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Live Migration Guide: MySQL On-premises to HeatWave MySQL on Oracle Cloud Infrastructure (OCI)

Before you start:

- You must have an account on Oracle Cloud Infrastructure (OCI).
- Some OCI knowledge is preferred.
- This live migration document only covers how to migrate your database from MySQL on-premises to HeatWave MySQL (HW) on OCI. Before performing the migration, you should have considered downtime (even though this is a live migration - some/minimal downtime will be required to make sure your database application points to the new HW MySQL database once migrated), application compatibility, current database metrics (CPU, storage size, RAM, max number of concurrent users, backups, binary logs expiration, number of replicas if any, etc.), desired database metrics, networking, security, user testing, etc.
- The live migration method shown in this guide works for MySQL on-premises v5.7 and above. This can be a MySQL Community Edition, MySQL Standard Edition, MySQL Enterprise Edition, or a Percona Server.
- When following the guide, you should always execute the commands/steps shown as an admin/root user wherever applicable.
    - On OCI you must have the ability to create and manage resources.
    - For your on-premises MySQL instance, use an admin/root user.
- This live migration method requires binary logs to be present on the on-premises MySQL instance. To enable binary logs - you must set the `log_bin` variable to `ON`. After you have made sure that binary logging is enabled for your on-premises MySQL, ensure that its `binlog_format` system variable is set to `ROW` (as HW MySQL on OCI only uses row-based binary logging). Any other values besides `ROW` will not work. For more information on how to enable the on-premises MySQL binary logging and how to change the binary log format, see [MySQL Binary Log]() and [Binary Logging Formats]().
- This live migration can be performed using two replication methods - using GTIDs and binary log position. As HeatWave MySQL only supports GTIDs on OCI, once you migrate your on-premises MySQL instance to HeatWave MySQL - you cannot go back to using the binary log position for replication.
- If you have MySQL replication configured in your current on-premises environment, you can perform the migration steps shown in this guide from either your writer or reader instance, although it is recommended to use the reader instance for the migration when applicable. This is because if you have a high concurrency for your on-premises MySQL instance, performing the migration using the writer instance could negatively impact the database application performance.
- The Overview section of this live migration guide contains all the steps that are needed to finish the database migration from on-premises MySQL to HeatWave MySQL on OCI.
- In the Walkthrough section of this live migration guide, we will apply the information provided in the Overview section and give you a simple step-by-step guide. In this step-by-step guide, we will have an on-premises MySQL instance with some sample data pre-loaded and will migrate it over to HeatWave MySQL on OCI. This will help you follow and better visualize the process/information provided in the Overview section.
- You can use the Walkthrough section's step-by-step guide as a reference for your live migration from MySQL on-premises to HeatWave MySQL. When following the guide, make changes along the way to your on-premises and OCI environment accordingly or as required. Since each user following the step-by-step guide will have their environments configured differently, we cannot provide an ideal example that works for everyone.

Overview:

Following are the required steps to migrate data from MySQL on-premises to HeatWave MySQL on OCI using live migration (with zero or minimal downtime):

I) Have an Oracle Cloud Infrastructure (OCI) account.

OCI Sign in/Sign up page: https://cloud.oracle.com

II) Set up a VPN connection from OCI to on-premises.

[A VPN connection will allow you to bridge your on-premises network with the OCI VCN. The VPN connection will allow your on-premises MySQL to connect to HeatWave MySQL on OCI and it also ensures that your data in transit while it is being migrated is encrypted.]
VPN Connection to on-premises: https://docs.public.oneportal.content.oci.oraclecloud.com/en-us/iaas/mysql-database/doc/vpn-connection.html

III) On OCI, create a standalone HeatWave MySQL instance.

[If you require High Availability for your HeatWave MySQL instance, you must enable it after completing section **VIII)** of this guide.]
Provision OCI HeatWave MySQL: https://docs.oracle.com/en-us/iaas/mysql-database/doc/creating-db-system1.html

IV) Install MySQL Shell 8.2 or above on an on-premises instance that can connect to MySQL on-premises.

[MySQL Shell will be used to copy DDL and data from on-premises MySQL to HeatWave MySQL on OCI. You must download MySQL Shell 8.2 or above.]
Download MySQL Shell: https://dev.mysql.com/downloads/shell/
Install MySQL Shell: https://dev.mysql.com/doc/mysql-shell/8.2/en/mysql-shell-install.html

V) For your on-premises MySQL, ensure `log_bin` is set to `ON`, `binlog_format` is set to `ROW`, and increase the `binlog_expire_logs_seconds` system variable if needed - to retain binary logs for a longer period (if using MySQL 5.6 or 5.7, increase the `expire_logs_days` system variable).

[The on-premises MySQL binary logs are needed to set up replication from MySQL on-premises to HeatWave MySQL on OCI for data synchronization. The on-premises MySQL binary logs need to be retained until replication is set up from on-premises MySQL to HeatWave MySQL and all the pending transactions from MySQL on-premises have been replicated to HeatWave MySQL. Adjust your `binlog_expire_logs_seconds` or `expire_logs_days` accordingly. The default values for `binlog_expire_logs_seconds` and `expire_logs_days` are `2592000` and `0` respectively.]
Enabling MySQL Binary Logging:
https://dev.mysql.com/doc/refman/8.0/en/binary-log.html
Setting The MySQL Binary Log Format:
https://dev.mysql.com/doc/refman/8.0/en/binary-log-setting.html
MySQL Binary Log Expiration:
https://dev.mysql.com/doc/refman/8.0/en/replication-options-binary-log.html#sysvar_binlog_expire_logs_seconds

VI) Connect to MySQL on-premises using MySQL Shell and create a replication user. Afterwards, execute MySQL Shell's `util.copyInstance()` utility to export all schemas (including users, indexes, routines, triggers) from MySQL on-premises to HeatWave MySQL on OCI. After the `util.copyInstance()` utility finishes, save the MySQL Shell `Dump_metadata` values.

[The dump created by MySQL Shell's instance copy utility comprises DDL files specifying the schema structure, and tab-separated `.tsv` files containing the data. MySQL Shell's `Dump_metadata` values will let the HeatWave MySQL instance on OCI know where to start the replication from for data synchronization.]
MySQL Shell Copy Utilities: https://dev.mysql.com/doc/mysql-shell/8.2/en/mysql-shell-utils-copy.html

VII) On OCI, create a replication channel to set up replication from MySQL on-premises to HeatWave MySQL on OCI. During the channel creation process, if the on-premises MySQL instance is using binary log positioning - under the replication positioning section, select Source cannot use GTID auto-positioning and provide the binlogFile and binlogPosition values. If the on-premises MySQL instance is using GTIDs - select Source can use GTID auto-positioning (recommended). Create the replication channel afterwards.

[Setting up this replication channel will propagate all the pending data changes to HeatWave MySQL that had occurred on the on-premises MySQL after the execution of MySQL Shell `util.copyInstance()` utility.]
Create OCI Replication Channel: https://docs.oracle.com/en-us/iaas/mysql-database/doc/creating-replication-channel.html#GUID-521ECA6C-4528-4DE9-8928-D9620893872A

VIII) After the replication channel is up, connect to HeatWave MySQL and execute the `SHOW REPLICA STATUS\G` command. From the query output, look for the `seconds_behind_source` and `Replica_SQL_Running_State` fields. If the `seconds_behind_source` field displays a value of `0` and the `Replica_SQL_Running_State` field displays a message of `Replica has read all relay log; waiting for more updates` - this indicates that the HeatWave MySQL instance has fully caught up with the on-premises MySQL changes and the replication channel can now be disabled.

[During this step, it is recommended to stop the database application for ~5 minutes to ensure that no writes are happening to the on-premises MySQL instance before the replication channel between HeatWave MySQL and on-premises MySQL is disabled. After the replication channel has been disabled, you may turn on High Availability for your HeatWave MySQL instance.]
MySQL Replica Replication Status: https://dev.mysql.com/doc/refman/8.0/en/show-replica-status.html
Disabling OCI Replication Channel: https://docs.oracle.com/en-us/iaas/mysql-database/doc/managing-replication-channel.html#GUID-4CD38EFA-7463-4175-8838-0EE40C0FABC9

IX) At this point, the live migration process for the database is complete. The database applications can now point to HeatWave MySQL on OCI.

X) (Optional) On OCI, if the HeatWave option was enabled during HeatWave MySQL DB creation, add the HW Cluster and load data from MySQL InnoDB storage into the HW Cluster using automation.

[Attaching the HeatWave in-memory Cluster combines transactions, analytics, and machine learning services into one MySQL Database.]
Add a HeatWave Cluster: https://docs.oracle.com/en-us/iaas/mysql-database/doc/adding-heatwave-cluster.html#GUID-2335AC1F-FB01-4701-9EFD-810A3489A850
Load Data into HeatWave: https://dev.mysql.com/doc/heatwave/en/mys-hw-auto-parallel-load.html

Walkthrough:

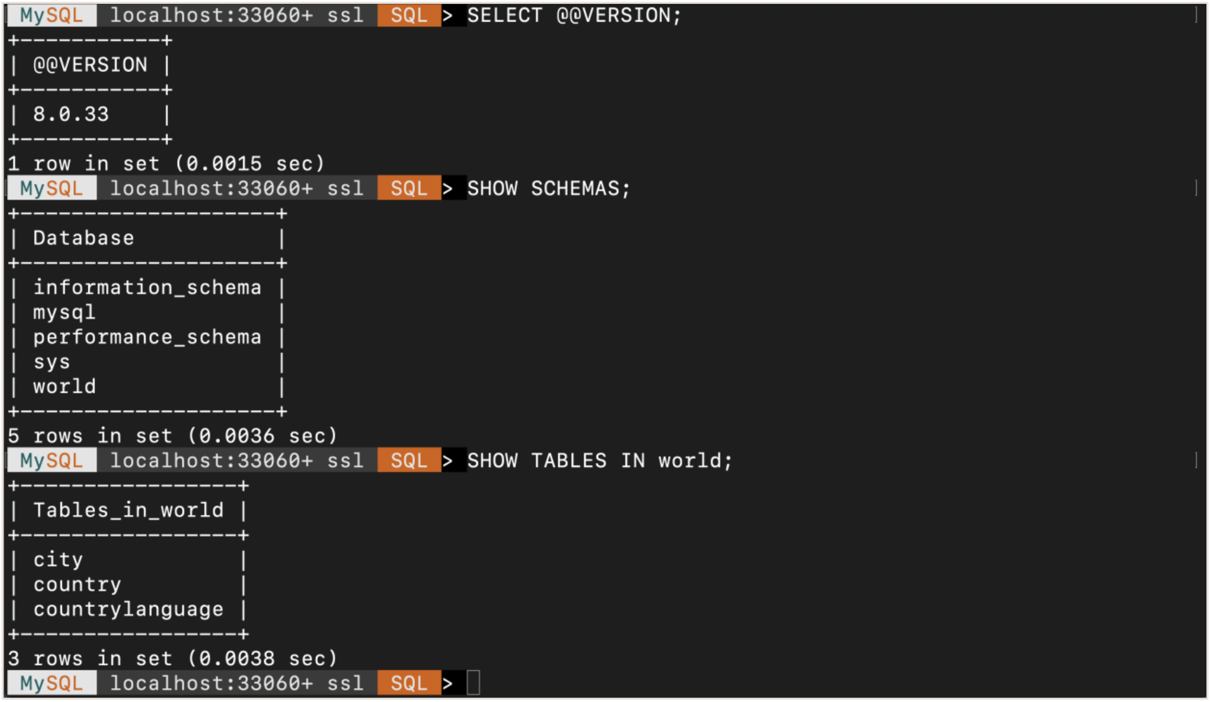
I) Have an Oracle Cloud Infrastructure (OCI) account.

OCI Sign in/Sign up page: https://cloud.oracle.com

II) Set up a VPN connection from OCI to on-premises.

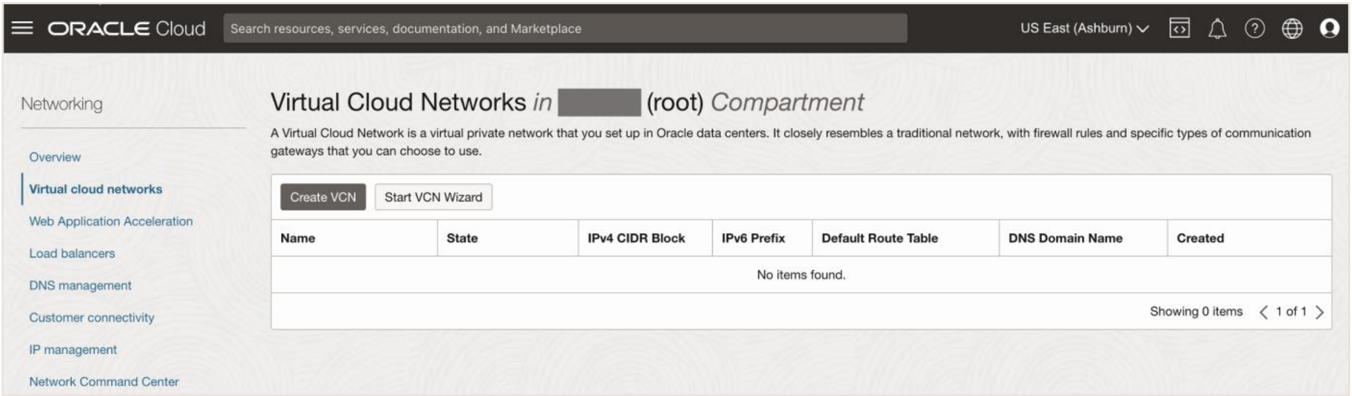
Note: this guide uses OpenVPN Access Server which lets you connect your on-premises MySQL with OCI HeatWave MySQL. You cannot use OpenVPN Access Server to connect entire sites or networks to an Oracle VCN; in that scenario, it is recommended to use Site-to-site VPN or FastConnect.

1. Below is the on-premises MySQL instance version and the sample database (“world”) that will be migrated for this guide. The sample world database consists of 3 tables.



```
 MySQL  localhost:33060+ ssl  SQL > SELECT @@VERSION;
+-----------+
| @@VERSION |
+-----------+
| 8.0.33    |
+-----------+
1 row in set (0.0015 sec)
 MySQL  localhost:33060+ ssl  SQL > SHOW SCHEMAS;
+--------------------+
| Database           |
+--------------------+
| information_schema |
| mysql              |
| performance_schema |
| sys                |
| world              |
+--------------------+
5 rows in set (0.0036 sec)
 MySQL  localhost:33060+ ssl  SQL > SHOW TABLES IN world;
+-----------------+
| Tables_in_world |
+-----------------+
| city            |
| country         |
| countrylanguage |
+-----------------+
3 rows in set (0.0038 sec)
 MySQL  localhost:33060+ ssl  SQL > 
```

2. Log in to OCI and create a VCN. Open the navigation menu, click **Networking**, and click **Virtual cloud networks**.
3. Ensure you are in your desired compartment - we have chosen the `root` compartment. Click **Start VCN Wizard**.



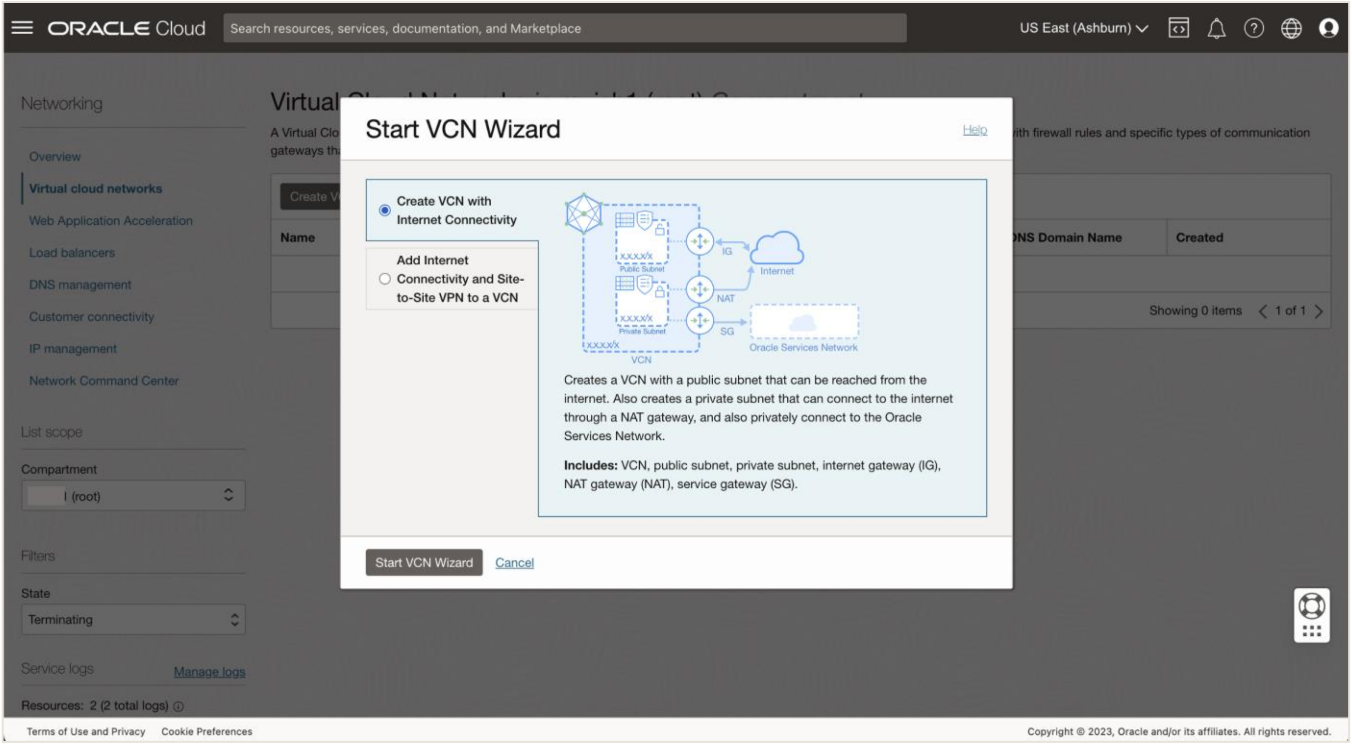
Virtual Cloud Networks *in* [redacted] (root) *Compartment*

A Virtual Cloud Network is a virtual private network that you set up in Oracle data centers. It closely resembles a traditional network, with firewall rules and specific types of communication gateways that you can choose to use.

Name	State	IPv4 CIDR Block	IPv6 Prefix	Default Route Table	DNS Domain Name	Created
No items found.						

Showing 0 items 1 of 1

4. Select **Create VCN with Internet Connectivity** and click **Start VCN Wizard**.



Compartment: [redacted] (root)

State: Terminating

Resources: 2 (2 total logs)

Start VCN Wizard

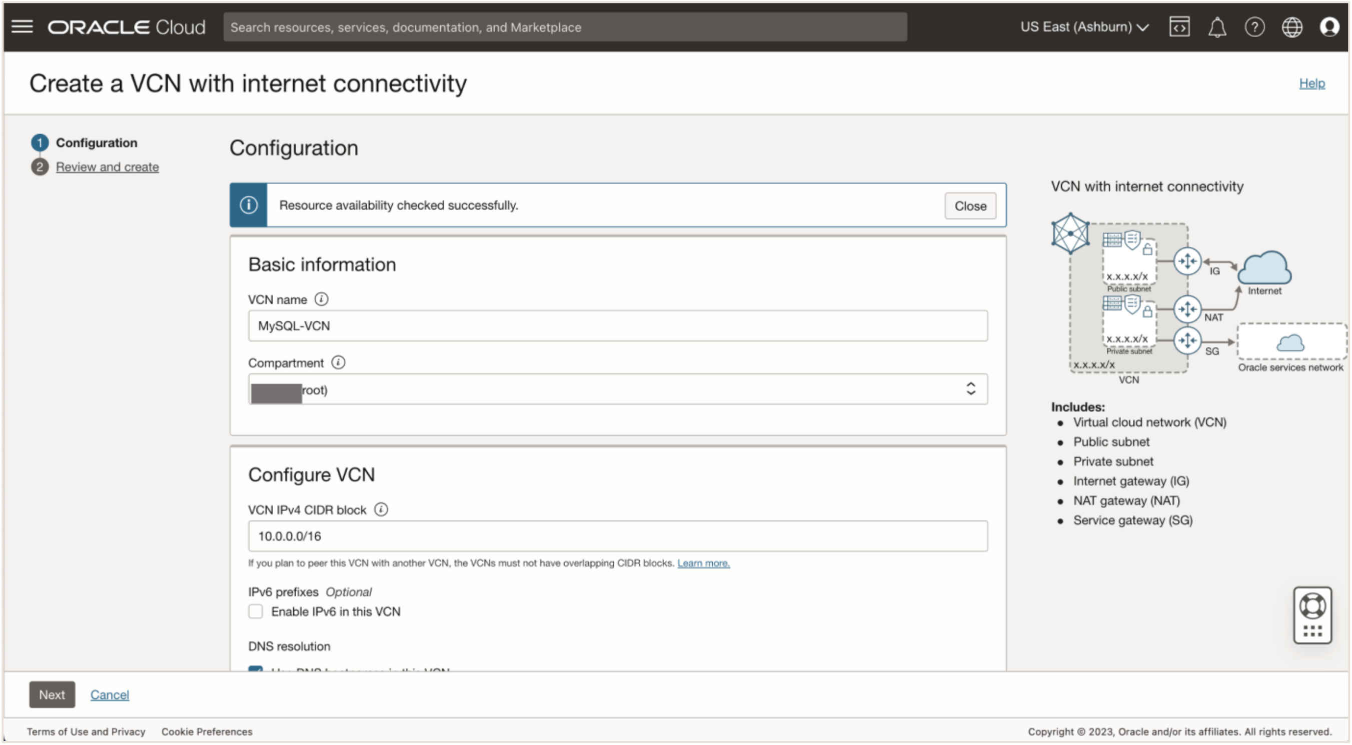
● Create VCN with Internet Connectivity

○ Add Internet Connectivity and Site-to-Site VPN to a VCN

Creates a VCN with a public subnet that can be reached from the internet. Also creates a private subnet that can connect to the internet through a NAT gateway, and also privately connect to the Oracle Services Network.

Includes: VCN, public subnet, private subnet, internet gateway (IG), NAT gateway (NAT), service gateway (SG).

5. Enter a **VCN name** and **configure your VCN's IPv4 CIDR block** - **including the public and the private subnet**. The guide uses the default values for all. Make sure that the OCI VCN IPv4 CIDR block does not overlap with your on-premises network.



Create a VCN with internet connectivity

Configuration

Resource availability checked successfully.

Basic information

VCN name: MySQL-VCN

Compartment: [redacted] root)

Configure VCN

VCN IPv4 CIDR block: 10.0.0.0/16

If you plan to peer this VCN with another VCN, the VCNs must not have overlapping CIDR blocks. Learn more.

IPv6 prefixes *Optional*

□ Enable IPv6 in this VCN

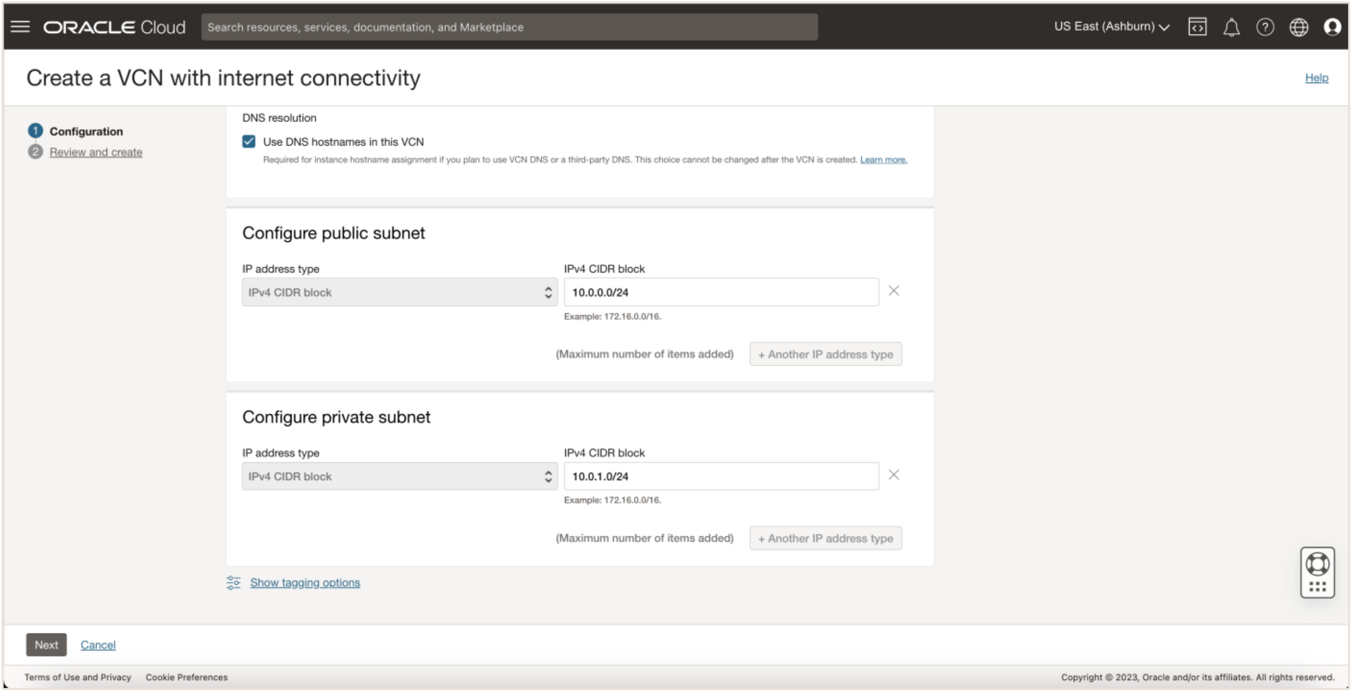
DNS resolution

VCN with internet connectivity

Includes:

- Virtual cloud network (VCN)
- Public subnet
- Private subnet
- Internet gateway (IG)
- NAT gateway (NAT)
- Service gateway (SG)

6. Click **Next** after the configuration for your VCN is completed.



Create a VCN with internet connectivity

1 Configuration
2 Review and create

DNS resolution

☑ Use DNS hostnames in this VCN

Required for instance hostname assignment if you plan to use VCN DNS or a third-party DNS. This choice cannot be changed after the VCN is created. Learn more.

Configure public subnet

IP address type: IPv4 CIDR block

IPv4 CIDR block: 10.0.0.0/24

Example: 172.16.0.0/16.

(Maximum number of items added) + Another IP address type

Configure private subnet

IP address type: IPv4 CIDR block

IPv4 CIDR block: 10.0.1.0/24

Example: 172.16.0.0/16.

(Maximum number of items added) + Another IP address type

Show tagging options

Next Cancel

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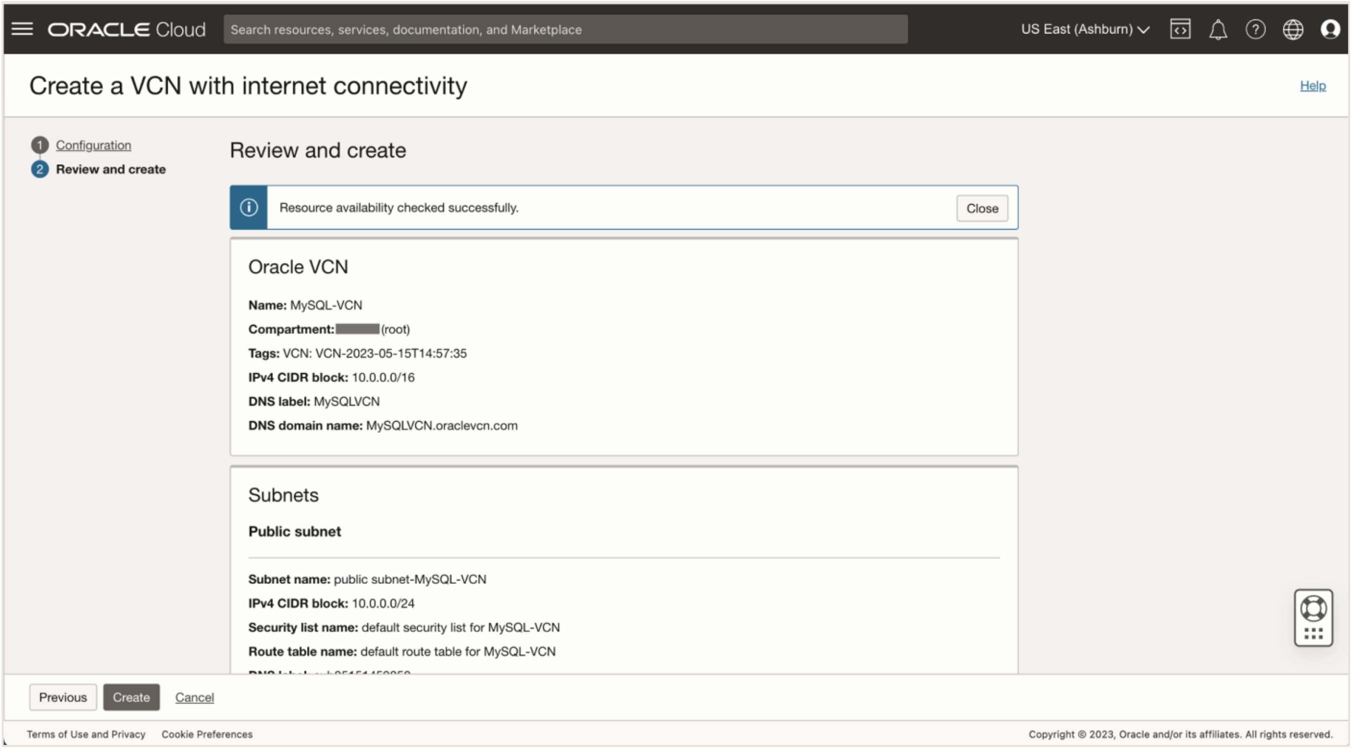
7. On the Review and create page, validate the information for your VCN and click **Create**.



Create a VCN with internet connectivity

1 Configuration
2 Review and create

Review and create

Resource availability checked successfully. Close

Oracle VCN

Name: MySQL-VCN

Compartment:[redacted](root)

Tags: VCN: VCN-2023-05-15T14:57:35

IPv4 CIDR block: 10.0.0.0/16

DNS label: MySQLVCN

DNS domain name: MySQLVCN.oraclevcn.com

Subnets

Public subnet

Subnet name: public subnet-MySQL-VCN

IPv4 CIDR block: 10.0.0.0/24

Security list name: default security list for MySQL-VCN

Route table name: default route table for MySQL-VCN

Previous Create Cancel

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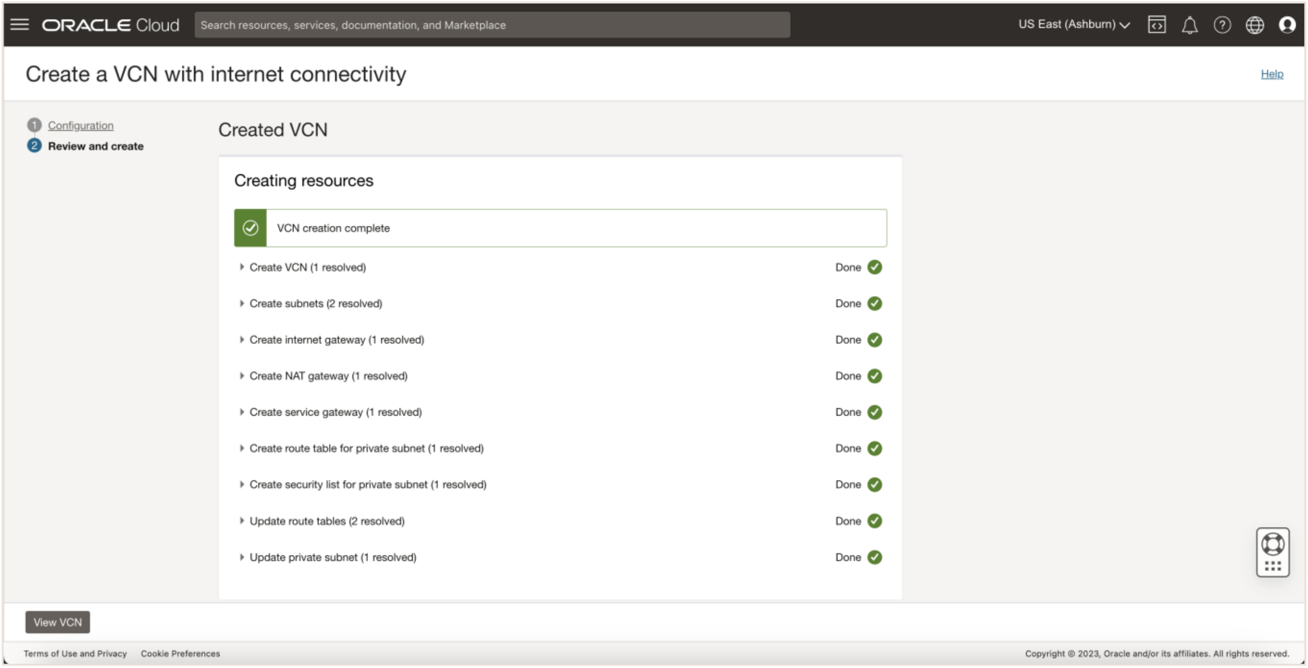
8. Click **View VCN** after your VCN creation has been completed.



