



MongoDB Advanced Administrator Training

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1 Advanced Administrator

Advanced Administrator Course (page 2) Introduction to Ops Manager and installation

Lab: Ops Manager Installation (page 5) Introduction to Ops Manager and installation

Lab: Enable the Ops Manager Public API (page 13) Setting up API access in Ops Manager

Lab: Ops Manager User Administration (page 13) Managing groups and users in Ops Manager

Lab: Secure Replica Set (page 16) Deploy a secure replica set using Ops Manager

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1.1 Advanced Administrator Course

Learning Objectives

Upon completing this training, students should understand:

- How to install and configure a highly available Ops Manager deployment
- Understand all the necessary components and architecture choices for an Ops Manager deployment
- How to effectively manage clusters using Ops Manager
- How to deploy and operate secured MongoDB deployments

Note: You should be familiar with the tools to setup the hosts for this course. More details at:

- https://docs.google.com/document/d/1vhA6NvITsPe1rw_fb7N5NrYzJ78odiHWBd5yf9vPd64

For this workshop, we will group students into teams.

- There will be a maximum of 9 teams!

At this point you should have created the infrastructure for the students and be retrieving its configuration by running the following command that will create the /tmp/<run>* files with all the info about IPs, LBs, VPCs:

```
./describe.py --run <TRAINING-RUN> --out /tmp/advadmin
```

Hands-on Approach

This training is a full hands-on experience.

- You will be given access to a set of AWS instances.
- You are expected to work in teams. So you will be sharing a set of machines with your colleagues.
- All the necessary software will be available within those same instances
- However, all architecture decisions and configuration steps will be made by the students
- Use the instructor for guidance and advice but he should mostly be there for observation and time boxing the labs.

Note:

- show the students how many teams have been created

Expected Takeaways

There are a few important objectives that we want to accomplish by the end of this course:

- Understand the necessary infrastructure needed to run Ops Manager
- Understand the different architecture choices and their tradeoffs in different deployments
- Understand the different options that Ops Manager offers for backup
- Clear understanding of the benefits of using Ops Manager to manage different clusters
- Deploy secured, monitored, and fully managed infrastructure for your application

Note: Make sure the students understand that, for this completion of this course, they are expected to have a significant experience with MongoDB, and that we assume that terms like:

- Replica Set
- Shard Cluster
- mongos
- mongod
- config servers
- indexes
- shard keys
- ...

are very familiar to the them.

Take your time, ask questions

It's important to foster the discussion of different options and review those options so:

- Use the whiteboard (if available)
- Talk to your team members to defined clear tasks and responsibilities
- Use the instructor for guidance and ask for advice
- Take chances, break stuff!

Note: Reinforce that this is the perfect opportunity for students to make experiments and test configuration options.

You are there to guide them but they should make use of this time to actually put in practice some ideas and check if they would work, in the context of the exercises in hand

At this point you should assemble the teams and share the teams machine details files.

Let's review what we have

Once we have our teams assembled it is time to do our first checklist.

Within your team configuration file you should have:

- Load balancer address.
- Public and private ip address for each AWS instance.
- An internal VPC set of ip addresses for each instance.
- 3 *<opsmgr>* instances.
- Up to 12 *<node>* instances.
- *AdvancedAdministrator.pem* key file to allow access to the instances.

Note: At this point you should make sure the students have all the necessary files needed to access the infrastructure.

- everyone should be assigned to one team, max of 3 person teams
- check if everyone has their team configuration file

You may want to explain to the students that:

- each team works in under their private vpc
 - to navigate and configure the infrastructure, students should be using the `/etc/hosts` defined names
-

Exercise: Accessing your instances from Windows

- Download and install Putty from <http://www.putty.org/>
- Start Putty with: **All Programs > PuTTY > PuTTY**
- In **Session**:
 - In the **Host Name** box, enter `centos@<publicIP>`
 - Under **Connection type**, select **SSH**
- In **Connection/SSH/Auth**,
 - Browse to the **AdvancedAdministrator.ppk** file
- Click **Open**
- Detailed info at: [Connect to AWS with Putty¹](#)

Note: [TODO] fix agent forwarding.

You can convert .pem files on Mac by:

- `brew install putty`
 - `puttygen mykey.pem -o mykey.ppk`
-

¹ <http://docs.aws.amazon.com/AWSEC2/latest/UserGuide/putty.html>

Exercise: Accessing your instances from Linux or Mac

- Get your .pem file and close the permissions on it

```
chmod 600 AdvancedAdministrator.pem
```

- Enable the keychain and ssh into node1, propagating your credentials

```
ssh-add -K AdvancedAdministrator.pem  
ssh -i AdvancedAdministrator.pem -A centos@54.235.1.1
```

- SSH into node2 from node1

```
ssh -A node2
```

Solution: Accessing your instances

In our machines we will have access to all nodes in the deployment:

```
cat /etc/hosts
```

A /share/downloads folder with all necessary software downloaded

```
ls /share/downloads  
ls /etc/ssl/mongodb
```

Note:

- quickly describe the contents of the dirs under downloads Don't emphasize validation, this is where your validation scripts are
 - necessary certificates can be found in both /etc/ssl/mongodb and /share/downloads/certs
-

1.2 Lab: Ops Manager Installation

Premise

Ops Manager is an On-Prem operational solution for the management of MongoDB clusters.

Enables features like:

- Automation
- Backup and Recovery
- Monitoring

Over the course of this lab we will be installing Ops Manager with high availability and scalability in mind.

Note: As a reminder, for details on how to setup clusters for this class, see:

- https://docs.google.com/document/d/1vhA6NvITsPe1rw_fb7N5NrYzJ78odiHWBd5yf9vPd64
-

Ops Manager HA

Ops Manager requires a number of servers for high availability (HA).

- Monitoring and backup/recovery are essential for production operations.
- Therefore, it's important to assure high availability for Ops Manager.
- For this we need to follow a specific deployment topology.

