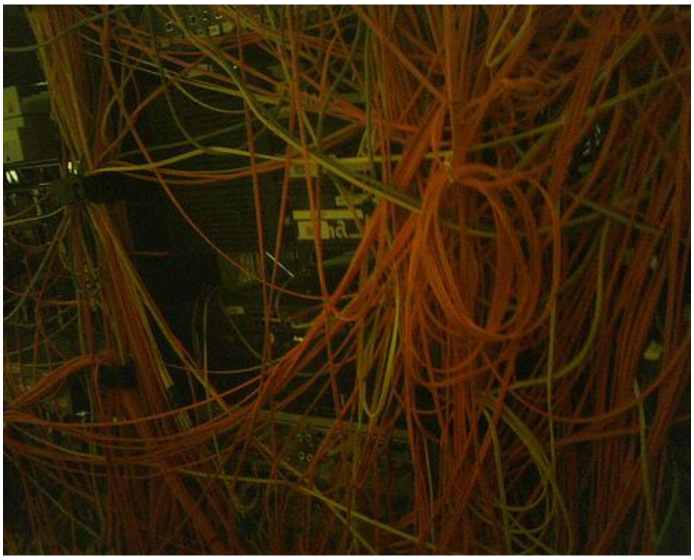


Figure 18 Photo of cabling

✓ On Site2, cable organizers are used everywhere and are accurately laid.

✗ Cable labels are partially used. There is no formal naming convention.

Physical state recommendations

№	Physical State problem description and recommendations			
P1	Severity	High	Description	Conditioning on Site1 doesn't have enough power
	Recommendation	Consider possibility to implement additional or new conditioning system		
	Implementation level	High	Resources	Conditioning system
P2	Severity	High	Description	Local administrators on Site1 don't have information where switches are located
	Recommendation	Share documents describing physical location of switches with administrators on Site1		
	Implementation level	Low	Resources	Documentation
P3	Severity	Medium	Description	On Site1 and Site3, cables are not accurately laid
	Recommendation	Re-cable optical links		
	Implementation level	Medium	Resources	SAN administrator's work
P4	Severity	High	Description	Cable labels are partially used
	Recommendation	Label all cables		
	Implementation level	Medium	Resources	Label printer and SAN administrator's work
P5	Severity	Medium	Description	Naming convention is not formalized
	Recommendation	Develop naming convention and describe it in formal document		
	Implementation level	Low	Resources	SAN administrator's and architect's work

Table 12 Physical state recommendations

Physical state maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
1		**Factor Physical State value**	-	1,8	-	2,9
2.1		**Components**		**3**		**3**
		State of switches' components				
2.1.1	0	Faults of non-redundant components are detected				
2.1.2	1	Faults of redundant components are detected				
2.1.3	2	Faults of some ports are detected				
2.1.4	3	Components fault were not detected	x	3	x	3

2.2		**Electricity**		**2**		**3**
		State of power				
2.2.1	0	During the last year, power outages were registered, power supplies are not redundant or powered by only source				
2.2.2	1	During the last year, power outages were registered, power supplies are redundant and powered by two independent sources				
2.2.3	2	During the last year, power outages were not registered, power supplies are not redundant or powered by only one source	x	2		
2.2.4	3	During the last year, power outages were not registered, power supplies are redundant and powered from two independent sources			x	3
2.3		**Conditioning**		**1**		**3**
		State of conditioning of server room where storage is located				
2.3.1	0	Conditioning is not used or doesn't have enough power				
2.3.2	1	During the last year, conditioning outages were registered or switches are mounted with conditioning rules violation	x	1		
2.3.3	2	During the last year, conditioning outages were not registered, switches are mounted without conditioning rules violations, conditioning system is not redundant				
2.3.4	3	During the last year, conditioning outages were not registered, switches are mounted without conditioning rules violations, conditioning system is redundant			x	3
2.4		**Mounting**		**2,5**		**2,5**
		Quality of mounting in cabinets				
2.4.1	0	Switches are not mounted in cabinets				
2.4.2	1	Switches are mounted in cabinets but are not reliable or with service space requirements violations				
2.4.3	2,5	Switches are mounted correctly but in non-specialized cabinets	x	2,5	x	2,5
2.4.4	3	Switches are mounted in specialized cabinets correctly				
2.5		**Cables**		**1**		**3**
		State of cables				
2.5.1	0	Cable organizers are not used, cables are not accurately laid (mixed up without any system, too long or short, can be easily broken)				
2.5.2	1	Cable organizers are partially used, cables are not accurately laid	x	1		
2.5.3	2	Cable organizers are partially used everywhere, cables are accurately laid				
2.5.4	3	Cable organizers are used everywhere, cables are accurately laid			x	3
2.6		**Labels**		**1**		**3**
		State of cables and switches labels				
2.6.1	0	Labels are not used				
2.6.2	1	Labels are partially used, naming convention is not formalized	x	1		
2.6.3	2	Labels are used everywhere, naming convention is not formalized				
2.6.4	3	Labels are used everywhere, naming convention is formalized			x	3

Table 13 Physical state maturity calculation

Fault tolerance

Redundant ISLs

✓ ISLs Site1_7_Up-Site1_7_Low and Site2_2_Up-Site2_2_Low are redundant.

✗ ISLs between other switches are not redundant.

Redundant links to end devices

✓ Links between most critical servers/all disk arrays and switches are redundant. PowerPath®, Veritas VxVM, and native multipathing are used.

Redundant fabrics

✓ SAN is built on two redundant fabrics.

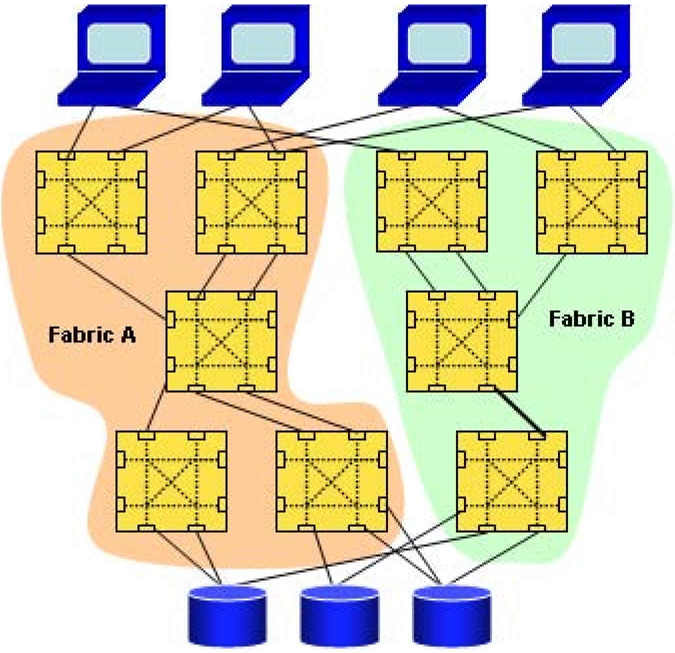


Figure 19 SAN with two redundant fabrics

Redundant components

✦ Currently, modular directors in ABC Company are not used.

✗ Switches Site1_3_Up, Site1_3_Low, Site3_h08_Blue and Site3_h08_Red have only one power supply and aren’t protected from their faults.

Warranty and services

✓ Site1_3_Up and Site1_3_Low are under service contracts.

✗ Warranties for all other switches are expired; relevant service contracts were not agreed upon.

Spare cables

✗ Spare cables are not laid.

Fault-tolerance recommendations

№	Fault-tolerance problem description and recommendations			
F1	Severity	Medium	Description	Switches Site1_3_Up, Site1_3_Low, Site3_h08_Blue and Site3_h08_Red have only one power supply
	Recommendation	Consider possibility of usage of switches with all redundant components		
	Implementation level	High	Resources	Replace switches with non-redundant components
F2	Severity	Medium	Description	ISLs between some switches are not redundant
	Recommendation	Consider possibility of usage of redundant ISLs between all switches		
	Implementation level	Medium	Resources	Additional trunking licenses, SFPs, and optical cables

F3	**Severity**	High	**Description**	Warranties for some switches are expired; relevant service contracts did not agree
	Recommendation	Consider possibility to arrange service contracts agreements		
	Implementation level	Medium	**Resources**	Service contract agreements
F4	**Severity**	High	**Description**	Spare cables are not laid
	Recommendation	Lay spare cables to most critical switches		
	Implementation level	Medium	**Resources**	Optical cables, SAN administrator's work

