Technical Report

MongoDB Best Practices on NetApp SolidFire

SolidFire Tech Solutions Group, NetApp

June 2017 | TR-4600

Abstract

This document outlines the guidelines to create a stable, high-performance MongoDB instance on NetApp® SolidFire® storage. SolidFire storage offers a compelling advantage for a wide range of database application use cases. This document introduces SolidFire storage to the database administrator and provides important system-design paradigms to consider when using SolidFire storage for MongoDB. From these design points, you can learn about application profiles that are best suited for SolidFire storage and how to identify those types of applications.

TABLE OF CONTENTS

LIST OF FIGURES

1 Introduction

NetApp SolidFire storage systems were born out of some of the largest cloud infrastructures in the world. They are designed to serve next-generation data center needs, including scaling with multitenancy, set-and-forget management, and guaranteed performance. Adopting the SolidFire architecture provides you with greater predictability for your shared storage infrastructure. SolidFire storage optimizes solid-state drive (SSD) capacity to create high utilization and volume performance.

Because of the innovative quality-of-service (QoS) properties that are inherent in SolidFire systems, running MongoDB on SolidFire simplifies deployment and maintenance. When combined with the available throughput and low-latency characteristics that SolidFire technology provides, this configuration offers an optimal storage solution for nearly any type of MongoDB use case. This guide gives you the basic steps and best practices for setting up a high-performing MongoDB instance on SolidFire storage volumes. NetApp SolidFire storage systems have the following capabilities to support your next-generation data center needs:

- Thin provisioning
- Compression and deduplication
- QoS

These features reduce the amount of storage space that is required without affecting performance. You can use these features with various database use cases.

1.1 Thin Provisioning

SolidFire uses granular 4K thin provisioning that does not require any reserve space, which increases effective capacity by consuming less space. This feature increases efficiency and reduces overhead by using the smallest allocation possible and by maintaining alignment with the native 4KB allocation format that modern operating systems use.

Because SolidFire volumes do not use any reserve space, you can deploy a volume capacity for the estimated maximum size of the database. You can therefore purchase just enough physical hardware to support the actual space that is consumed by the database. As database space consumption approaches the physical limits of the installed cluster, you can dynamically add nodes to the cluster to increase its physical capacity. This process is completely transparent to the database and does not require downtime or reconfiguration of the operating system or the database.

Furthermore, SolidFire Helix® replication automatically redistributes existing data over the added nodes to create optimal load balancing of both existing and new data. With this deployment paradigm, you can configure logical storage capacity once for the lifetime of the supported databases rather than using incremental updates that depend on the needs of the database.

1.2 Compression and Deduplication

Each SolidFire node includes a PCIe NVRAM card that serves as a write cache. When a host sends writes, they are divided into 4KB blocks that are immediately compressed, hashed, and stored in the NVRAM of the two storage nodes before an acknowledgment is returned. The resulting value serves as a BlockID that determines block placement and that is randomly distributed across all nodes to create an even load distribution.

The SolidFire Deduplication Block Service identifies blocks that have previously been written based on the BlockID. If a block already exists, metadata is updated accordingly and the duplicate is discarded. The whole process is inline and global to the storage cluster.

The combination of inline compression and global deduplication has the following advantages:

- Reduced repetitive writes to media, prolonging drive life

- Increased system performance by minimizing system resources
- Evenly distributed capacity and performance loads across the system, eliminating hot spots

1.3 Quality of Service (QoS)

NetApp SolidFire storage arrays present performance and capacity as dynamic, independent pools. This feature enables administrators to set the performance requirements for all the databases or tenants that are hosted on the same cluster. The minimum, maximum, and burst control settings in the QoS policy guarantee the required performance and can be dynamically changed anytime. If the SolidFire hardware resources are pushed to their physical limits, more nodes can be added to the existing cluster. SolidFire Helix data distribution automatically redistributes data for optimal load balancing over all hardware resources. This process is transparent to upstream applications.

2 Application Use Cases

NetApp SolidFire can support a wide range of database application use cases, including OLTP, decision support systems (DSS), database consolidation, data protection, disaster recovery, development, testing, and quality assurance. This section shows how to identify when applications are a good fit for SolidFire. It also reviews the innovative benefits of SolidFire to these applications.

2.1 Database Consolidation

NetApp SolidFire provides an optimal storage system for database consolidation. The per-volume QoS controls of SolidFire help individual databases get the I/O throughput that they need without being affected by other databases that run in parallel on the same storage system. With QoS and data reduction efficiencies, you can achieve higher database density within the shared storage infrastructure. The use case of deploying hundreds of individual databases is an excellent fit for SolidFire.

With SolidFire, you can use a single LUN to provision all the data files. Because the maximum size of a SolidFire LUN is 8TB, however, the size of the database must be under 7TB. This configuration can achieve the required performance levels without spreading datafiles across multiple volumes, controllers, and arrays. SolidFire QoS provides guaranteed performance for each database. You do not need to use complex logical volume manager (LVM) configurations to consolidate multiple LUNs or volumes to meet the performance needs of your business.

2.2 Data Protection and Disaster Recovery

SolidFire Helix data protection is a distributed replication algorithm that spreads two redundant copies of data across all drives within the entire cluster. The shared-nothing architecture of SolidFire creates no single point of failure and can absorb multiple failures. The combined storage efficiency and QoS of SolidFire provides a compelling disaster recovery solution that enables the sharing of the same storage resources for disaster recovery and testing and development without performance penalties.

2.3 Development and Testing

Storage snapshots provide a point-in-time view of the contents of an active file system or storage volume. You can use these snapshots for rapid recovery of corrupted datasets and to create space-efficient copies of datasets for development and testing use cases. The cloning process can be coupled with SolidFire QoS control so that database clones can coexist with the production copies without any performance effects on upstream applications.

The CopyVolume feature of NetApp SolidFire allows you to refresh an existing cloned copy of a database without performing any file system remount operations. In this use case, you frequently refresh a copy of the database by only taking changes from the production copy.

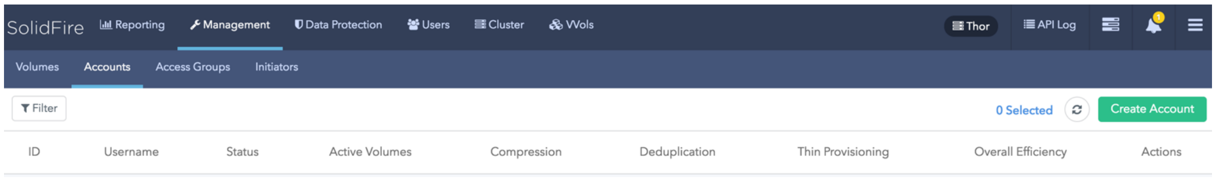
3 Storage Configuration

This section shows how to configure NetApp SolidFire volumes to support a MongoDB application. NetApp recommends that you have all the MongoDB data files, configuration files, and journal files on the SolidFire storage array. NetApp supports presenting the storage in a 4K sector size (native mode) and in a 512-byte sector size (512e). Testing shows no performance effect from choosing emulation mode as long as there is no partition misalignment at the host level.