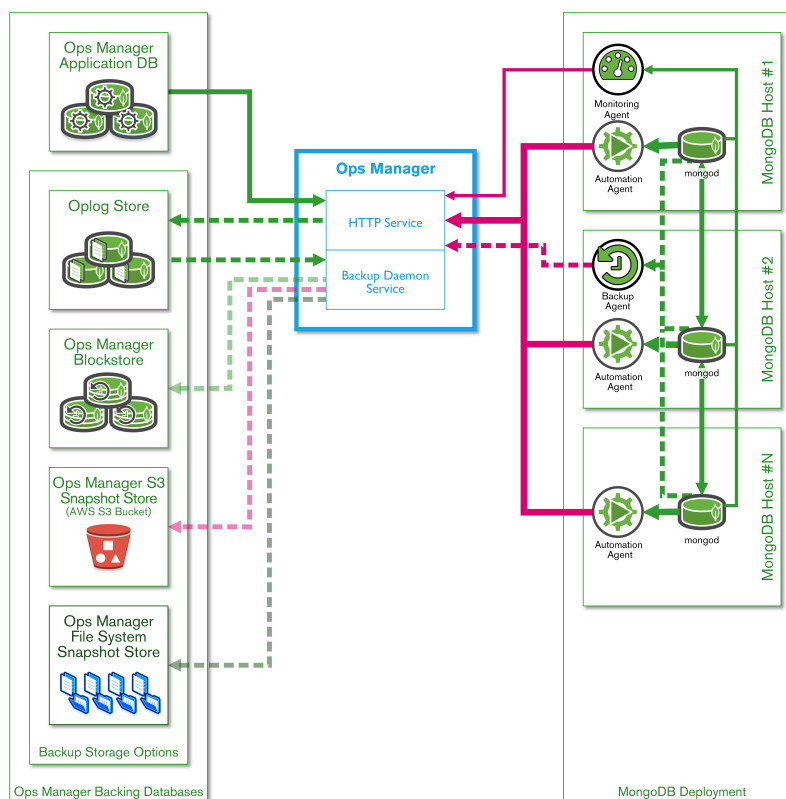
Ops Manager Scalability

Why do we need our operations tool to be scalable?

- The main reason is backup and recovery requirements
- The amount of data individual applications generate will grow
- The number of applications your Ops Manager deployment supports will grow
- Plan to accommodate both forms of growth

Ops Manager Architecture Review

Let's review the Ops Manager architecture² :



Note: Alternative deployments of Ops Manager are available at:

² <https://docs.opsmanager.mongodb.com/current/core/system-overview/>

- <https://docs.opsmanager.mongodb.com/current/core/deployments/>

For this diagram raise students attention to the following:

- Ops Manager is composed out of two main services
 - HTTP Service: Ops Manager Application
 - Backup daemon
 - Ops Manager will collect data from the different agents
 - backup
 - monitoring
 - automation
 - Ops Manager has three main data stores
 - Application DB (MongoDB Cluster)
 - * user info
 - * monitoring data
 - * group data
 - * backup job queries
 - * backup metadata
 - Backup DB (MongoDB Cluster)
 - * OpLog store
 - * Sync store
 - * Blockstore: data snapshots, divided in small chunks being compressed and de-duplicated
 - * or Filestore: data snapshots as files
 - Head Database
 - * Keeps track of oplog and initial syncs
 - * There's one head database for each backed-up replica set
 - * Similar load as a Secondary
-

Exercise: Architect the Ops Manager Deployment

It's time to set up the our Ops Manager Deployment. As a team, make a plan for the following:

- Two replica sets of 3 nodes
 - Application Database replica set as **APPDB**
 - Backup Database replica set as **BACKUPDB**
- A redundant service of the Ops Manager Application
 - The hosts that will be supporting the OM App: `opsmgr1`, `opsmgr2` and `opsmgr3`
 - Load Balancer in front of those 3 instances
 - The load balancer is already set up. The name is in the info file

Solution: Architect the Ops Manager Deployment

- 2 possible solutions:
 - each `opsmgr` node gets App, BackupDaemon, AppDB and BackupDB
 - each `opsmgr` node gets App, BackupDaemon and BackupDB, each `nodeX` node gets AppDB
- Do we need a replica set to support the Backup Daemon?
 - Yes, you always need one, and we will be using the *Blockstore* part of the Backup DB
 - * we can use a *Filestore* as an alternative but for the exercise let's use the *Blockstore*

Exercise: Configure Ops Manager Application Database

Ops Manager needs to store data:

- Configuration of nodes, groups, users
- Metrics for monitoring
- Backup metadata and job queries

Also consider relevant [security settings](#)³ for this database.

From the available machines go ahead and set up a replica set to support the *Application Database*.

Name this replica set **APPDB**

You can install MongoDB by running:

```
yum install -y /share/downloads/mongodb_packages/mongodb-enterprise-3.4.2-1.el7.x86_64.rpm
```

³ <https://docs.mongodb.com/manual/administration/security-checklist/>

Solution: Configure Ops Manager Application Database

```
mongod -f /share/etc/appdb.conf
```

- The `/share/etc/appdb.conf` file should have the following settings:

```
cat /share/etc/appdb.conf
replication:
  replSetName: "APPDB"
  oplogSizeMB: 100
storage:
  wiredTiger:
    engineConfig:
      cacheSizeGB: 2
      journalCompressor: zlib
net:
  port: 27001
```

Note: Pay attention to:

- cache size, because you can't run 2 DB with 50% of the memory each
-

Solution: Configure Ops Manager Application Database (con't)

- Connect to each `opsmgr` instance and launch a `mongod`
- Once all instances `mongod` instances are up initiate the replica set

```
mongo --host opsmgr1:27001
> rs.initiate({
  _id: "APPDB",
  members: [
    { _id: 1, host: "opsmgr1:27001" },
    { _id: 2, host: "opsmgr2:27001" },
    { _id: 3, host: "opsmgr3:27001" }
  ]
})
```

Note:

- To validate their deployment you should ask students to run `rs.status()` on one of their APPDB members.
-

Exercise: Configure Ops Manager Backup Database

Ops Manager needs to store backup blocks/snaphots, either

- in database
- file system

From the available machines go ahead and set up a replica set to support the *Backup Database*.