Create a VCN with internet connectivity

1 Configuration
2 **Review and create**

Created VCN

Creating resources

VCN creation complete

Create VCN (1 resolved)	Done ✓
Create subnets (2 resolved)	Done ✓
Create internet gateway (1 resolved)	Done ✓
Create NAT gateway (1 resolved)	Done ✓
Create service gateway (1 resolved)	Done ✓
Create route table for private subnet (1 resolved)	Done ✓
Create security list for private subnet (1 resolved)	Done ✓
Update route tables (2 resolved)	Done ✓
Update private subnet (1 resolved)	Done ✓

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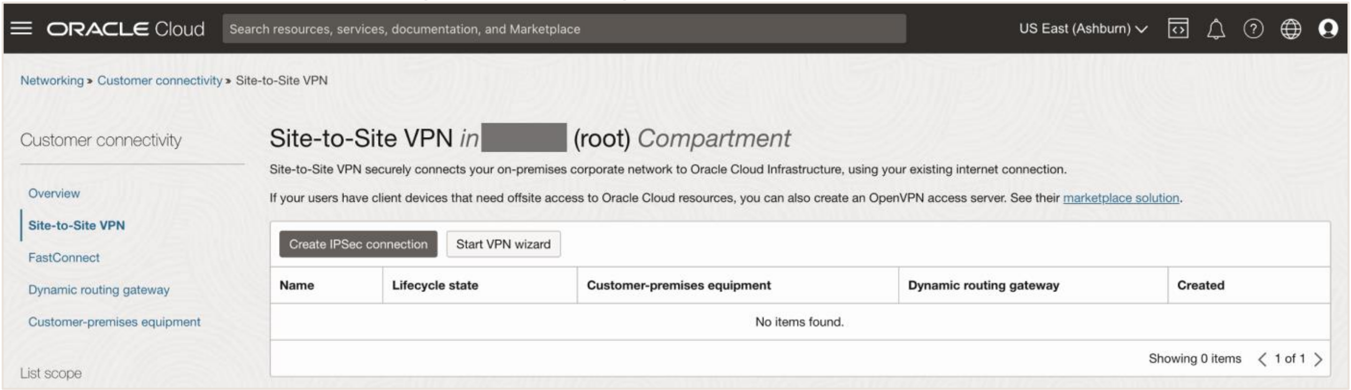
9. From the OCI navigation menu, click **Networking** and click **Site-to-Site VPN**.

10. Click **marketplace solution** on the right side of the page.



Site-to-Site VPN *in* [redacted] (root) *Compartment*

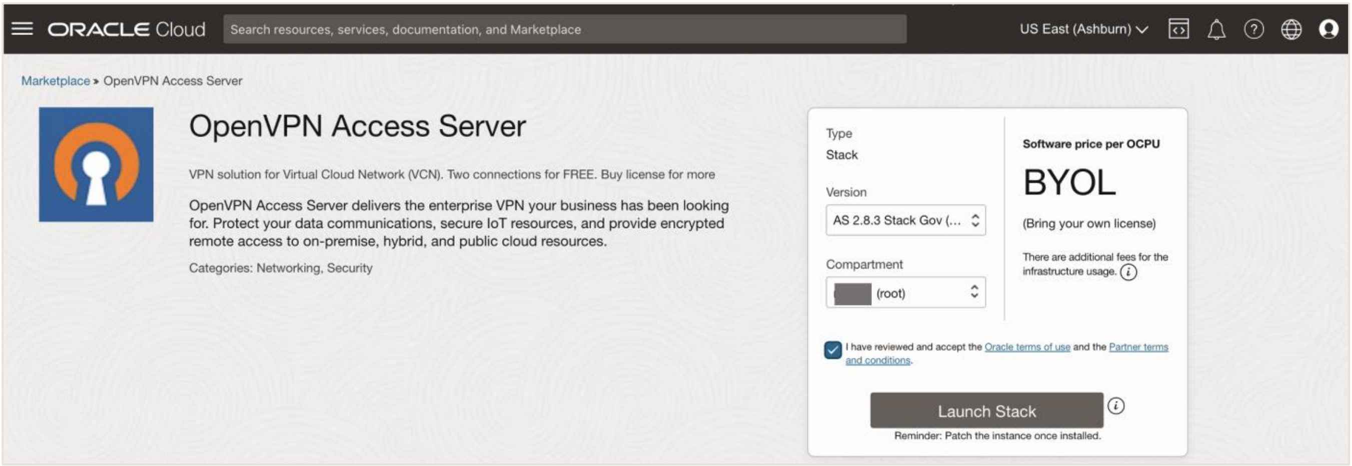
Site-to-Site VPN securely connects your on-premises corporate network to Oracle Cloud Infrastructure, using your existing internet connection.

If your users have client devices that need offsite access to Oracle Cloud resources, you can also create an OpenVPN access server. See their marketplace solution.

Name	Lifecycle state	Customer-premises equipment	Dynamic routing gateway	Created
No items found.				

Showing 0 items ‹ 1 of 1 ›

11. On the OpenVPN Access Server page, from the dropdown, **select the compartment where your VCN resides**. Check the **terms of use and conditions** checkbox and click **Launch Stack**.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Marketplace » OpenVPN Access Server
Launch Stack

OpenVPN Access Server

VPN solution for Virtual Cloud Network (VCN). Two connections for FREE. Buy license for more

OpenVPN Access Server delivers the enterprise VPN your business has been looking for. Protect your data communications, secure IoT resources, and provide encrypted remote access to on-premise, hybrid, and public cloud resources.

Categories: Networking, Security

Type
Stack

Version
AS 2.8.3 Stack Gov (...

Compartment
[redacted] (root)

Software price per OCPU

BYOL

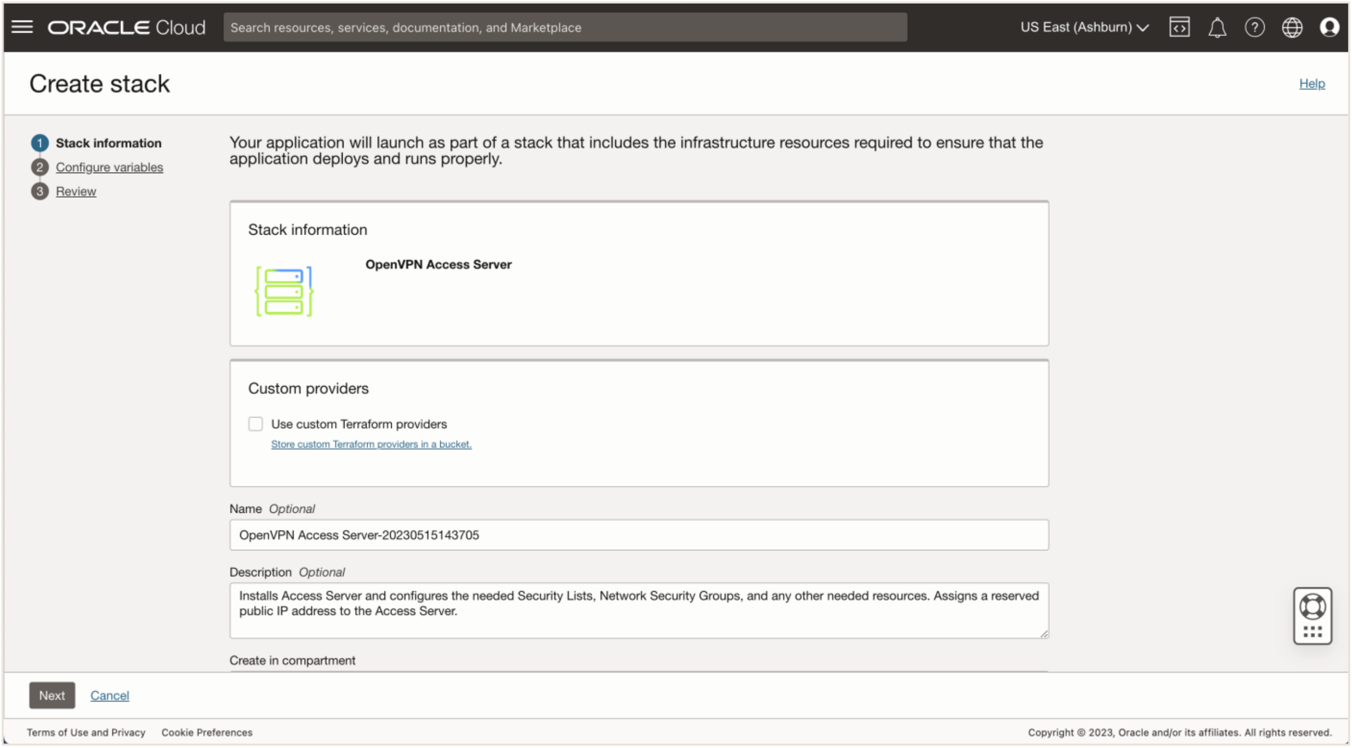
(Bring your own license)

There are additional fees for the infrastructure usage.

☑ I have reviewed and accept the Oracle terms of use and the Partner terms and conditions.

Reminder: Patch the instance once installed.

12. On the **Stack information** page of **Create stack**, leave everything as-is and click **Next**.



Create stack

1 Stack information
2 Configure variables
3 Review

Your application will launch as part of a stack that includes the infrastructure resources required to ensure that the application deploys and runs properly.

Stack information

OpenVPN Access Server

Custom providers

□ Use custom Terraform providers

Store custom Terraform providers in a bucket.

Name *Optional*: OpenVPN Access Server-20230515143705

Description *Optional*: Installs Access Server and configures the needed Security Lists, Network Security Groups, and any other needed resources. Assigns a reserved public IP address to the Access Server.

Create in compartment

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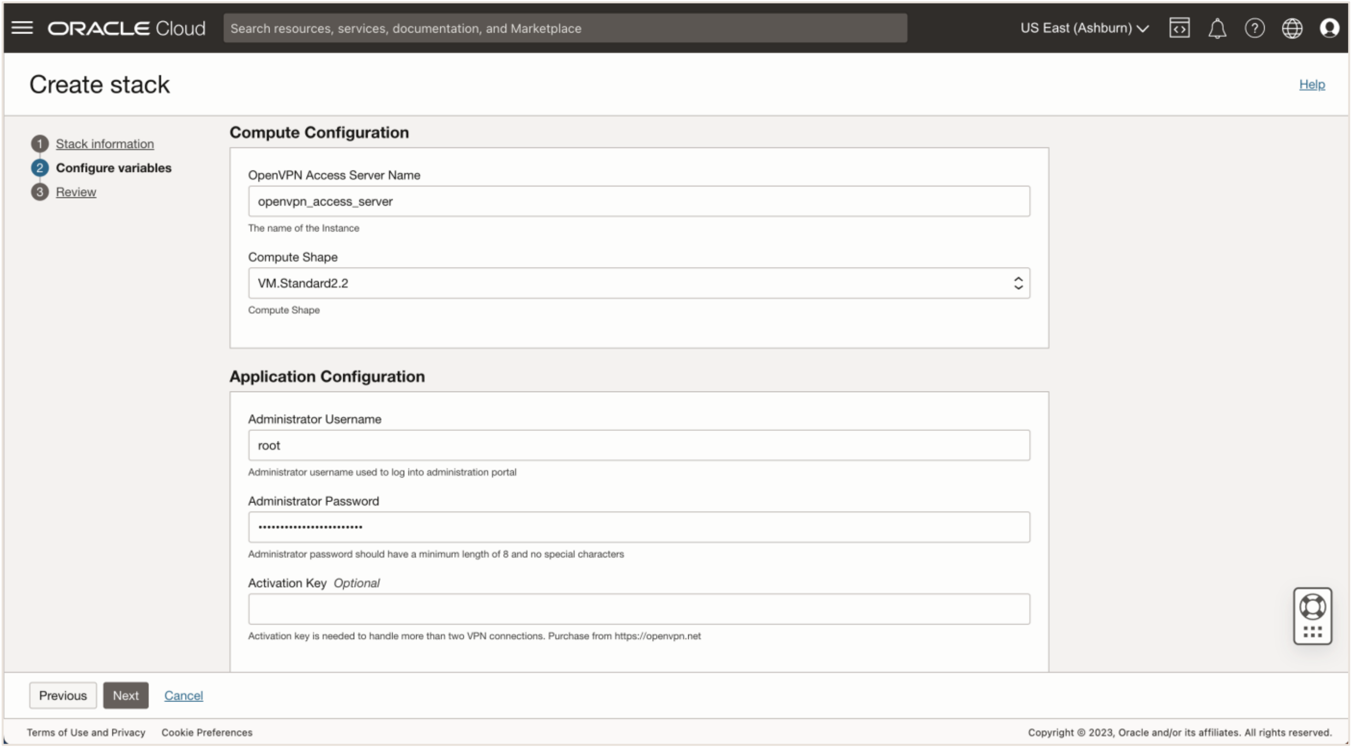
13. On the **Configure variables** page, under **Compute Shape** select **VM.Standard2.2**. For **Application Configuration**, **create an admin username and password**. Make a note of the admin credentials.



Create stack

1 Stack information
2 Configure variables
3 Review

Compute Configuration

OpenVPN Access Server Name: openvpn_access_server

The name of the Instance

Compute Shape: VM.Standard2.2

Compute Shape

Application Configuration

Administrator Username: root

Administrator username used to log into administration portal

Administrator Password: ••••••••••••••••••••••••

Administrator password should have a minimum length of 8 and no special characters

Activation Key *Optional*

Activation key is needed to handle more than two VPN connections. Purchase from https://openvpn.net

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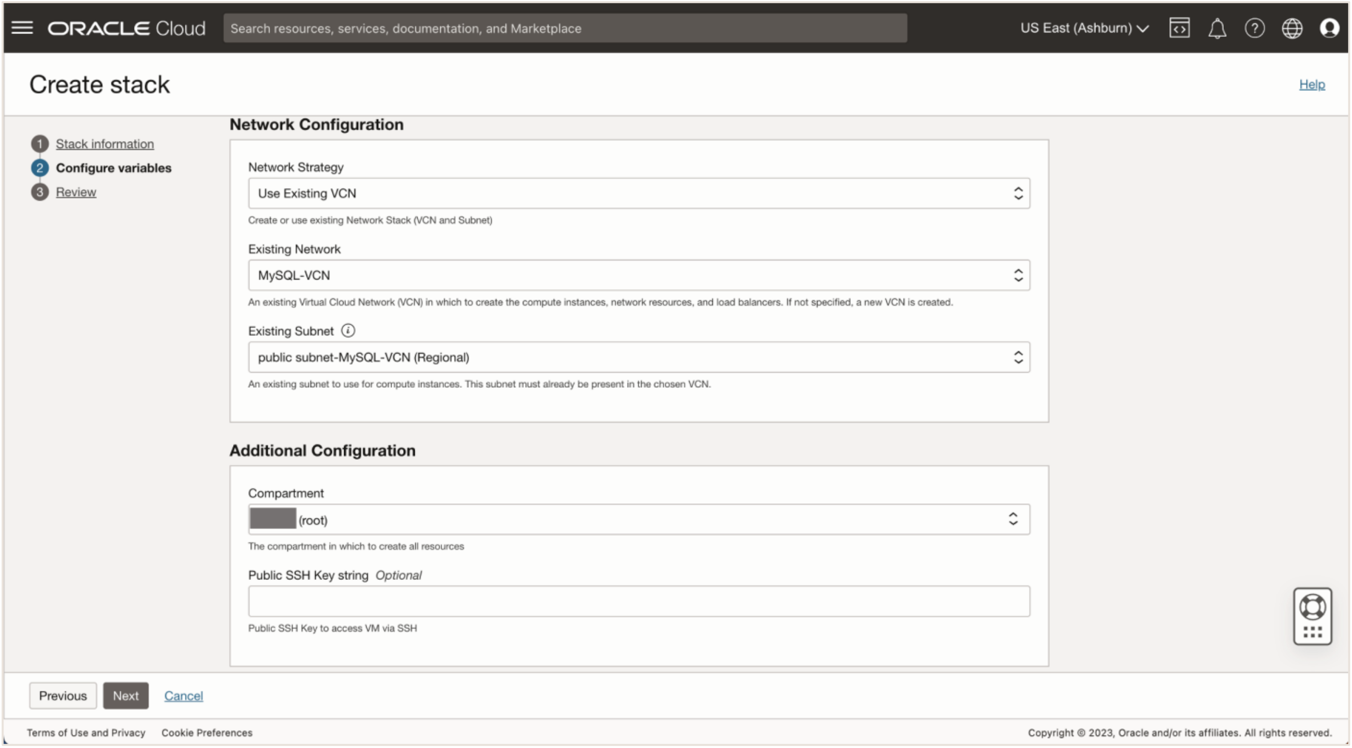
14. For **Network Configuration**, under **Network Strategy**, select **Use Existing VCN** and select the **VCN that we created earlier** from the **Existing Network** dropdown. For the **Existing Subnet**, select the **Public Subnet** of your VCN. Under **Additional Configuration**, ensure the compartment is where your VCN resides. Click **Next**.



Create stack

1 Stack information
2 Configure variables
3 Review

Network Configuration

Network Strategy: Use Existing VCN

Create or use existing Network Stack (VCN and Subnet)

Existing Network: MySQL-VCN

An existing Virtual Cloud Network (VCN) in which to create the compute instances, network resources, and load balancers. If not specified, a new VCN is created.

Existing Subnet: public subnet-MySQL-VCN (Regional)

An existing subnet to use for compute instances. This subnet must already be present in the chosen VCN.

Additional Configuration

Compartment: [redacted] (root)

The compartment in which to create all resources

Public SSH Key string *Optional*

Public SSH Key to access VM via SSH

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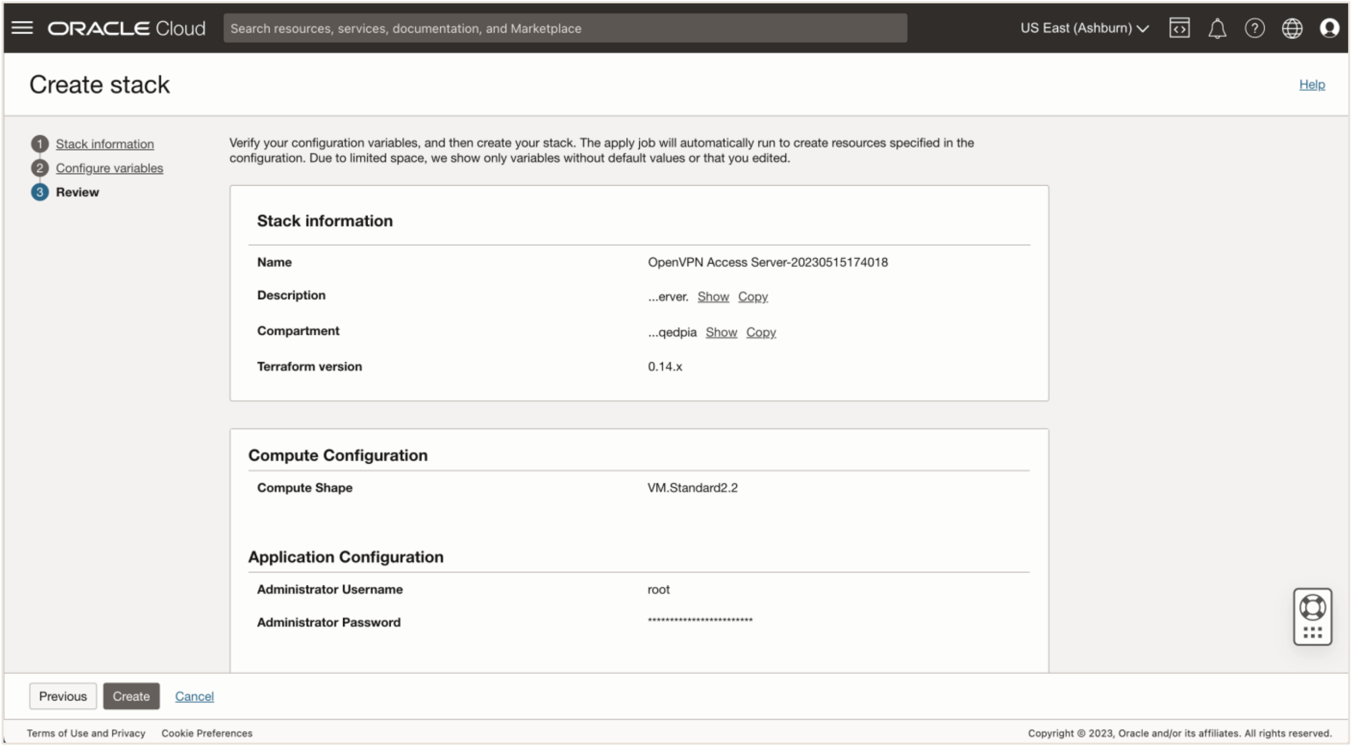
15. On the Review page of Create stack, click **Create**.



Create stack

1 Stack information
2 Configure variables
3 Review

Verify your configuration variables, and then create your stack. The apply job will automatically run to create resources specified in the configuration. Due to limited space, we show only variables without default values or that you edited.

Stack information

Name	OpenVPN Access Server-20230515174018
Description	...erver. Show Copy
Compartment	...qedpia Show Copy
Terraform version	0.14.x

Compute Configuration

Compute Shape	VM.Standard2.2

Application Configuration

Administrator Username	root
Administrator Password	************************

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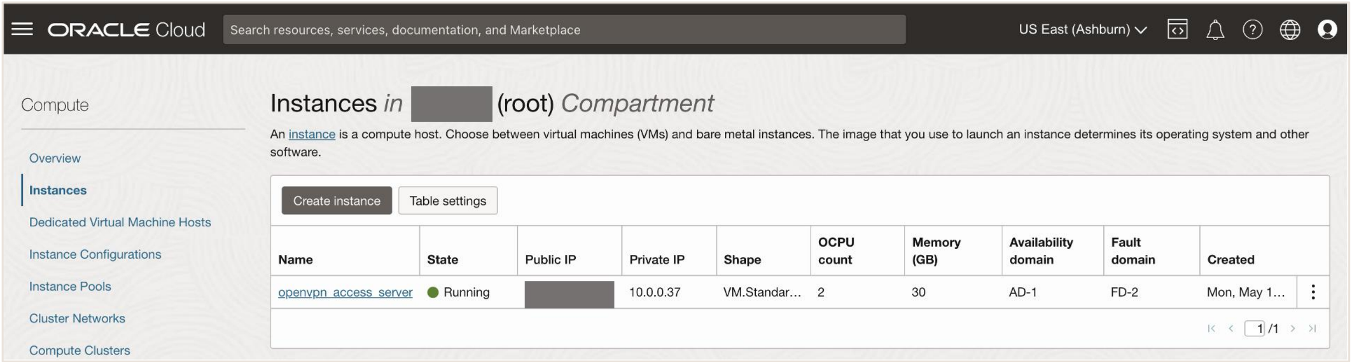
16. Finishing the previous step will provision a compute instance for the VPN. From the OCI navigation menu, click **Compute** and click **Instances**. It may take a few minutes for your compute host to be ready.

17. Copy and save the Public and the Private IP of the openvpn_access_server.

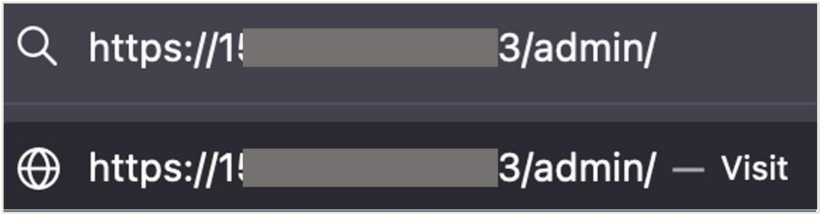


Instances *in* [redacted] (root) *Compartment*

An instance is a compute host. Choose between virtual machines (VMs) and bare metal instances. The image that you use to launch an instance determines its operating system and other software.

Name	State	Public IP	Private IP	Shape	OCPU count	Memory (GB)	Availability domain	Fault domain	Created
openvpn_access_server	● Running	[redacted]	10.0.0.37	VM.Standar…	2	30	AD-1	FD-2	Mon, May 1…

18. Open a web browser and enter the following in the search bar.
https://<openvpn-acess-server-public-ip>/admin/

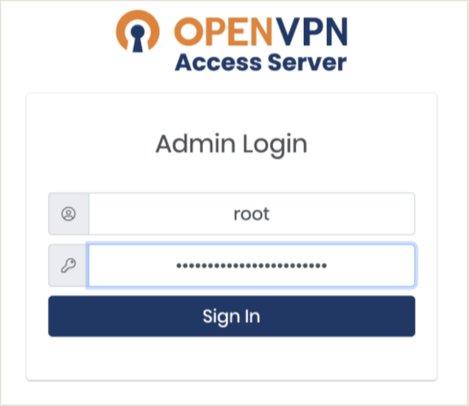


https://1[redacted]3/admin/

https://1[redacted]3/admin/ — Visit

Note: in the web browser when prompted, click **Advanced** and click **Proceed to <openvpn-access-server-public-ip> (unsafe)** or **Accept the Risk and Continue**.

19. Enter the admin credentials that you configured earlier in step 13 to log in.

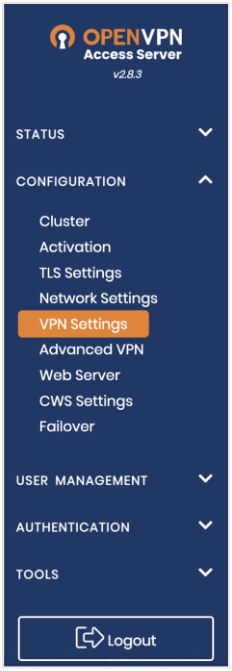


Admin Login

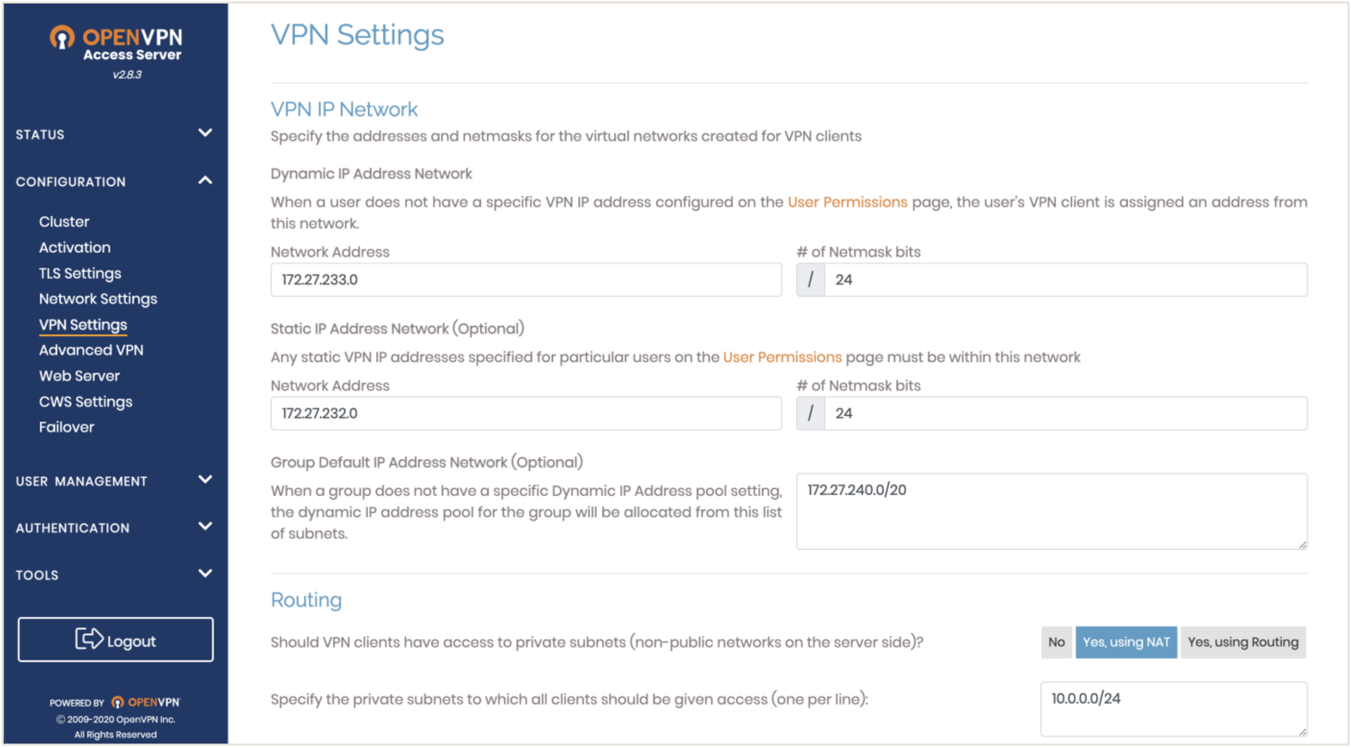
root

••••••••••••••••••••••••

20. After logging in, from the left-hand side menu, select **Configuration** and click **VPN Settings**.



21. On the VPN Settings page, under **Dynamic IP Address Network** - input **172.27.233.0** for **Network Address** and **24** for **# of Netmask bits**. Under **Static IP Address Network**, input **172.27.232.0** for **Network Address** and **24** for **# of Netmask bits**. Leave the **Group Default IP Address Network** field as-is.



VPN Settings

VPN IP Network

Specify the addresses and netmasks for the virtual networks created for VPN clients

Dynamic IP Address Network

When a user does not have a specific VPN IP address configured on the User Permissions page, the user's VPN client is assigned an address from this network.

Network Address: 172.27.233.0

# of Netmask bits: / 24

Static IP Address Network (Optional)

Any static VPN IP addresses specified for particular users on the User Permissions page must be within this network

Network Address: 172.27.232.0

# of Netmask bits: / 24

Group Default IP Address Network (Optional)

When a group does not have a specific Dynamic IP Address pool setting, the dynamic IP address pool for the group will be allocated from this list of subnets.

172.27.240.0/20

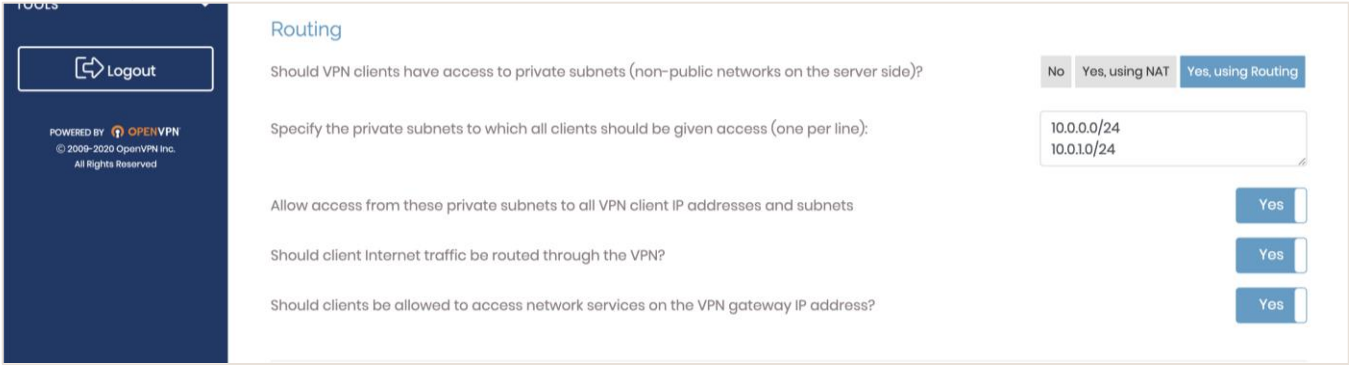
Routing

Should VPN clients have access to private subnets (non-public networks on the server side)? No [✓ Yes, using NAT] Yes, using Routing

Specify the private subnets to which all clients should be given access (one per line):

10.0.0.0/24

22. While on the VPN Settings page, scroll down to **Routing**. Select **Yes, using Routing**, and **specify your OCI VCN public and private subnets IPv4 CIDR blocks** next to **Specify the private subnets to which all clients should be given access (one per line)**.



Routing

Should VPN clients have access to private subnets (non-public networks on the server side)? No | Yes, using NAT | **Yes, using Routing**

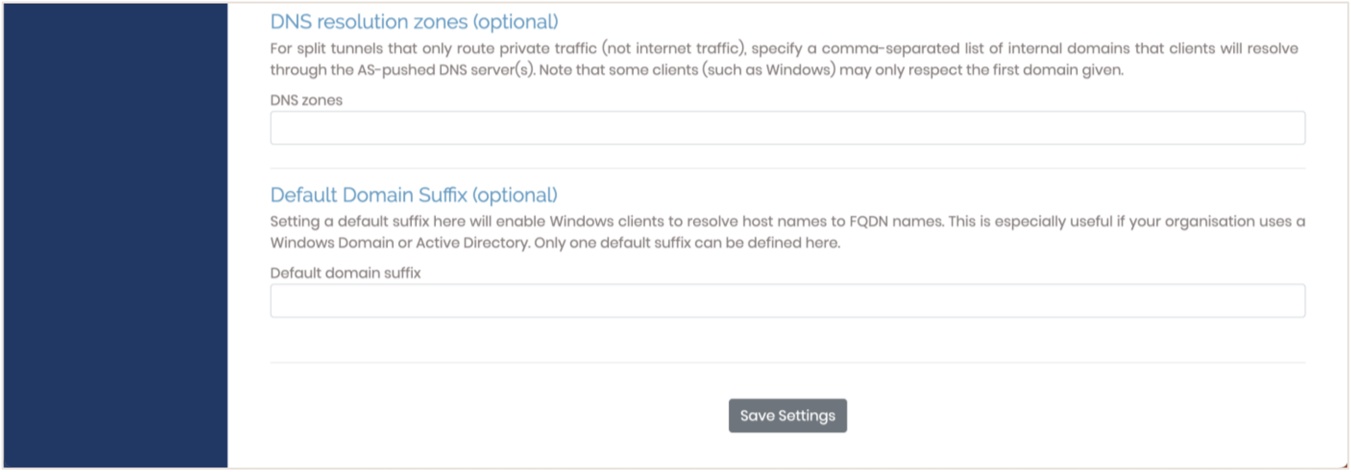
Specify the private subnets to which all clients should be given access (one per line):
10.0.0.0/24
10.0.1.0/24

Allow access from these private subnets to all VPN client IP addresses and subnets: Yes

Should client Internet traffic be routed through the VPN? Yes

Should clients be allowed to access network services on the VPN gateway IP address? Yes

23. Scroll down and click **Save Settings**.



DNS resolution zones (optional)

For split tunnels that only route private traffic (not internet traffic), specify a comma-separated list of internal domains that clients will resolve through the AS-pushed DNS server(s). Note that some clients (such as Windows) may only respect the first domain given.

