Preserve user response time by ensuring data availability

Dell EMC VMAX 250F all-flash storage and Dell EMC PowerEdge servers uphold performance of I/O-intensive Oracle Database 12c workloads and provide high availability

Resource contention and lost connections can put critical database application performance and availability at risk. By reducing the chance for performance lag and downtime, CTOs and storage admins lay the groundwork to create a positive user experience.

A Dell EMC™ VMAX™ 250F array and Dell EMC PowerEdge™ server solution can help companies achieve these goals. Our hands-on tests first proved that the array supports both production and test/dev environments in one spot. So when application owners and admins fix bugs, optimize an existing workload, and test patches or updates, applications continue to access critical data at the speed of business. Dell EMC AppSync® let us quickly create snapshots of production Oracle® Database 12c data, which ran with consistently low latency and high input/output per second (IOPS) even as we added seven test/dev database snapshots.

The solution also offers high availability. Testing proved that a production workload supported by a pair of VMAX 250F arrays continues to access data with no downtime and no performance drop if the primary storage is unavailable. In the unlikely event of a datacenter disaster, users won't notice because the application will continue to access production data.

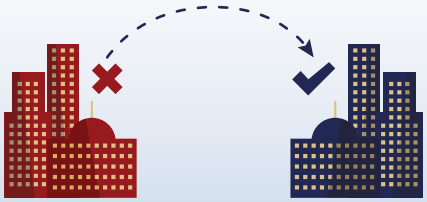
As you read on, we'll discuss how this Dell EMC solution helps your company and your users.

Maintain
low storage latency

≤1ms

during production and test/dev database workloads

Preserve
data access



with SRDF®/Metro high availability

Automated production data cloning with Dell EMC AppSync

AppSync offers integrated copy data management for Dell EMC storage. It automates the process of copying production data, which can therefore become a simpler process in and of itself. Admins use a single interface to copy data for business and datacenter operations such as data repurposing, operational recovery, and disaster recovery. Cloning data with AppSync ultimately helps manage resource utilization, and the software can alert application owners and storage admins when applications don't meet SLAs.[1]

Maintain low latency with or without test/dev environments

Due to its all-flash storage and powerful storage processing, the Dell EMC VMAX 250F delivered average latencies of less than 1 millisecond in our test configuration. We saw average writes of 0.66 milliseconds and average reads of 0.60 milliseconds.

We started our analysis of the Dell EMC VMAX 250F array and Dell EMC PowerEdge server with one Oracle Database 12c VM supporting a single workload created by Silly Little Oracle Benchmark (SLOB).[2] First, we established a steady state for the production environment without resource contention. Then, we added test/dev VMs at consistent intervals. By the end of our test, the Dell EMC solution supported eight VMs: one for the original production workload and seven VMs (from snapshots created by using AppSync) that ran lighter workloads. The average storage latency for both reads and writes stayed at or under a millisecond. For a detailed breakdown of the storage latency, see Appendix F.

Uphold production-level performance while increasing storage IOPS

We configured a 1.2TB Oracle 12c database running on an Oracle Linux® 7.2 VM to mimic an active production database. Each of the seven snapshots we created and mounted ran a SLOB workload sized to generate roughly 2,000 input/output operations per second (IOPS), which simulates lighter test/dev copy environment workloads.

Despite this increased activity for the VMAX 250F, the original production environment maintained its intended performance level. After the first snapshot began its workload and before we created the second snapshot, the production environment averaged 26,949 IOPS. The production environment averaged 26,408 IOPS after the seventh snapshot began its workload. The average degradation of production environment IOPS between these two periods was two percent. For a detailed breakdown of the storage IOPS, see Appendix F.

Run production applications and test/dev environments together harmoniously

Having test/dev environments for updates and patches ensures a safety net for production applications. Looking at a national bank for example, this can mean improving risk management, customer relationship management (CRM), general ledger, and enterprise resource planning (ERP) software without affecting mission-critical applications that customers use for online banking and ecommerce. These applications, backed by Oracle Database 12c, require solid, constant access to assess financial risk of customers, to carry out marketing campaigns, and to authorize and process credit card payments.

This national bank, like most large banks, grew from acquisitions and mergers. The number of applications the organization runs is quite high. Consolidating hardware, such as storage arrays, in their datacenters can provide an opportunity to reduce IT expenditures and ease the burden of some IT operations.

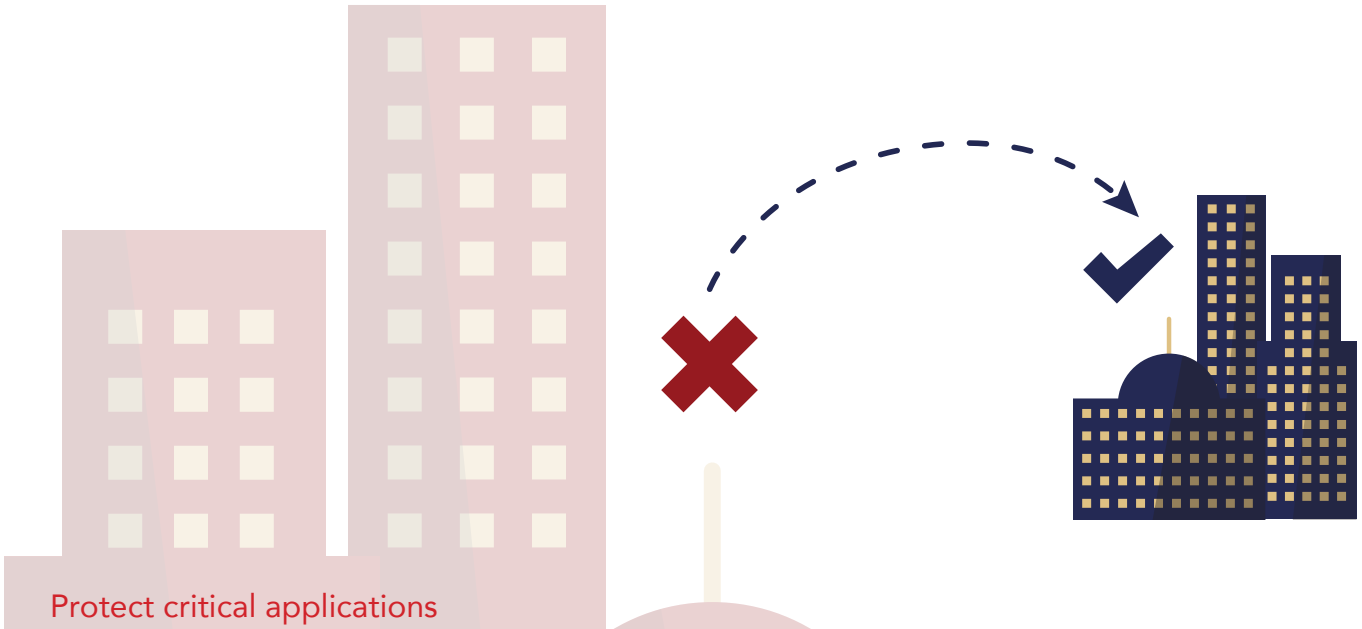
The Dell EMC VMAX 250F could support production applications and test/dev environments at the same time for this national bank without sacrificing performance or storage space. With these Oracle 12c databases existing together and functioning optimally, the national bank could gain a host of business growth-oriented benefits, including a reduction in storage hardware.

Ensure critical data stays available without disrupting users

Without highly available storage for data, a company runs the risk of a critical application going down. Users could become frustrated or employees could be less productive.

