

# Department of Computing Science University of Alberta

MINT 709 Master of Science in Internetworking

Virtualization Performance Analysis

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Submitted To :

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Title:

#### **Virtualization Performance Analysis**

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#### LIST OF SYMBOLS AND ABBREVIATIONS

- MPLS Multi-Protocol label switching
- SAN Storage Area Network
- VNC Virtual Network Computing
- VPN Virtual Private Network
- FTP File Transfer Protocol
- iSCSI Internet Small Computer Systems Interface
- OS Operating System
- CentOS Community Enterprise Operating System
- NFS Network File System
- SMB Server Message Block
- LDAP Lightweight Directory Access Protocol
- BGP Border Gateway Protocol
- IGP Interior Gateway Protocol

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#### **EXECUTIVE SUMMARY**

This report is to present "Virtual Server Performance Analysis over an MPLS Network". It compares the server's CPU and network performance under normal load and high load. It also aims to explain the basics along with the performance of SANs from a customer perspective. It also goes through overall configuration including security. A part of this report sheds light on benchmarking. Some of the other parts briefly discuss the Openfiler Operating System.

# **1.0 INTRODUCTION**

This report contains the results achieved after configuring virtual servers over an MPLS network through utilization of tools like iozone and the built-in performance reporting mechanism in ESXI-4.1. It also demonstrates several physical server specifications, virtual server specifications, SAN configurations, performance analysis and benchmarking.

This report includes an analysis of network performance under normal conditions and when a large amount of data is being transferred. It explains the use of MPLS/VPN and sham link with emphasis on SANs and the basic configuration of the Openfiler OS.

### **1.1 Server Specifications**

The servers used in my tests are as specified in Table 1, Figure 1 and Figure 2.

Feature	Server-PE-1	Server-PE-2
CPU type	Intel Xeon	Intel Xeon
Memory	4GB	16GB
Processor	3.36GHz	3.36GHz
Hard disk	300GB	200GB
L2 cache	1MB	1MB
System bus	800MHz	800MHz
OS support	64bit	64bit
LAN cards	Gigabit supported	Gigabit supported

**Table.1. Server Specifications** 

General		Resources			
Manufacturer: Model: CPU Cores: Processor Type:	Supermicro X6DH8-XG2 1 CPU x 3.6 GHz Intel(R) Xeon(TM) CPU 3.60GHz	CPU usage: 411 MHz	18	Capacity 1 x 3.6 GHz Capacity 16382.73 MB	
License:	Evaluation Mode	Datastore 🕢	Capacity	Free	Last Updat
Processor Sockets: Cores per Socket:	1	datastore1	293.00 GB	166.83 GB	6/14/2012 ►
Logical Processors:	2	Network	Туре		1
Hyperthreading: Number of NICs: State: Virtual Machines and Templates:	Active 6 Connected 3	VM Network 2     VM Network	Standard sw Standard sw	itch network itch network	Þ
vMotion Enabled: VMware EVC Mode:	N/A N/A	Fault Tolerance			
Host Configured for FT:	N/A	Fault Tolerance Version:	2.0.1-2.0 Refresh	0.0-2.0.0 Virtual Machine	Counts
Host Profile: Profile Compliance:	N/A 🕝 N/A	Total Primary VMs: Powered On Primary VMs: Total Secondary VMs:	0 0 0		

# Figure 1. Server-PE-1 Summary

Figure 2. Server-PE-2 Summary

General		Resources			
Manufacturer: Model: CPU Cores: Processor Type:	Supermicro X6DH8-XG2 1 CPU x 3.6 GHz Intel(R) Xeon(TM) CPU 3.60GHz	CPU usage: 106 MHz Memory usage: 1557.00 M	<b>B</b>	Capacity 1 x 3.6 GHz Capacity 4094.81 MB	
License:	Evaluation Mode	Datastore 🗸	Capacity	Free	LastUpdat
Processor Sockets: Cores per Socket: Logical Processors:	1 1 2	datastore1 datastore2	106.75 GB 107.00 GB	68.19 GB 92.92 GB	10/27/2002 10/27/2002
Hyperthreading:	Active	Network	Туре		1
Number of NICs: State:	2 Connected	Image: WM Network           Image: WM Network 2	Standard sw Standard sw	itch network itch network	<u>.</u>
Virtual Machines and Templates: vMotion Enabled:	2 N/A	<b>4</b>			<b>F</b>
VMware EVC Mode:	N/A	Fault Tolerance			
Host Configured for FT: Active Tasks:	N/A	Fault Tolerance Version:	2.0.1-2.0	0.0-2.0.0	
Host Profile: Profile Compliance:	N/A 🍘 N/A	Total Primary VMs: Powered On Primary VMs:	Refresh 0 0	Virtual Machine	Counts

# **1.2 Network Device Specifications**

The network devices used in my tests are as specified in Table 2.

Features	2900-Routers	2800-Router	2600-Router
Brand	Cisco	Cisco	Cisco
NVRAM	255Kb	240Kb	32Kb
Flash	254464Kb	62720Kb	32768Kb
Ports	Gigabit	Gigabit	Fast

 Table. 2. Network Device Specifications

# **1.3 Performance Strategy**

To improve the performance of the servers, the following guidelines were used.

- All RAM chips available in the lab were utilized to allocate more RAM per server.
- Dedicated a larger fraction of the physical server to the virtual servers.
- Used SCSI instead of IDE, because SCSI is faster than IDE.
- Used fixed size Virtual Hard Disk.
- For performance analysis, I used iozone and some built-in tools in VMware.

### **1.4** Network Diagram

Figure 3 shows an MPLS-enabled network. CE-1 is configured with OSPF to the service provider network (PE-1). PE-1 is configured with OSPF. PE-1 is also configured with BGP. An IBGP session is configured between PE-1 and PE-2. For provider network routing, an IGP is configured. For the purpose of this network, OSPF is used as the IGP. The provider network is configured with OSPF.

CE-2 is also configured with OSPF. A sham link is configured between PE-1 and PE-2 for redundancy. A layer 3 VPN is configured between CE-1 and CE-2 clients.

There are two physical servers connected to routers PE-1 and PE-2. Both servers and the CE clients are in the same VPN so that they can communicate with each other. This network design is scalable. We can add more servers for additional clients in different VPNs.

I have configured server PE-1 with virtual FTP, VNC and SAN servers while in PE-2 server, FTP and VNC have been configured. The SAN server is providing services to both CE-1 and CE-2 clients.