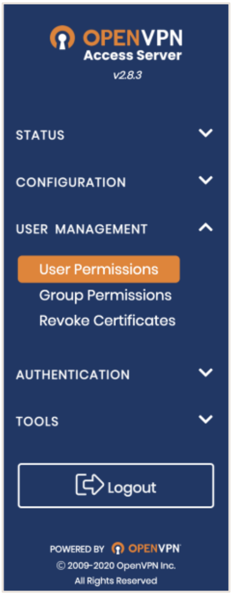
DNS zones

Default Domain Suffix (optional)

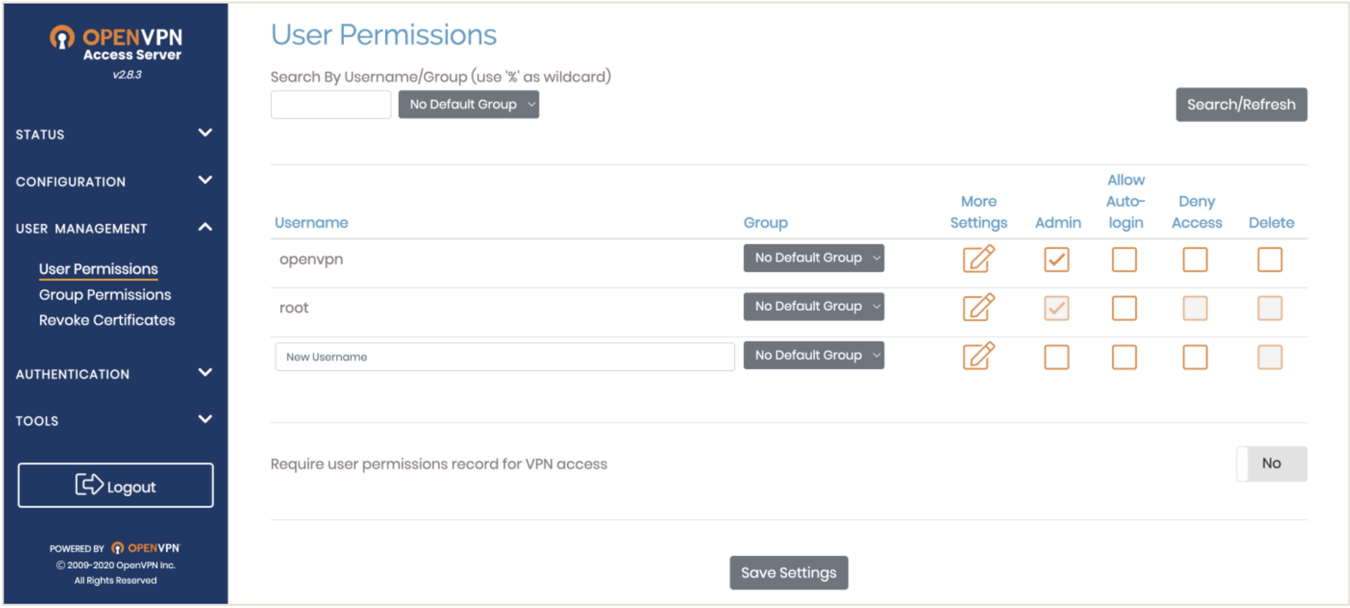
Setting a default suffix here will enable Windows clients to resolve host names to FQDN names. This is especially useful if your organisation uses a Windows Domain or Active Directory. Only one default suffix can be defined here.

Default domain suffix

24. From the left-hand OpenVPN Access Server menu, select **USER MANAGEMENT** and click **User Permissions**.



25. Enter a username in the **New Username** field and click the **More Settings** icon in the adjacent column.



OPENVPN Access Server v2.8.3

STATUS
CONFIGURATION
USER MANAGEMENT
User Permissions
Group Permissions
Revoke Certificates
AUTHENTICATION
TOOLS
Logout

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User Permissions

Search By Username/Group (use '%' as wildcard)

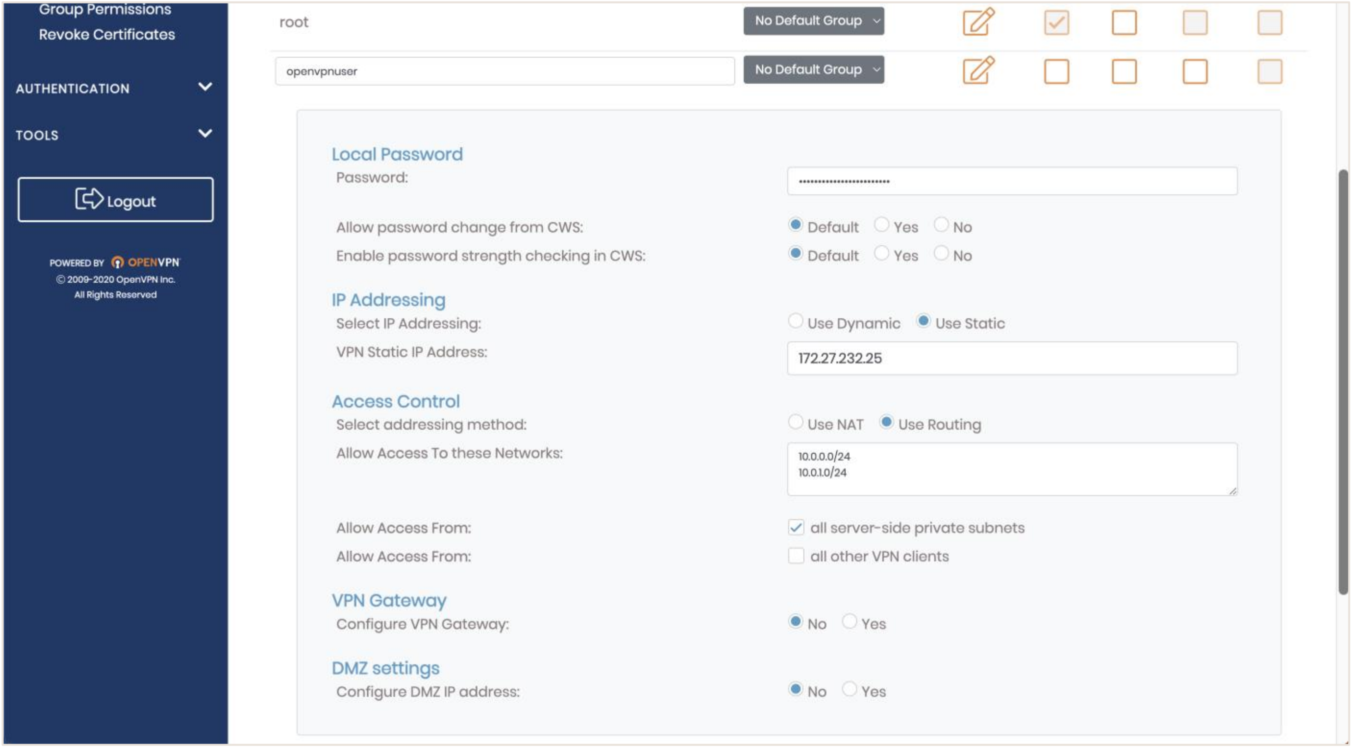
No Default Group | Search/Refresh

Username	Group	More Settings	Admin	Allow Auto-login	Deny Access	Delete
openvpn	No Default Group	✎	☑	□	□	□
root	No Default Group	✎	☑	□	□	□
New Username	No Default Group	✎	□	□	□	□

Require user permissions record for VPN access: No

Save Settings

26. Enter a **Password** for the user you created in the previous step. For **Select IP Addressing**, click **Use Static** and specify the IP address to assign to the new user in the **VPN Static IP Address** field. This IP address must be in the range defined in the **Static IP Address Network** field of the VPN Configuration, see step 21. For this guide, we have chosen **172.27.232.25**. **Save the VPN Static IP Address** for later use. Select **Use Routing** for **Select addressing method** and **specify your OCI VCN public and private subnets IPv4 CIDR blocks** in the **Allow Access To these Networks** field. For **Allow Access From**, select **all server-side private subnets**. Scroll down and click **Save Settings**.



Group Permissions
Revoke Certificates
AUTHENTICATION
TOOLS
Logout

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root	No Default Group	✎	☑	□	□	□
openvpnuser	No Default Group	✎	□	□	□	□

Local Password
Password: ••••••••••••••••••••••

Allow password change from CWS: ● Default ○ Yes ○ No
Enable password strength checking in CWS: ● Default ○ Yes ○ No

IP Addressing
Select IP Addressing: ○ Use Dynamic ● Use Static
VPN Static IP Address: 172.27.232.25

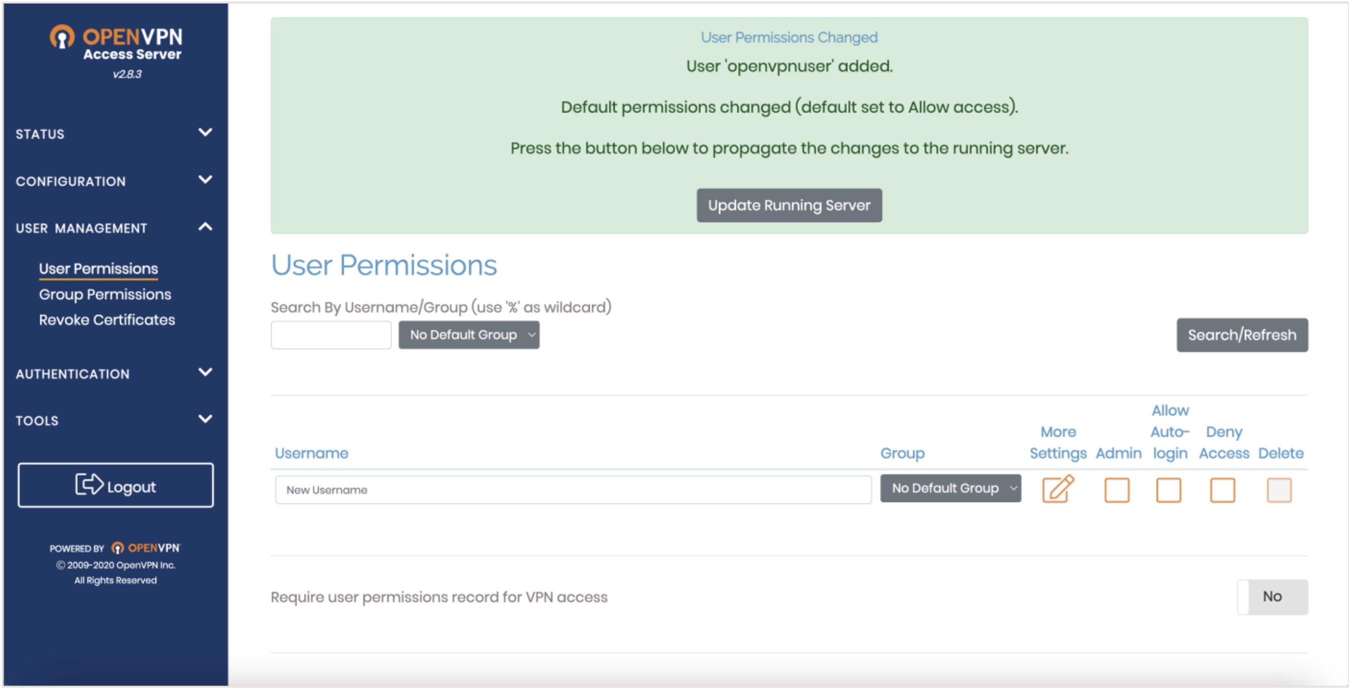
Access Control
Select addressing method: ○ Use NAT ● Use Routing
Allow Access To these Networks:
10.0.0.0/24
10.0.1.0/24

Allow Access From: ☑ all server-side private subnets
Allow Access From: □ all other VPN clients

VPN Gateway
Configure VPN Gateway: ● No ○ Yes

DMZ settings
Configure DMZ IP address: ● No ○ Yes

27. After saving the completed previous step, click **Update Running Server**.



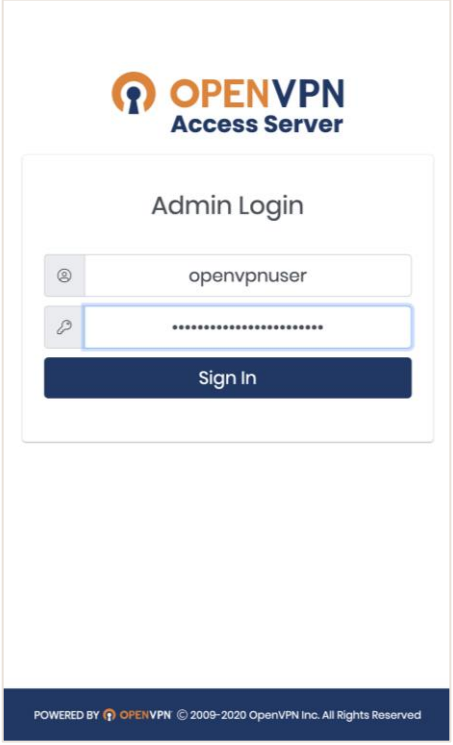
User Permissions Changed

User 'openvpnuser' added.

Default permissions changed (default set to Allow access).

Press the button below to propagate the changes to the running server.

28. Log out and log in using the new user credentials that you created in step 26. Remove the `/admin` from the URL when logging in if you did not assign the new user to be an admin.
https://<openvpn-acess-server-public-ip>/



OPENVPN
Access Server
Admin Login

openvpnuser

••••••••••••••••••••••••

Sign In
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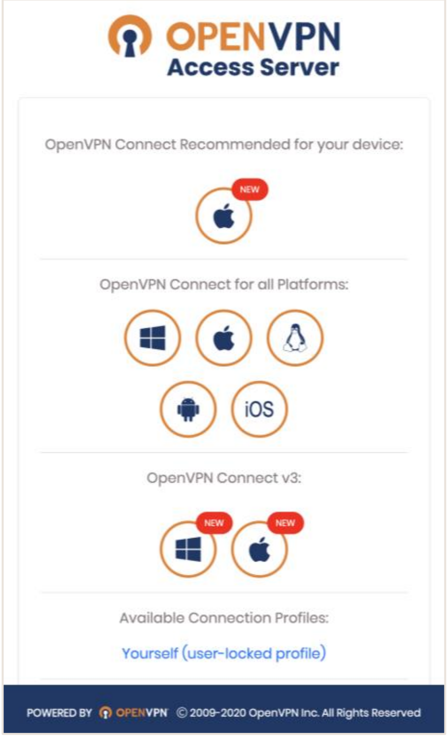
29. Once logged in as the new user, click **Yourself (user-locked profile)** to download `client.ovpn` profile.


OPENVPN
Access Server
OpenVPN Connect Recommended for your device:
NEW
OpenVPN Connect for all Platforms:
iOS
OpenVPN Connect v3:
NEW
NEW
Available Connection Profiles:
Yourself (user-locked profile)
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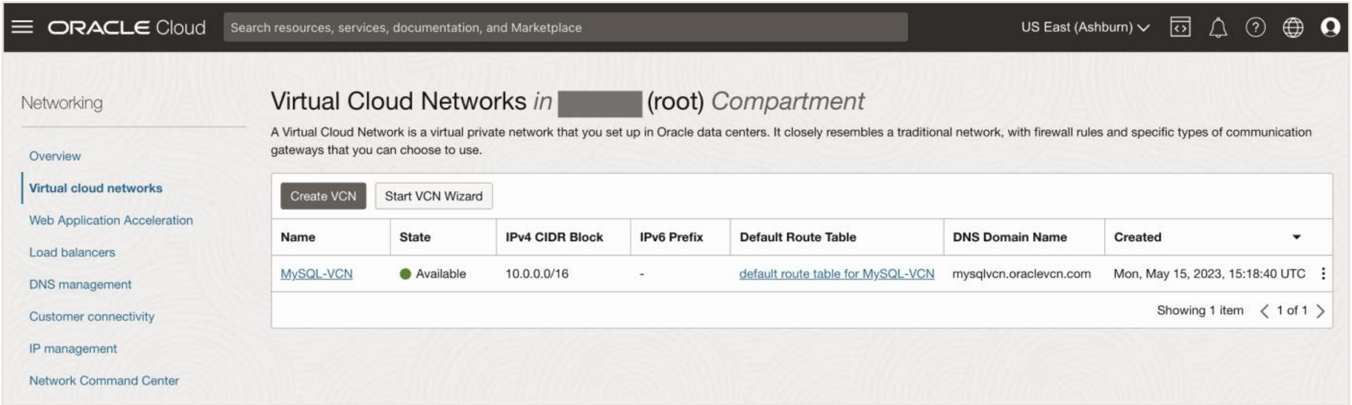
30. Click the appropriate platform icon depending on the Operating System (OS) you are running to download the OpenVPN client. For this guide, we are using macOS. After downloading the client, install it. For more information see, Installation guide for macOS, Installation guide for Windows, and Connecting to Access Server with Linux.

31. After installing the OpenVPN client on your OS**,** import the `client.ovpn` profile. For more information see, Import a Profile.

32. Once the profile has been imported, **start the OpenVPN Client**. It is now time to configure the OCI VCN to enable communications from the OpenVPN Access Server.

33. Login to OCI and open the navigation menu. Select **Networking** and click **Virtual Cloud Networks**.

34. Save the VCN **IPv4 CIDR Block** for later use and click on the **name of your VCN**.

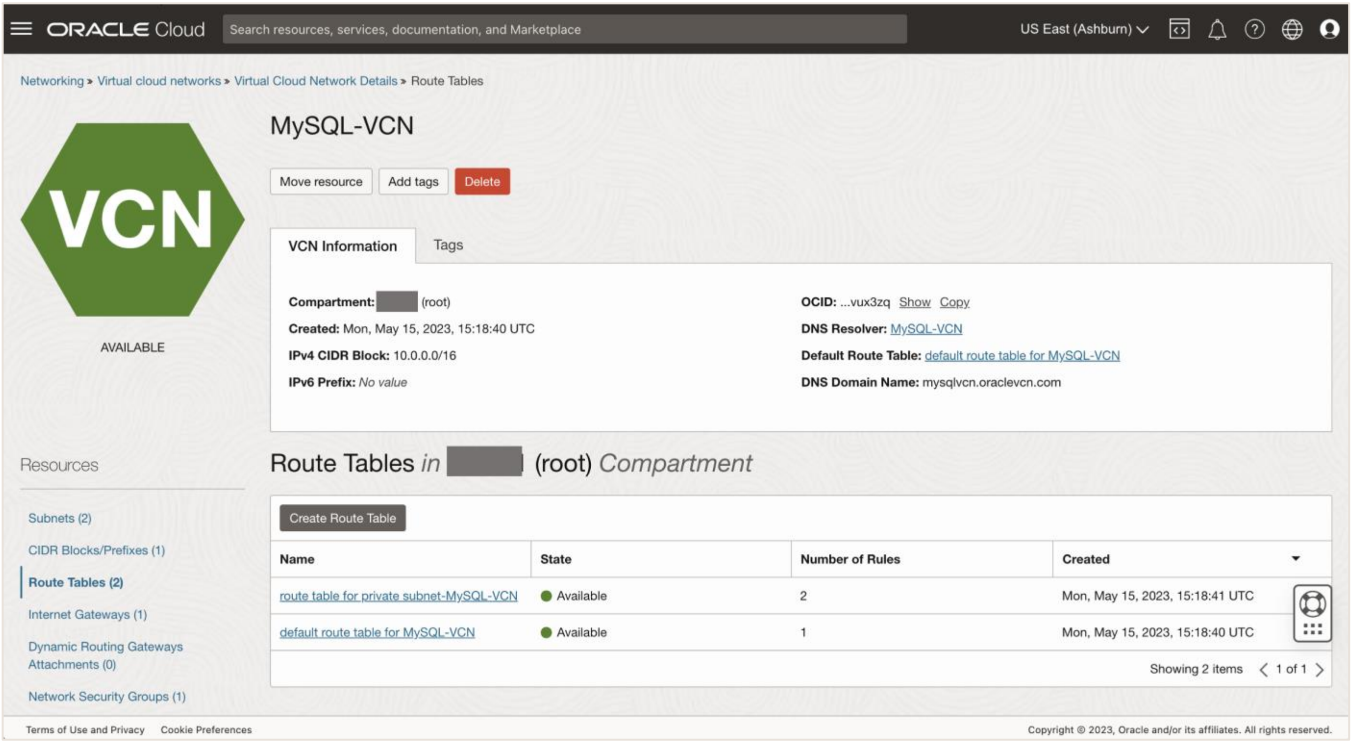


Virtual Cloud Networks *in* [redacted] (root) *Compartment*

A Virtual Cloud Network is a virtual private network that you set up in Oracle data centers. It closely resembles a traditional network, with firewall rules and specific types of communication gateways that you can choose to use.

Name	State	IPv4 CIDR Block	IPv6 Prefix	Default Route Table	DNS Domain Name	Created
MySQL-VCN	● Available	10.0.0.0/16	-	default route table for MySQL-VCN	mysqlvcn.oraclevcn.com	Mon, May 15, 2023, 15:18:40 UTC

35. On the Virtual Cloud Network Details page, click **Route Tables** and click **route table for private subnet-<vcn-name>**.



MySQL-VCN

Compartment: [redacted] (root)
Created: Mon, May 15, 2023, 15:18:40 UTC
IPv4 CIDR Block: 10.0.0.0/16
IPv6 Prefix: *No value*

OCID: ...vux3zq Show Copy
DNS Resolver: MySQL-VCN
Default Route Table: default route table for MySQL-VCN
DNS Domain Name: mysqlvcn.oraclevcn.com

Route Tables *in* [redacted] (root) *Compartment*

Name	State	Number of Rules	Created
route table for private subnet-MySQL-VCN	● Available	2	Mon, May 15, 2023, 15:18:41 UTC
default route table for MySQL-VCN	● Available	1	Mon, May 15, 2023, 15:18:40 UTC

Showing 2 items 1 of 1

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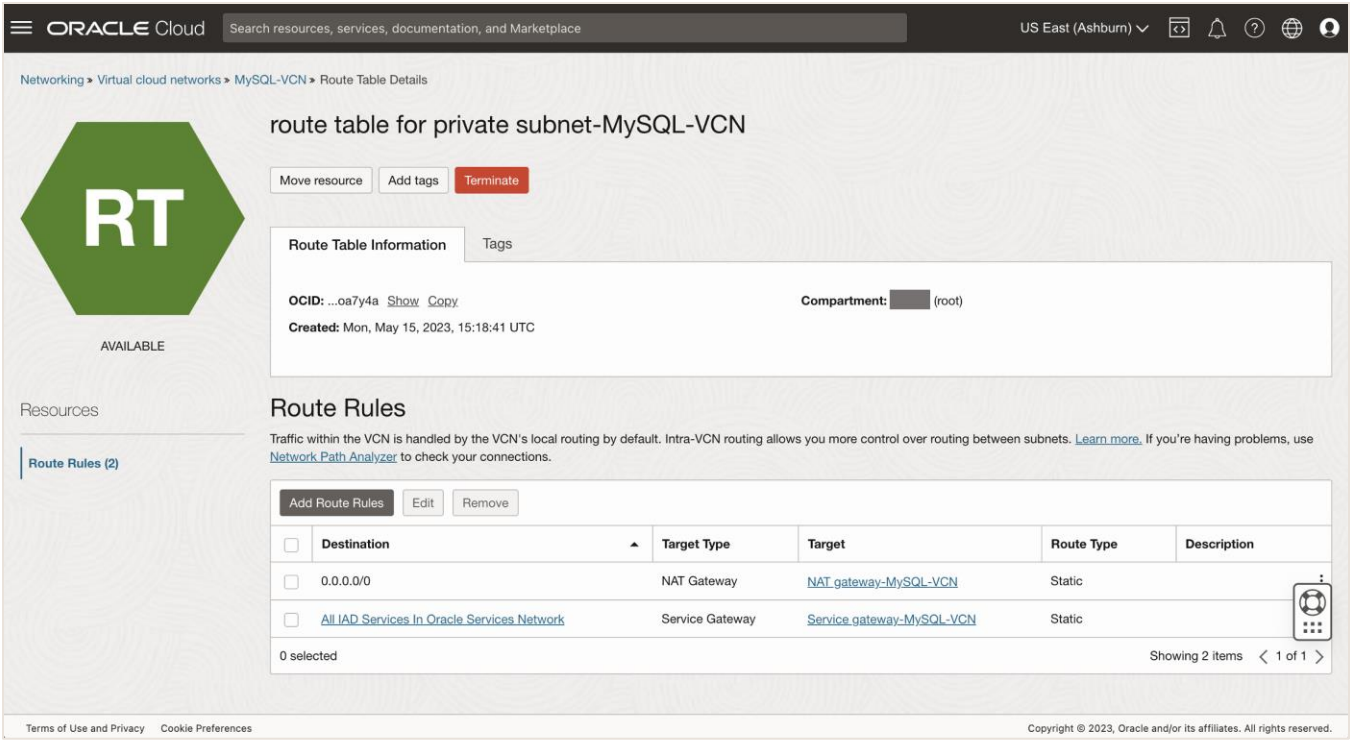
36. Click **Add Route Rules**.



route table for private subnet-MySQL-VCN

OCID: ...oa7y4a Show Copy
Created: Mon, May 15, 2023, 15:18:41 UTC

Compartment: [redacted] (root)

Route Rules

Traffic within the VCN is handled by the VCN's local routing by default. Intra-VCN routing allows you more control over routing between subnets. Learn more. If you're having problems, use Network Path Analyzer to check your connections.

	Destination	Target Type	Target	Route Type	Description
□	0.0.0.0/0	NAT Gateway	NAT gateway-MySQL-VCN	Static	
□	All IAD Services In Oracle Services Network	Service Gateway	Service gateway-MySQL-VCN	Static	

0 selected Showing 2 items 1 of 1

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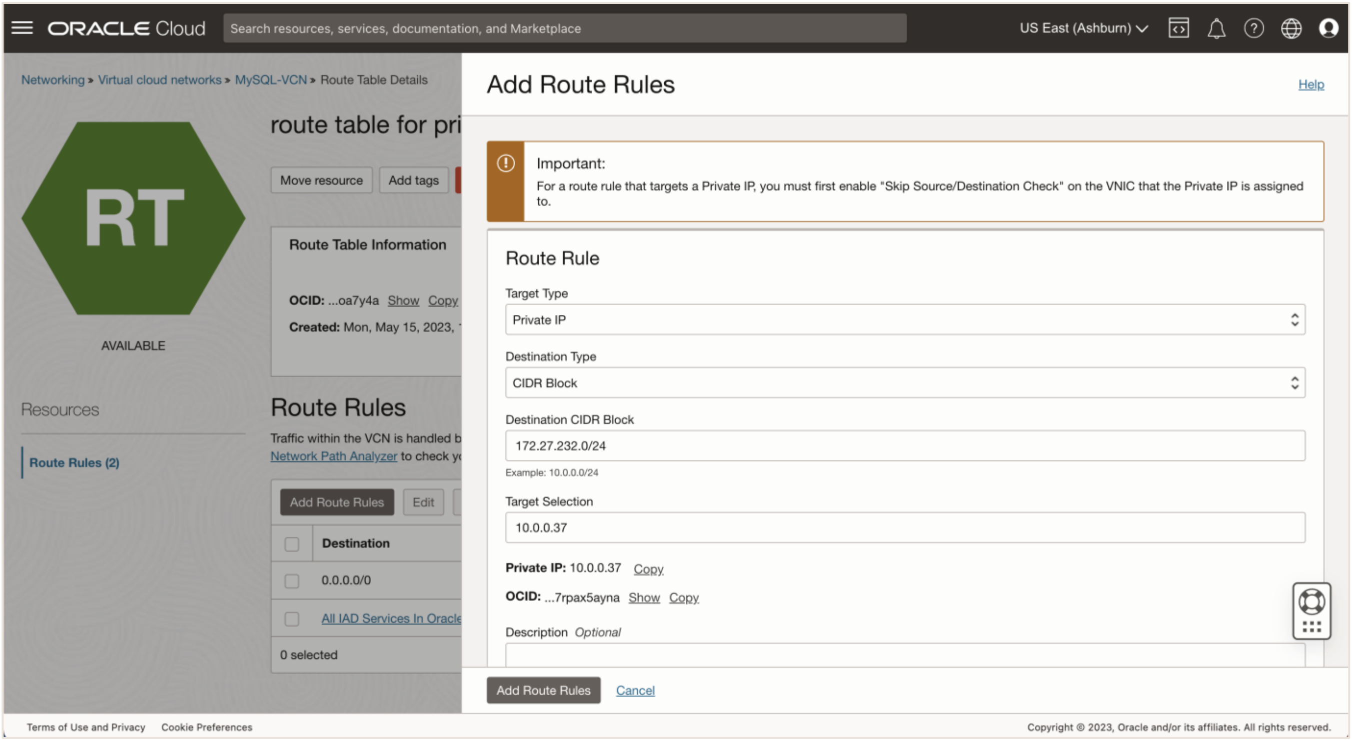
37. For **Target Type** select **Private IP**. Make sure **CIDR Block** is selected under **Destination Type**. For **Destination CIDR Block**, input the **Static IP Address Network CIDR Block** from step 21 - in our case, it is **172.27.232.0/24**. Under **Target Selection**, enter the **Private IP** of the OpenVPN access server from step 17. Click **Add Route Rules**.



Networking » Virtual cloud networks » MySQL-VCN » Route Table Details

route table for pri

Route Table Information

OCID: ...oa7y4a Show Copy

Created: Mon, May 15, 2023,

Route Rules

Traffic within the VCN is handled b Network Path Analyzer to check y

Destination
0.0.0.0/0
All IAD Services In Oracle

0 selected

Add Route Rules

Important:
For a route rule that targets a Private IP, you must first enable "Skip Source/Destination Check" on the VNIC that the Private IP is assigned to.