We set up two VMAX 250F arrays in SRDF/Metro configurations to test high availability for a production database. We stressed the database, which was active/active and residing on both arrays, with an I/O-intensive workload. Then, we initiated a lost host connection on the primary array. The workload continued to perform at virtually the same level, averaging more than 27,000 IOPS for the Oracle data before the non-disruptive disaster recovery and more than 28,000 after.

If something unfortunate were to happen to your on-site VMAX 250F array, using an off-site array for disaster recovery could bolster your data protection plans and ensure that critical applications stay available to users in times of crisis.



Protect critical applications with SRDF/Metro

The VMAX array family offers disaster recovery and data protection with remote replication technology called Symmetrix Remote Data Facility (SRDF). The SRDF/Metro (SRDF/M) configuration extends core SRDF functionality to offer active/active access of storage devices by presenting devices on local and remote VMAX systems with the same identity to the clustered hosts at synchronous distances. Standalone, virtualized, and clustered application hosts can leverage SRDF/M for load balancing by running on either array or by spreading the I/O load from a single instance to either device. Additionally, by synchronously changing data on each array, the primary array can fail without data loss as the host can access the same data on the second array. This active/active access to storage can potentially lower the application recovery time objective in the event of failover.[3]

Fast and vast storage: The Dell EMC VMAX 250F all flash array

The Dell EMC VMAX 250F is part of the VMAX All Flash enterprise storage family. The foundation of each VMAX All Flash array is the V-Brick, which encompasses a single VMAX engine. Each 250F can house either one or two V-Bricks and features up to 1.1 petabytes effective flash capacity. The array can use the latest 7.6TB and 15TB enterprise flash drives.

The array we used had 10.25 TB of usable storage capacity.[4]

Conclusion: The Dell EMC VMAX 250F helps critical application users stay happy and productive

Slow performance and unavailable critical applications can impinge a company's progress. You can apply patches and updates to improve application quality and user experience, but these changes need to be tested in resource-intensive environments before deployment. Keeping these applications accessing data is vital, too, as on-premises events can put availability at risk.

Our Dell EMC VMAX 250F and PowerEdge server solution supported test/dev environments and production database applications simultaneously without affecting the production applications' performance. As we added VMs designed for test/dev environments, the production workload maintained an acceptable level of IOPS and achieved an average storage latency of less than a millisecond. The solution also kept data highly available with no downtime and no performance drop when we initiated a lost host connection for the primary storage. To support critical database applications of your company, consider the Dell EMC VMAX 250F for your datacenter.

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1 For more information on AppSync, please visit https://www.emc.com/storage/data-replication/appsync.htm.

2 For more information on SLOB, visit https://kevinclosson.net/2012/02/06/introducing-slob-the-silly-little-oracle-benchmark/.

3 For more information on SRDF/Metro, please visit https://www.emc.com/collateral/technical-documentation/h14556-vmax3-srdf-metro-overview-and-best-practices-tech-note.pdf.

4 For more information on the Dell EMC VMAX All Flash enterprise storage family, please visit https://www.emc.com/en-us/storage/vmax-all-flash.htm.

On December 8, 2016, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on March 22, 2017.

Appendix A: Testing configurations and benchmark

About our Oracle Database 12c configuration

We created a new VM, installed Oracle Enterprise Linux on the VM, and configured the VM with 32GB RAM and eight vCPUs. Each VM had a 70GB virtual disk, on which we installed the Oracle OS and database software. We then added eight 165GB VMDKs to hold the database data files, and four 5GB VMDKs to store the database log files.

We made the necessary networking adjustments and prepared the VM for Oracle installation prerequisites (see Appendix B). In addition, we configured other OS settings, such as stopping unneeded services, setting the system's kernel parameters in sysctl.conf, and reserving huge pages for Oracle.

We installed Oracle Grid Infrastructure 12c for Linux x86-64 on the VM and created Oracle ASM disk groups for data and log, and then installed and configured the Oracle database. For each database instance, we set the database to use large_pages true.

Finally, we used the SLOB 2.3 tool to generate the initial database schema. We used a benchmark scale of 9,600MB in SLOB's workload generator to create approximately 1.2TB of data, and we configured SLOB to create the tables and indices. For details, including the SLOB configuration file, see Appendix C and Appendix D.

About the SLOB 2.3 benchmark

The Silly Little Oracle Benchmark (SLOB) can assess Oracle random physical I/O capability on a given platform in preparation for potential OLTP/ERP-style workloads by measuring IOPS capacity. The benchmark helps evaluate performance of server hardware and software, storage system hardware and firmware, and storage networking hardware and firmware.

SLOB contains simple PL/SQL and offers the ability to test the following:

1. Oracle logical read (SGA buffer gets) scaling
2. Physical random single-block reads (db file sequential read)
3. Random single block writes (DBWR flushing capacity)
4. Extreme REDO logging I/O

SLOB is free of application contention yet is an SGA-intensive benchmark. According to SLOB's creator Kevin Closson, SLOB can also offer more than testing IOPS capability, such as studying host characteristics via NUMA and processor threading. For more information on SLOB, links to information on version 2.2, and links to download the benchmark, visit https://www.kevinclosson.net/slob/.

Server configuration information	Dell EMC PowerEdge R930
BIOS name and version	Dell EMC 2.1.3
Non-default BIOS settings	Virtualization enabled
Operating system name and version	VMware® ESXi® 6.0.0 build-4192238
Date of last OS updates/patches applied	09/15/2016
Power management policy	Performance
Processor	
Number of processors	4
Vendor and model	Intel® Xeon® E7-8890 v4
Core count (per processor)	24
Core frequency (GHz)	2.20
Stepping	1
Memory module(s)	
Total memory in system (GB)	512
Number of memory modules	16
Vendor and model	Samsung® M386AG40DM0-CPB
Size (GB)	32
Type	PC4-2133P
Speed (MHz)	1,600
Speed running in the server (MHz)	1,600
Storage controller	
Vendor and model	Dell EMC PERC H730p
Cache size (GB)	2
Firmware version	25.4.1.0004
Driver version	6.903.82.00
Local storage	
Number of drives	2
Drive vendor and model	Seagate® ST9146852SS
Drive size (GB)	146
Drive information (speed, interface, type)	15K, 6Gb SAS, HDD
Network adapter	
Vendor and model	Intel Ethernet Converged Network Adapter X520-2
Number and type of ports	2 x 10GbE
Driver version	4.1.1.1-iov

Server configuration information	Dell EMC PowerEdge R930
Network adapter	
Vendor and model	QLogic® QLE2692 16Gb FC Adapter
Number and type of ports	2 x 16Gb
Driver version	2.1.24.0-1OEM.600.0.0.2768847
Cooling fans	
Vendor and model	Dell EMC A1234
Number of cooling fans	5
Power stupplies	
Vendor and model	R930-1: Dell EMC L1100E-S1; R930-2: Dell EMC E1100E-S0
Number of power supplies	4
Wattage of each (W)	1,100

Table 1: Detailed configuration information for the server under test.

Storage configuration information	Dell EMC VMAX 250F
Controller firmware revision	Hypermax OS 5977.945.890
Number of storage controllers	2 (1 V-Brick)
Number of storage shelves	2
Number of drives per shelf	8, 9
Drive vendor and model number	Samsung MZ-ILS9600
Drive size (GB)	960
Drive information (speed, interface, type)	RAID5 (3+1), SSD

Table 2: Detailed configuration information for the storage solution.

Appendix B: Detailed test procedure

We used the following steps to configure each server and our Oracle environment.