Name this replica set **BACKUPDB**

Solution: Configure Ops Manager Backup Database

```
mongod -f /share/etc/backupdb.conf
```

- The */share/etc/backupdb.conf* file should have the following settings:

```
cat /share/etc/backupdb.conf
replication:
  replSetName: "BACKUPDB"
  oplogSizeMB: 100
storage:
  wiredTiger:
    engineConfig:
      cacheSizeGB: 2
      journalCompressor: zlib
net:
  port: 27002
```

Note: Pay attention to:

- cache size, because you can't run 2 DB with 50% of the memory each
-

Solution: Configure Ops Manager Backup Database (con't)

- Connect to each `opsmgr` instance and launch a `mongod`
- Once all instances `mongod` instances are up initiate the replica set

```
mongo --host opsmgr1:27002
> rs.initiate({
  _id: "BACKUPDB",
  members: [
    { _id: 1, host: "opsmgr1:27002" },
    { _id: 2, host: "opsmgr2:27002" },
    { _id: 3, host: "opsmgr3:27002" }
  ]
})
```

Exercise: Install, Configure and Launch the Ops Manager Service

Habemus Replica Sets! Now it's time to launch the **Ops Manager** service. For this you will need to:

- Install Ops Manager
 - The files can be found in `/share/downloads/opsmgr_packages`
 - Follow the instructions to [install from rpm](#)⁴
- Edit Ops Manager configuration `conf-mms.properties`:
 - Point the config to the replica set: **APPDB**
- Launch the Ops Manager service
- Hint: there is a common keyfile shared by all 3 instances
- You can install Ops Manager by running:

```
yum install -y /share/downloads/opsmgr_packages/mongodb-mms-3.4.3.402-1.x86_64.rpm
```

Note: The next page, first part of the solution, is given in the student notes, as this one may prove complicated.

We are striving for an Highly Available Ops Manager deployment therefore:

- Before mentioning *again* the HA requirement you may ask students why do we need at least 2 opsmgr nodes?
 - Make sure students use machines that are tagged with Ops Manager
-

Solution: Install, Configure and Launch the Ops Manager Service

Details on how to configure HA [configure HA app](#)⁵

Generate a keyfile `gen.key` for the 3 hosts:

```
# Make sure you use replace opsmgr for the host ip
ssh -A centos@opsmgr1

# Install ops manager server
yum install -y /share/downloads/opsmgr_packages/mongodb-mms-3.4.3.402-1.x86_64.rpm

# Edit the configuration options
vi /opt/mongodb/mms/conf/conf-mms.properties

# Generate a gen.key file
openssl rand 24 > /share/gen.key
cp /share/gen.key /etc/mongodb-mms/

# Copy this generated file to all opsmgr hosts
# You might need to first scp to a folder you have permissions on
scp /share/gen.key centos@opsmgr2:/etc/mongodb-mms/
scp /share/gen.key centos@opsmgr3:/etc/mongodb-mms/
```

⁴ <https://docs.opsmanager.mongodb.com/current/tutorial/install-on-prem-with-rpm-packages/#install-the-onprem-package-on-each-server-being-used-for-onprem>

⁵ <https://docs.opsmanager.mongodb.com/current/tutorial/configure-application-high-availability/>

Solution: Install, Configure and Launch the Ops Manager Service (con't)

- Edit Ops Manager configuration file `/opt/mms/conf-mms.properties`

```
# Replace mongo.mongoUri with APPDB replica set connection string
# e.g., mongodb://opsmgr1:27001,opsmgr2:27001,opsmgr3:27001/?replicaSet=APPDB
sed -i.bak "s/^\(mongo.mongoUri=\) .*/\lmongodb:\/\/\opsmgr1\:27001,opsmgr2\:27001, \
opsmgr3\:27001\/\?replicaSet=APPDB/" /opt/mms/conf-mms.properties

# Repeat the operation on all opsmgr hosts
```

- Launch Ops Manager on all opsmgr hosts

```
ssh -A centos@opsmgr1 "service mongoddb-mms start"
ssh -A centos@opsmgr2 "service mongoddb-mms start"
ssh -A centos@opsmgr3 "service mongoddb-mms start"
```

Note: To validate this exercise the students should be able to:

- Connect to the Ops Manager Installation via their load balancer URL
- Register admin user credentials and Ops Manager group

You can go ahead and walk them through the series of Ops Manager setup screens.

Exercise: Install Ops Manager Automation Agents

At this point **Ops Manager** should be up and running. Now it's time to install our [Automation Agents](#)⁶:

- In the remaining VMs (node1, node2, etc) install the automation agent
- Make sure that all nodes are discoverable on the server's dashboard
- Validate that all agents are reporting pings correctly

Note: You should ask the students to install the agents on the remaining VMs

- Validate that all nodes are discoverable
- All agents are reporting data without errors

You'll also want to make sure that students successfully changed their instance hostnames to the `nodeX` form. This enables them to use the certificates that are on the machines for later labs.

⁶ <https://docs.opsmanager.mongodb.com/current/tutorial/nav/install-automation-agent/>

1.3 Lab: Enable the Ops Manager Public API

Learning Objectives

Upon completing this lab, students will be able to:

- Understand the requirements for enabling Ops Manager Public API

Exercise: Enable Public API Access

Ops Manager, for most users, is primarily controlled via its web UI, but it has an API that supports most of the operations that users perform.

Enable your deployment of Ops Manager to allow API calls.

- Generate an API Key called “generic”

To verify that you’ve done this properly you can make the following request:

```
curl -u "$EMAIL:$APIKEY" --digest \  
-i "$OPSMGRURL/api/public/v1.0/groups"
```

Note: Enabling the Public API on Ops Manager enables it across all groups. Previously, the API had to be enabled on a group by group basis.

1.4 Lab: Ops Manager User Administration

Learning Objectives

Upon completing this lab, students will be able to:

- Administer Ops Manager groups
- Identify the differences between Ops Manager user roles
- Create and define Ops Manager users

Exercise: Create Group

Connect to your Ops Manager instance and create the following group:

- **CIRCUS_MAXIMUS**

Note: This is a very simple exercise.

Take the time to explore the `admin` menu with students.