Route Rule

Target Type: Private IP

Destination Type: CIDR Block

Destination CIDR Block: 172.27.232.0/24

Example: 10.0.0.0/24

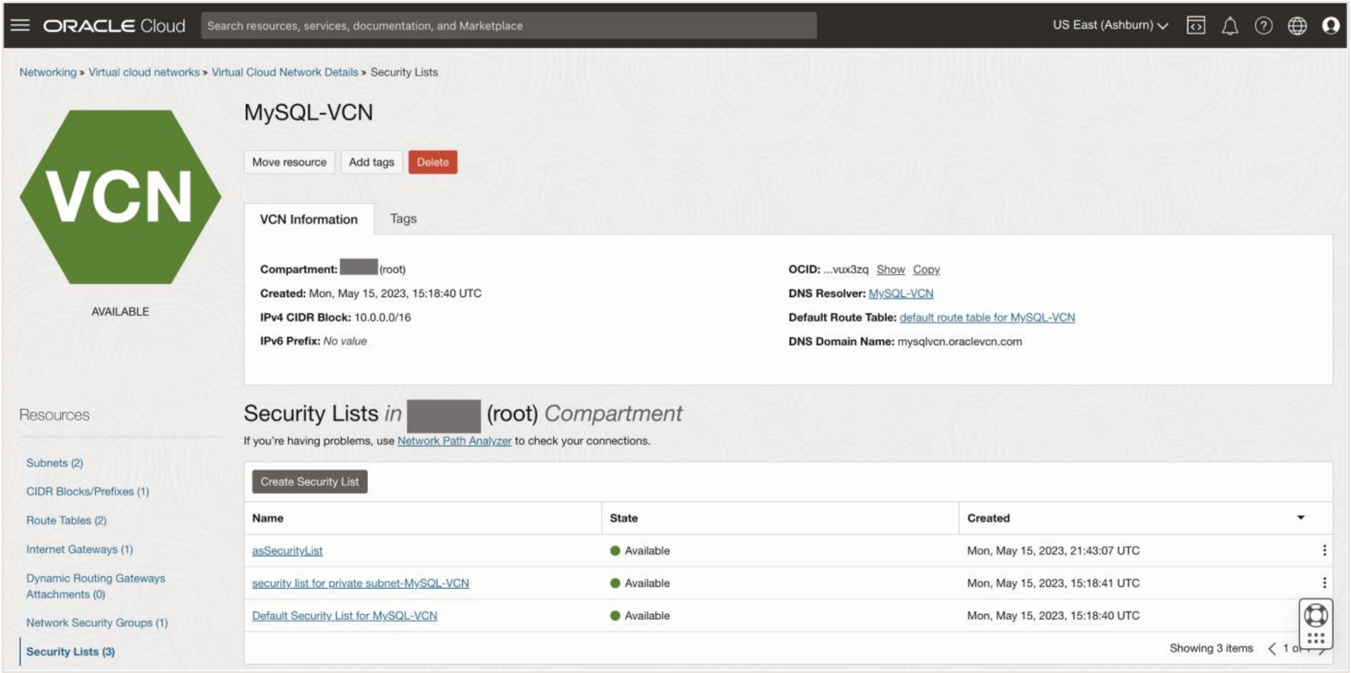
Target Selection: 10.0.0.37

Private IP: 10.0.0.37 Copy

OCID: ...7rpax5ayna Show Copy

Description *Optional*

38. Go back to the Virtual Cloud Network Details page of your VCN and click **Security Lists**.



Networking » Virtual cloud networks » Virtual Cloud Network Details » Security Lists

MySQL-VCN

VCN Information

Compartment: [redacted] (root)
Created: Mon, May 15, 2023, 15:18:40 UTC
IPv4 CIDR Block: 10.0.0.0/16
IPv6 Prefix: *No value*

OCID: ...vux3zq Show Copy
DNS Resolver: MySQL-VCN
Default Route Table: default route table for MySQL-VCN
DNS Domain Name: mysqlvcn.oraclevcn.com

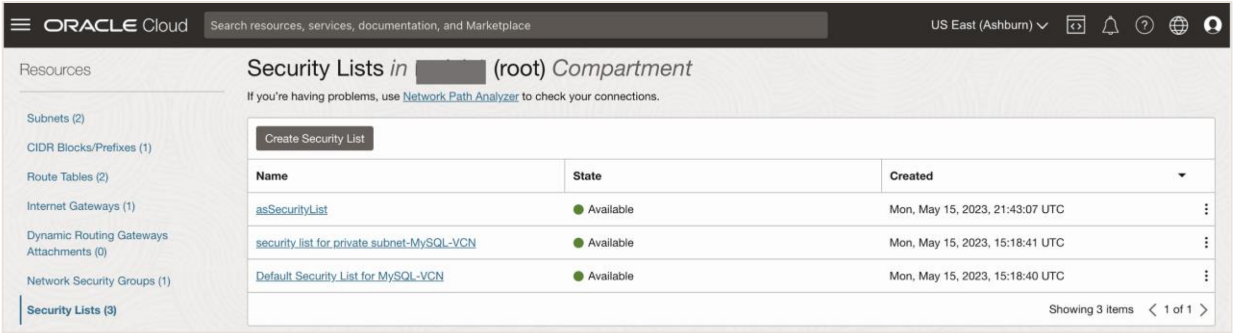
Security Lists *in* [redacted] (root) *Compartment*

If you're having problems, use Network Path Analyzer to check your connections.

Name	State	Created
asSecurityList	● Available	Mon, May 15, 2023, 21:43:07 UTC
security list for private subnet-MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:41 UTC
Default Security List for MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:40 UTC

Showing 3 items

39. Click on the **security list for private subnet-<vcn-name>**.



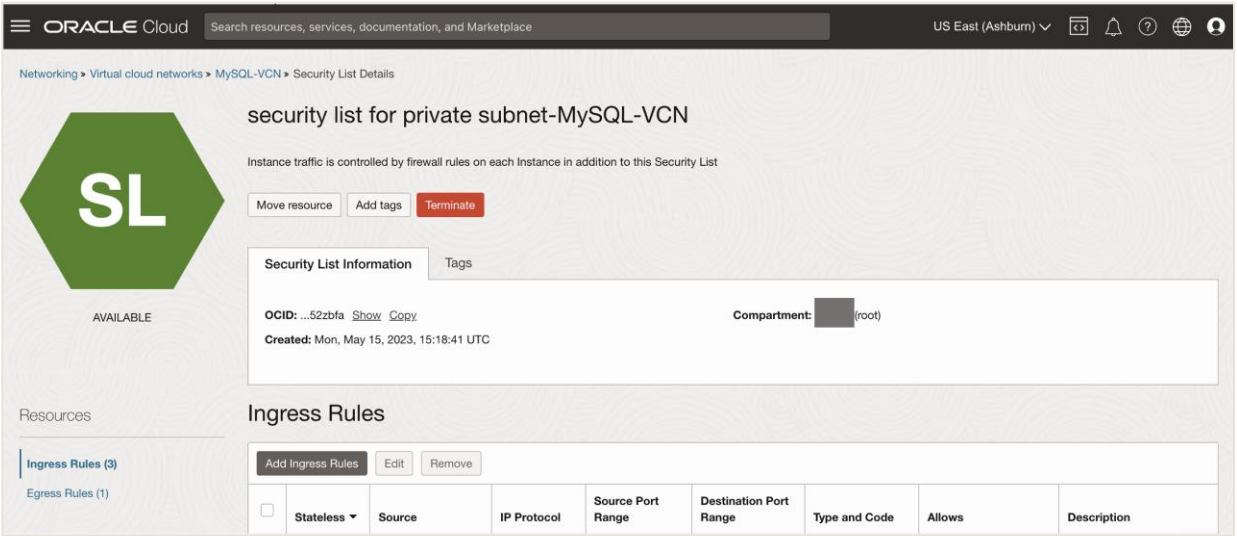
Security Lists *in* [redacted] (root) *Compartment*

If you're having problems, use Network Path Analyzer to check your connections.

Name	State	Created
asSecurityList	● Available	Mon, May 15, 2023, 21:43:07 UTC
security list for private subnet-MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:41 UTC
Default Security List for MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:40 UTC

Showing 3 items 1 of 1

40. Click **Add Ingress Rules**.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Search resources, services, documentation, and Marketplace
US East (Ashburn)
Networking » Virtual cloud networks » MySQL-VCN » Security List Details
SL
AVAILABLE
Move resource
Add tags
Terminate
Security List Information
Tags
Resources
Ingress Rules (3)
Egress Rules (1)
Add Ingress Rules
Edit
Remove

security list for private subnet-MySQL-VCN

Instance traffic is controlled by firewall rules on each Instance in addition to this Security List

OCID: ...52zbfa Show Copy

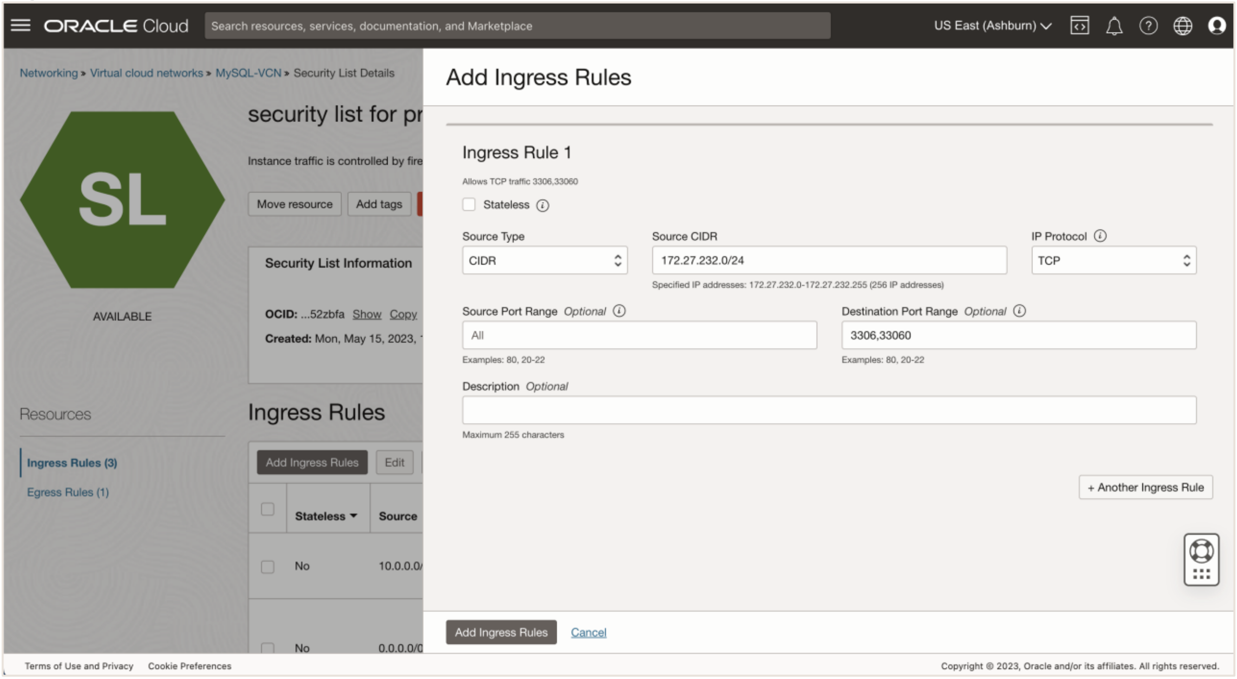
Compartment: [redacted] (root)

Created: Mon, May 15, 2023, 15:18:41 UTC

Ingress Rules

□	Stateless	Source	IP Protocol	Source Port Range	Destination Port Range	Type and Code	Allows	Description

41. For **Source CIDR**, input the **Static IP Address Network CIDR Block** from step 21 - in our case, it is **172.27.232.0/24**. For **Destination Port Range**, specify **3306,33060**. Leave everything as-is and click **Add Ingress Rules**.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US East (Ashburn)
Networking » Virtual cloud networks » MySQL-VCN » Security List Details
security list for pr
Instance traffic is controlled by fire
SL
AVAILABLE
Move resource
Add tags
Security List Information
OCID: ...52zbfa Show Copy
Created: Mon, May 15, 2023,
Resources
Ingress Rules (3)
Egress Rules (1)
Ingress Rules
Add Ingress Rules
Edit
Stateless
Source
No 10.0.0.0/
No 0.0.0.0/0
+ Another Ingress Rule
Add Ingress Rules
Cancel
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Cookie Preferences
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Add Ingress Rules

Ingress Rule 1

Allows TCP traffic 3306,33060

□ Stateless

Source Type: CIDR

Source CIDR: 172.27.232.0/24

Specified IP addresses: 172.27.232.0-172.27.232.255 (256 IP addresses)

IP Protocol: TCP

Source Port Range *Optional*: All

Examples: 80, 20-22

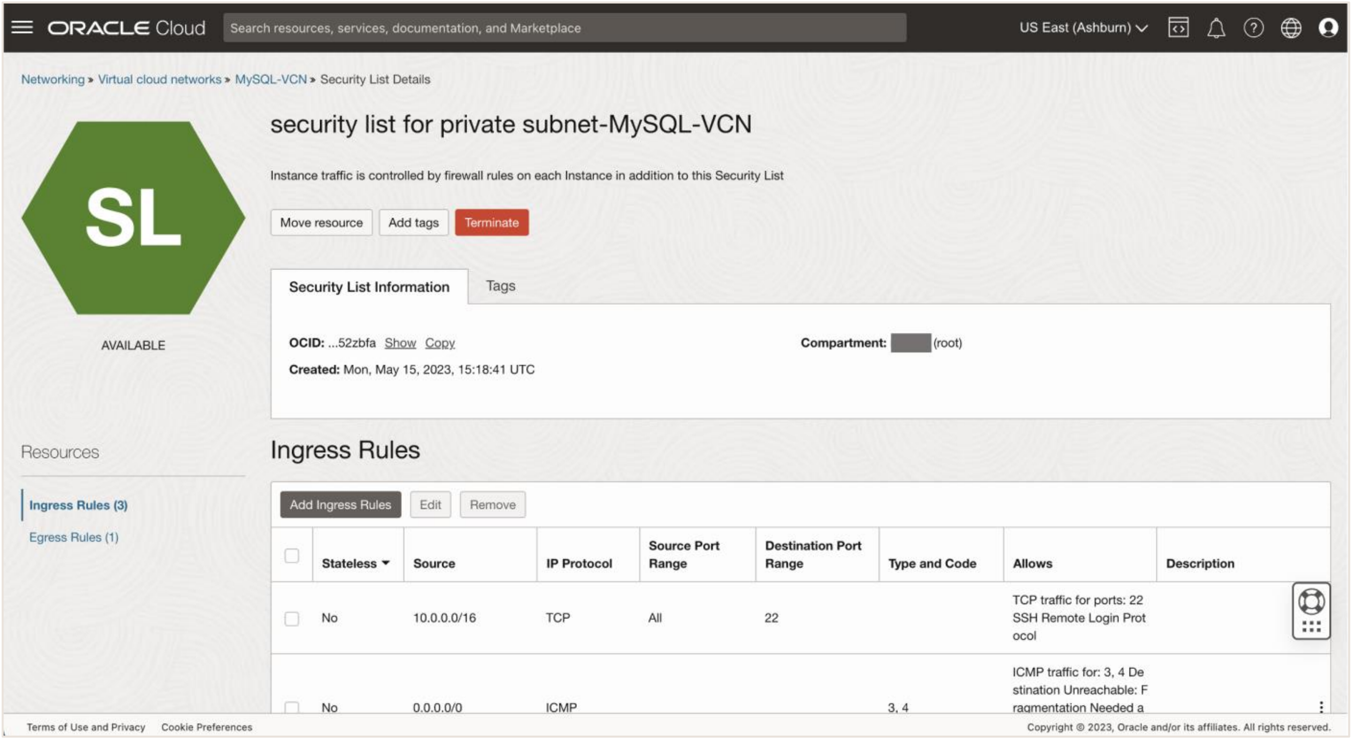
Destination Port Range *Optional*: 3306,33060

Examples: 80, 20-22

Description *Optional*:

Maximum 255 characters

42. Stay on the same security list for private subnet-<vcn-name> page and click **Add Ingress Rules** again.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Networking » Virtual cloud networks » MySQL-VCN » Security List Details
SL
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Move resource
Add tags
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Tags
Resources
Ingress Rules (3)
Egress Rules (1)
Add Ingress Rules
Edit
Remove
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security list for private subnet-MySQL-VCN

Instance traffic is controlled by firewall rules on each Instance in addition to this Security List

OCID: ...52zbfa Show Copy

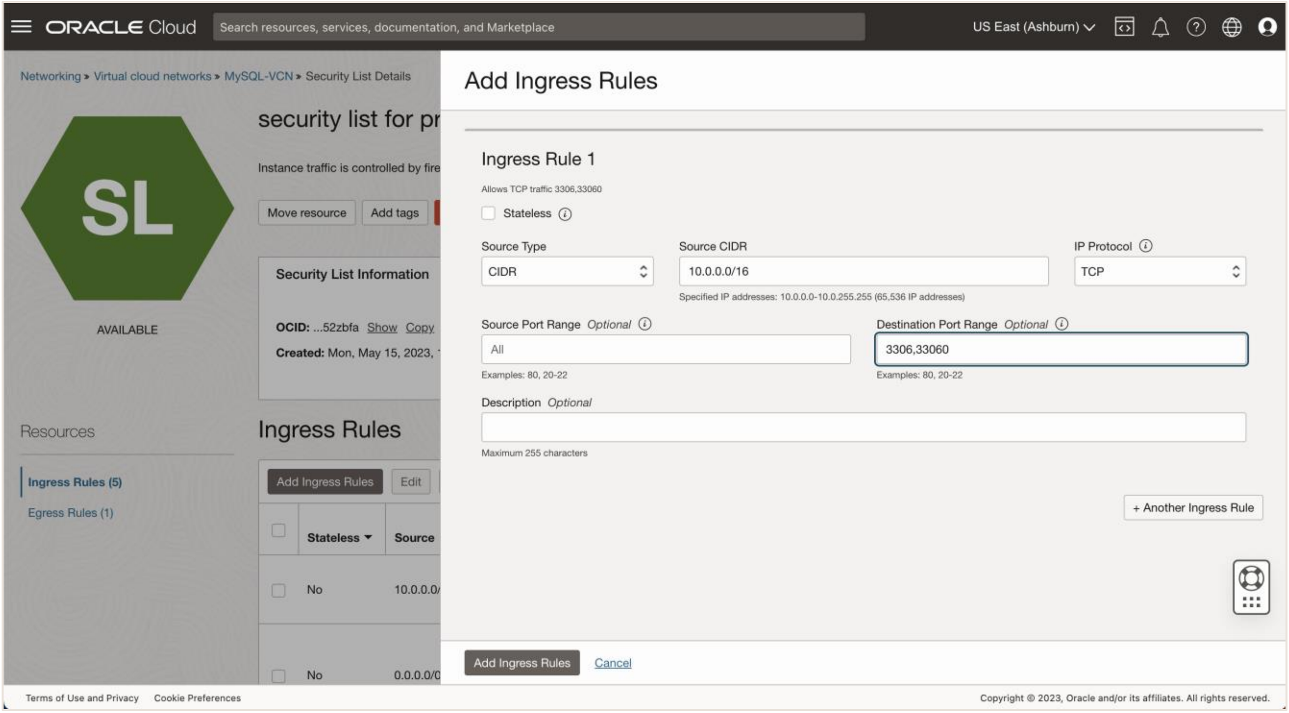
Compartment: [redacted] (root)

Created: Mon, May 15, 2023, 15:18:41 UTC

Ingress Rules

□	Stateless	Source	IP Protocol	Source Port Range	Destination Port Range	Type and Code	Allows	Description
□	No	10.0.0.0/16	TCP	All	22		TCP traffic for ports: 22 SSH Remote Login Protocol	
□	No	0.0.0.0/0	ICMP			3, 4	ICMP traffic for: 3, 4 Destination Unreachable: Fragmentation Needed a	

43. For **Source CIDR**, enter the **IPv4 CIDR Block** of your OCI VCN from step 34. For **Destination Port Range**, specify **3306,33060**. Leave everything as-is and click **Add Ingress Rules**.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US East (Ashburn)
Networking » Virtual cloud networks » MySQL-VCN » Security List Details
security list for pr
Instance traffic is controlled by fire
SL
AVAILABLE
Move resource
Add tags
Security List Information
OCID: ...52zbfa Show Copy
Created: Mon, May 15, 2023,
Resources
Ingress Rules (5)
Egress Rules (1)
Ingress Rules
Add Ingress Rules
Edit
Stateless
Source
No
10.0.0.0/
No
0.0.0.0/0
+ Another Ingress Rule
Add Ingress Rules
Cancel
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Add Ingress Rules

Ingress Rule 1

Allows TCP traffic 3306,33060

□ Stateless

Source Type: CIDR

Source CIDR: 10.0.0.0/16

Specified IP addresses: 10.0.0.0-10.0.255.255 (65,536 IP addresses)

IP Protocol: TCP

Source Port Range *Optional*: All

Examples: 80, 20-22

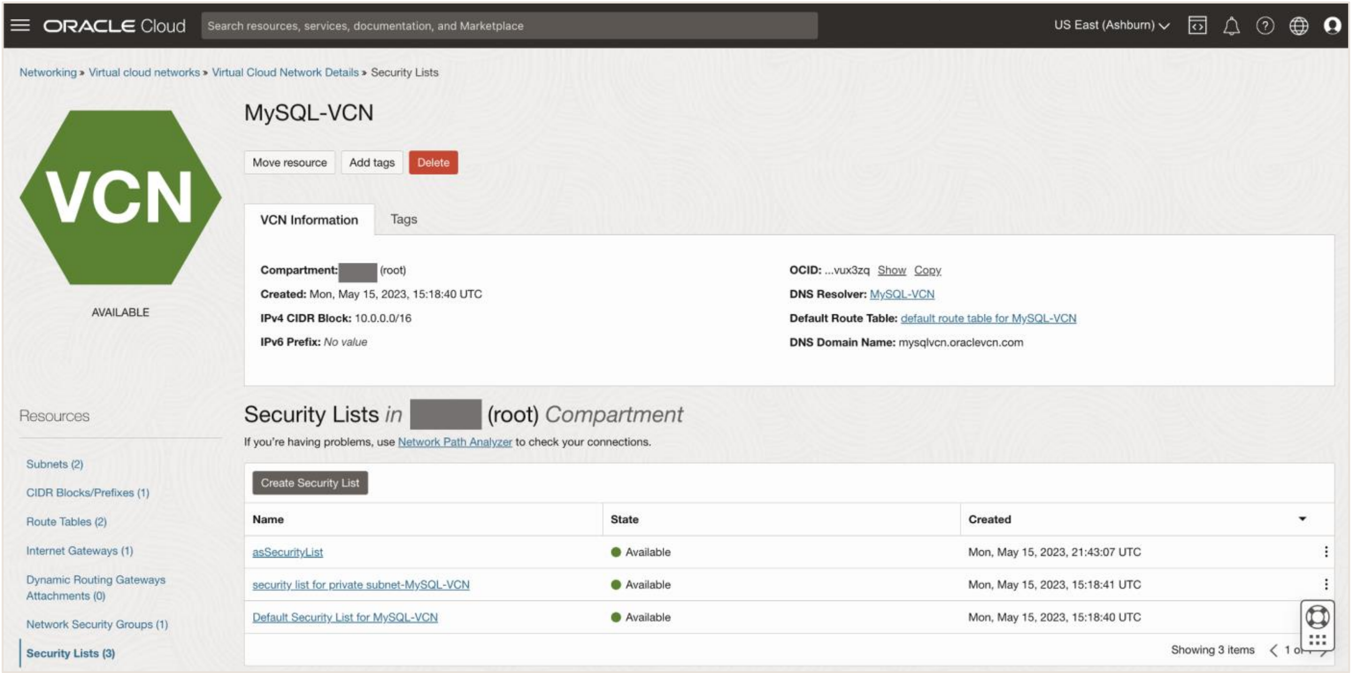
Destination Port Range *Optional*: 3306,33060

Examples: 80, 20-22

Description *Optional*:

Maximum 255 characters

44. Go back to the **Virtual Cloud Network Details** page of your VCN and click **Security Lists**.



MySQL-VCN

Compartment: [redacted] (root)
Created: Mon, May 15, 2023, 15:18:40 UTC
IPv4 CIDR Block: 10.0.0.0/16
IPv6 Prefix: *No value*

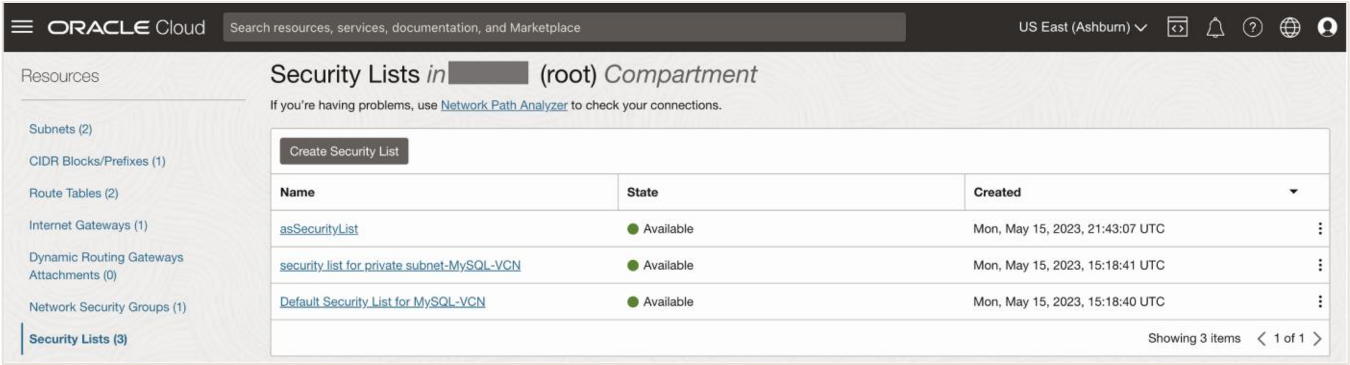
OCID: ...vux3zq Show Copy
DNS Resolver: MySQL-VCN
Default Route Table: default route table for MySQL-VCN
DNS Domain Name: mysqlvcn.oraclevcn.com

Security Lists *in* [redacted] (root) *Compartment*

If you're having problems, use Network Path Analyzer to check your connections.

Name	State	Created
asSecurityList	● Available	Mon, May 15, 2023, 21:43:07 UTC
security list for private subnet-MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:41 UTC
Default Security List for MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:40 UTC

45. Click on **Default Security List for <vcn-name>**.

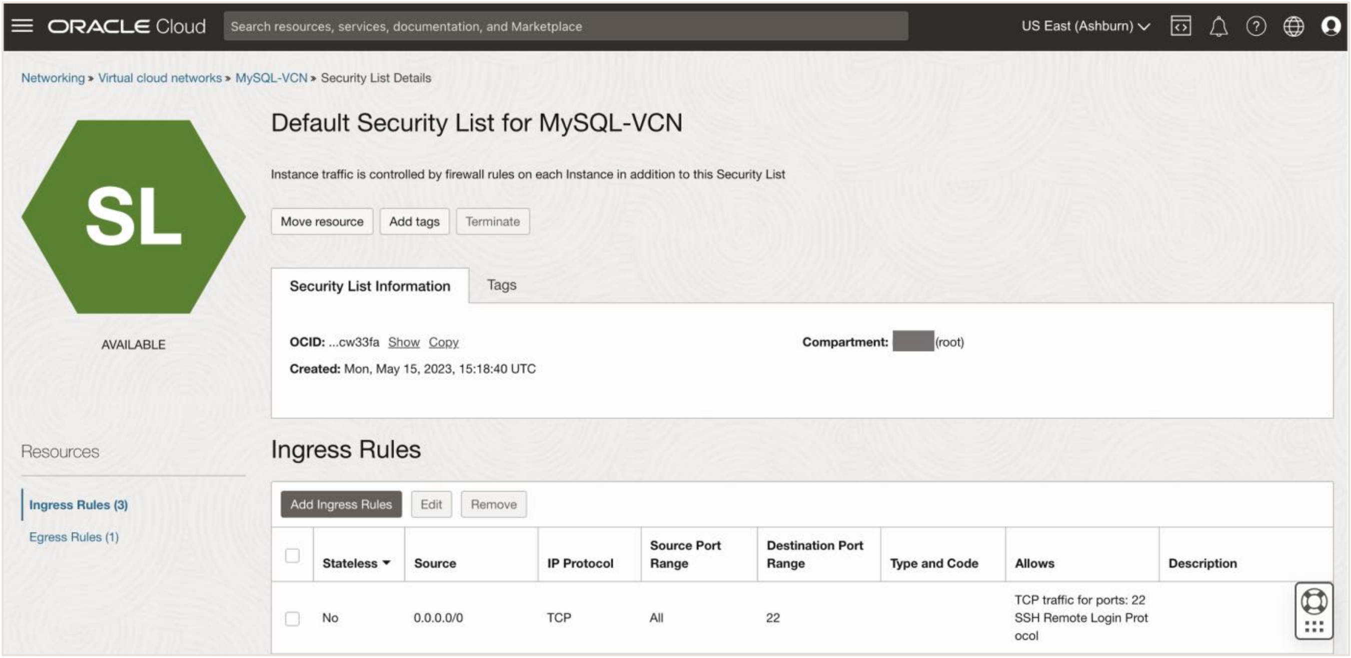


Security Lists *in* [redacted] (root) *Compartment*

If you're having problems, use Network Path Analyzer to check your connections.

Name	State	Created
asSecurityList	● Available	Mon, May 15, 2023, 21:43:07 UTC
security list for private subnet-MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:41 UTC
Default Security List for MySQL-VCN	● Available	Mon, May 15, 2023, 15:18:40 UTC

46. Click **Add Ingress Rules**.



Networking » Virtual cloud networks » MySQL-VCN » Security List Details

Default Security List for MySQL-VCN

Instance traffic is controlled by firewall rules on each Instance in addition to this Security List

OCID: ...cw33fa Show Copy

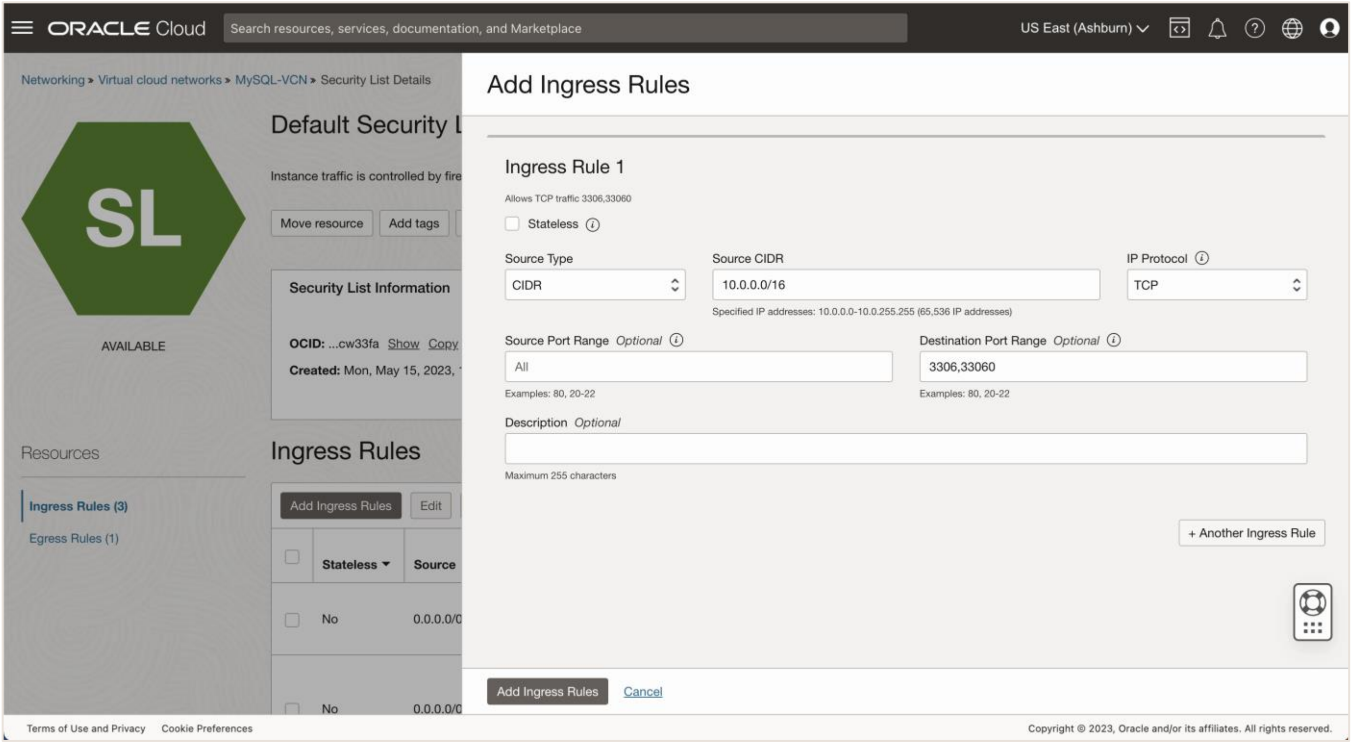
Created: Mon, May 15, 2023, 15:18:40 UTC

Compartment: [redacted] (root)

Ingress Rules

	Stateless	Source	IP Protocol	Source Port Range	Destination Port Range	Type and Code	Allows	Description
□	No	0.0.0.0/0	TCP	All	22		TCP traffic for ports: 22 SSH Remote Login Protocol	

47. For **Source CIDR**, enter the **IPv4 CIDR Block** of your OCI VCN from step 34. For **Destination Port Range**, specify **3306,33060**. Leave everything as-is and click **Add Ingress Rules**.



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Default Security L
SL
AVAILABLE
Resources
Ingress Rules (3)
Egress Rules (1)

Add Ingress Rules

Ingress Rule 1

Allows TCP traffic 3306,33060

□ Stateless

Source Type: CIDR

Source CIDR: 10.0.0.0/16

Specified IP addresses: 10.0.0.0-10.0.255.255 (65,536 IP addresses)

IP Protocol: TCP

Source Port Range *Optional*: All

Examples: 80, 20-22

Destination Port Range *Optional*: 3306,33060

Examples: 80, 20-22

Description *Optional*:

Maximum 255 characters

+ Another Ingress Rule
Add Ingress Rules
Cancel
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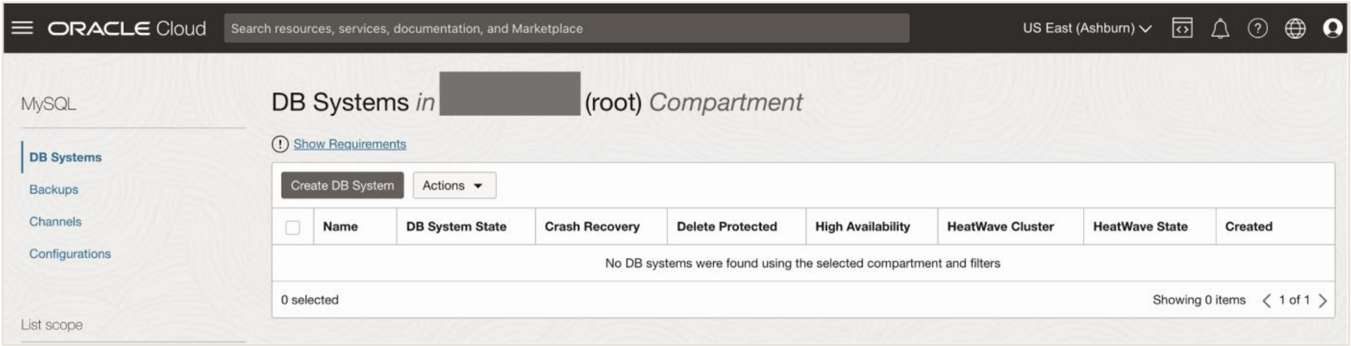
48. The VPN connection from on-premises to OCI is now set up. Make sure the OpenVPN client is started/running. We are now ready to perform the Live Migration.