## 2.1 Virtual Servers Specifications

Below are the technical specifications of FTP, VNC and SAN servers. Figure 4 through Figure 8 show memory and other resource allocations to the virtual servers.

#### 2.1.1 File Transfer Protocol Server

Resources allocated to the FTP server are as shown in Figure 4.

General		Resources			
Guest OS: VM Version: CPU: Memory: Memory Overhead: VMware Tools: IP Addresses:	Red Hat Enterprise Linux 6 (32-bit) 7 2 vCPU 1024 MB 166.15 MB Not installed	Consumed Host CPU: Consumed Host Memory: Active Guest Memory: Provisioned Storage: Not-shared Storage: Used Storage:		Refresh Sto	52 MHz 983.00 MB 10.00 MB orage Usage 31.00 GB 2.23 KB 2.23 KB
DNS Name:		Datastore 🔨	Capacity	Free	LastUpda
State:	Powered On	datastore1	293.00 GB	166.83 GB	6/14/2012
Host: Active Tasks:	localhost.	•			۲

**Figure 4. FTP Server** 

## 2.1.2 Virtual Network Computing Server

Resources allocated to the VNC server are as shown in Figure 5.

Figure 5. VNC	Server
---------------	--------

General		Resources				
Guest OS:	Red Hat Enterprise Linux 6 (32-bit)	Consumed Host CPU:			487 MHz	
VM Version:	7	Consumed Host Memory:	766.00 MB			
CPU:	2 vCPU	Active Guest Memory:		61.00 MB		
Memory:	1024 MB		Refresh Stora		orage Usage	
Memory Overhead:	163.73 MB	Provisioned Storage:		21.00 GE		
VMware Tools:	Notinstalled	Not-shared Storage:			3.45 GB	
IP Addresses:		Used Storage:			3.45 GB	
DNS Name:		Datastore 🖉	Capacity	Free	LastUpda	
State:	Powered On	datastore1	293.00 GB	166.83 GB	6/14/2012	
Host:	localhost.	•			•	

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### 2.1.3 Storage Area Network Server

Resources allocated to the SAN server are as shown in Figure 6.

General		Resources				
Guest OS:	Debian GNU/Linux 5 (64-bit)	Consumed Host CPU:			93 MHz	
VM Version:	7	Consumed Host Memory:			290.00 MB	
CPU:	2 vCPU	Active Guest Memory:		10.00 MB		
Memory:	1024 MB			Refresh Sto	orage Usage	
Memory Overhead:	135.74 MB	Provisioned Storage:			81.00 GB	
VMware Tools:	Notinstalled	Not-shared Storage:			2.52 GB	
IP Addresses:		Used Storage:			2.52 GB	
DNS Name:		Datastore 🖉	Capacity	Free	Last Upda	
State:	Powered On	datastore1	293.00 GB	166.83 GB	6/14/2012	
Host:	localhost.	1	m			
Active Tasks:		Network	Type			

**Figure 6. SAN Server** 

### **PE-2-Server-FTP**

Resources allocated to the FTP server are as shown in Figure 7.

Figure '	7.	FTP	Server
----------	----	-----	--------

General		Resources				
Guest OS:	Red Hat Enterprise Linux 6 (32-bit)	Consumed Host CPU:		56 MHz		
VM Version:	7	Consumed Host Memory:		699.00 MB		
CPU:	2 vCPU					
Memory:	1024 MB			Refresh Storage Lisage		
Memory Overhead:	144.22 MB	Provisioned Storage:		31.00 GB		
VMware Tools:	Notinstalled	Not-shared Storage:		2.93 GB		
IP Addresses:		Used Storage:	2.93 GB			
DNS Name:		Datastore 🗸	Capacity	Free Last Upda		
State:	Powered On	*	m	•		
Host:	localhost.	Network	Туре			
Active Tasks:		WM Network 2	Standard switch	network		

#### **PE-2-Server-VNC**

Resources allocated to the VNC server are as shown in Figure 8.

General		Resources					
Guest OS:	Red Hat Enterprise Linux 6 (32-bit)	Consumed Host CPU:			2750 MHz		
VM Version:	7	Consumed Host Memory:			304.00 MB		
CPU:	2 vCPU	Active Guest Memory:					
Memory:	1024 MB		Refresh Stora		rage Lisage		
Memory Overhead:	138.95 MB	Provisioned Storage:			16.00 GB		
VMware Tools:	Notinstalled	Not-shared Storage:			2.68 GB		
IP Addresses:		Used Storage:		2.68 GF			
DNS Name:		Datastore 🕢	Capacity	Free	LastUpda		
State:	Powered On	datastore1	106.75 GB	68.19 GB	10/27/200		
Host: Active Tasks:	localhost.			)	۲		

Figure 8. VNC Server

# 2.2 Network Configuration Strategy

Different technologies have been implemented to enhance network performance. These technologies are discussed below.

### 2.2.1 Multi-Protocol Label Switching Technology (MPLS)

MPLS is a packet forwarding technology that uses labels for forwarding decisions. With MPLS, the layer-3 header analysis is done just once to enter in the MPLS domain. MPLS could be used for the following reasons:

### Virtual Private Networking (VPN)

VPN is a network technology that creates a secure network connection over a public network such as the Internet or a private network owned by a service provider. Large corporations, educational institutions and government agencies use VPN technology to enable remote users to securely connect to a private network. A VPN can connect multiple sites over a large distance just like a WAN. VPNs are often used to extend intranets worldwide to disseminate information and news to a wide user base. Educational institutions use VPNs to connect campuses that can be distributed across the country or around the world.

#### **Traffic Engineering**

Traffic engineering is a method of optimizing the performance of a telecommunications network by dynamically analyzing, predicting and regulating the behaviour of data transmitted over that network. Traffic engineering is also known as teletraffic engineering and traffic management. The techniques of traffic engineering can be applied to networks of all kinds, including the PSTN, LANs, WANs, cellular telephone networks, proprietary business and the Internet.

#### **QoS enablement**

One of the primary benefits of MPLS-based services is the ability to support QoS. It plays a vital role for companies that provide voice and video services.

#### **Cost Savings**

Depending on the specific mix of applications and network configuration, MPLS-based services can reduce costs by 10% to 25% over comparable data services (frame relay and ATM). As companies add voice and video traffic, cost savings can rise to as much as 40% network wide.