Exercise: Create Users

Using the [Ops Manager API](#)⁷, create the following users:

- **aediles@localhost.com** :
 - password: “123ABCabc!”
 - role: [Owner](#)⁸
- **patrician@localhost.com** :
 - password: “DAXN3ZpM6U!”
 - role: [Monitoring Admin](#)⁹
- **consus@localhost.com** :
 - password: “&o7chac0v3r3d”
 - role: [Backup Admin](#)¹⁰

Note: To accomplish this task, the users will have to do the following steps:

- [enable the api](#)¹¹,
- create different users using the HTTP Rest API

e.g.: **Owner**

```
curl -u "$EMAIL:$APIKEY" -H "Content-Type: application/json" \
--digest -i -X POST "$OPSMGRURL/api/public/v1.0/users" --data '
{
  "username": "aediles@localhost.com",
  "emailAddress": "aediles@localhost.com",
  "firstName": "This",
  "lastName": "Mine",
  "password": "123ABCabc!",
  "roles": [{
    "groupId": "$GROUPID",
    "roleName": "GROUP_OWNER"
  }]
}'
```

⁷ <https://docs.opsmanager.mongodb.com/current/api/>

⁸ <https://docs.opsmanager.mongodb.com/current/reference/user-roles/#owner>

⁹ <https://docs.opsmanager.mongodb.com/current/reference/user-roles/#monitoring-admin>

¹⁰ <https://docs.opsmanager.mongodb.com/current/reference/user-roles/#backup-admin>

¹¹ <https://docs.opsmanager.mongodb.com/current/tutorial/enable-public-api/>

Exercise: Create Global Users

In various different situations, we will need users with global roles.

Please create, either through the API or web UI, the following users:

- **automater@localhost.com** :
 - password: “84hjdpx%ea3m”
 - role: [Global Automation Admin](#)¹²
- **masterchef@localhost.com** :
 - password: “c6ny3n4x*8”
 - role: [Global User Admin](#)¹³

Exercise: Create Global Users (con’t)

After creating these users, connect with the most appropriate user to change the password of the **CIRCUS_MAXIMUS Owner** user.

The new password should be “*\$superC00l*”

This last operation should be accomplished using the HTTP Rest API interface.

Note: Make sure that students understand which user to log in with and how to change the user password of *aediles@localhost.com*.

For the operation students will have to do the following steps:

- create a Public API key for user *masterchef@localhost.com*
- change user *aediles@localhost.com* password through the API

```
// get the user
curl -u "masterchef@localhost.com:$APIKEY" \
  --digest -i "$OPSMGRURL/api/public/v1.0/users/byName/aediles@localhost.com"

// change the user's password
curl -u "masterchef@localhost.com:$APIKEY" -H "Content-Type: application/json" \
  --digest -i -X PATCH "$OPSMGRURL/api/public/v1.0/users/$USERID" --data '
{
  "password": "$superC00lpa22"
}'
```

¹² <https://docs.opsmanager.mongodb.com/current/reference/user-roles/#global-automation-admin>

¹³ <https://docs.opsmanager.mongodb.com/current/reference/user-roles/#global-user-admin>

1.5 Lab: Secure Replica Set

Premise

- Setting up a MongoDB Replica set is quite easy and fast.
- Setting up a Secured MongoDB replica set requires a few extra steps.
- In this lab we will be exploring how to setup a secured Replica Set through Ops Manager.

Note: Security is an important topic of production deployments and we want the students to be fully acquainted with the different options of MongoDB Security.

X.509 Authentication Mechanism

We will be using [X.509 certificates](#)¹⁴ for authentication and TLS/SSL network encryption.

Note: The actual X.509 details are out-of-scope for this training. Our purpose is **not**:

- to educate people on the authentication mechanism itself
- detailed explanation on how TLS/SSL works

Our purpose is to:

- Review the different authentication mechanisms
 - How students can use such mechanism if they choose too
 - The tradeoffs of X.509 when compared with other auth mechanisms
-

Ops Manager Group SSL and Auth

To build secured MongoDB deployments you first need to [enable Auth and SSL](#)¹⁵ on your group.

All VMs have a set of certificates that you will be using to configure your secured deployment.

In folder `/share/downloads/certs` (linked to `/etc/ssl/mongodb`) you will find:

- `ca.pem`: SSL CA certificate
- `automation.pem`: Automation agent certificate
- `backup.pem`: Backup agent certificate
- `monitor.pem`: Monitoring agent certificate
- `nodeX.pem`: Replica set member certificates (X)
- `dbadmin.pem`: MongoDB DB Admin certificate

Note: Ask students to list the files under `/share/downloads/certs` on instances to validate that their installation process is correct. All our answers use `/etc/ssl/mongodb` which is linked to the above.

Make sure to highlight that:

¹⁴ <https://docs.mongodb.com/manual/core/security-x.509/>

¹⁵ <https://docs.opsmanager.mongodb.com/current/tutorial/enable-ssl-for-a-deployment/>

- The enabling of auth and ssl on a group level is to ensure correct communicate between all instances
 - Ensuring the same Certificate Authority (CA) certificate
 - Enabling agents to perform their normal operations
 - Create the required agent users
-

Exercise: VERYSAFE Group

Let's start by creating a group called VERYSAFE that has SSL enabled.

- Using the existing certificates, configure the agents accordingly.
- You need to specify certificates for
 - Certificate Authority
 - Monitoring Agent
 - Backup Agent
 - Automation Agent
- **The existing certificates do not have a decryption password!**

Note: This might be a bit hard for students that are not experienced with Ops / Cloud Manager

- Take the time to navigate users through the UI to configure these settings
- Make sure that students do not provide a decypher password for the certificates

Once the group is created you will need to reconfigure your existing agents to use the new group

- Either you install new agents or just stop the service and reconfigure the agents configuration file

```
sudo service mongodb-mms-automation-agent stop  
  
# edit /etc/mongodb-mms/automation-agent.config and add new APIKey and GroupId  
  
sudo service mongodb-mms-automation-agent start
```

- Students will find the corresponding instructions on *Settings -> Agents -> Host Version Agent*
-

Exercise: Secure Replica Set Deployment

Once the automation agent has been reconfigured and servers are detected on your deployment, it's then time to deploy our secure replica set.

Create a replica set named **SECURE** with the following configuration:

- 3 Nodes:
 - **node1**, **node2** and **node3**
 - Port 27000
- **sslMode**: requiredSSL
- **sslPEMKeyFile**: */etc/ssl/mongodb/nodeX.pem*

Note: Students should create a replica set from Ops Manager UI that will reflect the wanted configuration:

- Once the **VERYSAFE** group has been created we need to **Add -> New Replica Set**
 - Name: **SECURE**
 - Port Range: **27000**
 - DB Path Prefix: */data*
 - **sslMode**: requiredSSL
 - Apply
 - Before the replica set is created, we need to **Modify** the individual node members with the corresponding server **sslPEMKeyFile**
 - node1: */etc/ssl/mongodb/node1.pem*
 - *nodeX.pem*: there should be a certificate file per each node.
 - This setting needs to be configured on a per instance level.
-

Exercise: X509 Users

Time to create users that will authenticate using an X.509 certificate.