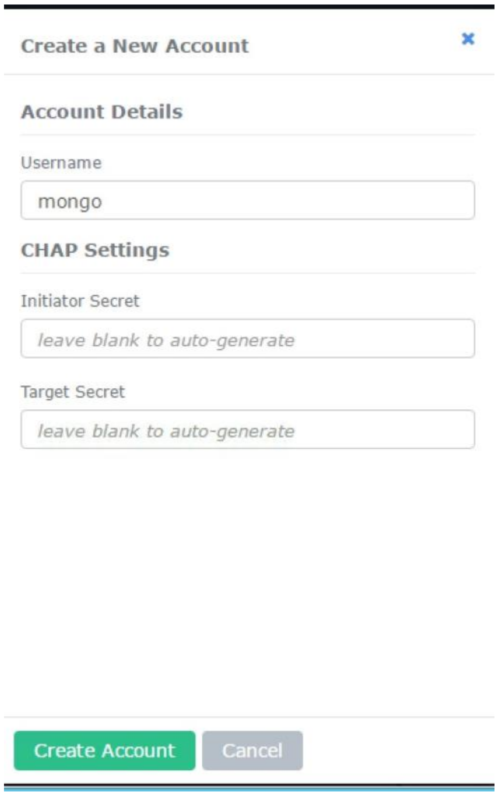
3.1 Create an Account

To create an account, complete the following steps:

1. Log in to the NetApp SolidFire Element® OS web UI.
2. Select Management → Accounts. The Account List window opens.



3. Click Create Account. The Create a New Account window opens.


Create a New Account

Account Details

Username: mongo

CHAP Settings

Initiator Secret: leave blank to auto-generate

Target Secret: leave blank to auto-generate

4. Enter a user name.
5. In the CHAP Settings section, fill in the following fields:
   – Initiator Secret for CHAP node session authentication
   – Target Secret for CHAP node session authentication

Note: Leave the credentials field blank if you want passwords to be generated automatically.

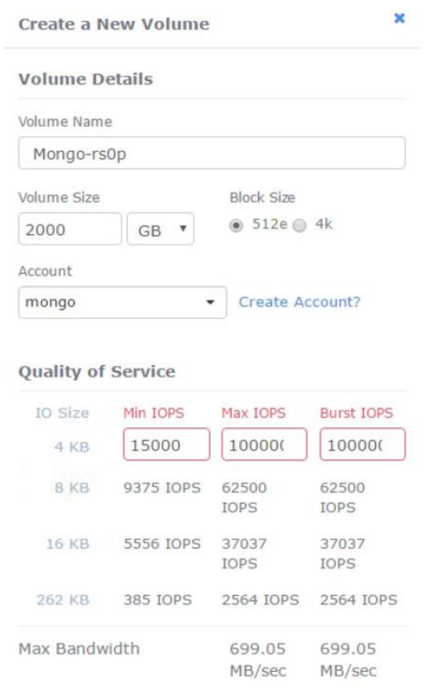
6. Click Create Account.

   Note: If an account with the same name exists, you get an error message.

3.2 Create a Volume

To create a volume, complete the following steps:

1. Log in to the Element OS web UI.
2. Select Management → Volumes. The Volumes List window opens.
3. Click Create Volume. The Create a New Volume window opens.



Volume Name: Mongo-rs0p

Volume Size: 2000 GB

Block Size: [✓ 512e] 4k

Account: mongo

IO Size	Min IOPS	Max IOPS	Burst IOPS
4 KB	15000	10000(	10000(
8 KB	9375 IOPS	62500 IOPS	62500 IOPS
16 KB	5556 IOPS	37037 IOPS	37037 IOPS
262 KB	385 IOPS	2564 IOPS	2564 IOPS
Max Bandwidth		699.05 MB/sec	699.05 MB/sec

4. Enter the volume name (1 to 64 characters in length). For example, enter the name `Mongo-rs0p`.
5. Enter the size of the volume.
6. Click the Account drop-down list and select the account that should have access to the volume. In this case, select mongo.
7. Set the Quality of Service values according to your requirements.

   Note: The sliders can be used to adjust the IOPS values, or you can click the number field to enter the desired IOPS values. For Mongo-rs0p, the following values were chosen for the QoS settings: maximum = 100,000, minimum = 15,000, and burst = 100,000.

8. Click Create Volume.
9. Repeat steps 1 through 7 for all volumes that are part of the MongoDB.

3.3 Create Volume Access Groups

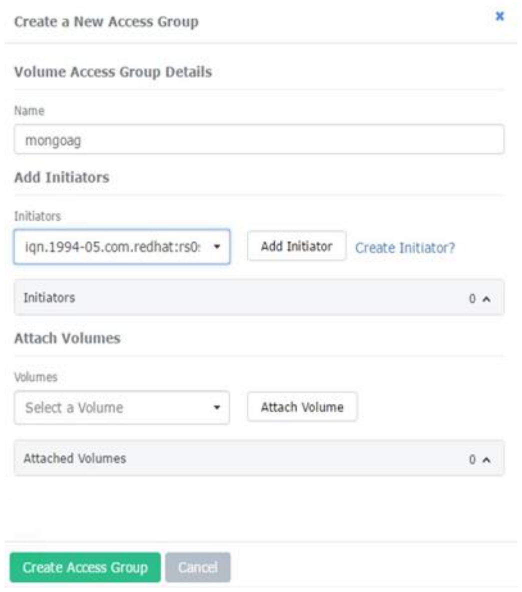
Volume access groups limit connectivity from designated host servers based on a unique identifier, whereas CHAP authentication uses secret keys for unidirectional or bidirectional authentication. In this document, initiator iSCSI Qualified Names (IQNs) are used to access the volumes.

Volume access groups have the following system limits:

- They can have a maximum of 64 IQNs.
- An IQN can belong to only one access group.
- A single volume can belong to a maximum of four access groups.

To create volume access groups, complete the following steps:

1. Log in to the Element OS web UI.
2. Select Management → Access Groups. The Access Group window opens.
3. Click Create Access Group. The Create a New Access Group window opens.



Name: mongoag

Initiators: iqn.1994-05.com.redhat:rs0:

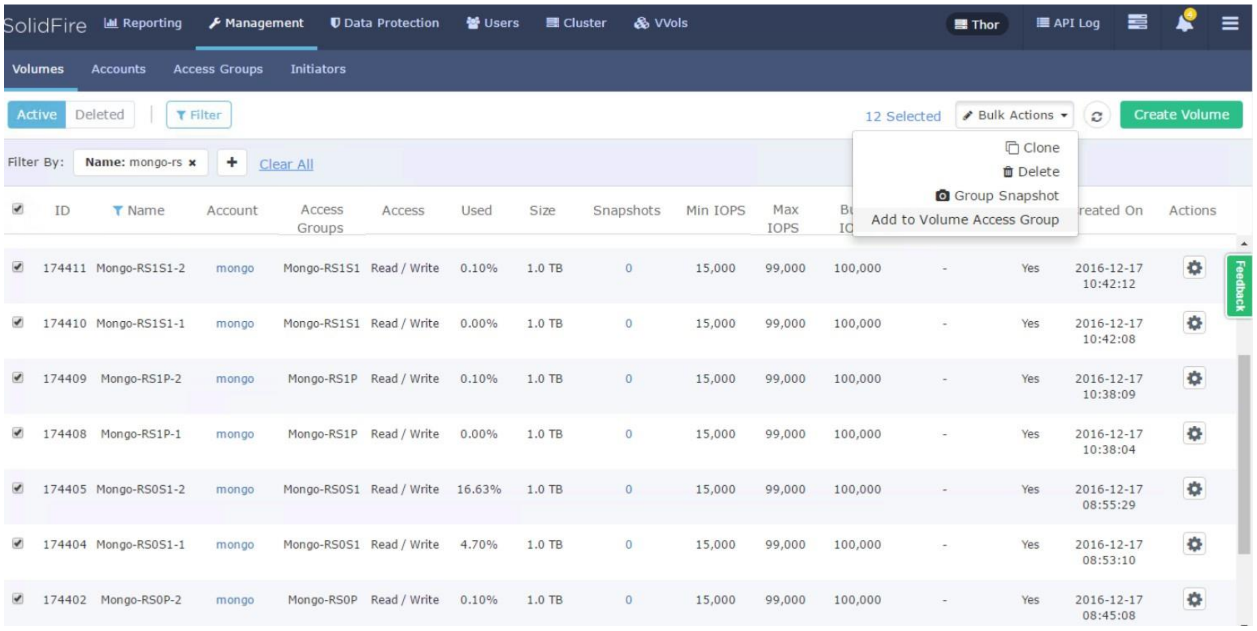
Initiators 0

Volumes: Select a Volume

Attached Volumes 0

4. Enter a name for the volume access group.
5. Select the IQN from the initiator drop-down or click Create Initiator.

   Note: Multiple IQNs are listed for shared cluster setup, depending on the number of nodes.
6. Click Create Access Group.
7. Add the volumes to the access group by selecting Management→Volumes.
8. Select the checkbox to the left of each volume.
9. Near the Create Volume button, click the Bulk Actions drop-down.



