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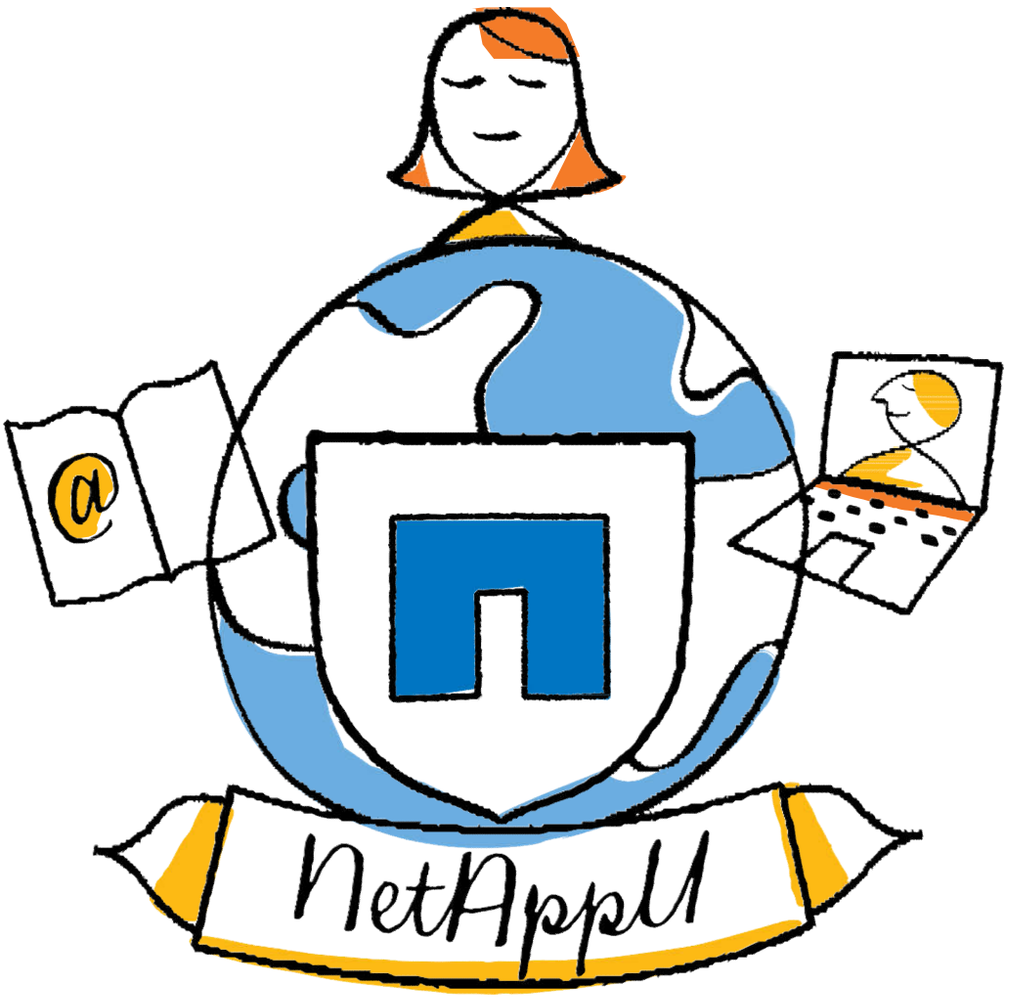
Performance Analysis on Clustered Data ONTAP

Extended Exercise Guide
9.1 Modified



NETAPP UNIVERSITY

Performance Analysis on Clustered Data ONTAP

Extended Exercise Guide

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MODULE 1: HOW A NETAPP STORAGE SYSTEM WORKS

There is no exercise associated with Module 1.

MODULE 2: PERFORMANCE OVERVIEW

EXERCISE

In this exercise, you identify your exercise equipment, log in to the exercise environment, and verify the equipment.

OBJECTIVES

By the end of this exercise, you should be able to:

- Identify the exercise environment
- Log in to the exercise environment
- Add a cluster to the OnCommand System Manager
- Configure the SNMP public community name
- Identify clustered Data ONTAP components
- Set the clustered Data ONTAP command-line system timeout value (optional)

TASK 1: IDENTIFY THE EXERCISE ENVIRONMENT

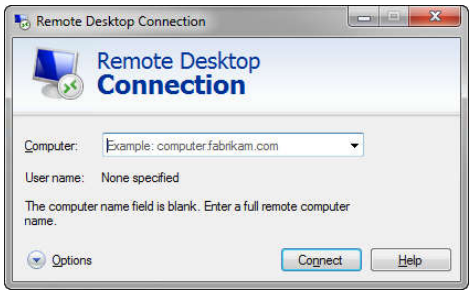
In this task, you log in to your assigned exercise environment. You perform all subsequent exercises from this assigned machine.

STEP	ACTION
1.	With the assistance of your instructor, identify your main Windows Domain Controller. Windows Server IP address: 192.168.0.11 Domain: learn.netapp.local Domain Administrator password: Netapp123 
2.	With the assistance of your instructor, identify your clustered NetApp Data ONTAP operating system nodes. Clustered Data ONTAP Node 1 Management LIF IP address: 192.168.0.91 Node 2 Management LIF IP address: 192.168.0.92 Cluster Management LIF IP address: 192.168.0.101 Cluster Administrator (admin) password: Netapp123 
3.	With the assistance of your instructor, identify your Linux machine. This machine might be a virtual machine. Linux Server IP address: 192.168.0.10 Root password: Netapp123 

STEP	ACTION
4.	With the assistance of your instructor, identify your OnCommand Unified Manager Server. Appliance IP address: 192.168.0.15 Admin password: Netapp123
5.	With the assistance of your instructor, identify your OnCommand Performance Manager Server. Appliance IP address: 192.168.0.16 Admin password: Netapp123
6.	With the assistance of your instructor, identify your NABOX/Harvest/Grafana Server. Appliance IP address: 192.168.0.17 Admin password: Netapp123

TASK 2: LOG IN TO THE EXERCISE ENVIRONMENT

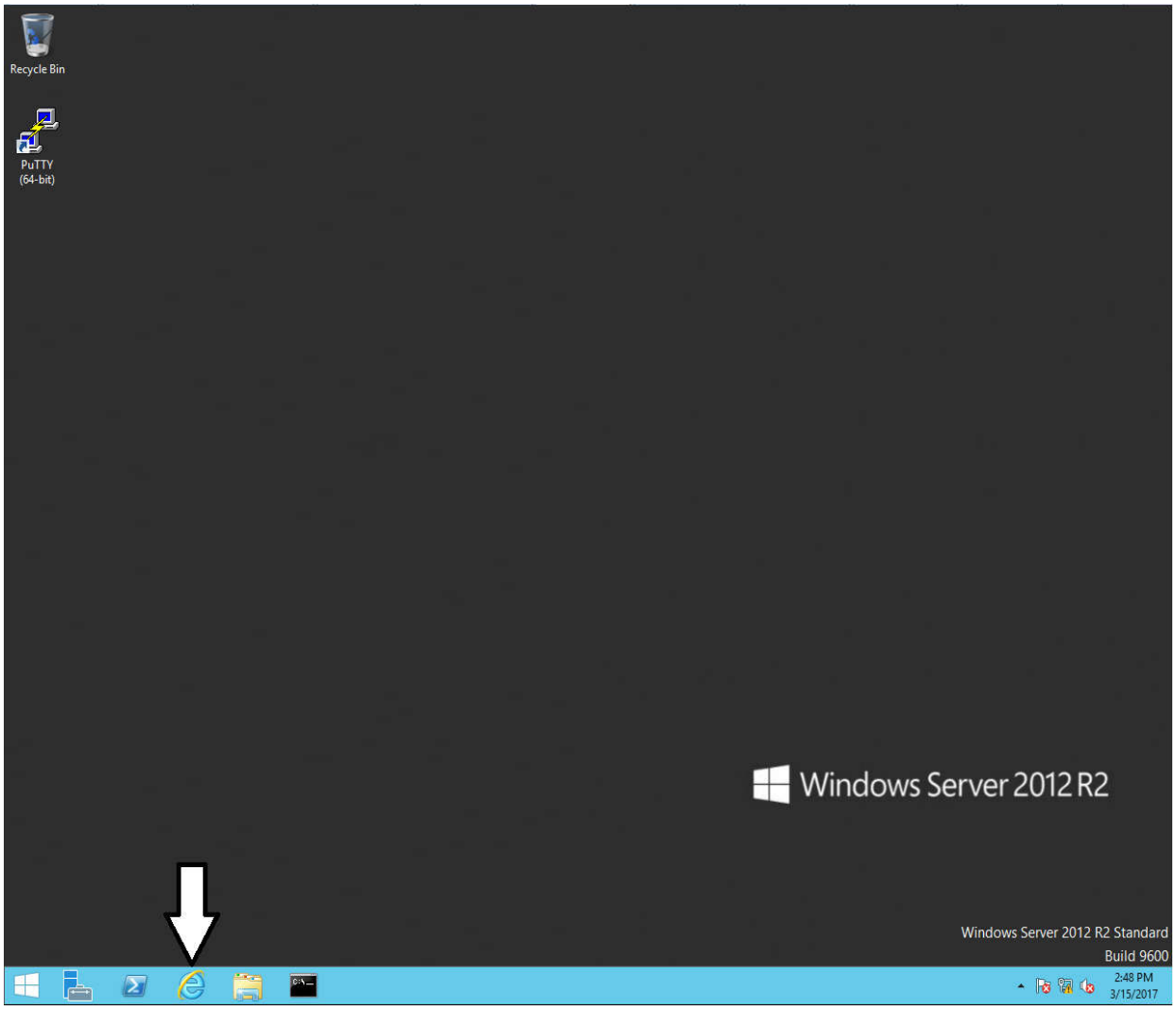
In this task, you use Remote Desktop Connection to log in to your assigned exercise environment. You perform all subsequent tasks from the Domain Controller.

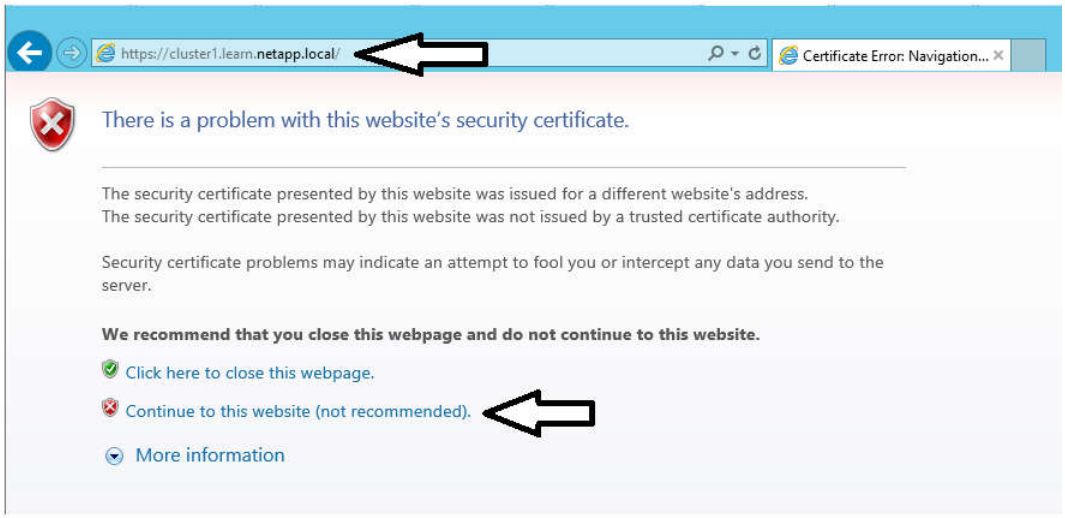
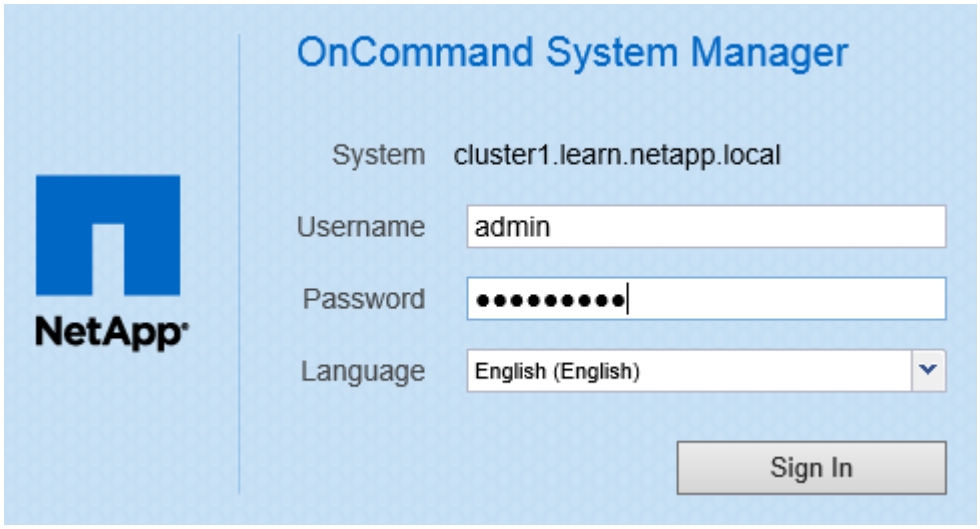
STEP	ACTION
1.	On your local Windows machine desktop, click the **Remote Desktop Connection** link to log in to the remote Windows machine through the Remote Desktop Connection tool. If this link is not available, ask your instructor where to find the tool. 
2.	Enter the IP address of your remote Windows server, and then click **Connect**.
3.	Verify that the desktop of the remote machine is displayed.
4.	If you are asked for authentication, enter the user name and password that your instructor gave you.

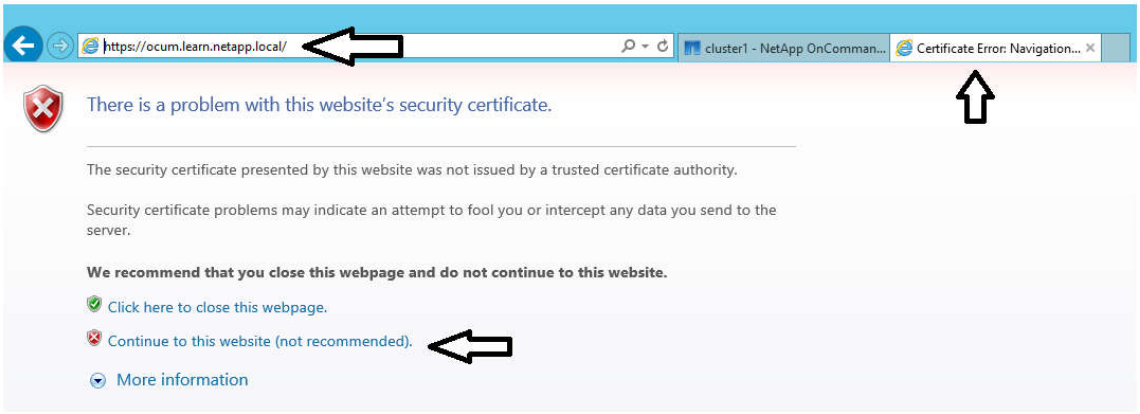
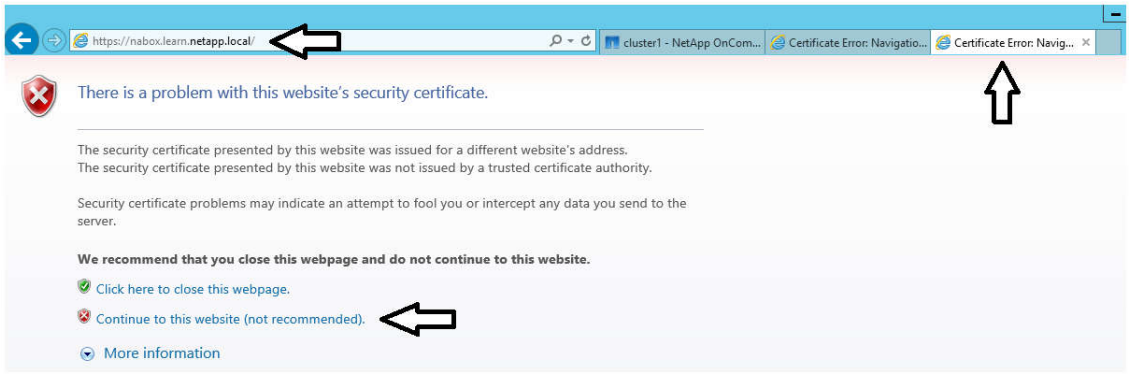
TASK 3: LOG INTO YOUR CLUSTER USING ONCOMMAND SYSTEM MANAGER

In this task, you will log into your cluster using System Manager

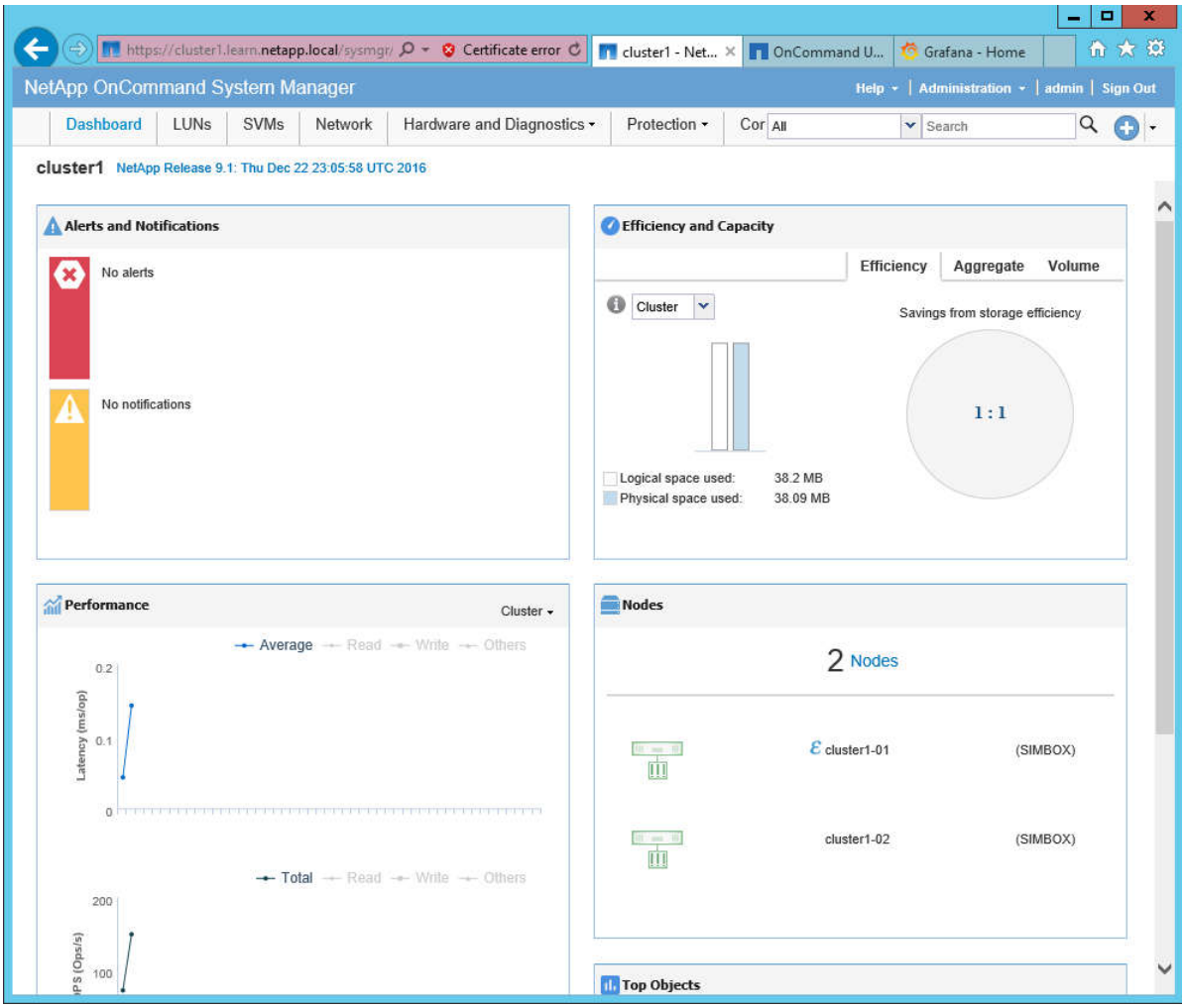
NOTE: For more information about configuring a storage system with System Manager, see the *Clustered Data ONTAP Administration* course.

STEP	ACTION
1.	On the Windows Server desktop, open Internet Explorer. 

STEP	ACTION
2.	This will open 3 tabs for each management and monitoring application. On each tab click the **Continue to this Website (not recommended)** link and login as shown in the next few steps. 
3.	Log in using the username `admin` and the password `Netapp123` 

STEP	ACTION
4.	On the `https://ocum.learn.netapp.local`. You will log into the OnCommand Unified Manager appliance. From here you can see Capacity and Performance Health information. Log in using the username `admin` and the password `Netapp123`. 
5.	On the third tab log into `https://nabox.learn.netapp.local`. This will connect you to the Harvest appliance. Harvest is a freely available tool you can download from the Netapp Support site in the Utility Toolchest. You can also get a preconfigured appliance from https://nabox.tynsoe.org/ . Log in using the username `admin` and the password `Netapp123`. 

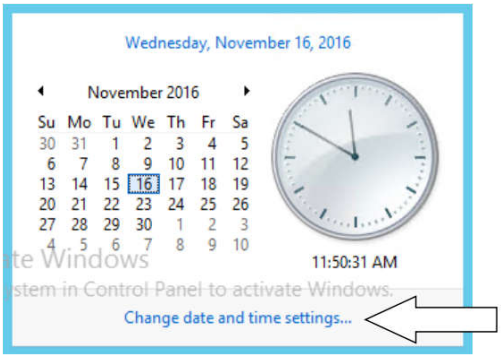
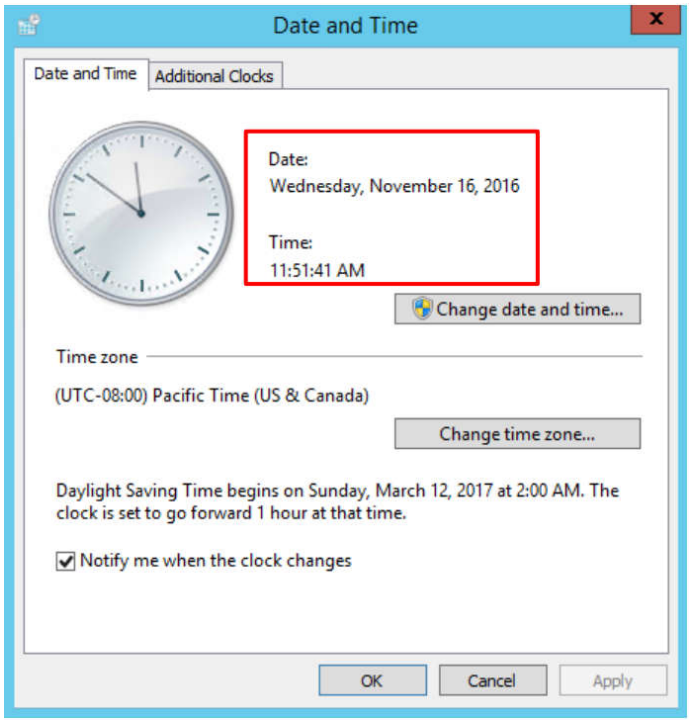
STEP	ACTION
6.	Return to the System Manager Tab in the Web Browser to continue the lab configuration.



TASK 4: CONFIGURE SNMP PUBLIC COMMUNITY NAME AND SYNCHRONIZE TIME

In this task, you configure time synchronization and the SNMP public community name so that third party applications can discover information easier. SNMP is NOT needed for the applications we are using in this lab environment

NOTE: In some highly secure environments, this might not be appropriate.

STEP	ACTION
1.	Windows domains must be synchronized to within 5 minutes of all member servers. If the time of the ONTAP cluster is not synchronized with a domain controller, the ONTAP cluster cannot join or remain joined to the Windows domain. Without synchronization, computers in the Windows domain cannot access resources in the ONTAP cluster, and resources in the cluster cannot access the Windows domain. In the next steps, you synchronize date and time between the ONTAP clusters and the Windows domain controller.
2.	View the time zone, date, and time by clicking Change date and time settings: 
3.	Review the date, time, and time zone on the Windows 2012 Server. 

STEP	ACTION
4.	In the following steps, you determine which time zone has been configured on your ONTAP cluster and then, if necessary, you change the cluster time zone to match the Domain Controller.

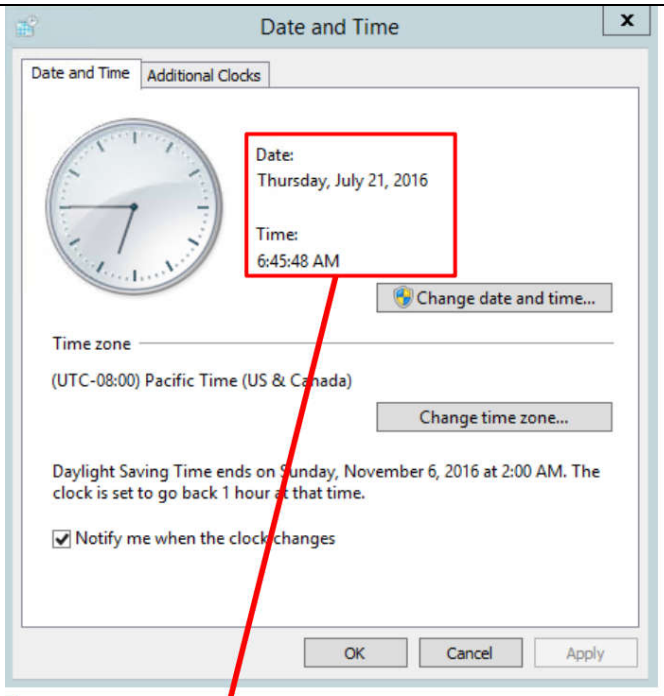
5.	Display the configured time zone on the ONTAP cluster:
	
	`Timezone`
	
	`SVLc1::> timezone`
	`Timezone: America//Los_Angeles`

6.	Your ONTAP clusters might have a different time zone from the one that is displayed in this example. However, your goal is to make the time zone of the ONTAP clusters match the time zone of the Windows domain controller. In the next step, you verify the time zone of the Windows Server.

7.	On the ONTAP cluster, change the time zone to match the domain controller by entering this case-sensitive command: For Example.....
	
	`timezone US/Pacific`
	
	`SVLc1::> timezone`
	`Timezone: America//Los_Angeles`
	
	`SVLc1::> timezone US/Pacific`
	`1 entry modified`
	
	`SVLc1::>`

8.	Display the date, time, and time zone in the ONTAP cluster:
	
	`Date`
	
	`SVLc1::> date`
	`Node Date Time zone`
	`--- --- ---`
	`SVLc1-01 Wed Nov 16 11:29:26 2016 US/Pacific`
	`SVLc1-02 Wed Nov 16 11:29:31 2016 US/Pacific`
	`2 entries were displayed.`

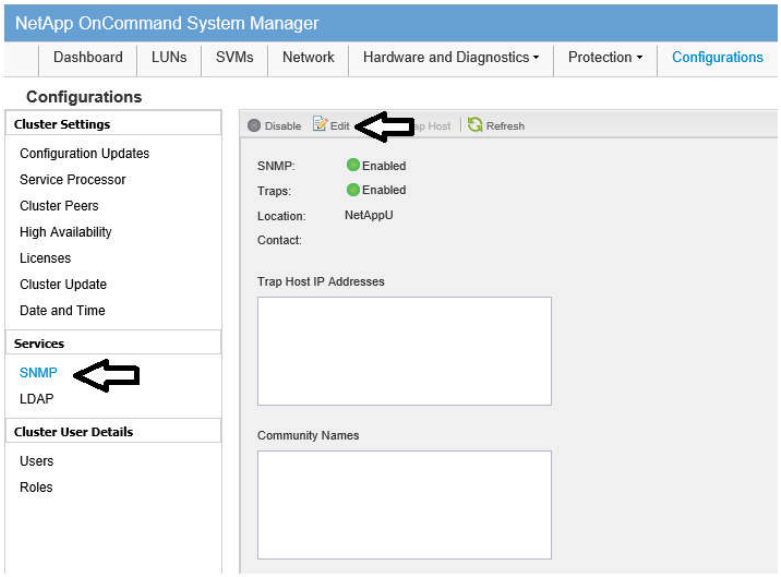
STEP	ACTION
9.	Compare the date and time on the Windows 2012 Server with the date and time in the ONTAP cluster.

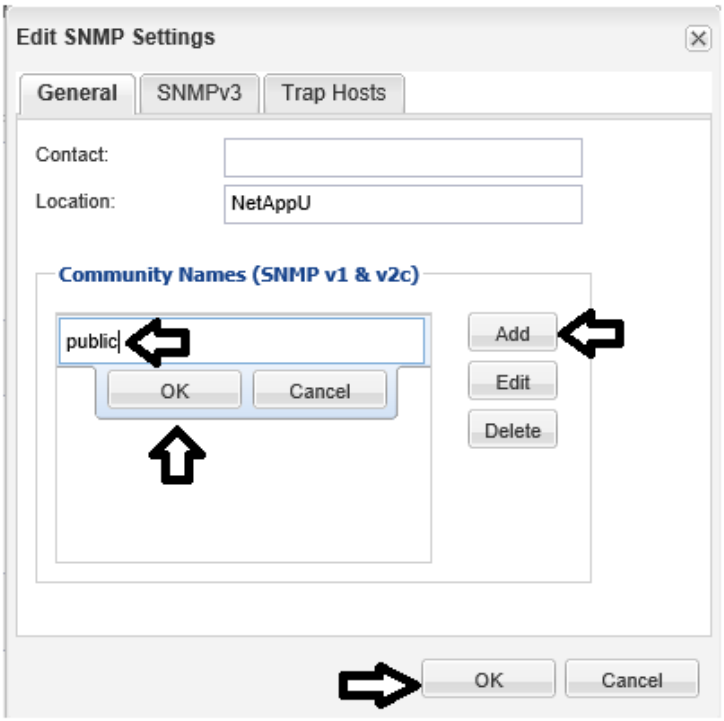
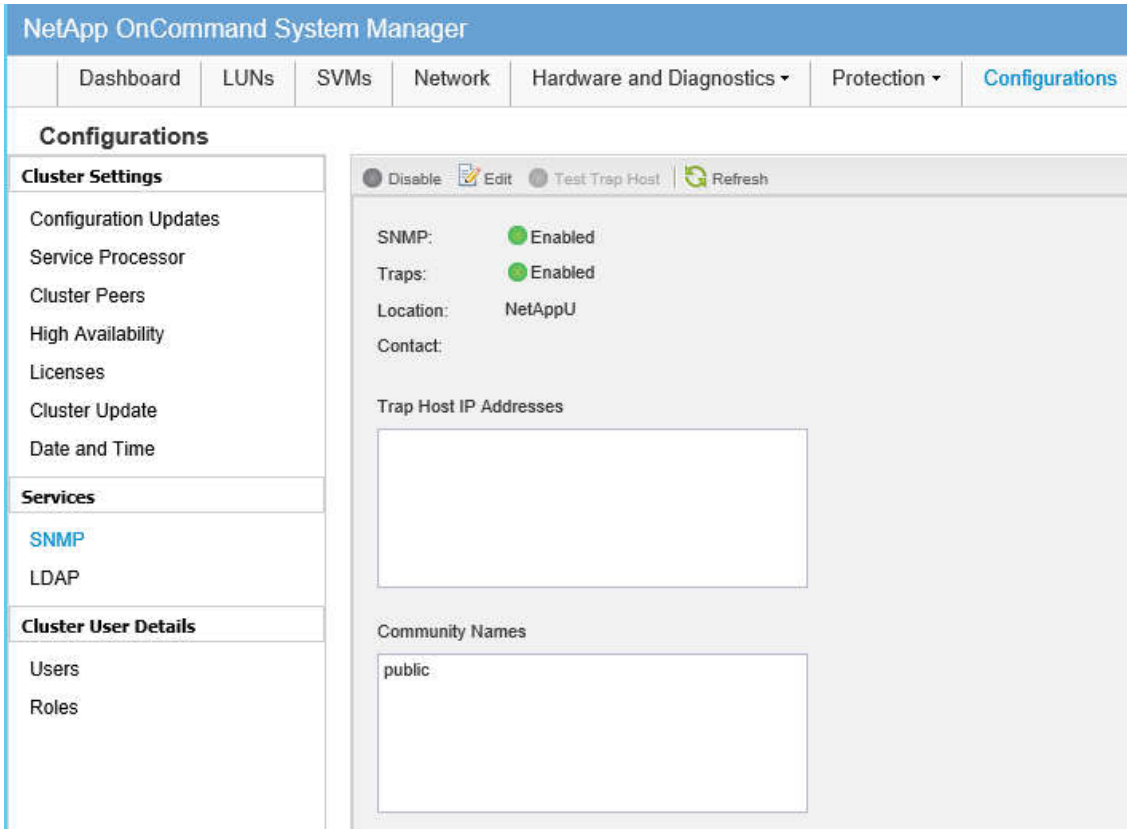
10.	
	`SVLc1::> date`
	`Node Date Time zone`
	`SVLc1-01 Wed Nov 16 11:52:37 2016 US/Pacific`
	`SVLc1-02 Wed Nov 16 11:52:42 2016 US/Pacific`
	`2 entries were displayed.`

11.	If the system date and time are not synchronized to within five minutes, correct the ONTAP cluster date.

12.	Enter the date command plus the accurate date and time. You use the 24-hour time format with the following syntax:
	`date [YYYY][MM][DD][HH][MM]`
	`SVLc1::> date 201611161156`
	`SVLc1::> date`
	`Node Date Time zone`
	`SVLc1-01 Wed Nov 16 11:56:03 2016 US/Pacific`
	`SVLc1-02 Wed Nov 16 11:56:03 2016 US/Pacific`
	`2 entries were displayed.`

13.	When you enter the date command on any node in the cluster, the date command sets the date and time on all nodes in the ONTAP cluster. NTP service synchronizes the date and time for all nodes in the cluster. If an NTP time server has been configured, all nodes in the cluster remain in time synchronization with the NTP time server.

STEP	ACTION
14.	Click the Configurations link from the menu. 
15.	Click **SNMP** then click **EDIT**. 

STEP	ACTION
16.	Click **Add** and enter the community name: **`public.`** Click **OK** to accept the community name. 
17.	Click **OK** to close the editor.
18.	Verify that "public" is now in the community names area. 

TASK 5: IDENTIFY CLUSTERED DATA ONTAP COMPONENTS

In this task, you use either System Manager or the clustered Data ONTAP CLI to identify key clustered Data ONTAP components and revert any LIFs that are not on their home ports.

STEP	ACTION
1.	Analyze and identify the following list of clustered Data ONTAP components: Aggregates_____ Storage virtual machines _____ Volumes_____ LUNs_____ Licenses (which features are installed?) _____ CIFS Shares _____ LIFs (are all LIFs home?)_____
2.	Revert any LIFs that are not on their home ports.

TASK 6: SET THE CLUSTERED DATA ONTAP COMMAND LINE SYSTEM TIMEOUT VALUE (OPTIONAL)

In this optional task, you set the clustered Data ONTAP command-line system timeout value.

STEP	ACTION
1.	Open a PuTTY session with **cluster1**.
2.	Check the current system timeout value. `system timeout show`
3.	Set the system timeout to 0 (no timeout). `system timeout modify -timeout 0`

END OF EXERCISE

MODULE 3: CLUSTERED STORAGE SYSTEM WORKLOADS AND BOTTLENECKS

EXERCISE

In this exercise, you examine the different variations of the `statistics` command, and identify storage system workloads and potential bottlenecks.

OBJECTIVES

By the end of this exercise, you should be able to:

- Use the `statistics catalog` command
- Use the `statistics start` and `statistics show` commands
- Define workload characteristics

TASK 1: EXAMINE THE STATISTICS CATALOG COMMAND

In this task, you issue the three `statistics catalog` commands and exercise the supporting parameters, using different privilege levels.