- Go ahead and create a **dbAdminAnyDatabase**¹⁶ user that authenticates using the *dbadmin.pem* certificate.
- To create users that authenticate using X509 certificates you should check the **Certificate Subject as user**¹⁷ documentation.
- After the user has been created, connect to the *Primary* node of the replica set and create database “allgood”.

Note:

- Students might not be familiar with this mechanism so point them to **Certificate Subject as user**¹⁸.
- Students will have to extract the certificate `subject` info

¹⁶ <https://docs.mongodb.com/manual/reference/built-in-roles/#dbAdminAnyDatabase>

¹⁷ <https://docs.mongodb.com/manual/tutorial/configure-x509-client-authentication/#add-x-509-certificate-subject-as-a-user>

¹⁸ <https://docs.mongodb.com/manual/tutorial/configure-x509-client-authentication/#add-x-509-certificate-subject-as-a-user>

```
$ openssl x509 -in /etc/ssl/mongodb/dbadmin.pem -inform PEM -subject -nameopt_
↳RFC2253
subject= C=US,ST=New York,L=New York City,O=MongoDB,OU=USERS,CN=dbadmin
-----BEGIN CERTIFICATE-----
MIIDeDCCAmCgAwIBAgICmDQwDQYJKoZIhvcNAQEFBQAwcjsESMBAGA1UEAxMJbG9j
...
```

and use that subject info to create the required user.

- We can create this user by connecting to the replica set and perform the following operations:
- Authenticate to primary node using automation agent certificate (students can do this from a opsmgrX machine, where mongo is installed)

```
mongo --host PRIMARY_NODE --ssl --sslPEMKeyFile /etc/ssl/mongodb/automation.pem --
↳sslCAFile /etc/ssl/mongodb/ca.pem
```

- Create the new dbAdminAnyDatabase user with the dbadmin.pem certificate

```
db.getSiblingDB("$external").runCommand({
  createUser: "C=US,ST=New York,L=New York City,O=MongoDB,OU=USERS,CN=dbadmin",
  roles: [
    { role: 'dbAdminAnyDatabase', db: 'admin' }
  ],
  writeConcern: { w: "majority" , wtimeout: 5000 }
})
```

- Connect to primary using dbadmin.pem:

```
mongo --host PRIMARY_NODE --ssl --sslPEMKeyFile /etc/ssl/mongodb/dbadmin.pem
--sslCAFile /etc/ssl/mongodb/ca.pem
```

- Authenticate and create new database allgood

```
db.getSiblingDB("$external").auth({
  mechanism: "MONGODB-X509",
  user:"C=US,ST=New York,L=New York City,O=MongoDB,OU=USERS,CN=dbadmin"
})

db.createDatabase("allgood")
```

1.6 Lab: Reconfig Replica Set

Learning Objectives

Upon completing this lab, students should be able to:

- Reconfigure a replica set
- Outline the different stages of deployments

Dependencies

- In order to complete all purposed exercises we need to first enable the Public API.
- Go to your group settings and enable the Public API.
- Do not forget to set an appropriate CIDR block for the IP whitelist and Generate the API Key.

Note: Make sure students are aware of this dependency.

Exercise: Initial Replica Set

- Using the Ops Manager UI go ahead and create a 3 node replica set:
 - Replica set name `META`
 - Two data bearing nodes
 - * use hosts: `node3` and `node4`
 - One arbiter
 - * use host: `node5`
 - All nodes should be set to use port **27000**

Note: All instances should be installed using MongoDB 3.2.1 enterprise

Exercise: Add Replica Set Members

- Let's assume that we require higher level of High Availability (HA).
- Add 2 new data bearing nodes
 - First node should have priority 0
 - * use `node6`
 - Second node should be an hidden replica.
 - * use `node8`

Exercise: Decomission Replica Member

- One of your nodes is not making the cut. - Not pointing fingers but ... `node3` is *acting up*
- Change your replica set by “*decommissioning*” one of the instances
- Make sure that your replica set keeps up majority and previous level of node failure resilience

Note: Make sure students are aware that removing one of nodes might require adding an extra one.

- Make sure that they will need to change the Replica Set configuration priorities if they don't want to just remove the problematic node
 - In this case `node3`
- Changing the priority of `node6` to 1 will keep the same availability
- We can also remove the `arbiter` to keep an odd number of nodes

Questions to ask:

- Q: What happens if we just remove the problematic node and the arbiter?
 - A: This is not enough to guarantee the same availability. The remaining nodes are not capable of becoming **primary** nodes

Exercise: Upgrade MongoDB Version

- Our CTO, for compliance reasons, demands that all of our nodes should be on the latest version of MongoDB.
- Upgrade all nodes in your replica set without downtime.

Note:

- Please instruct students to change the version of MongoDB to the most recent version of MongoDB
- Make sure they know how to make the required version available in their Ops Manager deployment.
- Update the Version Manifest: Deployment -> Version Manager -> Update MongoDB Version Manifest

Exercise: Update Node Priority

Our initial setup is not in line with the expectations of the CTO in terms of hierarchy (*talking about micromanagement!*).

- Update the priorities of nodes to the following configuration:
 - **node4**: 10
 - **node6**: 7
 - **node5**: Arbiter
 - **node8**: 0 and slave delayed by 10hours
- All of these changes should be done using the Ops Manager API!

Note: This is the most challenging exercise of this lab. Walk the students through the exercise. Students will have to dig into the [API Documentation](#)¹⁹ to retrieve the necessary instructions.

Students will also have to enable the public api and generate a public API key.