✓	ID	Name	Account	Access Groups	Access	Used	Size	Snapshots	Min IOPS	Max IOPS	Bu IO			reated On	Actions
✓	174411	Mongo-RS1S1-2	mongo	Mongo-RS1S1	Read / Write	0.10%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 10:42:12	⚙
✓	174410	Mongo-RS1S1-1	mongo	Mongo-RS1S1	Read / Write	0.00%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 10:42:08	⚙
✓	174409	Mongo-RS1P-2	mongo	Mongo-RS1P	Read / Write	0.10%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 10:38:09	⚙
✓	174408	Mongo-RS1P-1	mongo	Mongo-RS1P	Read / Write	0.00%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 10:38:04	⚙
✓	174405	Mongo-RS0S1-2	mongo	Mongo-RS0S1	Read / Write	16.63%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 08:55:29	⚙
✓	174404	Mongo-RS0S1-1	mongo	Mongo-RS0S1	Read / Write	4.70%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 08:53:10	⚙
✓	174402	Mongo-RS0P-2	mongo	Mongo-RS0P	Read / Write	0.10%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2016-12-17 08:45:08	⚙

10. Click Add to Volume Access Group. The Add to Volume Access Group window opens.
11. Select the previously created volume access group from the drop-down list.
12. Click Add to join the selected volumes to the target group.

The MongoDB volumes are now listed as part of the selected volume access group and are ready to be mapped to the host operating system.

Note: For this configuration, two SolidFire volumes were chosen for each MongoDB replica and an LVM configuration was used to stripe data across both volumes. For a web-scale deployment with hundreds of databases, NetApp recommends that you configure one volume for an individual MongoDB replica and that you control performance with the QoS settings.

4 Operating System Configuration

The guidelines in this document apply to Red Hat Enterprise Linux 7.x distributions of the MongoDB Enterprise edition. Alternate distributions can be used, assuming that they have full compatibility with the MongoDB software.

4.1 Add MongoDB Packages

After installing the base operating system, you might need to add more packages to update the operating system to meet MongoDB installation requirements. For information about how to meet these requirements, see the latest MongoDB documentation.

4.2 Update Kernel Parameters

Update the kernel parameters for your host operating system to the following values:

```
vm.dirty_ratio = 15
vm.dirty_background_ratio = 5
vm.swappiness = 1
net.core.somaxconn = 4096
net.ipv4.tcp_fin_timeout = 30
net.ipv4.tcp_keepalive_intvl = 30
net.ipv4.tcp_keepalive_time = 120
net.ipv4.tcp_max_syn_backlog = 4096
```

4.3 Optimize Network Performance

Consider the following guidelines for optimal network performance:

- Enable jumbo frames for all host network interfaces.
- To isolate the data traffic, configure the interface that is used for the MongoDB data traffic with a different subnet from the public network.

4.4 Optimize iSCSI Parameters

The Linux iSCSI initiator configuration works with NetApp SolidFire volumes in its default configuration. To maximize system throughput, increase the number of sessions per target (`nr_sessions`) from the default of `1` to `8`.

1. Make the following changes to the iSCSI daemon in the `/etc/iscsi/iscsid.conf` file:

```
iscsid.startup = /etc/rc.d/init.d/iscsid force-start
node.startup = automatic
node.leading_login = No
node.session.timeo.replacement_timeout = 120
node.conn[0].timeo.login_timeout = 15
node.conn[0].timeo.logout_timeout = 15
node.conn[0].timeo.noop_out_interval = 5
node.conn[0].timeo.noop_out_timeout = 5
node.session.err_timeo.abort_timeout = 15
node.session.err_timeo.lu_reset_timeout = 30
node.session.err_timeo.tgt_reset_timeout = 30
node.session.initial_login_retry_max = 8
node.session.cmds_max = 128
node.session.queue_depth = 32
node.session.xmit_thread_priority = -20
node.session.iscsi.InitialR2T = No
node.session.iscsi.ImmediateData = Yes
node.session.iscsi.FirstBurstLength = 262144
node.session.iscsi.MaxBurstLength = 16776192
node.conn[0].iscsi.MaxRecvDataSegmentLength = 262144
node.conn[0].iscsi.MaxXmitDataSegmentLength = 0
discovery.sendtargets.iscsi.MaxRecvDataSegmentLength = 32768
node.conn[0].iscsi.HeaderDigest = None
node.session.iscsi.FastAbort = Yes
node.startup = automatic
node.session.nr_sessions = 8
```

2. Make discovery of iSCSI devices persistent over reboots.

```
chkconfig iscsid
```

3. To rescan the new storage volumes, run the following commands:

```
iscsiadm -m discovery -t sendtargets -p <SolidFire SVIP> --op update –n node.session.nr_sessions
–v 2
iscsiadm -m node -L all
```

4.5 Tune the I/O Scheduler

Run the following commands to tune the Linux operating system to take advantage of the performance characteristics of the SolidFire storage system (`<devpath>` is the device name).

```
echo 0 > /sys/<devpath>/queue/rotational
echo noop > /sys/<devpath>/queue/scheduler
echo 128 > /sys/<devpath>/queue/nr_requests
echo 2 > /sys/<devpath>/queue/rq_affinity
echo 0 > /sys/<devpath>/queue/add_random
```

4.6 Configure the Multipath Driver

Configure the Linux multipath driver (`multipathd`) by making the following changes to the `/etc/multipath.conf` file.

```
defaults {
        user_friendly_names yes
}

devices {
       device {
                vendor "SolidFir"
                product "SSD SAN"
               path_grouping_policy multibus
               path_checker tur
               hardware_handler  "0"
               failback immediate
               rr_weight uniform
               rr_min_io 10
               rr_min_io_rq 10
               features "0"
               no_path_retry 24
               prio const
                }
         }
```

Optionally, you can enable persistent mapping of `/dev/mapper` entries by associating the NetApp SolidFire storage system device's worldwide identifier (WWID) with a specific operating system alias. For this option, make the following additions to the `/etc/multipath.conf` file:

```
multipaths {

multipath {
wwid 36f47acc100000000707a646c000003b1
alias mongo-rs0p-disk1
}

multipath {
wwid 36f47acc100000000707a646c00000003
alias mongo-rs0p-disk2
}
}
```

4.7 Enable Multipathing

To enable multipathing, run the following command:

```
systemctl enable multipathd.service
```

You can check the status of the multipath daemon with the following command:

```
systemctl list-unit-files|grep multipath
multipathd.service     enabled
```

4.8 Set Up a Logical Volume Manager (LVM)

To set up an LVM to stripe the data across multiple SolidFire volume devices, complete the following steps:

1. Create a volume group by using the multipath devices `mpatha` and `mpathb`.

```
vgcreate mongovg /dev/mapper/mpatha /dev/mapper/mpathb
```

2. Create a logical volume on this volume group.

```
lvcreate -l 100%FREE -n mongolv mongovg
```

3. Create an XFS file system.

```
mkfs.xfs /dev/mongovg/mongolv
```

4. Create a database directory path for the MongoDB replicas and mount the file system.

```
mkdir -p /data/db/
mount -t xfs -o nobarrier,discard,noatime /dev/mongovg/mongolv /data/db/
```

Before you install MongoDB, you should set appropriate permissions so that the `mongod` user can access the devices on the SolidFire system. You can set permissions on multipath devices by creating a `udev` rule file that allows appropriate access to the devices.