Table 14 Fault-tolerance recommendations

Fault-tolerance maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
3		**Factor Fault-tolerance value**	-	1,7	-	2,4
3.1		**ISL redundancy**		**2**		**3**
		Duplicated ISLs between switches				
3.1.1	0	ISLs are not redundant				
3.1.2	1	Some ISLs are redundant, channel aggregation (Brocade trunking, Cisco PortChannel) is not used				
3.1.3	2	Some ISLs are redundant, channel aggregation is used	x	2		
3.1.4	3	All ISLs are redundant, channel aggregation is used			x	3
3.2		**Links to servers redundancy**		**2**		**2**
		Duplicated links between switches and servers inclusive of multipathing SW				
3.2.1	0	Channels are not redundant				
3.2.2	1	Channels to critical servers partially redundant				
3.2.3	2	Channels to critical servers fully redundant, channels to non-critical servers are partially redundant	x	2	x	2
3.2.4	3	All channels are redundant				
3.3		**Links to storages redundancy**		**3**		**3**
		Duplicated links between switches and disc arrays				
3.3.1	0	Channels are not redundant				
3.3.2	1,5	Channels are partially redundant				
3.3.3	3	All channels are redundant	x	3	x	3
3.4		**Component redundancy**		**1,5**		**3**
		Switches' reliability				
3.4.1	0	All switches have non-redundant components				
3.4.2	1,5	Some switches have non-redundant components	x	1,5		
3.4.3	3	All switches' components are redundant			x	3
3.5		**Warranty and service**		**1,5**		**3**
		Warranty and service contracts				
3.5.1	0	Warranties for all switches are expired, relevant service contracts are not agreed				
3.5.2	1,5	Some switches are in warranty or under service contracts	x	1,5		
3.5.3	3	All switches are in warranty or under service contracts			x	3
3.6		**Redundant fabrics**		**2**		**2**
		Redundant (mirrored) isolated fabrics				
3.6.1	0	Redundant fabrics are used				
3.6.2	2	Redundant fabrics are not used	x	2	x	2
3.7		**Spare cables**		**0**		**1**
		Optical links can be used in case of fault in other cables				
3.7.1	0	There are no spare cables	x	0		
3.7.2	1	Several spare cables from specific to most-critical switches			x	1
3.7.3	2	Several spare cables from all switches				

Table 15 Fault-tolerance maturity calculation

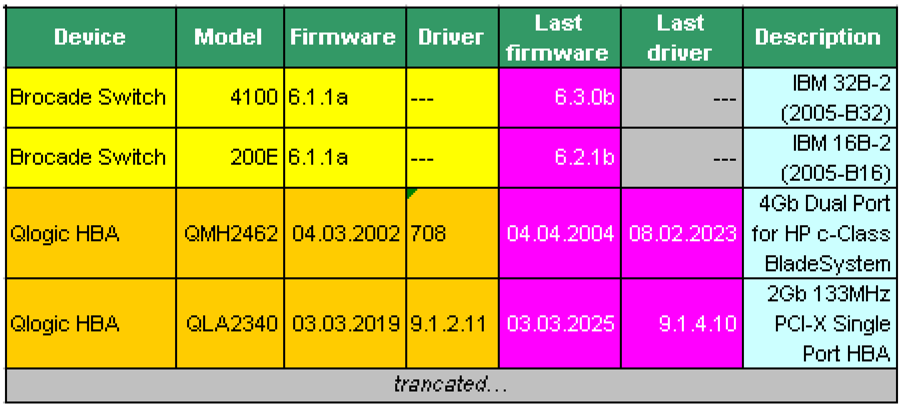
Configuration

Configuration faults and errors

✓ Faults and errors were not detected.

Drivers and firmware

✗ Last versions of drivers and firmware recommended by vendors are not used.



Device	Model	Firmware	Driver	Last firmware	Last driver	Description
Brocade Switch	4100	6.1.1a	---	6.3.0b	---	IBM 32B-2 (2005-B32)
Brocade Switch	200E	6.1.1a	---	6.2.1b	---	IBM 16B-2 (2005-B16)
Qlogic HBA	QMH2462	04.03.2002	708	04.04.2004	08.02.2023	4Gb Dual Port for HP c-Class BladeSystem
Qlogic HBA	QLA2340	03.03.2019	9.1.2.11	03.03.2025	9.1.4.10	2Gb 133MHz PCI-X Single Port HBA
trancated...						

Zoning

✗ Some zones are created without aliases.

✗ Aliases and zones naming convention are not defined.

✗ Same aliases, zones, and ZoneSet names in different fabrics.

✗ Dead zones and hanging aliases were detected.

✓ All zones contain only WWNs

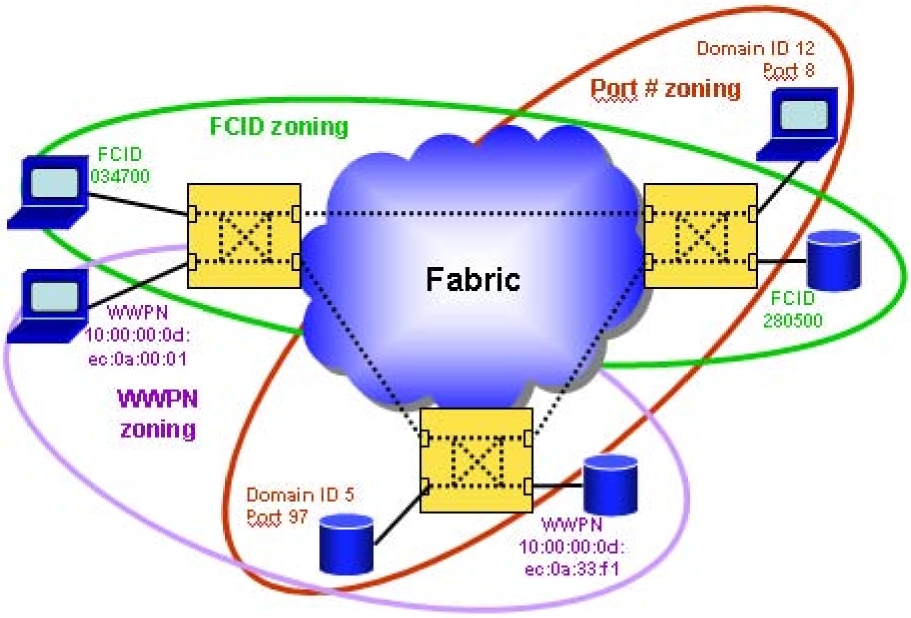


Figure 20 Zones on deferent types of end-device addressing

✓ All Zones contain only initiator.

Configuration destabilizing fabrics

✦ There are three important rules which everybody should follow during SAN design:

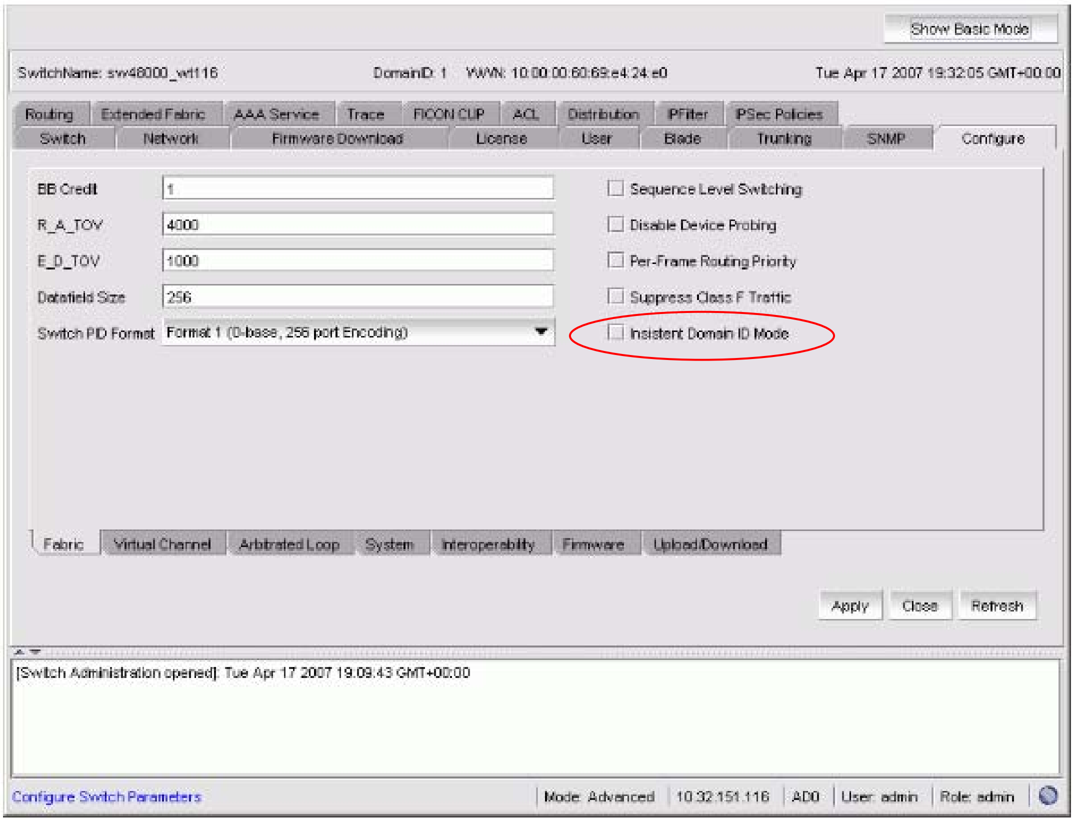
- no more when 5 hops between switches
- number of switches in fabric has to be < 55
- number of N_ports in fabric has to be < 6000

If these rules are broken, in some cases fabric can be unstable and data transfer performance low.

✓ All fabrics follow these rules.

Domain IDs

✗ Domain IDs are not insistent.