III) On OCI, create a standalone HeatWave MySQL instance.

49. From the OCI Console, click on the navigation menu, click **Databases**, and click **HeatWave MySQL**.

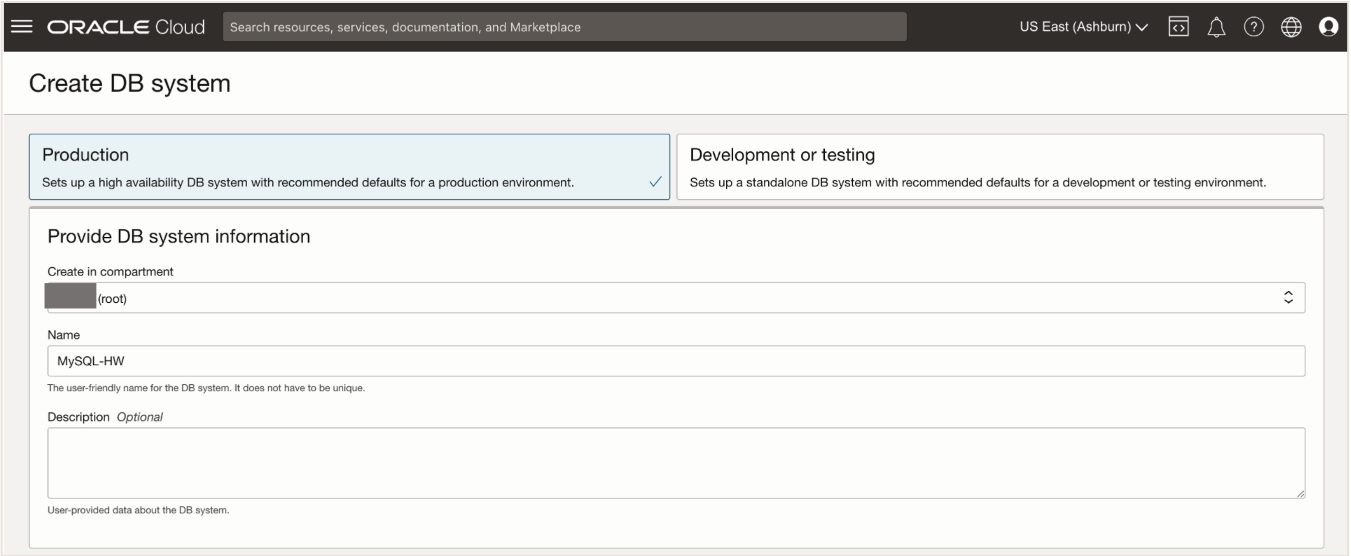


DB Systems *in* [redacted] (root) *Compartment*

☐	Name	DB System State	Crash Recovery	Delete Protected	High Availability	HeatWave Cluster	HeatWave State	Created
No DB systems were found using the selected compartment and filters								

0 selected — Showing 0 items — 1 of 1

50. Pick **Production** or **Development or testing** and enter **a MySQL DB system name**.



Create DB system

Production ✓
Sets up a high availability DB system with recommended defaults for a production environment.

Development or testing
Sets up a standalone DB system with recommended defaults for a development or testing environment.

Provide DB system information

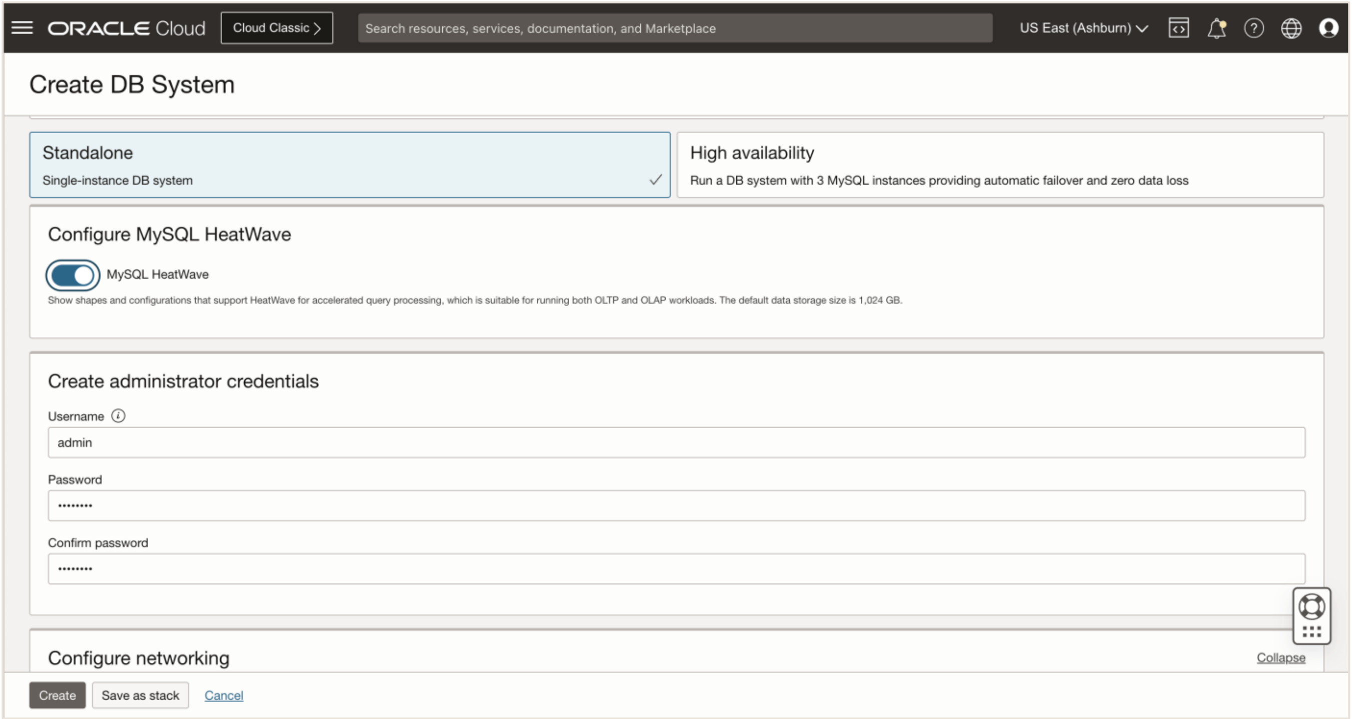
Create in compartment
[redacted] (root)

Name
MySQL-HW
The user-friendly name for the DB system. It does not have to be unique.

Description *Optional*

User-provided data about the DB system.

51. Select **Standalone**, do not choose High Availability (HA) here as replicating to a MySQL HA instance on OCI for this migration may create some complications. You may enable HA after you have completed section **VIII)** of this live migration guide. Information on how to enable HA later can be found here. Turn **ON** the button for HeatWave MySQL - if you want to run OLTP, OLAP, and ML workloads. Afterwards, create your **Administrator credentials** that will be used to manage the HeatWave MySQL database.



Create DB System

Standalone ✓
Single-instance DB system

High availability
Run a DB system with 3 MySQL instances providing automatic failover and zero data loss

Configure MySQL HeatWave

● MySQL HeatWave

Show shapes and configurations that support HeatWave for accelerated query processing, which is suitable for running both OLTP and OLAP workloads. The default data storage size is 1,024 GB.

Create administrator credentials

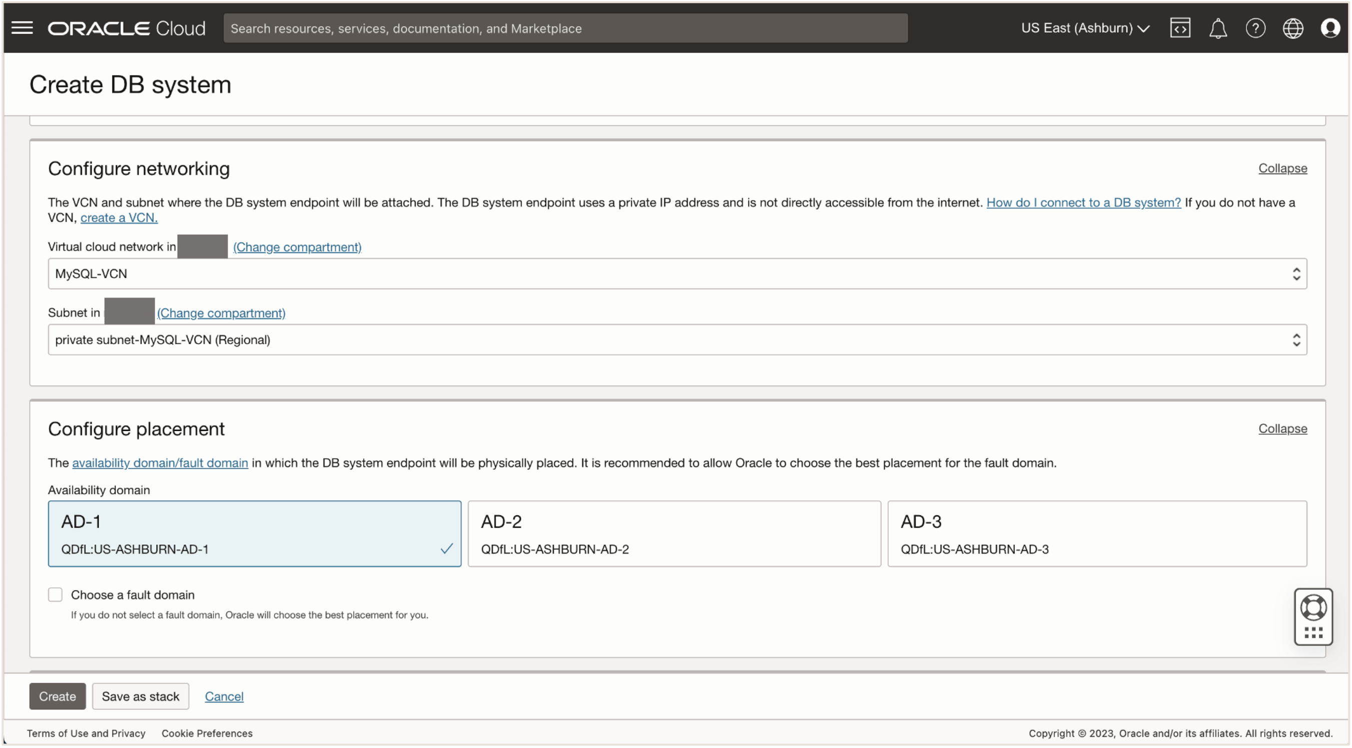
Username: admin

Password: ••••••••

Confirm password: ••••••••

Configure networking

52. For **Configuring Networking** - choose the earlier created VCN and make sure the **Private Subnet** is selected under **Subnet in <compartment-name>**. For **Configure Placement** leave it as-is.



Create DB system

Configure networking

The VCN and subnet where the DB system endpoint will be attached. The DB system endpoint uses a private IP address and is not directly accessible from the internet. How do I connect to a DB system? If you do not have a VCN, create a VCN.

Virtual cloud network in [redacted] (Change compartment)

MySQL-VCN

Subnet in [redacted] (Change compartment)

private subnet-MySQL-VCN (Regional)

Configure placement

The availability domain/fault domain in which the DB system endpoint will be physically placed. It is recommended to allow Oracle to choose the best placement for the fault domain.

Availability domain

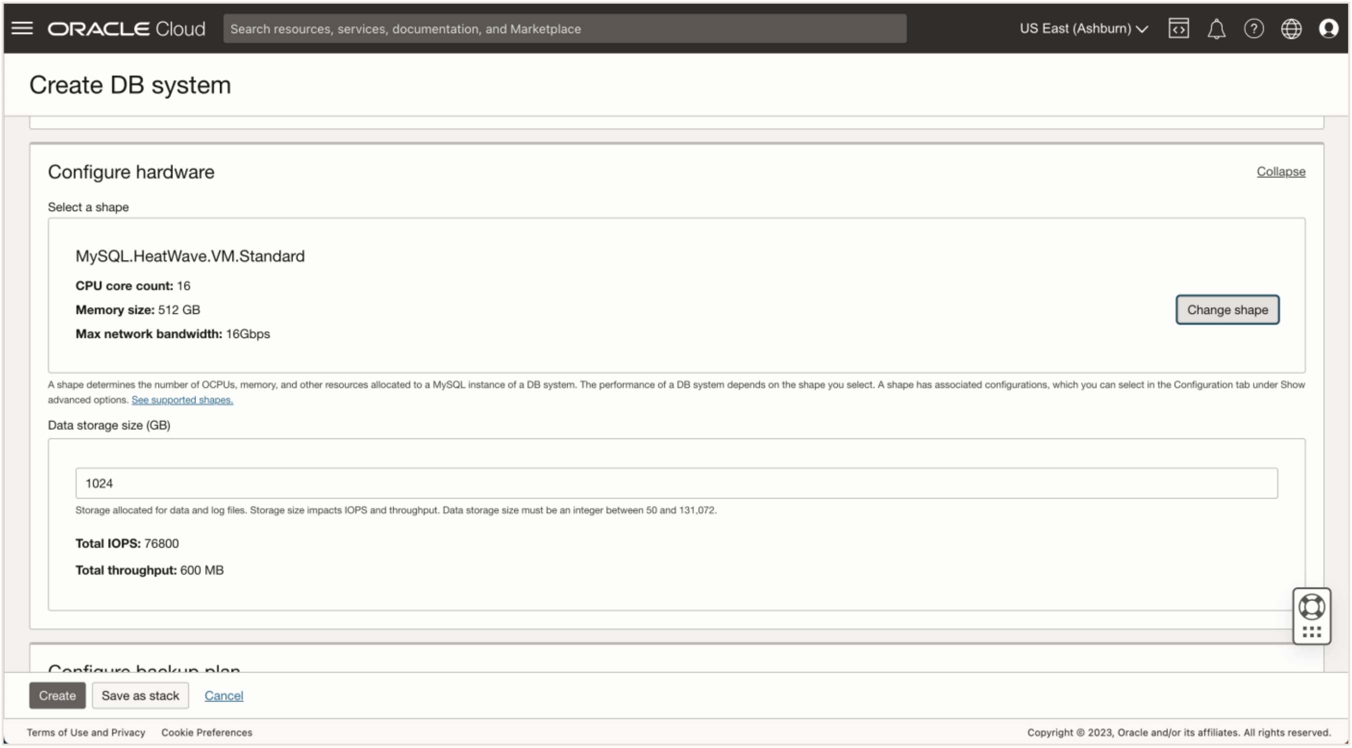
AD-1 ✓
QDfL:US-ASHBURN-AD-1

AD-2
QDfL:US-ASHBURN-AD-2

AD-3
QDfL:US-ASHBURN-AD-3

□ Choose a fault domain
If you do not select a fault domain, Oracle will choose the best placement for you.

53. **Configure hardware** (OCPU and Memory) for MySQL by choosing an appropriate DB Shape. For this guide, we will use the default HeatWave shape. For the **Data Storage Size** be sure to make the size large enough for future growth.


ORACLE Cloud
Search resources, services, documentation, and Marketplace
US East (Ashburn)
Collapse
Change shape
Create
Save as stack
Cancel
Terms of Use and Privacy
Cookie Preferences
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Create DB system

Configure hardware

Select a shape

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

A shape determines the number of OCPUs, memory, and other resources allocated to a MySQL instance of a DB system. The performance of a DB system depends on the shape you select. A shape has associated configurations, which you can select in the Configuration tab under Show advanced options. See supported shapes.

Data storage size (GB)

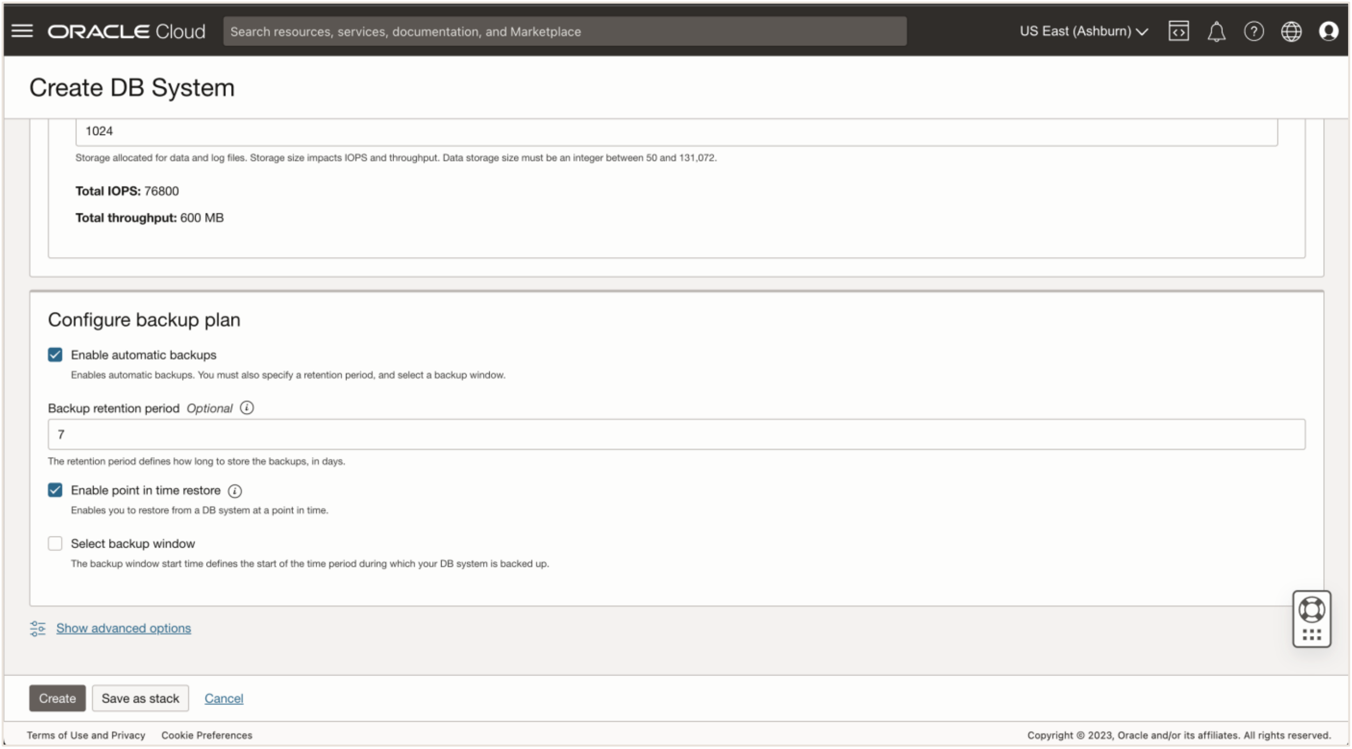
1024

Storage allocated for data and log files. Storage size impacts IOPS and throughput. Data storage size must be an integer between 50 and 131,072.

Total IOPS: 76800

Total throughput: 600 MB

54. **Configure a backup plan** according to what suits your needs. Lastly, scroll down until you see **Show advanced options**. Click on it to expand.


ORACLE Cloud
Search resources, services, documentation, and Marketplace
US East (Ashburn)
Show advanced options
Create
Save as stack
Cancel
Terms of Use and Privacy
Cookie Preferences
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Create DB System

1024

Storage allocated for data and log files. Storage size impacts IOPS and throughput. Data storage size must be an integer between 50 and 131,072.

Total IOPS: 76800

Total throughput: 600 MB

Configure backup plan

☑ Enable automatic backups
Enables automatic backups. You must also specify a retention period, and select a backup window.

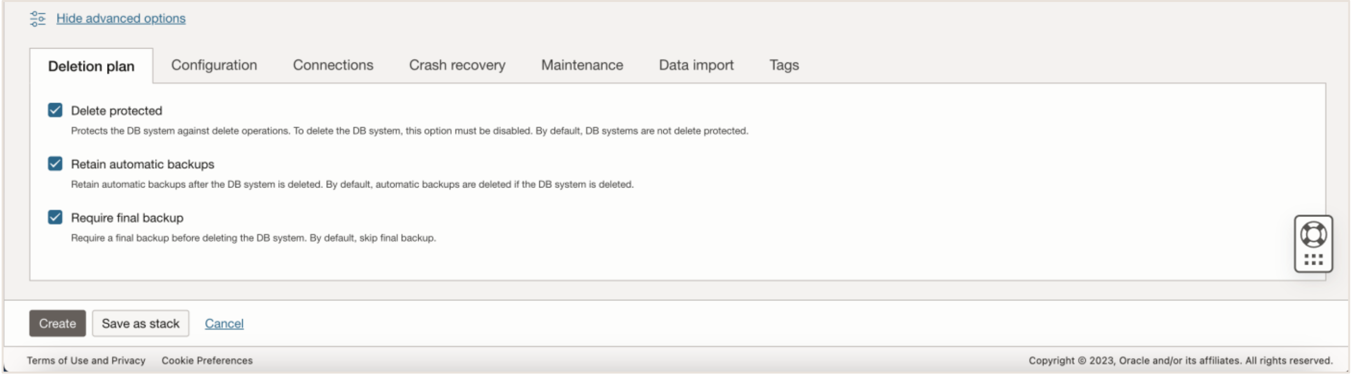
Backup retention period *Optional*

7

The retention period defines how long to store the backups, in days.

☑ Enable point in time restore
Enables you to restore from a DB system at a point in time.

☐ Select backup window
The backup window start time defines the start of the time period during which your DB system is backed up.



☑ Delete protected
Protects the DB system against delete operations. To delete the DB system, this option must be disabled. By default, DB systems are not delete protected.

☑ Retain automatic backups
Retain automatic backups after the DB system is deleted. By default, automatic backups are deleted if the DB system is deleted.

☑ Require final backup
Require a final backup before deleting the DB system. By default, skip final backup.

Create
Save as stack
Cancel
Terms of Use and Privacy
Cookie Preferences
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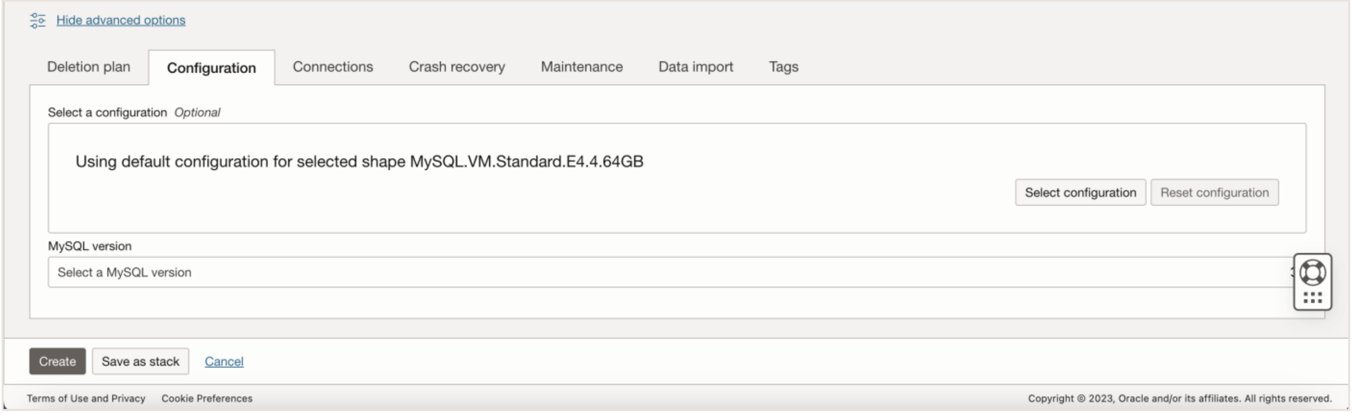
55. From the advanced options screen, go to the **Configuration** tab. If you have a custom configuration that you would like to apply to your HeatWave MySQL instance - you can do so by clicking **Select configuration**. Custom configurations allow you to tweak MySQL variables (i.e., max connections, binary log expire seconds, etc.) rather than using the default values. You must create a custom configuration in advance before applying. For more information regarding custom configurations, see [Configuration of a DB System](). For this guide, we have chosen the default configuration.



Select a configuration *Optional*

Using default configuration for selected shape MySQL.VM.Standard.E4.4.64GB

MySQL version

Select a MySQL version

Create
Save as stack
Cancel
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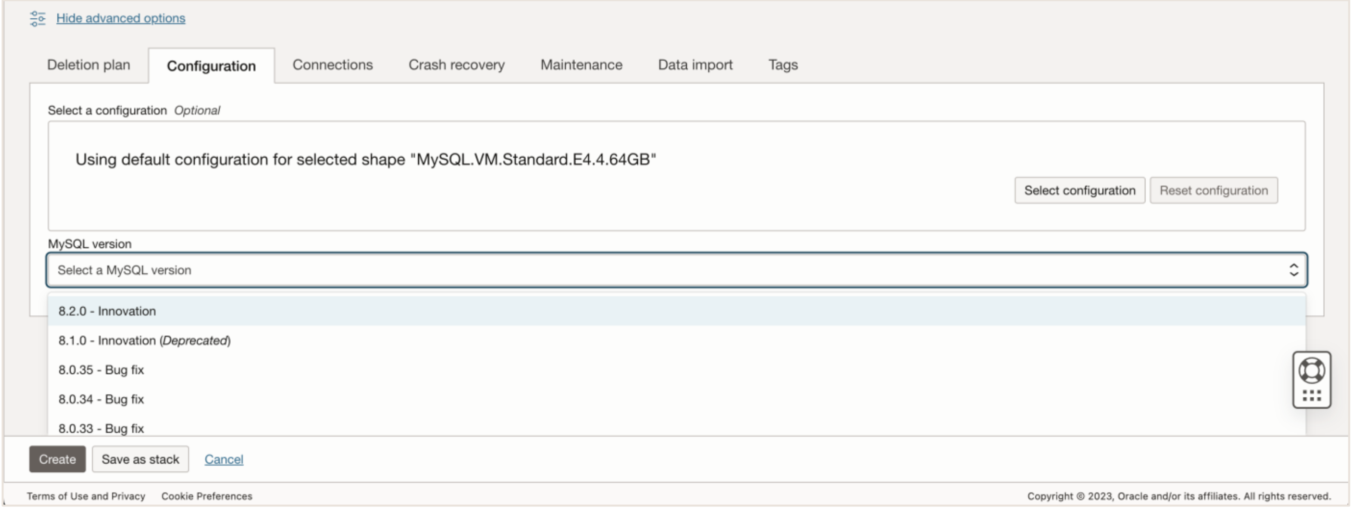
56. For **MySQL version**, choose either **Innovation** or **Bug fix**. With the new MySQL versioning model, you have the flexibility to select an innovation or a bug fix release. Both the releases are production-grade quality. MySQL innovation releases allow you to access the latest features and improvements. Innovation releases are ideal for fast-paced development environments with high levels of automated tests and modern continuous integration techniques for faster upgrade cycles. MySQL bug fix releases (aka long-term support releases) allow you to reduce the risks associated with changes in the database software behavior, as these releases only contain necessary fixes (bugfix and security patches). For more information regarding MySQL innovation and bug fix releases, see Introducing MySQL Innovation and Bug fix versions. For this guide, we have chosen **8.0.35 - Bug fix**.



Select a configuration *Optional*

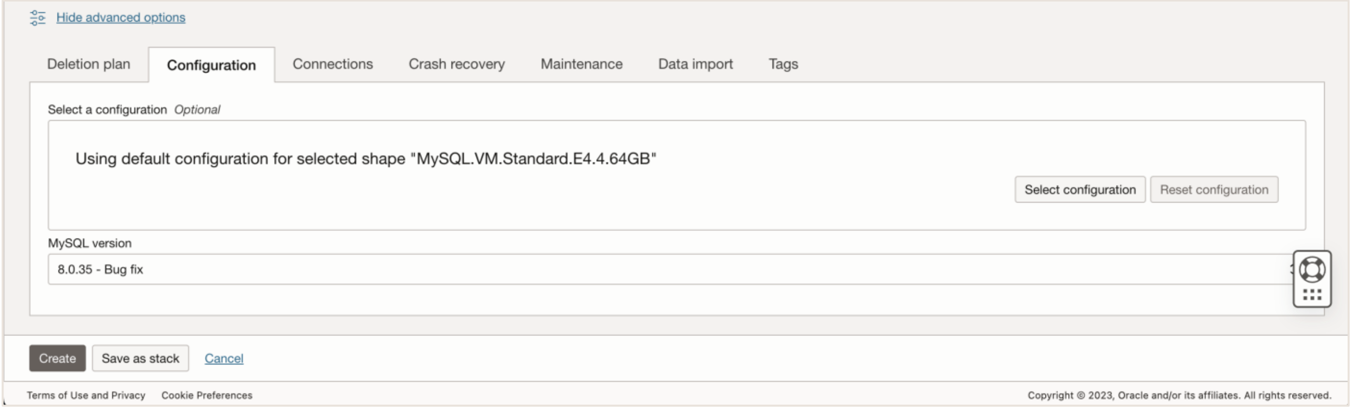
Using default configuration for selected shape "MySQL.VM.Standard.E4.4.64GB"

MySQL version

Select a MySQL version

8.2.0 - Innovation
8.1.0 - Innovation (*Deprecated*)
8.0.35 - Bug fix
8.0.34 - Bug fix
8.0.33 - Bug fix

57. Click **Create** to finish the HeatWave MySQL DB system creation process.



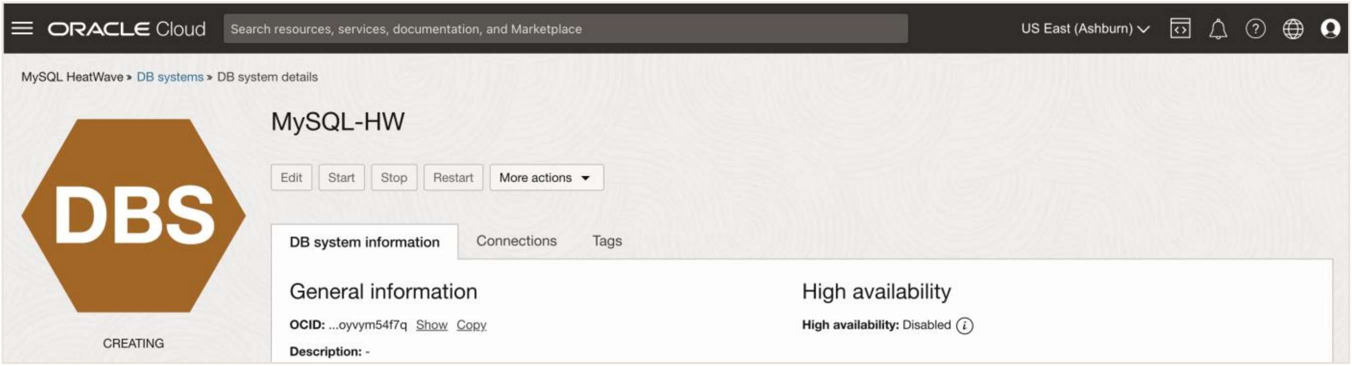
Select a configuration *Optional*

Using default configuration for selected shape "MySQL.VM.Standard.E4.4.64GB"

MySQL version

8.0.35 - Bug fix

58. Your HeatWave MySQL DB system will start **CREATING**.



MySQL-HW

General information

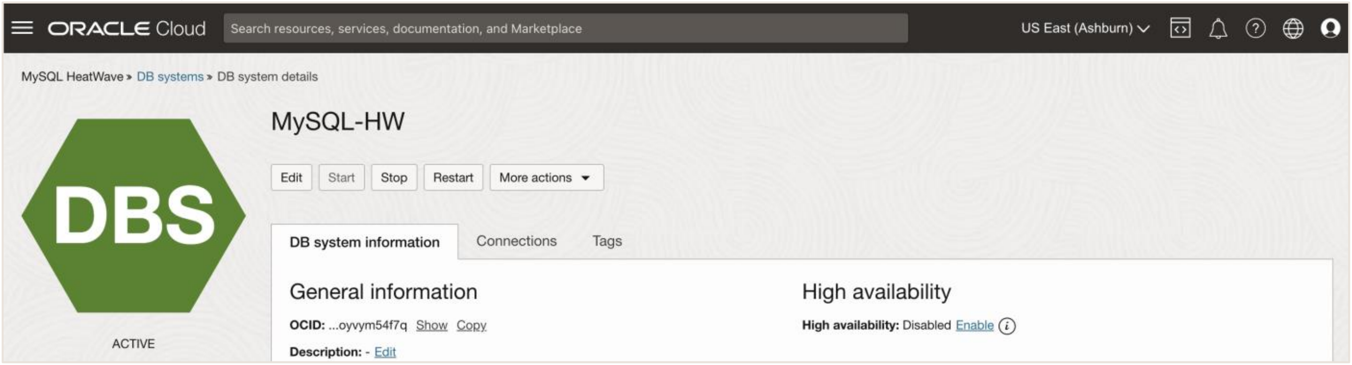
OCID: ...oyvym54f7q Show Copy

Description: -

High availability

High availability: Disabled

59. Within a few minutes, HeatWave MySQL DB system will change its state from CREATING to **ACTIVE** once the instance is ready.