Here's the set of instructions they will need to accomplish:

- set a variable containing ops manager admin username

```
export username=admin@localhost.com
```

- Get the group Id and add it to an environment variable
- Settings -> Group Settings (group id)

```
export GROUPID=YOURGROUPID
```

- Create a new API key
- Settings -> Public API Key -> Generate

```
export apiKey=YOURAPIKEY
```

- Get current automation configuration

```
curl -u "$username:$apiKey" -H "Content-Type: application/json" --digest -i  
"/api/public/v1.0/groups/$GROUPID/automationConfig"
```

- Save the json content payload into a file `automation.json`
- Edit that file to reflect the requested priorities changes

```
{  
  "auth": {  
    "disabled": true,  
    "usersDeleted": [],  
    "usersWanted": []  
  },  
  "backupVersions": [],  
  "indexConfigs": [],  
  "mongoDbVersions": [  
    {  
      "builds": [  
        {  
          "bits": 64,  
          "gitVersion": "ed70e33130c977bda0024c125b56d159573dbaf0",  
          "platform": "linux",  
          "url": "http://opsmgr.vagrant.dev:8080/automation/mongodb-releases/  
→linux/mongodb-linux-x86_64-3.2.1.tgz"  
        }  
      ],  
      "name": "3.2.1"  
    }  
  ],  
  "monitoringVersions": [  
    {  
      "baseUrl": null,  
      "directoryUrl": null,  
    }  
  ]  
}
```

¹⁹ <https://docs.opsmanager.mongodb.com/current/reference/api/automation-config/#update-automation-configuration-via-api>


```

        "hostname": "N",
        "name": "3.9.1.238-1"
    }
],
"options": {
    "downloadBase": "/var/lib/mongodb-mms-automation",
    "downloadBaseWindows": "%SystemDrive%\MMSAutomation\versions"
},
"processes": [
    {
        "args2_6": {
            "net": {
                "port": 27000
            },
            "operationProfiling": {},
            "replication": {
                "replSetName": "META"
            },
            "storage": {
                "dbPath": "/data/META_0"
            },
            "systemLog": {
                "destination": "file",
                "path": "/data/META_0/mongodb.log"
            }
        },
        "authSchemaVersion": 5,
        "hostname": "node4",
        "logRotate": {
            "sizeThresholdMB": 1000.0,
            "timeThresholdHrs": 24
        },
        "name": "META_0",
        "processType": "mongod",
        "version": "3.2.1"
    },
    {
        "args2_6": {
            "net": {
                "port": 27000
            },
            "operationProfiling": {},
            "replication": {
                "replSetName": "META"
            },
            "storage": {
                "dbPath": "/data/META_1"
            },
            "systemLog": {
                "destination": "file",
                "path": "/data/META_1/mongodb.log"
            }
        },
        "authSchemaVersion": 5,
        "hostname": "node6",
        "logRotate": {
            "sizeThresholdMB": 1000.0,
            "timeThresholdHrs": 24
        }
    }
]

```

```

    },
    "name": "META_1",
    "processType": "mongod",
    "version": "3.2.1"
  },
  {
    "args2_6": {
      "net": {
        "port": 27000
      },
      "operationProfiling": {},
      "replication": {
        "replSetName": "META"
      },
      "storage": {
        "dbPath": "/data/META_2"
      },
      "systemLog": {
        "destination": "file",
        "path": "/data/META_2/mongod.log"
      }
    },
    "authSchemaVersion": 5,
    "hostname": "node5",
    "logRotate": {
      "sizeThresholdMB": 1000.0,
      "timeThresholdHrs": 24
    },
    "name": "META_2",
    "processType": "mongod",
    "version": "3.2.1"
  },
  {
    "args2_6": {
      "net": {
        "port": 27000
      },
      "operationProfiling": {},
      "replication": {
        "replSetName": "META"
      },
      "storage": {
        "dbPath": "/data/META_3"
      },
      "systemLog": {
        "destination": "file",
        "path": "/data/META_3/mongod.log"
      }
    },
    "authSchemaVersion": 5,
    "hostname": "node3",
    "logRotate": {
      "sizeThresholdMB": 1000.0,
      "timeThresholdHrs": 24
    },
    "name": "META_3",
    "processType": "mongod",
    "version": "3.2.1"
  }

```

```

    },
    {
      "args2_6": {
        "net": {
          "port": 27000
        },
        "operationProfiling": {},
        "replication": {
          "replSetName": "META"
        },
        "storage": {
          "dbPath": "/data/META_4"
        },
        "systemLog": {
          "destination": "file",
          "path": "/data/META_4/mongod.log"
        }
      },
      "authSchemaVersion": 5,
      "hostname": "node8",
      "logRotate": {
        "sizeThresholdMB": 1000.0,
        "timeThresholdHrs": 24
      },
      "name": "META_4",
      "processType": "mongod",
      "version": "3.2.1"
    }
  ],
  "replicaSets": [
    {
      "_id": "META",
      "members": [
        {
          "_id": 0,
          "arbiterOnly": false,
          "hidden": false,
          "host": "META_0",
          "priority": 10.0,
          "slaveDelay": 0,
          "votes": 1
        },
        {
          "_id": 1,
          "arbiterOnly": false,
          "hidden": false,
          "host": "META_1",
          "priority": 7.0,
          "slaveDelay": 0,
          "votes": 1
        },
        {
          "_id": 2,
          "arbiterOnly": true,
          "hidden": false,
          "host": "META_2",
          "priority": 0,
          "slaveDelay": 0,

```

```

        "votes": 1
    },
    {
        "_id": 3,
        "arbiterOnly": true,
        "hidden": false,
        "host": "META_3",
        "priority": 0,
        "slaveDelay": 0,
        "votes": 1
    },
    {
        "_id": 4,
        "arbiterOnly": false,
        "hidden": true,
        "host": "META_4",
        "priority": 0,
        "slaveDelay": 36000,
        "votes": 1
    }
]
},
"roles": [],
"sharding": [],
"uiBaseUrl": null,
"version": 2
}

```

- Update the automation configuration

```

export username=yourusername
curl -u "$username:$apiKey" -H "Content-Type: application/json" --digest -i -X PUT
"https://opsmgr.training/api/public/v1.0/groups/$GROUPID/automationConfig" --data_
↪@automation.json

```

Lab: Shard Cluster (page 26) Deploy sharded cluster

Lab: Analyzing Profiler Data (page 32) Cluster performance analysis using profiler and monitoring dashboards

Lab: Ops Manager Point-in-Time Backup (page 34) Perform point-in-time backup restores using Ops Manager backup

1.7 Lab: Shard Cluster

Learning Objectives

Upon completing this lab, students will be able to:

- Create a sharded cluster using Ops Manager
- Identify the necessary steps to configure the cluster
- Create the correct shard key for a given dataset
- Understand Zone sharding
- Detect balancing issues

Exercise: Create Shard Cluster

Using the Ops Manager UI, let's create a MongoDB sharded cluster with the following configuration:

- Two shards cluster, with three nodes per shard, distributing the process like that:

- **shard001:** node1, node2 and node3
- **shard002:** node4, node5 and node6
- **config servers:** 3 processes on node9
- **mongos:** opsmgr1, node10 and node11
- Each mongod should be running on different hosts
- All **config servers**²⁰ should be running on a single host

* These should be placed on host node10

Note: The idea behind this exercise is to have students setup the cluster using the regex rules, on server name selection, that ops manager allows.