STEP	ACTION
1.	Open a PuTTY session with **cluster1**.
2.	Examine the available statistics objects at the admin privilege level. **`statistics catalog object show`**
3.	Change to the advanced privilege level and reissue the command.
4.	Notice the catalog is ONLY available at the advanced privilege level in version 9.x?
5.	What command syntax would you use to display statistics objects that are associated with storage virtual machines (SVMs)? **NOTE:** You should still be in the advanced privilege level. How many statistics objects are there in the list?
6.	Examine the instance names that are available for the statistics object "volume." **`statistics catalog instance show -object volume`**
7.	What command syntax would you use to display the instance names that are available for the statistics object that represents SVMs that have LIFs associated with them? How many instance names are there in the list?
8.	What command syntax would you use to display the instance names that are available for the statistics object that represents SVMs that have volumes associated with them? How many instance names are there in the list?

STEP	ACTION
9.	What command syntax would you use to display the instance names that are available for the statistics object that represents the disk that is associated with the second node in the cluster (cluster1-02)?
10.	Examine the counters that are available for the statistics object “disk” and show the detailed information. **statistics catalog counter show -object disk –describe**
11.	Examine the counters that are available for the statistics object “aggregate” and show the detailed information. **statistics catalog counter show -object aggregate -describe**
12.	Examine the counters that are available for the statistics object “volume” and show the detailed information. **statistics catalog counter show -object volume -describe**

TASK 2: EXAMINE THE STATISTICS START AND STATISTICS SHOW COMMANDS

In this task, you issue the `statistics start` and `statistics show` commands and exercise the supporting parameters, using different privilege levels.

STEP	ACTION
1.	Using the advanced privilege level, start statistics data collection on the statistics object “nfsv3.” **statistics start -object nfsv3 -sample-id sample_nfsv3_adv**
2.	Using the diag privilege level, start statistics data collection on the statistics object “nfsv3.” **set diag** **statistics start -object nfsv3 -sample-id sample_nfsv3_diag**
3.	Display the counters that are associated with the statistics object “nfsv3” instance “vs2” for both samples. **statistics show -object nfsv3 -instance vs2 -counter * -sample-id sample_nfsv3_adv** **statistics show -object nfsv3 -instance vs2 -counter * -sample-id sample_nfsv3_diag** Was there any difference in the displays?
4.	Using the advanced privilege level, start statistics data collection on the statistics object “disk.” **statistics start -object disk -sample-id sample_disk**

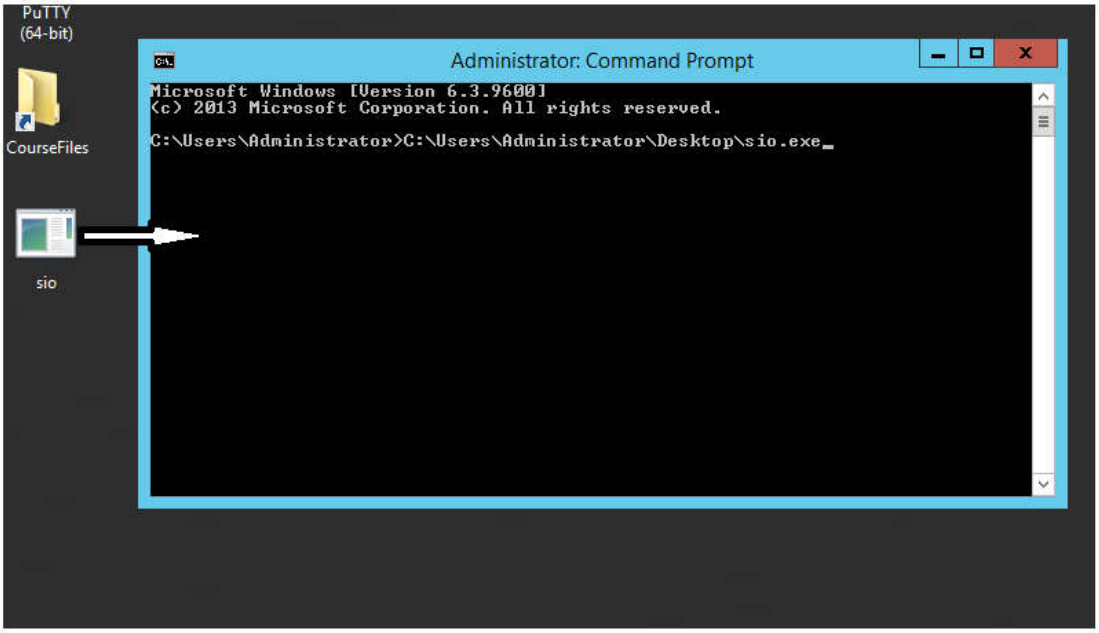
STEP	ACTION
5.	What command syntax would you use to display all of the latency related counters for disk NET-1.10 How many counters are there in the list?
6.	What command syntax would you use to display all of the user_read_latency counters for all disks in the cluster? How many counters are there in the list?
7.	Display only the disks with the user_read_latency counter between 1ms and 5ms. **statistics show -object disk -instance * -counter user_read_latency -sample-id sample_disk -value 1..5**
8.	What command syntax would you use to display all of the user_read_latency counters that are greater than 3ms for all disks in the cluster, limiting the display to only the counter and value fields? HINT: try using a greater or lesser than symbol
9.	Using the advanced privilege level, start statistics data collection on the statistics object "aggregate." **statistics start -object aggregate -sample-id sample_aggr**
10.	Display nonzero user_reads and user_writes counters for each aggregate. **statistics show -object aggregate -instance * -counter user_reads|user_writes -sample-id sample_aggr -value >0**
11.	Using the advanced privilege level, start statistics data collection on the statistics object "volume." **statistics start -object volume -sample-id sample_volume**
12.	Display all of the volume activity by displaying all of the data counters for each volume. **statistics show -object volume -instance * -counter *data -sample-id sample_volume**
13.	What command syntax would you use to display all of the latency counters for all volumes in the cluster? How about all nonzero latency counters?
14.	Using the advanced privilege level, start statistics data collection on the statistics object "processor." **statistics start -object processor -sample-id sample_processor**
15.	What command syntax would you use to display all of the counters for all processors in the cluster?

STEP	ACTION
16.	Using the advanced privilege level, start statistics data collection on the statistics object "workload." **statistics start -object workload -sample-id sample_workload**
17.	Display all of the latency counters for each workload and limit the display to the counter and value fields. **statistics show -object workload -instance * -counter *latency -sample-id sample_workload -fields counter,value**
18.	Stop all statistics data collection. **statistics stop -sample-id sample_nfsv3_adv** **statistics stop -sample-id sample_nfsv3_diag** **statistics stop -sample-id sample_disk** **statistics stop -sample-id sample_aggr** **statistics stop -sample-id sample_volume** **statistics stop -sample-id sample_processor** **statistics stop -sample-id sample_workload**

TASK 3: DEFINING WORKLOAD CHARACTERISTICS

In this task, you gather statistical data and evaluate the data to determine the workload characteristics.

STEP	ACTION
1.	Open a PuTTY session with **cluster1**.
2.	Turn off the Snapshot policy for volume vs2_vol01. **volume modify -vserver vs2 -volume vs2_vol01 -snapshot-policy none** Type **Y** to continue
3.	On your Windows Server desktop, double-click the **CourseFiles** shortcut: 
4.	Copy the file **300mfile** to the **z:** drive.
5.	Normally you would start data collection for all of the protocols that are being served by the cluster; however, for this exercise you use only CIFS. Using the diagnostic privilege level, start statistics data collection on the objects "cifs," "volume," and "readahead." **NOTE:** Diagnostic privilege level commands are required to capture **cifs_read_size_histo**, **cifs_write_size_histo**, **rand_read_req**, and **seq_read_req**. **set diagnostic** **statistics start -object cifs|volume|readahead -sample-id sample_cifs1**

STEP	ACTION
6.	On the Windows Server taskbar, click the **Command Prompt**. 
7.	Drag the **SIO.exe** shortcut to the **Command Prompt** window. 
8.	Press the **Spacebar**, type the following list of parameters, and then press **Enter**: `0 0 32k 300m 30 1 z:\300mfile`
9.	After the command ends and the command prompt returns, go to the PuTTY session and turn off data collection. `statistics stop -sample-id sample_cifs1`

STEP	ACTION
10.	Start statistics data collection again on the same objects, but this time change the sample name to **sample_cifs2**. **statistics start -object cifs|volume|readahead -sample-id sample_cifs2**
11.	In the Command Prompt window, press the **Up arrow**, change the SIO parameters to the following, and then press **Enter**: **100 0 32k 300m 30 4 z:\300mfile**
12.	After the command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_cifs2**
13.	Run through the same sequence (Steps 10–12) one more time for sample_cifs3, using the following SIO parameters: **sample_cifs3** **50 100 4k 300m 30 32 z:\300mfile** **NOTE:** After the command ends and the command prompt returns, remember to go to the PuTTY session and turn off data collection.
14.	After all three samples are collected; analyze the counters to determine the workload characteristics of each sample. The following commands will help to define the CIFS workload in each sample (sample_cifs1 through sample_cifs3). **NOTE:** Change the X in **sample_cifsX** to the sample being analyzed (1 through 3). **statistics show -object cifs -instance * -counter cifs_read_ops -sample-id sample_cifsX** **statistics show -object cifs -instance * -counter cifs_write_ops -sample-id sample_cifsX** **statistics show -object volume -instance * -counter cifs_read_latency -sample-id sample_cifsX** **statistics show -object volume -instance * -counter cifs_write_latency -sample-id sample_cifsX** **statistics show -object cifs -instance * -counter cifs_read_size_histo -sample-id sample_cifsX** **statistics show -object cifs -instance * -counter cifs_write_size_histo -sample-id sample_cifsX** The following statistics commands are specific to *read* workloads. If you have already determined that the workload is a *write* workload, you can skip these commands. **statistics show -object readahead -instance * -counter rand_read_reqs -sample-id sample_cifsX** **statistics show -object readahead -instance * -counter seq_read_reqs -sample-id sample_cifsX**

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td>15.</td><td>Record your observations for sample_cifs1 below:
<table>
<tr><th>CHARACTERISTIC</th><th colspan="2">OBSERVED VALUE</th></tr>
<tr><td></td><td>Read</td><td>Write</td></tr>
<tr><td>Throughput</td><td></td><td></td></tr>
<tr><td>Latency</td><td></td><td></td></tr>
<tr><td>Operation Size</td><td></td><td></td></tr>
<tr><td>Concurrency</td><td></td><td></td></tr>
<tr><td>Randomness</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>16.</td><td>What did the command-line output look like for throughput of sample_cifs1?</td></tr>
<tr><td>17.</td><td>What did the command-line output look like for latency of sample_cifs1?</td></tr>
<tr><td>18.</td><td>What did the command-line output look like for read operation size of sample_cifs1?</td></tr>
<tr><td>19.</td><td>What did the command-line output look like for write operation size of sample_cifs1?</td></tr>
<tr><td>20.</td><td>What did the calculation (throughput * latency) look like for concurrency of sample_cifs1?</td></tr>
<tr><td>21.</td><td>What did the command-line output look like for randomness (<code>rand_read_reqs</code>) of sample_cifs1?</td></tr>
<tr><td>22.</td><td>What did the command-line output look like for randomness (<code>seq_read_reqs</code>) of sample_cifs1?</td></tr>
<tr><td>23.</td><td>What workload did you conclude from your data collection of sample_cifs1?</td></tr>
</table>

STEP	ACTION
24.	Record your observations for sample_cifs2 below:

CHARACTERISTIC	OBSERVED VALUE	
	Read	Write
Throughput		
Latency		
Operation Size		
Concurrency		
Randomness		

25.	What did the command-line output look like for throughput of sample_cifs2?
26.	What did the command-line output look like for latency of sample_cifs2?
27.	What did the command-line output look like for read operation size of sample_cifs2?
28.	What did the command-line output look like for write operation size of sample_cifs2?
29.	What did the calculation (throughput * latency) look like for concurrency of sample_cifs2?
30.	What did the command-line output look like for randomness (`rand_read_reqs`) of sample_cifs2?
31.	What did the command-line output look like for randomness (`seq_read_reqs`) of sample_cifs2?
32.	What workload did you conclude from your data collection of sample_cifs2?

STEP	ACTION
33.	Record your observations for sample_cifs3 below:

CHARACTERISTIC	OBSERVED VALUE	
	Read	Write
Throughput		
Latency		
Operation Size		
Concurrency		
Randomness		

34.	What did the command-line output look like for throughput of sample_cifs3?
35.	What did the command-line output look like for latency of sample_cifs3?
36.	What did the command-line output look like for read operation size of sample_cifs3?
37.	What did the command-line output look like for write operation size of sample_cifs3?
38.	What did the calculation (throughput * latency) look like for concurrency of sample_cifs3?
39.	What did the command-line output look like for randomness (`rand_read_reqs`) of sample_cifs3?
40.	What did the command-line output look like for randomness (`seq_read_reqs`) of sample_cifs3?
41.	What workload did you conclude from your data collection of sample_cifs3?

STEP	ACTION
42.	The previous examples used CIFS as the basis for the workloads. What statistics objects and counters would be needed for NFSv3?

END OF EXERCISE

MODULE 4: CLUSTER PERFORMANCE MONITORING AND ANALYSIS

EXERCISE

In this exercise, you identify storage system performance baselines, analyze and isolate bottlenecks, and work with the Perfstat utility.

OBJECTIVES

By the end of this exercise, you should be able to:

- Perform initial health checks on a cluster
- Perform baseline performance monitoring from the cluster shell
- Perform performance monitoring and analysis from the cluster shell
- Unlock the diag userid
- Use the Performance and Statistics Collector (Perfstat)

TASK 1: PERFORM INITIAL HEALTH CHECKS ON THE CLUSTER

In this task, you query the cluster to assess the initial health status.

STEP	ACTION
1.	Open a PuTTY session with cluster1.
2.	Check to see if all of the nodes are healthy. **`cluster show`**
3.	Check to see if the replication rings have the same (or consistent) masters. **NOTE:** Remember to set advanced privilege before you execute this command. **`cluster ring show`**
4.	Using the advanced privilege level, check to see if the cluster connectivity is healthy. **`cluster ping-cluster -node local`**
5.	Check to see if the storage virtual machines (SVMs) are healthy. *Deprecated in ONTAP 9*. All health monitoring is under the **`system`** command syntax directory on ONTAP 9. For everything else we will use OCUM/OPM/Harvest in a later chapter **`dashboard health vserver show`** **`system health subsystem show`** (In ONTAP 9 we will use OCUM/OPM)
6.	If any of the SVMs return a nonzero status, add the **`-all`** parameter for additional information. *Deprecated in ONTAP 9*. **`dashboard health vserver show-all`** **`system health status show`** (In ONTAP 9 we will use OCUM/OPM)
7.	Check to see if any volumes are not online. **`volume show -state !online`**
8.	Check to see if any aggregates are not online. **`storage aggregate show -state !online`**

STEP	ACTION
9.	Check to see if any disks are in a broken state. **`storage disk show -state broken`**
10.	Normally at this point in the health check, you would check the performance status by using the commands that follow; however, because these commands will also be run as part of the next task, they *do not* have to be run at this time. To check the performance status (which is optional at this time), enter these commands from the advanced privilege level: a. Check the current level of activity on each node of the cluster. **`statistics show-periodic -node cluster1-01 -iterations 4`** **`statistics show-periodic -node cluster1-02 -iterations 4`** b. Check the current level of activity on the entire cluster. **`dashboard performance show`** (deprecated in ONTAP 9) (In ONTAP 9 we will use OCUM/OPM)

TASK 2: BASELINE PERFORMANCE MONITORING FROM THE CLUSTER SHELL

In this task, you use cluster shell commands to monitor cluster performance.

STEP	ACTION
1.	Check the performance status: a. Check the current level of activity on each node of the cluster. **`statistics show-periodic -node cluster1-01 -iterations 4`** **`statistics show-periodic -node cluster1-02 -iterations 4`** b. Check the current level of activity on the entire cluster and notice the overall latency column. **`dashboard performance show`** (deprecated in ONTAP 9) (In ONTAP 9 we will use OCUM/OPM)
2.	Check the current NAS operations level on the entire cluster. **`dashboard performance show -operations`** (In ONTAP 9 we will use OCUM/OPM)
3.	Use the **`-instance`** parameter to show everything and notice the overall latency by protocol fields. **`dashboard performance show -instance`** (In ONTAP 9 we will use OCUM/OPM)
4.	Check the overall latency for the entire cluster. **`statistics show-periodic -object cluster -instance latency -iterations 4`**

STEP	ACTION
5.	Check the overall latency for each node in the cluster. **statistics show-periodic –object cluster -node cluster1-01 -instance latency -iterations 4** **statistics show-periodic –object cluster -node cluster1-02 -instance latency -iterations 4**
6.	Check the throughput by cluster. **statistics show-periodic -iterations 4**
7.	Check the throughput by volume for volume vs2_vol01. **statistics show-periodic -object volume -instance vs2_vol01 -iterations 4** How can you make the output more readable?
8.	Normally at this point in the baseline check, you would check the ifnet status by using the command that follows; however, because the lab kits do not have any ifnets defined, the command *does not* have to be run at this time. If you want to do so at this time, check the throughput by interface. **statistics show-periodic -object ifnet -instance a0a -node cluster1-02 -iterations 4**
9.	Check the throughput by LIF (IP). **statistics show-periodic -object lif -instance vs2_cifs_nfs_lif1 -iterations 4**
10.	Using the advanced privilege level, start statistics data collection on the objects “volume,” “aggregate,” “disk,” “ext_cache_obj,” “port,” and “lif.” **set advanced** **statistics start -object volume|aggregate|disk|port|lif -sample-id sample_baseline1**
11.	Check the latency by volume for the entire cluster. **statistics show -object volume -counter *latency -sample-id sample_baseline1**
12.	Check volume latency for a specific volume. **statistics show-periodic -object volume -instance vs2_vol01 -iterations 4**
13.	Check volume activity. **statistics show -object volume -counter *data -sample-id sample_baseline1**

STEP	ACTION
14.	Check aggregate latency. `statistics show -object aggregate -counter user_reads|user_writes -sample-id sample_baseline1`
15.	Check disk latency. `statistics show -object disk -counter *latency -sample-id sample_baseline1`
16.	Check port throughput. `statistics show -object port -counter *data -sample-id sample_baseline1`
17.	Check the LIF or IP throughput. `statistics show -object lif -counter *data -sample-id sample_baseline1`
18.	After completing the task, turn off the statistics data collection. `statistics stop -sample-id sample_baseline1`

19.	Clean up any old samples.
	`statistics samples show`
	`statistics samples delete -sample-id *`

TASK 3: PERFORMANCE MONITORING FROM THE CLUSTER SHELL

In this task, you use cluster shell commands to monitor cluster performance.

STEP	ACTION
1.	On your Windows Server desktop, double-click the **CourseFiles** shortcut:  Copy **sio_ntap.tar.gz** to the **z:** drive.
2.	Using PuTTY, log in to the Linux server as **root** (password: **Netapp123**).
3.	Mount the vs2 export via NFS, using the following IP: `mount -t nfs 192.168.0.122:/vs2vol1 /mnt/path01`

4.	Change directory to **`/usr/tmp`**, make a new directory **sio**, and change directory into it.
	`cd /usr/tmp`
	`mkdir sio`
	`cd sio`

STEP	ACTION
5.	Extract (untar) the contents of **sio_ntap.tar.gz** into the current directory. **tar -xvf /mnt/path01/sio_ntap.tar.gz**
6.	In your cluster1 PuTTY session, verify that your LIFs that are associated with SVM vs2 are home and, if they are not, send them home. **network interface show -vserver vs2** **network interface revert -vserver vs2 -lif ***
7.	Normally you would start data collection for all of the protocols being served by the cluster; however, for this exercise you use only NFSv3. In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects "nfsv3," "volume," "aggregate," "disk," "port," "lif," and "readahead." **NOTE:** Diagnostic privilege level commands are required to capture `rand_read_req` and `seq_read_req`. **set diagnostic** **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs1**
8.	On the Linux server, start SIO with a 0% read workload, 0% random, 32-KB block size, 300-MB file size, run for one hundred seconds, one thread, and point it at the file on the NFS mount. **/usr/tmp/sio/sio_ntap_linux 0 0 32k 300m 100 1 /mnt/path01/300mfile**
9.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results. It is recommended that you increase the "Lines of scrollback" in your cluster1 PuTTY session to at least 2000. This information will be used to complete questions later in this task. **HINT:** Use the baseline analysis commands.
10.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_nfs1**
11.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects "nfsv3," "volume," "aggregate," "disk," "port," "lif," and "readahead." **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs2**
12.	On the Linux server, start SIO with a 0% read workload, 0% random, 32-KB block size, 300-MB file size, run for one hundred seconds, four threads, and point it at the file on the NFS mount. **/usr/tmp/sio/sio_ntap_linux 0 0 32k 300m 100 4 /mnt/path01/300mfile**
13.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results.

STEP	ACTION
14.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_nfs2**
15.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects “nfsv3,” “volume,” “aggregate,” “disk,” “port,” “lif,” and “readahead.” **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs3**
16.	On the Linux server, start SIO with a 100% read workload, 0% random, 32-KB block size, 300-MB file size, run for one hundred seconds, one thread, and point it at the file on the NFS mount. **/usr/tmp/sio/sio_ntap_linux 100 0 32k 300m 100 1 /mnt/path01/300mfile**
17.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results.
18.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_nfs3**
19.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects “nfsv3,” “volume,” “aggregate,” “disk,” “port,” “lif,” and “readahead.” **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs4**
20.	On the Linux server, start SIO with a 100% read workload, 0% random, 32-KB block size, 300-MB file size, run for one hundred seconds, four threads, and point it at the file on the NFS mount. **/usr/tmp/sio/sio_ntap_linux 100 0 32k 300m 100 4 /mnt/path01/300mfile**
21.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results.
22.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_nfs4**
23.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects “nfsv3,” “volume,” “aggregate,” “disk,” “port,” “lif,” and “readahead.” **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs5**
24.	On the Linux server, start SIO with a 100% read workload, 0% random, 32-KB block size, 20-MB file size, run for one hundred seconds, four threads, and point it at the file on the NFS mount. The 20-MB file will create a cached workload. **/usr/tmp/sio/sio_ntap_linux 100 0 32k 20m 100 4 /mnt/path01/300mfile**
25.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results.

STEP	ACTION
26.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_nfs5**
27.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects “nfsv3,” “volume,” “aggregate,” “disk,” “port,” “lif,” and “readahead.” **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs6**
28.	On the Linux server, start SIO with a 50% read and 50% write workload, 100% random, 4-KB block size, 300-MB file size, run for one hundred seconds, 32 threads, and point it at the file on the NFS mount. **/usr/tmp/sio/sio_ntap_linux 50 100 4k 300m 100 32 /mnt/path01/300mfile**
29.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results.
30.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **statistics stop -sample-id sample_nfs6**
31.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, did the throughput and I/Os increase when the number of threads increased?
32.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload had the highest throughput in terms of KBps?
33.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload had the highest throughput in terms of IOPS?
34.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload showed the lowest latencies on the storage system?
35.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload showed the highest disk utilization on the storage system?
36.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload showed the highest CPU utilization on the storage system?
37.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects “nfsv3,” “volume,” “aggregate,” “disk,” “port,” “lif,” and “readahead.” **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs7**
38.	On the Linux server, reissue the same SIO workload by starting SIO with a 50% read and 50% write workload, 100% random, 4-KB block size, 300-MB file size, run for one hundred seconds, 32 threads, and point it at the file on the NFS mount. **/usr/tmp/sio/sio_ntap_linux 100 0 32k 300m 100 4 /mnt/path01/300mfile**

STEP	ACTION
39.	While the SIO is running, in your cluster1 PuTTY session, migrate your NAS LIF that is associated with `/mnt/path01`. **`network interface migrate -vserver vs2 -lif vs2_cifs_nfs_lif2 -dest-node cluster1-02`**
40.	Using the analysis commands that you have learned, analyze the data and record or save the results.
41.	Compare your results with the results from **`sample_nfs6`** which uses the same workload without a migrating LIF.
42.	After the SIO command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **`statistics stop -sample-id sample_nfs7`**
43.	In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects "nfsv3," "volume," "aggregate," "disk," "port," "lif," and "readahead." **`statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs8`**
44.	On the Linux server, start SIO with a 50% read and 50% write workload, 100% random, 4-KB block size, 300-MB file size, run for one hundred seconds, 32 threads, and point it at the file on the NFS mount. **`/usr/tmp/sio/sio_ntap_linux 50 0 32k 300m 100 32 /mnt/path01/300mfile`**
45.	Perform a volume move of volume vs2_vol01 from aggregate n01_aggr1 to n02_aggr2. **`volume move start -vserver vs2 -volume vs2_vol01 -destination-aggregate n02_aggr1`**
46.	Using the analysis commands that you have learned, analyze the data and record or save the results. **HINT:** Analyze the cluster interconnect statistics. **NOTE:** You can view the status of the volume move with the following command: **`volume move show -vserver vs2 -volume vs2_vol01`**
47.	After the **`volume move`** command ends and the command prompt returns, go to the PuTTY session and turn off data collection. **`statistics stop -sample-id sample_nfs8`**
48.	After you finish your analysis, clean up any old samples. **`statistics samples show`** **`statistics samples delete -sample-id *`**

TASK 4: UNLOCK DIAG USERID

In this task, you unlock the diag userid for use with Perfstat.

STEP	ACTION
1.	Unlock the diag userid. **`security login unlock -username diag`**
2.	Change the diag userid's password. **`security login password -username diag`**
3.	At the "Enter a new password" prompt, type **`Netapp123`**.
4.	At the "Enter it again" prompt, type **`Netapp123`** again.

TASK 5: USING THE PERFORMANCE AND STATISTICS COLLECTOR (PERFSTAT)

In this task, you use Perfstat to collect detailed profile and troubleshooting data samples from a cluster.

STEP	ACTION
1.	On your Windows Server desktop, double-click the **Coursefiles** shortcut:  **NOTE:** Normally, you would open a browser and navigate to My Support > Downloads > Utility Toolchest on the Support site and download the Perfstat Converged compressed file for either Windows or Linux. This process has already been completed on your Windows Server.
2.	In the CourseFiles directory, create a directory called Perfstat, and then copy the perfstat8.exe file from the zip file into the Perfstat directory.
3.	In the **Perfstat** directory, create two directories called **workload1** and **workload2**.
4.	On the Windows Server taskbar, click the **Command Prompt** icon and navigate to **`C:\Users\Administrator\Desktop\CourseFiles\Perfstat\workload1`**.
5.	On the Linux server, start SIO with a 0% read workload, 0% random, 32-KB block size, 300-MB file size, run indefinitely, 32 threads, and point it at the file on the NFS mount. **`/usr/tmp/sio/sio_ntap_linux 0 0 32k 300m 0 32 /mnt/path01/300mfile`**
6.	In the first Command Prompt window, start Perfstat with the following command parameters: ▪ **`192.168.0.101`** (the cluster management LIF of cluster1) ▪ **`--mode="cluster"`** (to signify that this is a clustered Data ONTAP storage environment) ▪ **`--time 1`** (to signify one minute iterations) **`..\perfstat8 192.168.0.101 --mode="cluster" --time 1`**
7.	When prompted for the SSH passphrase, press **Enter**, and then press **Enter** again for same passphrase.
8.	When prompted for filer username enter **`admin`** when prompted for password, type **`Netapp123`**. After a few seconds you will see "**….**" where the curser was positioned. Perfstat runs one iteration for each controller in the cluster and one for the host machine (in this case Windows).

STEP	ACTION
9.	After the Perfstat operation is complete, issue **Ctrl-C** in the Linux server session to stop the SIO run.
10.	Look for the protocol latencies, CPU utilization, network utilization, and average per disk utilization in the Perfstat data.
11.	In the first **Command Prompt** window, navigate to **`C:\Users\Administrator\Desktop\CourseFiles\Perfstat\workload2`**.
12.	On the Linux server, start SIO with a 100% read workload, 100% random, 4-KB block size, 300-MB file size, run indefinitely, 32 threads, and point it at the file on the NFS mount. **`/usr/tmp/sio/sio_ntap_linux 100 100 4k 300m 0 32 /mnt/path01/300mfile`**
13.	In the first **Command Prompt** window, start Perfstat with the same parameters as the first run.
14.	After the Perfstat operation is complete, issue **Ctrl-C** in the Linux server session to stop the SIO run.
15.	Find the protocol latencies, CPU utilization, network utilization, and average per disk utilization in the Perfstat data.

END OF EXERCISE

MODULE 5: ONCOMMAND MANAGEMENT TOOLS

There is no exercise associated with Module 5.

MODULE 6: STORAGE QOS

EXERCISE

In this exercise, you work with the storage quality of service (QoS) feature to prevent problem workloads and tenants from impacting other workloads and tenants.

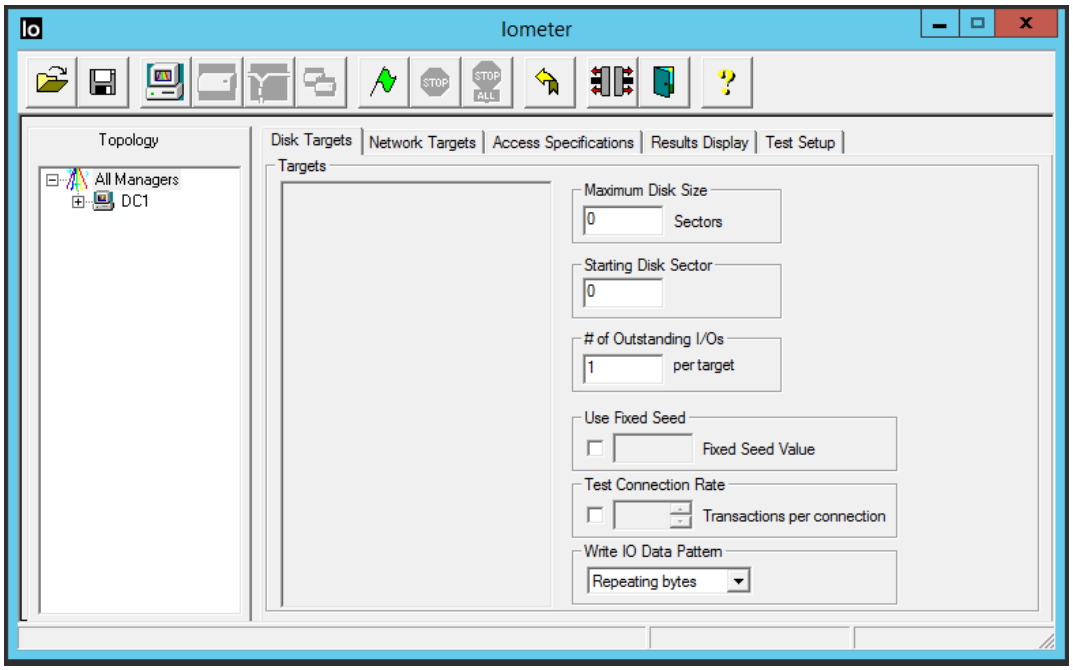
OBJECTIVES

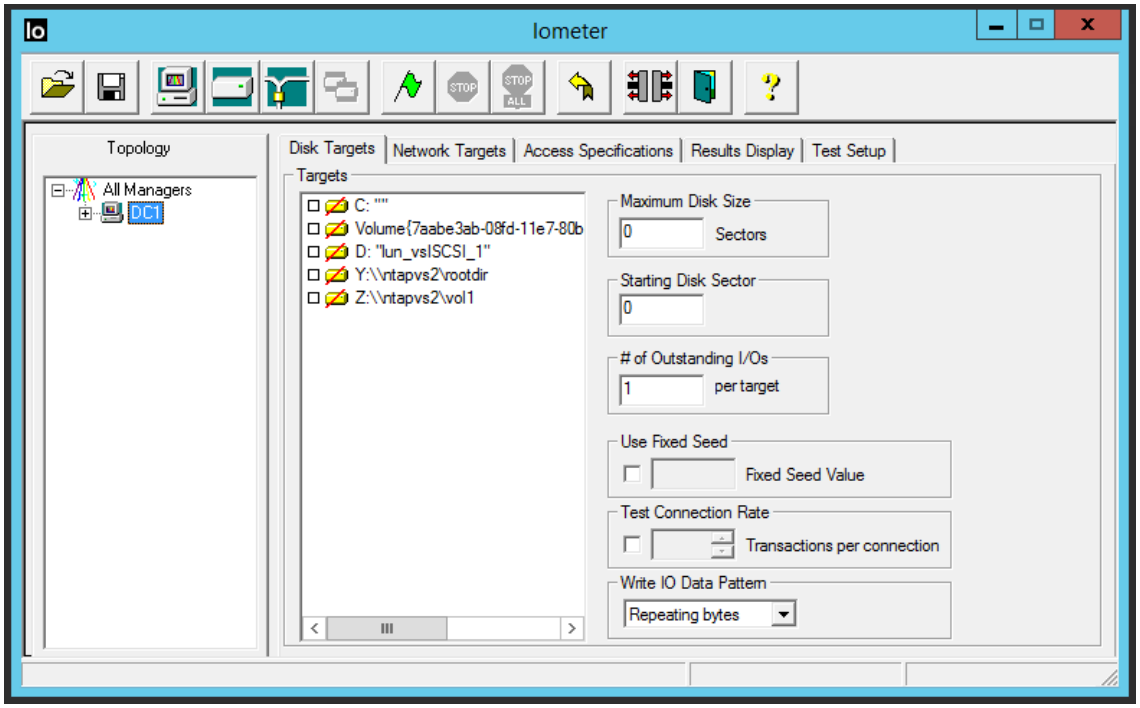
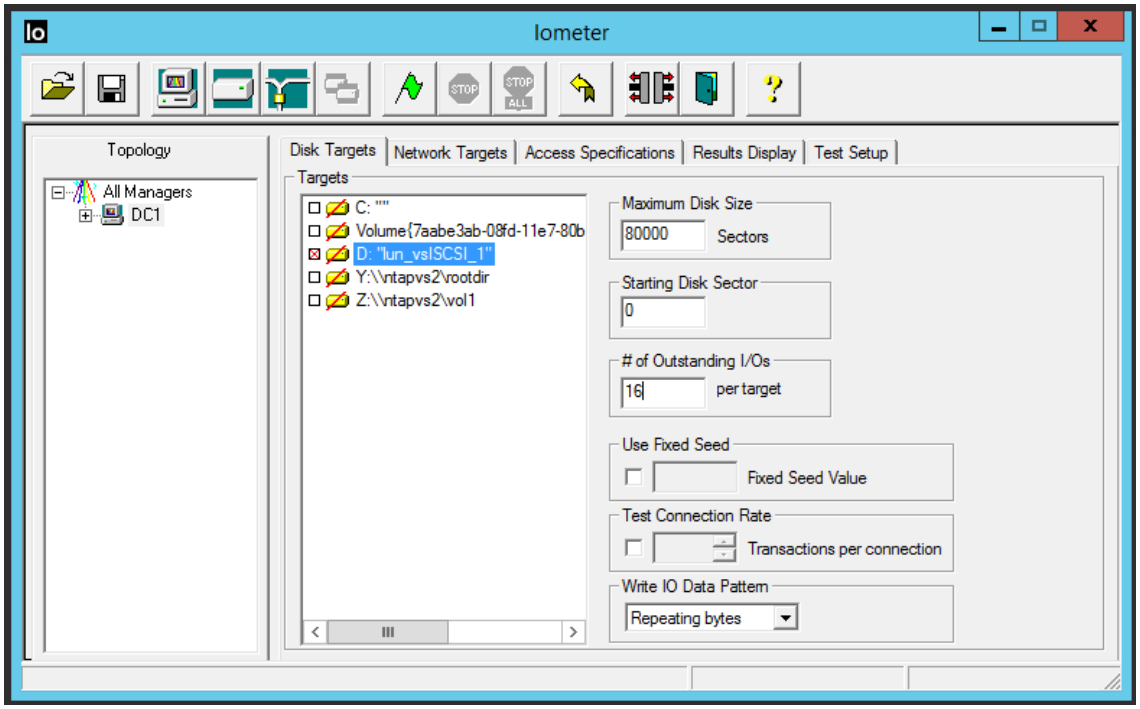
By the end of this exercise, you should be able to:

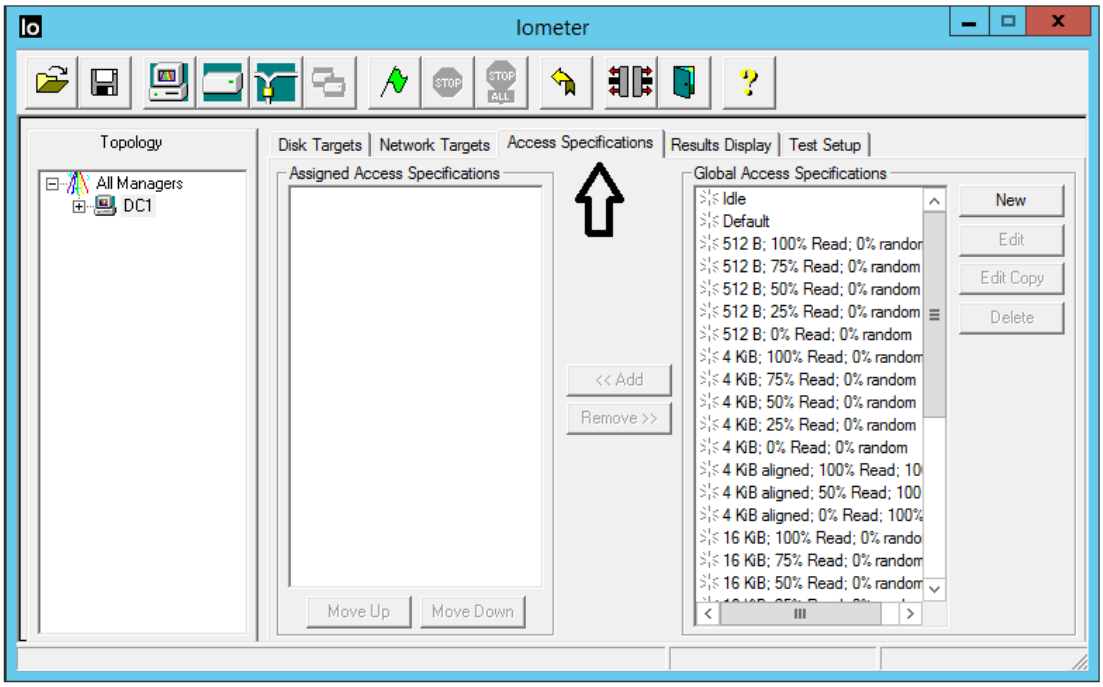
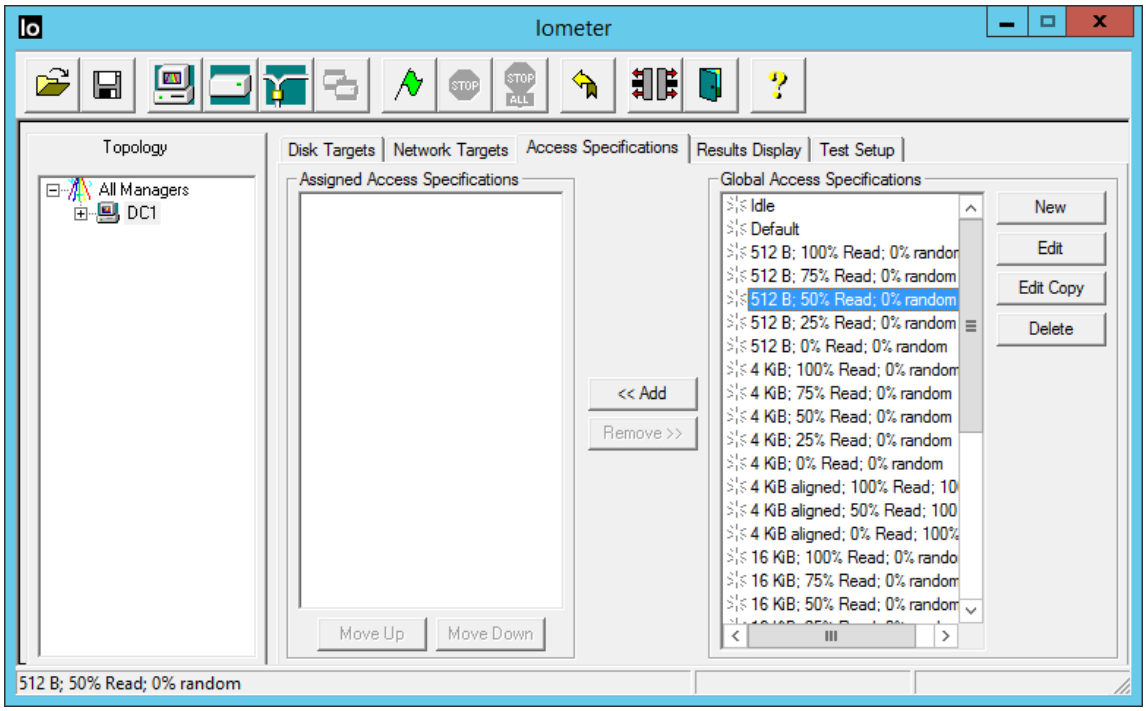
- Reactively limit throughput to a workload by associating the workload with a QoS policy group
- Proactively monitor workload performance by associating a workload with a QoS policy group
- Isolate a tenant workload by associating the workload with a QoS policy group

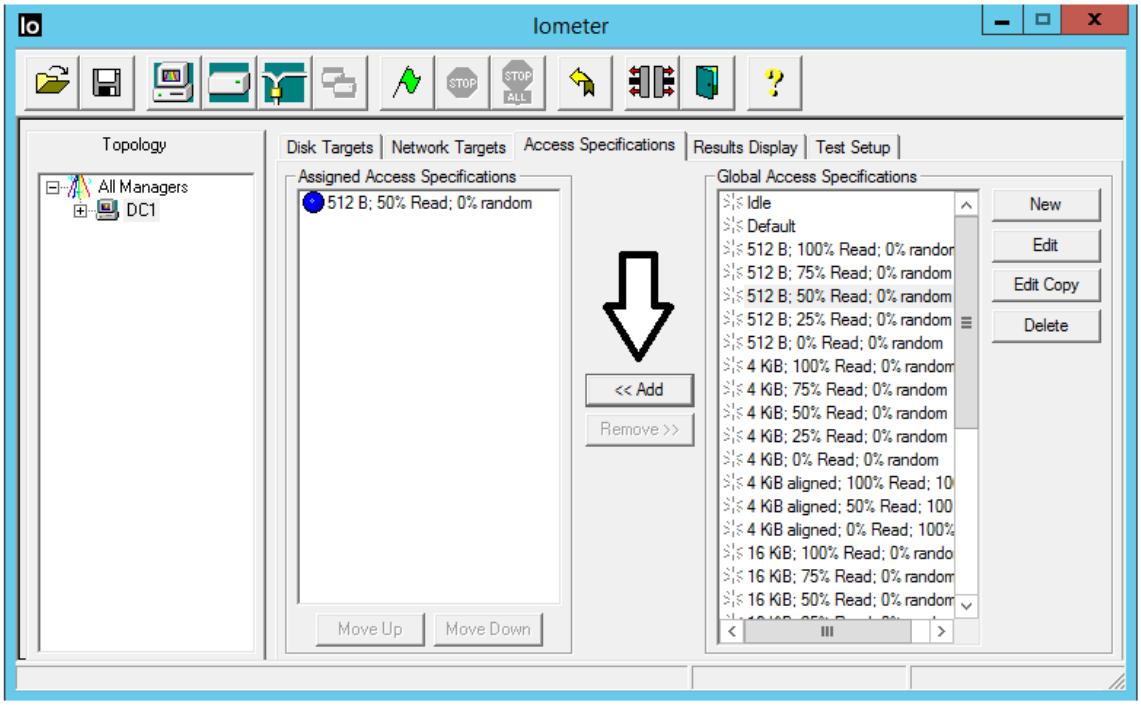
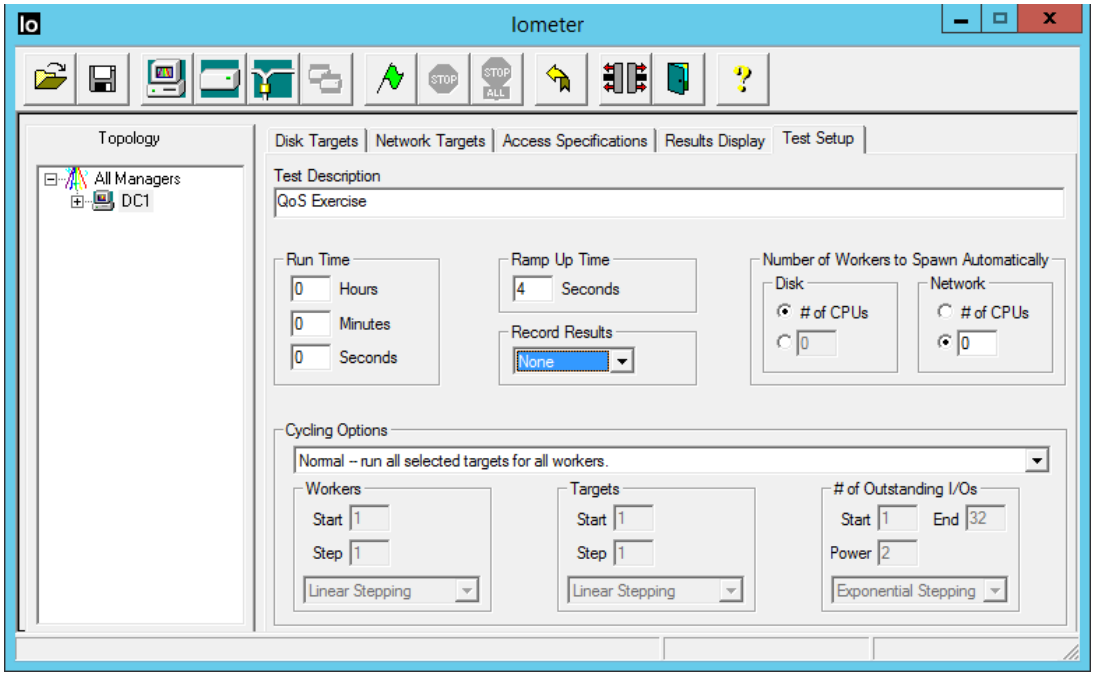
TASK 1: REACTIVELY LIMIT THROUGHPUT TO A WORKLOAD BY ASSOCIATING THE WORKLOAD WITH QOS POLICY GROUP

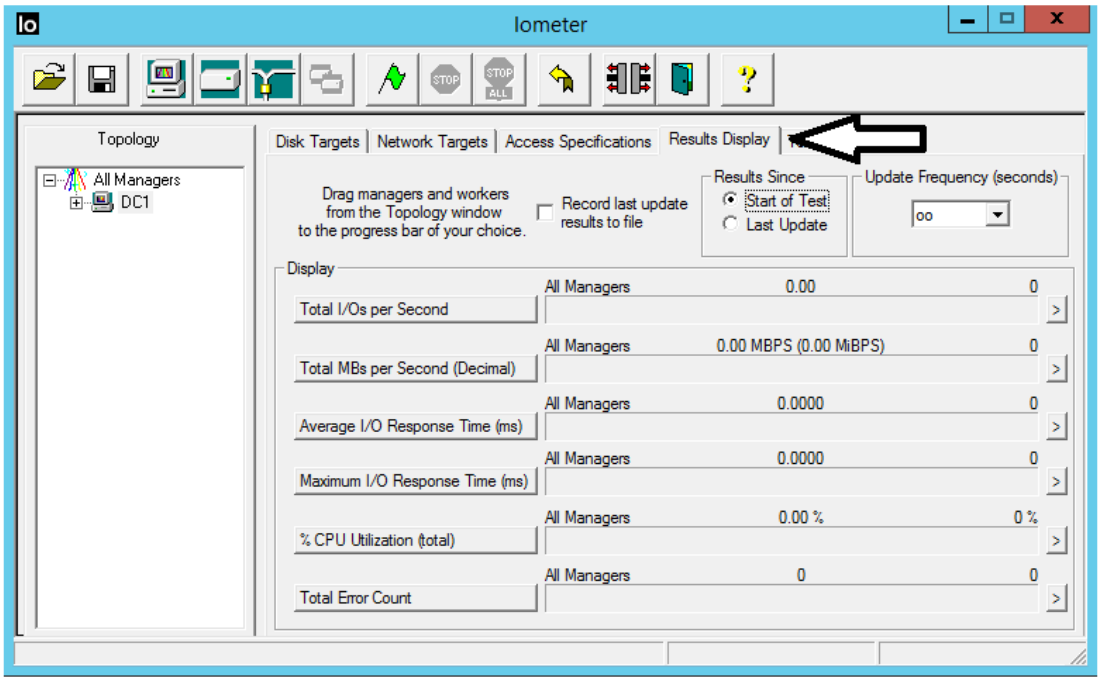
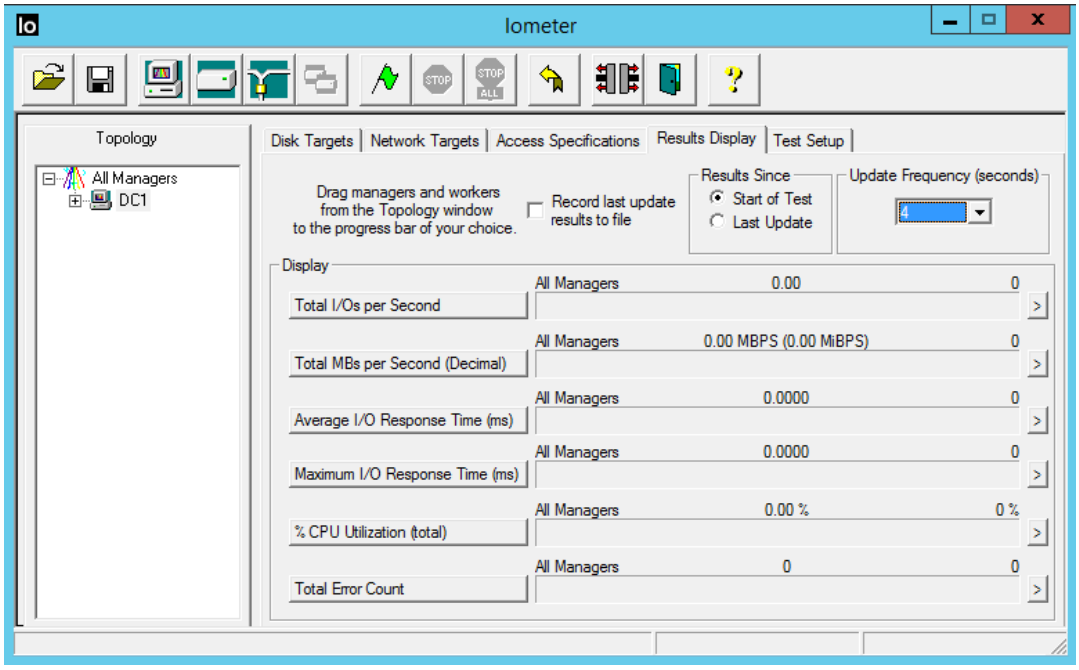
In this task, you use Iometer to generate a 50% write and 50% read workload on a LUN and set up a storage QoS limit to throttle the workload that is associated with the LUN.

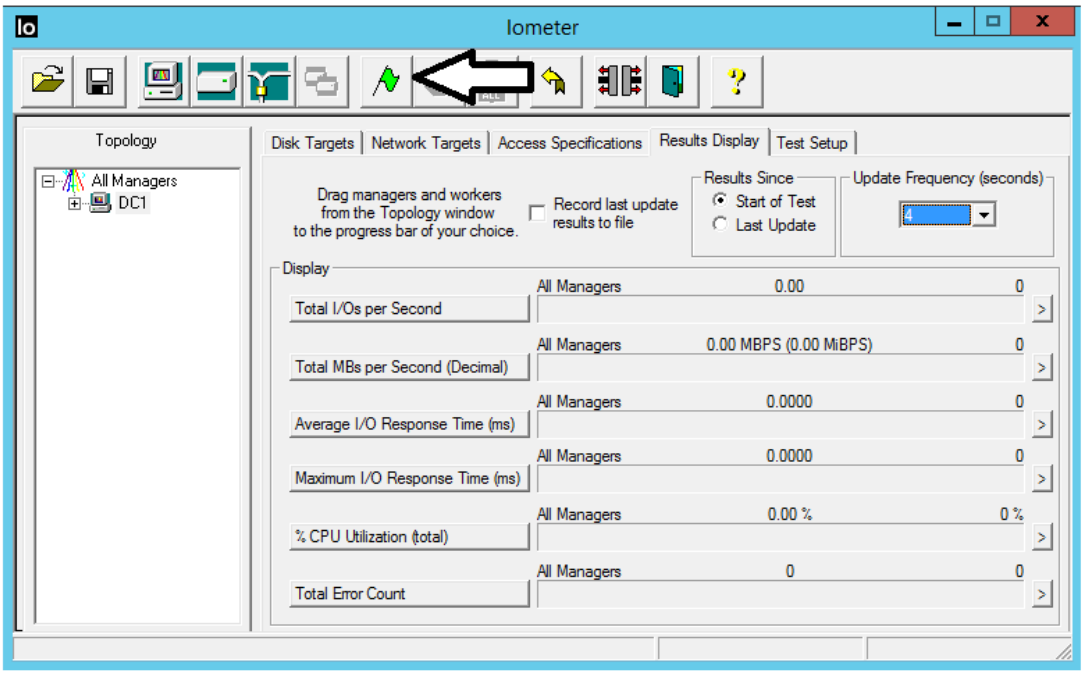
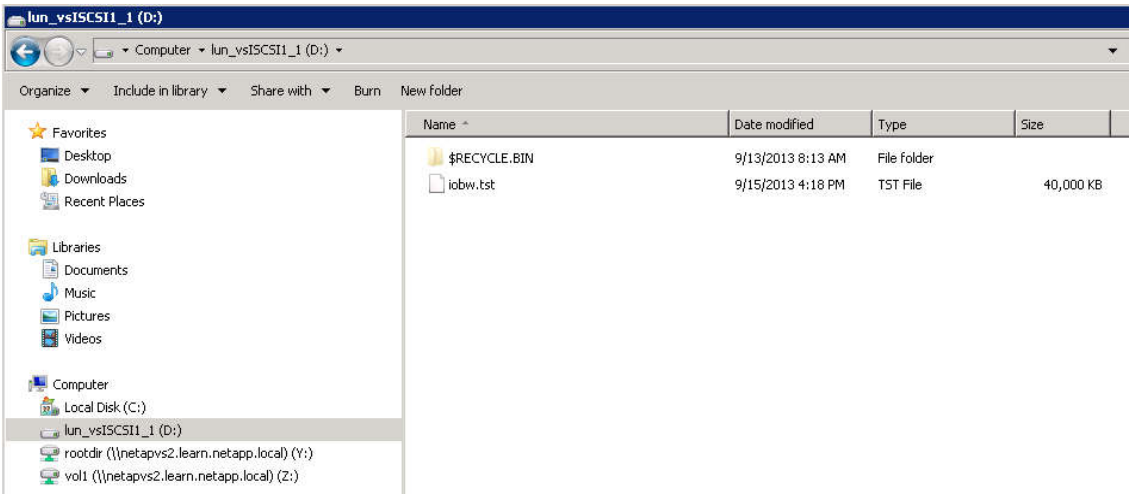
STEP	ACTION
1.	On the taskbar, click the Iometer icon and, if prompted, approve the Iometer EULA.  The Iometer window should open. 

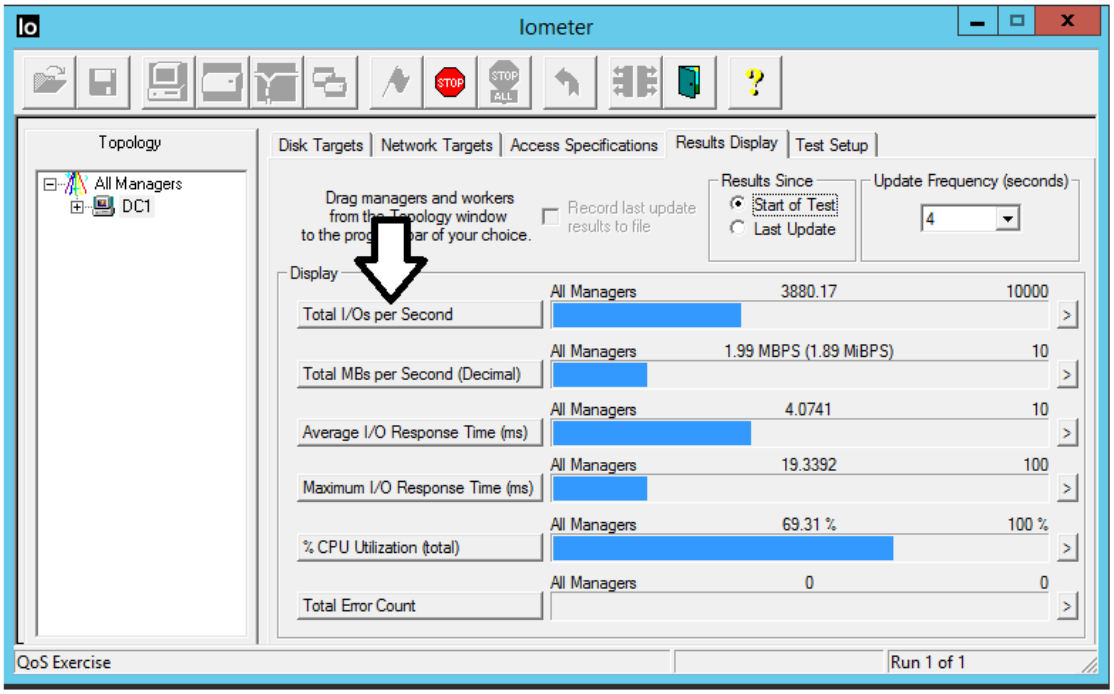
STEP	ACTION
2.	In the left pane, select the **DC1** node. 
3.	On the Disk Targets tab, specify the following: ▪ Targets: **D:lun_vsSCSI1_1** drive ▪ Maximum Disk Size: **80000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** 

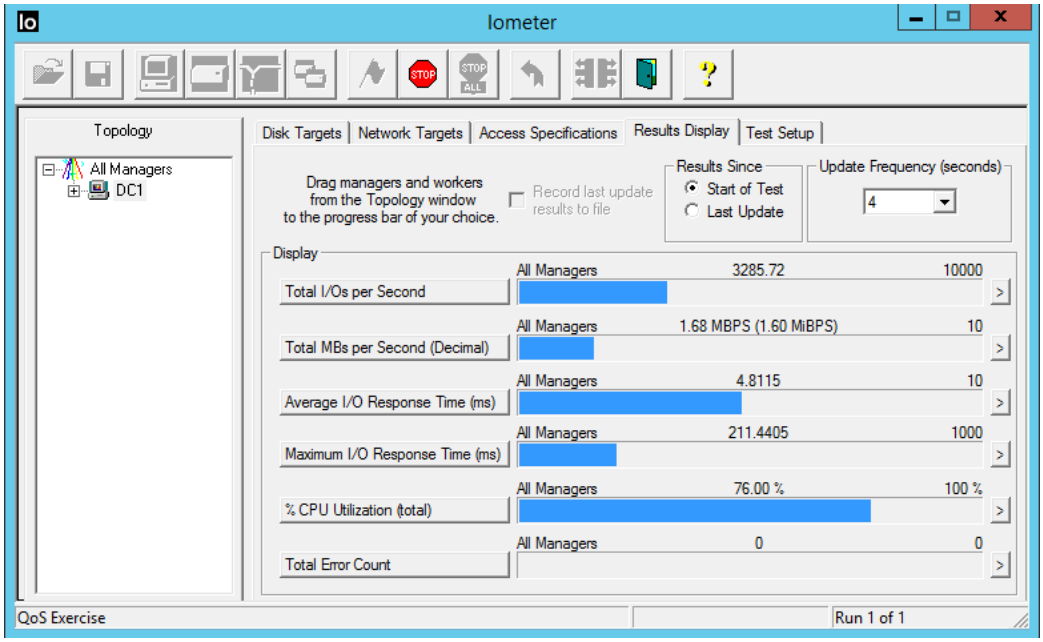
STEP	ACTION
4.	Click the **Access Specifications** tab. 
5.	Under Global Access Specifications, select **512B; 50% Read; 0% random**. 

STEP	ACTION
6.	Click the **Add** button. 
7.	Click the **Test Setup** tab.
8.	On the **Test Setup** tab, specify the following: ▪ Test Description: **QoS Exercise** ▪ Ramp Up Time: **4** seconds ▪ Record Results: **None** 

STEP	ACTION
9.	Click the **Results Display** tab. 
10.	Change the Update Frequency to **4** seconds. This reduces the load on the Windows machine to update the Iometer interface. 

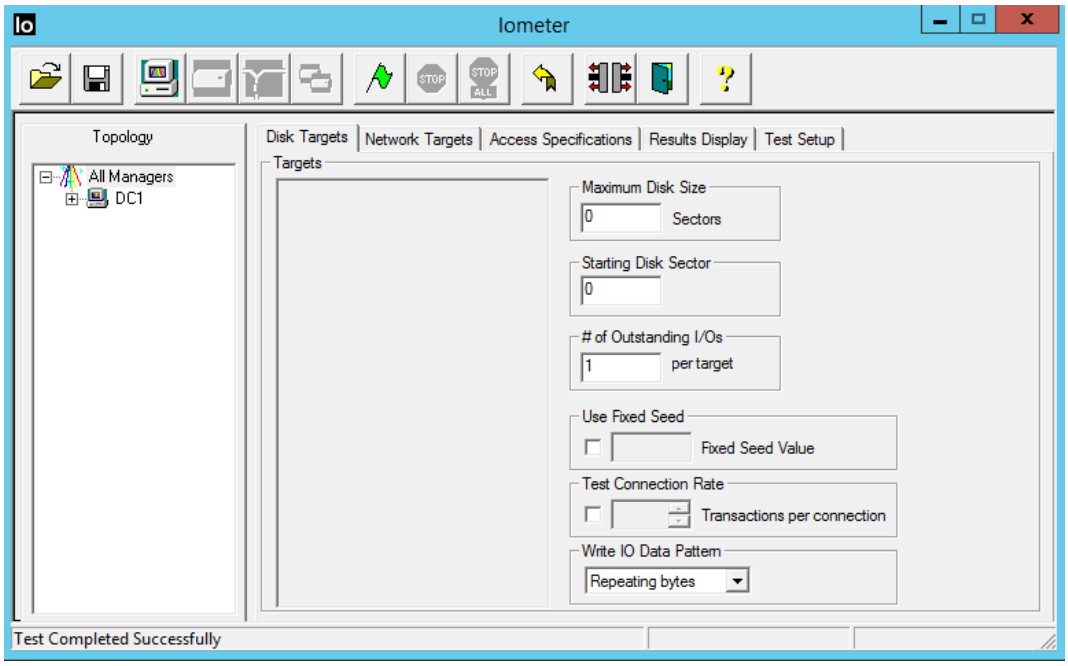
STEP	ACTION
11.	In the toolbar, click the **Start Tests** button (a green flag). 
12.	Open Windows Explorer to the **D:lun_vsISCSI1_1** drive and notice a new file, iobw.tst. This is the test file that is growing until it is 40,000 KB (80,000 x 512 B). 
13.	Notice that, when the file reaches its maximum size, the ramp up time begins to count down for four seconds. The ramp up time ensures that the storage is stable before the tests begin.

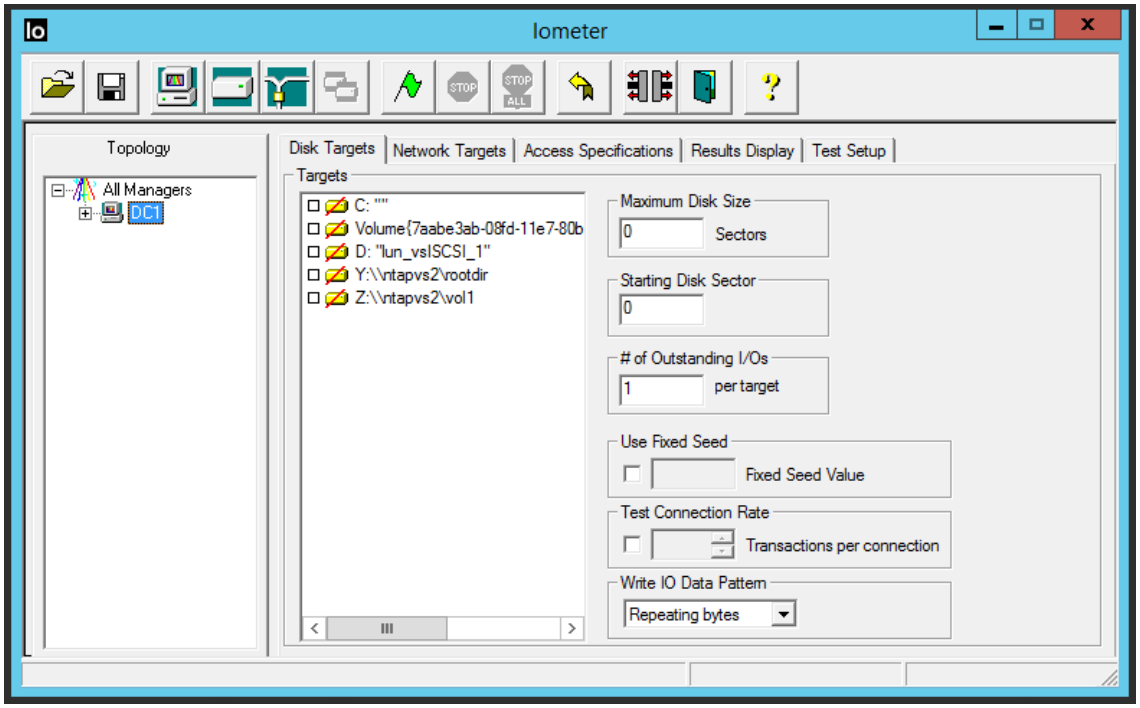
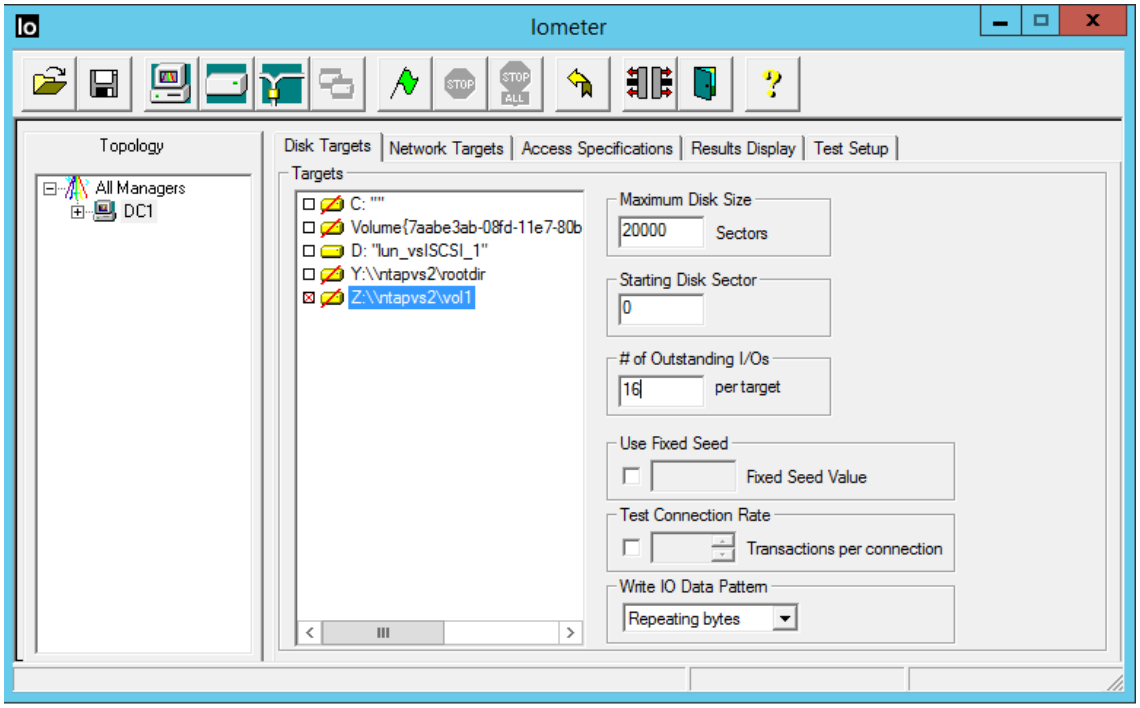
STEP	ACTION
14.	When the 50% read and 50% write test results begin to appear, notice that the total I/Os per second (IOPS) are recorded on the top row of the display output.  **NOTE:** On the test system, the total IOPS will probably fall in a range below that of a clustered system running on nonvirtualized equipment. Remember that this is a Windows machine and a cluster running in a shared virtualized environment.
15.	Leave the test running.
16.	Open a PuTTY session with cluster1.
17.	Using the **`statistics`** command, identify the volume or LUN that is doing the most IOPS.
18.	Show the current storage QoS policies. **`qos policy-group show`**

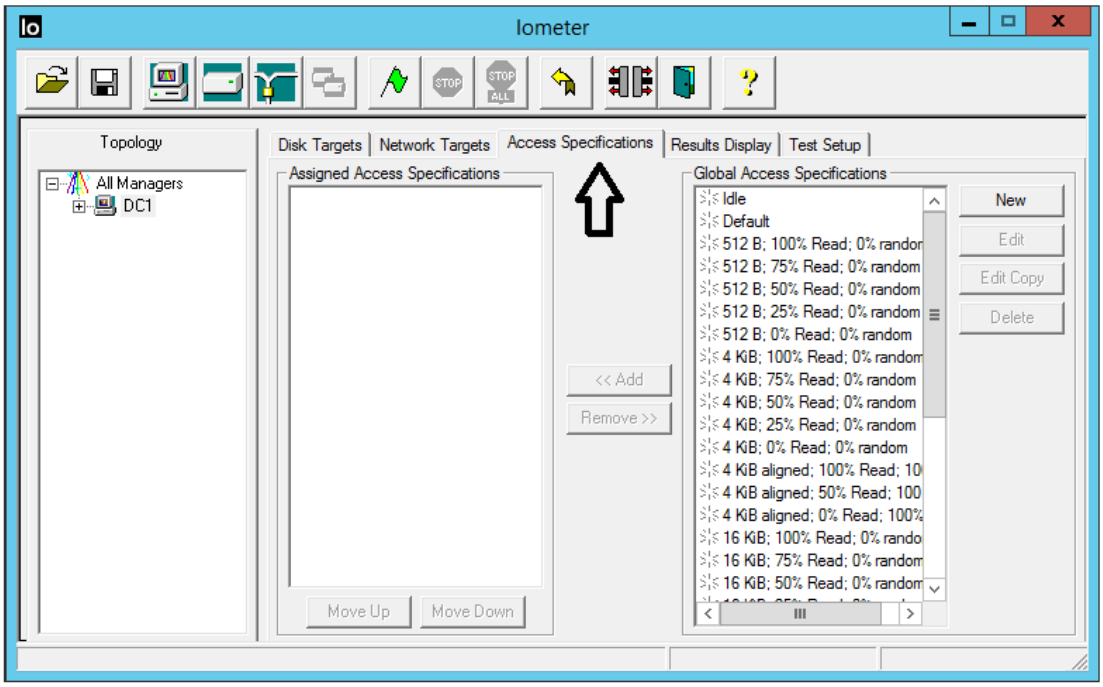
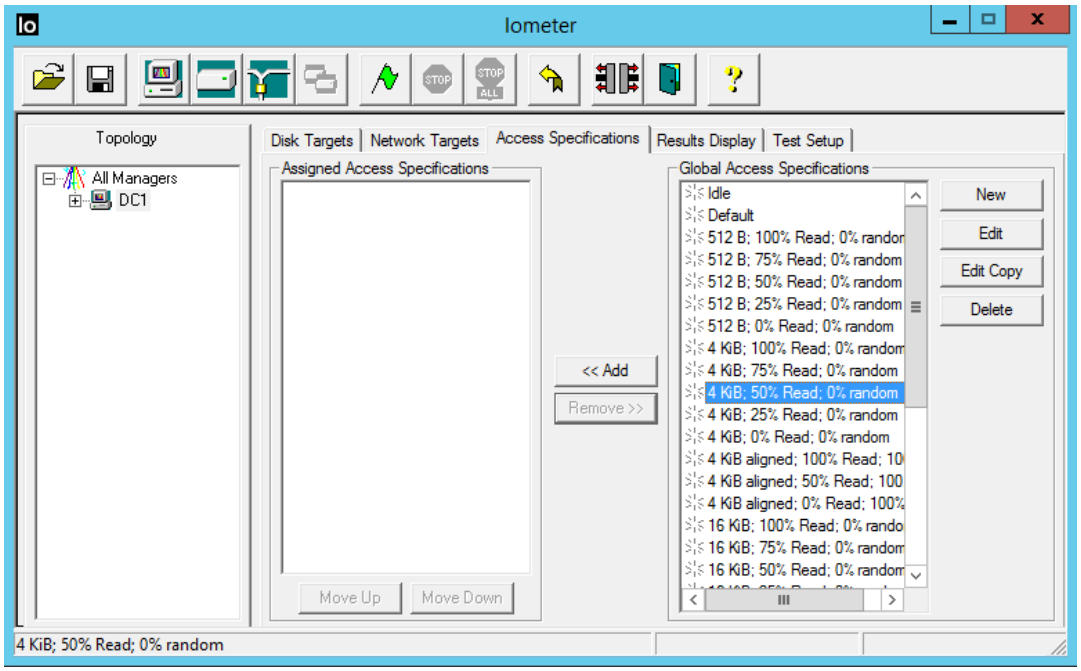
STEP	ACTION
19.	Switch back to the Iometer to see the current total IOPS. 
20.	Verify the current throughput from the storage. **`qos statistics performance show -iterations 4`**
21.	Create a new storage QoS policy. **NOTE:** If Iometer's current total IOPS is over 1000, set the **`-max-throughput`** parameter to **`1000iops`**; otherwise, set it to **`500iops`**. **`qos policy-group create -policy-group maxtp_policy -vserver vsISCSI -max-throughput 1000iops`**
22.	Show the current storage QoS policies. **`qos policy-group show`**
23.	Associate the policy to the hot volume or LUN. **NOTE:** You can associate a storage QoS policy to a storage virtual machine (SVM) with FlexVol volumes, LUNs, volumes, or files.
24.	Verify the current throughput from the storage. **`qos statistics performance show -iterations 4`**
25.	Wait a few moments and watch the Iometer's total IOPS drop. **NOTE:** You can continue to run the previous command to observe the current storage readings. It will take a few minutes for the IOPS to drop.
26.	When your testing is complete, stop the Iometer test by clicking the **Stop** button on the toolbar.
27.	In the PuTTY window, delete the policy. **`qos policy-group delete -policy-group maxtp_policy`**
28.	Close Iometer.