MySQL-HW

General information

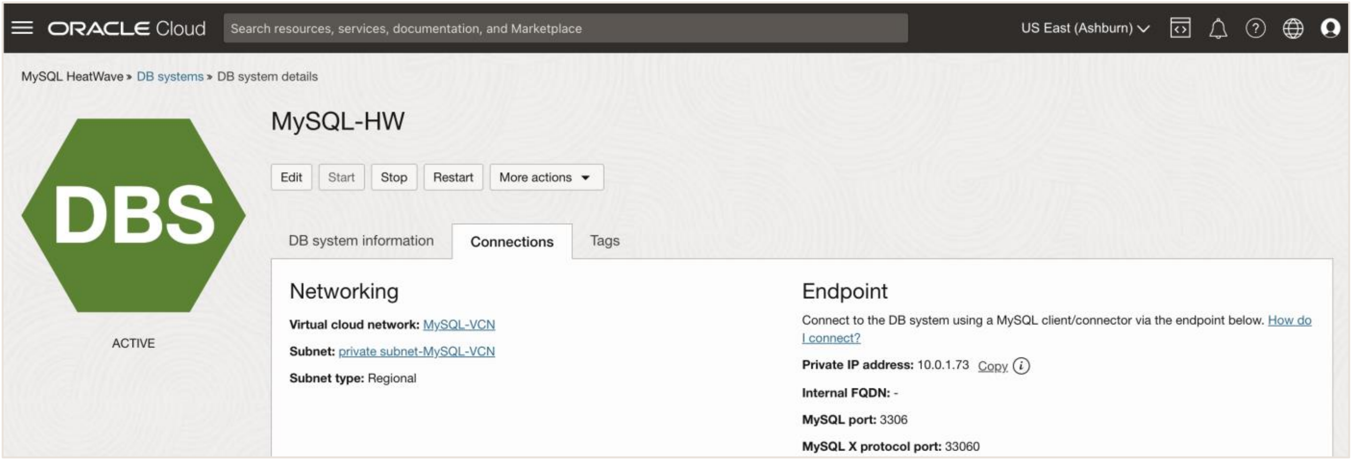
OCID: ...oyvym54f7q Show Copy

Description: - Edit

High availability

High availability: Disabled Enable

60. On the same DB system details page, click **Connections** to grab the **private IP address** for HeatWave MySQL. Save the private IP Address for later use.



MySQL-HW

Networking

Virtual cloud network: MySQL-VCN

Subnet: private subnet-MySQL-VCN

Subnet type: Regional

Endpoint

Connect to the DB system using a MySQL client/connector via the endpoint below. How do I connect?

Private IP address: 10.0.1.73 Copy

Internal FQDN: -

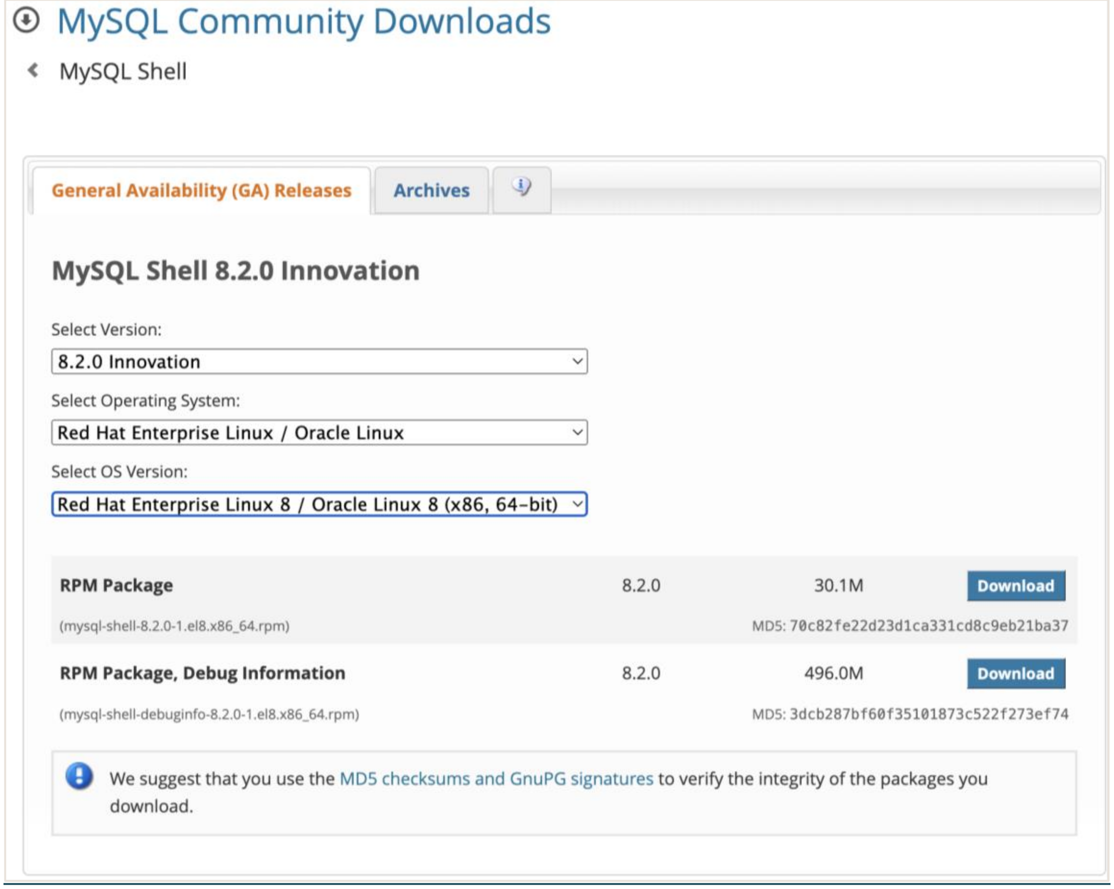
MySQL port: 3306

MySQL X protocol port: 33060

Note: you can navigate to the **DB System Details** page by going to the Navigation menu in OCI. Click **Databases** and click **HeatWave MySQL**. Click on the name of your MySQL DB System to open the **DB System Details** page.

IV) Install MySQL Shell 8.2 or above on an on-premises instance that can connect to MySQL on-premises.

61. Have an on-premises instance that can connect to your on-premises MySQL. Go to the below website and download MySQL Shell 8.2 on your on-premises instance. For this guide, we have deployed our on-premises MySQL on a Linux instance. From the MySQL Shell download page, ensure **8.2.x Innovation** is selected under **Select Version**. MySQL Shell 8.2 is fully compatible with MySQL 8.2, 8.1, 8.0, and 5.7. For **Operating System** and **OS Version** - pick the appropriate option depending on the OS and the OS Version that you are running. Click **Download**.
    https://dev.mysql.com/downloads/shell/



MySQL Shell 8.2.0 Innovation

Select Version: 8.2.0 Innovation

Select Operating System: Red Hat Enterprise Linux / Oracle Linux

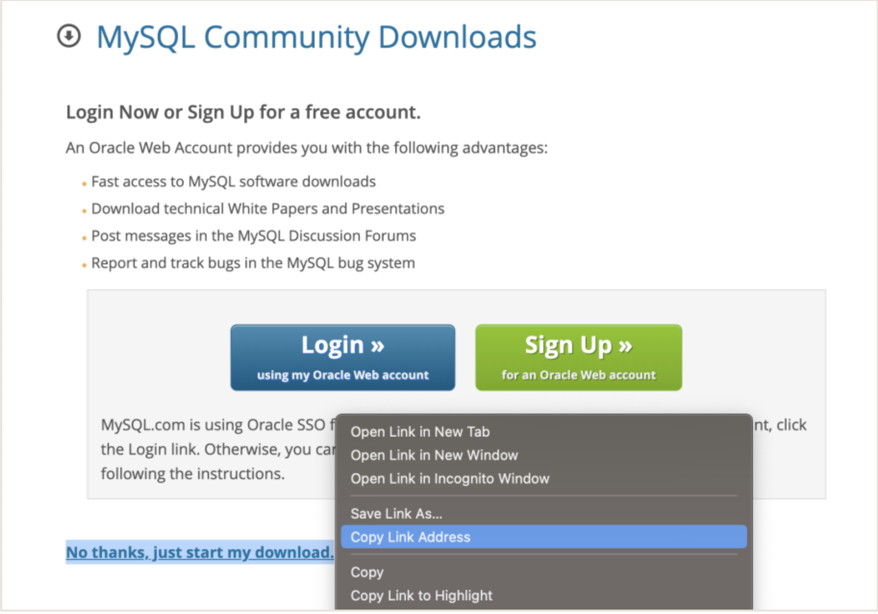
Select OS Version: Red Hat Enterprise Linux 8 / Oracle Linux 8 (x86, 64-bit)

RPM Package (mysql-shell-8.2.0-1.el8.x86_64.rpm)	8.2.0	30.1M MD5: 70c82fe22d23d1ca331cd8c9eb21ba37	Download
RPM Package, Debug Information (mysql-shell-debuginfo-8.2.0-1.el8.x86_64.rpm)	8.2.0	496.0M MD5: 3dcb287bf60f35101873c522f273ef74	Download

We suggest that you use the MD5 checksums and GnuPG signatures to verify the integrity of the packages you download.

Note: for this guide, we will show you how to install MySQL Shell on a Linux environment. For other environments, see Installing MySQL Shell on Windows, Installing MySQL Shell on Linux, and Installing MySQL Shell on macOS.

62. Right-click on **No thanks, just start my download** and click **Copy link address**.



MySQL Community Downloads

Login Now or Sign Up for a free account.

An Oracle Web Account provides you with the following advantages:

- Fast access to MySQL software downloads
- Download technical White Papers and Presentations
- Post messages in the MySQL Discussion Forums
- Report and track bugs in the MySQL bug system

MySQL.com is using Oracle SSO f nt, click the Login link. Otherwise, you ca following the instructions.

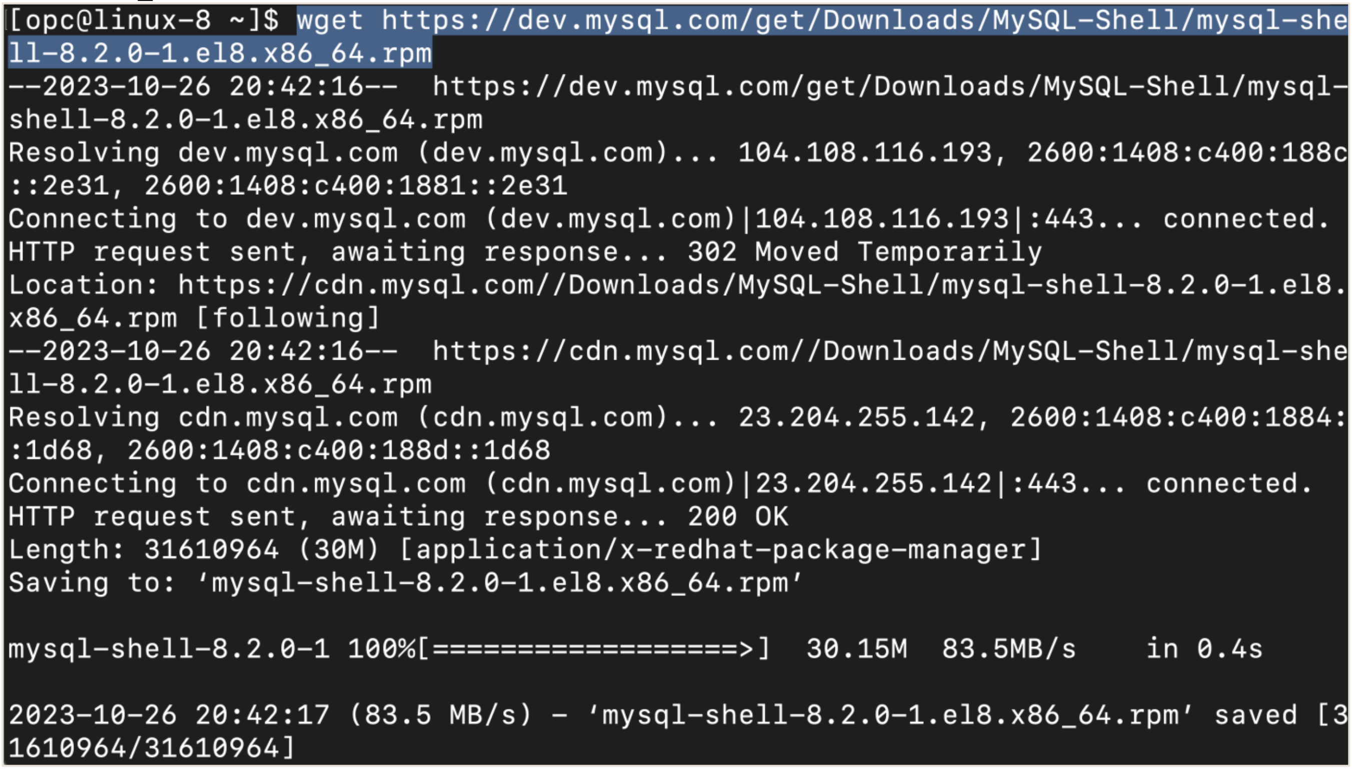
No thanks, just start my download.

63. Go back to the on-premises instance that can connect to your on-premises MySQL and execute the below command to download MySQL Shell:

```
$ wget <MySQL-Shell-Download-Link>
```

Replace the below link with what you have.

```
$ wget https://dev.mysql.com/get/Downloads/MySQL-Shell/mysql-shell-8.2.0-
1.el8.x86_64.rpm
```



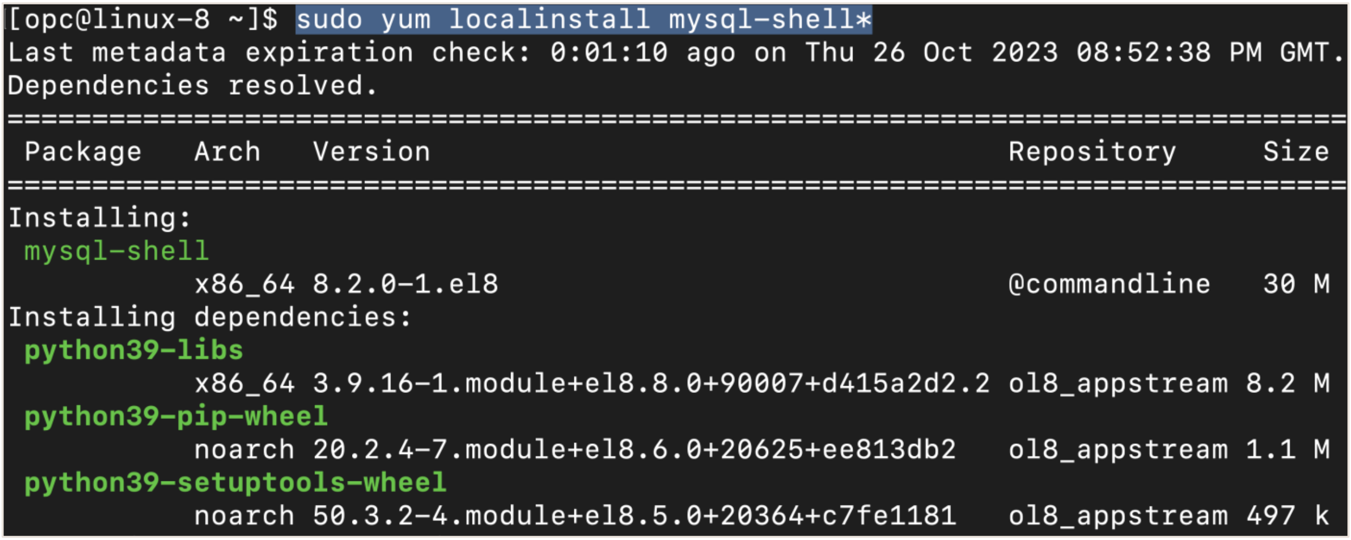
```
[opc@linux-8 ~]$ wget https://dev.mysql.com/get/Downloads/MySQL-Shell/mysql-she
ll-8.2.0-1.el8.x86_64.rpm
--2023-10-26 20:42:16--  https://dev.mysql.com/get/Downloads/MySQL-Shell/mysql-
shell-8.2.0-1.el8.x86_64.rpm
Resolving dev.mysql.com (dev.mysql.com)... 104.108.116.193, 2600:1408:c400:188c
::2e31, 2600:1408:c400:1881::2e31
Connecting to dev.mysql.com (dev.mysql.com)|104.108.116.193|:443... connected.
HTTP request sent, awaiting response... 302 Moved Temporarily
Location: https://cdn.mysql.com//Downloads/MySQL-Shell/mysql-shell-8.2.0-1.el8.
x86_64.rpm [following]
--2023-10-26 20:42:16--  https://cdn.mysql.com//Downloads/MySQL-Shell/mysql-she
ll-8.2.0-1.el8.x86_64.rpm
Resolving cdn.mysql.com (cdn.mysql.com)... 23.204.255.142, 2600:1408:c400:1884:
:1d68, 2600:1408:c400:188d::1d68
Connecting to cdn.mysql.com (cdn.mysql.com)|23.204.255.142|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 31610964 (30M) [application/x-redhat-package-manager]
Saving to: ‘mysql-shell-8.2.0-1.el8.x86_64.rpm’

mysql-shell-8.2.0-1 100%[==================>]  30.15M  83.5MB/s    in 0.4s

2023-10-26 20:42:17 (83.5 MB/s) - ‘mysql-shell-8.2.0-1.el8.x86_64.rpm’ saved [3
1610964/31610964]
```

64. After downloading the MySQL Shell rpm, install MySQL Shell:

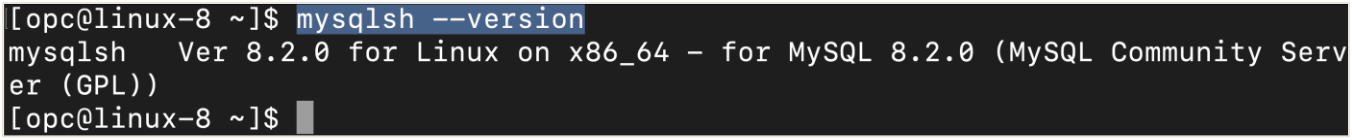
```
$ sudo yum localinstall mysql-shell*
```



```
[opc@linux-8 ~]$ sudo yum localinstall mysql-shell*
Last metadata expiration check: 0:01:10 ago on Thu 26 Oct 2023 08:52:38 PM GMT.
Dependencies resolved.
================================================================================
 Package    Arch    Version                                 Repository     Size
================================================================================
Installing:
 mysql-shell
            x86_64 8.2.0-1.el8                              @commandline   30 M
Installing dependencies:
 python39-libs
            x86_64 3.9.16-1.module+el8.8.0+90007+d415a2d2.2 ol8_appstream 8.2 M
 python39-pip-wheel
            noarch 20.2.4-7.module+el8.6.0+20625+ee813db2   ol8_appstream 1.1 M
 python39-setuptools-wheel
            noarch 50.3.2-4.module+el8.5.0+20364+c7fe1181   ol8_appstream 497 k
```

65. You can now verify if MySQL Shell has successfully installed on your on-premises instance by executing the below command:

```
$ mysqlsh --version
```



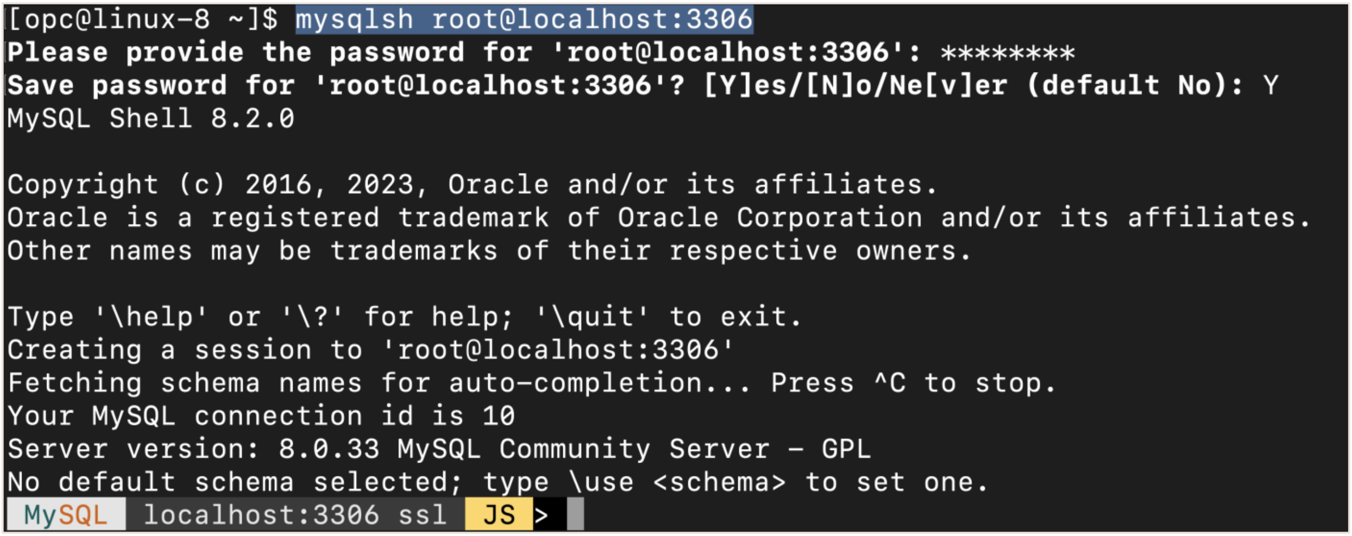
```
[opc@linux-8 ~]$ mysqlsh --version
mysqlsh   Ver 8.2.0 for Linux on x86_64 - for MySQL 8.2.0 (MySQL Community Serv
er (GPL))
[opc@linux-8 ~]$ 
```

66. To login to your on-premises MySQL using MySQL Shell, use the below commands:

```
$ mysqlsh <user>@<hostname>:<port-number>
```

-OR-

```
$ mysqlsh -u <user> -p -h <hostname> -P <port-number>
```



```
[opc@linux-8 ~]$ mysqlsh root@localhost:3306
Please provide the password for 'root@localhost:3306': ********
Save password for 'root@localhost:3306'? [Y]es/[N]o/Ne[v]er (default No): Y
MySQL Shell 8.2.0

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Other names may be trademarks of their respective owners.

Type '\help' or '\?' for help; '\quit' to exit.
Creating a session to 'root@localhost:3306'
Fetching schema names for auto-completion... Press ^C to stop.
Your MySQL connection id is 10
Server version: 8.0.33 MySQL Community Server - GPL
No default schema selected; type \use <schema> to set one.
 MySQL  localhost:3306 ssl  JS > 
```
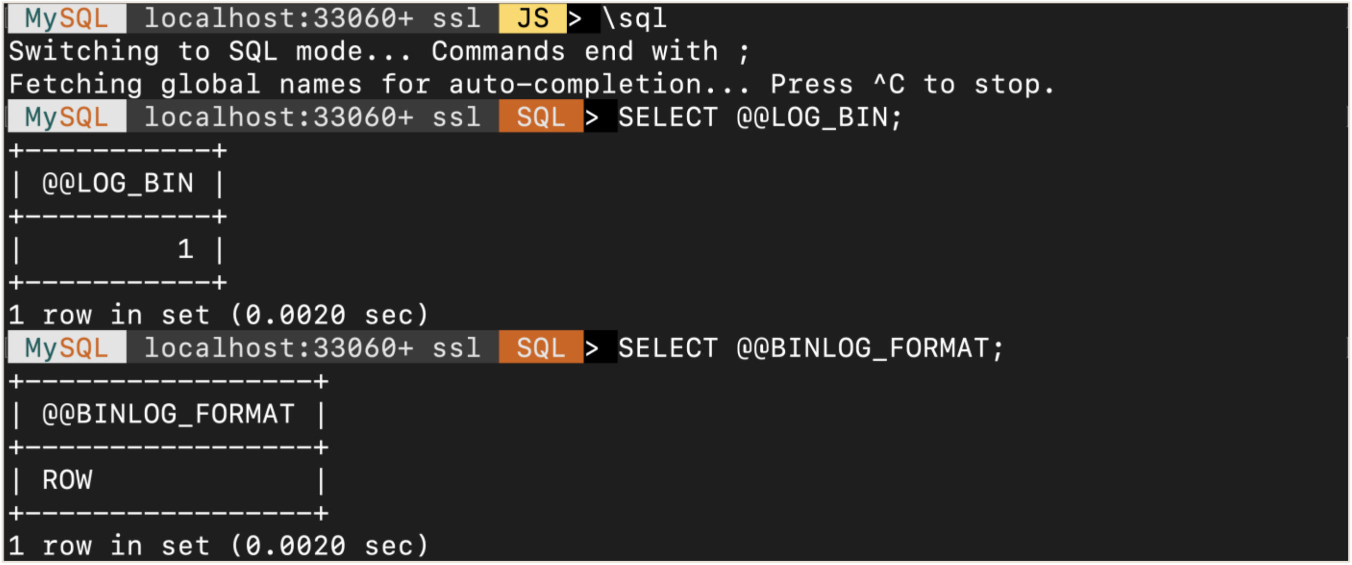

Note: you can interact with MySQL Shell using JavaScript, Python, or SQL mode. The default is JavaScript. To switch between the different modes, execute `/js` for JavaScript, `/py` for Python, and `/sql` for SQL mode inside MySQL Shell. To exit out of MySQL Shell, execute `/q`.

V) For your on-premises MySQL, ensure `log_bin` is set to `ON`, `binlog_format` is set to `ROW`, and increase the `binlog_expire_logs_seconds` system variable if needed - to retain binary logs for a longer period (if using MySQL 5.6 or 5.7, increase the `expire_logs_days` system variable).

67. Stay connected to your on-premises MySQL and execute the below commands to ensure your on-premises MySQL is configured correctly for the live migration.

```
MySQL JS> \sql
MySQL SQL> SELECT @@log_bin;
MySQL SQL> SELECT @@binlog_format;
```



```
 MySQL  localhost:33060+ ssl  JS > \sql
Switching to SQL mode... Commands end with ;
Fetching global names for auto-completion... Press ^C to stop.
 MySQL  localhost:33060+ ssl  SQL > SELECT @@LOG_BIN;
+-----------+
| @@LOG_BIN |
+-----------+
|         1 |
+-----------+
1 row in set (0.0020 sec)
 MySQL  localhost:33060+ ssl  SQL > SELECT @@BINLOG_FORMAT;
+-----------------+
| @@BINLOG_FORMAT |
+-----------------+
| ROW             |
+-----------------+
1 row in set (0.0020 sec)
```

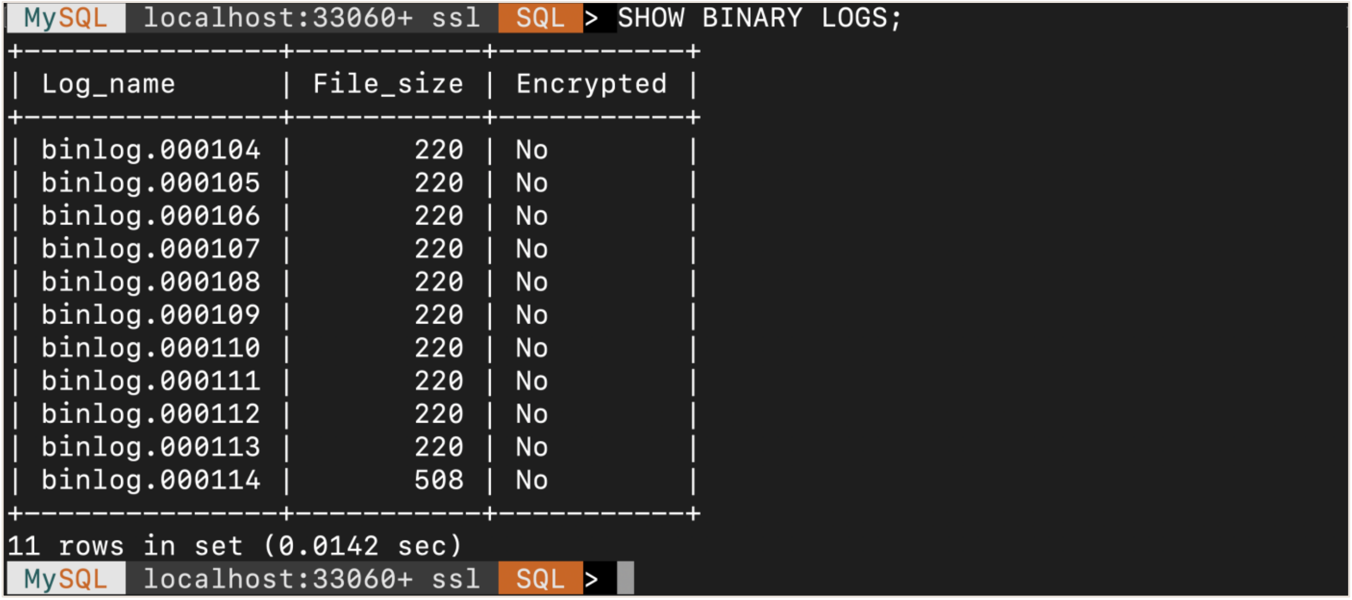
Note: you must have a value of `1` for `log_bin` and a value of `ROW` for `binlog_format`.

68. In order to perform the live database migration - we will need to retain the current binary log that is in use/will be used during the data export of on-premises MySQL to OCI HeatWave MySQL and the binary logs that will be generated afterwards. The binary logs will be needed until the replication setup is completed on OCI. Since the sample database 'world' (the one that will be migrated to HeatWave MySQL on OCI for this example step-by-step guide) is fairly small, we have kept the `binlog_expire_logs_seconds` to its default value of `2592000`. Set the `binlog_expire_logs_seconds` (if using MySQL v8.0 or above) or `expire_logs_days` (if using MySQL v5.6 or v5.7) accordingly depending on the data that you are migrating; high volumes of data will require a longer retention period. View if the binary logs are currently present and verify if the binary log retention period is set to your desired value.

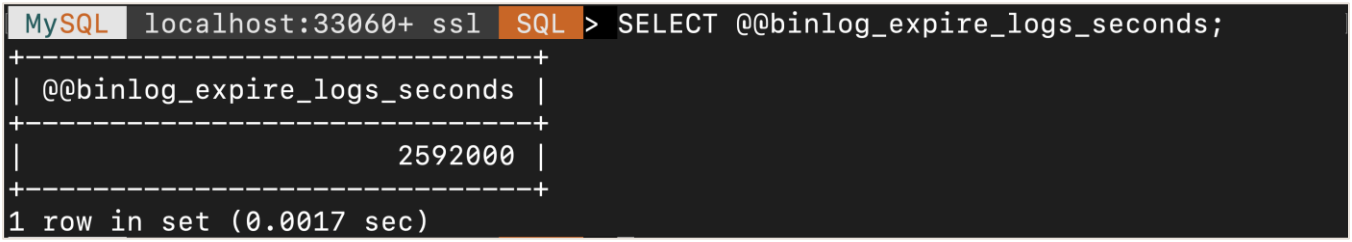
    ```
    MySQL SQL> SHOW BINARY LOGS;
    MySQL SQL> SELECT @@binlog_expire_logs_seconds;
    ```

    or

    ```
    MySQL SQL> SELECT @@expire_logs_days;
    ```



```
 MySQL  localhost:33060+ ssl  SQL > SHOW BINARY LOGS;
+---------------+-----------+-----------+
| Log_name      | File_size | Encrypted |
+---------------+-----------+-----------+
| binlog.000104 |       220 | No        |
| binlog.000105 |       220 | No        |
| binlog.000106 |       220 | No        |
| binlog.000107 |       220 | No        |
| binlog.000108 |       220 | No        |
| binlog.000109 |       220 | No        |
| binlog.000110 |       220 | No        |
| binlog.000111 |       220 | No        |
| binlog.000112 |       220 | No        |
| binlog.000113 |       220 | No        |
| binlog.000114 |       508 | No        |
+---------------+-----------+-----------+
11 rows in set (0.0142 sec)
 MySQL  localhost:33060+ ssl  SQL >
```



```
 MySQL  localhost:33060+ ssl  SQL > SELECT @@binlog_expire_logs_seconds;
+------------------------------+
| @@binlog_expire_logs_seconds |
+------------------------------+
|                      2592000 |
+------------------------------+
1 row in set (0.0017 sec)
```

Note: you can change the value of `binlog_expire_logs_seconds` and `expire_logs_days` by executing:

```
MySQL SQL> SET GLOBAL binlog_expire_logs_seconds = <number_of_seconds>;
MySQL SQL> SET GLOBAL expire_logs_days = <number_of_days>;
```

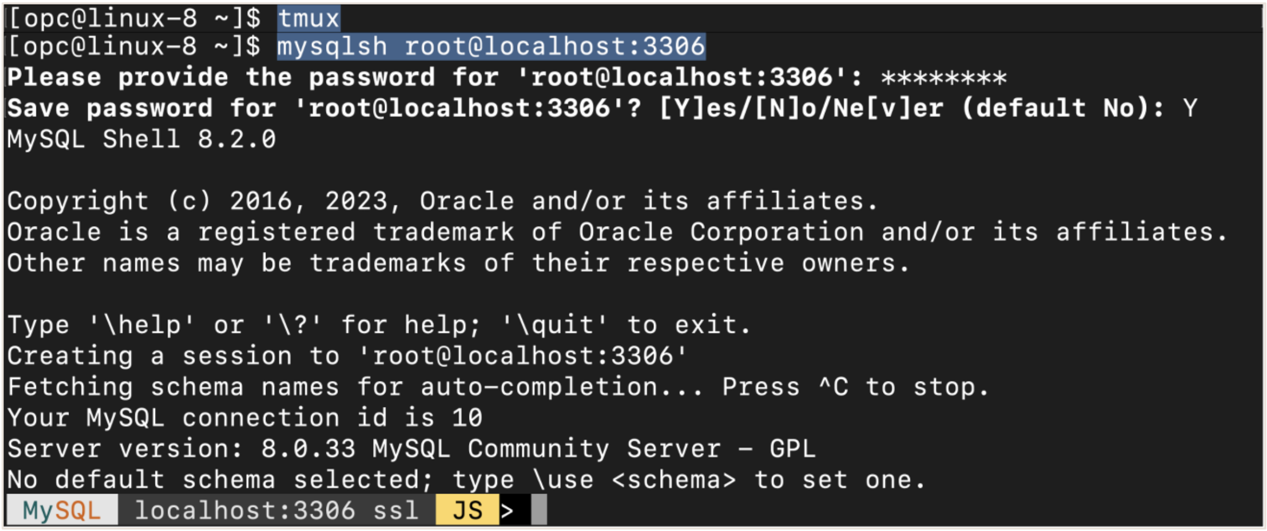
VI) Connect to MySQL on-premises using MySQL Shell and create a replication user. Afterwards, execute the MySQL Shell `util.copyInstance()` utility to export all schemas (including users, indexes, routines, triggers) from MySQL on-premises to HeatWave MySQL on OCI. After the `util.copyInstance()` utility finishes, save the MySQL Shell `Dump_metadata` values.