SwitchName: sw48000_wt116 DomainID: 1 WWN: 10:00:00:60:69:e4:24:e0 Tue Apr 17 2007 19:32:05 GMT+00:00

BB Credit: 1

R_A_TOV: 4000

E_D_TOV: 1000

Datafield Size: 256

Switch PID Format: Format 1 (0-base, 256 port Encoding)

□ Sequence Level Switching

□ Disable Device Probing

□ Per-Frame Routing Priority

□ Suppress Class F Traffic

□ Insistent Domain ID Mode

[Switch Administration opened]: Tue Apr 17 2007 19:09:43 GMT+00:00

Configure Switch Parameters | Mode: Advanced | 10.32.151.116 | AD0 | User: admin | Role: admin

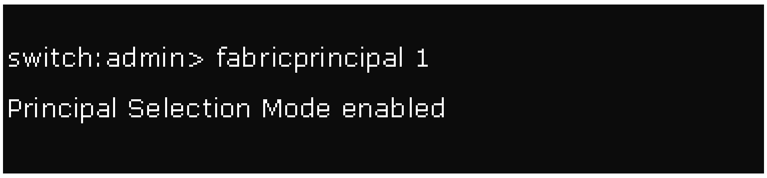
Figure 21 Insistent Domain ID option in Web Tools

✗ Domain IDs are not unique in different fabrics. Domain ID numbering convention didn't develop.

Principal Switch

✗ Principal Selection Mode is not used. In fabrics, inappropriate switches are principal.

✦ To enable Principal Selection Mode, use *fabricprincipal* FOS command.



```
switch:admin> fabricprincipal 1
Principal Selection Mode enabled
```

ISL aggregation

✓ Trunking licenses are installed on Site2_2_Up, Site1_7_Up, Site1_3_Up, Site2_2_Low, Site1_7_Low, Site1_3_Low.

✗ Distance difference between two redundant links is too high to create trunks Site1_7_Up-Site1_7_Low and Site2_2_Up-Site2_2_Low.

Routing

According to requirements for SnapMirror remote replication between IBM System Storage N5300 (OEM NetApp) disk arrays, the following configuration changes on all switches in fabrics Upper and Lower were made:

- Port-Based routing
- IOD (In Order Delivery) option enabled
- QOS (Quality of Service) option disabled

✗ Port-Based routing is less efficient in comparison with Exchange-Based routing.

Time and time zone settings

✓ Time settings look correct in all switches.

✗ Ntp synchronization is not configured.

Configuration switch

✓ Configuration changes are made only from principal switches.

EMC support

✓ All switches are supported by EMC.

Configuration recommendations

№	Configuration problem description and recommendations			
C1	**Severity**	Medium	**Description**	Last versions of drivers and firmware recommended by vendors are not used
	Recommendation	Upgrade drivers and firmware to recommended versions		
	Implementation level	Medium	**Resources**	SAN, storage, and server administrator's work
C2	**Severity**	High	**Description**	Principal Selection Mode is not used
	Recommendation	Set up Principal Selection option on core switches in logical center of the fabrics		
	Implementation level	Low	**Resources**	SAN administrator's work
C3	**Severity**	Medium	**Description**	Dead zones and hanging aliases were detected
	Recommendation	Clean dead zones and hanging aliases from configuration		
	Implementation level	Low	**Resources**	SAN administrator's work
C4	**Severity**	Medium	**Description**	Some zones are created without Aliases
	Recommendation	Recreate zones with Aliases		
	Implementation level	Low	**Resources**	SAN administrator's work
C5	**Severity**	Medium	**Description**	Aliases and Zones naming convention is not defined
	Recommendation	Define and accept Aliases and Zones formal naming convention		
	Implementation level	Medium	**Resources**	SAN administrator's work
C6	**Severity**	Low	**Description**	There are same Aliases, Zones, and ZoneSet names in different fabrics
	Recommendation	Avoid using same Aliases, Zones, and ZoneSet names in different fabrics in the future		
	Implementation level	Low	**Resources**	SAN administrator's work
C7	**Severity**	High	**Description**	Domain IDs are not insistent
	Recommendation	Configure insistent Domain IDs		
	Implementation level	Medium	**Resources**	SAN administrator's work
C8	**Severity**	Low	**Description**	Domain IDs are not unique in different fabrics
	Recommendation	Develop Domain ID numbering convention and follow it in the future		
	Implementation level	Low	**Resources**	SAN administrator's work
C9	**Severity**	Medium	**Description**	Ntp synchronization is not configured
	Recommendation	Configure synchronization with ntp server		
	Implementation level	Low	**Resources**	SAN administrator's work

Table 16 Configuration recommendations

Configuration maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
4		**Factor Configuration value**	-	1,6	-	2,9
4.1		**Naming conventions**		**0**		**3**
		Aliases, Zones, and ZoneSets conventions				
4.1.1	0	There are no naming conventions	x	0		
4.1.2	1,5	Naming conventions are defined but not formally accepted				
4.1.3	2	Naming conventions are defined and formally accepted				
4.1.4	3	Very strict control on naming according to formalized conventions			x	3
4.2		**Dead zones and hanging aliases**		**0**		**3**
		Unused zones and aliases on not connected end-devices				
4.2.1	0	Both dead zones and hanging aliases are detected	x	0		
4.2.2	1	Only dead zones are detected				
4.2.3	2	Only hanging aliases are detected				
4.2.4	3	Dead zones and hanging aliases are not detected or their number is reasonable			x	3
4.3		**Static Domain ID**		**0**		**3**
		Static (insistent) Domain ID configuration				

4.3.1	0	Domain IDs on all switches are dynamic	x	0		
4.3.2	1,5	Some domain IDs are static				
4.3.3	3	All domain IDs are static			x	3
4.4		**Domain ID uniqueness**		**2**		**3**
		Same Domain IDs in different fabrics (VSANs)				
4.4.1	2	Same Domain IDs are detected	x	2		
4.4.2	3	All domain IDs are unique			x	3
4.5		**Aliases and Zones uniqueness**		**2**		**3**
		Same Aliases and Zones in different fabrics (VSANs)				
4.5.1	2	Same Aliases and Zones are detected	x	2		
4.5.2	3	All Aliases and Zones are unique			x	3
4.6		**Single initiator**		**3**		**3**
		Only one HBA in Zones				
4.6.1	0	Zones with several initiators are detected				
4.6.2	3	All Zones contain single initiator or there are exceptions approved by storage vendor	x	3	x	3
4.7		**Principal switch**		**0**		**3**
		Principal switch selection				
4.7.1	0	Principal switch selection isn't controlled by Brocade Principal Selection Mode or Cisco Priorities	x	0		
4.7.2	1,5	Brocade Principal Selection Mode or Cisco Priorities are used but principal switch not located in the logical center of fabric				
4.7.3	3	Brocade Principal Selection Mode or Cisco Priorities are used and principal switch located in the logical center of fabric			x	3
4.8		**Destabilized fabrics**		**3**		**3**
		Rules on maximum number of ISL hops, switches, and N-ports				
4.1.1	0	Dangerous maximums are reached				
4.1.2	3	Dangerous maximums are not reached	x	3	x	3
4.9		**Aliases usage**		**1**		**3**
		Aliases in Zoning configuration				
4.9.1	1	Some Zones are configured without aliases	x	1		
4.9.2	3	All Zones are configured with aliases			x	3
4.10		**Addressing in Zoning configuration**		**3**		**3**
		WWNs and port numbers in Zones				
4.10.1	0	Some zones contain both WWNs and ports				
4.10.2	1,5	All zones contain only port numbers				
4.10.3	3	All zones contain only WWNs	x	3	x	3
4.11		**Errors**		**3**		**3**
		Errors and faults in logs				
4.11.1	0	Critical errors and faults are detected				
4.11.2	1	Non-critical errors and faults are detected				
4.11.3	3	Errors and faults are not detected	x	3	x	3
4.12		**Firmware and drivers**		**2**		**3**
		Versions of HBA drivers and switches firmware				
4.12.1	0	Drivers or firmware are very old				
4.12.2	2	Drivers or firmware versions of some HBAs or switches don't correspond to vendor's recommendations	x	2		
4.12.3	3	All drivers and firmware versions correspond to vendor's recommendations			x	3
4.13		**Time**		**2**		**3**
		Time and time zone settings				
4.13.1	0	Time or time zone settings in some switches are incorrect				
4.13.2	2	Time or time zone settings are correct in all switches, ntp synchronization is not used or used only in several switches	x	2		
4.13.3	3	Synchronization with ntp server configured in all switches			x	3
4.14		**Configuration switch**		**0**		**2**
		Switch from where configuration changes made				
4.14.1	0	Configuration changes are made from any of the switches	x	0		
4.14.2	2	Configuration changes are made only from principal switches			x	2

4.15		**EMC support**		**3**		**3**
		Switches in fabric are not supported by EMC				
4.15.1	0	Switches not supported by EMC are detected				
4.15.2	3	All switches are supported by EMC	x	3	x	3

Table 17 Configuration maturity calculation

Management

Management and monitoring console

✗ Single management console is not used. Management of specific switches is provided with WebTools and telnet.

✗ SAN monitoring is not permanent, but occasional.

Notifications

✗ Incidents and thresholds notifications are not used.

✗ Fabric Watch license installed on Site2_2_Up, Site1_7_Up, Site2_2_Low, Site1_7_Low. Fabric Watch functionality is not used.

Performance and resource utilization reports

✗ Performance and resource utilization reporting is not used.

Future development plan

✗ Currently, there is no clear SAN development plan for the next 2-3 years.

Service Management

During assessment, general approaches of ITSM (IT Service Management) are used.