#### **Improved Performance**

Because of the "any-to-any" nature of MPLS services, network designers can reduce the number of "hops" between network points, which translates directly to increased response time and improved application performance.

#### **Disaster Recovery**

MPLS-based services improve disaster recovery in a variety of ways. First and foremost, data centers and other key sites can be connected in multiply redundant ways to the cloud (and thus to other sites on the network). Secondly, remote sites can quickly and easily reconnect to backup locations if needed, unlike with ATM and frame networks, in which either switched or backup permanent-virtual-circuits are required.

In this project i have focused on the use of *VPNs*.

#### 2.2.2 Layer-3 VPN

A VPN is a private data network that makes use of the public network infrastructure while maintaining privacy and reservation through the use of a tunnelling protocol based on an MPLS network. In my project I designed the VPN in such a way that all servers and customer edge routers are in the same VPN so that the servers can be reachable from every client behind the customer routers.

#### **<u>Ping result from CE-1-Client station to :</u>**

#### (a) **PE-1-Server**

Figure 9 illustrates the ping result from CE-1 client to PE-1 server.

C:\Users\Administrator>ping 192.168.2.3
Pinging 192.168.2.3 with 32 bytes of data: Reply from 192.168.2.3: bytes=32 time=1ms TTL=60 Reply from 192.168.2.3: bytes=32 time=1ms TTL=60 Reply from 192.168.2.3: bytes=32 time=1ms TTL=60 Reply from 192.168.2.3: bytes=32 time=1ms TTL=60
Ping statistics for 192.168.2.3 Packets: Sent = 4, Receivedt = 0 (0% loss), Approximate round trip times in milli-seconds: Minimum = 1ms, Maximum = 1ms, Average = 1ms

#### Figure 9. Ping PE-1 Server

#### (b) PE-2-Server

Figure 10 illustrates the ping result from CE-1 client to PE-2 server.

Figure 10. Ping PE-2 Server

C:\Users\Administrator>ping 192.168.1.5 Pinging 192 .5 with 32 bytes of data: bytes=32 time=2ms Reply From bytes=32 time<1ms bytes=32 time<1ms bytes=32 time<1ms bytes=32 time<1ms y from 192. 168.1.5: y from 192.168.1.5: Reply from statistics for 192.168.1.5: Packets: Sent = 4, Received Ping Received = 4, Lost = 0 times in milli-seconds: = 0 (0% loss), proximate round trip Minimum = Oms, Maximum = 2ms, Average Øms

#### **<u>Ping Result from CE-2 Client Station to :</u>**

#### (a) **PE-1-Server**

Figure 11 illustrates the ping result from CE-2 client to PE-1 server.

Figure 11. Ping from CE-2 to PE-1 Server

C:\Users\Administrator>ping 192.168.2.3
Pinging 192.168.2.3 with 32 bytes of data: Reply from 192.168.2.3: bytes=32 time=1ms TTL=60 Reply from 192.168.2.3: bytes=32 time=1ms TTL=60 Reply from 192.168.2.3: bytes=32 time=1ms TTL=60 Reply from 192.168.2.3: bytes=32 time=1ms TTL=60
Ping statistics for 192.168.2.3 Packets: Sent = 4, Receivedt = 0 (0% loss), Approximate round trip times in milli-seconds: Minimum = 1ms, Maximum = 1ms, Average = 1ms

#### (b) PE-2-Server

Figure 12 illustrates the ping result from CE-2 client to PE-1 server.

C:\Users\Administrator>ping 192.168.1.5
Pinging 192.168.1.5 with 32 bytes of data: Reply from 192.168.1.5: bytes=32 time=2ms TTL=62 Reply from 192.168.1.5: bytes=32 time<1ms TTL=62 Reply from 192.168.1.5: bytes=32 time<1ms TTL=62 Reply from 192.168.1.5: bytes=32 time<1ms TTL=62
Ping statistics for 192.168.1.5: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss), Approximate round trip times in milli-seconds: Minimum = 0ms, Maximum = 2ms, Average = 0ms

#### Figure 12. Ping from CE-2 to PE-1 Server

#### 2.2.3 Sham Link

A sham link in OSPF is used in case MPLS network goes down. When we configure a backdoor sham link, OSPF gives priority to that link, which we actually don't need when we have an MPLS network. This link should be configured in such a way that it becomes active only if the MPLS network goes down.

Figure 13. Sham link configuration at PE-1 Router

```
!
!
router ospf 2 vrf customer
domain-id 0.0.0.1
area 0 sham-link 22.22.22.22 44.44.44.44
redistribute static
```

Figure 14. Sham link configuration at PE-2 Router

```
router ospf 2 vrf customer
domain-id 0.0.0.5
log-adjacency-changes
area 0 sham-link 44.44.44.44 22.22.22.22
redistribute static
```

#### 3.0 Introduction to Storage Area Networks

A SAN's primary purpose is to transfer data between computer systems and storage elements. A SAN consists of a communication infrastructure, which provides physical connection, and a management layer that organizes the connection, storage elements and computer systems so that data transfer is secure and robust. The term SAN is usually identified with block I/O service rather than file access service.

A SAN can also be a storage system consisting of storage elements, storage devices, computer systems and/or applications plus all control software. In this project I designed a SAN with an MPLS network rather than a traditional LAN. The SAN server is connected to the PE router and is accessible throughout the MPLS Network.

#### 3.1 Openfiler

To configure the SAN, I used Openfiler, which is an operating system. Openfiler can use a lot of characteristics to share files. When you have set up the application you have the possibility to develop disk volumes and share information from the SAN.

For example, this configuration can serve the objective of creating an iSCSI SAN. Numerous users use this software with dedicated machines in VMware workstation and ESX server. It is supplied in 32-bit, 64-bit, ISO, VMware ESX server and XEN appliances. It is a totally free application that can be put in every single laptop or computer ranging from the previous ones to a high efficiency tower. It supports LDAP and has volume-management, enabling simple storage management.

Openfiler is a storage management approach, and is a standalone Linux distribution. It supports all the main network directories. It is also easy to use. Once installed, we can access it via a Web interface and configure it graphically according to our needs.

#### **3.2 Openfiler Installation and Configuration**

The step by step installation procedure is:

 Download ISO for Openfiler and connect to virtual server. Upon restarting the 1<sup>st</sup> screen that appears is shown in Figure 15.