69. Before proceeding with the below steps, it is highly recommended that you use a command like **screen** or **tmux**. These commands will allow you to reconnect to a dropped session in case your connection drops in the middle of performing the MySQL Shell export using `util.copyInstance()`. For small databases, the screen or tmux may not be necessary. For this guide, we will use tmux. To learn more about tmux, see A beginner's guide to tmux. Below are the basics of using the tmux command:
    - Install tmux on Linux: `$ sudo yum install tmux`
    - Start a new tmux session, from your terminal execute: `$ tmux`
    - List all the active tmux sessions: `$ tmux ls`
    - Detach from a tmux session and leave it running in the background: `$ Ctrl+B d`
    - Attach a tmux session running in the background: `$ tmux attach`
    - End a tmux session: `$ Ctrl+B &`
70. Start a tmux session and connect to your on-premises MySQL using MySQL Shell.

    ```
    $ tmux
    $ mysqlsh <user>@<hostname>:<port-number>
    ```

    -OR-

    ```
    $ mysqlsh -u <user> -p -h <hostname> -P <port-number>
    ```



```
[opc@linux-8 ~]$ tmux
[opc@linux-8 ~]$ mysqlsh root@localhost:3306
Please provide the password for 'root@localhost:3306': ********
Save password for 'root@localhost:3306'? [Y]es/[N]o/Ne[v]er (default No): Y
MySQL Shell 8.2.0

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Other names may be trademarks of their respective owners.

Type '\help' or '\?' for help; '\quit' to exit.
Creating a session to 'root@localhost:3306'
Fetching schema names for auto-completion... Press ^C to stop.
Your MySQL connection id is 10
Server version: 8.0.33 MySQL Community Server - GPL
No default schema selected; type \use <schema> to set one.
 MySQL  localhost:3306 ssl  JS >
```
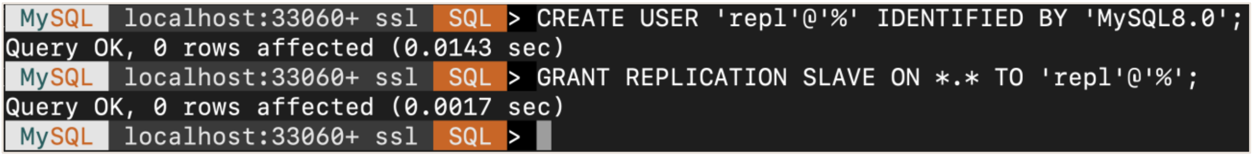

71. Change to the SQL mode of MySQL Shell and create a replication user, we will use this user to establish a replication connection from on-premises MySQL to HeatWave MySQL on OCI.

    ```
    MySQL SQL> CREATE USER 'repl'@'%' IDENTIFIED BY '<password>';
    MySQL SQL> GRANT REPLICATION SLAVE ON *.* TO 'repl'@'%';
    ```

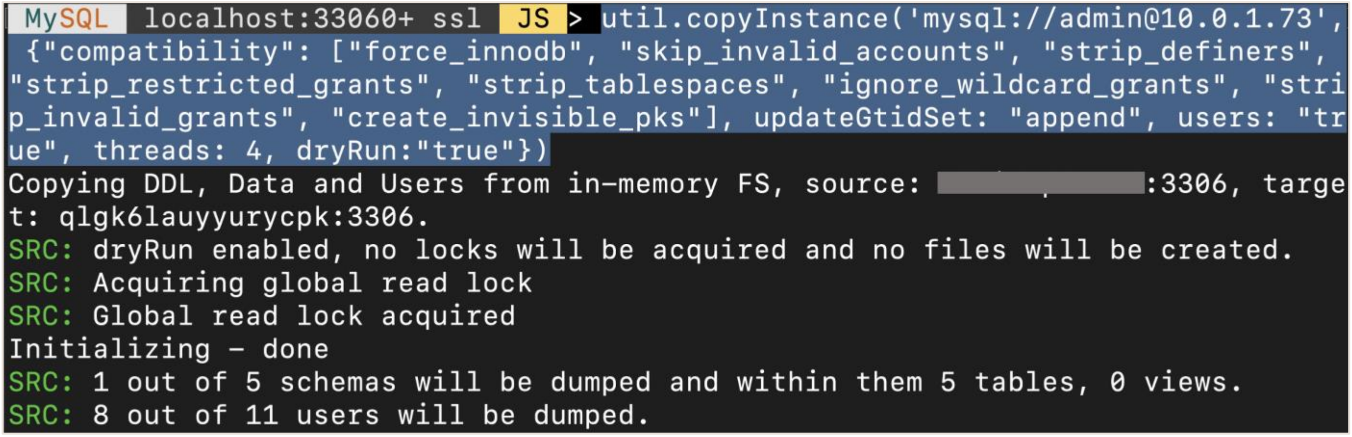


```
 MySQL  localhost:33060+ ssl  SQL > CREATE USER 'repl'@'%' IDENTIFIED BY 'MySQL8.0';
Query OK, 0 rows affected (0.0143 sec)
 MySQL  localhost:33060+ ssl  SQL > GRANT REPLICATION SLAVE ON *.* TO 'repl'@'%';
Query OK, 0 rows affected (0.0017 sec)
 MySQL  localhost:33060+ ssl  SQL >
```

72. Change to the JavaScript mode of MySQL Shell and run the `util.copyInstance()` utility to export all on-premises MySQL data into HeatWave MySQL on OCI.

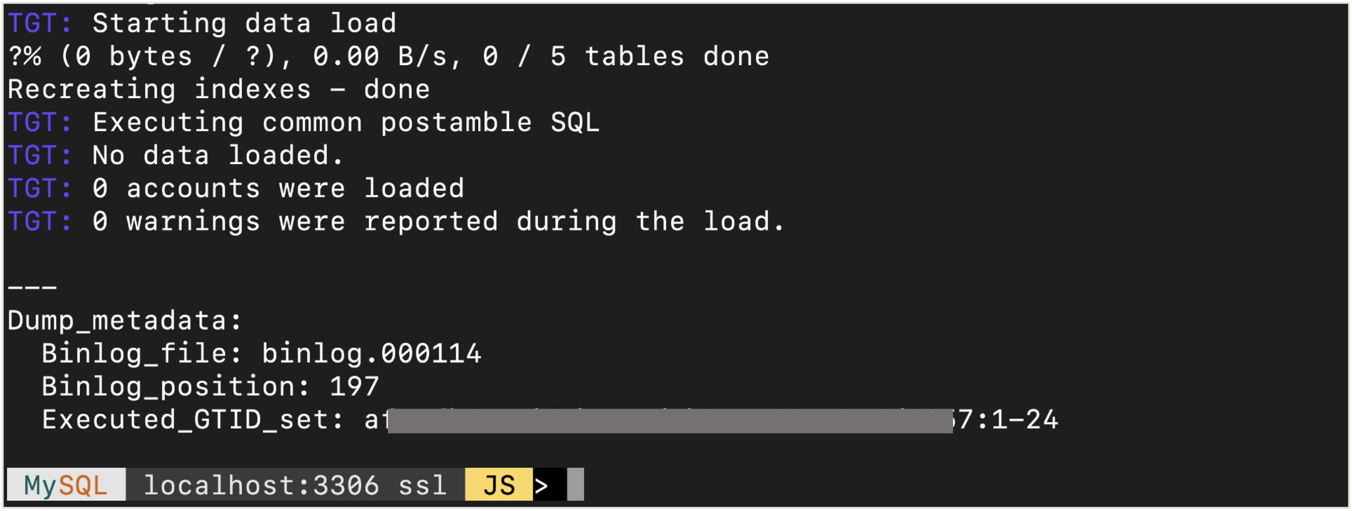
```
MySQL JS> \js
MySQL JS> util.copyInstance('mysql://admin@10.0.1.73', {"compatibility":
["force_innodb", "skip_invalid_accounts", "strip_definers",
"strip_restricted_grants", "strip_tablespaces", "ignore_wildcard_grants",
"strip_invalid_grants", "create_invisible_pks"], updateGtidSet: "append", users:
"true", threads: 4, dryRun:"true"})
```

Note: replace the username (`admin`) and IP address (`10.0.1.73`) with your HeatWave MySQL username and IP address (not the on-premises MySQL username and IP address). You will then be prompted to enter your HeatWave MySQL password after executing the copy command.



```
 MySQL  localhost:33060+ ssl  JS > util.copyInstance('mysql://admin@10.0.1.73',
 {"compatibility": ["force_innodb", "skip_invalid_accounts", "strip_definers",
"strip_restricted_grants", "strip_tablespaces", "ignore_wildcard_grants", "stri
p_invalid_grants", "create_invisible_pks"], updateGtidSet: "append", users: "tr
ue", threads: 4, dryRun:"true"})
Copying DDL, Data and Users from in-memory FS, source: [redacted]:3306, targe
t: qlgk6lauyyurycpk:3306.
SRC: dryRun enabled, no locks will be acquired and no files will be created.
SRC: Acquiring global read lock
SRC: Global read lock acquired
Initializing - done
SRC: 1 out of 5 schemas will be dumped and within them 5 tables, 0 views.
SRC: 8 out of 11 users will be dumped.
```

[… output truncated]



```
TGT: Starting data load
?% (0 bytes / ?), 0.00 B/s, 0 / 5 tables done
Recreating indexes - done
TGT: Executing common postable SQL
TGT: No data loaded.
TGT: 0 accounts were loaded
TGT: 0 warnings were reported during the load.

---
Dump_metadata:
  Binlog_file: binlog.000114
  Binlog_position: 197
  Executed_GTID_set: a[redacted]7:1-24

 MySQL  localhost:3306 ssl  JS >
```

Note:

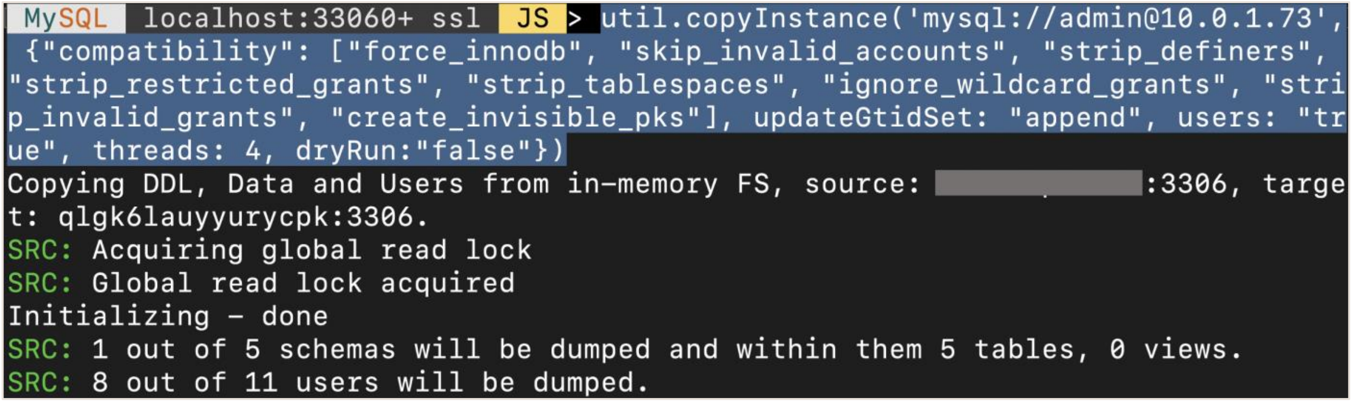
- `util.copyInstance(connectionData[, options])`: MySQL instance copy utility enables copying of an entire instance to another server. By default, this utility includes all schemas, users, indexes, routines, and triggers. See Copy Utilities.
  - `connectionData`: Defines the connection details for the destination server you want to copy to.
- `compatibility`: Apply the specified requirements for compatibility with HeatWave MySQL for all tables in the dump output, altering the dump files as necessary.
  - `force_innodb`: Change `CREATE TABLE` statements to use the InnoDB storage engine for any tables that do not already use it.
  - `skip_invalid_accounts`: You cannot export a user that has no password defined. This option skips any such users.
  - `strip_definers`: Remove the `DEFINER` clause from views, routines, events, and triggers, so these objects are created with the default definer (the user invoking the schema), and change the `SQL SECURITY` clause for views and routines to specify `INVOKER` instead of `DEFINER`. HeatWave MySQL requires special privileges to create these objects with a definer other than the user loading the schema. If your security model requires that views and routines have more privileges than the account querying or calling them, you must manually modify the schema before loading it.
  - `strip_restricted_grants`: Certain privileges are restricted in HeatWave MySQL. Privileges such as `RELOAD`, `FILE`, `SUPER`, `BINLOG_ADMIN`, and `SET_USER_ID`. You cannot create users granting these privileges. This option strips these privileges from dumped `GRANT` statements.
  - `strip_tablespaces`: Tablespaces have some restrictions in HeatWave MySQL. If you need tables created in their default tablespaces, this option strips the `TABLESPACE=` option from `CREATE TABLE` statements.
  - `ignore_wildcard_grants`: If enabled, ignores errors from grants on schemas with wildcards, which are interpreted differently in systems where the partial_revokes system variable is enabled.
  - `strip_invalid_grants`: If enabled, strips grant statements which would fail when users are copied. Such as grants referring to a specific routine which does not exist.
  - `create_invisible_pks`: Primary keys are required by High Availability and HeatWave. If you intend to export data for use in a highly available DB system or a HeatWave DB system, add primary keys as they are not defined on the tables. This compatibility flag adds invisible primary keys to each table that requires them.
- `updateGtidSet: append`: If your RDS MySQL is using GTIDs, for inbound replication, adds the transaction IDs from the source `gtid_executed` GTID set, to the replica `gtid_purged` GTID set. This lets you begin replication from the source without re-executing every past transaction from the source. Adding the GTIDs to `gtid_purged` tells the replica that those transactions have already been executed, although they are not present in the source binary log. This must be set to `append` during a live migration.
- `users`: Include (`true`) or exclude (`false`) users and their roles and grants in the dump.

- `threads`: (Optional) The number of parallel threads to use to copy chunks of data from the MySQL instance. Each thread has its own connection to the MySQL instance. The default is 4. The copy utilities require twice the number of threads, one thread to copy and one thread to write. If threads is set to N, 2N threads are used.
- `dryRun`: Displays information about the copy with the specified set of options, and about the results of HeatWave MySQL Service compatibility checks, but does not proceed with the copy. Setting this option enables you to list out all of the compatibility issues before starting the copy.

73. Once you have run the command in step 72 and did not see any errors in the output (warnings are okay), run the same step 72 command but this time change the `dryRun` option to `false`.

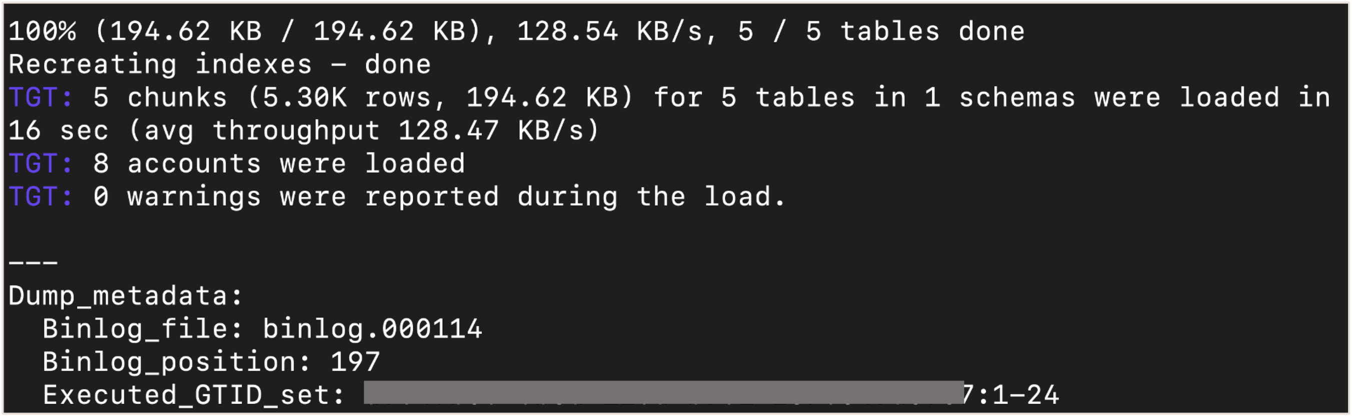
```
MySQL JS> util.copyInstance('mysql://admin@10.0.1.73', {"compatibility":
["force_innodb", "skip_invalid_accounts", "strip_definers",
"strip_restricted_grants", "strip_tablespaces", "ignore_wildcard_grants",
"strip_invalid_grants", "create_invisible_pks"], updateGtidSet: "append", users:
"true", threads: 4, dryRun:"false"})
```

Note: replace the username (`admin`) and IP address (`10.0.1.73`) with your HeatWave MySQL username and IP address (not the on-premises MySQL username and IP address).



```
 MySQL  localhost:33060+ ssl  JS > util.copyInstance('mysql://admin@10.0.1.73',
 {"compatibility": ["force_innodb", "skip_invalid_accounts", "strip_definers",
"strip_restricted_grants", "strip_tablespaces", "ignore_wildcard_grants", "stri
p_invalid_grants", "create_invisible_pks"], updateGtidSet: "append", users: "tr
ue", threads: 4, dryRun:"false"})
Copying DDL, Data and Users from in-memory FS, source: [redacted]:3306, targe
t: qlgk6lauyyurycpk:3306.
SRC: Acquiring global read lock
SRC: Global read lock acquired
Initializing - done
SRC: 1 out of 5 schemas will be dumped and within them 5 tables, 0 views.
SRC: 8 out of 11 users will be dumped.
```

[… output truncated]

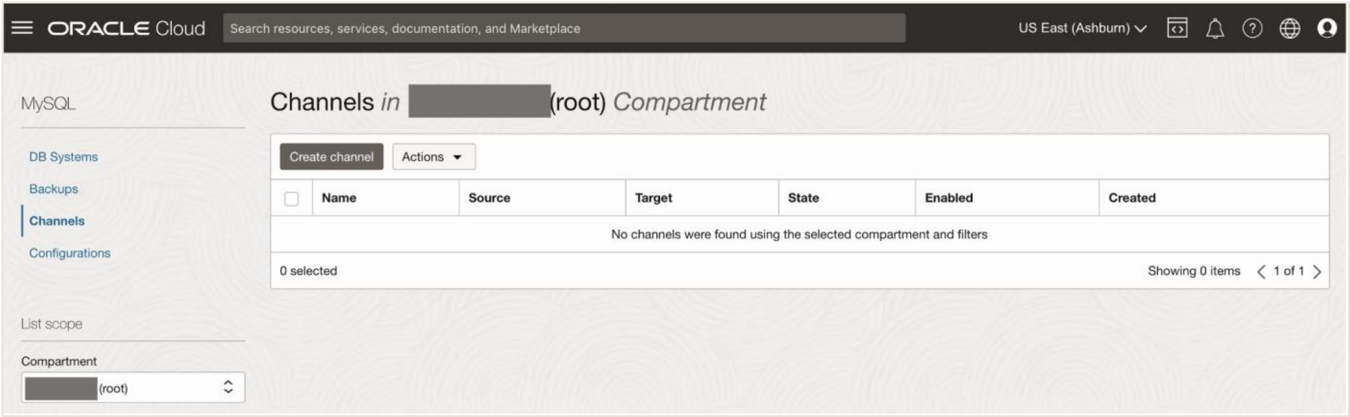


```
100% (194.62 KB / 194.62 KB), 128.54 KB/s, 5 / 5 tables done
Recreating indexes - done
TGT: 5 chunks (5.30K rows, 194.62 KB) for 5 tables in 1 schemas were loaded in
16 sec (avg throughput 128.47 KB/s)
TGT: 8 accounts were loaded
TGT: 0 warnings were reported during the load.

---
Dump_metadata:
  Binlog_file: binlog.000114
  Binlog_position: 197
  Executed_GTID_set: [redacted]7:1-24
```

74. Once the copy utility finishes, if your on-premises MySQL uses binary log positioning - save the `Binlog_file` and `Binlog_position` values from the MySQL Shell's latest `Dump_metadata` for later use. This will let the HeatWave MySQL instance on OCI know where to start the replication from for data synchronization. If your on-premises MySQL uses GTIDs, you don't need to save any of the MySQL Shell `Dump_metadata` values. The initial data transfer from MySQL on-premises to HeatWave MySQL on OCI is now complete, you can end your tmux session.

VII) On OCI, create a replication channel to set up replication from MySQL on-premises to HeatWave MySQL on OCI. During the channel creation process, if the on-premises MySQL instance is using binary log positioning - under the replication positioning section, select Source cannot use GTID auto-positioning and provide the binlogFile and binlogPosition values. If the on-premises MySQL instance is using GTIDs - select Source can use GTID auto-positioning (recommended). Create the replication channel afterwards.

75. After your data has successfully imported into HeatWave MySQL, from the OCI Console, click on the navigation menu again, go to **Databases**, and click **Channels**.
76. Click **Create channel** to set up replication between MySQL on-premises and HeatWave MySQL on OCI.



Channels *in* [redacted] (root) *Compartment*

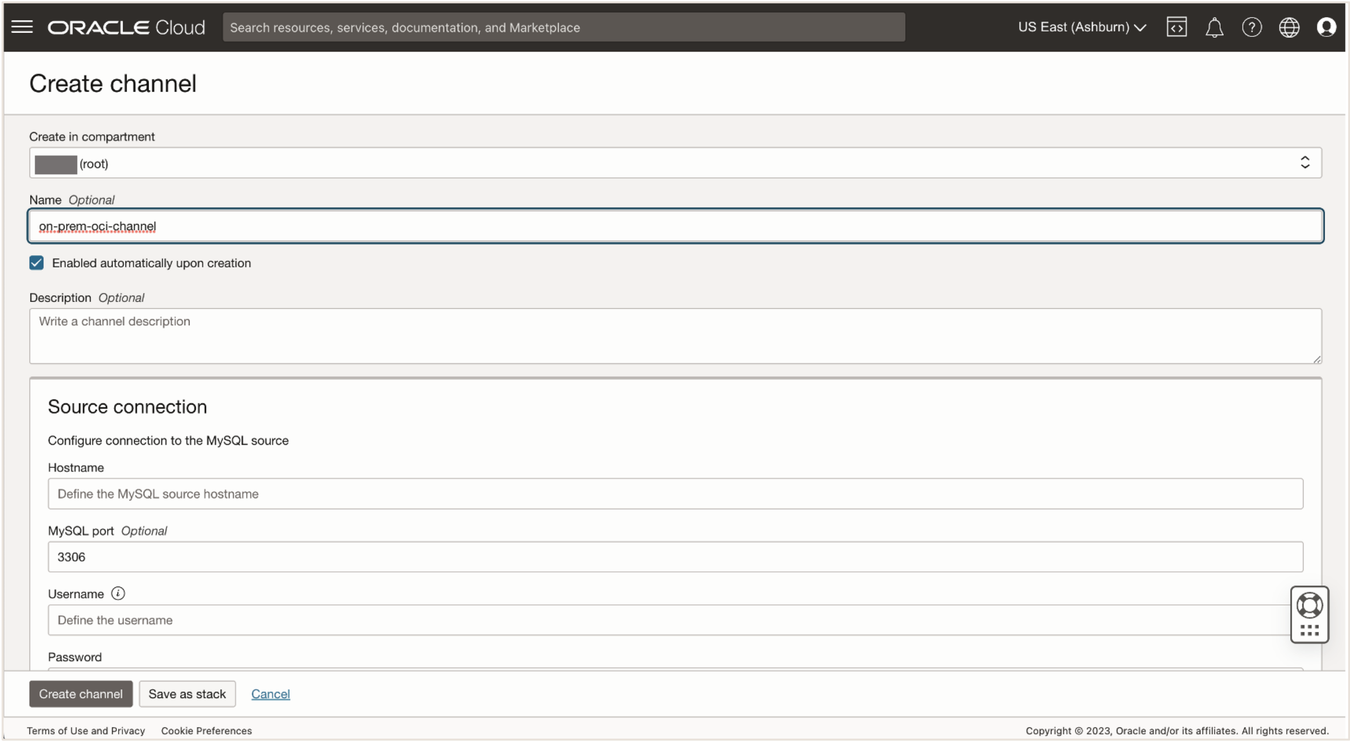
Create channel | Actions

□	Name	Source	Target	State	Enabled	Created
No channels were found using the selected compartment and filters						

0 selected — Showing 0 items — 1 of 1

Compartment: [redacted] (root)

77. Ensure you are in the right compartment and enter a **replication channel name**. Ensure that the **Enabled automatically upon creation** box is checked.



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Save as stack
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Create channel

Create in compartment: [redacted] (root)

Name *Optional*: on-prem-oci-channel

☑ Enabled automatically upon creation

Description *Optional*: Write a channel description

Source connection

Configure connection to the MySQL source

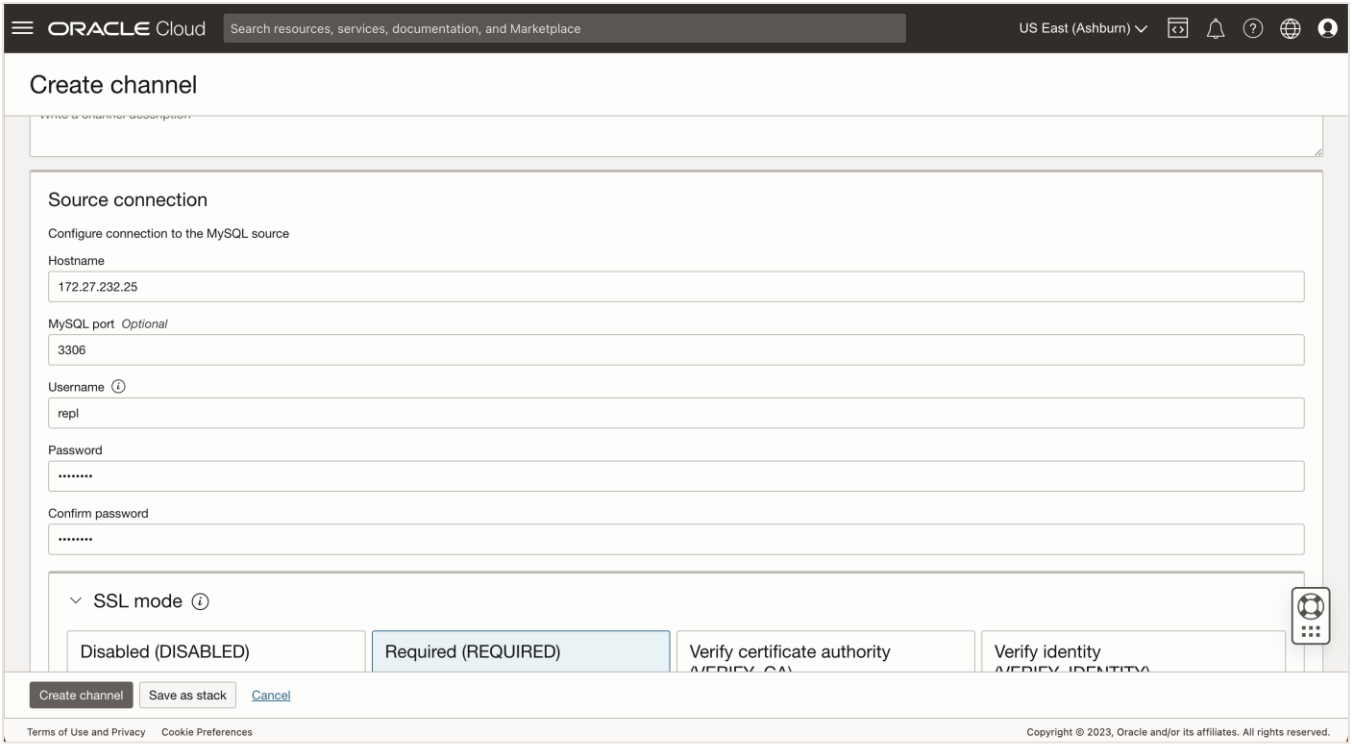
Hostname: Define the MySQL source hostname

MySQL port *Optional*: 3306

Username: Define the username

Password

78. Under **Source connection**, for **Hostname** input your OpenVPN's **VPN Static IP Address** from step 26. For **Port**, specify the port number the on-premises MySQL listens on - the default is **3306**. For **Username** and **Password** - specify **the replication username and password** for the account that you created on the on-premises MySQL instance.



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Create channel

Source connection

Configure connection to the MySQL source

Hostname: 172.27.232.25

MySQL port *Optional*: 3306

Username: repl

Password: ••••••••

Confirm password: ••••••••

SSL mode

Disabled (DISABLED) | Required (REQUIRED) | Verify certificate authority (VERIFY_CA) | Verify identity (VERIFY_IDENTITY)

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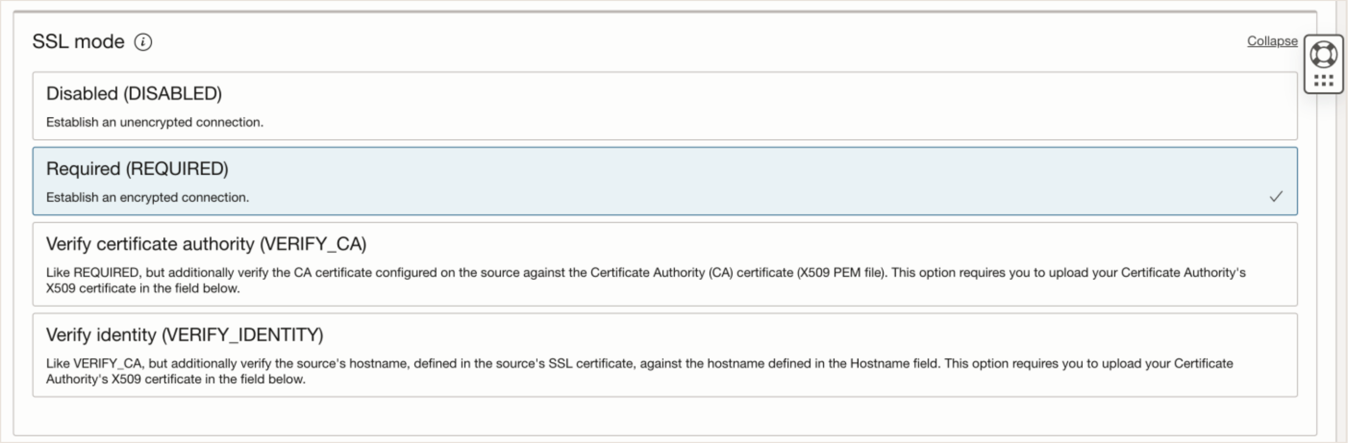
79. For **SSL mode** select the one that meets your need. For this guide, we have chosen **Required (REQUIRED)**.