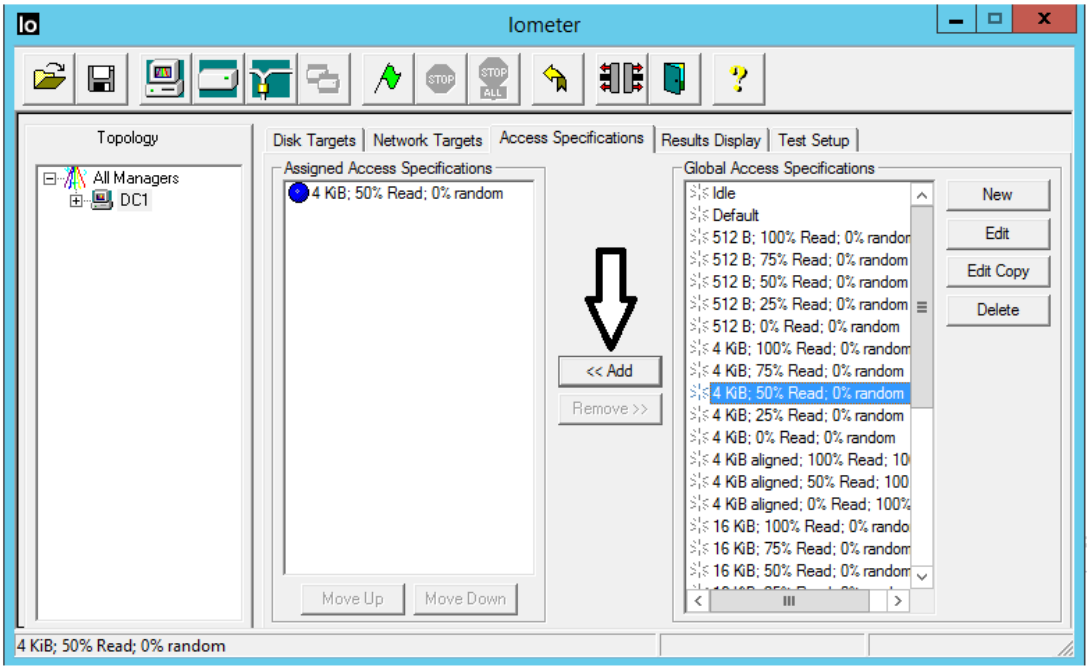
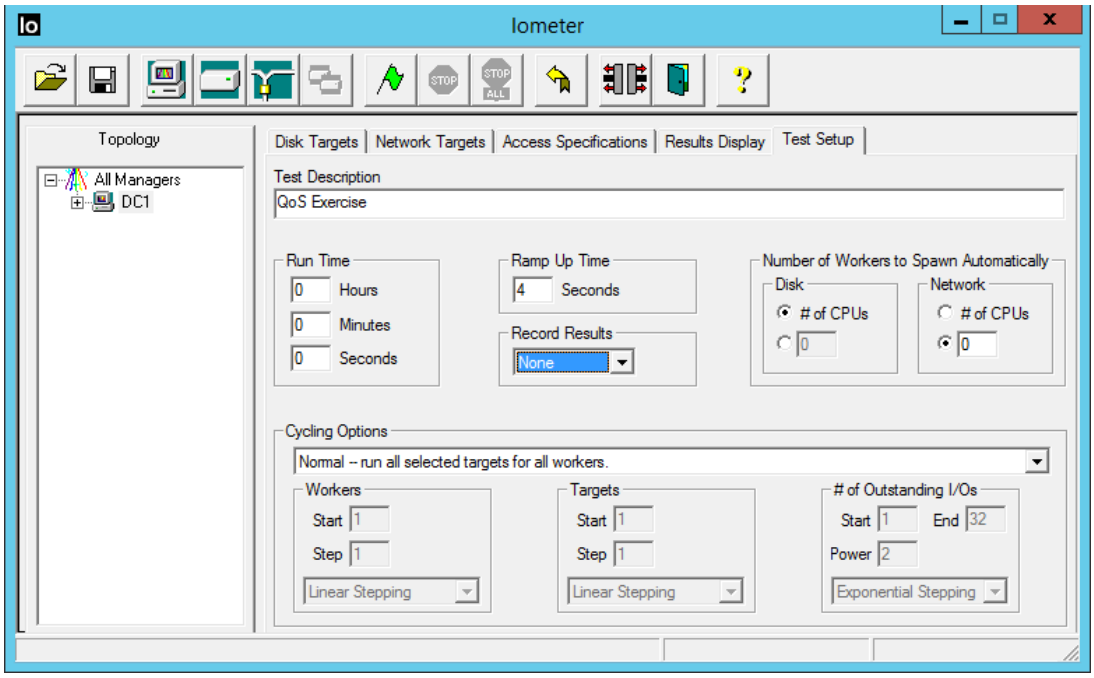
TASK 2: PROACTIVELY MONITOR WORKLOAD PERFORMANCE BY ASSOCIATING A WORKLOAD WITH A QOS POLICY GROUP

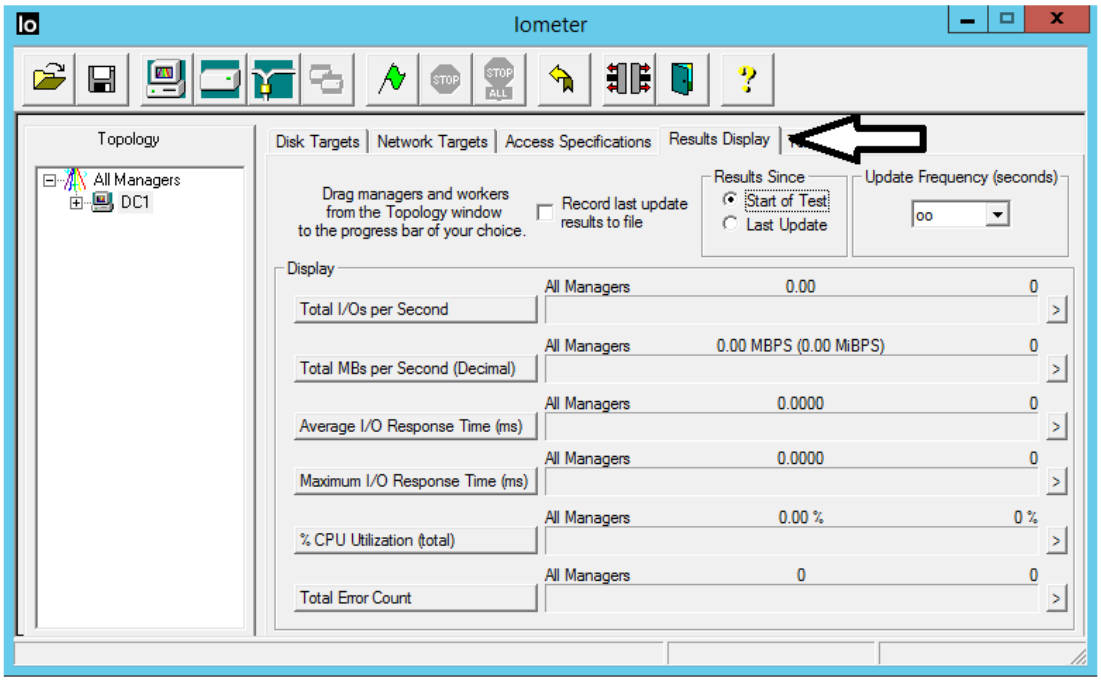
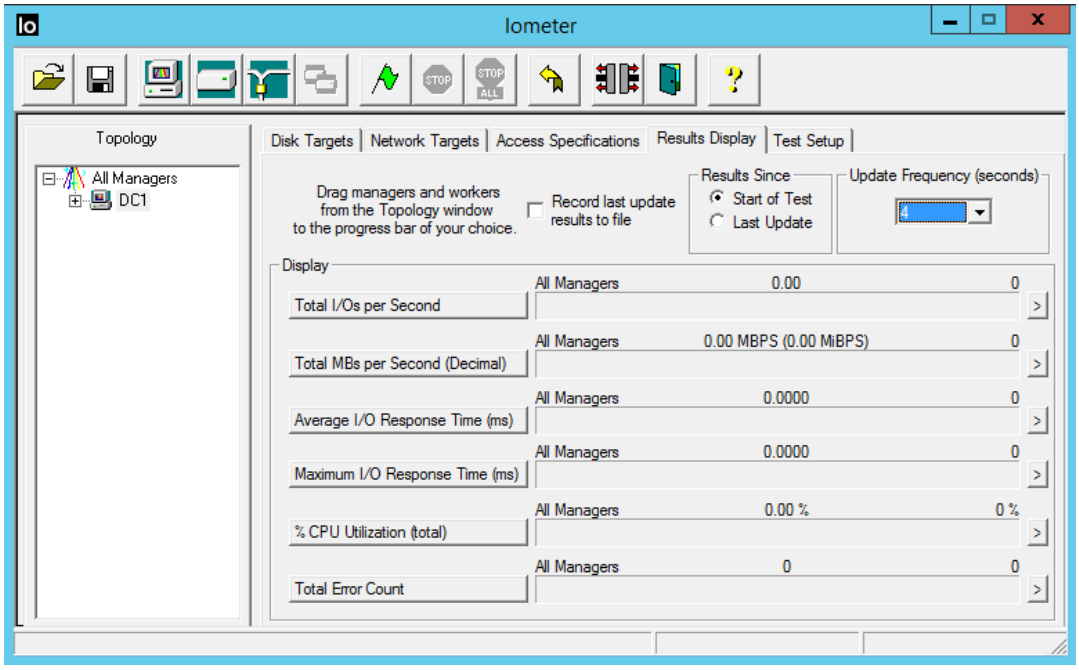
In this task, you set up a storage QoS limit for a volume and use Iometer to generate a 50% write and 50% read workload on the volume.

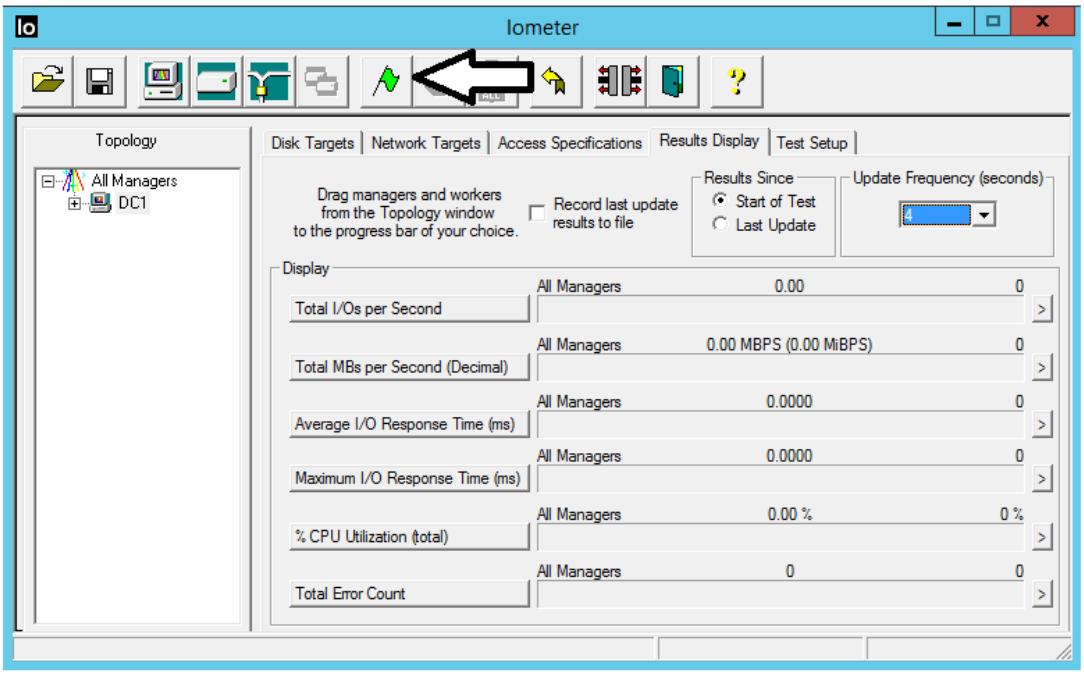
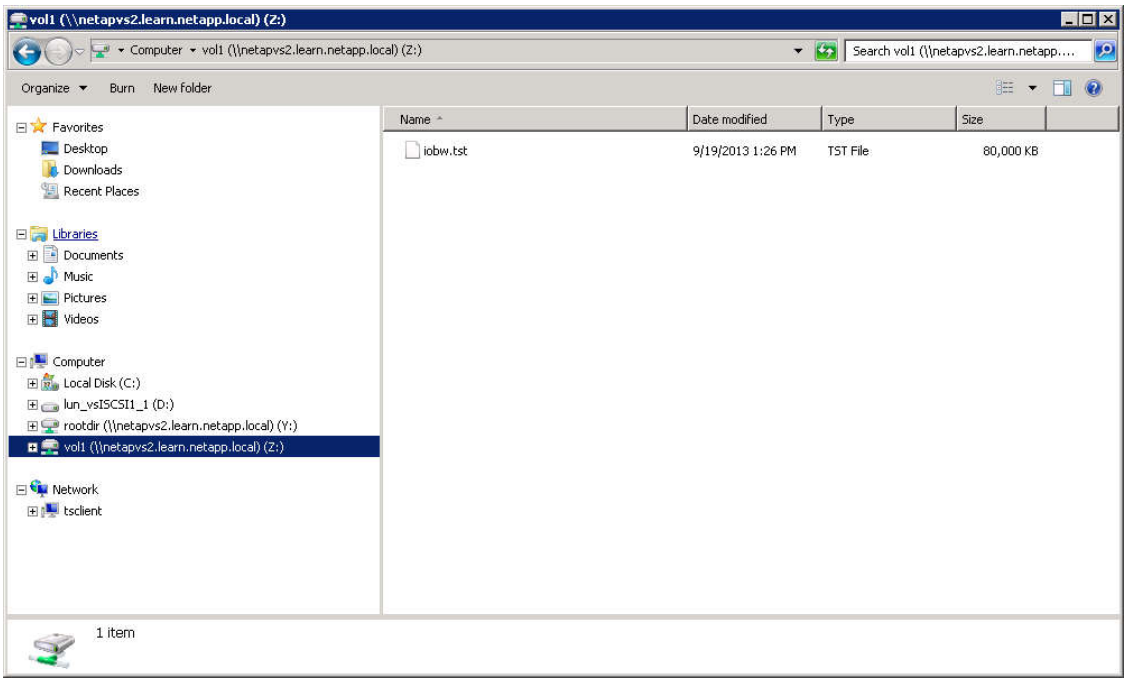
STEP	ACTION
1.	Open a PuTTY session with cluster1.
2.	Create a new storage QoS policy. **`qos policy-group create -policy-group prevent_policy -vserver vs2 -max-throughput 500iops`**
3.	Show the current storage QoS policies. **`qos policy-group show`**
4.	You have identified vs2_vol01 as a new and potentially runaway workload. Associate the storage QoS policy to the vs2_vol01 volume. **NOTE:** You can associate a storage QoS policy to an SVM with FlexVol volumes, LUNs, volumes, or files. **`volume modify vs2_vol01 -vserver vs2 -qos-policy-group prevent_policy`**
5.	Verify the current throughput from the storage. **`qos statistics performance show -iterations 4`**
6.	On the taskbar, click the Iometer icon.  The Iometer window should open. 

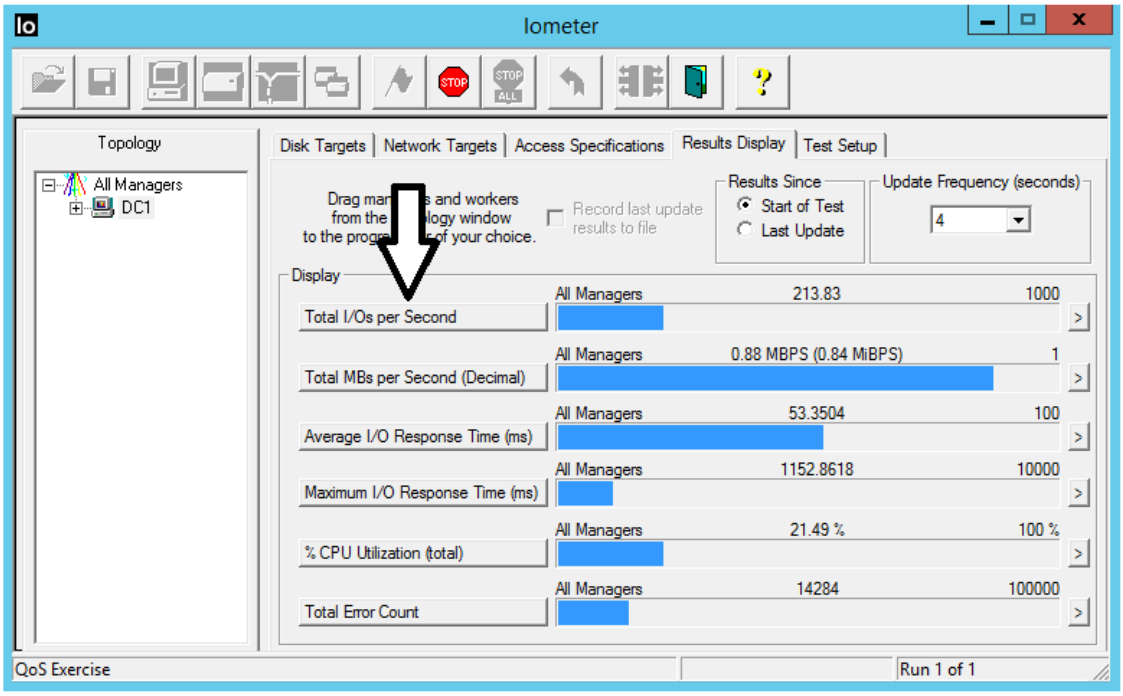
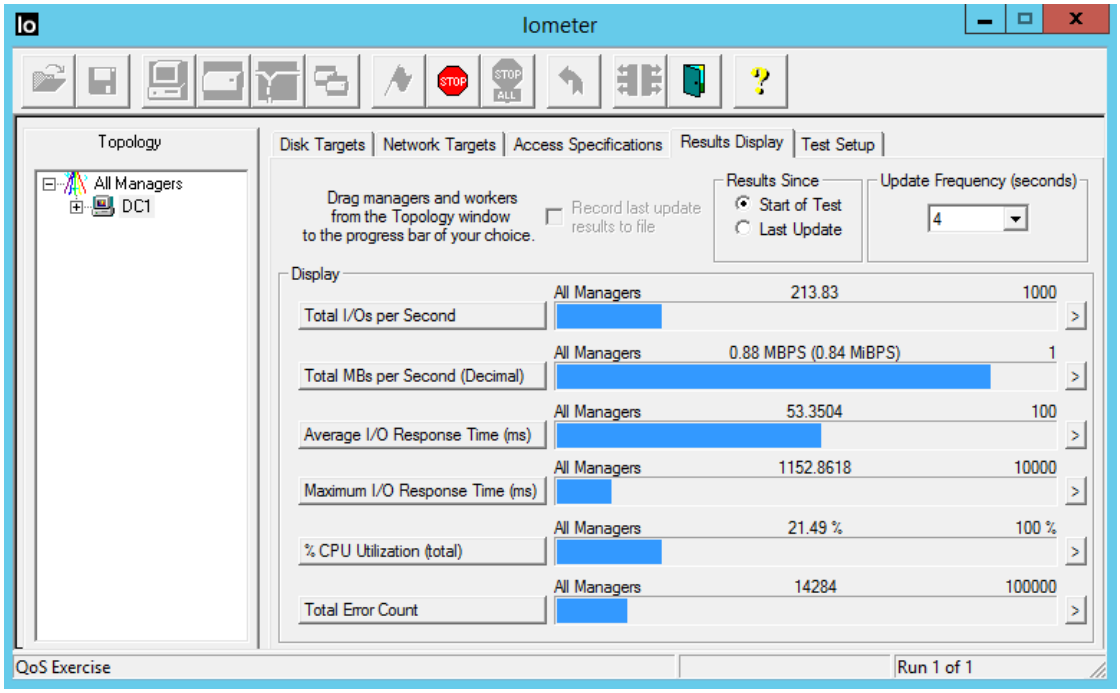
STEP	ACTION
7.	In the left pane, select the **DC** node. 
8.	On the Disk Targets tab, specify the following: ▪ Targets: **Z** drive ▪ Maximum Disk Size: **20000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** 

STEP	ACTION
9.	Click the **Access Specifications** tab. 
10.	Under Global Access Specifications, select **4K; 50% Read; 0% random**. 

STEP	ACTION
11.	Click the **Add** button. 
12.	Click the **Test Setup** tab.
13.	On the **Test Setup** tab, specify the following: ▪ Test Description: **QoS Exercise** ▪ Ramp Up Time: **4** seconds ▪ Record Results: **None** 

STEP	ACTION
14.	Click the **Results Display** tab. 
15.	Change the Update Frequency to **4** seconds. This reduces the load on the Windows machine to update the Iometer interface. 

STEP	ACTION
16.	In the toolbar, click the **Start Tests** button (a green flag). 
17.	Open Windows Explorer to the **Z** drive and notice a new file, iobw.tst. This is the test file that is growing until it is 80,000 KB (20,000 x 4 KB). 
18.	Notice that, when the file reaches its maximum size, the ramp up time begins to count down for four seconds. The ramp up time ensures that the storage is stable before the tests begin.

STEP	ACTION
19.	When the 50% read and 50% write test results begin to appear, notice that the total IOPS are recorded on the top row of the display output.  **NOTE:** Remember that this is a Windows machine and a cluster running in a shared virtualized environment.
20.	Leave the test running. If the total I/Os per second never approach 500 change QOS policy to just below the number displayed
21.	Notice the total IOPS: 

STEP	ACTION
22.	In the PuTTY window, verify the current throughput from the storage. `qos statistics performance show -iterations 4`
23.	When your testing is complete, stop the Iometer test by clicking the **Stop** button  on the toolbar.
24.	In the PuTTY window, delete the policy. `qos policy-group delete -policy-group prevent_policy`
25.	Close Iometer.

TASK 3: ISOLATE A TENANT WORKLOAD BY ASSOCIATING THE WORKLOAD WITH A QOS POLICY GROUP

In this task, you set up a storage QoS tenant limit at the SVM level and use Iometer to generate a 50% write and 50% read workload on one of the tenants.

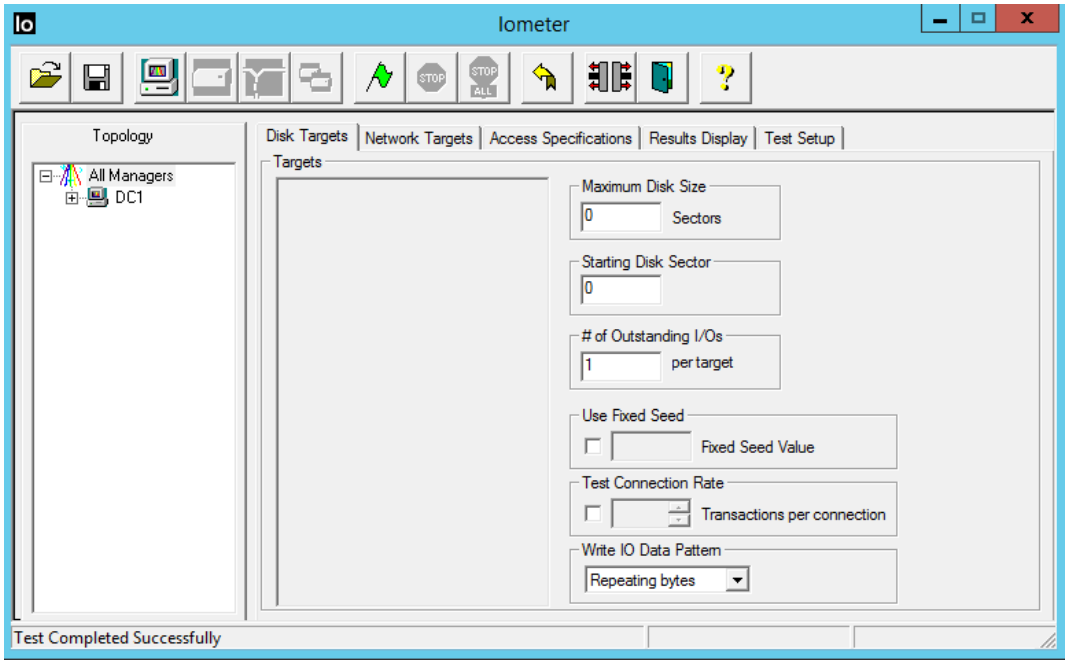
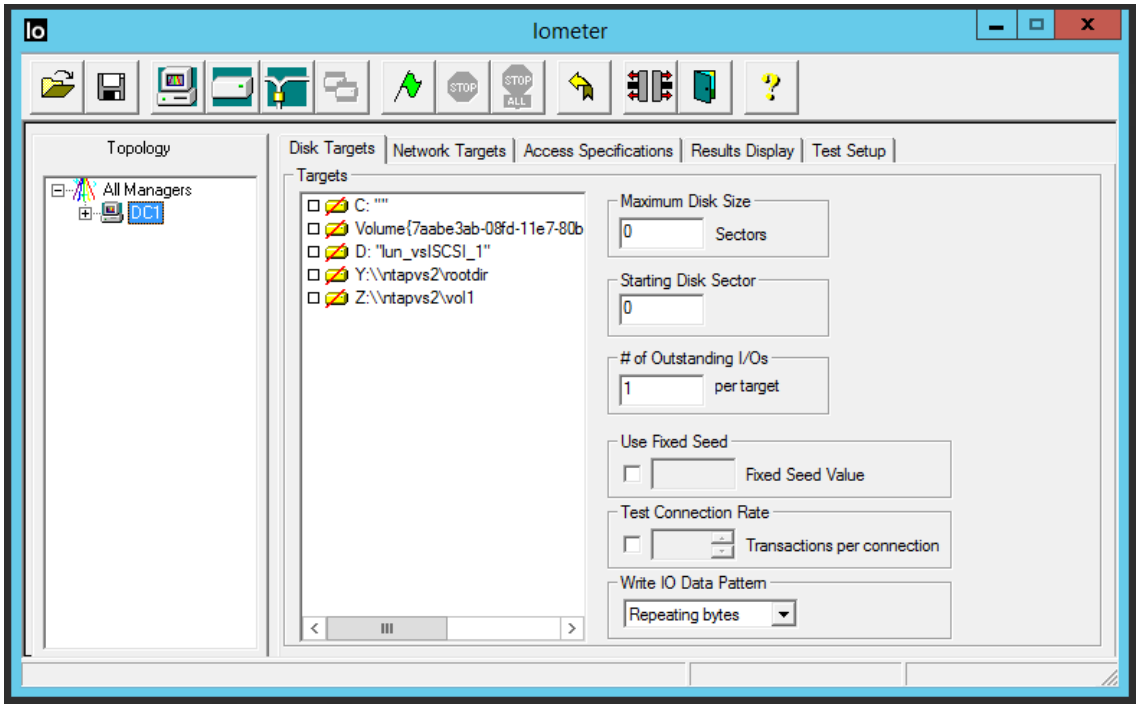
STEP	ACTION
1.	Open a PuTTY session with cluster1.

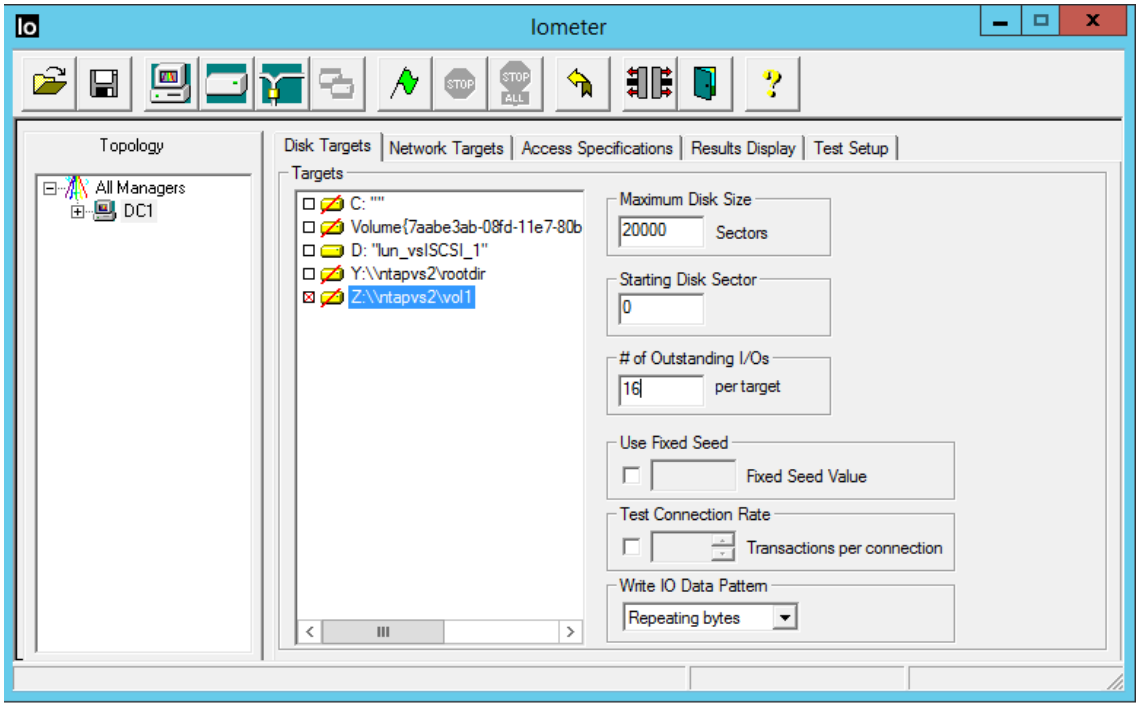
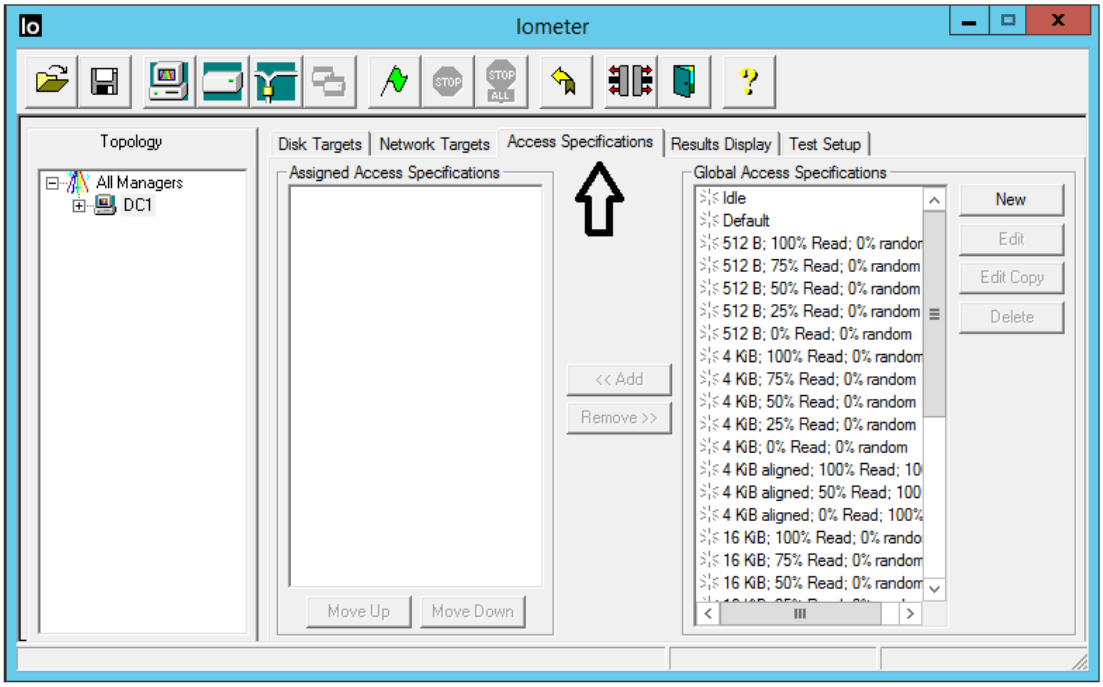
2.	Create three new storage QoS policies.
	`qos policy-group create -policy-group tenant1_policy -vserver vs1 -max-throughput 500iops`
	`qos policy-group create -policy-group tenant2_policy -vserver vs2 -max-throughput 500iops`
	`qos policy-group create -policy-group tenant3_policy -vserver vsISCSI1 -max-throughput 500iops`