4.9 Set Ulimits

The architecture of MongoDB delegates memory and paging functionality to the operating system. Therefore, you should increase the `ulimit` open file settings from the default value of `4096`. In addition, you should set the number of allowed processes to an optimal value for MongoDB. Edit the `/etc/security/limits.conf` file by adding the following `ulimit` values:

```
mongod soft nproc 64000
mongod hard nproc 64000
mongod soft nofile 64000
mongod hard nofile 64000
```

5 MongoDB Configuration

5.1 Install MongoDB Enterprise

The server that performs the installations should be configured to the Red Hat distribution so that the appropriate MongoDB installation files and any other dependencies can be installed. For this installation, version 3.4 was chosen. For information about the latest stable release, see the MongoDB documents before you start the installation process.

To install the software, complete the following steps:

1. Configure the `yum` repository.

   Create an `/etc/yum.repos.d/mongodb-enterprise.repo` file by copying the following commands so that the MongoDB Enterprise packages can be installed directly by using `yum`.

```
name=MongoDB Enterprise Repository
baseurl=https://repo.mongodb.com/yum/redhat/$releasever/mongodb-enterprise/3.4/$basearch/
gpgcheck=1
enabled=1 gpgkey=https://www.mongodb.org/static/pgp/server-3.4.asc
```

2. Install MongoDB Enterprise.
3. Install the MongoDB Enterprise packages and dependencies by using the `yum` command.

```
yum install -y mongodb-enterprise
```

4. Configure the MongoDB instance.

   `/etc/mongod.conf` is used to configure the MongoDB instance. The settings might differ based on the installations. For an example, see Appendix A.
5. Start MongoDB instances.

   Use the `systemctl` command to start the MongoDB instance. Verify that the logs that are available in `/var/log/mongodb/mongod.log` do not have any errors.
6. Start the replica, config, and Mongos/query router servers.

```
systemctl start mongod
```

7. Set up all the remaining replica servers, the config servers, and the Mongos/query router servers that are part of the shared cluster by following section 4 and section 5.1 (steps 1 through 8) of this report.
8. Start the mongo Shell.

   After the MongoDB instance is up and running, you can create replica sets for each shard. For this setup, three replica sets (one primary and two secondary) were configured on each shard, and a total of four shards were configured. To create the replica `rs0p`, run the mongo Shell with the following command:

```
mongo --host mongo-rs0p
```

9. Create a replica set.

   To create the replica set `rs0`, run the following commands in the mongo Shell. You can check the status of the replica set by running the `rs.status()` command in the mongo Shell. A sample output is given in Appendix B.

```
rs.initiate()
rs.add("mongo-rs0s1")
rs.add("mongo-rs0s2")
```

10. Set up MongoDB shards.

    Repeat steps 8 and 9 in this section to create the other replicas that are part of the shards. After you have created all the replicas for the shards, you should set up config servers and the query router, which are needed only during sharding.
11. Start `mongo shell` on the config server.

    Configure the replica set on the config servers. For this setup, three config servers were used to create the replica set with one primary and two secondary. To execute the mongo Shell, run the following command:

```
mongo --host mongo-c1
```

12. Create a replica set on the config servers.

    To create the replica set `rs0`, run the following command in the mongo Shell. You can check the status of the replica set by running the command `rs.status()` in the mongo Shell. A sample output is given in Appendix C. Also, a sample `mongod.conf` is also given in Appendix C for the `configReplSet`.

```
rs.initiate( {
_id: "configReplSet", configsvr: true, members: [
{ _id: 0, host: "mongo-c1:27019" },
{ _id: 1, host: "mongo-c2:27019" },
{ _id: 2, host: "mongo-c3:27019" }
]
} )
```

13. Start the `mongo shell` on the Mongos server.

    For this setup, two Mongos servers were used to run the workload. To start the mongo Shell, run the following command:

```
mongo --host mongo-q1:27107
```

14. Add the shard replica set.

    To add the shard replica sets to the Mongos instance, run the following commands in the mongo Shell. You can check the status of the replica set by running the `sh.status()` command in the Mongo Shell. Adding any one of the servers in a replica set adds all instances in that replica set. For this setup, the primary replica set name was used to add the shards. A sample output is provided in Appendix D. Also, a sample `mongod.conf` is provided in Appendix D for the Mongos instance.

```
sh.addShard("rs0/mongo-rs0p:27017")
sh.addShard("rs1/mongo-rs1p:27017")
sh.addShard("rs2/mongo-rs2p:27017")
sh.addShard("rs3/mongo-rs3p:27017")
```

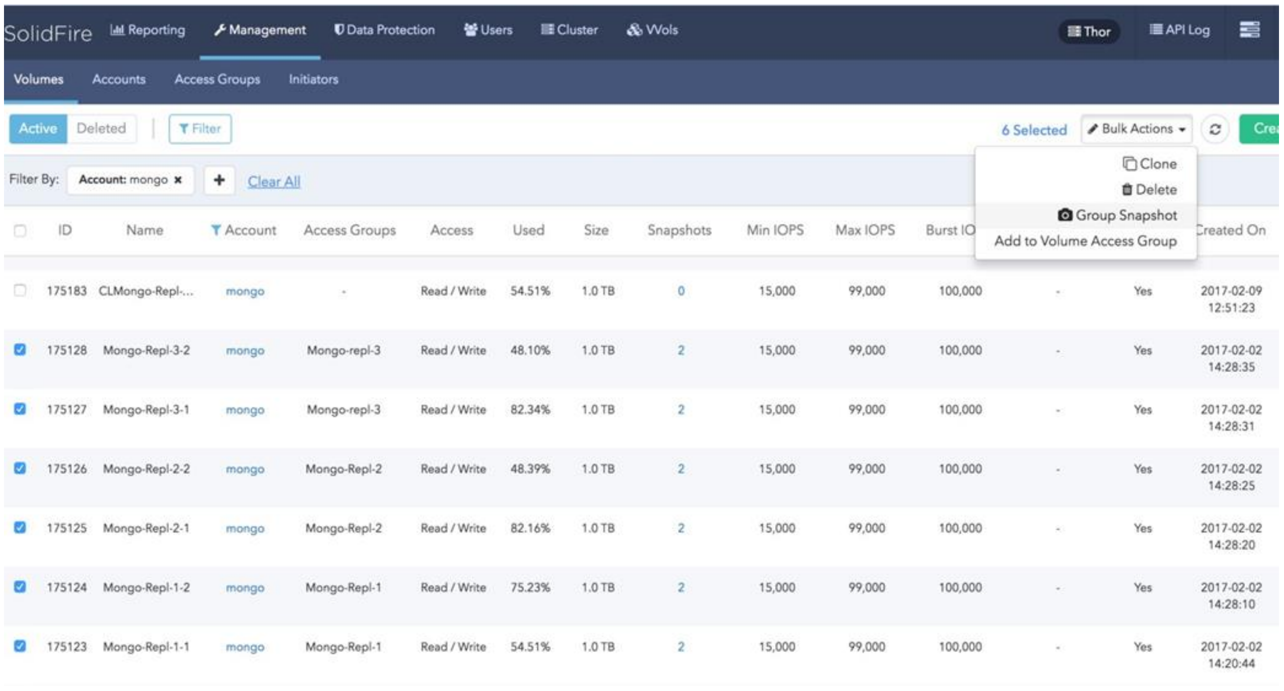
6 Backup and Recovery by Using Storage Snapshots

You can take point-in-time (PIT) snapshots of the volumes that are part of the MongoDB cluster. You can use the snapshots to recover the database if data corruption or media failure occurs. Both data and journal files can be in the same NetApp SolidFire volume for the PIT recovery to work. SolidFire supports having multiple volumes for the MongoDB database, and all volumes that are part of the database have the same consistency point during the group snapshot.