Figure 15. Setup step-1

2. Press ENTER.

Figure 16. Setup step-2

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3. Click next and select a keyboard.

### Figure 17. Setup step-3



4. Click next and configure partitions.



Figure 18. Setup step-4

5. Click next and configure networking.



Notwork	Network De	evices					
Configuration	Active o	n Boot D	evice	P/Netma	ısk	Edit	
Configuration		<b>v</b> et	h0 I	онср		_	
Any network devices you	E	dit Interfa	ice eth	)			
detected by the installatic program and shown in th <b>Network Devices</b> list.	Configure eth0 Configure using D Configure using D Configure on boot	PHCP					
To configure the network device, first select the device.	Hardware address: 00:0C:29:E6:EA:99				lomain.com")		
and then click <b>Edit</b> . In the	IP Address:	192	. 168	. 254	. 39		
nterface screen, you car	Netmask:	255	. 255	. 255	.0		
choose to have the IP an							
configured by DHCP or y			<b>X</b> ⊆a	ancel	₽ок		
also choose to make the active at boot time.	liont T						

6. Click next and set Root password.

### Figure 20. Setup step-6

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openfiler	
Set Root Password Use the root account <i>only</i> for administration. Once the installation has been completed, create a non-root account for your general use and su – to gain root access when you need to fix	Image: Constraint of the system is the system is the system.         Image: Constraint of the system is system is the system is the system is the system is the system i
something quickly. These basic rules minimize the chances of a typo or incorrect command doing damage to your system.	Reading package information

7. Make sure to disconnect .ISO before clicking reboot.



Figure 21. Setup step-7

8. Now we can access Openfiler via web interface by entering Openfiler IP address and port 446.

# Figure 22. Setup step-8

← → C States://192.168.2.3:446/admin/status.html

openfiler

### **Configuration:**

1. Initial Information/Status page.

#### Figure 23. System information

		System Info	ormation: SAI	N.mint.com	(192.168.2.3)
	System	Vital			Hardware Information
Canonical Hostname	SAN.mint.com		Processors	2	
Listening IP	192.168.2.3		Model	Intel(R) Xeon(TM) CPU 3.60GHz	
Kernel Version	2.6.26.8-1.0.11.	.smp.pae.gcc3.4.x86	.i686 (SMP)	CPU Speed	3.6 GHz
Distro Name	Openfiler NAS/SAN		Cache Size	2.00 MB	
Uptime	8 days 13 hours 7 minutes		System	14421.72	
Current Users	1		PCI	Prideou Intel Comprehies 00071AD/ED/MD DIIVA ACDI	
Load Averages	0.00 0.00 0.00			Devices	Ethernet controller: Intel Corporation 82545EM Gigabit Ethernet Controller
	Network l	Usage			<ul> <li>Host bridge: Intel Corporation 440BX/ZX/DX - 82443BX/ZX/DX Host bridge</li> </ul>
Device	Received	Sent	Err/Drop		- IDE interface: Intel Corporation 82371AB/EB/MB PIIX4 IDE
lo	224.38 KB	224.38 KB	0/0		- ISA bridge: Intel Corporation 82371AB/EB/MB PIIX4 ISA
eth0	2.13 GB	1.03 GB	0/0		<ul> <li>PCI bridge: Intel Corporation 440BX/ZX/DX - 82443BX/ZX/DX AGP bridge</li> </ul>
					- PCI bridge: VMware Inc: Unknown device 0790
					- (32x) PCI bridge: VMware Inc: Unknown device 07a0

Serial Attached SCSI controller: LSI Logic / Symbios Logic SAS1068 PCI-X Fusion-MPT SAS

80 GB virtual hard disk was used.

0	Status	📮 System	📾 Volumes	🚯 Quota	🚍 si	hares	Services	s 🤌 A	ccounts	
	Block Device Management									
				Edit Disk	Туре	Descript	ion	Size	Label type	Partitions
				<u>/dev/sda</u>	SCSI	VMware V	/irtual disk	80.00 GB	msdos	9 ( <u>view</u> )

Figure 24. Disk Information

2. Two volumes were created. The 1<sup>st</sup> one is shown below.



Figure 25. Disk Vol-1

The 2<sup>nd</sup> volume is.

Figure 26. Disk Vol-2



3. RAID is configured.

### Figure 27. Raid Vol

, Status 🕺 System	n 📾 V	olumes 🧃	Quota 📮	Shares	Services	🤌 Accounts			
Software RAID Management									
Array	Level	Array Size	Device Size	State	Synchronization	Manage	Add	Used In	Delete
/dev/md0	RAID-5	15.35 GB	7.68 GB	Clean	Synchronized	View members	All RAID partitions are used	mint VG	In use

3. Before setting up an iSCSI target, make sure that service is enabled under "SERVICES" as shown in figure below.



|--|

Service Name	Status	Modification
SMB / CIFS server	Disabled	Enable
NFSv3 server	Disabled	Enable
HTTP / WebDAV server	Disabled	Enable
FTP server	Disabled	Enable
iSCSI target server	Enabled	Disable
Rsync server	Disabled	Enable

Manage Services

4. Now click on iSCSI target setup and configure it.

### Figure 29. iSCSI Target Configuration

🙇 Status	🗊 System	📾 Volumes	🎒 Quota	🚍 Shares	Services	🤌 Accounts			
Targe	et Configuration	LUN Mappin	g Network	ACL CHAP	Authentication				
				Add	new iSCSI 1	arget			
			т	arget IQN		Ad	d		
				iqn.2006-01.com	.openfiler:tsn.d5d7	/116d62d9	dd		
	Select iSCSI Target								
			P	Please sele	ect an iSCSI target	to display and/o	r edit.		
				iqn.2012-06.con	n.mint:san.8san4ce	Chan	ge		
			Settings f	or target: id	qn.2012-06.0	com.mint:sa	an.8san4ce1		

5. Click on Lun Mapping and map it.

Figure 30. Lun Mapping

Ма	Map New LUN to Target: "iqn.2012-06.com.mint:san.8san4ce1"										
Name	LUN Path	R/W Mode	SCSI Serial No.	SCSI Id.	Transfer Mode	Map LUN					
Storage for MINT students	/dev/mint/sanserver	write-thru 💌	3dH4Ej-D5oK-9NJq	3dH4Ej-D5oK-9NJq	blockio 💌	Мар					
Storage for Business users	/dev/group/bus	write-thru 💌	6U6ngD-zvZI-LIFd	6U6ngD-zvZI-LIFd	blockio 💌	Мар					

For security purposes CHAP authentication is added.