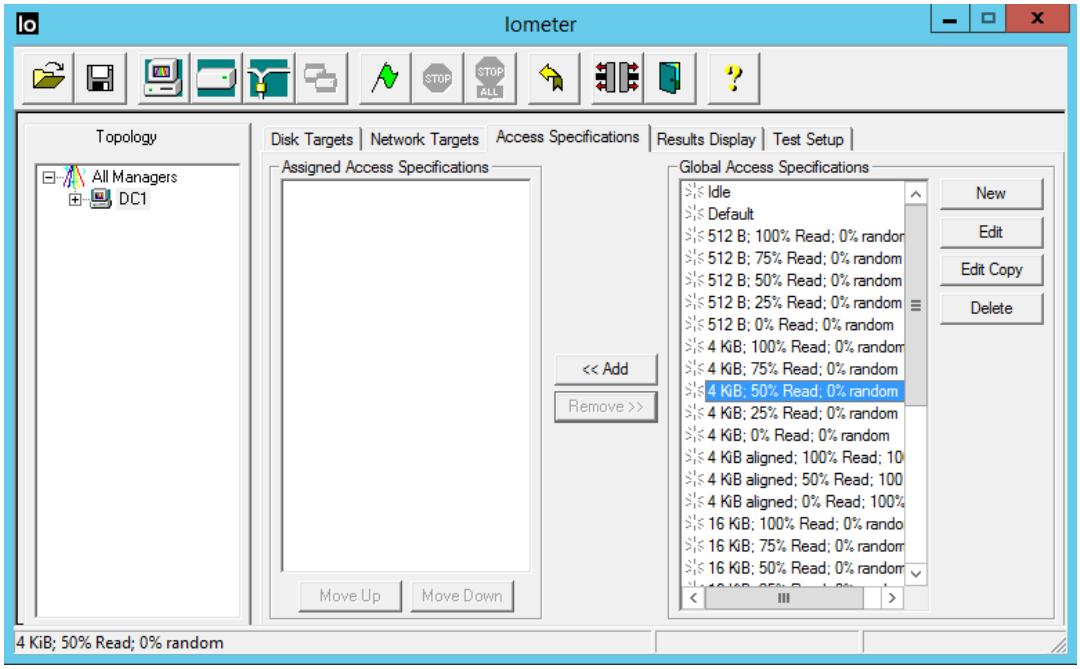
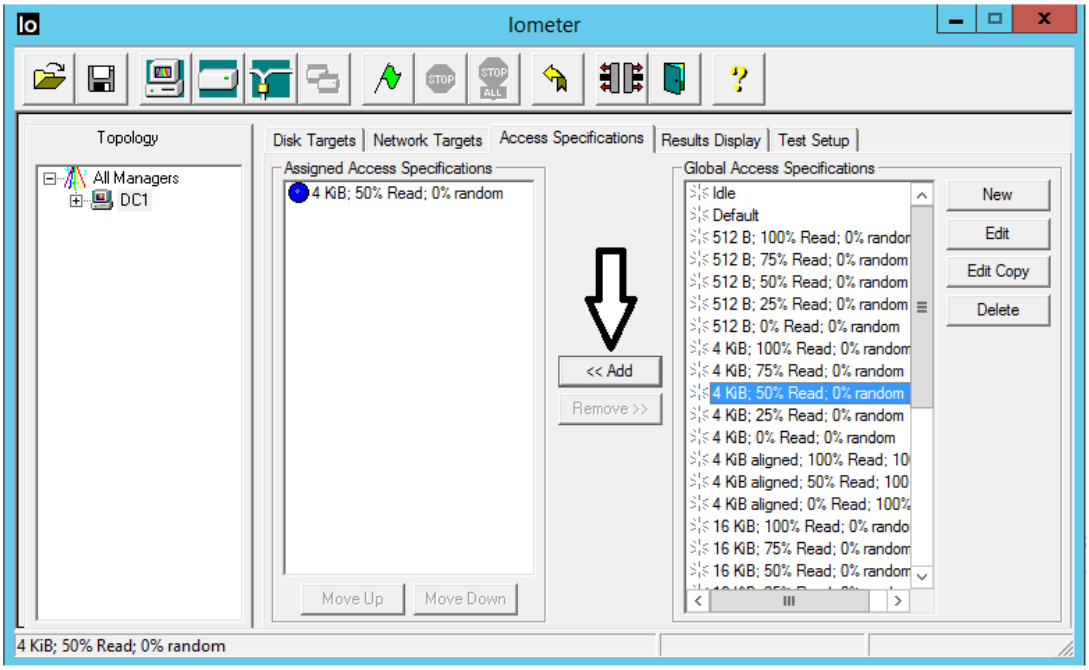
3.	Show the current storage QoS policies. `qos policy-group show`

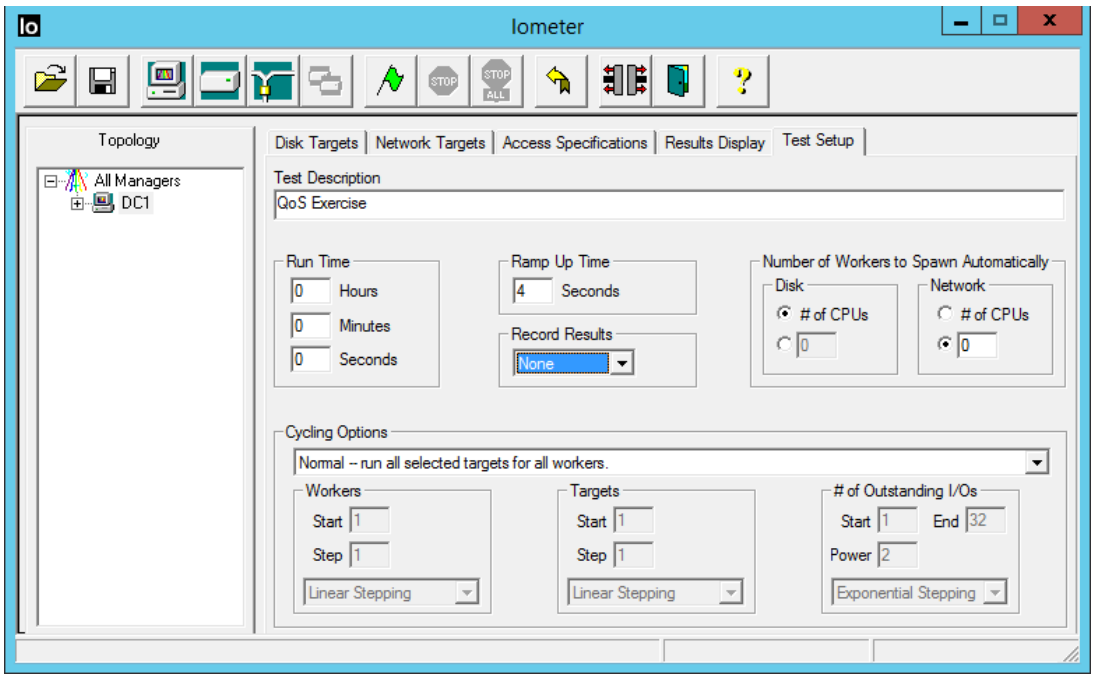
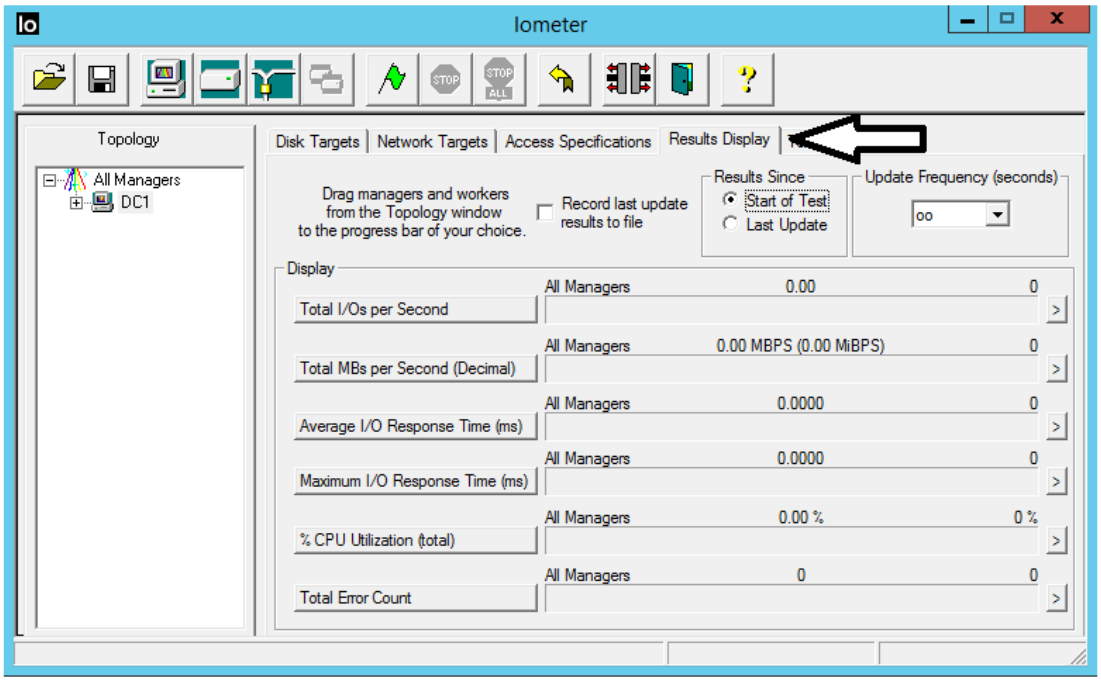
4.	Associate each policy to the corresponding SVM.
	NOTE: You can associate a storage QoS policy to an SVM with FlexVol volumes, LUNs, volumes, or files.
	`vserver modify -vserver vs1 -qos-policy-group tenant1_policy`
	`vserver modify -vserver vs2 -qos-policy-group tenant2_policy`
	`vserver modify -vserver vsISCSI1 -qos-policy-group tenant3_policy`

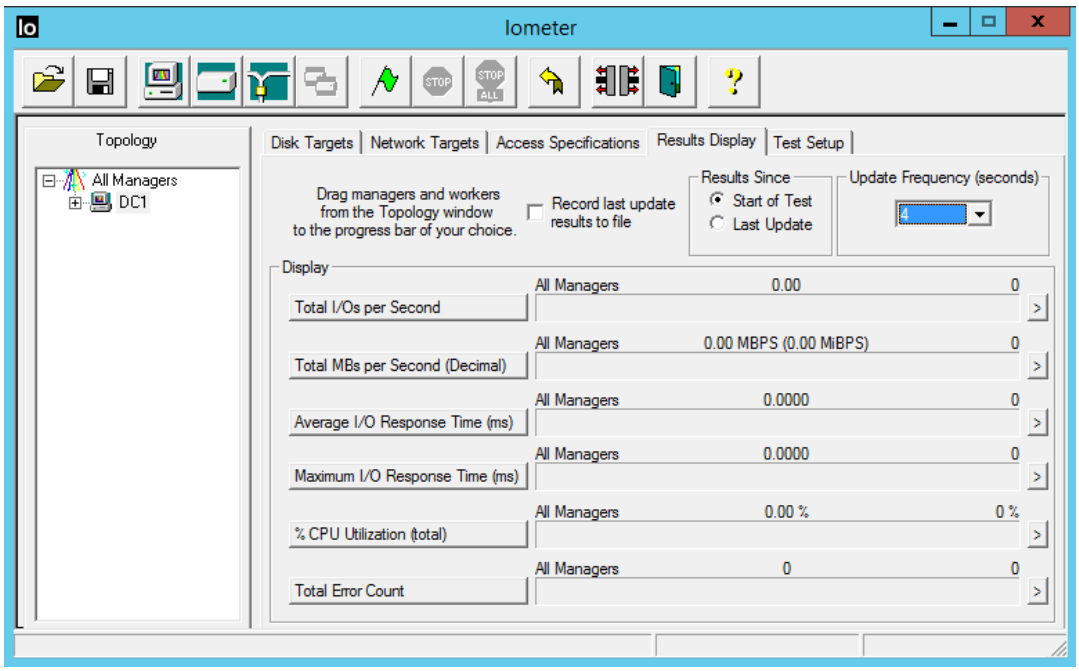
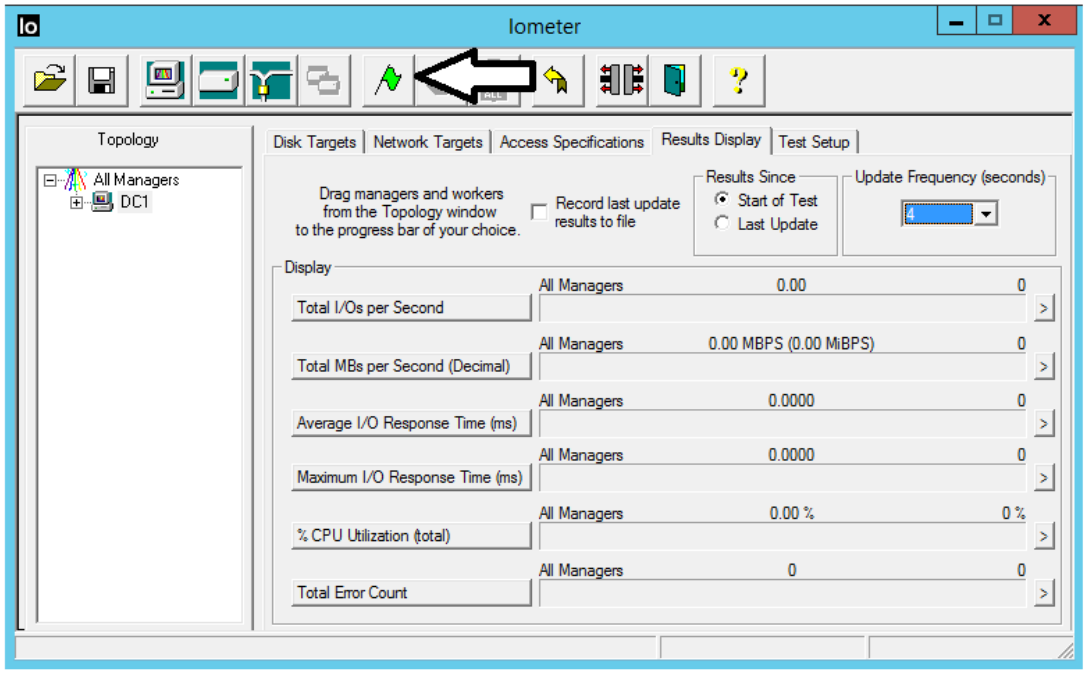
5.	Verify the current throughput from the storage. `qos statistics performance show -iterations 4`

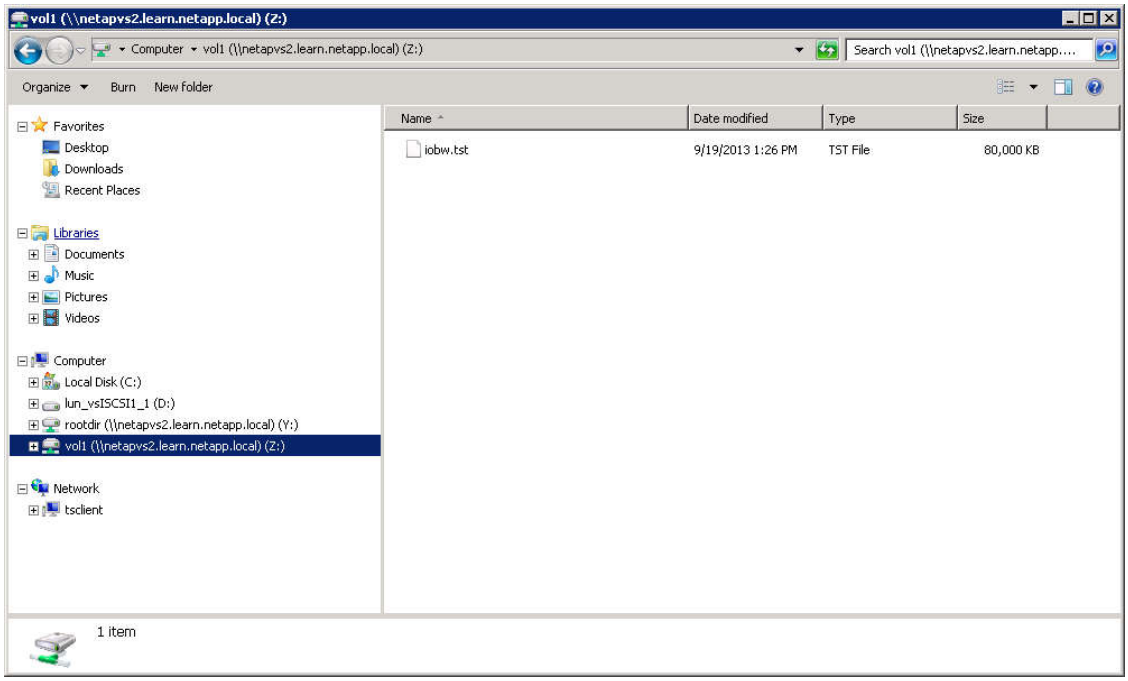
STEP	ACTION
6.	On the taskbar, click the Iometer icon.  The Iometer window should open. 
7.	In the left pane, select the **DC1** node. 

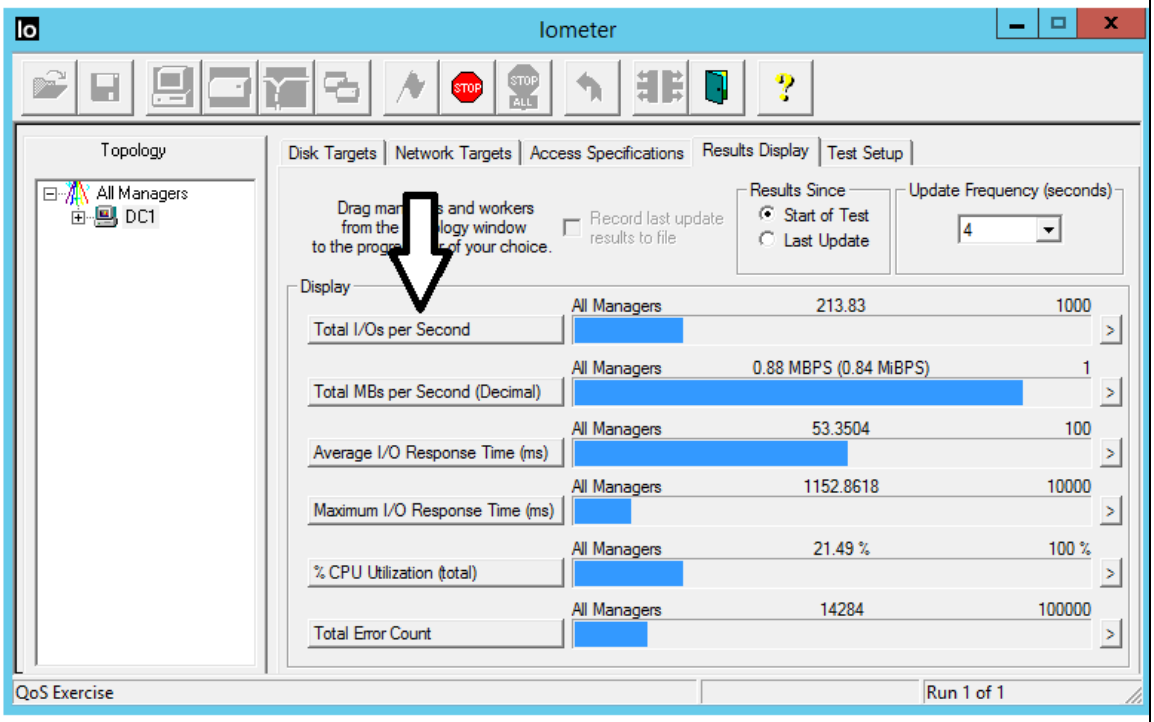
STEP	ACTION
8.	On the Disk Targets tab, specify the following: ▪ Targets: **Z** drive ▪ Maximum Disk Size: **20000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** 
9.	Click the **Access Specifications** tab. 

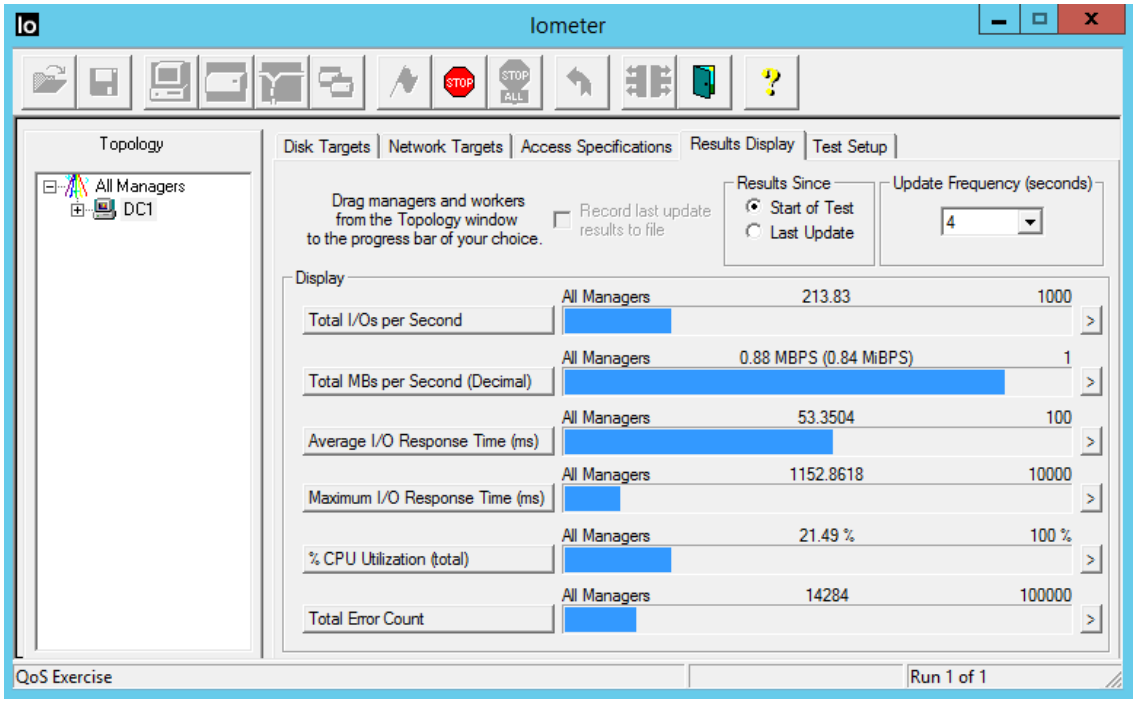
STEP	ACTION
10.	Under Global Access Specifications, select **4K; 50% Read; 0% random**. 
11.	Click the **Add** button. 
12.	Click the **Test Setup** tab.

STEP	ACTION
13.	On the **Test Setup** tab, specify the following: ▪ Test Description: **QoS Exercise** ▪ Ramp Up Time: **4** seconds ▪ Record Results: **None** 
14.	Click the **Results Display** tab. 

STEP	ACTION
15.	Change the Update Frequency to **4** seconds. This reduces the load on the Windows machine to update the Iometer interface. 
16.	In the toolbar, click the **Start Tests** button (a green flag). 

STEP	ACTION
17.	Open File Explorer to the **Z** drive and notice a new file, iobw.tst. This is the test file that is growing until it is 80,000 KB (20,000 x 4 KB). 
18.	Notice that, when the file reaches its maximum size, the ramp up time begins to count down for four seconds. The ramp up time ensures that the storage is stable before the tests begin.

STEP	ACTION
19.	When the 50% read and 50% write test results begin to appear, notice that the total IOPS are recorded on the top row of the display output.  **NOTE:** Remember that this is a Windows machine and a cluster running in shared virtualized
20.	Leave the test running.
21.	In the PuTTY window, verify the current throughput from the storage. `qos statistics performance show -iterations 4`

STEP	ACTION
22.	Switch back to the Iometer to see the current total IOPS. 
23.	When your testing is complete, stop the Iometer test by clicking the **Stop** button on the toolbar.
24.	Close Iometer.

END OF EXERCISE

MODULE 7: SUMMARY

There is no exercise associated with Module 7.

MODULE 8: MORE COMMAND LINE MONITORING

EXERCISE

In this exercise, you will work with many new commands to monitor the various subsystems within your Storage Array.

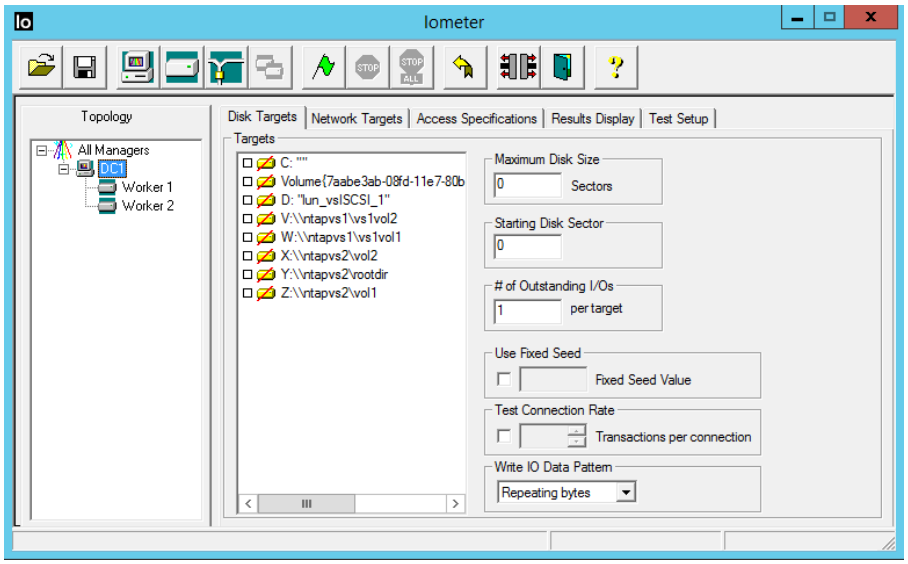
OBJECTIVES

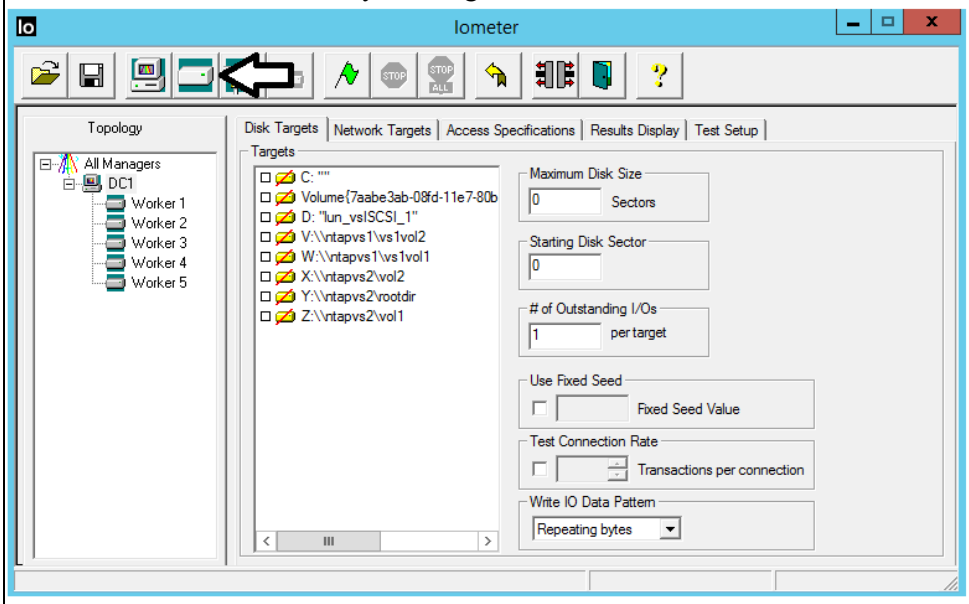
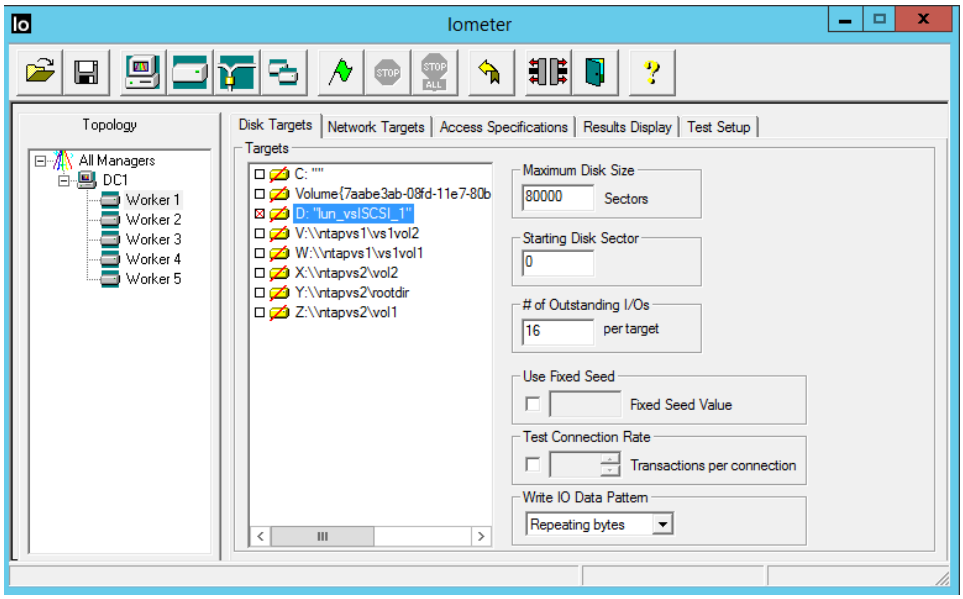
By the end of this exercise, you should be able to:

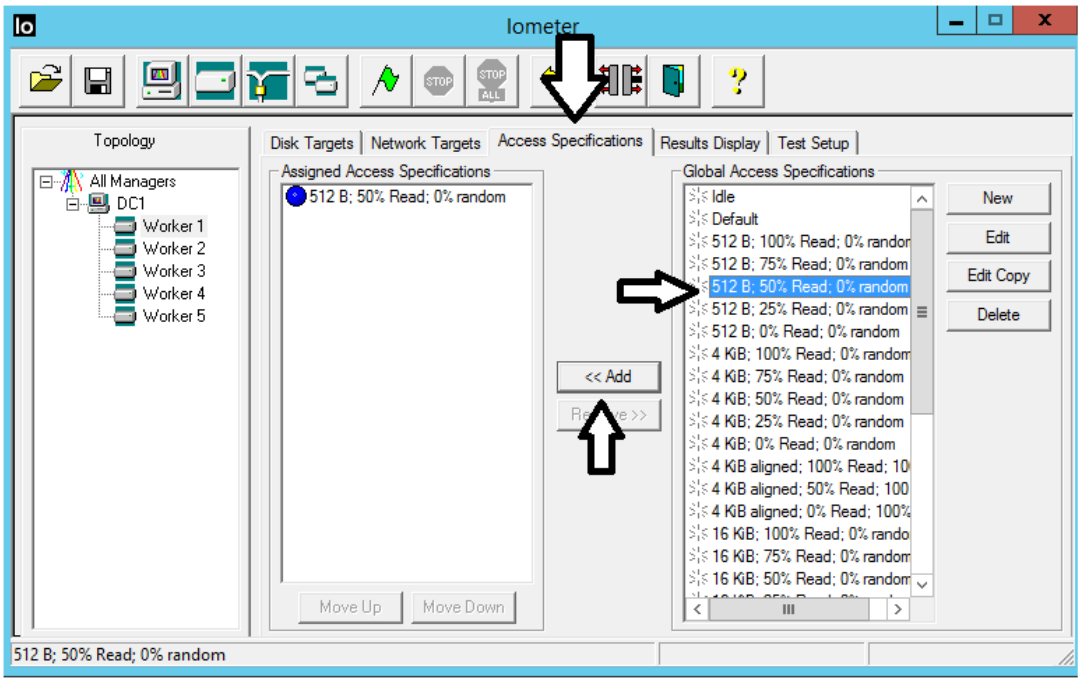
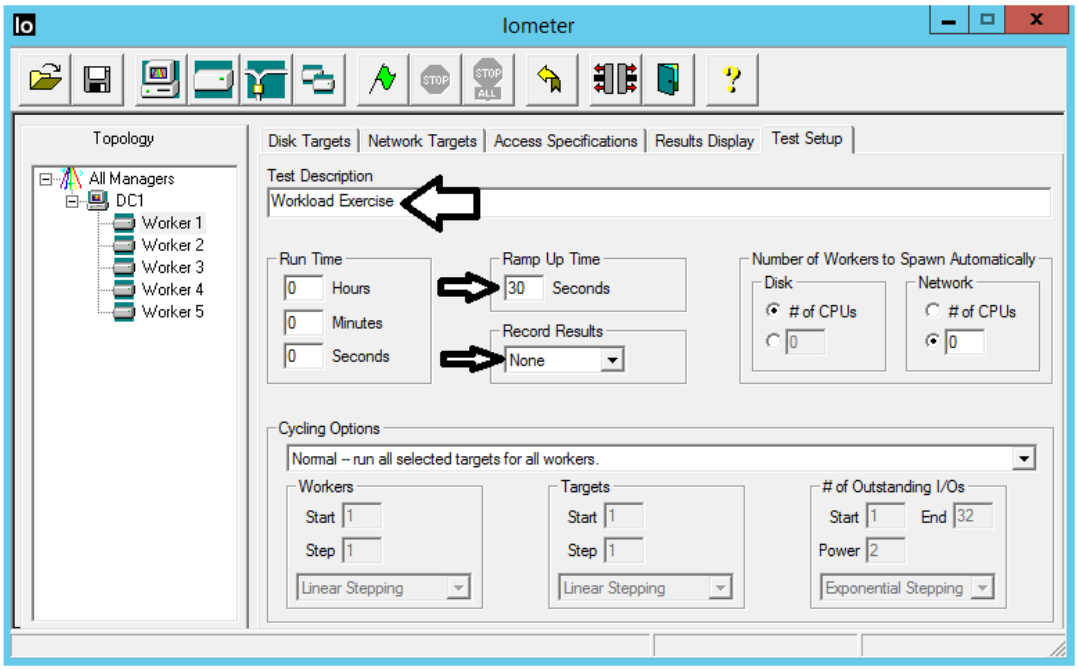
- Use commands to monitor CPU utilization and determine if you are CPU bound, and if so, what workload or domain is bound.
- Use commands to monitor the various subsystems within your Storage Array

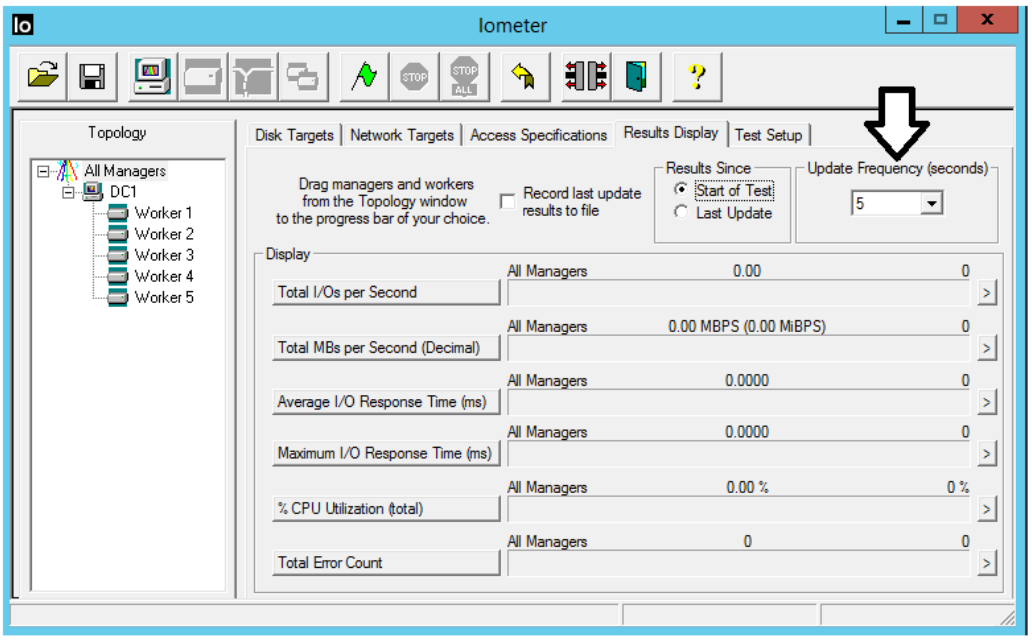
TASK 1: Create Workloads in your lab environment

In this task, you use Iometer to create a CIFS workload and SIO to generate an NFS workload within your storage system.