Installing VMware ESXi 6 Update 2

1. Attach the installation media.
2. Boot the server.
3. At the VMware Installer screen, press Enter.
4. At the EULA screen, to Accept and Continue, press F11.
5. Under Storage Devices, select the appropriate virtual disk, and press Enter.
6. As the keyboard layout, select US, and press Enter.
7. Enter the root password twice, and press Enter.
8. To start installation, press F11.
9. After the server reboots, press F2, and enter root credentials.
10. Select Configure Management Network, and press Enter.
11. Select the appropriate network adapter, and select OK.
12. Select IPv4 settings, and enter the desired IP address, subnet mask, and gateway for the server.
13. Select OK, and restart the management network.
14. Repeat steps 1-13 on the second R930.

Deploying the VMware vCenter Server® 6 Update 2

We used a client server running VMware ESXi to host our clients and virtualized management servers. For the VMware vCenter server VM, we installed Microsoft® Windows Server® 2012 R2 and performed the following steps to install and configure vCenter.

1. Log into the vCenter® VM.
2. From the VMware vCenter Server 6.0 install media, to start the install wizard, click Run.
3. Select vCenter Server, and click Install.
4. At the Install wizard welcome screen, click Next.
5. Agree to the License Agreement, and click Next.
6. Select the Embedded Deployment option, and click Next.
7. Enter the system IP address.
8. Enter and confirm the password you wish to use with the Administrator account for vCenter Single Sign On, and click Next.
9. Click Next.
10. Accept the default database settings, and click Next.
11. Accept the default https port, and click Next.
12. Accept the default installation path, and click Next.
13. Uncheck "Join the VMware Customer Experience Improvement Program", and click Next.
14. Click Install.
15. To exit the wizard, click Finish.
16. On the installer, click Exit.
17. Restart the server.
18. Once completed, log into the first vCenter's web client at https://vcenter-ip-address/vsphere-client/?csp.
19. Add all the necessary ESXi and vCenter licenses to the vCenter.

Creating the cluster and adding the hosts and storage to VMware vCenter

We used the following steps to create the R930 cluster and add the desired servers and storage to the vCenter.

1. Once logged into the vCenter, navigate to Hosts and Clusters.
2. Select the primary site management vCenter.
3. Right-click the vCenter object, and select New Datacenter…
4. Enter a name for the new datacenter, and click OK.
5. Right-click the new datacenter, and click New Cluster…
6. Enter a name for the new cluster.
7. Click OK.
8. Once the cluster has been created, right-click the cluster, and click Add Host.

9. Enter the IP address for the first PowerEdge R930 server, and click Next.
10. Enter the root credentials for the server, and click Next.
11. To accept the server's certificate, click Yes.
12. Review the server details, and click Next.
13. Assign the desired license, and click Next.
14. Disable Lockdown mode, and click Next.
15. Click Finish.
16. Repeat steps 8-15 for the remaining PowerEdge R930 server.
17. Once all the hosts are added to vCenter, use Update Manager to update the hosts, and install the latest Dell EMC PowerPath®.
18. Once all the servers are added to the cluster, right click a host, and click Storage→New Datastore.
19. Select VMFS, and click Next.
20. Enter a name for the new datastore as "OS", select the appropriate Dell EMC VMAX 250F OS LUN, and click Next.
21. Accept the defaults for the partition configuration, and click Next.
22. Click Finish.
23. Once the create datastore task is complete, ensure that all the hosts in the cluster are mounted on the new datastore.
24. Repeat steps 18-23 for the remaining eight data and four log LUNs.

Creating the VMs

We created one gold image VM for Oracle using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the desired host with available CPUs, and click Next.
6. Select the Dell EMC VMAX 250F LUN for the 70GB OS VMDK, and click Next.
7. Select the guest OS as Oracle Linux, and click Next.
8. In the Customize Hardware section, use the following settings:
    a. Set the vCPU count to 8.
    b. Set the Memory to 32GB, and check the Reserve all guest memory box.
    c. Add 8 x 165GB VMDKs for data and 4 x 5GB VMDKs for log. Set all VMDKs to thick provision eager zeroed.
    d. Create 2 additional VMware Paravirtual SCSI controllers, and assign all data VMDKs to one and all log VMDKs to the other.
    e. Attach an Oracle Linux 7.2 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.
11. Power on the VMs, and follow the steps outlined in the next section to install and configure the workload.

Installing Oracle Enterprise Linux 7.2

1. Attach the Oracle Enterprise Linux 7.2 ISO to the VM, and boot to it.
2. Select Install or upgrade an existing system.
3. Choose the language you wish to use, and click Continue.
4. Select Date & Time, and ensure the VM is set to the correct date, time, and timezone.
5. Click Done.
6. Select Installation Destination.
7. Select the desired virtual disk for the OS.
8. Under Other Storage Options, select I will configure partitioning.
9. Click Done.
10. Select Click here to create them automatically.
11. Remove the /home partition.
12. Expand the swap partition to 20GB.
13. Assign all remaining free space to the / partition.
14. Click Done.
15. Click Accept Changes.
16. Select Kdump.
17. Uncheck Enable kdump, and click Done.

18. Select Network & Hostname.
19. Enter the desired hostname for the VM.
20. Turn on the desired network port, and click Configure.
21. On the General tab, select Automatically connect to this network when it is available.
22. On the IPv4 Settings tab, select Manual under Method.
23. Under Addresses, click Add, and enter the desired static IP information for the VM.
24. Enter the desired DNS information.
25. Click save, and click Done.
26. Click Begin Installation.
27. Select Root Password.
28. Enter the desired root password, and click Done.
29. When the installation completes, select Reboot to restart the server.

Configuring OEL 7.2 for Oracle

1. Log into the server as root.
2. Disable the firewall:

```
systemctl stop firewalld

systemctl disable firewalld
```

3. Disable SELinux:

```
vi /etc/selinux/config

SELINUX=disabled
```

4. Update OEL 7.2:

```
yum update
```

5. Install VMware tools:

```
yum install open-vm-tools
```

6. Install the Oracle 12c preinstall RPM:

```
yum install oracle-rdbms-server-12cR1-preinstall
```

7. Using yum, install the following prerequisite packages for Oracle Database:

```
yum install elfutils-libelf-devel

yum install xhost

yum install unixODBC

yum install unixODBC-devel
```

8. Disable auditd:

```
systemctl disable auditd
```

9. Create a password for the Oracle user:

```
passwd oracle
```

10. Create Oracle users and groups by running these shell commands:

```
groupadd -g 54323 oper

groupadd -g 54327 asmdba

groupadd -g 54328 asmoper

groupadd -g 54329 asmadmin

usermod -u 54321 -g oinstall -G dba,oper,asmdba,asmoper,asmadmin oracle
```

11. Login as the Oracle user, and add the following lines to the .bash_profile file:

```
export TMP=/tmp

export TMPDIR=$TMP



export ORACLE_HOSTNAME=oracle-01.test.local

export ORACLE_UNQNAME=orcl

export ORACLE_BASE=/u01/app/oracle

export GRID_HOME=/u01/app/12.1.0.2/grid

export DB_HOME=$ORACLE_BASE/product/12.1.0.2/dbhome_1

export ORACLE_HOME=$DB_HOME

export ORACLE_SID=orcl

export ORACLE_TERM=xterm

export BASE_PATH=/usr/sbin:$PATH

export PATH=$ORACLE_HOME/bin:$BASE_PATH



export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib

export CLASSPATH=$ORACLE_HOME/JRE:$ORACLE_HOME/jlib:$ORACLE_HOME/rdbms/jlib



alias grid_env='. /home/oracle/grid_env'

alias db_env='. /home/oracle/db_env'
```