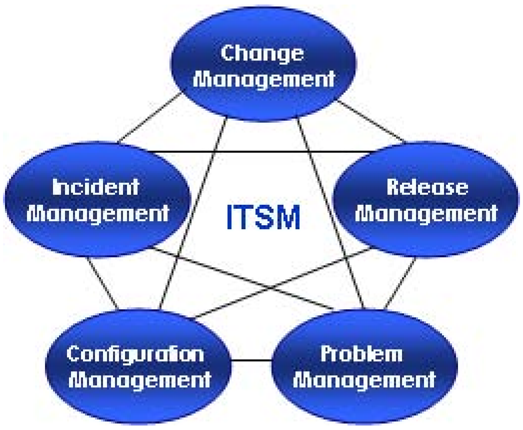


Figure 22 Main ITSM process areas

✗ Data about SAN configuration is only partially described in documents.

✗ CMDB (Configuration Management database) is not implemented.

✗ Change management procedures and tools are not implemented.

✓ Incident Management functionality is implemented by HP Service Desk.

✗ Problem's root cause analysis procedures and tools are not implemented

Access Gateways

✗ Access Gateway functionality is used on 2 HP blades only.

Management style

✗ SAN management style is reactive. Administrators react to problems only when they arise.

Management recommendations

№	Management problem description and recommendations			
M1	**Severity**	High	**Description**	Single management console is not used
	Recommendation	Implement single management console		
	Implementation level	Medium	**Resources**	One of these products: Brocade DCFM , HP StorageWorks, IBM Tivoli Storage Productivity Center, EMC ControlCenter.
M2	**Severity**	High	**Description**	Incidents and thresholds notifications are not used
	Recommendation	Use Fabric Watch functionality on all switches		
	Implementation level	Low	**Resources**	Fabric Watch licenses on some switches and SAN administrator's work
M3	**Severity**	Medium	**Description**	Performance and resource utilization reporting is not used
	Recommendation	Implement regular reporting of current performance and resource utilization		
	Implementation level	Medium	**Resources**	Regular SANhealth reporting
M4	**Severity**	High	**Description**	There is no clear SAN development plan
	Recommendation	Develop future SAN development strategy and plan		
	Implementation level	Medium	**Resources**	SAN architect's work
M5	**Severity**	Medium	**Description**	ITSM procedures and tools are only partially implemented
	Recommendation	Implement CMDB, change, and problem management procedures and tool		
	Implementation level	High	**Resources**	CMDB and other tools, management and SAN architect's work on procedures development
M6	**Severity**	Medium	**Description**	Access Gateway functionality is used on 2 HP blades only
	Recommendation	Configure Access Gateway functionality on all switches		
	Implementation level	Medium	**Resources**	SAN and servers administrator's work

Table 18 Management recommendations

Management maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
5		**Factor Management value**	-	0,3	-	2,2
5.1		**Management style**		**0**		**3**
		Management and provisioning style				
5.1.1	0	Administrators react to problems as they arise (Reactive style)	x	0		

5.1.2	1	Administrators monitor the current state on a regular basis to spot problems, resource provisioning only on direct request (Casually Observant style)				
5.1.3	2	Administrators monitor the current and past state of the environment, resource provisioning on achieved thresholds (Actively Observant style)				
5.1.4	3	Administrators monitor the current and past end-to-end state of the environment, proactive resource provisioning on historical trends (Proactive style)			x	3
5.2		**Single console**		**0**		**3**
		Single tool for monitoring and management of whole SAN				
5.2.1	0	There is no single console	x	0		
5.2.2	1	Single console for monitoring only				
5.2.3	2	Single console for management only				
5.2.4	3	Single console for monitoring and management			x	3
5.3		**Configuration management**		**0**		**2**
		Configuration items tracking (CMDB)				
5.3.1	0	Configuration management procedures and tools are not implemented	x	0		
5.3.2	1	Configuration management procedures and manual tools are implemented				
5.3.3	2	Configuration management procedures and automatic tools are implemented			x	2
5.3.4	3	Configuration management procedures and federated automatic tools are implemented				
5.4		**Change management**		**0**		**2**
		Efficient handling of all changes				
5.4.1	0	Change management procedures and tools are not implemented	x	0		
5.4.2	1	Change management procedures and manual tools are implemented				
5.4.3	2	Change management procedures and automatic tools are implemented			x	2
5.4.4	3	Change management procedures and federated automatic tools are implemented				
5.5		**Incident management**		**1**		**2**
		Incident registration and analysis				
5.5.1	0	Incident management procedures and tools are not implemented				
5.5.2	1	Incident management procedures and manual tools are implemented	x	1		
5.5.3	2	Incident management procedures and automatic tools are implemented			x	2
5.5.4	3	Incident management procedures and federated automatic tools are implemented				
5.6		**Problem management**		**0**		**1**
		Problem's root cause analysis				
5.6.1	0	Problem management procedures and tools are not implemented	x	0		
5.6.2	1	Problem management procedures and manual tools are implemented			x	1
5.6.3	2	Problem management procedures and automatic tools are implemented				
5.6.4	3	Problem management procedures and federated automatic tools are implemented				
5.7		**Use of automatic notifications**		**0**		**3**
		Incidents and thresholds notifications				
5.7.1	0	Notifications are not used	x	0		
5.7.2	1	Notifications are used on part of the switches				
5.7.3	2	Notifications are used on the most important switches				
5.7.4	3	Notifications are used on all switches in fabric			x	3
5.8		**Type of automatic notification**		**0**		**0**
		Types of notifications distribution				
5.8.1	0	Notifications are not distributed	x	0	x	0
5.8.2	1	Notifications are distributed on schedule by email only				
5.8.3	2	Notifications are distributed immediately after incident by email only				
5.8.4	3	Notifications are distributed immediately after incident by email and sms				
5.9		**Resource utilization reporting**		**0**		**2**
		Reports about switch utilization and free capacity				

5.9.1	0	Reporting is not used	x	0		
5.9.2	1	Reports are created manually (without special tools) on demand				
5.9.3	2	Reports are created by special tools on demand			x	2
5.9.4	3	Reports are regularly automatically created by special tools				
5.10		**Performance reporting**		**0**		**2**
		Reports about switch performance				
5.10.1	0	Reporting is not used	x	0		
5.10.2	1	Reports are created manually (without special tools) on demand				
5.10.3	2	Reports are created by special tools on demand			x	2
5.10.4	3	Reports are regularly automatically created by special tools				
5.11		**Future development plan**		**0**		**3**
		SAN development plan over next 3 years				
5.11.1	0	Development plan absent or administrators don't know about it	x	0		
5.11.2	1	There is informal (not formally accepted by management) development plan of some SAN subsystems				
5.11.3	2	There is formal development plan of some SAN subsystems				
5.11.4	3	There is formal development plan of whole SAN			x	3
5.12		**NPV/Access Gateway**		**2**		**3**
		Usage of NPV or Access Gateway functionality				
5.12.1	0	NPV/Access Gateway functionality is not used with blade servers				
5.12.2	2	NPV/Access Gateway functionality is used with part of blade servers	x	2		
5.12.3	3	NPV/Access Gateway functionality is used with all blade servers			x	3

Table 19 Management maturity calculation

Performance

Transfer rates

- Only 2Gbps and 4Gbps SFPs are used.

Oversubscription

Both switch and ISL oversubscriptions are considered.

Switch oversubscription is an internal performance characteristic of switch ports. It depends on switch or line card architecture and is equal to the ratio of the sum of front-end ports’ transfer rates to aggregated rate of internal switching channels of this group:

$$\mathbf{Oversubscription}_{\mathbf{Switch}} = \frac{\sum_{\mathbf{Group}} \mathbf{TranferRate}_{\mathbf{Port}}}{\sum_{\mathbf{Group}} \mathbf{TransferRate}_{\mathbf{Back-end}}}$$

Switches and linecards with oversubscription >= 1,5:1 have better “price / performance” and should be used for servers’ connections. Ports with oversubscription < 1,5:1 provide superior performance and should be used for ISL and storage connections.

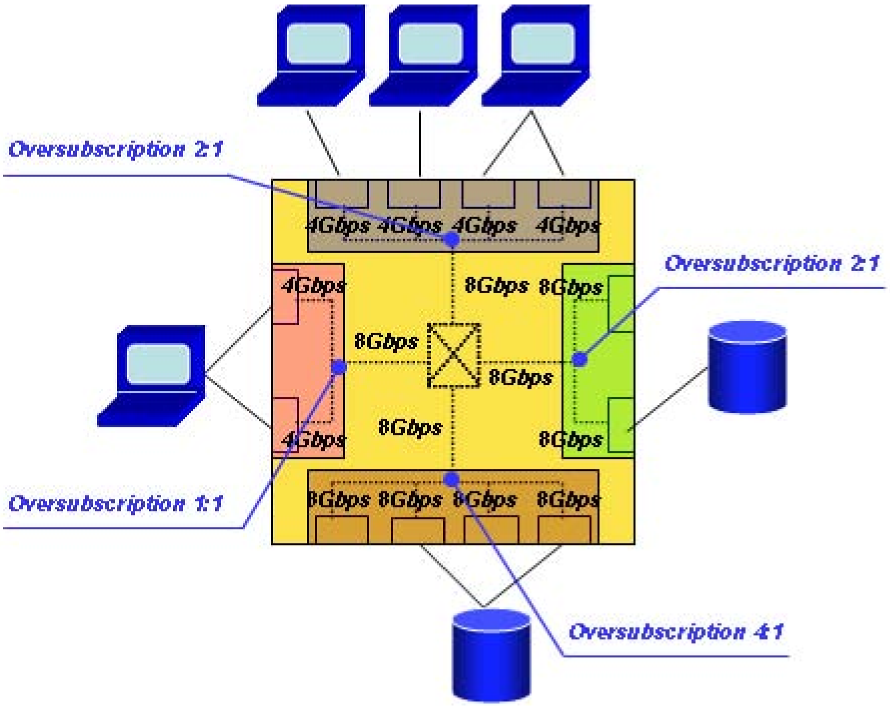


Figure 23 Switch oversubscription

✓ All switches are built on one ASIS. That means oversubscription equals 1:1.