Figure	31.	CHAP	Setup
--------	-----	------	-------

Target Configuration LUN Ma	pping Network ACL	CHAP Authentication		
CHAP Au	uthentication Setting	gs for target "iqn.20	12-06.com.mint	san.8san4ce1"
	$\triangle$	No users assigned to thi	is target.	
	Add CHAP user to ta	arget "iqn.2012-06.o	com.mint:san.8s	an4ce1"
	Username	Password	User Type	Add
			Incoming User 💌	Add

Now it's time to setup client as an iSCSI initiator. In my case I used Windows-7 and Ubuntu as an iSCSI initiator.

In Windows-7 click start to get the administrative tools and then click on iSCSI initiator.

#### Figure 32. ISCSI Initiator



When the screen in Figure 33 appears, write down the SAN server IP and click connect.

Figure 33. IP Configuration

argets	Discovery	Favorite Targets	Volumes and Devices	RADIUS Configuration					
Quick Connect									
To disc DNS na	over and log ame of the ta	g on to a target usin arget and then click	g a basic connection, Quick Connect.	type the IP address or					
Target	: 192	.168.2.3		Quick Connect					
Discove	ered targets								
				Refresh					
Name				Status					
ign.20	012-06.com.	mint:san.2sanforce	2	Connected					
				Constant					

Now right click on the My Computer icon. Then click on manage and select "Disk Management". The screen shown in Figure 34 will appear.

Palines band dian v Caldanta	inmater v Caller	anna Gilenartes en 💶 Meta Dumnina la en 🔽 🖬 10 incense Guerres en 🔺 Granartes acto 10 en 🚺 ancentites install y 🖓 Malamay ;	Mana × 💢 Connecting Win × 🗖 🔲 🗶
Computer Management	_		 ☆ �
File Action View Help	- F		
Computer Management (Local)	Volume	Layout   Type   File System   Status   Cast Duran Dura	
Dystein roois     Dystein roois     Dystein roois	HP_TOOLS (E:)	Simple Basic FAT32 Healthy (Primary Partition) 204 Disk Management	
Event Viewer	C Online (H:)	Simple Basic NTFS Healthy (Primary Partition) 9.7; More Actions	
Shared Folders	RECOVERY (D:)	Simple Basic NTFS Healthy (Primary Partition) 13.6 Simple Basic NTFS Healthy (Surtem Active Primary Partition) 100	
Device Manager	USB DISK (G:)	Simple Basic FAT32 Healthy (Primary Partition) 3.82	
A Storage			
Disk Management			
Services and Applications			
	< [	······································	
	Disk 0		
	Basic	SYSTEM (C.) RECOVERY (D:) HP_TOOL:	
	298.09 GB Online	199 MB NTF 284.17 GB NTFS 13.62 GB NTFS 103 MB FA Healthy (Sv. Healthy (Boot Date File Crack Dump Primary Partition) ti Healthy (P	
		Frenchy (by Frenchy lood, ruge Fre, crain burn, Frinning Function), Frenchy (Frenchy )	
	-		
	Removable	USB DISK (G)	
	3.83 GB	3.83 GB FAT32	
	Onine	Healthy (Primary Partition)	
	Disk 2		
	15.34 GB	15.34 GB	
	Online	Unallocated T	-
1	- Onanocated		Show all downloads X
			271.011
📾 📿 🚞 I			🎬 🔺 🏲 🗑 💷 🕪 354 PM

Figure 34. Disk Management

On this screen we can create as many drives as we want. They will all look like they are locally attached. In my case I created drive H named "online" for testing purposes.



) 🔾 🖓 🐏 🕨 Comput	ter 🕨			▼ 49	Search Compute	
Organize 🔻 🦷 System p	properties	Uninstall or change a program	Map network drive	Open C	Control Panel	
Eavorites 📃 Desktop	▲ Hard	Disk Drives (4)	RECOVER	Y (D:)		
Downloads		236 GB free of 284 GB		1.95 GB free of 13.6 GB		
🗃 Libraries 🗈 Documents	6	89.1 MB free of 99.3 MB	9.68 GB fr	ee of 9.76	GB	
J Music ■ Pictures	<ul> <li>Device</li> </ul>	ces with Removable Storage (	2) USB DISK	(G:)		
🛃 Videos		bvb ku bine (i.)	2.64 GB fr	ee of 3.82	GB	

# 3.3 Setting up Ubuntu as an iSCSI initiator

Open a terminal window and issue the following command:

iscsiadm –m discovery sendTargets –p 192.168.2.3

Once discovered, we can create partitions same way as we did in Linux.

# 4.1 Performance Analysis

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In general performance means the accomplishment of a given task measured against present known standards of accuracy, completeness, cost and speed.

### **4.1.1 Client's Perspective**

From the client's perspective, performance means how quickly and accurately the requested services are provided by the server.

### 4.1.2 Server's Perspective

From the server's perspective, performance means how quickly and accurately the requested services are being performed by the server. Server performance is said to be satisfactory if it performs many requests in a short amount of time.

# 4.2 Servers-PE-1 Performance Analysis

Server performance has been analyzed under normal and high load of data transfer and is discussed below.

### 4.2.1 Under Normal Conditions

(i) File Server: File is transferred at speed of 10.3 Mbps as shown in Figure 36.

#### **Figure 36. File Transfer Status**

Selected 1 file. Total size: 735,787,	Empty directory.				
Server/Local file	Direction	Remote file	Size	Priority	Status
<pre>ftpes://sheraz@192.168.2.5 C:\Users\Administrator\D 00:00:10 elapsed 00</pre>	>> ):01:01 left	/home/sheraz/Live.Free.Or.Di 12.2% 90,374,144	735,787,008 4 bytes (10.3 M	Normal B/s)	Transferring

Figure 37 shows that CPU usage is almost 45% while 7 GB was transferred.



#### **Figure 37. CPU Performance**

Figure 38 demonstrates that data was received at the rate of 2 Mbps, with a maximum of 8.5 Mbps.



**Figure 38. Network Performance** 

Table 3 elaborates that the data transfer started at 4:31AM. Initially data was received at the rate of 2 Mbps which reached a maximum of 8.5 Mbps at the time slot between 4:31:20 to 4:31:40. This means the data rate reached a maximum in 10 seconds. This is documented in Table 3.