12. Create the following files in the Oracle user's home folder.

```
>>>db_env<<<

export ORACLE_SID=orcl

export ORACLE_HOME=$DB_HOME

export PATH=$ORACLE_HOME/bin:$BASE_PATH



export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib

export CLASSPATH=$ORACLE_HOME/JRE:$ORACLE_HOME/jlib:$ORACLE_HOME/rdbms/jlib

>>>grid_env<<<

export ORACLE_SID=+ASM

export ORACLE_HOME=$GRID_HOME

export PATH=$ORACLE_HOME/bin:$BASE_PATH



export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib

export CLASSPATH=$ORACLE_HOME/JRE:$ORACLE_HOME/jlib:$ORACLE_HOME/rdbms/jlib
```

13. Create the following directories, and assign the following permissions.

```
mkdir -p  /u01/app/12.1.0.2/grid

mkdir -p /u01/app/oracle/product/12.1.0.2/dbhome_1

chown -R oracle:oinstall /u01

chmod -R 775 /u01/
```

14. Create passwords for the oracle and grid accounts with passwd.
15. Append the following to /etc/security/limits.conf:

```
oracle -  nofile  65536

oracle -  nproc   16384

oracle -  stack   32768

oracle -  memlock 152043520

* soft memlock unlimited

* hard memlock unlimited
```

16. We modified the system's kernel parameters by appending the following to /etc/sysctl.conf:

```
fs.file-max = 6815744

kernel.sem = 250 32000 100 128

kernel.shmmni = 4096

kernel.shmall = 1073741824

kernel.shmmax = 4398046511104

net.core.rmem_default = 262144

net.core.rmem_max = 20971520

net.core.wmem_default = 262144

net.core.wmem_max = 20971520

fs.aio-max-nr = 1048576

net.ipv4.ip_local_port_range = 9000 65500

vm.nr_hugepages = 14336

vm.hugetlb_shm_group = 54321
```

17. Install the oracleasmlib packages.

```
yum install -y oracleasm-support-* oracleasmlib-*
```

18. Create a partition on all VMDKs using fdisk.
19. Edit /etc/sysconfig/oracleasm to contain the following:

```
# ORACLEASM_UID: Default UID owning the /dev/oracleasm mount point.

ORACLEASM_UID=oracle



# ORACLEASM_GID: Default GID owning the /dev/oracleasm mount point.

ORACLEASM_GID=oinstall



# ORACLEASM_SCANBOOT: 'true' means fix disk perms on boot

ORACLEASM_SCANBOOT=true



# ORACLEASM_USE_LOGICAL_BLOCK_SIZE: 'true' means use the logical block

# size reported by the underlying disk instead of the physical. The

# default is 'false'

ORACLEASM_USE_LOGICAL_BLOCK_SIZE=false
```

20. Run the following commands to configure all disks for Oracle ASM:

```
oracleasm createdisk DATA1 /dev/sdb1

oracleasm createdisk DATA1 /dev/sdc1

oracleasm createdisk DATA2 /dev/sdc1

oracleasm createdisk DATA3 /dev/sdd1

oracleasm createdisk DATA4 /dev/sde1

oracleasm createdisk DATA5 /dev/sdf1

oracleasm createdisk DATA6 /dev/sdg1

oracleasm createdisk DATA7 /dev/sdh1

oracleasm createdisk DATA8 /dev/sdi1

oracleasm createdisk LOG1 /dev/sdj1

oracleasm createdisk LOG2 /dev/sdk1

oracleasm createdisk LOG3 /dev/sdl1

oracleasm createdisk LOG4 /dev/sdm1
```

Installing Oracle Grid and RAC

1. Log in as the `oracle` user.
2. Unzip `linuxamd64_12c_grid_1of2.zip` and `linuxamd64_12c_grid_2of2.zip`
3. Open a terminal to the unzipped database directory.
4. Type `grid_env` to set the Oracle grid environment.
5. To start the installer, type `./runInstaller`
6. At the Updates screen, select Skip updates.
7. In the Select Installation Option screen, select Install and Configure Grid Infrastructure for a Standalone Server, and click Next.
8. Choose the language, and click Next.
9. In the Create ASM Disk Group screen, choose the Disk Group Name, and change redundancy to External.
10. Change the path to /dev/oracleasm/disks and select the eight disks that you are planning to use for the database, and click Next.
11. In the Specify ASM Password screen, choose Use same password for these accounts, write the passwords for the ASM users, and click Next.
12. Leave the default Operating System Groups, and click Next.
13. Leave the default installation, and click Next.
14. Leave the default inventory location, and click Next.
15. Under Root script execution, select Automatically run configuration scripts and enter root credentials.
16. In the Prerequisite Checks screen, make sure that there are no errors.
17. In the Summary screen, verify that everything is correct, and click Finish to install Oracle Grid Infrastructure.
18. At one point during the installation, the installation prompts you to execute two configuration scripts as root. Follow the instructions to run the scripts.
19. At the Finish screen, click Close.

Creating Oracle ASM disk groups for the database

1. Log into the system as the oracle user.
2. Set the X Window DISPLAY variable as appropriate for your configuration.
3. Type grid_env to set the Oracle grid environment.
4. Start the ASM configuration assistant, asmca.

5. On the Disk Groups tab, click Create.
6. On the Create Disk Group pop-up screen, enter LOG for the Disk Group Name.
7. Select External (None) for Redundancy.
8. Select /dev/oracleasm/disks for the Disk Path.
9. Select the four Log disks.
10. Click Show Advanced Options, and set the ASM and Database compatibilities to 12.1.0.0.
11. Click OK to create the LOG disk group, and click OK on the completed-task pop-up screen.
12. Right-click the DATA drive, and choose Edit Attributes. Make sure both ASM and Database Compatibility fields list 12.1.0.0.0, and click OK.
13. Click Exit to close the ASM configuration assistant.

Installing the software for Oracle Database 12c

1. Log into the system as the oracle user.
2. Set the X Window DISPLAY variable as appropriate for your configuration.
3. Copy the extracted download files for the Database install to /database.
4. Run the Database GUI installer.

```
./database/runInstaller.sh
```

5. On the Configure Security Updates screen, unselect I wish to receive security updates via My Oracle Support, and click Next.
6. On the warning pop-up screen, click Yes.
7. On the Download Software Updates screen, select Skip software updates, and click Next.
8. On the Select Installation Option screen, select Install database software only, and click Next.
9. On the Grid Installation Options screen, select Single instance database installation, and click Next.
10. On the Select Product Languages screen, leave the default setting of English, and click Next.
11. On the Select Database Edition screen, select Enterprise Edition, and click Next.
12. On the Specify Installation Location, leave the defaults, and click Next.
13. On the Create Inventory screen, leave the default settings, and click Next.
14. On the Privileged Operating System groups screen, keep the defaults, and click Next.
15. Allow the prerequisite checker to complete.
16. On the Summary screen, click Install.
17. Once the Execute Configuration scripts prompt appears, ssh into the server as root, and run the following command:

```
/home/oracle/app/oracle/product/12.1.0/dbhome_1/root.sh
```

18. Return to the prompt, and click OK.
19. Once the installer completes, click Close.

Creating the database

We used the following steps to create our Oracle database. For specific spfile configurations, see Appendix C.