ISL oversubscription is the characteristic of switch performance from an end-devices load to ISLs perspective. It is equal to the ratio of the sum of all end-devices transfer rates to aggregated rate of all ISLs.

$$\text{Oversubscription}_{\text{ISL}} = \frac{\sum \text{TranferRate}_{\text{EndDevice}}}{\sum \text{TransferRate}_{\text{ISL}}}$$

Optimal ISL oversubscription has to be in 6:1 - 12:1 range.

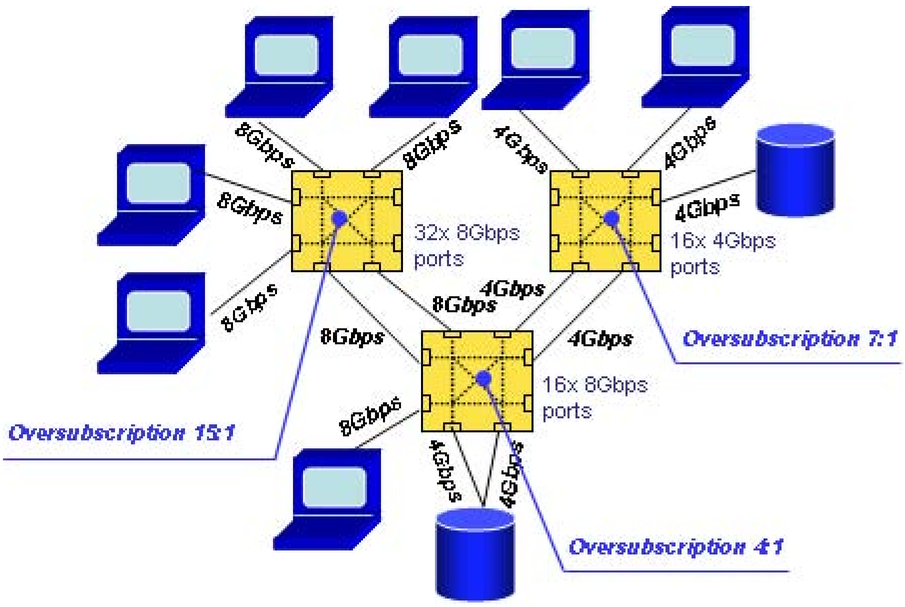


Figure 24 ISL oversubscription

ISL oversubscription is shown in Table 20. Maximum value is 8:1.

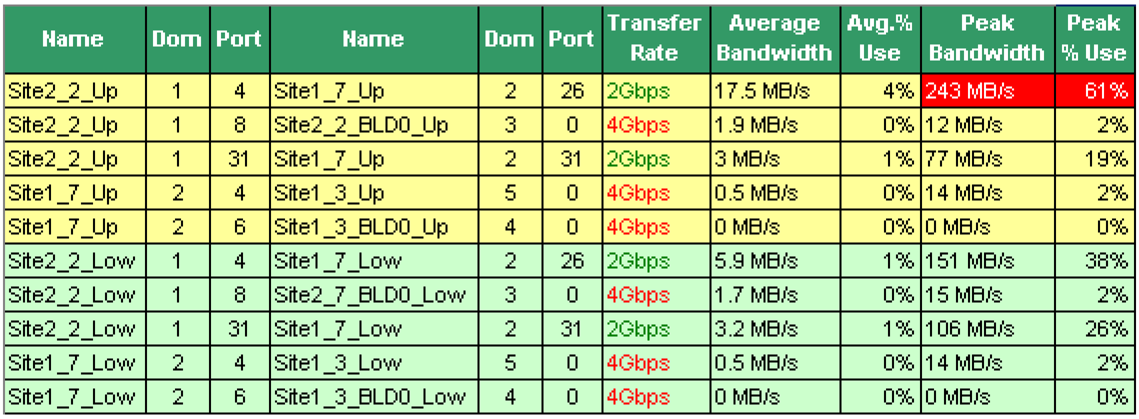
Switch Name	ISLs	Attached Device Types			Fan-out	ISL oversubscription
		Disk	Tape	Host		
Site2_2_Up	3	5	2	15	2.14:1	7.33:1
Site1_7_Up	4	5	2	13	1.86:1	5:01
Site2_2_BLD0_Up	1	0	0	4	4:00	4:01
Site1_3_BLD0_Up	1	0	0	8	8:00	8:01
Site1_3_Up	1	1	0	2	2:01	3:01
Site2_2_Low	3	5	2	15	2.14:1	7.33:1
Site1_7_Low	4	5	2	13	1.86:1	5:01
Site2_7_BLD0_Low	1	0	0	4	4:00	4:01
Site1_3_BLD0_Low	1	0	0	8	8:00	8:01
Site1_3_Low	1	1	0	2	2:01	3:01

Table 20 ISL oversubscription

✘ Redundant ISLs are not aggregated.

ISL utilization

ISL utilization and bandwidth are shown in Table 21.



Name	Dom	Port	Name	Dom	Port	Transfer Rate	Average Bandwidth	Avg.% Use	Peak Bandwidth	Peak % Use
Site2_2_Up	1	4	Site1_7_Up	2	26	2Gbps	17.5 MB/s	4%	243 MB/s	61%
Site2_2_Up	1	8	Site2_2_BLD0_Up	3	0	4Gbps	1.9 MB/s	0%	12 MB/s	2%
Site2_2_Up	1	31	Site1_7_Up	2	31	2Gbps	3 MB/s	1%	77 MB/s	19%
Site1_7_Up	2	4	Site1_3_Up	5	0	4Gbps	0.5 MB/s	0%	14 MB/s	2%
Site1_7_Up	2	6	Site1_3_BLD0_Up	4	0	4Gbps	0 MB/s	0%	0 MB/s	0%
Site2_2_Low	1	4	Site1_7_Low	2	26	2Gbps	5.9 MB/s	1%	151 MB/s	38%
Site2_2_Low	1	8	Site2_7_BLD0_Low	3	0	4Gbps	1.7 MB/s	0%	15 MB/s	2%
Site2_2_Low	1	31	Site1_7_Low	2	31	2Gbps	3.2 MB/s	1%	106 MB/s	26%
Site1_7_Low	2	4	Site1_3_Low	5	0	4Gbps	0.5 MB/s	0%	14 MB/s	2%
Site1_7_Low	2	6	Site1_3_BLD0_Low	4	0	4Gbps	0 MB/s	0%	0 MB/s	0%

Table 21 ISL utilization

Performance statistics for a whole day were collected during assessment. ISL bandwidth peaks in fabric Upper are shown in Figure 25.

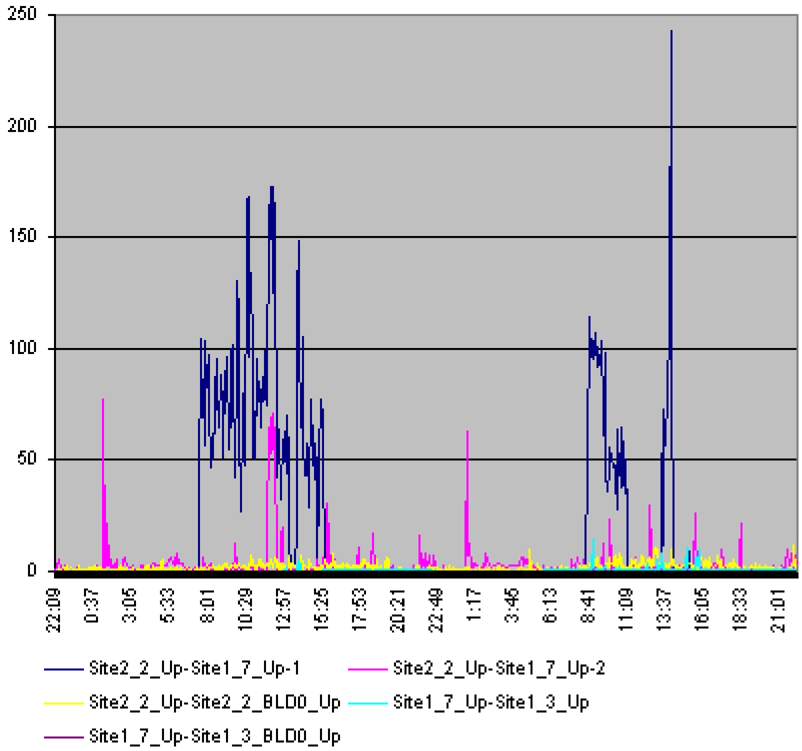


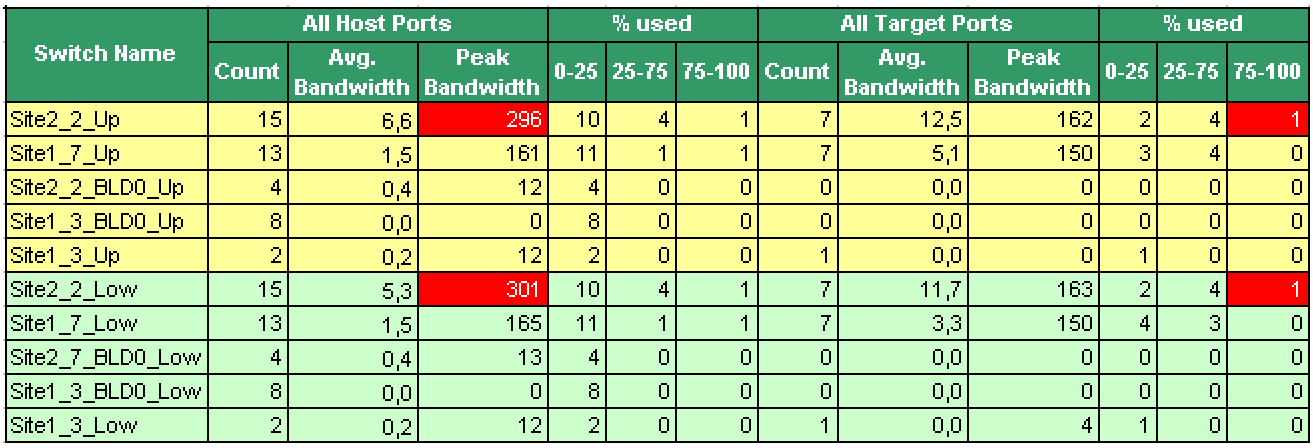
Figure 25 Fabric Upper ISL bandwidth

✘ Site1 and Site2 are connected by two links. Load between these links (blue and magenta lines on the graph) is not well balanced. The main reason is ineffective port-based routing.