		Data transmit rate			Data receive rate -
Time	Usage	- 4000	Data receive rate	Data transmit rate	4000
6/26/2012 4:30:40					
AM	0	0	0	0	0
6/26/2012 4:31:00					
AM	2086	26	2059	26	2059
6/26/2012 4:31:20					
AM	7512	70	7442	70	7442
6/26/2012 4:35:00					
AM	6356	31	6324	31	6324
6/26/2012 4:36:40	0	0	0	0	0

### (ii) Virtual Network Computing (VNC) Server

In this case two VNC connections were established to the VNC server from the Windows-7 client. Figure 39 illustrates the CPU usage, which is almost 50%. Even at this load, the key strokes and mouse responses was still very quick. Response time was totally acceptable for users.

Figure 39. CPU Performance

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Figure 40 illustrates no conspicuous load on network when establishing VNC connections. Initially the rate at which the server received data was only 2 kbps. This reached a maximum of 6 kbps.





Table 4 shows that a few kilobytes were transferring, and network usage is 95 kbps.

		Data transmit rate			Data receive rate -
Time	Usage	- 4000	Data receive rate	Data transmit rate	4000
6/26/2012 4:52:20					
AM	26	24	2	24	2
6/26/2012 4:52:40					
AM	18	16	1	16	1
6/26/2012 4:53:20					
AM	19	17	1	17	1
6/26/2012 4:53:40					
AM	95	88	6	88	6

### Table 4. Data Transmission

### (iii) Storage Server

Figure 41 shows a file transfer from client to SAN server.

Figure 4	41.	Data	Transfer	Rate
----------	-----	------	----------	------

	Line Free On Die Llevel (2007) D. Drie (Free L. VV -
vame:	Live Free Or Die Hard(2007)DvDrip[Eng]-aXX0
Tor.	Online (H)
lime remain	ning Calculating
tems remain	ning: 1 (603 MB)
Speed:	12.2 MB/second

Figure 42 demonstrates a clear 10% CPU usage when copying a 7 GB file from client to SAN.

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Figure 42. CPU Performance

Figure 43 proves the maximum rate at which the SAN server received data was almost 9 MB/sec.



**Figure 43. Network Performance** 

Table 5 depicts the maximum network usage was 8.8 MB/sec.

		Data transmit rate			Data receive rate -
Time	Usage	- 4000	- 4000 Data receive rate		4000
6/26/2012					
5:00:20 AM	0	0	0	0	0
6/26/2012					
5:00:40 AM	653	12	640	12	640
6/26/2012					
5:01:00 AM	6140	102	6037	102	6037
6/26/2012					
5:01:20 AM	8567	139	8428	139	8428
6/26/2012					
5:01:40 AM	8878	155	8722	155	8722

#### Table 5. Data Transfer

# 4.2.2 Under High Load

Virtual server performance analysis is discussed below.

#### (i) File Server

Figure 44 shows CPU performance when more than 20 GB data were transferred to the FTP server. Under high load, CPU usage was 46.76% which was 0.76% less than the CPU usage under normal load.



#### **Figure 44. CPU Performance**

Under high load, when 20 GB data was being transferred to FTP server, the maximum rate at which the server received data was 1.5 Mbps and at that time network usage was 1.2 Mbps.



#### **Figure 45. Network Performance**

Figure 45 gives a graphical representation of network performance, whereas Table 6 gives the tabular version of network performance.

		Data transmit rate			Data receive
Time	Usage	-4000	Data receive rate	Data transmit rate	rate - 4000
6/25/2012					
9:47:00 AM	0	0	0	0	0
6/25/2012					
9:47:20 AM	512	8	504	8	504
6/25/2012					
9:53:20 AM	5509	25	5484	25	5484
6/25/2012					
9:53:40 AM	6205	32	6173	32	6173
6/25/2012					
9:54:00 AM	7135	33	7101	33	7101
6/25/2012					
9:54:20 AM	7422	35	7387	35	7387
6/25/2012					
9:54:40 AM	6895	32	6862	32	6862
6/25/2012	6158	28	6129	28	6129

### Table 6. Data Transmission Rate

#### (ii) Virtual Network Computing

There was no evidence that VNC performance slowed down while the server was being accessed by many users at the same time. I tested 10 VNC connections on different ports and the performance was almost the same as when accessed by only 2 users.

#### (iii) Storage Server

Figure 46 illustrates the CPU usage, which rises to 28% when transferring 20 GB of data to the SAN.



**Figure 46. CPU Performance** 

Figure 47 shows that under high data load, network usage reached a maximum of 8.1 Mbps.



**Figure 47. Network Performance** 

Table 7 shows that the maximum rate at which server received data was almost 7.5 Mbps.

	Data transmit		Data transmit	Data receive rate
Usage	rate - 4000	Dat a receive rate	rate	-4000
0	0	0	0	0
1161	19	1141	19	1141
5429	94	5334	94	5334
8140	300	7839	300	7839
7788	283	7504	283	7504
7294	162	7132	162	7132
7459	222	7236	222	7236
7001	163	6837	163	6837
6360	155	6205	155	6205
7253	170	7082	170	7082

 Table 7 Data Transmission Rate

# 4.3 Server-PE-2 Performance Analysis

The aerver connected to router PE-2 has been analyzed under the conditions that are explained below.

# 4.3.1 Under Normal Conditions

Different servers have been analyzed under normal conditions.

## (i) File Server

Figure 48 shows a 15% CPU usage under normal conditions.

Figure 48. CPU Performance

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Figure 49 shows the maximum rate at which the server received data was 6.6 Mbps; network usage was almost 7 Mbps.



**Figure 49. Network Performance** 

Table 8 shows the tabular form of the graph in Figure 49.

Data transmit			Data transmit	Data receive rate
Usage	rate - 4000	Data receive rate	rate	- 4000
0	0	0	0	0
4276	55	4221	55	4221
6065	75	5990	75	5990
6790	79	6711	79	6711
6693	55	6638	55	6638
6543	60	6482	60	6482
6569	57	6511	57	6511
1034	5	1029	5	1029
0	0	0	0	0

### Table 8. Data Transmission Rate

### (ii) VNC Server

Figure 50 shows a remarkable rise in CPU usage, which is 45% during connection establishment.