1. Log into the system as the oracle user.
2. Set the X Window DISPLAY variable as appropriate for your configuration.
3. Start the database configuration assistant, dbca.
4. On the Database Operations screen, select Create a Database, and click Next.
5. On the Creation Mode screen, select Advanced Mode, and click Next.
6. On the Database Templates screen, select General Purpose or Transaction Processing.
7. Click Next.
8. On the Database Identification screen, enter orcl for Global Database Name and SID Prefix, and click Next.
9. On the Management Options screen, keep the defaults, and click Next.
10. On the Database Credentials screen, select Use the Same Administrative Password for All Accounts, enter the password twice, and click Next.
11. On the Storage Locations screen, select ASM for Storage Type, select Use Common Location for All Database Files, and enter +DATA for Database Files Locations.
12. On the Initialization Parameters screen, leave the defaults, and click Next.
13. On the Creation Options screen, select Create Database, and click Next.
14. On the Pre Requisite Checks screen, allow the prerequisite checker to complete, resolve any issues, and click Next.
15. On the Summary pop-up screen, click OK.

16. Click Exit on the final pop-up screen to close the configuration assistant.
17. Once the database installed, we created two redo log groups. Each contained a single 9GB file on the +LOG ASM group. All default groups were removed.
18. On the database, we created a tablespace named TPCC, set it to smallfile, and add 40 datafiles sized at 32GB with no auto-extend.

Installing SLOB and populating the database

1. Download the SLOB kit from www.kevinclosson.net/slob/.
2. Copy and untar the files to /home/oracle/.
3. Edit the slob.conf file to match Appendix D.
4. As the oracle user in the SLOB folder, type `./setup.sh SLOB 128` to start the data population to the SLOB tablespace we created earlier.
5. When the setup is complete, the database is populated.

Creating the AppSync VM

We created a base Windows Server 2012 R2 VM on our vCenter host to configure AppSync. We used the following steps to install and configure AppSync for our environment.

1. Download the AppSync install package from the Dell EMC support website.
2. Open the AppSync install package and run AppSync-3.1.0.0-win-x64.exe.
3. In the Introduction, click Next.
4. In License Agreement, accept the terms of the license agreement, and click Next.
5. In Choose Install Folder, accept defaults, and click Next.
6. In AppSync Administrator, write your admin password, and click Next.
7. In AppSync Ports, accept defaults, and click Next.
8. In Pre-Installation Summary, look over your choices to make sure you didn't make a mistake, and click Install.
9. In Installation Complete, click Next to complete the install.
10. When the information pops up, click Done and your default web browser will open to AppSync.
11. In the AppSync login, type your username and password, and click Login.
12. Click Settings→Storage Infrastructure.
13. Click Add→VMAX.
14. In SMI-S Provider, type the IP address, username, and password, and click Next.
15. In Select VMAX, select the array you are trying to add, and click Next.
16. In Groups and Pools, select the Storage Group and the Storage Pools you made for AppSync, then click Finish.
17. Click Settings→VMware vCenter Servers.
18. Click Add.
19. In Add vCenter Server, type the hostname, username, and password for your vCenter server, then click OK.
20. Click Service Plans→VMware Datacenters.
21. Click Create.
22. In the Create New Plan window, select Bronze as your template AppSync service plan, name your service plan, and click OK.
23. Click your new service plan.
24. In Plan Startup, select On demand.
25. In Create local copy, select Crash Consistent.
26. Check Mount copy.
27. In Mount Copy, select your host, change Mount Signature to Use new signature, and keep Cluster Mount at Yes, then click Apply.
28. Click Copy Management→VMware Datacenters.
29. Click your VMware Datacenter you added earlier.
30. Highlight the LUNs you wish to protect, and click Protect→Subscribe to Plan→Your plan name.

Running the AppSync copy test

1. Open a web browser and navigate to your AppSync address.
2. In the AppSync login, type your username and password, and click Login.
3. Click Service Plans→VMware Datacenters.
4. Select the service plan you made previously, and click Run.
5. After the service plan has finished running, open a connection to your vCenter.
6. Click Hosts & Clusters.

7. Select the host on which you intend to add a VM.
8. Select Related Objects→Datastores.
9. Right-click the new datastore that has your VM OS, and click Register VM.
10. Navigate to the directory containing your VM address, and click OK.
11. In Name and location, give your VM a different name from the original VM, select the datacenter, and click Next.
12. In Host / Cluster, select your relevant cluster, and click Next.
13. In Specify a Specific Host, select your host, and click Next.
14. In Ready to Complete, click Finish.

Running the performance test

1. Once the database build is complete or in between test runs, shut down the VM, and reboot the host.
2. Once the host is rebooted, power on the baseline VM, and let it sit idle for 10 minutes to ensure that the database is started and ready for testing.
3. Start esxtop, capturing data every minute for twelve hours.
4. As the oracle user, navigate to the SLOB folder, and type `./runit.sh 128` to kick off the SLOB run.
5. After the baseline VM has been running for one hour, follow steps 3-14 in the Running the AppSync copy test section above to create your first AppSync Copy VM.
6. When the VM is visible in your vCenter, highlight the VM, and reset the MAC address conflict to green.
7. Power on the AppSync copy VM, and click Answer Question.
8. Select I copied it, and click Finish.
9. Once the VM has been fully powered on, right-click the VM and select Open Console.
10. In the console that opens in a new browser tab, edit the ethernet adapter config file to change the IP address, and then activate the ethernet adapter.
11. Log into the AppSync Copy VM as the oracle user, and edit the /home/oracle/SLOB/slob.conf file.
12. As the oracle user, navigate to the SLOB folder, and type `./runit.sh 128` to kick off the SLOB run.
13. Repeat steps 5-12 every hour until there are 7 AppSync Copy VMs, and adjust the Hotspot_MB, Hotspot_MB_Offset, Run_Time, and Think_TM settings for each VM to match Appendix E.
14. Once the test is complete, collect all SLOB output files and esxtop data for parsing.
15. Repeat steps 1-14 for all subsequent test runs.

Creating SRDF/Metro witnesses

1. Log into the Unisphere® for VMAX of the array you wish to use as a witness.
2. Select All Symmetrix→your witness storage array
3. Select Data Protection→Create SRDF Group
4. In the Create SRDF Group pop-up, choose the following options:
   - Communication Protocol: FC
   - SRDF Group Label: Your choice
   - SRDF Group Number: Your choice (make sure to choose a number not already chosen, though)
   - Director: Choose all available RDF directors
   - Remote Symmetrix ID: Your site A storage array
   - Remote SRDF Group Number: the same number as SRDF Group Number
   - Remote Director: Choose all available remote RDF directors
   - SRDF/Metro Witness Group: Checked
5. Click OK.
6. Select Data Protection→Create SRDF Group
7. In the Create SRDF Group pop-up, choose the following options:
   - Communication Protocol: FC
   - SRDF Group Label: Your choice
   - SRDF Group Number: Your choice (make sure to choose a number not already chosen, though)
   - Director: Choose all available RDF directors
   - Remote Symmetrix ID: Your site B storage array
   - Remote SRDF Group Number: the same number as SRDF Group Number
   - Remote Director: Choose all available remote RDF directors
   - SRDF/Metro Witness Group: Checked
8. Click OK.