We also want the students to change the configuration in following labs:

- point out that this configuration is there to be changed
- should **not** be followed in production

To validate the students implementation check the following:

- after running `describe.py` on this training run get all the private and public ips to validate that the defined clusters follow the expected recipe
-

Exercise: Correct Config Servers Distribution

Like Britney Spears used to say “*Oops, I did it again*”, we made a mistake on our previous setup and installed all our **config servers**²¹ on a single host.

So now we need to fix our deployment by doing a configuration change:

- Edit the cluster configuration by setting the **config servers**²² into separate instances
 - They should be placed on node9, node8 and node7

Note: In this exercise we want the students to understand that these operations will happen with no down time.

To validate this exercise, after the reconfiguration is complete, ask the students to connect to the defined hosts and verify that the running instance is infact a config server node.

²⁰ <https://docs.mongodb.com/manual/core/sharded-cluster-config-servers/>

²¹ <https://docs.mongodb.com/manual/core/sharded-cluster-config-servers/>

²² <https://docs.mongodb.com/manual/core/sharded-cluster-config-servers/>

Exercise: Detect Node Down

Our shard cluster is composed by several different nodes (mongods) running on several different hosts.

It's critical that we keep an eye on our cluster. Using the tools available to you, create the necessary mechanisms to be notified in the event of a node failure.

Note: In this exercise we want students to create a set of alerts:

- for host failure
- for process failure

The instructor will be responsible of injecting failures in the teams environment

To *inject process failure* we need to connect to a designated host (instructor should pick one) and kill the process(es) running on that host.

For *host failure* to be triggered, the instructor should connect to [aws console](#)²³ and stop the execution of a given host.

These can also be `opsmgr` instances where students should be monitoring the running Application DB replica set.

Exercise: Configure Shard

Time to use our distributed database in its full power.

We will be using a dataset of US consumer complaints. These are records of complaints, on several sectors/states/companies, filed by US consumers.

The dataset should be imported as collection "*complaints*" in the database "*consumer*", which can also be referred as the "**complaints.consumer**" namespace.

We also want you to configure a few settings:

- set the `chunksize`²⁴ to 1MB (the smallest allowed)
- set the primary shard to max `shard size`²⁵ of 500MB (512)

Note: The idea behind these configuration options are: - a) to get user administrators acquainted with them - b) create the conditions to simulate `jumbo chunks`²⁶ situation

Make sure to note that using the smallest size allowed or setting such a low shard max size will have implications. Mostlikely, other values should be considered for production environments

For the exercise students should do the following: - set chunk size and `primary shard`²⁷ max size

```
use config
db.settings.save( { _id:"chunksize", value: 1 } )
db.runCommand({
  addShard: "<replica_set>/<hostname><:port>",
  maxSize: 512 })
```

²³ <https://console.aws.amazon.com/console/home>

²⁴ <https://docs.mongodb.com/manual/tutorial/modify-chunk-size-in-sharded-cluster/>

²⁵ <https://docs.mongodb.com/manual/tutorial/manage-sharded-cluster-balancer/#sharded-cluster-config-max-shard-size>

²⁶ <https://docs.mongodb.com/manual/core/sharding-data-partitioning/#jumbo-chunk>

²⁷ <https://docs.mongodb.com/manual/core/sharded-cluster-shards/#primary-shard>

Exercise: Configure Shard (continued)

Let's go ahead and import the **consumer** dataset that is available in the `opsmgr` instances in the folder `/dataset/consumer`:

- import/restore this dataset into the `consumer.complaints` namespace
- Once data is imported let's shard the `complaints` collection using the following shard key:

```
sh.enableSharding('consumer')
sh.shardCollection('consumer.complaints', {company:1, state: 1})
```

Note: The above set of instructions are incomplete. We need a prior step, before running `db.shardCollection` command!

Which command is it ?

Note: To select a correct shard key this should have a few properties:

- query isolation
- write distribution
- high cardinality
- non-monotonically growing
- key value frequency
- key immutable
- key values are also immutable

Make sure you highlight these with the students

For this exercise we will not take all of them in consideration, and just use **company** and **state** to attend the expected distribution.

The missing command is the creation of an index on the selected shard key fields:

```
use consumer
db.complaints.createIndex({company:1, state: 1})
```

There are several aspects of the selected shard key that are not optimal:

- Frequency is inappropriate. If we run the following aggregation query we can see that standard deviation is quite of

```
db.complaints.aggregate( [
  {$group: { _id: { c: '$company', st: '$state'}, count: {$sum:1}}},
  {$group: { _id: "", std: {$stdDevPop: '$count'}, avg: {$avg: "$count"}}}
])
```

- There is no indication that **query isolation** will be assured
 - can only be guaranteed on cases where **company** field is used.

Apart from all of this points we will be using this shard key for several other operations.

Exercise: Zone Sharding

We want to isolate subsets of data into a particular shard.

Let's create a [zone shard](#)²⁸ that assigns all data from the company **Bank of America** to one particular shard, **shard002**, and all other data on the remaining shard.

Note: We want students to understand the benefits of zone sharding and also its limitations.