Figure 50. CPU Performance

Figure 51 shows performance graph during VNC connection establishment. The maximum rate at which the server received data was only 3 kbps, and network usage at that time was 30 kbps.



#### Figure 51. Network Performance

Table 9 is the tabular representation of VNC connection establishment.

	Data transmit		Data transmit	Data receive rate
Usage	rate - 4000	Data receive rate	rate	- 4000
0	0	0	0	0
3	3	0	3	0
2	2	0	2	0
1	0	0	0	0
4	3	1	3	1
10	8	1	8	1
30	27	3	27	3
28	25	3	25	3
16	14	2	14	2
0	0	0	0	0

### Table 9. Data Transmission Rate

# 4.3.2 Under High Load

In this section, analysis of virtual servers has been carried out under high load of data transfer.

#### (i) File Server

Figure 52 illustrates the maximum data rate at which server received data was 6.5 Mbps and network usage at that time was 6 Mbps.



**Figure 52. Network Performance** 

Table 10 represents the data of Figure 52 in tabular form.

Data transmit		Data transmit	Data receive rate	
Usage	rate - 4000	Data receive rate	rate	- 4000
0	0	0	0	0
18	8	9	8	9
3	1	1	1	1
877	10	867	10	867
5760	62	5697	62	5697
6354	41	6313	41	6313
6443	80	6363	80	6363
6124	50	6074	50	6074
6418	83	6334	83	6334
6229	45	6184	45	6184

Table 10. Data Transmission Rate

(ii) VNC Server

It has been found that the performance of the VNC server is not noticeably affected by establishing many connections on different ports. All key strokes and mouse clicks were responding with an acceptable latency.

# 5.0 Benchmarking

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Benchmarking is the process of evaluating the performance of servers running different tests.

# 5.1 Benchmarking for SAN

In the SAN sever, two hard drives were utilized and then two logical volumes were created. In one volume, a 15 GB RAID-5 was configured. I named it media-2. The other volume, which I named media-1, was 30 GB, normally partitioned. It is used as Windows partitions for clients. The software used for benchmarking is called iozone, which is a command-line oriented file system benchmark tool. The benchmark generates and measures a variety of file operations. The command used to generate the output displayed in the screen shots below was:

#### iozone -Rb -l5 -u5 - r 4k -s 100m.

This command generates an Excel file with 5 records per process in which every write and read is 1 GB with 4kb record size.

Read – Indicates the performance of reading a file that already exists in the file system.

Write – Indicates the performance of writing a new file to the file system.

**Re-read** – After reading a file, this indicates the performance of reading a file again.

Re-write – Indicates the performance of writing to an existing file.

### 5.2 Benchmarking from CE-1 Client

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### 5.2.1 To Media-1



Excel chart generation enabled Record Size 4 KB File size set to 102400 KB Command line used: iozone -Rb -15 -u5 -r 4k -s : Output is in Kbytes/sec Time Resolution = 0.000000 seconds. Processor cache size set to 1024 Kbytes. Processor cache line size set to 32 bytes. File stride size set to 17 * record size. Min process = 1 Max process = 5 Throughput test with 1 process Each process writes a 102400 Kbyte file in 4 Kb	100 yte	n records	
Children see throughput for 1 initial writers Parent sees throughput for 1 initial writers Min throughput per process Max throughput per process Avg throughput per process Min xfer		244898.38 5890.67 244898.38 244898.38 244898.38 102400.00	KB/sec KB/sec KB/sec KB/sec KB/sec KB
Children see throughput for 1 rewriters Parent sees throughput for 1 rewriters Min throughput per process Max throughput per process Avg throughput per process Min xfer		582269.31 5673.66 582269.31 582269.31 582269.31 582269.31 102400.00	KB/sec KB/sec KB/sec KB/sec KB/sec KB
Children see throughput for 1 readers Parent sees throughput for 1 readers Min throughput per process Max throughput per process Avg throughput per process Min xfer		715243.12 702961.34 715243.12 715243.12 715243.12 715243.12 102400.00	KB/sec KB/sec KB/sec KB/sec KB/sec KB
Children see throughput for 1 re-readers Parent sees throughput for 1 re-readers Min throughput per process Max throughput per process Aug throughput per process Min xfer		687131.69 664822.63 687131.69 687131.69 687131.69 687131.69 102400.00	KB/sec KB/sec KB/sec KB/sec KB/sec KB

5.2.2: To Media-2

### Figure 54. Benchmarking CE-1 to Media-2

	Excel chart generation enabled						
Record Size 4 KB							
	File size set to 102400 KB						
	Command line used: jozone -Ph output uke -15 -uk		-n 4k - n 100	<b>a</b> m			
	Output in in Vhuten (and		L JV 2 TO	210			
	Time Peeelution - 0 000000 eccende						
	Durante Accolucion - 0.000000 seconds.						
	Trucessur cache size set tu 1024 Kuytes.						
	Processor cache line size set to 32 Dytes.						
	File stride size set to 17 * record size.						
	fin process = 5						
	Max process = 5						
	Throughput test with 5 processes						
	Each process writes a 102400 Kbyte file in 4 Kby	γte	e records				
	Children see throughput for 5 initial writers	=	130079.97	KB/sec			
	Parent sees throughput for 5 initial writers		1596.69	KB/sec			
	Min throughput per process		17646.49	KB/sec			
	Max throughput per process		43698.76	KB/sec			
	Avg throughput per process		26015.99	KB/sec			
	Min xfer		40832.00	KB			
	Children see throughput for 5 rewriters		25275.76	KB/sec			
	Parent sees throughput for 5 rewriters		2457.36	KB/sec			
	Min throughput per process		3994.77	KB/sec			
	Max throughput per process		6433.94	KB/sec			
	Avg throughput per process		5055.15	KB/sec			
	Min xfer		63588.00	KB			
	Children see throughput for 5 readers		1062813.04	KB/sec			
	Parent sees throughout for 5 readers		990008.35	KB/sec			
	Min throughput per process	=	130472.29	KB/sec			
	Max throughput per process	=	297043.97	KB/sec			
	Aug throughput per process	=	212562-61	KB/sec			
	Min vfew	=	45116 00	KR			
			10110.00	ND			
	Children see throughout for 5 re-readers		1165854 58	KB/sec			
	Pawent sees throughput for 5 ve-veaders	_	1070423 40	KB/sec			
	Min throughput new process		172500 47	KB/sec			
	Max throughput per process		220025 04	VD/Sec			
	Aug throughput per process		22212622.01	VD/oor			
	Min vfou		E2204 00	ND/SEC			
				IN THE OWNER OF THE OWNER OWNER OF THE OWNER OWNE			