Creating the SRDF/Metro connection

1. Log into the Unisphere for VMAX of the site A storage array.
2. Select All Symmetrix→your site A storage array.
3. Select Data Protection→Create SRDF Group
4. In the Create SRDF Group pop-up, choose the following options:
   - Communication Protocol: FC
   - SRDF Group Label: Your choice
   - SRDF Group Number: Your choice (make sure to choose a number not already chosen, though)
   - Director: Choose all available RDF directors
   - Remote Symmetrix ID: Your site B storage array
   - Remote SRDF Group Number: the same number as SRDF Group Number
   - Remote Director: Choose all available remote RDF directors
5. Click OK.
6. Select Data Protection→Protection Dashboard.
7. In the Protection Dashboard, click Unprotected.
8. Select the storage group you wish to protect, and click Protect.
9. In the Protect Storage Group window, select High Availability Using SRDF/Metro, and click Next.
10. In the Select SRDF/Metro Connectivity step, select your site B storage, make sure that your SRDF group is protected via Witness and compression is enabled, and click Next.
11. In the Finish step, click the dropdown list beside Add to Job List and select Run Now.
12. Select Data Protection→SRDF.
13. Select SRDF/Metro.
14. Monitor the state of the SRDF metro pair you made, and proceed to the next step once the pair reads as ActiveActive.
15. Select All Symmetrix→your site B storage array.
16. Select Storage→Storage Groups Dashboard.
17. Double-click the newly-synced SRDF storage group.
18. Select Provision Storage to Host.
19. In Select Host/Host Group, select your site A server.
20. In Select Port Group, allow a new port group to be automatically created.
21. In Review, click the down arrow beside Add to Job List and click Run Now.

Running the SRDF/Metro test

1. Clean up prior outputs from the target system and the client driver system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Shut down the target.
5. Reboot the host and client system.
6. Wait for a ping response from the server under test and the client system.
7. Let the test server idle for 10 minutes.
8. Start the DVD Store driver on each of the four clients.
9. After an hour, disconnect the ports from the site A storage, and continue the test for another hour.

Appendix C: Oracle Spfile

Database: ORCL

```
orcl.__data_transfer_cache_size=0

orcl.__db_cache_size=7952400384

orcl.__java_pool_size=67108864

orcl.__large_pool_size=100663296

orcl.__oracle_base='/u01/app/oracle'#ORACLE_BASE set from environment

orcl.__pga_aggregate_target=3355443200

orcl.__sga_target=10066329600

orcl.__shared_io_pool_size=503316480

orcl.__shared_pool_size=1409286144

orcl.__streams_pool_size=0

*.audit_file_dest='/u01/app/oracle/admin/orcl/adump'

*.audit_trail='db'

*.compatible='12.1.0.2.0'

*.control_files='+DATA/ORCL/CONTROLFILE/current.261.926251959','/u01/app/oracle/fast_recovery_area/
ORCL/controlfile/o1_mf_d11ohp17_.ctl'

*.db_block_size=8192

*.db_create_file_dest='+DATA'

*.db_domain=''

*.db_name='orcl'

*.db_recovery_file_dest='/u01/app/oracle/fast_recovery_area'

*.db_recovery_file_dest_size=4560m

*.diagnostic_dest='/u01/app/oracle'

*.dispatchers='(PROTOCOL=TCP) (SERVICE=orclXDB)'

*.fast_start_mttr_target=180

*.filesystemio_options='setall'

*.local_listener='LISTENER_ORCL'
```

```
*.open_cursors=2000

*.pga_aggregate_target=3190m

*.processes=2000

*.recyclebin='off'

*.remote_login_passwordfile='EXCLUSIVE'

*.sga_target=9570m

*.trace_enabled=FALSE

*.undo_retention=1

*.undo_tablespace='UNDOTBS1'
```

Appendix D: Benchmark parameters

We used the following slob.conf parameter settings.

```
UPDATE_PCT=40

RUN_TIME=43200

WORK_LOOP=0

SCALE=9600M

WORK_UNIT=64

REDO_STRESS=LITE

LOAD_PARALLEL_DEGREE=8

THREADS_PER_SCHEMA=1

# Settings for SQL*Net connectivity:

#ADMIN_SQLNET_SERVICE=slob

#SQLNET_SERVICE_BASE=slob

#SQLNET_SERVICE_MAX=2

#SYSDBA_PASSWD=change_on_install

#########################

#### Advanced settings:

#

# The following are Hot Spot related parameters.

# By default Hot Spot functionality is disabled (DO_HOTSPOT=FALSE).

#

DO_HOTSPOT=TRUE

HOTSPOT_MB=100

HOTSPOT_OFFSET_MB=100

HOTSPOT_FREQUENCY=1

#

# The following controls operations on Hot Schema

# Default Value: 0. Default setting disables Hot Schema
```

```
#

HOT_SCHEMA_FREQUENCY=0

# The following parameters control think time between SLOB

# operations (SQL Executions).

# Setting the frequency to 0 disables think time.

#

THINK_TM_FREQUENCY=1

THINK_TM_MIN=.175

THINK_TM_MAX=.175

#########################

export UPDATE_PCT RUN_TIME WORK_LOOP SCALE WORK_UNIT LOAD_PARALLEL_DEGREE REDO_STRESS

export DO_HOTSPOT HOTSPOT_MB HOTSPOT_OFFSET_MB HOTSPOT_FREQUENCY HOT_SCHEMA_FREQUENCY THINK_TM_
FREQUENCY THINK_TM_MIN THINK_TM_MAX
```

Appendix E: Run times and HotSpot configurations

The table below shows the SLOB settings we used for the baseline and the seven snapshots. We ran the baseline for twelve hours and configured the snapshots to end one hour after the baseline completed. For our reporting, we measured a total of eight hours of run data covering the first hour of just the baseline up to one hour of the seventh snapshot workload. Additionally, we added more think time to the snapshots to reduce their IOPS to approximately 2,000. To simulate a more real-world use case with SLOB, we configured a SLOB HotSpot. With this setting enabled, we were able to target a higher read cache hit percentage by targeting a smaller subset of each schema's data. This created more hot data, which allowed more use of the VMAX cache pool. Additionally, we staggered each snapshot's offset and reduced the size of each snapshot to provide even more read hit. See Figure 4 in Appendix F for the percent read hit data from our testing.

VM	Run time (seconds)	HotSpot size (MB)	HotSpot offset (MB)	Think time (seconds)
Baseline	43,200	100	100	0.175
AppSync 1	43,200	50	200	1
AppSync 2	39,600	50	250	1
AppSync 3	36,000	50	300	1
AppSync 4	32,400	50	350	1
AppSync 5	28,800	50	400	1
AppSync 6	25,200	50	450	1
AppSync 7	21,600	50	500	1

Table 3: Our SLOB settings for the baseline and the seven snapshots

Appendix F: Detailed findings

Storage snapshot testing

We pulled latency and IOPS data from the performance tracking tools provided by Dell EMC Unisphere for VMAX.