STEP	ACTION
1.	On the taskbar, click the Iometer icon and, if prompted, approve the Iometer EULA.  The Iometer window should open. Expand DC1 to view your workers 

STEP	ACTION
2.	Create 3 additional workers by clicking the "Start a New Disk Worker icon 3 times. 
3.	Select **Worker 1** and specify the following ▪ Targets: **D:lun_vsSCSI1_1** drive ▪ Maximum Disk Size: **80000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** 

STEP	ACTION
4.	Click the **Access Specifications** tab. Under Global Access Specifications, select **512B; 50% Read; 0% random**. Click the **Add** button. 
5.	Click the **Test Setup** tab. On the **Test Setup** tab, specify the following: ▪ Test Description: **Workload Exercise** ▪ Ramp Up Time: **30** seconds ▪ Record Results: **None** 

STEP	ACTION
6.	Click the **Results Display** tab. Change the Update Frequency to **5** seconds. 
7.	Select **Worker 2** and specify the following commands to create a sequential write workload ▪ Targets: **V:\\ntapvs1\vs1vol2** drive ▪ Maximum Disk Size: **20000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** ▪ Under Global Access Specifications, select **4KB; 0% Read; 0% random**. Select **Worker 3** and specify the following commands to create a sequential read workload ▪ Targets: **W:\\ntapvs1\vs1vol1** drive ▪ Maximum Disk Size: **20000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** ▪ Under Global Access Specifications, select **4KB; 100% Read; 0% random**. Select **Worker 4** and specify the following commands to create a random write workload ▪ Targets: **X:\\ntapvs2\vol2** drive ▪ Maximum Disk Size: **20000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** ▪ Under Global Access Specifications, select **4KB aligned; 0% Read; 100% random**. Select **Worker 5** and specify the following commands to create a random read workload ▪ Targets: **Z:\\ntapvs2\vol1** drive ▪ Maximum Disk Size: **20000** ▪ Starting Disk Sector: **0** ▪ # of Outstanding I/Os: **16** ▪ Under Global Access Specifications, select **4KB aligned; 100% Read; 100% random**.

STEP	ACTION
8.	Copy the file **300mfile** to the **v:**, **w:**, **x:**, and **z:** drives. If the file is already there just overwrite it. Use the following commands to mount the vs1 and vs2 exports **mount -t nfs 192.168.0.122:/vs2vol1 /mnt/path01 (may already be mounted)** **mount -t nfs 192.168.0.121:/vs2vol2 /mnt/path02** **mount -t nfs 192.168.0.142:/vs1vol1 /mnt/path03** **mount -t nfs 192.168.0.141:/vs1vol2 /mnt/path04** Ensure **sio_ntap_linux** is in the **/usr/tmp/sio** directory. If it isn't use the steps from Module 4, Task 3 Steps 1 – 5 to place it there. Use the following commands to create 4 different NFS workloads. Use 4 different putty sessions, one for each workload **/usr/tmp/sio/sio_ntap_linux 100 100 32k 300m 3600 4 /mnt/path01/300mfile** **/usr/tmp/sio/sio_ntap_linux 0 100 32k 300m 3600 4 /mnt/path02/300mfile** **/usr/tmp/sio/sio_ntap_linux 100 0 32k 300m 3600 4 /mnt/path03/300mfile** **/usr/tmp/sio/sio_ntap_linux 0 0 32k 300m 3600 4 /mnt/path04/300mfile** After starting each workload minimize the putty window.
9.	In the iometer toolbar, click the **Start Tests** button  (a green flag) to start the CIFS workload. Click the Results Display tab to see the workloads being processed. (takes a few minutes). The NFS workloads will run for about an hour. You will need to go back and restart them after they stop if you want to continue creating NFS workloads

TASK 2: PROACTIVELY MONITOR WORKLOAD PERFORMANCE AND DETERMINE WORKLOAD CHARACTERISTICS

In this task, you will use various commands to determine workload characteristics within your storage system.

STEP	ACTION
1.	Open a putty connection to the cluster management interface of your cluster. Make it full screen.

2.	To check CPU utilization we can use sysstat -M. At the cluster shell type the following:
	`cluster1::> set -rows 0`
	`cluster1::> set diag`
	`Warning: These diagnostic commands are for use by NetApp personnel only.`
	`Do you want to continue? {y|n}: y`
	`cluster1::*> node run -node cluster1-01 sysstat -M 1`
	Let it run for a couple minutes then use **ctrl-c** to break the run.
	Run the same command on node **cluster1-02**
	Run the following commands on both node 1 and 2 to see the breakdown of the workloads.
	`cluster1::*> node run -node cluster1-01 sysstat -x 1`

3.	Which node appears to have the highest CPU utilization? What domain is the busiest on each node? What is the second busiest domain? Why is there such a disparity between the CPU utilization of each node? What can you do to balance the CPU utilization between the nodes? What do you think is causing the CPU to be so high?
4.	Move volume **vs2_vol01** to aggregate **n02_aggr2**. Run the **sysstat -M** and **sysstat -x** commands again on nodes **cluster1-01** and **cluster1-02**. Did you see a difference in workload utilization? Do you understand why? If not, discuss with your instructor and the rest of the class.
5.	Move volume **vs1_vol01** to aggregate **n02_aggr2** Run the **sysstat -M** and **sysstat -x** commands again on nodes **cluster1-01** and **cluster1-02**. Did you see a difference in workload utilization? Do you understand why? If not, discuss with your instructor and the rest of the class.

STEP	ACTION
6.	Why, after moving both volumes to a different node, is there still such a big difference in CPU utilization? Can you tell which type of workloads you moved? How should you have distributed the volumes on the nodes to distribute the workloads? Move volumes **vs1_vol01** and **vs2_vol01** back to aggregate **n01_aggr2**. Do this one volume at a time in the lab environment. Verify the volume moves worked. If they don't, stop the workloads, do the move, and restart the workloads.
7.	Use the command **`qos statistics characteristics show`** to view your workload characteristics. How much work is being done by your users? Look at `User-Best-Effort` How much is system? Can you tell what is generating the user workload?
8.	Create a QoS policy in each SVM, called **unlimitedVS1, unlimitedVS2** and **unlimitedISCSI** respectively, with unlimited iops and attach it to the appropriate SVM to it. **`vserver modify -vserver vsXXXX -qos-policy-group unlimitedXXX`** You can remove the policy by modifying the vserver and using the policy-group called **none**. Run **`qos statistics characteristics show`** again and notice `User-Best-Effort` is gone. This is because all of the workloads are accounted for in a policy. Remove an SVM or two from a policy and notice that all unaccounted workloads are aggregated together. How would I figure out, using this method, the per volume workload information? Create a policy for each volume in **vs1**, **vs2**, and **vsISCSI** named `unlimitedvsXvolX`. Use the command **`vserver modify -vserver vs* -qos-policy-group none`** to remove the QoS policy from the data SVMs. Assign the appropriate volume QoS policy to their respective volumes. Run **`qos statistics characteristics show`** again to see the details of each workload as it corresponds to each volume. Which volume is generating the most IOPS? Which volume is generating the most Throughput? Are they the same volume? Why or why not? Which volumes are mostly read? Which volumes are mostly write? Do a vol move and move a data volume from node1 to node2. Watch the statistics while moving the workload. Run the command **`vol modify -vserver XXX -volume * -qos-policy-group none`** to remove the QoS policy from every volume in each SVM. Examples of the QoS policy commands are in a text file called *`qos policy group commands`* in the course files folder. Modify the command based on what you called the policy group. Then just copy/paste them into the putty window as appropriate.

STEP	ACTION
9.	Use the command **`qos statistics latency show`** to view your workload latency characteristics. Notice we can get over all information but its not broken down by SVM or volume workload. Apply the appropriate QoS policy at the SVM level to see latency information for the entire SVM Do any of the SVMs have indirect I/O? If so, can you tell which volume is being effected? What is the largest contributor to each SVMs overall latency? Can you tell which volumes are most effected? Remove the QoS policy from the SVM and apply the appropriate QoS policy to each data volume. Which volume or volumes are experiencing indirect I/O? Which ones have the highest latency? Which subsystem is the latency coming from? Can you see a pattern with respect to latency generation? i.e. random vs sequential, read vs write. If you don't understand what you are seeing with respect to a pattern talk to your instructor about it. Do a vol move and move a data volume from node1 to node2. Watch the statistics while moving the workload. Remove the QoS policies from all of the data volumes.
10.	Use the command **`qos statistics performance show`** to view your workload performance characteristics. Notice we can get over all information but its not broken down by SVM or volume workload. Apply the appropriate QoS policy at the SVM level to see performance information for each SVM. Run the command **`qos statistics performance show`** to view your workload performance characteristics by SVM. Which SVM has the lowest latency? Which has the Highest? Which SVM is generating the most I/O Which SVM has the most throughput? Remove the QoS policy from the SVMs and apply the volume QoS policies. Use the command **`qos statistics performance show`** to view your workload performance characteristics by volume workload. Which volume has the lowest latency? Which has the Highest? Which volume is generating the most I/O Which volume has the most throughput? Do a vol move and move a data volume from node1 to node2. Watch the statistics while moving the workload. Remove the volume QoS policies.

STEP	ACTION
11.	Use the command **qos statistics resource cpu show –node cluster1-01** to view your workload CPU utilization on node 1. Run the same command on node **cluster1-02**. To view the workload CPU utilization on node 2. Notice we can get over all information but its not broken down by SVM or volume workload. Apply the appropriate QoS policy at the SVM level to see CPU utilization for each SVM on each node. Run the command **qos statistics resource cpu show –node XXXXX** to view your workload CPU utilization by SVM on each node. Which Nodes CPU is being most utilized by VS1? Which Nodes CPU is being most utilized by VS2? Which Nodes CPU is being most utilized by VSISCSI Notice the processor domain utilization and see if the utilization makes sense. If it doesn't talk to your instructor about it. Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **qos statistics resource cpu show –node XXXXX** to view your workload CPU utilization by volume on each node. Which volume is utilizing the most CPU on node 1? Which volume is utilizing the most CPU on node 2? Which volumes are utilizing the most Network domain? Do a vol move and move a data volume from node1 to node2. Watch the statistics while moving the workload. Remove the volume QoS policies.
12.	Use the command **qos statistics resource disk show –node cluster1-01** to view your disk resource utilization by workload and node. Run the same command on node **cluster1-02**. To view the workload CPU utilization on node 2. Notice we can get over all information but its not broken down by SVM or volume workload. Apply the appropriate QoS policy at the SVM level to see disk utilization for each SVM on each node. Run the command **qos statistics resource disk show –node XXXXX** to view your workload disk utilization by SVM on each node. Which SVM is generating the most HDD utilization on node 1? On node 2? Which SVM is generating the most SSD utilization on node 1? On node 2? Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **qos statistics resource disk show –node XXXXX** to view your workload disk utilization by volume on each node.

STEP	ACTION
12 Continued.	Which volume policy group is generating the most HDD utilization on node 1? On node 2? Which volume policy group is generating the most SSD utilization on node 1? On node 2? Do a vol move and move a data volume from node1 to node2. If you don't have any data volumes on node1, then move one from node2 back to node 1. Watch the statistics while moving the workload. Remove the volume QoS policies.
13.	Use the command **`qos statistics workload characteristics show`** to view your workload characteristics. Note we can see the amount of total work being done in the cluster and see the total throughput, percent read and average request size but we can't see which SVM is generating it. Apply the appropriate QoS policy at the SVM level to see our workload characteristics broken down by SVM. Which SVM workload has an almost even split between read and write? Which SVMworkload has a consistent request size? Why are the other two SVMs inconsistent? Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **`qos statistics workload characteristics show`** to view your workload characteristics by volume. Which volumes are primarily read? Which volumes are primarily write? What do you notice about the request size now that they are broken down by volume? Why do some volumes seem to fluctuate between 4k and 32k+ request size? Do a vol move and move a data volume from node1 to node2. If you don't have any data volumes on node1, then move one from node2 back to node 1. Watch the statistics while moving the workload. Remove the volume QoS policies.

STEP	ACTION
14.	Use the command **`qos statistics workload latency show`** to view your workload latency. Note we can see the amount of total latency in our system and which subsystem is generating it but we can't see how its broken down by SVM. Apply the appropriate QoS policy at the SVM level to see our workload characteristics broken down by SVM. Which SVMs have the highest latency? On the SVM with the highest latency, which subsystem is generating the most latency? Which SVMs are getting latency because of indirect I/O? Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **`qos statistics workload latency show`** to view your workload latency by volume. Which volume has the highest latency? On the volume with the highest latency, which subsystem is generating the most latency? Which volumes are getting latency because of indirect I/O? How can you tell when a read is coming from cache and not from disk? Do a vol move and move a data volume from node1 to node2. If you don't have any data volumes on node1, then move one from node2 back to node 1. Watch the statistics while moving the workload. Remove the volume QoS policies.
15.	Use the command **`qos statistics workload performance show`** to view your workload performance. Note we can see the amount of total latency, IOPs and throughput in our system but we can't see how its broken down by SVM. Apply the appropriate QoS policy at the SVM level to see our workload characteristics broken down by SVM. Which SVM has the least overall latency? Which SVM has the highest overall IOP utilization? Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **`qos statistics workload performance show`** to view your workload latency by volume. Which volume has the least overall latency? Which volume has the highest overall IOP utilization?

STEP	ACTION
15. Continued	Do a vol move and move a data volume from node1 to node2. If you don't have any data volumes on node1, then move one from node2 back to node 1. Watch the statistics while moving the workload. Remove the volume QoS policies.
16.	Use the command **`qos statistics workload resource cpu show –node cluster1-01`** to view your workload CPU utilization on node 1. Run the same command on node **`cluster1-02`**. To view the workload CPU utilization on node 2. Notice we can get over all information but its not broken down by SVM or volume workload. You may notice that with the **`workload`** statistics we are getting lower level information. It allows us to see additional system workloads, like **`_WAFL.`** Apply the appropriate QoS policy at the SVM level to see CPU utilization for each SVM on each node. Run the command **`qos statistics workload resource cpu show –node XXXXX`** to view your workload CPU utilization by SVM on each node. Is there any difference when adding QoS policy groups at the SVM level? Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **`qos statistics resource cpu show –node XXXXX`** to view your workload CPU utilization by SVM on each node. Which volume is utilizing the most CPU on node 1? Which volume is utilizing the most CPU on node 2? Which volumes are utilizing the most Network domain? Do a vol move and move a data volume from node1 to node2. Watch the statistics while moving the workload. Remove the volume QoS policies.
17.	Use the command **`qos statistics workload resource disk show –node cluster1-01`** to view your disk resource utilization by workload and node. Run the same command on node **`cluster1-02`**. To view the workload CPU utilization on node 2. Notice we can get over all information but its not broken down by SVM or volume workload. Apply the appropriate QoS policy at the SVM level to see disk utilization for each SVM on each node. Run the command **`qos statistics workload resource disk show –node XXXXX`** to view your workload disk utilization by SVM on each node. Notice the user workload has been removed. This statistic only works on the actual volume/lun workload

STEP	ACTION
17. Continued	Remove the SVM QoS policies and apply the Volume QoS policies. Run the command **`qos statistics workload resource disk show -node xxxxx`** to view your workload disk utilization by volume on each node. Which volume policy group is generating the most HDD utilization on node 1? On node 2? Which volume policy group is generating the most SSD utilization on node 1? On node 2? Do a vol move and move a data volume from node1 to node2. If you don't have any data volumes on node1, then move one from node2 back to node 1. Watch the statistics while moving the workload. Remove the volume QoS policies.
18.	Use the command **`qos statistics volume latency show`** to view your volume latency characteristics. Notice we can received this information without applying any QoS policies to either the SVM or the volumes themselves. Which volume or volumes are experiencing indirect I/O? Which ones have the highest latency? Which subsystem is the latency coming from? Can you see a pattern with respect to latency generation? i.e. random vs sequential, read vs write. Which workloads appear to be disk bound? This command is one which is used a lot. You should practice gathering data while generating different types of workloads so you can recognize the impact of various workloads on the storage subsystems. Also try doing a vol move while looking at various subsystems. Stop your various workloads, both CIFS and NFS. To view a specific type of workload, in the iometer toolbar, click the **Open Config File** button  (a yellow folder) and browse to the CourseFiles folder on the desktop to load a specific type of CIFS workload. *`workload exercise 0% read 0% random`* for a sequential write workload *`workload exercise 0% read 100% random`* for a random write workload *`workload exercise 100% read 0% random`* for a sequential read workload *`workload exercise 100% read 100% random`* for a random read workload *`workload exercise`* for a mixed workload (the default config from the previous labs) *`vs2vol1 50% read 50% random`* for a mixed workload to only vs2vol1.

18.	Stop all workloads running against your storage array Ensure vs2_vol01, vs1_vol01, and lun_vsISCSI_1_vol are all in aggregate no1_aggr1. You may need to move them to this aggregate In Drive D: (the iSCSI LUN) start a mixed workload using IOMETER and the *D Workload* ICF file. Let this workload run for 5 minutes then use the **qos statistics volume latency show** command to view the latency characteristics of the lun_vsISCSI_1_vol volume. Stop the workload and then create additional workloads in Drives W: and Z: using the *D W Z workload* ICF file in iometer. Let this workload run for 5 minutes then use the **qos statistics volume latency show** command to view the latency characteristics of the lun_vsISCSI_1_vol volume. What do you notice about the workload characteristics? Move the volume **lun_vsISCSI_1_vol** to **n02_aggr2** Use the **qos statistics volume latency show** command to view the latency characteristics of the lun_vsISCSI_1_vol volume. What changed? Use the **qos statistics volume latency show** command to view the latency characteristics of the vs1_vol01 volume. Move the LIF used by drive W to another node During the move use the **qos statistics volume latency show** command to view the latency characteristics of the lun_vsISCSI_1_vol volume. What was the impact of the move on the overall performance of the iSCSI LUN? After the move completes Use the **qos statistics volume latency show** command to view the latency characteristics of the vs1_vol01 volume. What changed? Look at the volume containing the LUN, did the move have an impact on it?

TASK 3: FLASH-POOL MONITORING AND CANDIDACY TESTING

In this task, you will see the effect of different workloads while monitoring flash cache utilization.

STEP	ACTION
1.	In the iometer toolbar, click the **Open Config File** button  (a yellow folder) to load a specific type of CIFS workload. Load the *`workload exercise`* file for a mixed workload generation. If you want to see an NFS workload use the SIO configuration from Task 1 Step 8.
2.	Type the command **`statistics cache flash-pool show`** to view the flash-pool utilization Which volumes are getting write hits? Which volumes are getting read hits? Which volumes aren't storing any data in the flash-pool?
3.	If you need to determine whether an existing aggregate would be a good candidate for conversion to a Flash Pool aggregate, determine how busy the disks in the aggregate are during a period of peak load, and how that is affecting latency: **`statistics show-periodic -object disk:raid_group -instance raid_group_name -counter disk_busy|user_read_latency -interval 1 -iterations 60`** You can decide whether reducing latency by adding Flash Pool cache makes sense for this aggregate. Example The following command shows the statistics for the first RAID group of the aggregate "n01_aggr2": **`statistics show-periodic -object disk:raid_group -instance /n01_aggr2/plex0/rg0 -counter disk_busy|user_read_latency -interval 1 -iterations 60`** If your aggregate doesn't need reallocation then the utilization would be evenly spread across all of the raid groups so monitoring just the first one should give you a fairly good representation of your total aggregate. Try the above command in the lab, but since we are using simulators the result is very misleading. And the aggregate, n01_aggr2 is already a "flash-pool"

TASK 4: HOW TO VIEW AND SET FLASH-POOL CACHING AND RETENTION POLICIES

In this task, you will see the effect of different workloads while monitoring flash cache utilization.

STEP	ACTION
1.	To view the current caching and retention for a volume use the following command **`volume show -volume vs1_vol02 -vserver vs1 -fields caching-policy,cache-retention-priority`** or **`volume show -vserver vs1 -fields caching-policy,cache-retention-priority`** or **`volume show -fields caching-policy,cache-retention-priority`**
2.	To set maximum caching on a volume set the caching-policy to all and the cache retention priority to high. Stop the IOMETER workload generation. Start the IOMETER workload using the *`vs2vol1 50% read 50% random`* configuration. We will now see if *`vs2_vol01`* has started caching reads and writes. Let the workload generator run for about 5 minutes, then: Type **`statistics cache flash-pool show -interval 100 -iterations 2`** Note the read and write hit rates. Type **`volume modify -volume vs2_vol01 -vserver vs2 -caching-policy all_read_random_write-random_write -cache-retention-priority high`** Verify the caching policy and retention has been changed Type **`volume show -vserver vs2 -volume vs2_vol01 -fields caching-policy,cache-retention-priority`** Type **`statistics cache flash-pool show -interval 100 -iterations 2`** We should now see an increase on read and write hits. The data would also be stored in the cache longer.

END OF EXERCISE

MODULE 9: USING GUI TOOLS TO VIEW PERFORMANCE DATA

EXERCISE

In this exercise, you will work with System Manager, OnCommand Performance Manager, and Harvest to view performance data within your cluster.

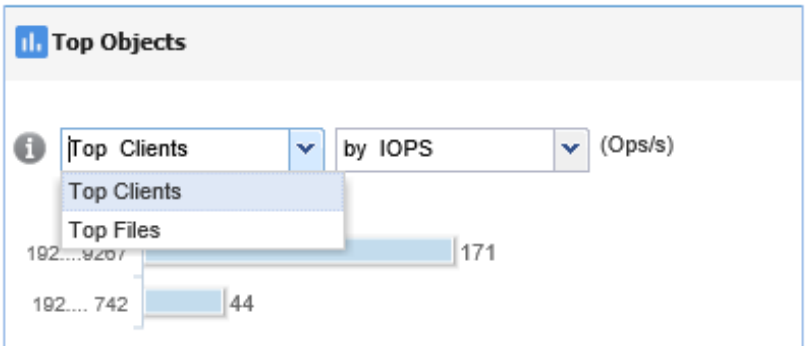
OBJECTIVES

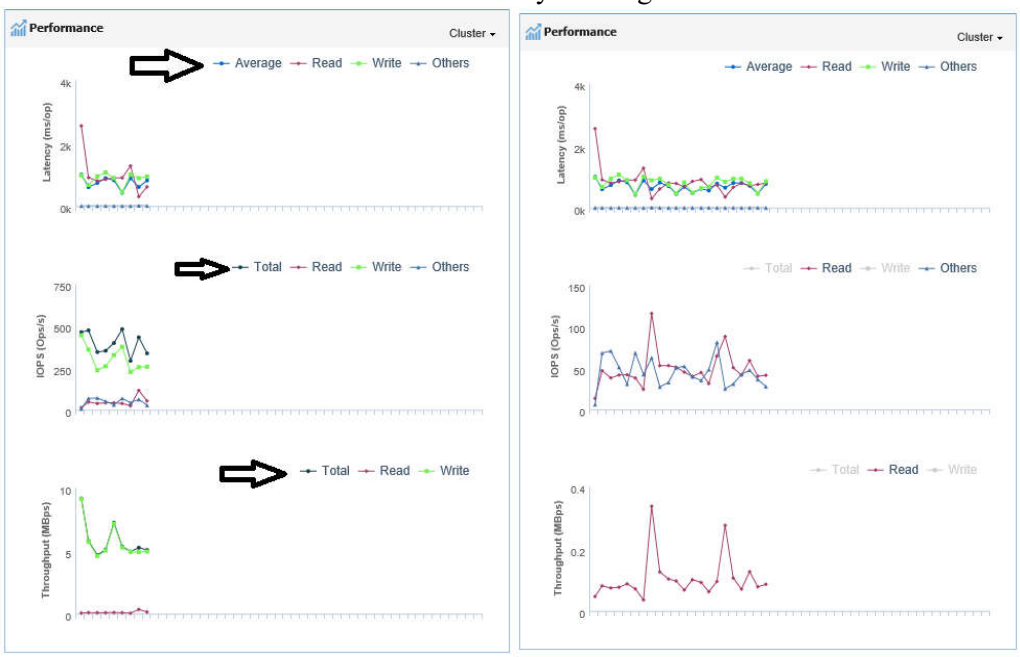
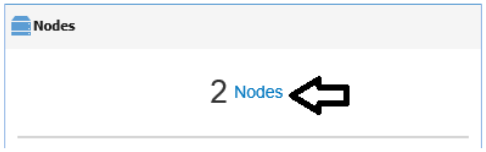
By the end of this exercise, you should be able to:

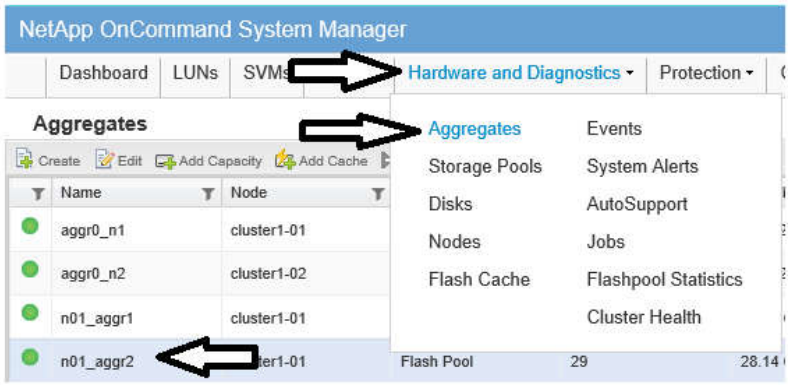
- Find bully workloads in an aggregate
- Analyze Latency, IOPS, and throughput issues on various system resources
- View performance by protocol
- Analyze flashpool and flashcache utilization and set caching policies.

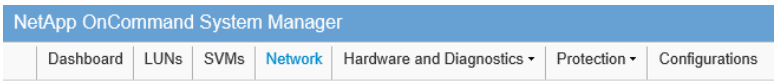
TASK 1: USE SYSTEM MANAGER TO ANALYZE NEAR REAL TIME PERFORMANCE INFORMATION

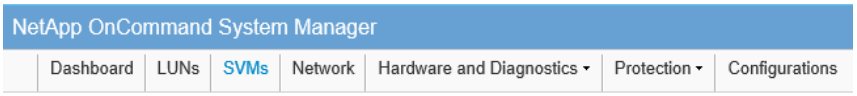
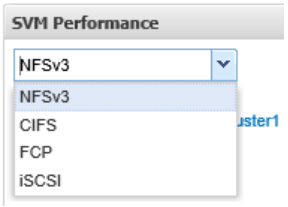
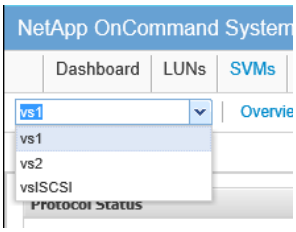
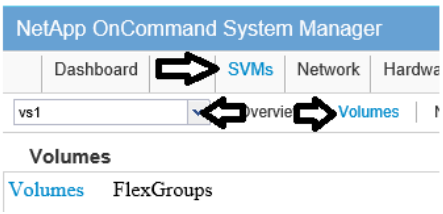
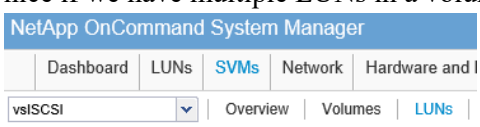
In this task, you use Iometer and SIO to generate a various workloads while analyzing the impact of those workloads on various storage system objects.

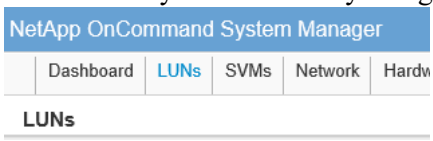
STEP	ACTION
1.	In this step we are going to consolidate all volumes in one aggregate and generate an NFS and CIFS workload. Stop Iometer and move all of the volumes and luns to n01_aggr2. Wait for all of the moves to finish before continuing. Load the `workload exercise` configuration into IOMETER and start the workload generation On the Linux box use 4 putty sessions to run 4 different SIO sessions as detailed in Exercise 8, Task 1, Step 8.
2.	Open System Manager and log in. On the Dashboard landing page Use the top objects pane to view utilization by Top Client or Top File. You can also view by IOP or throughput. Which client is using the most IOPs in your cluster? What protocol are they using? Which file is the most utilized in your cluster? 

STEP	ACTION
3.	On the Dashboard using the performance pane you can average performance for your cluster. Enable the other counter views in the charts by clicking on the metrics in the chart.  Enable and disable various metrics and watch the scale dynamically change
4.	On the performance pane, change the view to **`Node`** view and view **`cluster1-01`**  Enable the other counters to view reads and writes on the node. Change the view to look at cluster1-02 Which node has the highest average latency? On the node with the highest latency which latency is highest? Read or write? In the Nodes pane click Nodes  Select cluster1-01 in the node selection pane On the bottom select the performance tab to view that nodes performance data. Drag the window resize bar, in the middle, up to view more performance data on the screen.

STEP	ACTION
5.	In the System Manager menu select `Hardware and Diagnostics`. From there select `Aggregates`. On the Aggregates landing page select `n01_aggr2`. 
6.	On the bottom of the page select the `Performance` tab and expand the performance pane to make it as large as you can.  From here you can see aggregate workload characteristics. Let the system collect data for a minute or two and look at your workload. Is the aggregate doing more Reads or Writes? Where are most of the transfers coming from HDD or SSD? Notice the workload impact percentage. This is for NON-READ impact. Stop all of your workloads, NFS and CIFS. Toggle your view from n01_aggr2 to n01_aggr1 then back to n01_aggr2. This will reset the graphs flushing history In Iometer load the various workload configurations and run them for a few minutes. Watch the impact on the workload impact percentage chart. Between workload changes remember to reset the chart. Which type of workload had the lowest workload impact on your aggregate? In the Simulator which subsystem do you think is impacting the performance? We will analyze other subsystems and see if you change your mind. Restart the NFS workloads. Restart the `workload exercise` configuration in Iometer

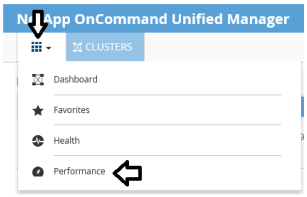
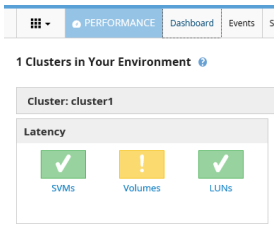
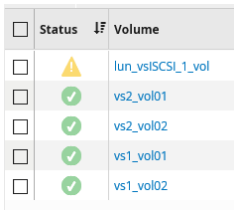
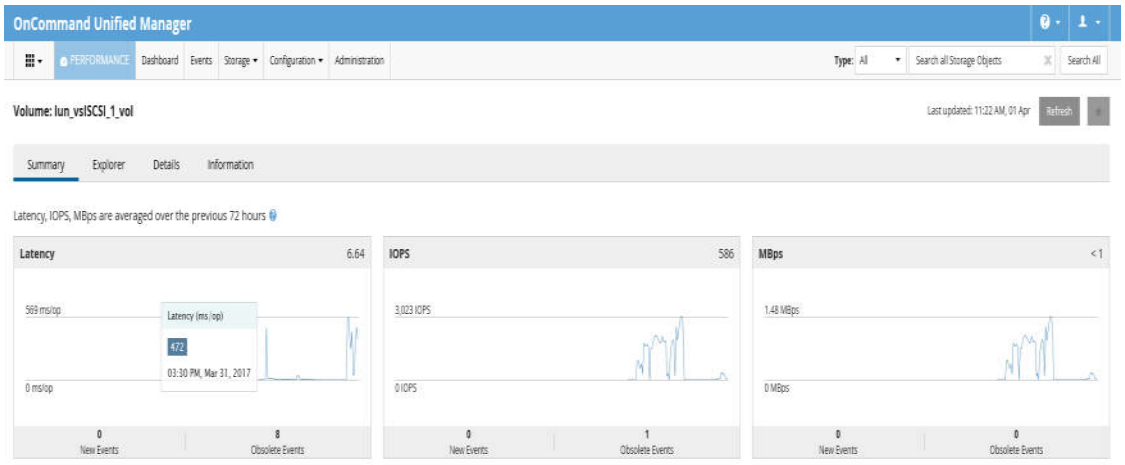
STEP	ACTION
7.	In the System Manager menu select `Hardware and Diagnostics`. From there select `Flashpool Statistics`.  On the Flashpool Statistics landing page select `n01_aggr2`.  Notice the number of read requests compared to read hits Notice the number of write requests compared to write hits Notice we can't determine which volumes are generating the most hits. We can only determine overall utilization of the pool
8.	On the menu select `Network`.  On the Network landing page select the `Network Interfaces` tab. Notice there is no way to view LIF performance in System Manager. On the Network Landing page select `Ethernet Ports` tab. On the bottom of the Ethernet ports tab select the `Performance` tab. Highlight the ports utilized in this class to view the total port throughput and error rates. We are using ports e0c, e0d, and e0e on nodes 1 and 2. Notice there is no way to easily compare performance, or get the top utilized port. All we can do is look at current utilization and error rates. On the Network Landing page select `FC/FCoE Adapters` tab. On the bottom of the FC/FCoE Adapters tab select the `Performance` tab. In the simulator you can't see anything, but if we had a physical array we would be able to see each ports performance, just like the Ethernet adapters.

STEP	ACTION
9.	On the menu select SVMs.  On the SVMs landing page select the VS1 SVM to go to its landing page. On the SVM overview landing page, in the SVM Performance pane, you can view performance by protocol. Select NVSv3 and CIFS from the drop down menu and look at the over all performance, by protocol, of the SVM vs1. If you don't see both NFS and CIFS traffic make sure the SIO and Iometer workloads are still running, and you are using the correct workloads in each.  Change to SVM vs2 and look at its CIFS and NFS performance. Change to SVM vsISCSI and look at its iSCSI performance.  Change back to SVM vs1 and click the Volumes tab.  Select volume vs1_vol01 then select the performance tab at the bottom of the page to view the volume performance. Resize the performance pane to its maximum size. From here you can see the volumes Latency, throughput, and IOPs charted by Average/Total, read, and write. View the performance of the other data volumes in SVMs vs1, vs2, and vsISCSI. Go to vsISCSI and select the LUNs tab. From there select performance on the bottom of the page and expand the performance pane to its largest size. Here we can see LUN performance. This is nice if we have multiple LUNs in a volume and want to see each LUN individually. 

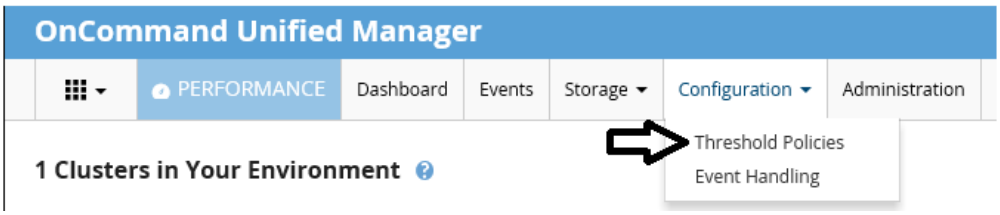
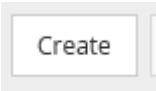
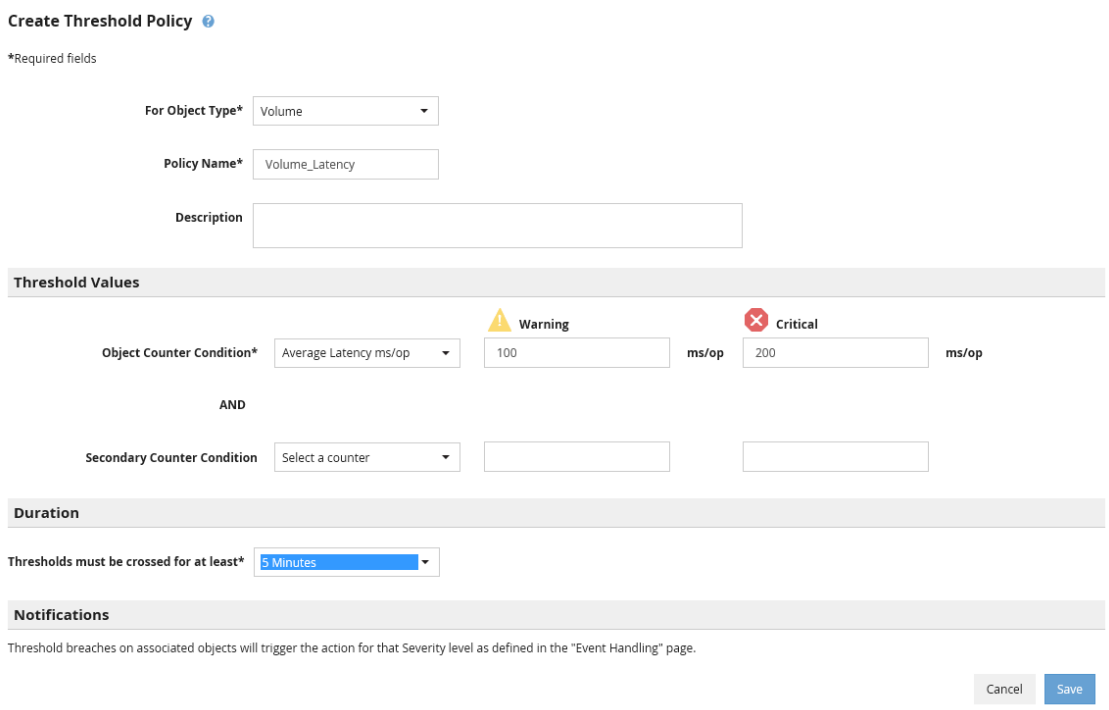
STEP	ACTION
10.	On the menu select `LUNS`. This will take us to the LUNs landing page where we can see every LUN in our system. You may recognize this page from the last action in the previous step.  From here you can select any LUN from any SVM and view its performance. This is much easier than browsing to an SVM first then going to LUNs and then clicking performance.
11.	Now that you have seen how to view different objects performance within System Manager you can perform a few experiments and see the impact on those various components. Try doing a vol move from n01_aggr2 to n02_aggr2, or vice versa, and see the impact on the volume performance, aggregate performance cluster port performance This is the end of using System Manager to view performance and we are going to move on to OnCommand Performance Manager.