6.1 Create Snapshots (Backup)

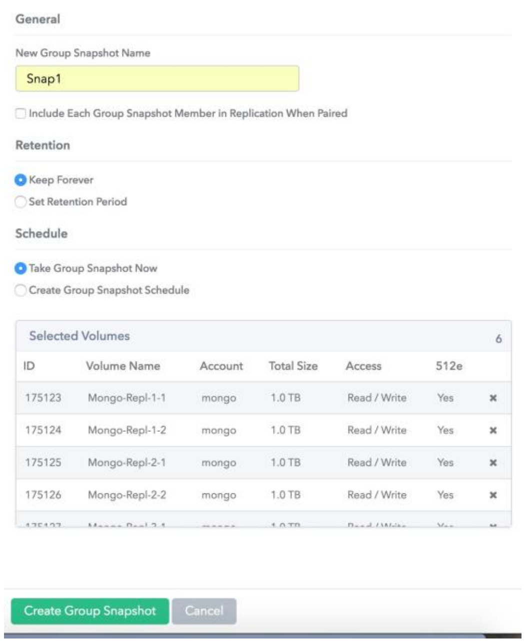
To create backup snapshots, complete the following steps:

1. Log in to the SolidFire Element OS web UI.
2. Select Management → Volumes. The Volumes List window opens.
3. Select the volumes that are part of the database.
4. Select Bulk Actions → Group Snapshot.



	ID	Name	Account	Access Groups	Access	Used	Size	Snapshots	Min IOPS	Max IOPS	Burst IO			Created On
☐	175183	CLMongo-Repl-...	mongo	-	Read / Write	54.51%	1.0 TB	0	15,000	99,000	100,000	-	Yes	2017-02-09 12:51:23
✓	175128	Mongo-Repl-3-2	mongo	Mongo-repl-3	Read / Write	48.10%	1.0 TB	2	15,000	99,000	100,000	-	Yes	2017-02-02 14:28:35
✓	175127	Mongo-Repl-3-1	mongo	Mongo-repl-3	Read / Write	82.34%	1.0 TB	2	15,000	99,000	100,000	-	Yes	2017-02-02 14:28:31
✓	175126	Mongo-Repl-2-2	mongo	Mongo-Repl-2	Read / Write	48.39%	1.0 TB	2	15,000	99,000	100,000	-	Yes	2017-02-02 14:28:25
✓	175125	Mongo-Repl-2-1	mongo	Mongo-Repl-2	Read / Write	82.16%	1.0 TB	2	15,000	99,000	100,000	-	Yes	2017-02-02 14:28:20
✓	175124	Mongo-Repl-1-2	mongo	Mongo-Repl-1	Read / Write	75.23%	1.0 TB	2	15,000	99,000	100,000	-	Yes	2017-02-02 14:28:10
✓	175123	Mongo-Repl-1-1	mongo	Mongo-Repl-1	Read / Write	54.51%	1.0 TB	2	15,000	99,000	100,000	-	Yes	2017-02-02 14:20:44

5. In the Create Group Snapshot window, enter a name for the snapshot (`Snap1` in this case).
6. Set the desired retention time.
7. Select Take Group Snapshot Now. You can schedule the snapshot by using the option Create Group Snapshot Schedule.
8. Scroll to the bottom, and click Create Group Snapshot.



General

New Group Snapshot Name: Snap1

Include Each Group Snapshot Member in Replication When Paired

Retention

[✓ Keep Forever] Set Retention Period

Schedule

[✓ Take Group Snapshot Now] Create Group Snapshot Schedule

Selected Volumes 6

ID	Volume Name	Account	Total Size	Access	512e
175123	Mongo-Repl-1-1	mongo	1.0 TB	Read / Write	Yes
175124	Mongo-Repl-1-2	mongo	1.0 TB	Read / Write	Yes
175125	Mongo-Repl-2-1	mongo	1.0 TB	Read / Write	Yes
175126	Mongo-Repl-2-2	mongo	1.0 TB	Read / Write	Yes

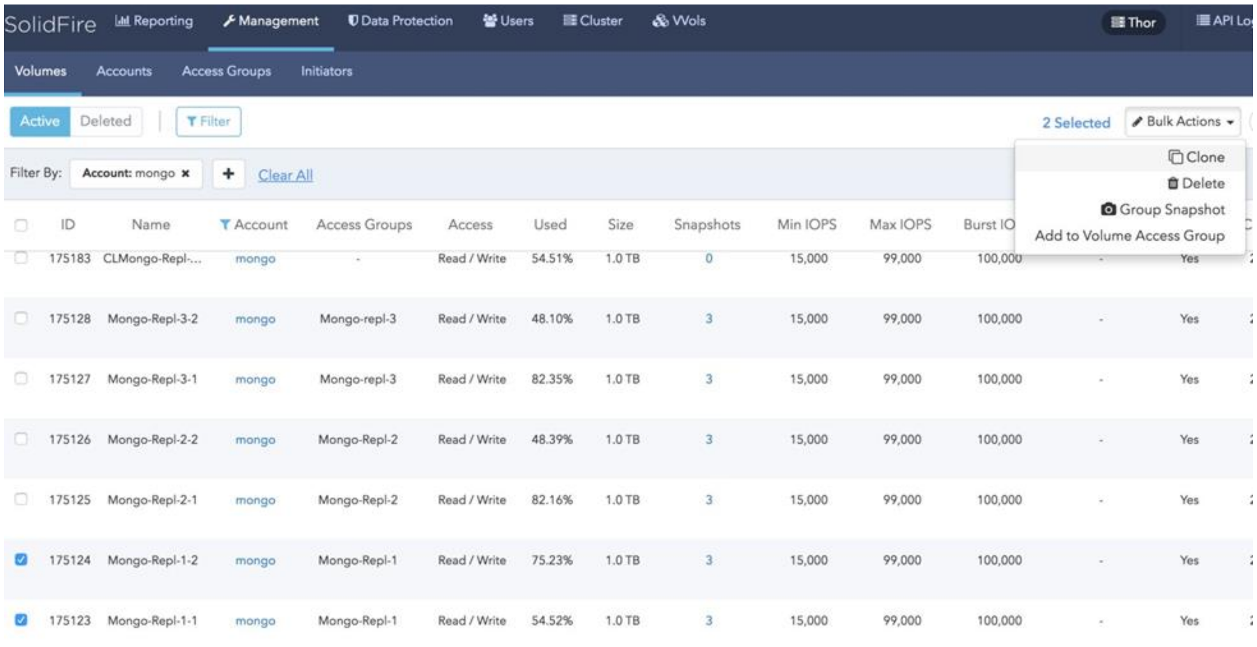
6.2 Restore Snapshots (Recovery)

You can perform database recovery by reverting the volumes on the SolidFire system with a snapshot. To recover the database, complete the following steps:

1. Log in to the MongoDB cluster, stop all the `mongod` instances, and unmount the file systems that are part of the database.

```
systemctl stop mongod
unmount /data/db
```