5.3 Benchmarking from CE-2 Clients

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### 5.3.1 To Media-1



Excel chart generation enabled Record Size 4 KB File size set to 102400 KB Command line used: iozone -Rb output.wks -15 -u Output is in Kbytes/sec Time Resolution = -0.000000 seconds. Processor cache size set to 1024 Kbytes. Processor cache line size set to 32 bytes. File stride size set to 17 * record size. Min process = 5 Max process = 5 Throughput test with 5 processes Each process writes a 102400 Kbyte file in 4 Kb	5 - yte	∵r 4k -s 101 :: records	ðm
Children see throughput for 5 initial writers		51934.52	KB/sec
Parent sees throughput for 5 initial writers		9519.14	KB/sec
Min throughput per process		7635.56	KB/sec
Max throughput per process		12667.68	KB/sec
Avg throughput per process		10386.90	KB/sec
Min xfer		61844.00	KB
Children see throughput for 5 rewriters		489356.37	KB/sec
Parent sees throughput for 5 rewriters		11048.26	KB/sec
Min throughput per process		64760.96	KB/sec
Max throughput per process		132335.20	KB/sec
Avg throughput per process		97871.27	KB/sec
Min xfer		50176.00	KB
Children see throughput for 5 readers		1157613.44	KB/sec
Parent sees throughput for 5 readers		1067430.12	KB/sec
Min throughput per process		113831.44	KB/sec
Max throughput per process		310056.72	KB/sec
Avg throughput per process		231522.69	KB/sec
Min xfer		37424.00	KB
Children see throughput for 5 re-readers		1190798.91	KB/sec
Parent sees throughput for 5 re-readers		1097157.69	KB/sec
Min throughput per process		143536.03	KB/sec
Max throughput per process		304086.28	KB/sec
Avg throughput per process		238159.78	KB/sec
Min xfer		48072.00	KB

#### 5.3.2 To Media-2

Figure 56. Benchmarking CE-2 to Media-2

Processor cache size set to 1024 Kbytes. Processor cache line size set to 32 bytes. File stride size set to 17 * record size. Min process = 1 Max process = 5 Throughput test with 1 process Each process writes a 102400 Kbyte file in 4 KD	byte	records	
Children see throughput for 1 initial writers		237103.95	KB/sec
Parent sees throughput for 1 initial writers		4656.53	KB/sec
Min throughput per process		237103.95	KB/sec
Max throughput per process		237103.95	KB/sec
Avg throughput per process		237103.95	KB/sec
Min xfer		102400.00	KB
Children see throughput for 1 rewriters		627396.62	KB/sec
Parent sees throughput for 1 rewriters		4724.27	KB/sec
Min throughput per process		627396.62	KB/sec
Max throughput per process		627396.62	KB/sec
Avg throughput per process		627396.62	KB/sec
Min xfer		102400.00	KB
Children see throughput for 1 readers		698116.56	KB/sec
Parent sees throughput for 1 readers		686561.91	KB/sec
Min throughput per process		698116.56	KB/sec
Max throughput per process		698116.56	KB/sec
Avg throughput per process		698116.56	KB/sec
Min xfer		102400.00	KB
Children see throughput for 1 re-readers Parent sees throughput for 1 re-readers Min throughput per process Max throughput per process Avg throughput per process Min xfer		694367.81 683140.75 694367.81 694367.81 694367.81 102400.00	KB/sec KB/sec KB/sec KB/sec KB/sec KB/sec KB

## 6.0 CONCLUSION & RECOMMENDATIONS

University Of Alberta Capstone Project Report

In this project virtual servers using an MPLS network under normal conditions and under high data transfer loads have been tested to assess their performance. For testing purposes, a concept of connecting virtual servers to provider edge routers and keeping them in one layer-3 VPN has been introduced. An MPLS sham link is used for redundancy.

All clients and servers were in the same VPN to prevent unreachability. I used two physical Intel servers, installed ESXI-4.1, and configured virtual servers. An FTP server and a VNC server were configured on both physical servers while Openfiler for storage was configured on the PE-1 server. In addition to the above, an SSL certificate has been configured for secure data transfer. The VNC server was configured in such a way that all users can VNC only via a secure channel.

CentOS 6.2 is considered to be the preeminent server OS, because it provides a free enterprise class computing platform to anyone. It is free, stable and there are many online free resources available. For reliability and security purposes, the SAN was configured in the open source operating system called Openfiler. This is a modified version of Linux which provides an iSCSI target for iSCSI initiators like VMware ESX and Windows.

As with a physical computer, the overall objective in improving virtual server performance is to eliminate any performance bottlenecks. In general, the more processors, RAM and hard disk space that exists, the better the virtual server's performance will be. It is recommended to overestimate the amount of RAM required to run the host OS, virtual servers and the guest OS. Performance drops dramatically when a virtual machine runs out of available RAM and starts paging. In addition, poor host OS performance turns directly into poor virtual machine performance. It is also recommended to use iSCSI and SANs to enhance virtual hard disk performance.

Recommendations for improving disk performance:

- Use a hard disk solution that allows fast access, such as a SCSI hard disk, a redundant array of RAID, or a SAN.
- Put each virtual hard disk on a dedicated volume, SCSI hard disk, RAID or SAN. It is easiest to put virtual hard disks together with their associated virtual machine configuration files on a RAID or SAN because this keeps everything in one place.
- Put virtual hard disks on a different physical disk than the host OS.
- Defragmentation should be done on a regular basis, if a dynamically expanding virtual hard disk is configured. A fixed-size virtual hard disk uses a reserved block of storage space, which means that data is less likely to be fragmented as it is stored.
- In order to free up more physical disk space it is necessary to "compact" the hard drive.

Recommendations for improving network performance:

- Distribute the networking load. If several instances of a virtual server are running, the networking load should be distributed between them in the same manner as the physical servers.
- Physical network adapters should be added. Dedicating at least one physical network adapter to each virtual machine is highly recommended for best performance.
- Configure a separate VLAN to host the virtual server.
- The network should be monitored regularly so that corrective steps may be taken to improve network performance.

#### REFERENCES

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