TASK 2: USING ONCOMMAND PERFORMANCE MANAGER TO ANALYZE PERFORMANCE WITHIN OUR CLUSTER.

In this task, you will look at over all cluster performance, drill down to specific object performance, look at trending performance on an object, and correlate performance trends on objects.

STEP	ACTION
1.	Log in Oncommand Performance Manager (OPM) and from the clusters landing page use the drop down to select Performance. 
2.	On the Dashboard you may notice a yellow or red object This is telling us we have a performance issue with that particular object. In the case of my screen shot we have a volume, or volumes, that are having a latency issue. By clicking on the object we can drill down and look at the details. 
3.	From the volumes landing page we can see which volume is having the problem 
4.	Click on the volume name to go to the instance landing page. From there click on Summary. On the summary page you can see information about your selected instance of an object. If you hover your mouse over the graph details will appear in a pop up. 

STEP	ACTION
7.	From the Explorer view we can see the performance of the selected volume. Change the time range to Last Hour Add all of the charts (notice some are not applicable to volumes, and remove them) Add all of the other volumes to the comparison windows so we can see if there is any correlation
8.	In iometer start the bully workload after 5 minutes analyze the latency of vs1_vol01 in OPM **NOTE:** To create threshold policies look at the example in step 9-10 create a threshold policy for warning event for 10ms above average(approximately 100), and a crit for 50ms above average (approximately 200) and apply to all volumes create a threshold policy for warning event above 100ms, and crit above 200ms latency for an aggregate create a threshold policy for warning event above 40% utilization and crit of above 80% utilization for a node create a threshold policy for warning event above 40% utilization and crit of above 80% utilization for an aggr wait for the write workload to kick in After about 5 to 10 minutes you should start seeing events. To view events Click on Events in the Performance Title Menu.

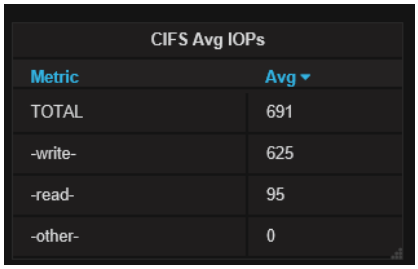
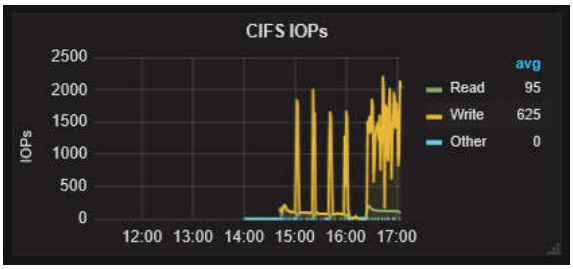
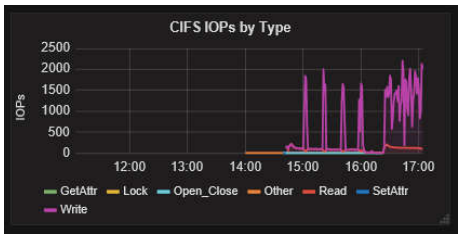
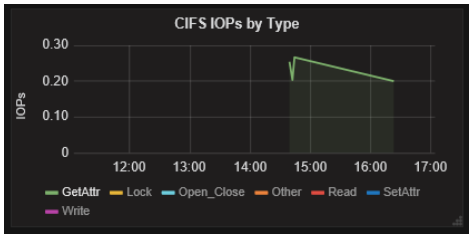
STEP	ACTION
9.	In the OPM title bar select Configuration then threshold Policies  Click Create 
10.	Under object type, pick the proper type of object, Vol/Aggr. Give your policy a descriptive name Pick the appropriate condition and settings for Warning and Critical Pick a threshold duration for the triggering event. Click Save 

TASK 3: Analyze performance using Harvest

In this task, you will use Harvest to view performance data about your Storage Cluster.

STEP	ACTION
1.	Stop all workloads, iometer and SIO (on linux) if any are currently running
2.	Move vs2_vol01 to n01_aggr1 Move vs2_vol02 to n02_aggr2 Move vs1_vol01 to n01_aggr1 Move vs1_vol02 to n01_aggr2 Move lun_vsISCSI_1_vol to n01_aggr1 We are now generating indirect I/O to vs2_vol02 and direct I/O to all of the other volumes
3.	Start the CIFS workload by loading the BULLY from the coursefiles folder workload into iometer. Start the NFS workload by using SIO. Use Module 8 Task 1 step 8 as your template to create the NFS workload.
4.	Open a browser to *https://nabox.learn.netapp.local/* and log in as `admin` with the password of `Netapp123`
5.	Click the Home button and select `NetApp Dashboard: Cluster` to view a summary of utilization on your cluster. In the upper Right hand corner change the range to be the last 5 minutes (depending on when you started the workloads) 

STEP	ACTION
6.	In the Highlights section notice which node of your cluster has the highest latencies. Is the biggest problem Read or Write latency? Which Node is has the largest Read Latency? Which Node has the largest Write Latency? Look at the Throughput and IOPS Which node is generating the most throughput? Which node is generating the most IOPS?
7.	Expand the SVM Performance Drilldown Which SVM is generating the Highest latency? Which SVM is generating the Top Throughput? Which SVM is generating the TOP I/Os?
8.	Open the NetApp Dashboard: SVM In the menu select the SVM with the highest latency from the previous step Use the picture as an example 
9.	Expand `Highlights` and look at the overall performance of your SVM. Expand the `Top Volumes Performance Drilldown` and look at the R/W Latency, R/W Throughput, and R/W IOPs for each volume in the SVM. Remove the volumes you don't want to look at by clicking on the volume you want to keep in the display. For example. In the write latency window click on vs2_vol02. You should notice the display scale change and vs2_vol01 disappear from the graph and greys out. To bring the undisplayed data back click on vs2_vol02 again. You can use this to remove data from the graph which is of no interest to you

STEP	ACTION
10.	Using the `CIFS Frontend Drilldown` display, notice the AVG amount of CIFS iops coming into the selected SVM. And, we can see the timeline for the different types of IOPs. For example   Notice we can break down the Other types of IOPs in another graph. And we can even drill down to concentrate on a particular type by selecting it in the graph.  
11.	Analyze the iSCSI, NFS, and CIFs traffic on each of your SVMs. Do any of the workloads seem bursty? If so, which ones? Is there a discernable pattern? You may need to change your timeframe to get a better view of the data.
12.	Which volume has the most utilization, by protocol, by SVM? Which Dashboard did you use to find this?

TASK 5: Using Harvest – Free Form

In this task, you will use Harvest to view performance data about your Storage Cluster.

STEP	ACTION
1.	Ensure your volumes are configured as Module 9, Task 3, step 2 Ensure all of your workloads are still running
2.	Which Dashboard would you use to analyze SVM Peformance and Capacity? Using that dashboard Identify the busiest volume in each SVM
3.	Which Dashboard would you use to view detailed LUN information? In that dashboard see if you have any indirect SAN access to a LUN Which Dashboard would you use to view the detailed LIF information Which LIFs are being used for iSCSI access? Is the load being balanced across the LIFs? Do you have any indirect access to the LUN? If so where did you go to see it? Disable the iSCSI interfaces being used on Node2 (if that's where the LUN is NOT) and see if your indirect I/O is displayed (may take a couple of minutes). Move the volume containing the LUN to n02_aggr2. Watch the Indirect Access chart in the LUN details. Re-Enable your iSCSI interfaces on Node2 Does the indirect I/O go away? What does your LIF usage look like now? Move the volume containing the LUN back to n01_aggr1 (you may have to stop I/O to perform the move in the simulator, remember to restart I/O after the move finishes).
4.	Where would you go to find FlashPool utilization and efficiency? Do you have any volumes in a FlashPool aggregate? How percentage of data is being served out of the FlashPool?
5.	Think of the types of problems you might experience in your place of work and try to simulate a similar workload in the lab. Analyze the workloads you have designed Discuss the results with your instructor, and the class, to come up with a troubleshooting methodology.

END OF EXERCISE

MODULE 10: BASIC MONITORING AND PREVENTATIVE MAINTENANCE

EXERCISE

In this exercise, you work with various commands to analyze performance.

OBJECTIVES

By the end of this exercise, you should be able to:

- View the top Clients and top Files in your cluster
- Manually calculate headroom
- Modify the output of a command to sort and limit

TASK 1: Use various commands to view statistical data, sort it, and limit the output.

Ensure you are still generating CIFS and NFS workloads..

STEP	ACTION
1.	Ensure the CIFS and NFS workloads are running Use the `statistics top client show` command to see the top client utilization. Sort by protocol Use the `statistics top file show` command to see the top file usage on each node Sort by node
2.	Use the following commands to get a current headroom sample ▪ `set -privilege diag` ▪ `statistics start -object resource_headroom_cpu` ▪ `statistics show -object resource_headroom_cpu` Subtract the `utilization` result from the `optimal_point_utilization`. If the number is a negative number you are overutilized. Use the following options to get hourly, daily, weekly, and monthly overutilization information • `-raw -counter ewma_daily` • `-raw -counter ewma_weekly` • `-raw -counter ewma_monthly` Notice the other values you can use, besides utilization, to determine optimal usage

STEP	ACTION
3.	Use the following commands to get a current headroom sample ▪ `set -privilege diag` ▪ `statistics start -object resource_headroom_aggr` ▪ `statistics show -object resource_headroom_aggr` Subtract the `utilization` result from the `optimal_point_utilization`. If the number is a negative number you are overutilized. Use the following options to get hourly, daily, weekly, and monthly overutilization information • `-raw -counter ewma_daily` • `-raw -counter ewma_weekly` • `-raw -counter ewma_monthly` Notice the other values you can use, besides utilization, to determine optimal usage
4.	Check in OPM and see if the calculations you came up with are similar to what is shown in OPM Are they the same? If not why would they be different?
5.	Use the following commands to test the network connectivity between two nodes, simulating a snapmirror ▪ `set -privilege advanced` ▪ `network test-path -source-node cluster1-01 -destination-cluster cluster1 -destination-node cluster1-02 -session-type AsyncMirrorlocal` Now use a session type of RemoteDataTransfer to simulate NAS requests

STEP	ACTION
6.	Use the following command to view disk response times in your cluster `statistics disk show -sort-key operation_latency` Limit the output of the command to only the top 10 disks with the highest latency. Can I get this information in OPM? If so where? Can I get this information in Harvest? If so where?
7.	Use the following command to view disk response times in your cluster `statistics aggregate show` Sort the output by highest Latency Limit the output of the command to only the top 2. Can I get this information in OPM? If so where? Can I get this information in Harvest? If so where?
8.	Use the following command to view disk response times in your cluster `statistics lif show` Sort the output by highest Sent Data Limit the output of the command to only the top 2. Can I get this information in OPM? If so where? Can I get this information in Harvest? If so where?

STEP	ACTION
9.	Use the following command to view disk response times in your cluster `statistics volume show` Sort the output by highest Latency Limit the output of the command to only the top 5 with the highest latency. Can I get this information in OPM? If so where? Can I get this information in Harvest? If so where?
10.	Use the following command to view disk response times in your cluster `statistics workload show` Sort the output by highest Latency Limit the output of the command to only the top 2. Can I get this information in OPM? If so where? Can I get this information in Harvest? If so where?

END OF EXERCISE

MODULE 11: ONTAP Cloud

There is no exercise associated with Module 1.

END OF EXERCISE

NETAPP UNIVERSITY

Performance Analysis on Clustered Data ONTAP

Appendix A: Answers

Course ID: STRSW-ILT-PERFCDOT
Catalog Number: STRSW-ILT-PERFCDOT-EG
Content Version: 1.0

MODULE 2: PERFORMANCE OVERVIEW

EXERCISE

TASK 5: IDENTIFY CLUSTERED DATA ONTAP COMPONENTS

In this task, you use either System Manager or the clustered Data ONTAP CLI to identify key clustered Data ONTAP components and revert any LIFs that are not on their home ports.

STEP	ACTION
1.	Analyze and identify the following list of clustered Data ONTAP components: Aggregates aggr0_n1, aggr0_n2, n01_aggr1, n02_aggr1 Storage virtual machines cluster1, cluster1-01, cluster1-02, vs1, vs2, vsISCSI1 Volumes vol0, vol0, vs1_root, vs2_root, vs2_vol01, lun_ vsISCSI1_1 _vol, vsISCSI1_root LUNs /vol/lun_vsISCSI1_1_vol/lun_vsISCSI1_1 Licenses (which features are installed?) Base, Insight Balance, CIFS, NFS, iSCSI CIFS Shares admin$, ipc$, rootdir, vol1, ~%w LIFs (are all LIFs home?) No

MODULE 3: CLUSTERED STORAGE SYSTEM WORKLOADS AND BOTTLENECKS

EXERCISE

TASK 1: EXAMINE THE STATISTICS CATALOG COMMAND

In this task, you issue the three `statistics catalog` commands and exercise the supporting parameters, using different privilege levels.

STEP	ACTION
4.	What command syntax would you use to display only the advanced level statistics objects without their descriptions? **`statistics catalog object show -privilege advanced -fields object`**
5.	What command syntax would you use to display statistics objects that are associated with storage virtual machines (SVMs)? **NOTE:** You should still be in the advanced privilege level. **`statistics catalog object show -object *vserver*`** How many statistics objects are there in the list? 11 (in Clustered Data ONTAP 8.2)
7.	What command syntax would you use to display the instance names that are available for the statistics object that represents SVMs that have LIFs associated with them? **`statistics catalog instance show -object lif:vserver`** How many instance names are there in the list? 5
8.	What command syntax would you use to display the instance names that are available for the statistics object that represents SVMs that have volumes associated with them? **`statistics catalog instance show -object volume:vserver`** How many instance names are there in the list? 3
9.	What command syntax would you use to display the instance names that are available for the statistics object that represents the disk that is associated with the second node in the cluster (cluster1-02)? **`statistics catalog instance show -object disk -node cluster1-02`**

TASK 2: EXAMINE THE STATISTICS START AND STATISTICS SHOW COMMANDS

In this task, you issue the `statistics start` and `statistics show` commands and exercise the supporting parameters, using different privilege levels.

STEP	ACTION
3.	Display the counters that are associated with the statistics object "nfsv3" instance "vs2" for both samples. **`statistics show -object nfsv3 -instance vs2 -counter * -sample-id sample_nfsv3_adm`** **`statistics show -object nfsv3 -instance vs2 -counter * -sample-id sample_nfsv3_adv`** Was there any difference in the displays? Yes

STEP	ACTION
5.	What command syntax would you use to display all of the latency related counters for disk v4.20? **`statistics show -object disk -instance v4.20 -counter *latency* -sample-id sample_disk`** How many counters are there in the list? 10
6.	What command syntax would you use to display all of the user_read_latency counters for all disks in the cluster? **`statistics show -object disk -instance * -counter user_read_latency -sample-id sample_disk`** How many counters are there in the list? 28
8.	What command syntax would you use to display all of the user_read_latency counters that are greater than 10000us for all disks in the cluster, limiting the display to only the counter and value fields? **`statistics show -object disk -instance * -counter user_read_latency -sample-id sample_disk -fields counter,value -value >10000`**
13.	What command syntax would you use to display all of the latency counters for all volumes in the cluster? How about all nonzero latency counters? **`statistics show -object volume -instance * -counter *latency -sample-id sample_volume`** **`statistics show -object volume -instance * -counter *latency -sample-id sample_volume -value >0`**
15.	What command syntax would you use to display all of the counters for all processors in the cluster? **`statistics show -object processor -instance * -sample-id sample_processor`**

TASK 3: DEFINING WORKLOAD CHARACTERISTICS

In this task, you gather statistical data and evaluate the data to determine the workload characteristics.

STEP	ACTION
15.	Record your observations for sample_cifs1 below:

CHARACTERISTIC	OBSERVED VALUE	
	Read	Write
Throughput	0/sec	99/sec
Latency	-	6.32ms
Operation Size	-	32K
Concurrency	0	0.63
Randomness	-	

STEP	ACTION

16.	What did the command-line output look like for throughput of sample_cifs1?
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_read_ops -sample-id sample_cifs1`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 21:56:21`
	`End-time: 9/22/2013 21:58:18`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_read_ops 0`
	`cifs_read_ops 0`
	`2 entries were displayed.`
	
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_write_ops -sample-id sample_cifs1`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 21:56:21`
	`End-time: 9/22/2013 21:58:18`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_ops 99`
	`cifs_write_ops 0`
	`2 entries were displayed.`

STEP	ACTION

17.	What did the command-line output look like for latency of sample_cifs1?
	`cluster1::*> statistics show -object volume -instance * -counter cifs_read_latency -sample-id sample_cifs1`
	
	`...`
	
	`Object: volume`
	`Instance: vs2_vol01`
	`Start-time: 9/22/2013 21:56:21`
	`End-time: 9/22/2013 21:58:18`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_read_latency -`
	
	`...`
	`7 entries were displayed.`
	`cluster1::*> statistics show -object volume -instance * -counter cifs_write_latency -sample-id sample_cifs1`
	
	`...`
	
	`Object: volume`
	`Instance: vs2_vol01`
	`Start-time: 9/22/2013 21:56:21`
	`End-time: 9/22/2013 21:58:18`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_latency 6324us`
	
	`Object: volume`
	`Instance: vsISCSI1_root`
	`Start-time: 9/22/2013 21:56:21`
	`End-time: 9/22/2013 21:58:18`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_latency -`
	`7 entries were displayed.`

STEP	ACTION
18.	What did the command-line output look like for read operation size of sample_cifs1?

```
cluster1::*> statistics show -object cifs -instance * -counter cifs_read_size_histo -
sample-id sample_cifs1


Object: cifs

Instance: vs2

Start-time: 9/22/2013 21:56:21

End-time: 9/22/2013 21:58:18

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- ----------------------------------
    cifs_read_size_histo                                            -
                               0 bytes                              0
                         <= 256 bytes                               0
                         <= 512 bytes                               0
                              <= 1 KB                               0
                              <= 2 KB                               0
                              <= 4 KB                               0
                              <= 8 KB                               0
                             <= 16 KB                               0
                             <= 32 KB                               0
                             <= 64 KB                               0
                              > 64 KB                               0
    cifs_read_size_histo                                            -
                               0 bytes                              0
                         <= 256 bytes                               0
                         <= 512 bytes                               0
                              <= 1 KB                               0
                              <= 2 KB                               0
                              <= 4 KB                               0
                              <= 8 KB                               0
                             <= 16 KB                               0
                             <= 32 KB                               0
                             <= 64 KB                               0
                              > 64 KB                               0

2 entries were displayed.
```

STEP	ACTION

19.	What did the command-line output look like for write operation size of sample_cifs1?
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_write_size_histo -sample-id sample_cifs1`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 21:56:21`
	`End-time: 9/22/2013 21:58:18`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_size_histo -`
	`0 bytes 0`
	`<= 256 bytes 0`
	`<= 512 bytes 0`
	`<= 1 KB 0`
	`<= 2 KB 0`
	`<= 4 KB 0`
	`<= 8 KB 0`
	`<= 16 KB 0`
	`<= 32 KB 23284`
	`<= 64 KB 0`
	`> 64 KB 0`
	`cifs_write_size_histo -`
	`0 bytes 0`
	`<= 256 bytes 0`
	`<= 512 bytes 0`
	`<= 1 KB 0`
	`<= 2 KB 0`
	`<= 4 KB 0`
	`<= 8 KB 0`
	`<= 16 KB 0`
	`<= 32 KB 0`
	`<= 64 KB 0`
	`> 64 KB 0`
	`2 entries were displayed.`

20.	What did the calculation (throughput * latency) look like for concurrency of sample_cifs1? **`99/sec * 0.00632 (6.32ms) = 0.63`**
21.	What did the command-line output look like for randomness (`rand_read_reqs`) of sample_cifs1? **100% write workload, no reason to run this command**

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td>22.</td><td>What did the command-line output look like for randomness (<code>seq_read_reqs</code>) of sample_cifs1?
100% write workload, no reason to run this command</td></tr>
<tr><td>23.</td><td>What workload did you conclude from your data collection of sample_cifs1?
All writes, large operations, virtually no concurrency</td></tr>
<tr><td>24.</td><td>Record your observations for sample_cifs2 below:
<table>
<tr><th>CHARACTERISTIC</th><th colspan="2">OBSERVED VALUE</th></tr>
<tr><td></td><td>Read</td><td>Write</td></tr>
<tr><td>Throughput</td><td>715/sec</td><td>0/sec</td></tr>
<tr><td>Latency</td><td>3.20ms</td><td>-</td></tr>
<tr><td>Operation Size</td><td>32K</td><td>-</td></tr>
<tr><td>Concurrency</td><td>2.29</td><td>0</td></tr>
<tr><td>Randomness</td><td>Sequential</td><td></td></tr>
</table></td></tr>
</table>

STEP	ACTION

25.	What did the command-line output look like for throughput of sample_cifs2?
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_read_ops -sample-id sample_cifs2`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 22:21:55`
	`End-time: 9/22/2013 22:23:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_read_ops 715`
	`cifs_read_ops 0`
	`2 entries were displayed.`
	
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_write_ops -sample-id sample_cifs2`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 22:21:55`
	`End-time: 9/22/2013 22:23:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_ops 0`
	`cifs_write_ops 0`
	`2 entries were displayed.`

STEP	ACTION
26.	What did the command-line output look like for latency of sample_cifs2? **cluster1::*> statistics show -object volume -instance * -counter cifs_read_latency -sample-id sample_cifs2** **...** **Object: volume** **Instance: vs2_vol01** **Start-time: 9/22/2013 22:21:55** **End-time: 9/22/2013 22:23:31** **Cluster: cluster1** **Counter Value** **-------------------------------- --------------------------------** **cifs_read_latency 3196us** **...** **7 entries were displayed.** **cluster1::*> statistics show -object volume -instance * -counter cifs_write_latency -sample-id sample_cifs2** **...** **Object: volume** **Instance: vs2_vol01** **Start-time: 9/22/2013 22:21:55** **End-time: 9/22/2013 22:23:31** **Cluster: cluster1** **Counter Value** **-------------------------------- --------------------------------** **cifs_write_latency -** **Object: volume** **Instance: vsISCSI1_root** **Start-time: 9/22/2013 22:21:55** **End-time: 9/22/2013 22:23:31** **Cluster: cluster1** **Counter Value** **-------------------------------- --------------------------------** **cifs_write_latency -** **7 entries were displayed.**

STEP	ACTION
27.	What did the command-line output look like for read operation size of sample_cifs2?

```
cluster1::*> statistics show -object cifs -instance * -counter cifs_read_size_histo -
sample-id sample_cifs2


Object: cifs

Instance: vs2

Start-time: 9/22/2013 22:21:55

End-time: 9/22/2013 22:23:31

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- ----------------------------------
    cifs_read_size_histo                                            -
                               0 bytes                              0
                          <= 256 bytes                              0
                          <= 512 bytes                              0
                               <= 1 KB                              0
                               <= 2 KB                              0
                               <= 4 KB                              0
                               <= 8 KB                              0
                              <= 16 KB                              0
                              <= 32 KB                         137368
                              <= 64 KB                              0
                               > 64 KB                              0
    cifs_read_size_histo                                            -
                               0 bytes                              0
                          <= 256 bytes                              0
                          <= 512 bytes                              0
                               <= 1 KB                              0
                               <= 2 KB                              0
                               <= 4 KB                              0
                               <= 8 KB                              0
                              <= 16 KB                              0
                              <= 32 KB                              0
                              <= 64 KB                              0
                               > 64 KB                              0

2 entries were displayed.
```

STEP	ACTION

28.	What did the command-line output look like for write operation size of sample_cifs2?
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_write_size_histo -sample-id sample_cifs2`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 22:21:55`
	`End-time: 9/22/2013 22:23:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_size_histo -`
	`0 bytes 0`
	`<= 256 bytes 0`
	`<= 512 bytes 0`
	`<= 1 KB 0`
	`<= 2 KB 0`
	`<= 4 KB 0`
	`<= 8 KB 0`
	`<= 16 KB 0`
	`<= 32 KB 0`
	`<= 64 KB 0`
	`> 64 KB 0`
	`cifs_write_size_histo -`
	`0 bytes 0`
	`<= 256 bytes 0`
	`<= 512 bytes 0`
	`<= 1 KB 0`
	`<= 2 KB 0`
	`<= 4 KB 0`
	`<= 8 KB 0`
	`<= 16 KB 0`
	`<= 32 KB 0`
	`<= 64 KB 0`
	`> 64 KB 0`
	`2 entries were displayed.`

29.	What did the calculation (throughput * latency) look like for concurrency of sample_cifs2? `715/sec * 0.00320 (3.20ms) = 2.29`

STEP	ACTION
30.	What did the command-line output look like for randomness (`rand_read_reqs`) of sample_cifs2?

```
cluster1::*> statistics show -object readahead -instance * -counter rand_read_reqs -
sample-id sample_cifs2


Object: readahead

Instance: readahead

Start-time: 9/22/2013 22:21:55

End-time: 9/22/2013 22:23:31

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- --------------------------------
    rand_read_reqs                                                 -
                                UNUSED                             -
                                    4K                           100
                                    8K                            98
                                   12K                           100
                                   16K                           100
                                   20K                           100
                                   24K                             -
                                   28K                            50
                                   32K                             0
                                   40K                             -
                                   48K                             -
                                   56K                             -
...
                                   MAX                             -
    rand_read_reqs                                                 -
                                UNUSED                             -
                                    4K                           100
                                    8K                           100
                                   12K                           100
                                   16K                             -
                                   20K                           100
                                   24K                           100
                                   28K                           100
                                   32K                             -
                                   40K                             -
                                   48K                             -
                                   56K                             -
...
                                   MAX                             -
2 entries were displayed.
```

STEP	ACTION
31.	What did the command-line output look like for randomness (`seq_read_reqs`) of sample_cifs2?

```
cluster1::*> statistics show -object readahead -instance * -counter seq_read_reqs -
sample-id sample_cifs2


Object: readahead

Instance: readahead

Start-time: 9/22/2013 22:21:55

End-time: 9/22/2013 22:23:31

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- --------------------------------
    seq_read_reqs                                                   -
                                 UNUSED                             -
                                     4K                             0
                                     8K                             1
                                    12K                             0
                                    16K                             0
                                    20K                             0
                                    24K                             -
                                    28K                            50
                                    32K                            99
                                    40K                             -
                                    48K                             -
                                    56K                             -
...
                                    MAX                             -
    seq_read_reqs                                                   -
                                 UNUSED                             -
                                     4K                             0
                                     8K                             0
                                    12K                             0
                                    16K                             -
                                    20K                             0
                                    24K                             0
                                    28K                             0
                                    32K                             -
                                    40K                             -
                                    48K                             -
                                    56K                             -
...
                                    MAX                             -
2 entries were displayed.
```

STEP	ACTION
32.	What workload did you conclude from your data collection of sample_cifs2? **All reads, large operations, some concurrency, mostly random**
33.	Record your observations for sample_cifs3 below:

CHARACTERISTIC	OBSERVED VALUE	
	Read	Write
Throughput	159/sec	159/sec
Latency	168.37ms	0.14ms
Operation Size	4K	4K
Concurrency	26.77	0.02
Randomness	Random	

STEP	ACTION

34.	What did the command-line output look like for throughput of sample_cifs3?
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_read_ops -sample-id sample_cifs3`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 22:25:56`
	`End-time: 9/22/2013 22:27:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_read_ops 159`
	`cifs_read_ops 0`
	`2 entries were displayed.`
	
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_write_ops -sample-id sample_cifs3`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 22:25:56`
	`End-time: 9/22/2013 22:27:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_ops 159`
	`cifs_write_ops 0`
	`2 entries were displayed.`

STEP	ACTION

35.	What did the command-line output look like for latency of sample_cifs3?
	`cluster1::*> statistics show -object volume -instance * -counter cifs_read_latency -sample-id sample_cifs3`
	
	`...`
	
	`Object: volume`
	`Instance: vs2_vol01`
	`Start-time: 9/22/2013 22:25:56`
	`End-time: 9/22/2013 22:27:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_read_latency 168371us`
	
	`...`
	`7 entries were displayed.`
	
	`cluster1::*> statistics show -object volume -instance * -counter cifs_write_latency -sample-id sample_cifs3`
	
	`...`
	
	`Object: volume`
	`Instance: vs2_vol01`
	`Start-time: 9/22/2013 22:25:56`
	`End-time: 9/22/2013 22:27:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_latency 143us`
	
	`Object: volume`
	`Instance: vsISCSI1_root`
	`Start-time: 9/22/2013 22:25:56`
	`End-time: 9/22/2013 22:27:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_latency -`
	`7 entries were displayed.`

STEP	ACTION
36.	What did the command-line output look like for read operation size of sample_cifs3?

```
cluster1::*> statistics show -object cifs -instance * -counter cifs_read_size_histo -
sample-id sample_cifs3


Object: cifs

Instance: vs2

Start-time: 9/22/2013 22:25:56

End-time: 9/22/2013 22:27:31

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- ----------------------------------
    cifs_read_size_histo                                            -
                               0 bytes                              0
                          <= 256 bytes                              0
                          <= 512 bytes                              0
                               <= 1 KB                              0
                               <= 2 KB                              0
                               <= 4 KB                          30356
                               <= 8 KB                              0
                              <= 16 KB                              0
                              <= 32 KB                              0
                              <= 64 KB                              0
                               > 64 KB                              0
    cifs_read_size_histo                                            -
                               0 bytes                              0
                          <= 256 bytes                              0
                          <= 512 bytes                              0
                               <= 1 KB                              0
                               <= 2 KB                              0
                               <= 4 KB                              0
                               <= 8 KB                              0
                              <= 16 KB                              0
                              <= 32 KB                              0
                              <= 64 KB                              0
                               > 64 KB                              0

2 entries were displayed.
```

STEP	ACTION

37.	What did the command-line output look like for write operation size of sample_cifs3?
	`cluster1::*> statistics show -object cifs -instance * -counter cifs_write_size_histo -sample-id sample_cifs3`
	
	`Object: cifs`
	`Instance: vs2`
	`Start-time: 9/22/2013 22:25:56`
	`End-time: 9/22/2013 22:27:31`
	`Cluster: cluster1`
	
	`Counter Value`
	`-------------------------------- --------------------------------`
	`cifs_write_size_histo -`
	`0 bytes 0`
	`<= 256 bytes 0`
	`<= 512 bytes 0`
	`<= 1 KB 0`
	`<= 2 KB 0`
	`<= 4 KB 30288`
	`<= 8 KB 0`
	`<= 16 KB 0`
	`<= 32 KB 0`
	`<= 64 KB 0`
	`> 64 KB 0`
	`cifs_write_size_histo -`
	`0 bytes 0`
	`<= 256 bytes 0`
	`<= 512 bytes 0`
	`<= 1 KB 0`
	`<= 2 KB 0`
	`<= 4 KB 0`
	`<= 8 KB 0`
	`<= 16 KB 0`
	`<= 32 KB 0`
	`<= 64 KB 0`
	`> 64 KB 0`
	`2 entries were displayed.`

38.	What did the calculation (throughput * latency) look like for concurrency of sample_cifs3?
	`Read: 159/sec * 0.16837 (168.37ms) = 26.77`
	`Write: 159/sec * 0.00014 (0.14ms) = 0.02`

STEP	ACTION
39.	What did the command-line output look like for randomness (`rand_read_reqs`) of sample_cifs3?

```
cluster1::*> statistics show -object readahead -instance * -counter rand_read_reqs -
sample-id sample_cifs3


Object: readahead

Instance: readahead

Start-time: 9/22/2013 22:25:56

End-time: 9/22/2013 22:27:31

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- --------------------------------
    rand_read_reqs                                                  -
                                 UNUSED                             -
                                     4K                            82
                                     8K                            50
                                    12K                            97
                                    16K                             0
                                    20K                            83
                                    24K                           100
                                    28K                             0
                                    32K                            13
                                    40K                             -
                                    48K                             -
                                    56K                             -
...
                                    MAX                             -
    rand_read_reqs                                                  -
                                 UNUSED                             -
                                     4K                           100
                                     8K                             -
                                    12K                           100
                                    16K                           100
                                    20K                           100
                                    24K                           100
                                    28K                           100
                                    32K                           100
                                    40K                             -
                                    48K                             -
                                    56K                             -
...
                                    MAX                             -
2 entries were displayed.
```

STEP	ACTION
40.	What did the command-line output look like for randomness (`seq_read_reqs`) of sample_cifs3?

```
cluster1::*> statistics show -object readahead -instance * -counter seq_read_reqs -
sample-id sample_cifs3


Object: readahead

Instance: readahead

Start-time: 9/22/2013 22:25:56

End-time: 9/22/2013 22:27:31

Cluster: cluster1


    Counter                                                     Value
    -------------------------------- --------------------------------
    seq_read_reqs                                                   -
                                 UNUSED                             -
                                     4K                            17
                                     8K                            50
                                    12K                             2
                                    16K                           100
                                    20K                            16
                                    24K                             0
                                    28K                           100
                                    32K                            86
                                    40K                             -
                                    48K                             -
                                    56K                             -
...
                                    MAX                             -
    seq_read_reqs                                                   -
                                 UNUSED                             -
                                     4K                             0
                                     8K                             -
                                    12K                             0
                                    16K                             0
                                    20K                             0
                                    24K                             0
                                    28K                             0
                                    32K                             0
                                    40K                             -
                                    48K                             -
                                    56K                             -
...
                                    MAX                             -
2 entries were displayed.
```

STEP	ACTION
41.	What workload did you conclude from your data collection of sample_cifs3? **50% reads 50% writes, small operations, some read concurrency minimal write concurrency**

42.	The previous examples used CIFS as the basis for the workloads. What statistics objects and counters would be needed for NFSv3?
	
	`set diagnostic`
	`statistics start -object nfsv3|volume|readahead -sample-id sample_nfsv3`
	
	`statistics show -object nfsv3 -instance * -counter nfsv3_read_ops -sample-id sample_nfsv3`
	`statistics show -object nfsv3 -instance * -counter nfsv3_write_ops -sample-id sample_nfsv3`
	
	`statistics show -object volume -instance * -counter nfs_read_latency -sample-id sample_nfsv3`
	`statistics show -object volume -instance * -counter nfs_write_latency -sample-id sample_nfsv3`
	
	`statistics show -object nfsv3 -instance * -counter nfsv3_read_size_histo -sample-id sample_nfsv3`
	`statistics show -object nfsv3 -instance * -counter nfsv3_write_size_histo -sample-id sample_nfsv3`
	
	`statistics show -object readahead -instance * -counter rand_read_reqs -sample-id sample_nfsv3`
	`statistics show -object readahead -instance * -counter seq_read_reqs -sample-id sample_nfsv3`

MODULE 4: CLUSTER PERFORMANCE MONITORING AND ANALYSIS

EXERCISE

TASK 1: PERFORM INITIAL HEALTH CHECKS ON THE CLUSTER

In this task, you query the cluster to assess the initial health status.