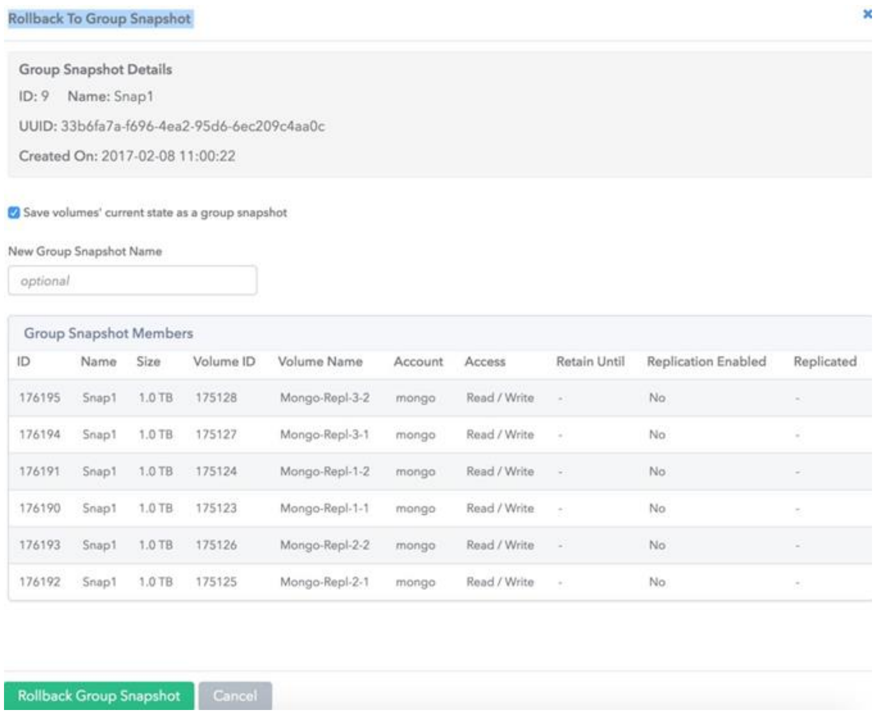
   a. Log in to the SolidFire Element OS UI.
   b. Select Data Protection→ Group Snapshots. The Group Snapshot list opens.



Filter By: Account: mongo Clear All

ID	Name	Account	Access Groups	Access	Used	Size	Snapshots	Min IOPS	Max IOPS	Burst IO		
175183	CLMongo-Repl-...	mongo	-	Read / Write	54.51%	1.0 TB	0	15,000	99,000	100,000	-	Yes
175128	Mongo-Repl-3-2	mongo	Mongo-repl-3	Read / Write	48.10%	1.0 TB	3	15,000	99,000	100,000	-	Yes
175127	Mongo-Repl-3-1	mongo	Mongo-repl-3	Read / Write	82.35%	1.0 TB	3	15,000	99,000	100,000	-	Yes
175126	Mongo-Repl-2-2	mongo	Mongo-Repl-2	Read / Write	48.39%	1.0 TB	3	15,000	99,000	100,000	-	Yes
175125	Mongo-Repl-2-1	mongo	Mongo-Repl-2	Read / Write	82.16%	1.0 TB	3	15,000	99,000	100,000	-	Yes
✓ 175124	Mongo-Repl-1-2	mongo	Mongo-Repl-1	Read / Write	75.23%	1.0 TB	3	15,000	99,000	100,000	-	Yes
✓ 175123	Mongo-Repl-1-1	mongo	Mongo-Repl-1	Read / Write	54.52%	1.0 TB	3	15,000	99,000	100,000	-	Yes

2. Select the volumes that are part of the database:
   a. Select Bulk Actions → Group Snapshot.
   b. Click Actions.
   c. Select Rollback Volumes to Group Snapshot. The Rollback to Group Snapshot window opens.



Rollback To Group Snapshot

Group Snapshot Details

ID: 9   Name: Snap1

UUID: 33b6fa7a-f696-4ea2-95d6-6ec209c4aa0c

Created On: 2017-02-08 11:00:22

☑ Save volumes' current state as a group snapshot

New Group Snapshot Name: optional

Group Snapshot Members

ID	Name	Size	Volume ID	Volume Name	Account	Access	Retain Until	Replication Enabled	Replicated
176195	Snap1	1.0 TB	175128	Mongo-Repl-3-2	mongo	Read / Write	-	No	-
176194	Snap1	1.0 TB	175127	Mongo-Repl-3-1	mongo	Read / Write	-	No	-
176191	Snap1	1.0 TB	175124	Mongo-Repl-1-2	mongo	Read / Write	-	No	-
176190	Snap1	1.0 TB	175123	Mongo-Repl-1-1	mongo	Read / Write	-	No	-
176193	Snap1	1.0 TB	175126	Mongo-Repl-2-2	mongo	Read / Write	-	No	-
176192	Snap1	1.0 TB	175125	Mongo-Repl-2-1	mongo	Read / Write	-	No	-

3. Click Rollback Group Snapshot.
4. After the volume is successfully reverted, log in to the MongoDB instances.
5. Mount the file systems backup and start the `mongod` instance.

```
mount /data/db
systemctl start mongod
```

6. Check for any errors in the logs.

7 MongoDB Database Cloning

NetApp SolidFire volume cloning technology helps database and system administrators deliver a near-instantaneous, space-efficient, point-in-time copy of the production database. The SolidFire volume cloning process is completed very quickly, with virtually no performance effect on the production system. The cloned database is similar to the primary replica copy of a MongoDB database in all aspects, and it does not consume extra disk space at the time of creation.

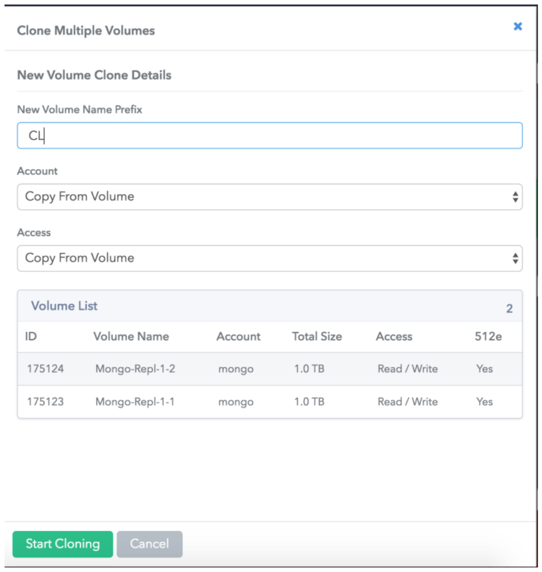
If the secondary replica copy is corrupted or if you want to add another secondary copy of the MongoDB instance, perform the steps in section 7.1.

7.1 Clone a Volume

To clone a volume, complete the following steps:

1. Log in to the SolidFire Element OS UI.
2. Select Management → Volumes → Select the Volumes for Cloning.

3. Select Bulk Actions → Clone. The Clone Multiple Volumes window opens.
4. Enter a prefix (`CL` for this example).
5. Give the account and access information, depending on what access you need for the clone volumes.