- Ask the students to create the necessary shard ranges and tag the shards accordingly
- Ask the students if it's possible to isolate all data of a particular company, in this case **"Bank Of America"** into a single shard.
 - Ask if we could do the same by **zip_code**: Answer should be *no*
 - * **zip_code** does not make part of the shardkey!
- Ask students if the order of the shard key would affect their ability to isolate subsets of data
 - It will, because the order of the shard key definition will inevitably affect the shard ranges and therefore the chunk distribution
- Ranges to be created

```
sh.addTagRange("consumer.complaints",
  {company: MinKey, state: MinKey },
  {company: 'Bank of America', state: MinKey },
  "BeforeBankOfAmerica")

sh.addTagRange("consumer.complaints",
  {company: 'Bank of America', state: MinKey },
  {company: 'Bank of America_', state: MinKey },
  "BankOfAmerica")

sh.addTagRange("consumer.complaints",
  {company: "Bank of America_", state: MinKey },
  {company: MaxKey, state: MaxKey },
  "AfterBankOfAmerica")
```

- Then apply these to the appropriate shards

```
use config
sh.addShardTag("shard001", "BeforeBankOfAmerica")
sh.addShardTag("shard002", "BankOfAmerica")
sh.addShardTag("shard003", "AfterBankOfAmerica")
```

- If students insert the following documents

```
db.complaints.insert({"company":"Bank", "state":"CA"})
db.complaints.insert({"company":"Bank of America", "state":"CA"})
db.complaints.insert({"company":"Bank of Canada", "state":"CA"})
```

- And then run the following queries

```
db.complaints.find({"company":"Bank"}).explain()
db.complaints.find({"company":"Bank of America"}).explain()
db.complaints.find({"company":"Bank of Canada"}).explain()
```

²⁸ <https://docs.mongodb.com/manual/release-notes/3.3-dev-series/#sharded-cluster>

- These commands should respectively hit only one shard: shard001, shard002 and shard003
-

Exercise: Detect Balancing Issues

To avoid having unbalanced shards we should look for some metrics on the sharded collection:

- Which command should we use to detect possible imbalances?
- What's the procedure to solve unbalanced distribution of data across shards?

Note: The first reaction of students will be to look for number of chunks per shard. You should also mention that imbalances might be caused by existence of *hot shards* - despite having a balanced distribution of chunks they are not balanced in terms of traffic on the different shards.

- Students should use one of 2 things:
 - Query the **config.chunks** collection

```
use config
db.chunks.aggregate([
  {$match: {"ns" : "consumer.complaints"},
  {$group: {_id: "$shard", nchunks: {$sum:1}}}
])
```

- Run `sh.status()` command and look for the shard number of chunks per shard
-

Exercise: Move Primary Shard

All **sharding enabled**²⁹ databases will have a primary shard. The primary shard will host/hold all non-sharded collections.

We can check each database primary shard using the `sh.status()` command.

For this exercise we are going to do the following:

- add two more shard nodes
 - three data bearing *mongod* each
 - each mongod a separate host
 - these should be named **shard003** and **shard004**
- **move primary**³⁰ shard of **consumer** database to **shard003**

Note: To perform this task students should run the following:

- add new shards - use the Ops Manager UI to add the new shards
- **move primary**³¹

```
db.adminCommand( { movePrimary : "consumer", to : "shard003" } )
```

- While approaching this topic, make sure you clarify with students the considerations around primary move

²⁹ <https://docs.mongodb.com/manual/reference/method/sh.enableSharding/#sh.enableSharding>

³⁰ <https://docs.mongodb.com/manual/reference/command/movePrimary/>

³¹ <https://docs.mongodb.com/manual/reference/command/movePrimary/>

Exercise: Drain Shard

So apparently our application can survive with only two shards.

Given the elastic nature of MongoDB we can change the sharding configuration and consequent server footprint.

Go ahead and remove one of the shards from your sharded cluster.

The procedure should be: - make sure we have ready backup - remove it from the cluster

Note: In this exercise we want students to be acquainted with MongoDB elastic nature where we can remove and add shards with some agility.

To accomplish this task students should do the following:

- generate a backup dump from Ops Manager
- change the shard ranges and tags so we can maintain the pre-defined dataset isolation

```
use config
sh.addShardTag("shard0004", "BeforeBankOfAmerica")
sh.addShardTag("shard0004", "AfterBankOfAmerica")
sh.addShardTag("shard0003", "BankOfAmerica")
```

- remove shard - run this operation through Ops Manager UI
-

1.8 Lab: Analyzing Profiler Data

Premise

“Your cluster is experiencing some performance issues and you would like to determine where the bottlenecks are. You will need to create statistics on slow queries, locking, and operations: use the database profiler and write some aggregation queries to analyze the profiling data.”

Note: Ask students to students to set up a replica set with the following config: - **Replica Set Name** : AFK - **node10** : priority 10 - **node9** : priority 9 - **node11** : hidden

Setup

1. First enable the profiler for a new agg database (to record all queries):

```
use agg;
db.setProfilingLevel(2);
```

2. Add some sample data.

```
for (i=0; i<100000; i++) { db.aggcol.insert( { count : i } ); }
```

3. Add some queries.

```
for (i=0; i<100; i++) { db.aggcol.find( { count : i } ).toArray(); }
for (i=0; i<100; i++) { db.aggcol.update( { count : i },
    { $set : { "another_field" : i } } ); }
```

Exercise

Find the maximum response time and average response time for each type of operation in the `system.profile` collection.

Hint: group on the `op` field.

Results

Your aggregation query should return documents of the following form:

```
{
  "_id" : "update",
  "count" : <NUMBER>,
  "max response time" : <NUMBER>,
  "avg response time" : <NUMBER>
}
{
  "_id" : "insert",
  "count" : <NUMBER>,
  "max response time" : <NUMBER>,
  "avg response time" : <NUMBER>
}
// ... for every operation in the system.profile.op field
```

Note: Solution:

```
// response time by operation type
db.system.profile.aggregate( { $group : {
  _id : "$op",
  count : { $sum : 1 },
  "max response time" : { $max : "$millis" },
  "avg response time" : { $avg : "$millis" }
} } );
```

1.9 Lab: Ops Manager Point-in-Time Backup

Exercise: Point-in-Time Backup

Premise: “*Suppose someone introduced an incorrect code path that randomly drops the database from our production environment.*”

Your data is backed up in Ops Manager, so you can recover all the data that existed immediately before the drop. You’ll need to request a point-in-time backup and then restore it.

The collection is `injector.data` and the total number of documents, regardless of the drop, should be 20,000.

Note: In the `/shared/` folder students can find a script called `inject20k`. This is an executable that will insert 20K documents and will drop the database at a random point in time.

Students will have to: - Determine the which data was lost - Request a PITR from Ops Manager - Reinsert any data post drop

Ask the students to set up a 3 node replica set with the following config:

- **Replica Set Name** : DROP_OUT
- **node1** : Priority 10
- **node2** : Priority 3
- **node3** : Priority 0

The replica set should be set up using the Ops Manager UI.



Find out more

mongodb.com | mongodb.org
university.mongodb.com

Having trouble?

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jira.mongodb.org

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