STEP	ACTION

2.	Check to see if all of the nodes are healthy.
	cluster show
	`cluster1::> cluster show`
	`Node Health Eligibility`
	`--- --- ---`
	`cluster1-01 true true`
	`cluster1-02 true true`
	`2 entries were displayed.`

3.	Check to see if the replication rings have the same (or consistent) masters.
	NOTE: Remember to set advanced privilege before you execute this command.
	cluster ring show
	`cluster1::> set advanced`
	`Warning: These advanced commands are potentially dangerous; use them only when directed to do so by NetApp personnel.`
	`Do you want to continue? {y|n}: y`
	`cluster1::*> cluster ring show`
	`Node UnitName Epoch DB Epoch DB Trnxs Master Online`
	`--- --- --- --- --- --- ---`
	`cluster1-01 mgmt 3 3 3910 cluster1-01 master`
	`cluster1-01 vldb 3 3 11 cluster1-01 master`
	`cluster1-01 vifmgr 3 3 20 cluster1-01 master`
	`cluster1-01 bcomd 3 3 22 cluster1-01 master`
	`cluster1-02 mgmt 3 3 3910 cluster1-01 secondary`
	`cluster1-02 vldb 3 3 11 cluster1-01 secondary`
	`cluster1-02 vifmgr 3 3 20 cluster1-01 secondary`
	`cluster1-02 bcomd 3 3 22 cluster1-01 secondary`
	`8 entries were displayed.`

STEP	ACTION

4.	Using the advanced privilege level, check to see if the cluster connectivity is healthy.
	cluster ping-cluster -node local
	`cluster1::*> cluster ping-cluster -node local`
	`Host is cluster1-02`
	`Getting addresses from network interface table...`
	`Local = 169.254.173.221 169.254.230.66`
	`Remote = 169.254.224.211 169.254.185.5`
	`Ping status:`
	`....`
	`Basic connectivity succeeds on 4 path(s)`
	`Basic connectivity fails on 0 path(s)`
	`................`
	`Detected 1500 byte MTU on 4 path(s):`
	`Local 169.254.173.221 to Remote 169.254.185.5`
	`Local 169.254.173.221 to Remote 169.254.224.211`
	`Local 169.254.230.66 to Remote 169.254.185.5`
	`Local 169.254.230.66 to Remote 169.254.224.211`
	`Larger than PMTU communication succeeds on 4 path(s)`
	`RPC status:`
	`2 paths up, 0 paths down (tcp check)`
	`2 paths up, 0 paths down (udp check)`

5.	Check to see if the storage virtual machines (SVMs) are healthy.
	dashboard health vserver show
	`cluster1::> dashboard health vserver show`
	`EMS Issues`
	`Vserver Status Health Crit Warn Info`
	`---------- -------- ------- ----- ----- -----`
	`vs1 offline ok 0 0 0`
	`Issues: There are no data lifs configured.`
	`The filesystem protocols are not configured.`
	`vs2 online ok 0 0 0`
	`Issues: LIF vs2_cifs_nfs_lif2 is not home.`
	`vsISCSI1 offline ok 0 0 0`
	`Issues: The filesystem protocols are not configured.`
	`3 entries were displayed.`

6.	If any of the SVMs return a nonzero status, add the **-all** parameter for additional information.
	dashboard health vserver show-all
	`cluster1::> dashboard health vserver show-all`
	`There are no Vserver health issues reported.`

7.	Check to see if any volumes are not online.
	volume show -state !online
	`cluster1::> volume show -state !online`
	`There are no entries matching your query.`

8.	Check to see if any aggregates are not online.
	storage aggregate show -state !online
	`cluster1::> storage aggregate show -state !online`
	`There are no entries matching your query.`

STEP	ACTION
9.	Check to see if any disks are in a broken state. **storage disk show -state broken** **cluster1::> storage disk show -state broken** **There are no entries matching your query.**

TASK 2: BASELINE PERFORMANCE MONITORING FROM THE CLUSTER SHELL

In this task, you use cluster shell commands to monitor cluster performance.

STEP	ACTION
1.	Check the performance status: a. Check the current level of activity on each node of the cluster. **statistics show-periodic -node cluster1-01 -instance node -iterations 4**

```
cluster1::> statistics show-periodic -node cluster1-01 -instance node -iterations 4
cluster1-01: node.node: 10/15/2013 13:11:44
  cpu    total                  data     data     data cluster  cluster  cluster     disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent     read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- -------- --------
   3%        0        0        0   0%       0B       0B      0%   3.35KB   35.0KB       0B       0B
   3%        0        0        0   0%     192B       0B      0%   2.28KB   6.11KB    337KB    294KB
   3%        0        0        0   0%      97B       0B      0%   2.99KB   7.87KB       0B       0B
   2%        0        0        0   0%      96B       0B      0%   2.03KB   6.01KB       0B       0B
cluster1-01: node.node: 10/15/2013 13:11:53
  cpu    total                  data     data     data cluster  cluster  cluster     disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent     read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- -------- --------
Minimums:
   2%        0        0        0   0%       0B       0B      0%   2.03KB   6.01KB       0B       0B
Averages for 4 samples:
   2%        0        0        0   0%      96B       0B      0%   2.66KB   13.8KB   84.4KB   73.7KB
Maximums:
   3%        0        0        0   0%     192B       0B      0%   3.35KB   35.0KB    337KB    294KB
```

statistics show-periodic -node cluster1-02 -instance node -iterations 4

```
cluster1::> statistics show-periodic -node cluster1-02 -instance node -iterations 4
cluster1-02: node.node: 10/15/2013 13:13:28
  cpu    total                  data     data     data cluster  cluster  cluster     disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent     read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- -------- --------
   3%        0        0        0   0%     412B     487B      0%   29.8KB   2.10KB    217KB    341KB
   2%        0        0        0   0%     826B     329B      0%   4.02KB   9.79KB       0B       0B
   3%        0        0        0   0%     315B      99B      0%   1.11KB      600B      0B       0B
   1%        0        0        0   0%      31B      99B      0%   1.96KB   1.39KB       0B       0B
cluster1-02: node.node: 10/15/2013 13:13:37
  cpu    total                  data     data     data cluster  cluster  cluster     disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent     read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- -------- --------
Minimums:
   1%        0        0        0   0%      31B      99B      0%   1.11KB      600B      0B       0B
Averages for 4 samples:
   2%        0        0        0   0%     396B     253B      0%   9.22KB   3.47KB   54.4KB   85.3KB
Maximums:
   3%        0        0        0   0%     826B     487B      0%   29.8KB   9.79KB    217KB    341KB
```

b. Check the current level of activity on the entire cluster and notice the overall latency column.

dashboard performance show

```
cluster1::> dashboard performance show
          Average      ---Data-Network--- -Cluster--Network- ----Storage---
    Total Latency  CPU Busy    Recv    Sent Busy    Recv    Sent    Read   Write
    Ops/s in usec Busy Util    MB/s    MB/s Util    MB/s    MB/s    MB/s    MB/s
   ------ ------- ---- ---- ------- ------- ---- ------- ------- ------- -------
cluster1-01
        0       0   3%   0%       0       0   0%       0       0       0       0
cluster1-02
        0       0   3%   0%       0       0   0%       0       0       0       0
cluster:summary
        0       0   3%   0%       0       0   0%       0       0       0       0
3 entries were displayed.
```

STEP	ACTION

2.	Check the current NAS operations level on the entire cluster.
	dashboard performance show –operations
	`cluster1::> dashboard performance show -operations`
	`          Total  Average     NFS      NFS    CIFS     CIFS`
	`Node      Ops/s  Latency   Ops/s  Latency   Ops/s  Latency`
	`------- ------- -------- ------- -------- ------- --------`
	`cluster1-01   0      0us       0      0us       0      0us`
	`cluster1-02   0      0us       0      0us       0      0us`
	`cluster:summary 0    0us       0      0us       0      0us`
	`3 entries were displayed.`

STEP	ACTION

3.	Use the **-instance** parameter to show everything and notice the overall latency by protocol fields.
	dashboard performance show -instance
	`cluster1::> dashboard performance show -instance`
	
	`Node: cluster1-01`
	`Average Latency (usec): 0us`
	`CPU Busy: 2%`
	`Total Ops/s: 0`
	`NFS Ops/s: 0`
	`CIFS Ops/s: 0`
	`Data Network Utilization: 0%`
	`Data Network Received (per sec): 0`
	`Data Network Sent (per sec): 0`
	`Cluster Network Utilization: 0%`
	`Cluster Network Received (per sec): 0`
	`Cluster Network Sent (per sec): 0`
	`Storage Read (per sec): 0`
	`Storage Write (per sec): 0`
	`CIFS Average Latency: 0us`
	`NFS Average Latency: 0us`
	
	`Node: cluster1-02`
	`Average Latency (usec): 0us`
	`CPU Busy: 2%`
	`Total Ops/s: 0`
	`NFS Ops/s: 0`
	`CIFS Ops/s: 0`
	`Data Network Utilization: 0%`
	`Data Network Received (per sec): 0`
	`Data Network Sent (per sec): 0`
	`Cluster Network Utilization: 0%`
	`Cluster Network Received (per sec): 0`
	`Cluster Network Sent (per sec): 0`
	`Storage Read (per sec): 0`
	`Storage Write (per sec): 0`
	`CIFS Average Latency: 0us`
	`NFS Average Latency: 0us`
	
	`Node: cluster:summary`
	`Average Latency (usec): 0us`
	`CPU Busy: 2%`
	`Total Ops/s: 0`
	`NFS Ops/s: 0`
	`CIFS Ops/s: 0`
	`Data Network Utilization: 0%`
	`Data Network Received (per sec): 0`
	`Data Network Sent (per sec): 0`
	`Cluster Network Utilization: 0%`
	`Cluster Network Received (per sec): 0`
	`Cluster Network Sent (per sec): 0`
	`Storage Read (per sec): 0`
	`Storage Write (per sec): 0`
	`CIFS Average Latency: 0us`
	`NFS Average Latency: 0us`
	`3 entries were displayed.`

STEP	ACTION
4.	Check the overall latency for the entire cluster. **statistics show-periodic -instance latency -iterations 4**

```
cluster1::> statistics show-periodic -instance latency -iterations 4
cluster:summary: cluster.cluster: 10/15/2013 13:19:18
  cpu    total                   data     data     data cluster  cluster  cluster
disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent
read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------
-- --------
   3%        0        0        0   0%     371B     279B      0%   98.2KB   97.8KB
0B       0B
  10%        0        0        0   0%     222B     100B      0%   34.1KB   33.6KB
0B       0B
   4%        0        0        0   0%     413B     100B      0%   11.3KB   11.5KB
333KB    413KB
   3%        0        0        0   0%      31B     100B      0%   7.80KB   7.71KB
238KB    335KB
cluster:summary: cluster.cluster: 10/15/2013 13:19:26
  cpu    total                   data     data     data cluster  cluster  cluster
disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent
read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------
-- --------
Minimums:
   3%        0        0        0   0%      31B     100B      0%   7.80KB   7.71KB
0B       0B
Averages for 4 samples:
   5%        0        0        0   0%     259B     144B      0%   37.9KB   37.7KB
142KB    187KB
Maximums:
  10%        0        0        0   0%     413B     279B      0%   98.2KB   97.8KB
333KB    413KB
```

STEP	ACTION
5.	Check the overall latency for each node in the cluster. **statistics show-periodic -node cluster1-01 -instance latency -iterations 4** **statistics show-periodic -node cluster1-02 -instance latency -iterations 4**

```
cluster1::> statistics show-periodic -node cluster1-01 -instance latency -iterations 4
cluster1-01: node.latency: 10/15/2013 13:20:57
  cpu    total                   data     data     data cluster  cluster  cluster
disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent
read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------
-- --------
   3%        0        0        0   0%     192B       0B      0%   3.35KB   34.9KB
0B       0B
   2%        0        0        0   0%      96B       0B      0%   2.25KB   6.50KB
0B       0B
   3%        0        0        0   0%      96B       0B      0%   2.82KB   7.12KB
0B       0B
   4%        0        0        0   0%     194B       0B      0%   3.80KB   7.02KB
275KB    329KB
cluster1-01: node.latency: 10/15/2013 13:21:05
  cpu    total                   data     data     data cluster  cluster  cluster
disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent
read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------
-- --------
Minimums:
   2%        0        0        0   0%      96B       0B      0%   2.25KB   6.50KB
0B       0B
Averages for 4 samples:
   3%        0        0        0   0%     144B       0B      0%   3.05KB   13.9KB
69.0KB   82.3KB
Maximums:
   4%        0        0        0   0%     194B       0B      0%   3.80KB   34.9KB
275KB    329KB
```

```
cluster1::> statistics show-periodic -node cluster1-02 -instance latency -iterations 4
cluster1-02: node.latency: 10/15/2013 13:22:03
  cpu    total                   data     data     data cluster  cluster  cluster
disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent
read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------
-- --------
   7%        0        0        0   0%     412B     458B      0%   30.8KB   3.41KB
0B       0B
   3%        0        0        0   0%      31B      99B      0%   1.19KB     831B
0B       0B
   3%        0        0        0   0%     219B      99B      0%   2.08KB   1.04KB
0B       0B
   3%        0        0        0   0%     125B      99B      0%   1.25KB     892B
570KB    764KB
cluster1-02: node.latency: 10/15/2013 13:22:11
  cpu    total                   data     data     data cluster  cluster  cluster
disk     disk
 busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent
read    write
 ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------
-- --------
Minimums:
   3%        0        0        0   0%      31B      99B      0%   1.19KB     831B
0B       0B
Averages for 4 samples:
   4%        0        0        0   0%     196B     188B      0%   8.84KB   1.53KB
142KB    191KB
Maximums:

   7%        0        0        0   0%     412B     458B      0%   30.8KB   3.41KB
570KB    764KB
```

STEP	ACTION

6.	Check the throughput by cluster.
	statistics show-periodic -iterations 4
	`cluster1::> statistics show-periodic -iterations 4`
	`cluster:summary: cluster.cluster: 10/15/2013 13:23:49`
	`  cpu    total                    data     data     data cluster  cluster  cluster disk     disk`
	` busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent read    write`
	` ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------ --------`
	`  10%        0        0        0   0%   9.37KB     279B      0%   89.5KB   89.1KB 0B       0B`
	`   2%        0        0        0   0%   3.02KB     100B      0%   8.33KB   8.22KB 0B       0B`
	`   4%        0        0        0   0%     796B     100B      0%   8.45KB   8.34KB 290KB    349KB`
	`  12%        0        0        0   0%   3.84KB     100B      0%   11.1KB   10.9KB 0B       0B`
	`cluster:summary: cluster.cluster: 10/15/2013 13:23:57`
	`  cpu    total                    data     data     data cluster  cluster  cluster disk     disk`
	` busy      ops  nfs-ops cifs-ops busy     recv     sent    busy     recv     sent read    write`
	` ---- -------- -------- -------- ---- -------- -------- ------- -------- -------- ------ --------`
	`Minimums:`
	`   2%        0        0        0   0%     796B     100B      0%   8.33KB   8.22KB 0B       0B`
	`Averages for 4 samples:`
	`   7%        0        0        0   0%   4.25KB     144B      0%   29.3KB   29.1KB 72.5KB   87.3KB`
	`Maximums:`
	`  12%        0        0        0   0%   9.37KB     279B      0%   89.5KB   89.1KB 290KB    349KB`

STEP	ACTION
7.	Check the throughput by volume for volume vs2_vol01.

statistics show-periodic -object volume -instance vs2_vol01 -iterations 4

```
cluster1::> statistics show-periodic -object volume -instance vs2_vol01 -iterations 4
cluster1: volume.vs2_vol01: 10/15/2013 13:24:54
          cifs_protocol cifs_protocol cifs_protocol fcp_protocol fcp_protocol fcp_protocol          iscsi_protocol
iscsi_protocol iscsi_protocol nfs_protocol nfs_protocol nfs_protocol
total_protocol total_protocol total_protocol
      avg         other          read         write        other         read         write instance          other
read          write        other read           write         node       node    otherother  process          read
read              total          other            read          write  vserver  vserverwrite        write    write
  latency       latency        latency        latency      latency      latency      latency     name         latency
latency        latencylatency latency    latency      name         uuid  latency      ops        name         data
latency read_opsops            latency          latency        latency      name      uuid      data  latency       ops
 -------- ------------- ------------- ------------- ------------ ------------ ------------ -------- -------------- ---
----------- -------------- ------------ ------------ ------------ -------- -------- -------- -------- -------- -------
- -------- -------- -------- -------------- -------------- -------------- -------- -------- -------- -------- --------
      0us            -             -             -            -            -            - vs2_vol01             -
-              -           -           -            - cluster1-01 dc52885e-cd79-11e2-923d-418872c5fb78 0us 0 - 0B
0us       0        0              -              -             -      vs2 ae9c5c97-107e-11e3-823d-123478563412 0B 0us
0
      0us            -             -             -            -            -            - vs2_vol01             -
-              -           -           -            - cluster1-01 dc52885e-cd79-11e2-923d-418872c5fb78 0us 0 - 0B
0us       0        0              -              -             -      vs2 ae9c5c97-107e-11e3-823d-123478563412 0B 0us
0
      0us            -             -             -            -            -            - vs2_vol01             -
-              -           -           -            - cluster1-01 dc52885e-cd79-11e2-923d-418872c5fb78 0us 0 - 0B
0us       0        0              -              -             -      vs2 ae9c5c97-107e-11e3-823d-123478563412 0B 0us
0
      0us            -             -             -            -            -            - vs2_vol01             -
-              -           -           -            - cluster1-01 dc52885e-cd79-11e2-923d-418872c5fb78 0us 0 - 0B
0us       0        0              -              -             -      vs2 ae9c5c97-107e-11e3-823d-123478563412 0B 0us
0
cluster1: volume.vs2_vol01: 10/15/2013 13:25:02
          cifs_protocol cifs_protocol cifs_protocol fcp_protocol fcp_protocol fcp_protocol          iscsi_protocol
iscsi_protocol iscsi_protocol nfs_protocol nfs_protocol nfs_protocol
total_protocol total_protocol total_protocol
      avg         other          read         write        other         read         write instance          other
read          write        other read           write         node       node    otherother  process          read
read              total          other            read          write  vserver  vserverwrite        write    write
  latency       latency        latency        latency      latency      latency      latency     name         latency
latency        latencylatency latency    latency      name       uuid  latency        ops        name         data
latency read_opsops            latency          latency        latencyname          uuid      data  latency       ops
 -------- ------------- ------------- ------------- ------------ ------------ ------------ -------- -------------- ---
----------- -------------- ------------ ------------ ------------ -------- -------- -------- -------- -------- -------
- -------- -------- -------- -------------- -------------- -------------- -------- -------- -------- -------- --------
Minimums:
      0us            -             -             -            -            -            -          -             -
-              -           -           -            -        -        -       0us        0        -        0B      0us
0        0           -              -              -        -        -       0B       0us        0
Averages for 4 samples:
      0us            -             -             -            -            -            -          -             -
-              -           -           -            -        -        -       0us        0        -        0B      0us
0        0           -              -              -        -        -       0B       0us        0
Maximums:
      0us            -             -             -            -            -            -          -             -
-              -           -           -            -        -        -       0us        0        -        0B      0us
0        0           -              -              -        -        -       0B       0us        0
```

How can you make the output more readable? **Specify only the fields that you want to see with the -fields parameter.**

STEP	ACTION
9.	Check the throughput by LIF (IP). **statistics show-periodic -object lif -instance vs2:vs2_cifs_nfs_lif1 -iterations 4** cluster1::> statistics show-periodic -object lif -instance vs2:vs2_cifs_nfs_lif1 -iterations 4 cluster1: lif.vs2:vs2_cifs_nfs_lif1: 10/15/2013 13:36:26 instance instance node node process recv recv recv sent sent sent vserver vserver name uuid name uuid name data errors packet data errors packet up_time id name -------- -------- -------- -------- -------- -------- -------- ------- - -------- -------- -------- -------- -------- -------- vs2:vs2_cifs_nfs_lif1 1026 cluster1-02 dc82ec7d-cd68-11e2-9692- 2d8687fb65b7 - 0B 0 0 0B 0 0 438684778 4 vs2 vs2:vs2_cifs_nfs_lif1 1026 cluster1-02 dc82ec7d-cd68-11e2-9692- 2d8687fb65b7 - 0B 0 0 0B 0 0 438686875 4 vs2 vs2:vs2_cifs_nfs_lif1 1026 cluster1-02 dc82ec7d-cd68-11e2-9692- 2d8687fb65b7 - 0B 0 0 0B 0 0 438688952 4 vs2 vs2:vs2_cifs_nfs_lif1 1026 cluster1-02 dc82ec7d-cd68-11e2-9692- 2d8687fb65b7 - 0B 0 0 0B 0 0 438691049 4 vs2 cluster1: lif.vs2:vs2_cifs_nfs_lif1: 10/15/2013 13:36:35 instance instance node node process recv recv recv sent sent sent vserver vserver name uuid name uuid name data errors packet data errors packet up_time id name -------- -------- -------- -------- -------- -------- -------- ------- - -------- -------- -------- -------- -------- -------- Minimums: - - - - - 0B 0 0 0B 0 0 - - - Averages for 4 samples: - - - - - 0B 0 0 0B 0 0 - - - Maximums: - - - - - 0B 0 0 0B 0 0 - - -
10.	Using the advanced privilege level, start statistics data collection on the objects “volume,” “aggregate,” “disk,” “ext_cache_obj,” “port,” and “lif.” **set advanced** **statistics start -object volume|aggregate|disk|port|lif -sample-id sample_baseline1** cluster1::> set advanced Warning: These advanced commands are potentially dangerous; use them only when directed to do so by NetApp personnel. Do you want to continue? {y|n}: y cluster1::*> statistics start -object volume|aggregate|disk|port|lif -sample-id sample_baseline1 Statistics collection is being started for Sample-id: sample_baseline1

STEP	ACTION
11.	Check the latency by volume for the entire cluster. **statistics show -object volume -counter *latency -sample-id sample_baseline1** cluster1::*> statistics show -object volume -counter *latency -sample-id sample_baseline1 Object: volume Instance: lun_vsISCSI1_1_vol Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:43:43 Cluster: cluster1 Counter Value -------------------------------- ---------- avg_latency 34us cifs_other_latency - cifs_protocol_other_latency - <20us 0 <40us 0 <60us 0 <80us 0 <100us 0 ...

STEP	ACTION
12.	Check volume latency for a specific volume.

statistics show-periodic -object volume -instance vs2_vol01 -iterations 4

```
cluster1::*> statistics show-periodic -object volume -instance vs2_vol01 -iterations 4
cluster1: volume.vs2_vol01: 10/15/2013 13:45:17
              cifs     cifs cifs_protocol cifs_protocol cifs_protocol      cifs     cifs     cifs     cifs     cifs
cifs fcp_protocol fcp_protocol fcp_protocol          iscsi_protocol iscsi_protocol iscsi_protocol       nfs      nfs
nfs_protocol nfs_protocol nfs_protocol      nfs      nfs      nfs      nfsnfs
total_protocol total_protocol total_protocol
      avg    other    otherother       read          write    read             read       read      write    write
write        other          read        write instance         other            read          write  other    other
other         read          write      read      read      read     write     write      node      node     other    other
process      read      read              total          other            read          write  vserver  vserver     write
write    write
  latency  latency       ops       latency       latency       latency      data  latency       ops      data  latency
ops      latency       latency      latency      name          latency         latency        latency  latency      ops
latency      latency      latency      data  latency       ops  latency      opsname          uuid  latency       ops
name      data  latency read_ops      ops          latency         latency         latency      name      uuid      data
latency       ops
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      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          - vs2_vol01          -             -             -      0us          0
-             -             -       0B       0us          0       0us          0 cluster1-01 dc52885e-cd79-11e2-923d-
418872c5fb78 0us 0 - 0B 0us       0        0             -             -             -       vs2 ae9c5c97-107e-11e3-
823d-123478563412 0B 0us 0
      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          - vs2_vol01          -             -             -      0us          0
-             -             -       0B       0us          0       0us          0 cluster1-01 dc52885e-cd79-11e2-923d-
418872c5fb78 0us 0 - 0B 0us       0        0             -             -             -       vs2 ae9c5c97-107e-11e3-
823d-123478563412 0B 0us 0
      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          - vs2_vol01          -             -             -      0us          0
-             -             -       0B       0us          0       0us          0 cluster1-01 dc52885e-cd79-11e2-923d-
418872c5fb78 0us 0 - 0B 0us       0        0             -             -             -       vs2 ae9c5c97-107e-11e3-
823d-123478563412 0B 0us 0
      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          - vs2_vol01          -             -             -      0us          0
-             -             -       0B       0us          0       0us          0 cluster1-01 dc52885e-cd79-11e2-923d-
418872c5fb78 0us 0 - 0B 0us       0        0             -             -             -       vs2 ae9c5c97-107e-11e3-
823d-123478563412 0B 0us 0
cluster1: volume.vs2_vol01: 10/15/2013 13:45:26
              cifs     cifs cifs_protocol cifs_protocol cifs_protocol      cifs     cifs     cifs     cifs     cifs
cifs fcp_protocol fcp_protocol fcp_protocol          iscsi_protocol iscsi_protocol iscsi_protocol       nfs      nfs
nfs_protocol nfs_protocol nfs_protocol      nfs      nfs      nfs      nfsnfs
total_protocol total_protocol total_protocol
      avg    other    otherother       read          write    read             read       read      write    write
write        other          read        write instance         other            read          write    other    other
other         read          write      read      read      read     write     write      node      node     other    other
process      read      read              total          other            read          write  vserver  vserver     write
write    write
  latency  latency       ops       latency       latency       latency      data  latency       ops      data  latency
ops      latency       latency      latency      name          latency         latency        latency  latency      ops
latency      latency      latency      data  latency       ops  latency      opsname          uuid  latency       ops
name      data  latency read_ops      ops          latency         latency         latency      name      uuid      data
latency       ops
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Minimums:
      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          -         -             -             -             -      0us          0
-             -             -       0B       0us          0       0us          0         -         -         -      0us          0        -
0B       0us          0         0             -             -             -         -         -       0B       0us
0
Averages for 4 samples:
      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          -         -             -             -             -      0us          0
-             -             -       0B       0us          0       0us          0         -         -         -      0us          0        -
0B       0us          0         0             -             -             -         -         -       0B       0us
0
Maximums:
      0us      0us         0             -             -             -       0B0us             0      0B 0us
0             -             -          -         -             -             -             -      0us          0
-             -             -       0B       0us          0       0us          0         -         -         -      0us          0        -
0B       0us          0         0             -             -             -         -         -       0B       0us
0
```

STEP	ACTION
13.	Check volume activity. **statistics show -object volume -counter *data -sample-id sample_baseline1**

```
cluster1::*> statistics show -object volume -counter *data -sample-id sample_baseline1

Object: volume
Instance: lun_vsISCSI1_1_vol
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:49:01
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    cifs_read_data                                                 0B
    cifs_write_data                                                0B
    nfs_read_data                                                  0B
    read_data                                                      0B
    write_data                                                     0B

Object: volume
Instance: vol0
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:49:01
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    cifs_read_data                                                 0B
    cifs_write_data                                                0B
    nfs_read_data                                              34.2KB
    read_data                                                  34.2KB
    write_data                                                 7.61KB
    cifs_read_data                                                 0B
    cifs_write_data                                                0B
    nfs_read_data                                              20.0KB
    read_data                                                  21.3KB
    write_data                                                 8.43KB

...
Object: volume
Instance: vs2_vol01
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:49:01
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    cifs_read_data                                                 0B
    cifs_write_data                                                0B
    nfs_read_data                                                  0B
    read_data                                                      0B
    write_data                                                     0B

Object: volume
Instance: vsISCSI1_root
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:49:01
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    cifs_read_data                                                 0B
    cifs_write_data                                                0B
    nfs_read_data                                                  0B
    read_data                                                      0B
    write_data                                                     0B
35 entries were displayed.
```

STEP	ACTION
14.	Check aggregate latency. **statistics show -object aggregate -counter user_reads|user_writes -sample-id sample_baseline1**

```
cluster1::*> statistics show -object aggregate -counter
user_reads|user_writes -sample-id sample_baseline1

Object: aggregate
Instance: aggr0_n1
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:53:07
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    user_reads                                                      0
    user_writes                                                     2

Object: aggregate
Instance: aggr0_n2
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:53:07
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    user_reads                                                      0
    user_writes                                                     2

Object: aggregate
Instance: n01_aggr1
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:53:07
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    user_reads                                                      0
    user_writes                                                     0

Object: aggregate
Instance: n02_aggr1
Start-time: 10/15/2013 13:38:10
End-time: 10/15/2013 13:53:07
Cluster: cluster1

    Counter                                                     Value
    -------------------------------- --------------------------------
    user_reads                                                      0
    user_writes                                                     0
8 entries were displayed.
```

STEP	ACTION
15.	Check disk latency. **statistics show -object disk -counter *latency -sample-id sample_baseline1** cluster1::*> statistics show -object disk -counter *latency -sample-id sample_baseline1 Object: disk Instance: v4.16 Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:54:21 Cluster: cluster1 Counter Value -------------------------------- -------------------------------- cp_read_latency 3630us guarenteed_read_latency - guarenteed_write_latency - user_read_latency - user_write_latency - cp_read_latency 3886us guarenteed_read_latency - guarenteed_write_latency - user_read_latency 3235us user_write_latency 3034us Object: disk Instance: v4.17 Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:54:21 Cluster: cluster1 Counter Value ...

STEP	ACTION
16.	Check port throughput. **statistics show -object port -counter *data -sample-id sample_baseline1** cluster1::*> statistics show -object port -counter *data -sample-id sample_baseline1 Object: port Instance: e0a Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:56:47 Node: cluster1-01 Counter Value -------------------------------- -------------------------------- recv-data 1.05GB sent-data 1.44GB Object: port Instance: e0b Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:56:47 Node: cluster1-01 Counter Value -------------------------------- -------------------------------- recv-data 656MB sent-data 810MB ... Object: port Instance: e0f Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:56:47 Node: cluster1-02 Counter Value -------------------------------- -------------------------------- recv-data 53.6MB sent-data 1.35MB 24 entries were displayed.

STEP	ACTION
17.	Check the LIF or IP throughput. **statistics show -object lif -counter *data -sample-id sample_baseline1** cluster1::*> statistics show -object lif -counter *data -sample-id sample_baseline1 Object: lif Instance: cluster1-01:clus1 Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:59:39 Cluster: cluster1 Counter Value -------------------------------- -------------------------------- recv_data 258B sent_data 490B Object: lif Instance: cluster1-01:clus2 Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:59:39 Cluster: cluster1 Counter Value -------------------------------- -------------------------------- recv_data 213B sent_data 335B ... Object: lif Instance: vsISCSI1:cluster1_02_iscsi_lif_2 Start-time: 10/15/2013 13:38:10 End-time: 10/15/2013 13:59:39 Cluster: cluster1 Counter Value -------------------------------- -------------------------------- recv_data 0B sent_data 0B 26 entries were displayed.
18.	After completing the task, turn off the statistics data collection. **statistics stop -sample-id sample_baseline1** cluster1::*> statistics stop -sample-id sample_baseline1 Statistics collection is being stopped for Sample-id: sample_baseline1

STEP	ACTION

19.	Clean up any old samples.
	statistics samples show
	statistics samples delete -sample-id *
	`cluster1::*> statistics samples show`
	`Vserver Sample ID Start Time Stop Time Status`
	`cluster1 sample_baseline1 10/15 13:38:10 10/15 14:01:22 Ready`
	`cluster1::*> statistics samples delete -sample-id *`
	`1 entry was acted on.`

TASK 3: PERFORMANCE MONITORING FROM THE CLUSTER SHELL

In this task, you use cluster shell commands to monitor cluster performance.

STEP	ACTION

5.	Extract (untar) the contents of **sio_ntap.tar.gz** into the current directory.
	tar xvfz /mnt/path01/sio_ntap.tar.gz
	`[root@CM-CentOS-001 sio]# tar xvfz /mnt/path01/sio_ntap.tar.gz`
	`Make_win32.bat`
	`Makefile`
	`README`
	`sio_unx.h`
	`sio_win32.h`
	`sio_ntap.c`
	`sio_ntap.htm`
	`sio_ntap_aix`
	`sio_ntap_hpux_ia64`
	`sio_ntap_hpux_parisc`
	`sio_ntap_linux`
	`sio_ntap_sol`
	`sio_ntap_sol64`
	`sio_ntap_win32.exe`

STEP	ACTION
7.	Normally you would start data collection for all of the protocols being served by the cluster; however, for this exercise you use only NFSv3. In your cluster1 PuTTY session, using the diagnostic privilege level, start statistics data collection on the objects “nfsv3,” “volume,” “aggregate,” “disk,” “port,” “lif,” and “readahead.” **NOTE:** Diagnostic privilege level commands are required to capture `rand_read_req` and `seq_read_req`. **set diagnostic** **statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs1** **cluster1::*> set diagnostic** **Warning: These diagnostic commands are for use by NetApp personnel only.** **Do you want to continue? {y|n}: y** **cluster1::*> statistics start -object nfsv3|volume|readahead -sample-id sample_nfs1** **Statistics collection is being started for Sample-id: sample_nfs1**

STEP	ACTION

9.	Using the analysis commands that you learned in the previous task, analyze the data and record or save the results. It is recommended that you increase the "Lines of scrollback" in your cluster1 PuTTY session to at least 2000.
	
	This information will be used to complete questions later in this task.
	
	HINT: Use the baseline analysis commands.
	
	`statistics show-periodic -node cluster1-01 -instance node -iterations 4`
	`statistics show-periodic -node cluster1-02 -instance node -iterations 4`
	
	`dashboard performance show`
	
	`dashboard performance show -operations`
	
	`dashboard performance show -instance`
	
	`statistics show-periodic -instance latency -iterations 4`
	
	`statistics show-periodic -node cluster1-01 -instance latency -iterations 4`
	`statistics show-periodic -node cluster1-02 -instance latency -iterations 4`
	
	`statistics show-periodic -iterations 4`
	
	`statistics show-periodic -object volume -instance vs2_vol01 -iterations 4`
	
	`statistics show-periodic -object lif -instance vs2:vs2_cifs_nfs_lif1 -iterations 4`
	
	`statistics show -object volume -counter *latency -sample-id sample_nfs1`
	
	`statistics show-periodic -object volume -instance vs2_vol01 -iterations 4`
	
	`statistics show -object volume -counter *data -sample-id sample_nfs1`
	
	`statistics show -object aggregate -counter user_reads|user_writes -sample-id sample_nfs1`
	
	`statistics show -object disk -counter *latency -sample-id sample_nfs1`
	
	`statistics show -object port -counter *data -sample-id sample_nfs1`
	
	`statistics show -object lif -counter *data -sample-id sample_nfs1`
	
	The following can be run from the cluster shell as a single command:
	
	`row 0; set diagnostic; statistics start -object nfsv3|volume|aggregate|disk|port|lif|readahead -sample-id sample_nfs1; statistics show-periodic -node cluster1-01 -instance node -iterations 4; statistics show-periodic -node cluster1-02 -instance node -iterations 4; dashboard performance show; dashboard performance show -operations; dashboard performance show -instance; statistics show-periodic -instance latency -iterations 4; statistics show-periodic -node cluster1-01 -instance latency -iterations 4; statistics show-periodic -node cluster1-02 -instance latency -iterations 4; statistics show-periodic -iterations 4; statistics show-periodic -object volume -instance vs2_vol01 -iterations 4 ; statistics show-periodic -object lif -instance vs2:vs2_cifs_nfs_lif1 -iterations 4; statistics show -object volume -counter *latency -sample-id sample_nfs1; statistics show-periodic -object volume -instance vs2_vol01 -iterations 4; statistics show -object volume -counter *data -sample-id sample_nfs1; statistics show -object aggregate -counter user_reads|user_writes -sample-id sample_nfs1; statistics show -object disk -counter *latency -sample-id sample_nfs1; statistics show -object port -counter *data -sample-id sample_nfs1; statistics show -object lif -counter *data -sample-id sample_nfs1; statistics stop -sample-id sample_nfs1`

STEP	ACTION
31.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, did the throughput and I/Os increase when the number of threads increased? **Yes, when all of the other parameters stayed the same.**
32.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload had the highest throughput in terms of KBps? **100% read workload, 0% random, 32-KB block size, 20-MB file size, and four threads.**
33.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload had the highest throughput in terms of IOPS? **50% read and 50% write workload, 100% random, 4-KB block size, 300-MB file size, 32 threads.**
34.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload showed the lowest latencies on the storage system? **100% read workload, 0% random, 32-KB block size, 20-MB file size, and four threads.**
35.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload showed the highest disk utilization on the storage system? **50% read and 50% write workload, 100% random, 4-KB block size, 300-MB file size, 32 threads.**
36.	Using the data collected in sample_nfs1 through sample_nfs6 and the analysis done on this data, which workload showed the highest CPU utilization on the storage system? **0% read workload, 0% random, 32-KB block size, 300-MB file size, run for one hundred seconds, four threads.**