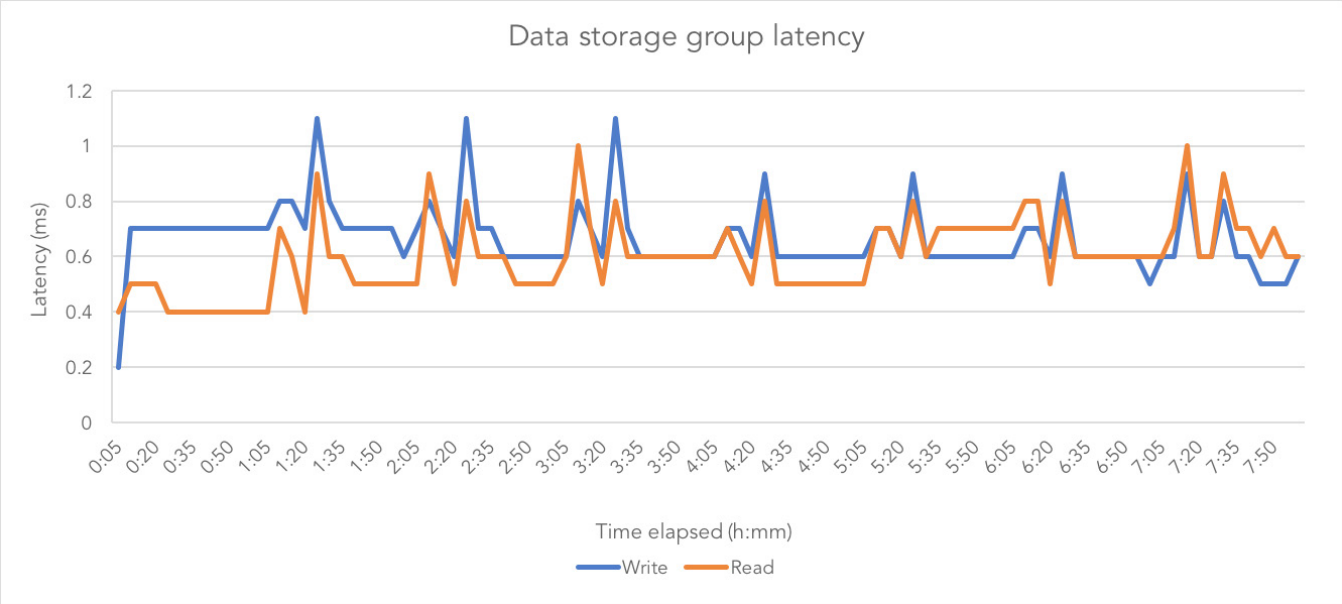

Figure 1: Data storage group latency during the snapshot creation test

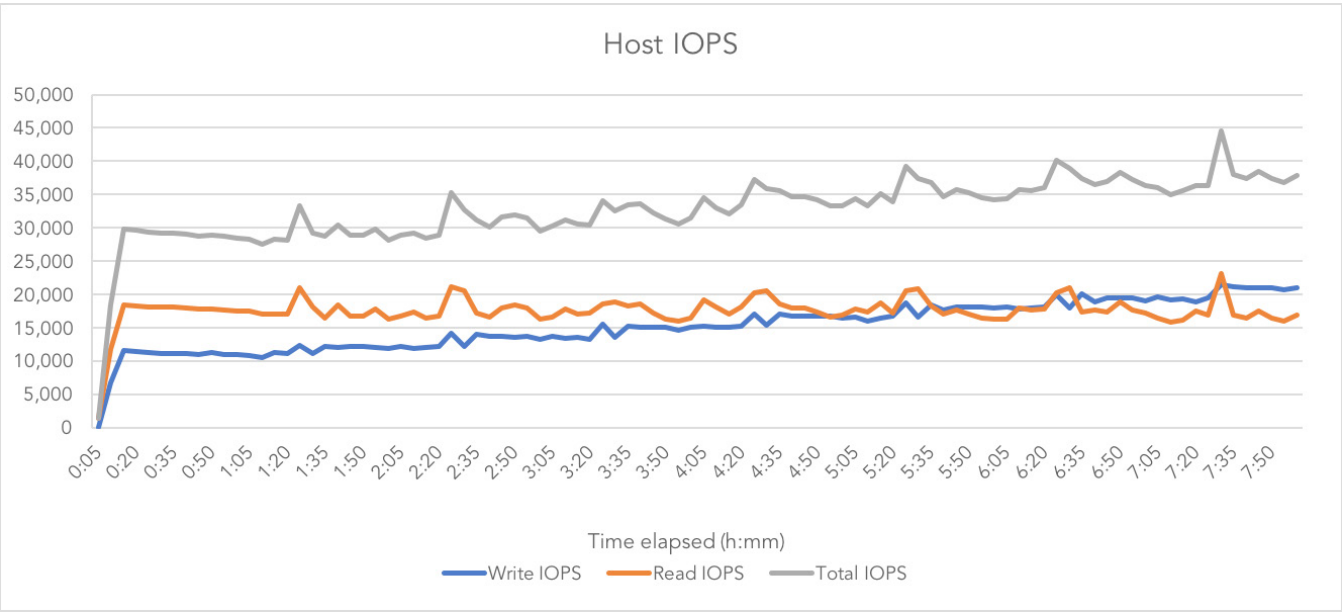

Figure 2: Host IOPS during the snapshot creation test

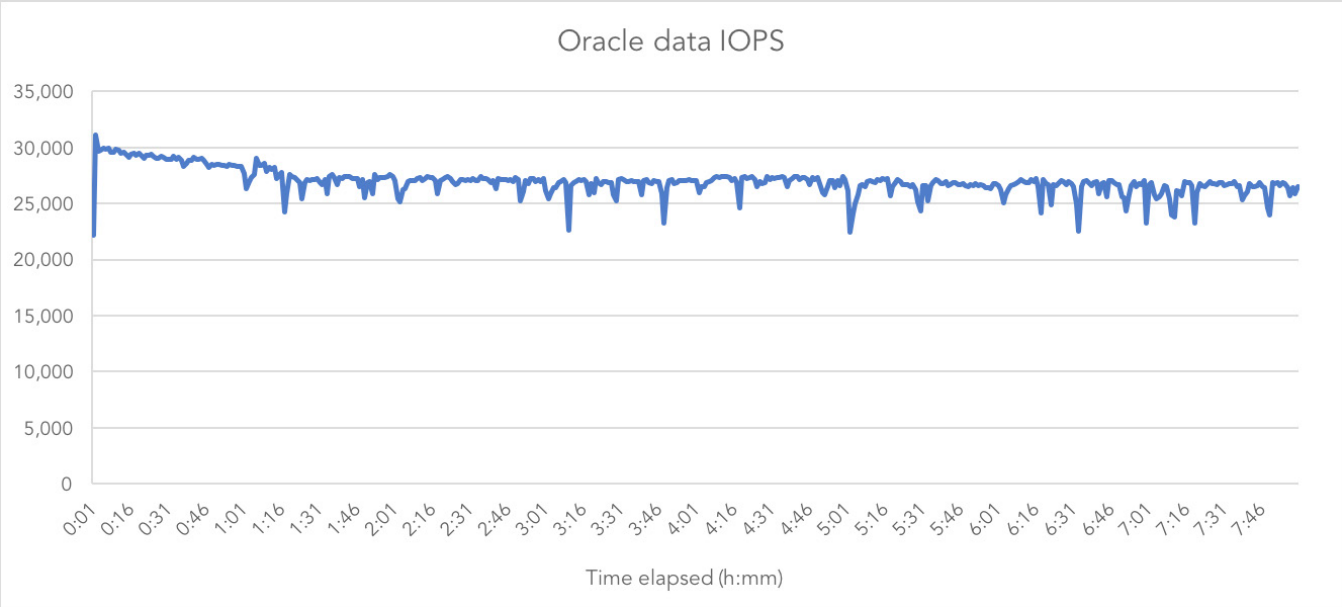

Figure 3: Oracle data IOPS during the snapshot creation test

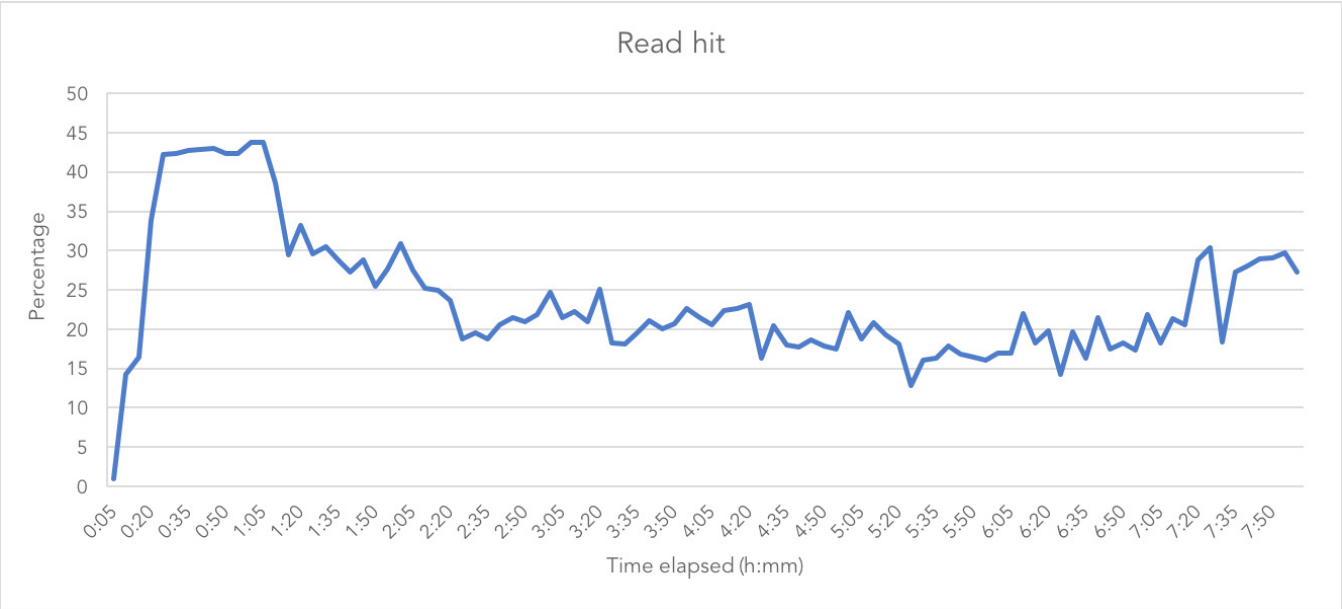