Clone Multiple Volumes

New Volume Clone Details

New Volume Name Prefix: CL

Account: Copy From Volume

Access: Copy From Volume

Volume List 2

ID	Volume Name	Account	Total Size	Access	512e
175124	Mongo-Repl-1-2	mongo	1.0 TB	Read / Write	Yes
175123	Mongo-Repl-1-1	mongo	1.0 TB	Read / Write	Yes

6. Click Start Cloning.
7. After the clone process is complete, add the newly created volumes to the volume access group of the secondary Mongo host or a new host.
8. Log in to the secondary or new host.
9. Rescan the iSCSI devices to present the newly cloned volumes.

```
iscsiadm -m discovery -t sendtargets -p <SolidFire SVIP> --op update -n node.session.nr_sessions
-v 2 -> where "n" is the number of paths
iscsiadm -m node -L all
```

10. Create the mount point and mount the file system.

```
mkdir -p /data/db
mount -t xfs -o nobarrier,discard,noatime /dev/mongovg/mongolv /data/db
```

11. Start the MongoDB instance.

```
systemctl start mongod
```

12. Start Mongo Shell on the primary replica.

    To add the newly created clone as a replica, start the mongo Shell on the primary instance.

```
mongo --host mongo-rs0p
```

13. Add the new replica set.

    To add the newly created clone to the replica set `rs0`, run the command inside the mongo Shell.

```
rs.add("mongo-rs0s3")
```

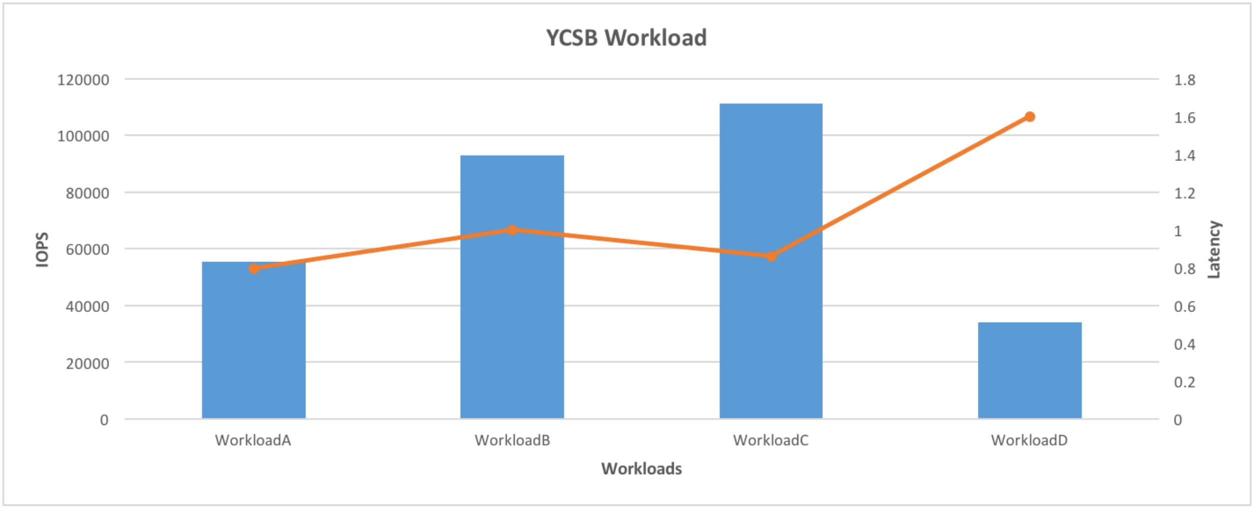
14. To check the status of the newly added replica, run the command in themongo Shell. Also check the logs to make sure that there are no errors.

```
rs.status()
```

8 Workload Testing

The MongoDB setup was validated by running a Yahoo! Cloud Serving Benchmark (YCSB) workload on a single replica. YCSB is not designed to generate storage-centric workloads. However, it has been used extensively by other storage vendors to evaluate MongoDB performance. YCSB was executed from a single client server, and the number of threads of YCSB was increased to an optimal number to get the maximum IOPS and the lowest latency for this setup. All data points were collected from the YCSB output to plot the graph in Figure 1.

Figure 1) YCSB workload.



9 Summary

NetApp SolidFire offers an optimal storage system for database applications that use all-flash media to provide performance, capacity, thin provisioning, per-volume QoS, inline deduplication, and compression. This architecture benefits system planners who are deploying and maintaining database applications that are similar to the use cases that are outlined in this report. You can find additional information on the SolidFire website. You can also contact SolidFire directly at info@solidfire.com.

Appendix A: mongod.conf File

```
# mongod.conf

# for documentation of all options, see:
#   http://docs.mongodb.org/manual/reference/configuration-options/

# where to write logging data.
systemLog:
  component:
    network:
      verbosity: 2
    storage:
      verbosity: 2
    replication:
      verbosity: 2
    sharding:
      verbosity: 2

  path: /var/log/mongodb/mongod.log
  logRotate: rename
  destination: file
  timeStampFormat: ctime

# Where and how to store data.
storage:
  dbPath: /data/db
  journal:
    enabled: false
  directoryPerDB: true
  engine: wiredTiger
  wiredTiger:
    engineConfig:
      journalCompressor: snappy
    collectionConfig:
      blockCompressor: snappy
    indexConfig:
      prefixCompression: true

# how the process runs
processManagement:
  fork: true  # fork and run in background
  pidFilePath: /var/run/mongodb/mongod.pid  # location of pidfile

# network interfaces
net:
  bindIp: mongo-rs0p
  port: 27017
  wireObjectCheck: true
  http:
    enabled: false
    JSONPEnabled: false
    RESTInterfaceEnabled: false

#security:
#operationProfiling:

replication:
  replSetName: rs0

sharding:
  clusterRole: shardsvr

## Enterprise-Only Options
#auditLog:
```

Appendix B: Output of rs.status() for a Shard Replica

```
rs.status()
{
        "set" : "rs0",
        "date" : ISODate("2017-01-30T20:53:41.070Z"),
        "myState" : 1,
        "term" : NumberLong(1),
        "heartbeatIntervalMillis" : NumberLong(2000),
        "optimes" : {
                "lastCommittedOpTime" : {
                        "ts" : Timestamp(0, 0),
                        "t" : NumberLong(-1)
                },
                "appliedOpTime" : {
                        "ts" : Timestamp(1485809621, 121),
                        "t" : NumberLong(1)
                },
                "durableOpTime" : {
                        "ts" : Timestamp(1485809558, 2539),
                        "t" : NumberLong(1)
                }
        },
        "members" : [
                {
                        "_id" : 0,
                        "name" : "mongo-rs0p:27017",
                        "health" : 1,
                        "state" : 1,
                        "stateStr" : "PRIMARY",
                        "uptime" : 23342,
                        "optime" : {
                                "ts" : Timestamp(1485809621, 121),
                                "t" : NumberLong(1)
                        },
                        "optimeDate" : ISODate("2017-01-30T20:53:41Z"),
                        "electionTime" : Timestamp(1485786316, 2),
                        "electionDate" : ISODate("2017-01-30T14:25:16Z"),
                        "configVersion" : 3,
                        "self" : true
                },
                {
                        "_id" : 1,
                        "name" : "mongo-rs0s1:27017",
                        "health" : 1,
                        "state" : 2,
                        "stateStr" : "SECONDARY",
                        "uptime" : 23290,
                        "optime" : {
                                "ts" : Timestamp(1485806570, 1477),
                                "t" : NumberLong(1)
                        },
                        "optimeDurable" : {
                                "ts" : Timestamp(0, 0),
                                "t" : NumberLong(-1)
                        },
                        "optimeDate" : ISODate("2017-01-30T20:02:50Z"),
                        "optimeDurableDate" : ISODate("1970-01-01T00:00:00Z"),
                        "lastHeartbeat" : ISODate("2017-01-30T20:53:39.951Z"),
                        "lastHeartbeatRecv" : ISODate("2017-01-30T20:53:40.752Z"),
                        "pingMs" : NumberLong(1),
                        "syncingTo" : "mongo-rs0p:27017",
                        "configVersion" : 3
                },
                {
                        "_id" : 2,
                        "name" : "mongo-rs0s2:27017",
                        "health" : 1,
                        "state" : 2,
                        "stateStr" : "SECONDARY",
                        "uptime" : 23287,
                        "optime" : {
                                "ts" : Timestamp(1485806803, 9174),
                                "t" : NumberLong(1)
                        },
                        "optimeDurable" : {
                                "ts" : Timestamp(0, 0),
                                "t" : NumberLong(-1)
                        },
                        "optimeDate" : ISODate("2017-01-30T20:06:43Z"),
                        "optimeDurableDate" : ISODate("1970-01-01T00:00:00Z"),
                        "lastHeartbeat" : ISODate("2017-01-30T20:53:39.231Z"),
                        "lastHeartbeatRecv" : ISODate("2017-01-30T20:53:39.155Z"),
                        "pingMs" : NumberLong(0),
                        "syncingTo" : "mongo-rs0p:27017",
                        "configVersion" : 3
                }
        ],
        "ok" : 1
}
```