✘ Loads between Upper and Lower fabrics are also unbalanced due to sub-optimal host to storage mapping.

End-device links utilization

Aggregated utilization of end-device links is shown in Table 22. High loaded devices are connected to the Site2_2_Up and Site2_2_Low.



Switch Name	All Host Ports			% used			All Target Ports			% used		
	Count	Avg. Bandwidth	Peak Bandwidth	0-25	25-75	75-100	Count	Avg. Bandwidth	Peak Bandwidth	0-25	25-75	75-100
Site2_2_Up	15	6,6	296	10	4	1	7	12,5	162	2	4	1
Site1_7_Up	13	1,5	161	11	1	1	7	5,1	150	3	4	0
Site2_2_BLD0_Up	4	0,4	12	4	0	0	0	0,0	0	0	0	0
Site1_3_BLD0_Up	8	0,0	0	8	0	0	0	0,0	0	0	0	0
Site1_3_Up	2	0,2	12	2	0	0	1	0,0	0	1	0	0
Site2_2_Low	15	5,3	301	10	4	1	7	11,7	163	2	4	1
Site1_7_Low	13	1,5	165	11	1	1	7	3,3	150	4	3	0
Site2_7_BLD0_Low	4	0,4	13	4	0	0	0	0,0	0	0	0	0
Site1_3_BLD0_Low	8	0,0	0	8	0	0	0	0,0	0	0	0	0
Site1_3_Low	2	0,2	12	2	0	0	1	0,0	4	1	0	0

Table 22 End-device links utilization

Maximum bandwidth on Site2_2_Up is generated by these ports:

- disk array DS8100-TXT port IO303;
- backup server BSGV-TSM02 ports 2 and 3;
- tape library TS3584-TEXT ports 1 and 2.

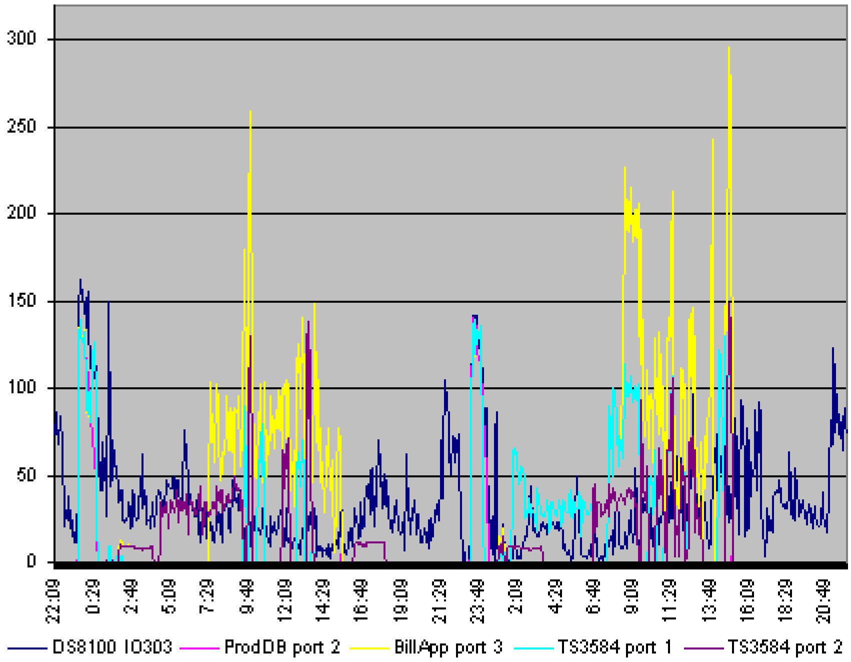


Figure 26 Site2_2_Up end-device links bandwidth

✗ Performance Monitor license is installed on Site2_2_Up, Site1_7_Up, Site2_2_Low, Site1_7_Low, Pre_Name_Site2_Up, Pre_Name_Site1_Up, Pre_Name_Site2_Up and Pre_Name_Site1_Up. Advance performance monitoring features are currently not used.

Long distance

✘ Extended Fabric license is installed on Site2_2_Up, Site1_7_Up, Site1_3_Up, Pre_Name_Site2_Up, Pre_Name_Site1_Up, Site2_2_Low, Site1_7_Low, Pre_Name_Site2_Up, Pre_Name_Site1_Up and Site1_3_Low. But there is no need of this license on Site1_3_Up и Site1_3_Low.

✘ According to requirements to SnapMirror remote replication between disk arrays, IBM System Storage N5300 (OEM NetApp) on ports of Site2_2_Up, Site1_7_Up, Site2_2_Low and Site1_7_Low static long distance mode LS 40km is configured. This value is too high and wastes internal resources of switches.

Performance recommendations

№	Performance problem description and recommendations			
P1	Severity	Medium	Description	There is load imbalance between two links Site1–Site2 in each fabric Loads between Upper and Lower fabrics are unbalanced
	Recommendation	Develop and implement configuration for more effective load sharing in and between fabrics		
	Implementation level	High	Resources	SAN architect’s and administrator’s work
P2	Severity	Low	Description	Advance performance monitoring features are not used
	Recommendation	Use Performance Monitor functionality		
	Implementation level	Low	Resources	SAN administrator’s work
P3	Severity	Low	Description	On ports of Site2_2_Up, Site1_7_Up, Site2_2_Low and Site1_7_Low static long distance mode LS 40km is configured
	Recommendation	Configure LS 15km or LD mode on ports		
	Implementation level	Medium	Resources	SAN administrator’s work

Table 23 Performance recommendations

Performance maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
6		**Factor Performance value**	-	1,7	-	2,1
6.1		**ISL utilization**		**3**		**3**
		ISL utilization in terms of bandwidth (MB/s)				
6.1.1	0	Some ISLs are utilized >90 percent				
6.1.2	1,5	Some ISLs are utilized 75-90 percent				
5.1.3	3	All ISL utilization <75 percent	x	3	x	3
6.2		**Long distance**		**3**		**3**
		BB-credits configuration				
6.2.1	0	BB-credits on some ports are not enough				
6.2.2	3	BB-credits on all ports are enough	x	3	x	3
6.3		**Switch oversubscription**		**3**		**3**
		Switch front-end to back-end channels oversubscription				
6.3.1	1,5	Oversubscription of some ports > 1,5:1				
6.3.2	2	Oversubscription of all ports 1:1 - 1,5:1				
6.3.3	3	Oversubscription of all ports = 1:1	x	3	x	3
6.4		**ISL oversubscription**		**2**		**2**
		Oversubscription of end-devices ports to ISLs				
6.4.1	0	Oversubscription of some ISLs > 12:1				

6.4.2	2	Oversubscription of all ISLs 6:1 - 12:1	x	2	x	2
6.4.3	3	Oversubscription of all ISLs < 6:1				
6.5		**ISL transfer rate**		**1**		**1**
		Transfer rates of used ISL				
6.5.1	0	1Gbps or 2Gbps				
6.5.2	1	4Gbps	x	1	x	1
6.5.3	2	8Gbps				
6.5.4	3	12,25Gbps (10GFC)				
6.6		**ISL aggregation**		**0**		**3**
		Brocade trunking or Cisco port channel				
6.6.1	0	Redundant ISLs are not aggregated	x	0		
6.6.2	2	Some redundant ISLs are aggregated				
6.6.3	3	All redundant ISLs are aggregated			x	3
6.7		**Acceleration**		**0**		**0**
		Fast write/Write acceleration and Tape Pipelaning/Tape accelerating functionalities				
6.7.1	0	Fast write/Write acceleration and Tape Pipelaning/Tape accelerating are not used	x	0	x	0
6.7.2	2	Fast write/Write acceleration and Tape Pipelaning/Tape accelerating are used				
6.8		**Traffic localization**		**3**		**3**
		Traffic localization in switches and ASICs				
6.8.1	1,5	Traffic is not localized				
6.8.2	2	Traffic is partially localized inside switches				
6.8.3	3	Traffic is partially localized inside ASICs (for Brocade only)	x	3	x	3
6.9		**Symmetric load**		**0**		**1**
		Load similarity in redundant fabrics				
6.9.1	0	Loads in fabrics don't correlate each other	x	0		
6.9.2	1	There is general correlation between loads in fabrics			x	1
6.9.3	3	Loads in fabrics are very similar				
6.10		**ISLs on oversubscribed ports**		**2**		**2**
		ISLs connected to oversubscribed switch ports				
6.10.1	0	Some ISLs are connected to oversubscribed switch ports				
6.10.2	2	All ISLs are connected to switch port with subscription 1:1	x	2	x	2

Table 24 Performance maturity calculation

Operations

Administration procedures

✗ Everyday SAN and storage administration procedures are not documented.