Figure 4: Percent read hit during the snapshot creation test

SRDF/Metro high availability testing

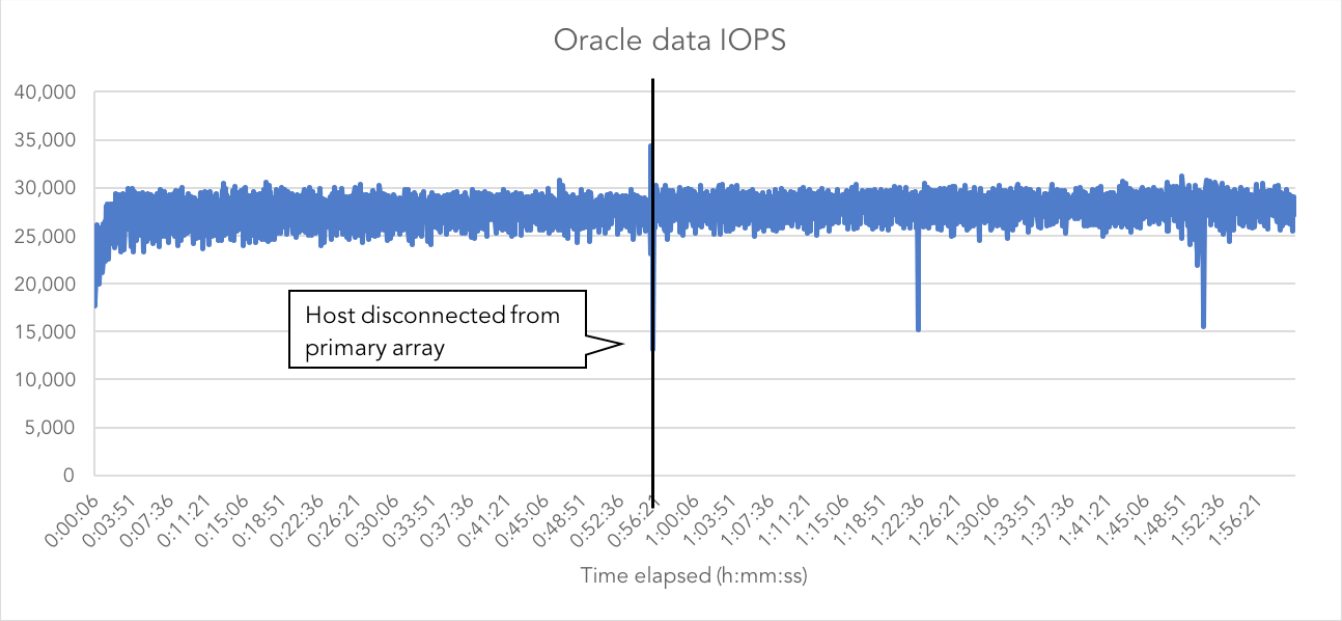

Figure 5: Oracle data IOPS as reported by SLOB from the two-hour SRDF/Metro test

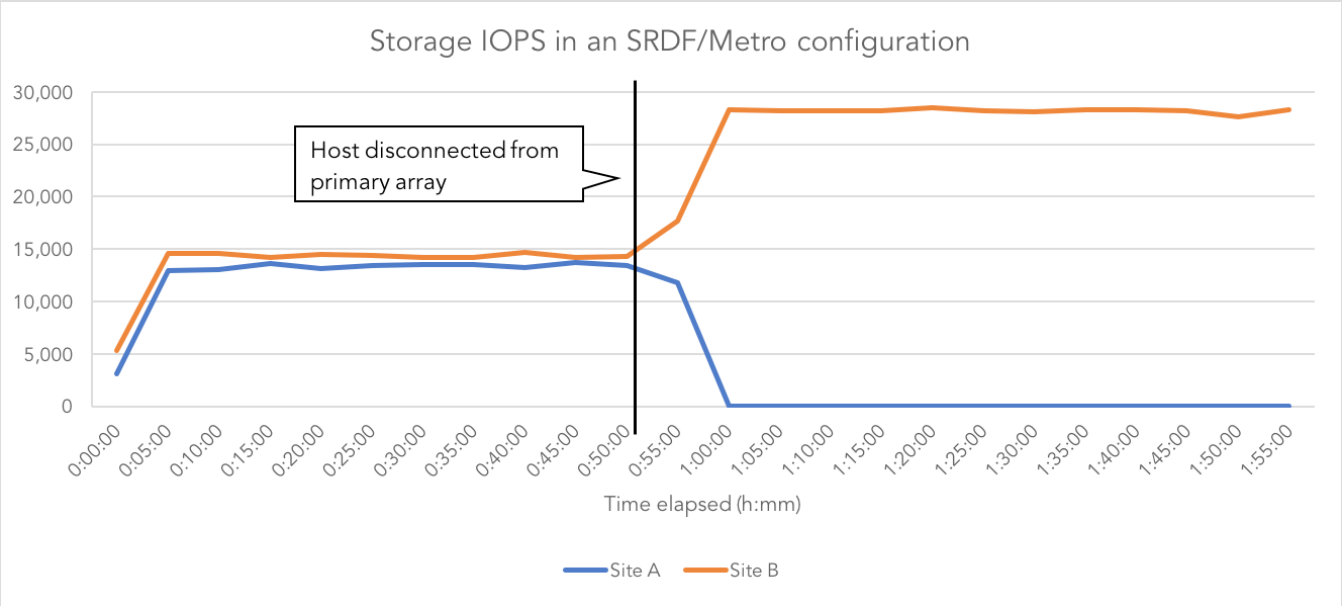

Figure 6: Storage IOPS during the two-hour SRDF/Metro test

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