Appendix C: Output of rs.status() for a Config Replica

```
MongoDB Enterprise configReplSet:PRIMARY> rs.status()
```

```
{
        "set" : "configReplSet",
        "date" : ISODate("2017-01-30T21:07:57.928Z"),
        "myState" : 1,
        "term" : NumberLong(1),
        "configsvr" : true,
        "heartbeatIntervalMillis" : NumberLong(2000),
        "optimes" : {
                "lastCommittedOpTime" : {
                        "ts" : Timestamp(1485810475, 3),
                        "t" : NumberLong(1)
                },
                "readConcernMajorityOpTime" : {
                        "ts" : Timestamp(1485810475, 3),
                        "t" : NumberLong(1)
                },
                "appliedOpTime" : {
                        "ts" : Timestamp(1485810475, 3),
                        "t" : NumberLong(1)
                },
                "durableOpTime" : {
                        "ts" : Timestamp(1485810475, 3),
                        "t" : NumberLong(1)
                }
        },
        "members" : [
                {
                        "_id" : 0,
                        "name" : "mongo-c1:27019",
                        "health" : 1,
                        "state" : 1,
                        "stateStr" : "PRIMARY",
                        "uptime" : 88152,
                        "optime" : {
                                "ts" : Timestamp(1485810475, 3),
                                "t" : NumberLong(1)
                        },
                        "optimeDate" : ISODate("2017-01-30T21:07:55Z"),
                        "electionTime" : Timestamp(1485722556, 1),
                        "electionDate" : ISODate("2017-01-29T20:42:36Z"),
                        "configVersion" : 1,
                        "self" : true
                },
                {
                        "_id" : 1,
                        "name" : "mongo-c2:27019",
                        "health" : 1,
                        "state" : 2,
                        "stateStr" : "SECONDARY",
                        "uptime" : 87932,
                        "optime" : {
                                "ts" : Timestamp(1485810475, 3),
                                "t" : NumberLong(1)
                        },
                        "optimeDurable" : {
                                "ts" : Timestamp(1485810475, 3),
                                "t" : NumberLong(1)
                        },
                        "optimeDate" : ISODate("2017-01-30T21:07:55Z"),
                        "optimeDurableDate" : ISODate("2017-01-30T21:07:55Z"),
                        "lastHeartbeat" : ISODate("2017-01-30T21:07:57.643Z"),
                        "lastHeartbeatRecv" : ISODate("2017-01-30T21:07:56.224Z"),
                        "pingMs" : NumberLong(0),
                        "syncingTo" : "mongo-c1:27019",
                        "configVersion" : 1
                },
                {
                        "_id" : 2,
                        "name" : "mongo-c3:27019",
                        "health" : 1,
                        "state" : 2,
                         "stateStr" : "SECONDARY",
                         "uptime" : 87932,
                         "optime" : {
                                 "ts" : Timestamp(1485810475, 3),
                                 "t" : NumberLong(1)
                         },
                         "optimeDurable" : {
                                 "ts" : Timestamp(1485810475, 3),
                                 "t" : NumberLong(1)
                         },
                         "optimeDate" : ISODate("2017-01-30T21:07:55Z"),
                         "optimeDurableDate" : ISODate("2017-01-30T21:07:55Z"),
                         "lastHeartbeat" : ISODate("2017-01-30T21:07:57.643Z"),
                         "lastHeartbeatRecv" : ISODate("2017-01-30T21:07:57.169Z"),
                         "pingMs" : NumberLong(0),
                         "syncingTo" : "mongo-c1:27019",
                         "configVersion" : 1
                 }
         ],
         "ok" : 1
}
```

Sample mongod.conf for the configReplSet

```
# mongod.conf

# for documentation of all options, see:
#   http://docs.mongodb.org/manual/reference/configuration-options/

# where to write logging data.
systemLog:
  destination: file
  logAppend: true
  path: /var/log/mongodb/mongod.log

# Where and how to store data.
storage:
  dbPath: /mongo-metadata
  journal:
    enabled: true
# how the process runs
processManagement:
  fork: true  # fork and run in background
  pidFilePath: /var/run/mongodb/mongod.pid  # location of pidfile

# network interfaces
net:
  port: 27019
  bindIp: mongo-c1



replication:
  replSetName: configReplSet

sharding:
  clusterRole: "configsvr"
```

Appendix D: Output of sh.status() for a mongos Instance

```
MongoDB Enterprise mongos> sh.status()
--- Sharding Status ---
  sharding version: {
        "_id" : 1,
        "minCompatibleVersion" : 5,
        "currentVersion" : 6,
        "clusterId" : ObjectId("588e53bdeb523d881aba55a6")
}
```

```
  shards:
        {  "_id" : "rs0",  "host" : "rs0/mongo-rs0p:27017,mongo-rs0s1:27017,mongo-rs0s2:27017",
"state" : 1 }
        {  "_id" : "rs1",  "host" : "rs1/mongo-rs1p:27017,mongo-rs1s1:27017,mongo-rs1s2:27017",
"state" : 1 }
        {  "_id" : "rs2",  "host" : "rs2/mongo-rs2p:27017,mongo-rs2s1:27017,mongo-rs2s2:27017",
"state" : 1 }
        {  "_id" : "rs3",  "host" : "rs3/mongo-rs3p:27017,mongo-rs3s1:27017,mongo-rs3s2:27017",
"state" : 1 }
  active mongoses:
        "3.4.1" : 1
 autosplit:
        Currently enabled: yes
  balancer:
        Currently enabled:  yes
        Currently running:  yes
                Balancer lock taken at Sun Jan 29 2017 15:42:37 GMT-0500 (EST) by
ConfigServer:Balancer
        Failed balancer rounds in last 5 attempts:  0
        Last reported error:  could not find host matching read preference { mode: "primary" }
for set rs0
        Time of Reported error:  Tue Jan 31 2017 09:10:58 GMT-0500 (EST)
        Migration Results for the last 24 hours:
                No recent migrations
  databases:
        {  "_id" : "ycsdb",  "primary" : "rs0",  "partitioned" : false }
```

mongos Config File

```
mongod.conf

# for documentation of all options, see:
#   http://docs.mongodb.org/manual/reference/configuration-options/

# where to write logging data.
systemLog:
  destination: file
  logAppend: true
  path: /var/log/mongodb/mongod.log

# how the process runs
processManagement:
  fork: true  # fork and run in background
  pidFilePath: /var/run/mongodb/mongod.pid  # location of pidfile

# network interfaces
net:
  port: 27017
  bindIp: mongo-q1

sharding:
  configDB: configReplSet/mongo-c1:27019,mongo-c2:27019,mongo-c3:27019
```

References

The following references were used in this TR:

- Configuring SolidFire on Linux for Element OS
  Error! Hyperlink reference not valid.

Version History

Version	Date	Document Version History
Version 1.0	June 2014	Initial document creation.

Version	Date	Document Version History
Version 2.0	June 2017	Refresh for NetApp SolidFire Element OS 9.x.

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.