✗ There are no documents which describe what administrators must do in case of disaster or failures.

✗ Currently, the senior SAN administrator is also responsible for Oracle administration. Because of high load, he doesn't have enough time for effective SAN monitoring and proactive management.

✓ Administrators' experience in SAN management is high.

Education

✗ SAN and storage administrators attend education courses twice a year. However, no education plan has been accepted by the IT management for the next year.

✗ Company's culture doesn't support knowledge transfer on internal workshops.

Backup procedures

✗ Main switches configuration is backed up only once a year. Configuration of some switches was backed up only once during initial installation.

✗ Backup configuration is stored somewhere in administrator desktop.

Testing and change configuration procedures

✓ Before production, all new products and functionalities are tested in special test environment. Testing procedures are documented and accepted by the IT management.

✗ Change configuration procedures are documented and accepted by the IT management but administrators don’t regularly follow them.

Problem escalation procedures

✗ Problem escalation procedures are developed but have yet to be accepted by IT management.

Security audit procedures

✗ SAN audit practice is not implemented. Procedures are not documented.

Operations recommendations

№	Operations problem description and recommendations			
O1	Severity	Medium	Description	Daily SAN and storage administration procedures are not documented.
	Recommendation	Develop and accept procedures		
	Implementation level	Medium	Resources	SAN administrator’s and architect’s work
O2	Severity	High	Description	There are no documents describing what administrators must do in case of disaster or failures
	Recommendation	Develop and accept procedures		
	Implementation level	Medium	Resources	SAN administrator’s and IT management work
O3	Severity	High	Description	There is no configuration backup procedure
	Recommendation	Develop and accept procedures		
	Implementation level	Low	Resources	SAN administrator’s work
O4	Severity	Low	Description	There is no education plan for next year
	Recommendation	Develop and accept education plan		
	Implementation level	Low	Resources	IT management
O5	Severity	Medium	Description	Change configuration procedures are documented and accepted but administrators don’t regularly follow them
	Recommendation	Force procedures execution		
	Implementation level	Medium	Resources	IT management work

O6	**Severity**	Low	**Description**	SAN audit practice is not implemented
	Recommendation	Develop and accept procedures		
	Implementation level	Medium	**Resources**	SAN administrator’s and IT management work
O7	**Severity**	High	**Description**	Procedures of problem escalation are developed but not yet accepted by management
	Recommendation	Force procedures acceptment		
	Implementation level	Low	**Resources**	IT management work

Table 25 Operations recommendations

Operations maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
7		**Factor Operations value**	-	0,9	-	3,0
7.1		**Administration procedures**		**0**		**3**
		Procedures describe FC-switches administration tasks				
7.1.1	0	Procedures are not documented	x	0		
7.1.2	1	Procedures are partially documented				
7.1.3	2	Procedures are fully documented but not formally accepted by management				
7.1.4	3	Procedures are fully documented and formally accepted by management			x	3
7.2		**Change configuration procedures**		**1**		**3**
		Procedures describe configuration changes tasks				
7.2.1	0	Procedures are not documented				
7.2.2	1	Procedures are partially documented or administrators don't follow them	x	1		
7.2.3	2	Procedures are fully documented but not formally accepted by management				
7.2.4	3	Procedures are fully documented and formally accepted by management			x	3
7.3		**Backup procedures**		**0**		**3**
		Procedures of switches’ configuration backup				
7.3.1	0	Procedures are not documented	x	0		
7.3.2	1	Procedures are partially documented				
7.3.3	2	Procedures are fully documented but not formally accepted by management				
7.3.4	3	Procedures are fully documented and formally accepted by management			x	3
7.4		**Testing procedures**		**3**		**3**
		Procedures of pre-production testing for new equipment				
7.4.1	0	Procedures are not documented				
7.4.2	1	Procedures are partially documented				
7.4.3	2	Procedures are fully documented but not formally accepted by management				
7.4.4	3	Procedures are fully documented and formally accepted by management	x	3	x	3
7.5		**Security audit procedures**		**0**		**3**
		Procedures of SAN security audit				
7.5.1	0	Procedures are not documented	x	0		
7.5.2	1	Procedures are partially documented				
7.5.3	2	Procedures are fully documented but not formally accepted by management				
7.5.4	3	Procedures are fully documented and formally accepted by management			x	3
7.6		**Escalation procedures**		**2**		**3**
		Problem escalation procedures				
7.6.1	0	Procedures are not documented				
7.6.2	1	Procedures are partially documented				
7.6.3	2	Procedures are fully documented but not formally accepted by management	x	2		

7.6.4	3	Procedures are fully documented and formally accepted by management			x	3
7.7		**SAN administrators**		**1**		**3**
		Administrators dedicated for SAN administration				
7.7.1	1	SAN administration shared by administrators with other tasks	x	1		
7.7.2	3	There are dedicated SAN administrators			x	3
7.8		**SAN administrators qualification**		**3**		**3**
		Level of professional experience of SAN administrators				
7.8.1	0	Low				
7.8.2	1,5	Medium				
7.8.3	3	High	x	3	x	3
7.9		**Education**		**0**		**3**
		Administrators are educated on SAN administration courses				
7.9.1	0	There is no education plan	x	0		
7.9.2	1,5	There is an education plan but it is not formally accepted by management				
7.9.3	3	There is education plan formally accepted by management			x	3
7.10		**Internal workshops**		**0**		**3**
		Informal knowledge transfer between SAN and storage administrators				
7.10.1	0	Company's culture doesn't support knowledge transfer on internal workshops	x	0		
7.10.2	1,5	Irregular seminars are given				
7.10.3	3	There is a plan of regular workshops			x	3

Table 26 Operations maturity calculation

Security

SAN can be divided into several safety zones.

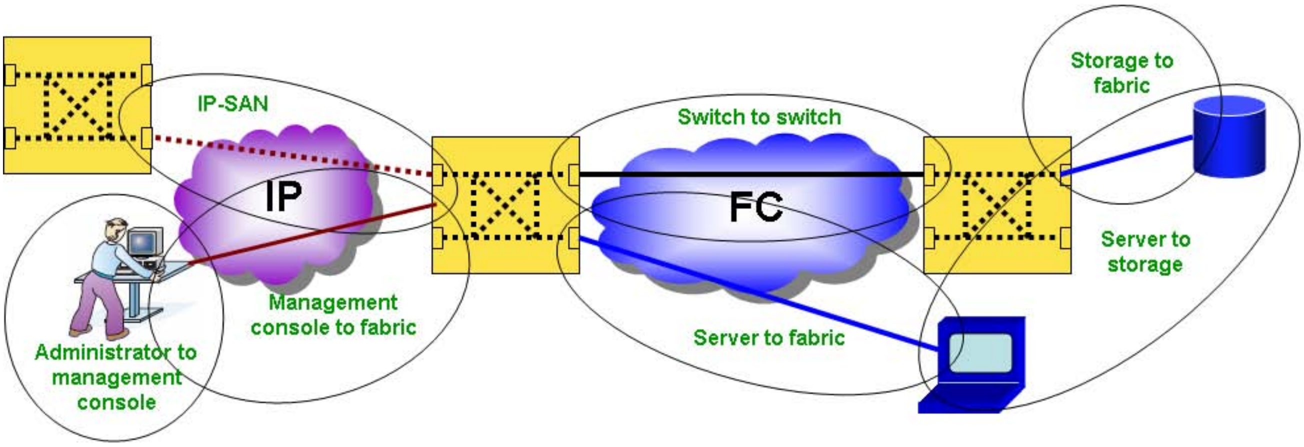


Figure 27 Safety zones

Administrator to management console zone

✘ Currently single management console is not used.

Management console to fabric zone

✘ Switches are accessible only from dedicated management VLAN by protocols telnet and http.

Switch to switch communication zone

✦ Inter-switch communication control is not required.

Server to fabric zone

✓ Persistent binding is configured in most critical servers.

Storage to fabric zone

✓ LUN masking is configured in all disks arrays.

Server to storage zone

✓ Hard zoning based on WWPNs only is used.

IP-SAN zone

✦ There is no IP-SAN traffic in the SAN.

Users

✗ Switches are not integrated with corporate MS Active Directory.

✗ Default user admin is used to log in to the switches.

✗ On some switches, default password for user admin is used.

✗ There is no obligatory procedure to change users' passwords.

✓ List of passwords in all switches are regularly printed out and stored in a safe.

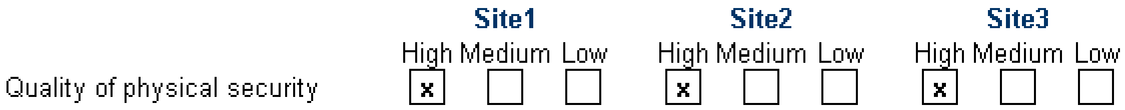
Port security

✗ Transfer rate and mode autonegotiation is used in all ports. Unused ports are in online state.

Physical access

✓ Physical access to server room where switches are located is controlled by special automated system and restricted to administrators only.

✓ Temporary access for engineers who are not employees must be controlled by administrators.



	Site1			Site2			Site3		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Quality of physical security	☒	□	□	☒	□	□	☒	□	□

Figure 28 Physical access

✓ CCTV cameras are installed in all server rooms. Video is saved for long-term.

Security recommendations

№	Security problem description and recommendations			
S1	Severity	Medium	Description	Switches are accessible only from dedicated management VLAN by protocols telnet and http
	Recommendation	Force to use secured protocols https and ssh		
	Implementation level	Low	Resources	SAN administrator's work
S2	Severity	Low	Description	Free ports are in online state
	Recommendation	Manually disable unused ports		
	Implementation level	Medium	Resources	SAN administrator's work
S3	Severity	Medium	Description	To log in to the switches, default user admin is used
	Recommendation	Configure role-based access to switches and use non-default users		
	Implementation level	Low	Resources	SAN administrator's work
S4	Severity	Medium	Description	On some switches, default password for user admin is used There is no obligatory procedure to change users' passwords
	Recommendation	Develop procedure for regular password change		
	Implementation level	Low	Resources	SAN administrator's work
S5	Severity	Medium	Description	Switches are not integrated with corporate MS Active Directory
	Recommendation	Configure role-based access by integration with MS Active Directory		
	Implementation level	Low	Resources	SAN and system administrator's work

Table 27 Security recommendations

Security maturity level calculation

№	Cost	Characteristics and variants of state	Current state	Current value	Target state	Target value
8		**Factor Security value**	-	0,9	-	1,9
8.1		**Administrator to management console access**		**0**		**3**
		Control of network access to management console				
8.1.1	0	Console is accessible from users' LAN by unsecured protocols (http, telnet) or there is no console	x	0		
8.1.2	1	Console is accessible from users' LAN only by secured protocols (ssh, https)				
8.1.3	2	Console is accessible only from dedicated management VLAN by unsecured protocols				
8.1.4	3	Console is accessible only from dedicated management VLAN by secured protocols			x	3
8.2		**Management console to fabric access**		**2**		**3**
		Control of network access to switches				
8.2.1	0	Switches are accessible from users' LAN by unsecured protocols (http, telnet) or there is no console				
8.2.2	1	Switches are accessible from users' LAN only by secured protocols (ssh, https)				
8.2.3	2	Switches are accessible only from dedicated management VLAN by unsecured protocols	x	2		
8.2.4	3	Switches are accessible only from dedicated management VLAN by secured protocols			x	3
8.3		**Inter-switch communication**		**0**		**0**
		Control of communication between switches				
8.3.1	0	There are no controls	x	0	x	0
8.3.2	1	ACLs are used				
8.3.3	2	Traffic encryption is used				
8.3.4	3	Authentication control by FCAP or DHCHAP protocols, ACLs are used, traffic encryption is used				
8.3		**Server to fabric traffic**		**1**		**1**
		Control of communication between servers and switches				
8.3.1	0	There are no controls				
8.3.2	1	Persistent binding is used	x	1	x	1

8.3.3	2	Persistent binding and ACLs are used				
8.3.4	3	Persistent binding, RADIUS or TACACS+ protocols, and DHCHAP authentication are used				
8.3		**Storage to switch traffic**		**1**		**1**
		Control of communication between storage and switches				
8.3.1	0	There are no controls				
8.3.2	1	LUN masking is used	x	1	x	1
8.3.3	2	LUN masking and ACLs are used				
8.3.4	3	LUN masking, RADIUS or TACACS+ protocols, and DHCHAP authentication are used				
8.4		**Server to storage communication**		**3**		**3**
		Control of communication between storage and servers				
8.7.1	0	Zoning is not used				
8.7.2	1,5	Soft enforced zoning used				
8.7.3	3	Hard enforced zoning used	x	3	x	3
8.5		**IP-SAN security**		**0**		**0**
		Control of communication on protocols iSCSI and FCIP				
8.5.1	0	IPsec is not used or IP-SAN is not implemented	x	0	x	0
8.5.2	3	IPsec is used				
8.6		**Port security**		**0**		**2**
		Communication control on ports level				
8.6.1	0	Unused ports are enabled	x	0		
8.6.2	2	All unused ports are disabled			x	2
8.7		**Passwords**		**0**		**3**
		Passwords management				
8.7.1	0	Default passwords are used	x	0		
8.7.2	1,5	Default passwords were changed				
8.7.3	3	Passwords are changed regularly			x	3
8.8		**Users**		**0**		**3**
		Users access control				
8.8.1	0	Default users with administrator privileges (admin) are used	x	0		
8.8.2	1	Non-default users with administrator privileges are used for all activities				
8.8.3	2	Role-based access (RBAC) is used				
8.8.4	3	User’s access control integrated with active directory			x	3
8.9		**Physical access**		**3**		**3**
		Control of physical access to SAN equipment				
8.10.1	0	Access is not controlled				
8.10.2	1	Access is controlled by formal administrative method only				
8.10.3	2	Access is controlled by special security devices and formal administrative method				
8.10.4	3	Access is controlled by special security devices, video control, and formal administrative method	x	3	x	3

Table 28 Security maturity calculation

Results

Now we have to combine current “as is” and target “to do” values for all considered factors.

Factors	Current value	Target value	Gap
Architecture	1,2	1,8	good
Physical state	1,8	2,9	bad
Fault-tolerance	1,7	2,4	good
Configuration	1,6	2,9	bad
Performance	1,7	2,1	good
Management	0,3	2,2	worst
Operations	0,9	3,0	worst
Security	0,9	1,9	bad

Table 29 Current and target maturity levels in ABC Company

Spider Diagram visualizes maturity of SAN in multidimensional perspective.

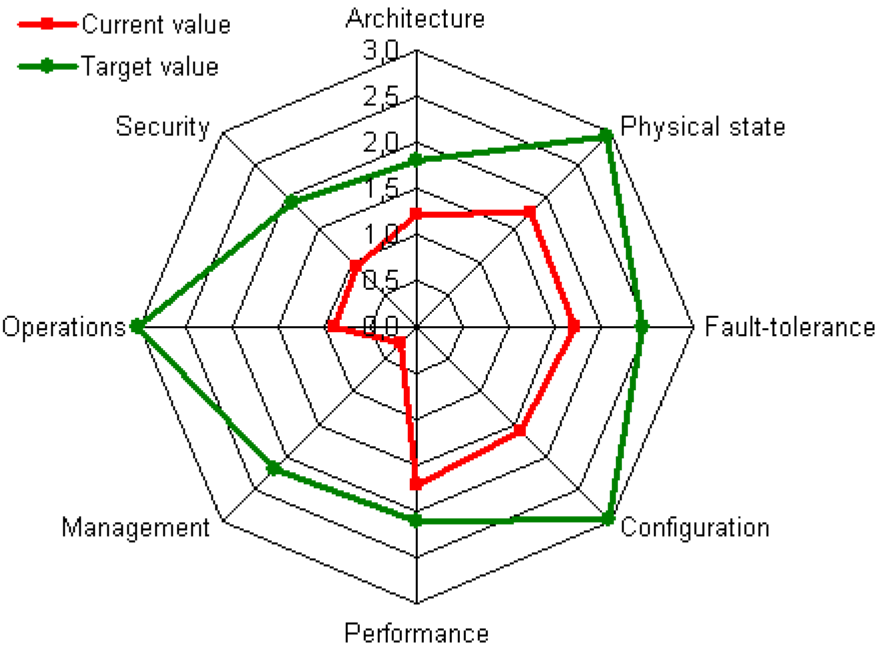


Figure 29 Maturity spider diagram in ABC Company

We can conclude that current state of factors Architecture, Fault-tolerance, and Performance is very close to the ideal target. The customer should make some minor changes to improve these factors.

The factors Physical state, Configuration, and Security are far from perfect conditions. Customer needs to be aware of them and must find time and resources for improvement.

Management and Operations are in the worst state and require forcing serious efforts to achieve acceptable condition.

Specific improvement recommendations are already done in corresponding sections of this document. Next steps are:

- Generally consider all pros and cons of all target architectures and choose one of them which better fit ABC Company's future requirements and available resources.
- Consider what additional functionalities ABC Company will need in the next 2-3 years (e.g. NPIV virtualization for VMware, virtual fabrics to separate test/dev and production environments, and so forth)
- Design in details of all specific subsystems (data center infrastructure, distance between sites, switch models, SFPs types, number of ISLs, and so on).
- Combine the given recommendations and other actions required to achieve target architecture in bigger blocks of activities which can be considered as a reasonable number of medium size separate projects.
- Estimate required efforts and resources for each project. Be aware of the budget!
- Create detailed step-by-step design for projects implementation.
- Accurately schedule the projects for the next year. Plan the order, in general, of projects in Years 2 and 3.
- Go… and good luck!

Conclusion

3D SAN assessment is the best–and sometimes the only–way to investigate all aspects of a customer's storage area network. The main result is the clear understanding of what happens in the environment now and what the customer can expect in the future. Optimization findings and localization of potential issues help to improve infrastructure and avoid serious problems.

Detailed design of the target architecture allows defining a step-by-step roadmap for the next couple of years. Regular assessments provide the opportunity to check how insistent the customer is on the way to that target and correct stages or even whole architecture according to company changes in real life.