SSL mode

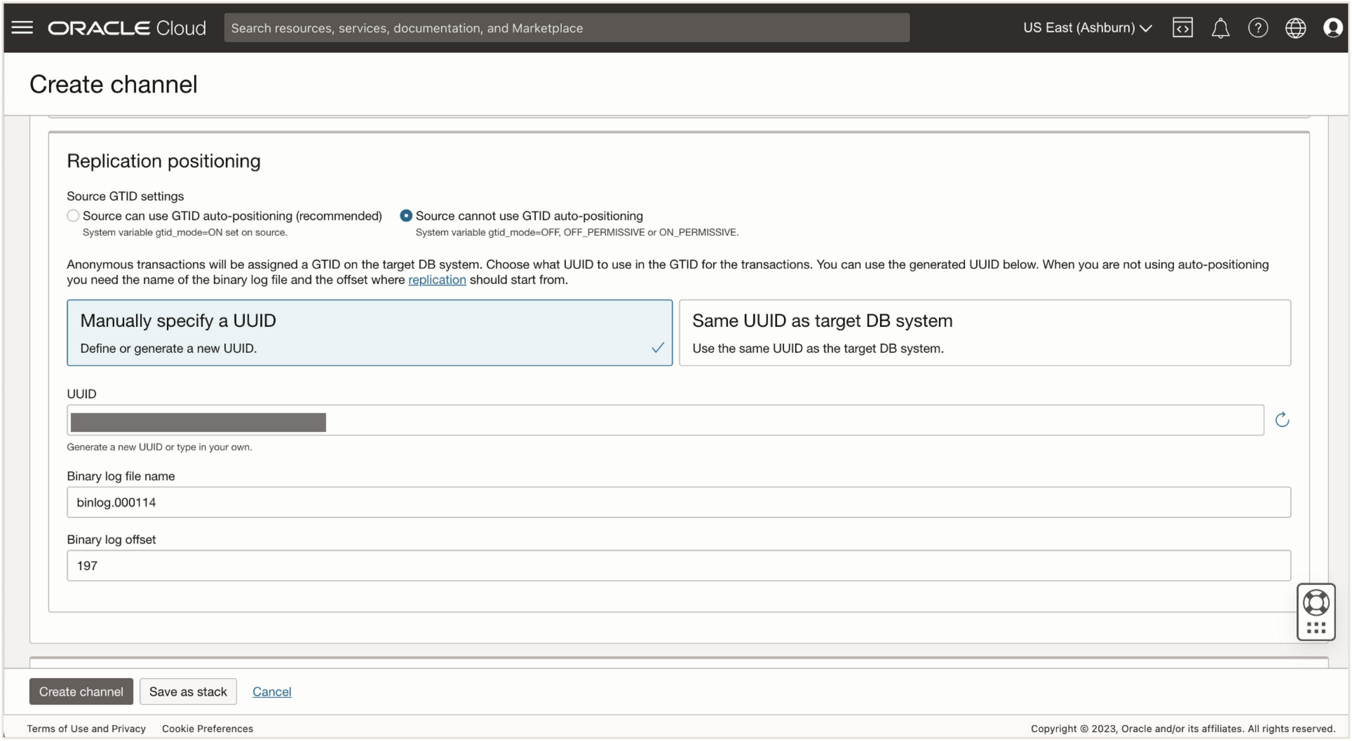
Disabled (DISABLED)
Establish an unencrypted connection.

Required (REQUIRED) ✓
Establish an encrypted connection.

Verify certificate authority (VERIFY_CA)
Like REQUIRED, but additionally verify the CA certificate configured on the source against the Certificate Authority (CA) certificate (X509 PEM file). This option requires you to upload your Certificate Authority's X509 certificate in the field below.

Verify identity (VERIFY_IDENTITY)
Like VERIFY_CA, but additionally verify the source's hostname, defined in the source's SSL certificate, against the hostname defined in the Hostname field. This option requires you to upload your Certificate Authority's X509 certificate in the field below.

80. For **Replication positioning**, if your on-premises MySQL uses binary log positioning – select **Source cannot use GTID auto-positioning**. Keep the **UUID** field as-is, for **Binary log file name** and **Binary log offset**, input the `Binlog_file` and `Binlog_position` values respectively from the MySQL Shell's `Dump_metadata` that you had saved from step 73.



Create channel

Replication positioning

Source GTID settings

○ Source can use GTID auto-positioning (recommended)
System variable gtid_mode=ON set on source.

● Source cannot use GTID auto-positioning
System variable gtid_mode=OFF, OFF_PERMISSIVE or ON_PERMISSIVE.

Anonymous transactions will be assigned a GTID on the target DB system. Choose what UUID to use in the GTID for the transactions. You can use the generated UUID below. When you are not using auto-positioning you need the name of the binary log file and the offset where replication should start from.

Manually specify a UUID ✓
Define or generate a new UUID.

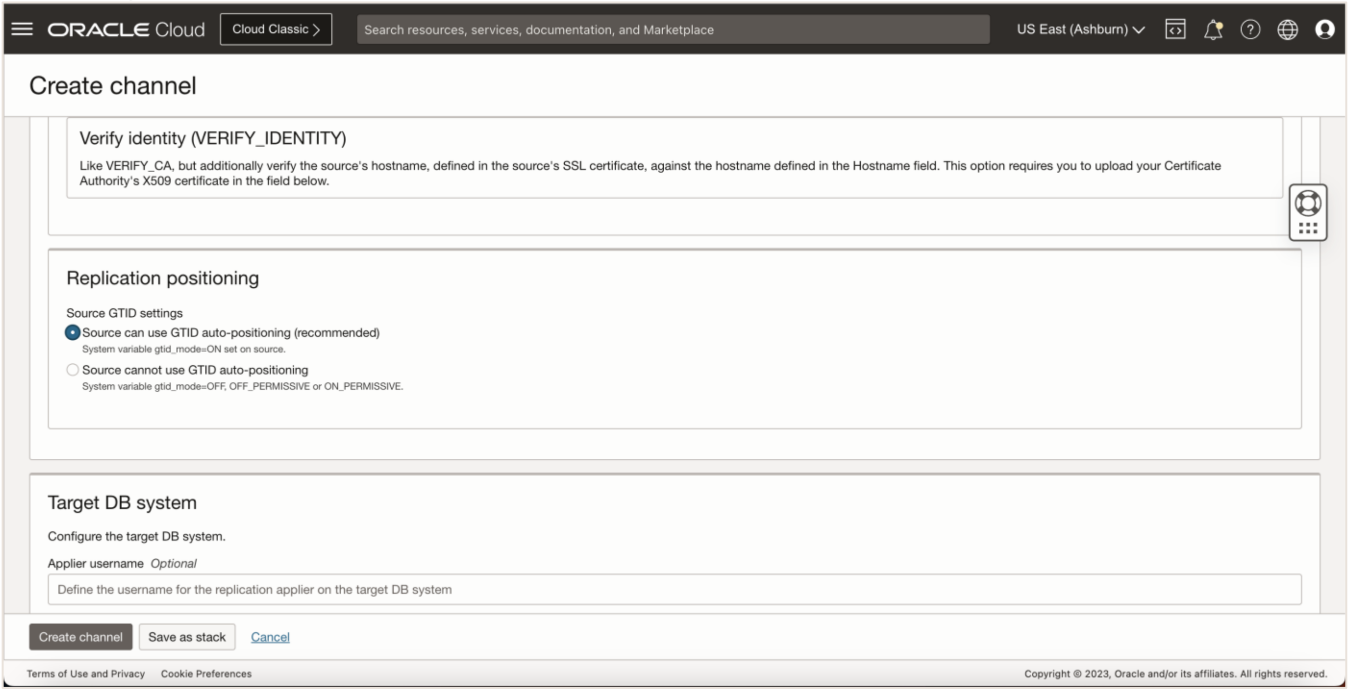
Same UUID as target DB system
Use the same UUID as the target DB system.

UUID
[redacted]
Generate a new UUID or type in your own.

Binary log file name
binlog.000114

Binary log offset
197

81. For **Replication positioning**, if your on-premises MySQL uses GTIDs – select **Source can use GTID auto-positioning (recommended)**.



Create channel

Verify identity (VERIFY_IDENTITY)
Like VERIFY_CA, but additionally verify the source's hostname, defined in the source's SSL certificate, against the hostname defined in the Hostname field. This option requires you to upload your Certificate Authority's X509 certificate in the field below.

Replication positioning

Source GTID settings

● Source can use GTID auto-positioning (recommended)
System variable gtid_mode=ON set on source.

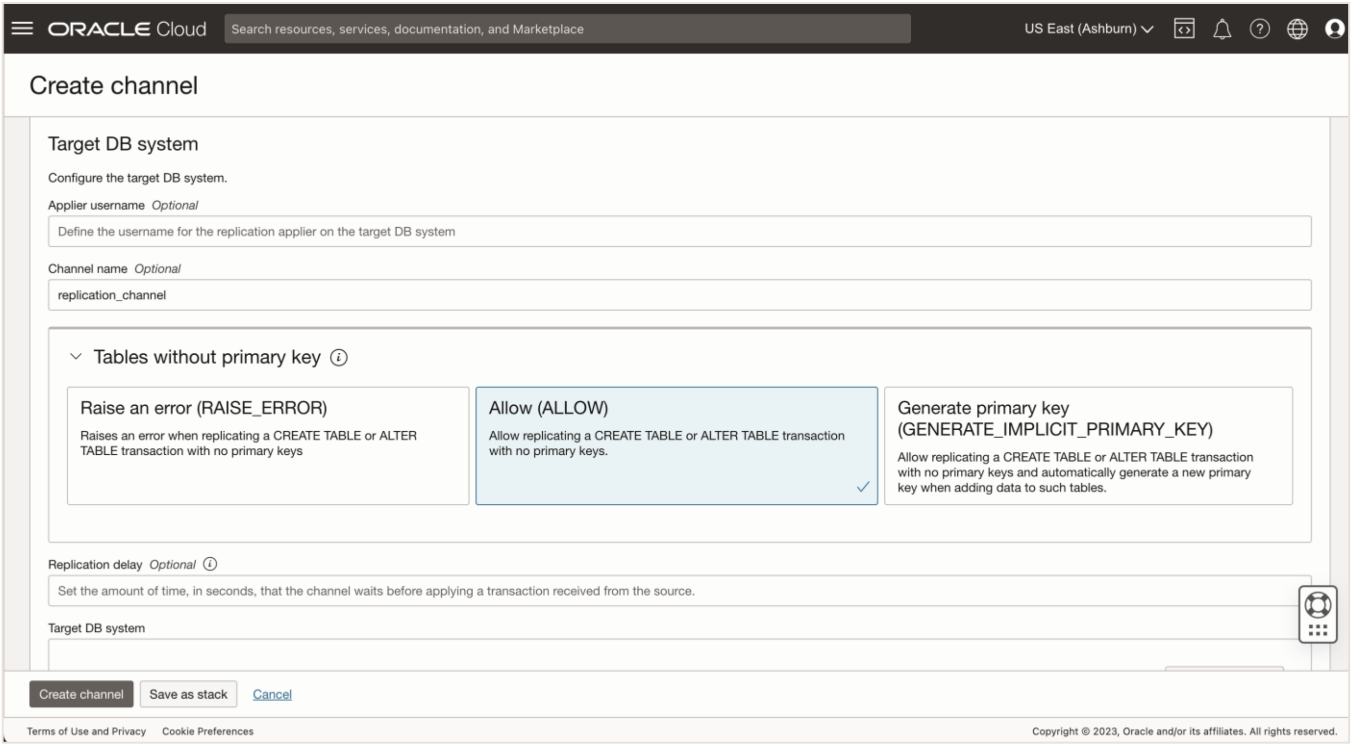
○ Source cannot use GTID auto-positioning
System variable gtid_mode=OFF, OFF_PERMISSIVE or ON_PERMISSIVE.

Target DB system

Configure the target DB system.

Applier username *Optional*
Define the username for the replication applier on the target DB system

82. Scroll down until you see **Tables without primary key**. If you plan on using the High Availability or HeatWave option, select **Generate primary key** since these options require primary keys on every table. If you don't plan on using High Availability or HeatWave – you can either select **Raise an error** or **Allow**. For this guide, we have chosen **Allow**.



Create channel

Target DB system

Configure the target DB system.

Applier username *Optional*

Define the username for the replication applier on the target DB system

Channel name *Optional*

replication_channel

Tables without primary key

Raise an error (RAISE_ERROR)
Raises an error when replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys

Allow (ALLOW) ✓
Allow replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys.

Generate primary key (GENERATE_IMPLICIT_PRIMARY_KEY)
Allow replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys and automatically generate a new primary key when adding data to such tables.

Replication delay *Optional*

Set the amount of time, in seconds, that the channel waits before applying a transaction received from the source.

Target DB system

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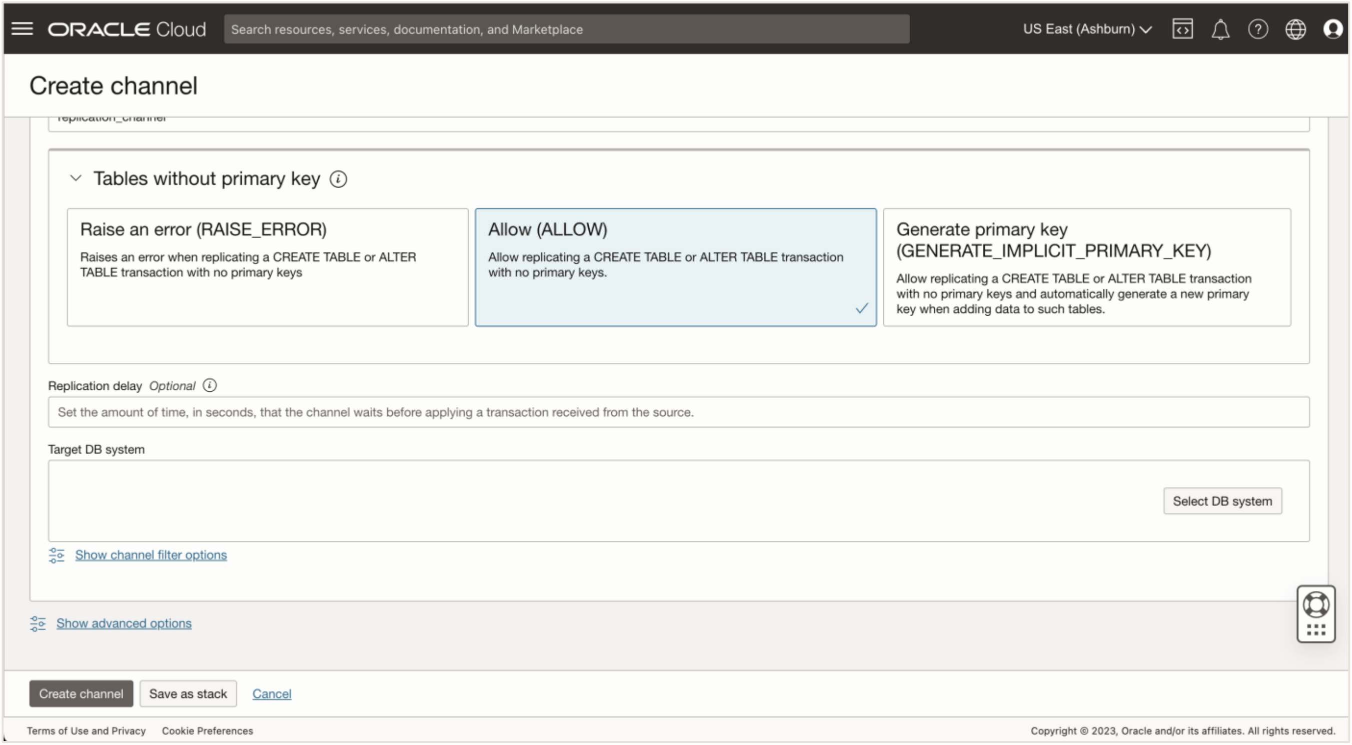
83. Under Tables without primary key, you should see **Target DB system**. Click **Select DB system**.



Create channel

Tables without primary key

Raise an error (RAISE_ERROR)
Raises an error when replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys

Allow (ALLOW) ✓
Allow replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys.

Generate primary key (GENERATE_IMPLICIT_PRIMARY_KEY)
Allow replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys and automatically generate a new primary key when adding data to such tables.

Replication delay *Optional*

Set the amount of time, in seconds, that the channel waits before applying a transaction received from the source.

Target DB system

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Select DB system
Show channel filter options
Show advanced options
Create channel
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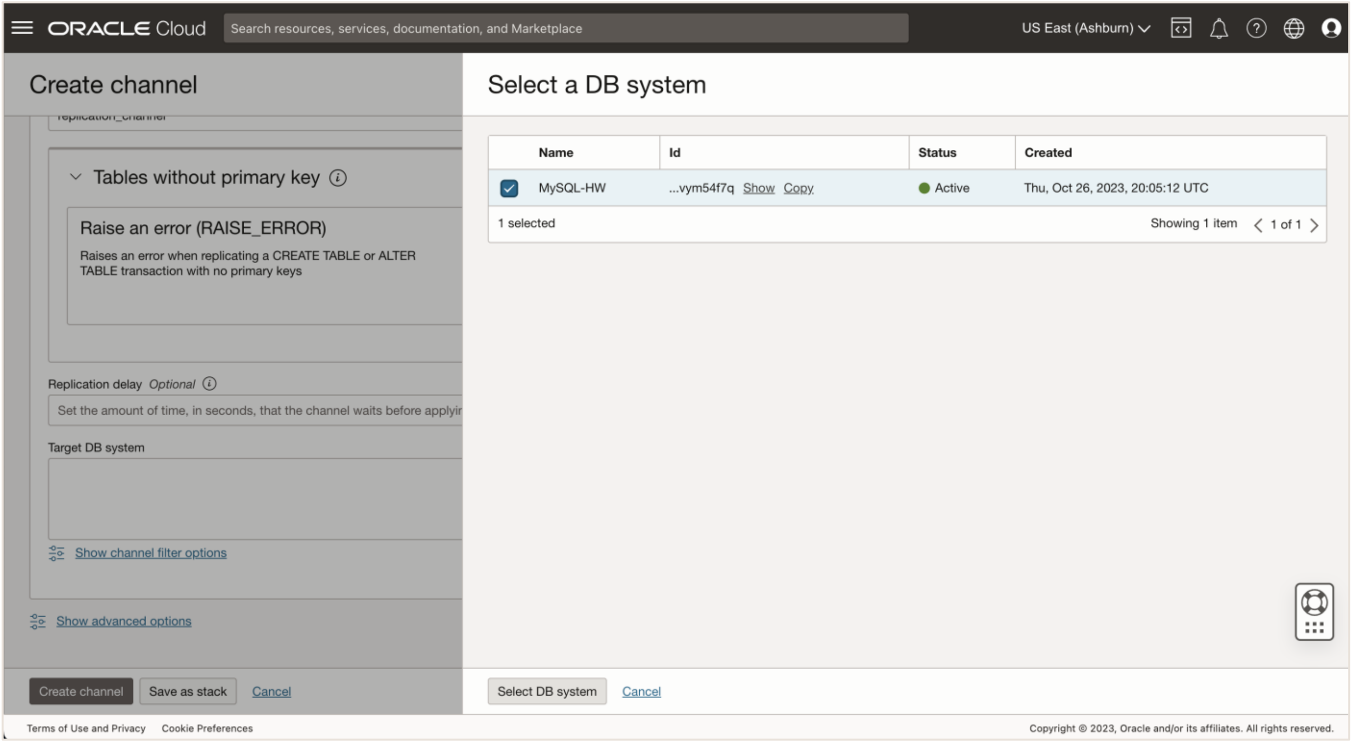
84. A list of your MySQL DB systems will open after completing the previous step. Select the **HeatWave MySQL system** that you created earlier and click **Select DB system**.



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Create channel
Tables without primary key
Show channel filter options
Show advanced options
Create channel
Save as stack
Cancel
Select DB system
Cancel
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Select a DB system

	Name	Id	Status	Created
☑	MySQL-HW	...vym54f7q Show Copy	● Active	Thu, Oct 26, 2023, 20:05:12 UTC

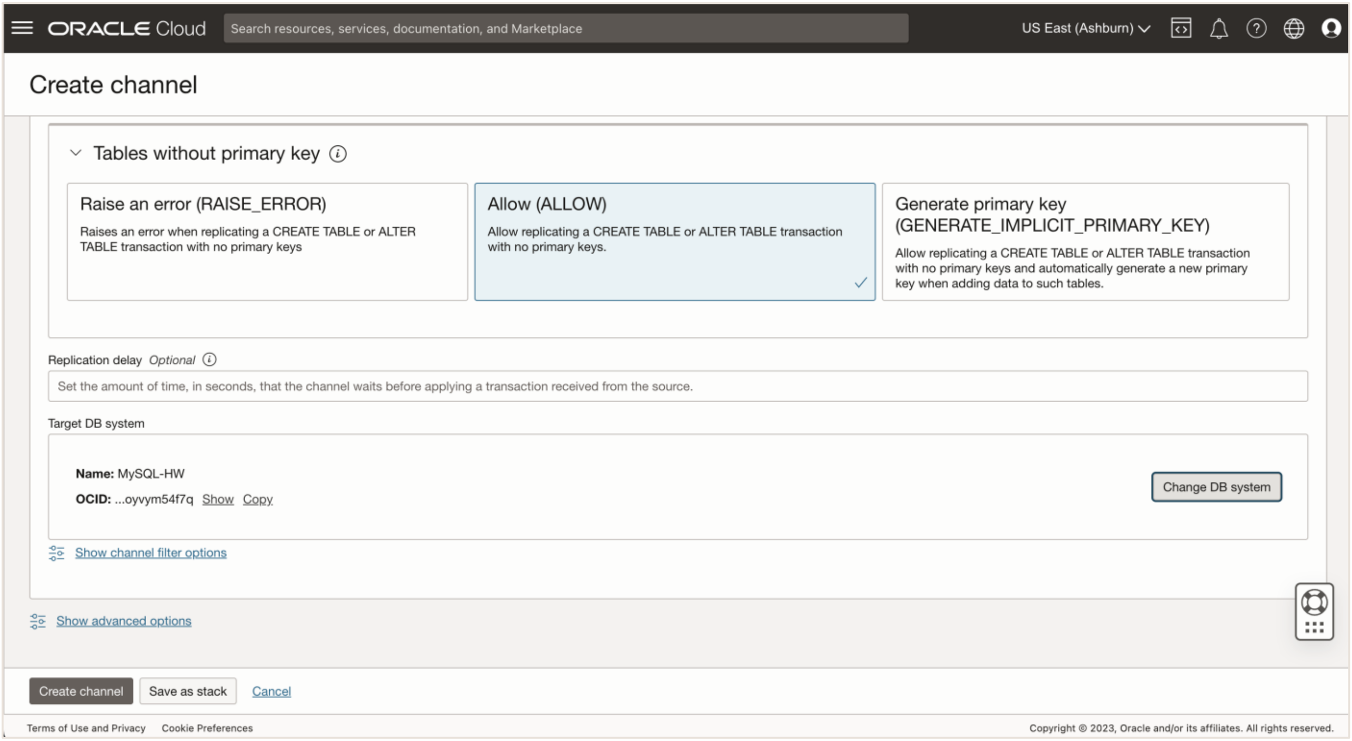
1 selected — Showing 1 item 1 of 1

Raise an error (RAISE_ERROR)
Raises an error when replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys

Replication delay *Optional*
Set the amount of time, in seconds, that the channel waits before applyi

Target DB system

85. Click **Create channel**.



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Change DB system
Show channel filter options
Show advanced options
Create channel
Save as stack
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Create channel

Tables without primary key

Raise an error (RAISE_ERROR)
Raises an error when replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys

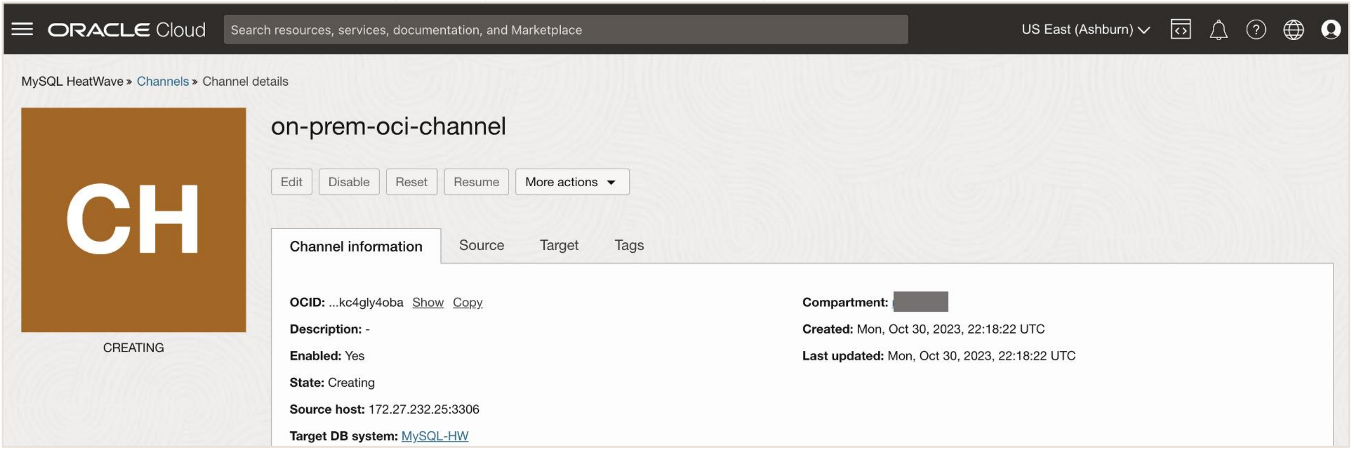
Allow (ALLOW) ✓
Allow replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys.

Generate primary key (GENERATE_IMPLICIT_PRIMARY_KEY)
Allow replicating a CREATE TABLE or ALTER TABLE transaction with no primary keys and automatically generate a new primary key when adding data to such tables.

Replication delay *Optional*
Set the amount of time, in seconds, that the channel waits before applying a transaction received from the source.

Target DB system
Name: MySQL-HW
OCID: ...oyvym54f7q Show Copy

86. The replication channel from your on-premises MySQL to HeatWave MySQL on OCI will now start CREATING so that we can propagate all the pending data changes to HeatWave MySQL that had occurred on the on-premises MySQL after the execution of MySQL Shell `util.copyInstance()` utility. Your channel should change its status to **ACTIVE** shortly if everything was done correctly.



on-prem-oci-channel

CREATING

OCID: ...kc4gly4oba

Description: -

Enabled: Yes

State: Creating

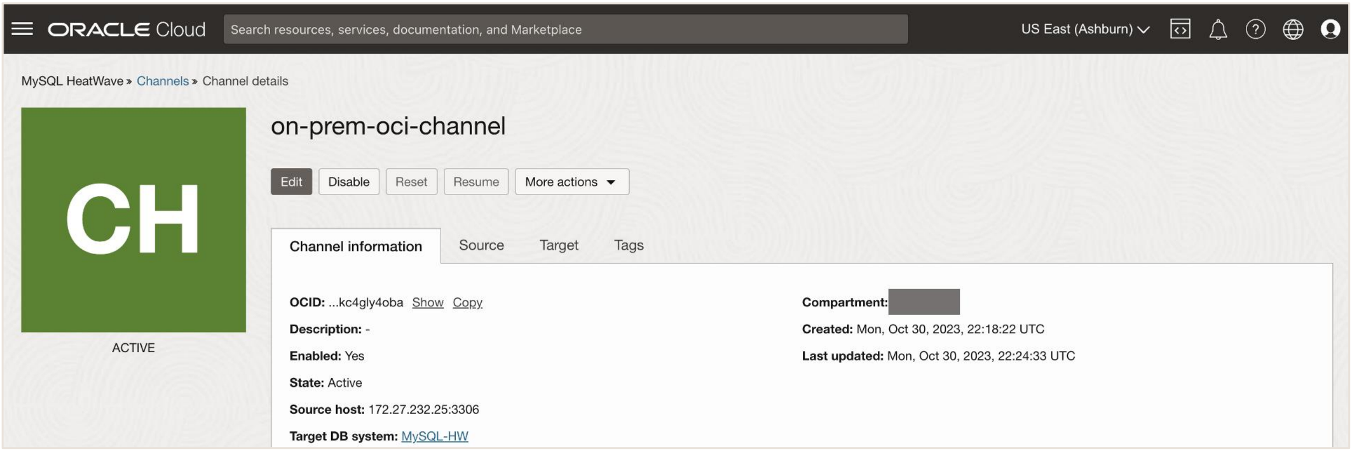
Source host: 172.27.232.25:3306

Target DB system: MySQL-HW

Compartment: [redacted]

Created: Mon, Oct 30, 2023, 22:18:22 UTC

Last updated: Mon, Oct 30, 2023, 22:18:22 UTC



on-prem-oci-channel

ACTIVE

OCID: ...kc4gly4oba

Description: -

Enabled: Yes

State: Active

Source host: 172.27.232.25:3306

Target DB system: MySQL-HW

Compartment: [redacted]

Created: Mon, Oct 30, 2023, 22:18:22 UTC

Last updated: Mon, Oct 30, 2023, 22:24:33 UTC

VIII) After the replication channel is up, connect to HeatWave MySQL and execute the `SHOW REPLICA STATUS\G` command. From the query output, look for the `seconds_behind_source` and `Replica_SQL_Running_State` fields. If the `seconds_behind_source` field displays a value of `0` and the `Replica_SQL_Running_State` field displays a message of `Replica has read all relay log; waiting for more updates` - this indicates that the HeatWave MySQL instance has fully caught up with the on-premises MySQL changes and the replication channel can now be disabled.

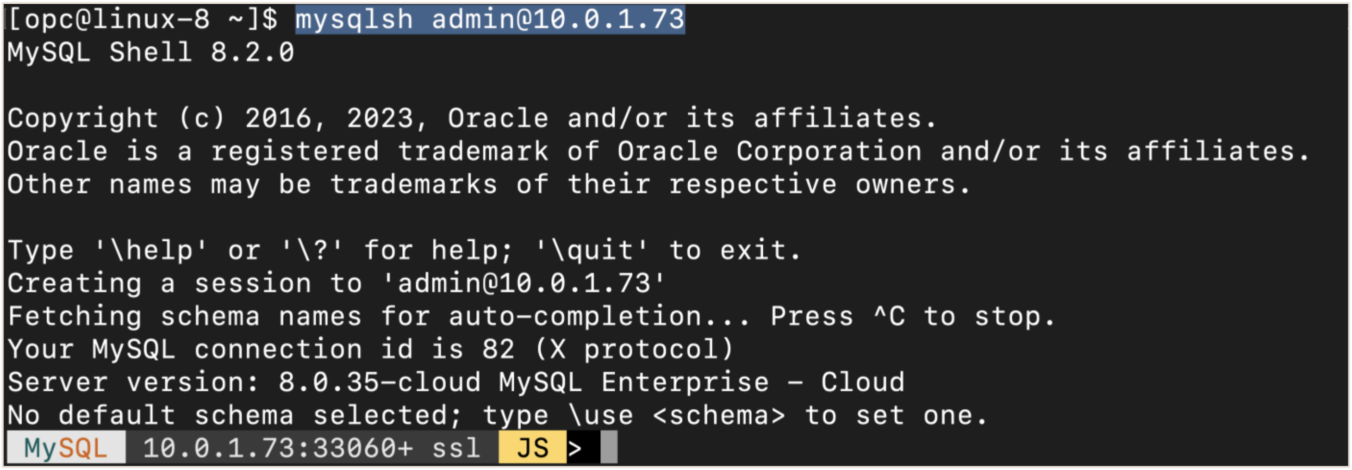
Note: During this step, it is recommended to stop the database application for ~5 minutes to ensure that no writes are happening to the on-premises MySQL instance before the replication channel between HeatWave MySQL and on-premises MySQL is disabled.

87. Connect to your HeatWave MySQL on OCI instance using MySQL Shell which is installed on your on-premises environment.

    ```
    $ mysqlsh <user>@<hostname>:<port-number>
    ```

    -OR-

    ```
    $ mysqlsh -u <user> -p -h <hostname> -P <port-number>
    ```



```
[opc@linux-8 ~]$ mysqlsh admin@10.0.1.73
MySQL Shell 8.2.0

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Other names may be trademarks of their respective owners.

Type '\help' or '\?' for help; '\quit' to exit.
Creating a session to 'admin@10.0.1.73'
Fetching schema names for auto-completion... Press ^C to stop.
Your MySQL connection id is 82 (X protocol)
Server version: 8.0.35-cloud MySQL Enterprise - Cloud
No default schema selected; type \use <schema> to set one.
 MySQL  10.0.1.73:33060+ ssl  JS >
```
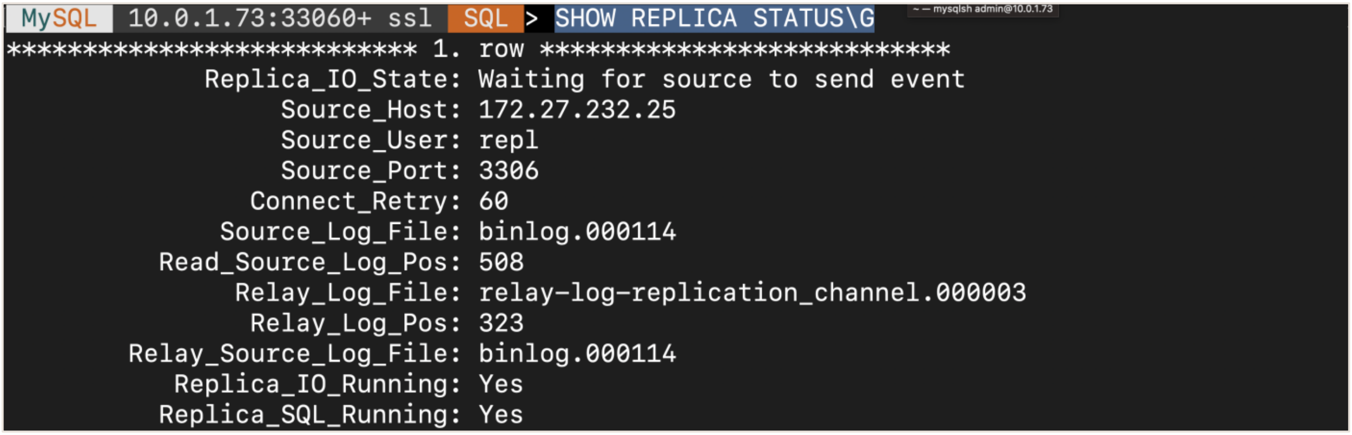

88. Switch to the SQL mode of MySQL Shell and run the below statement:

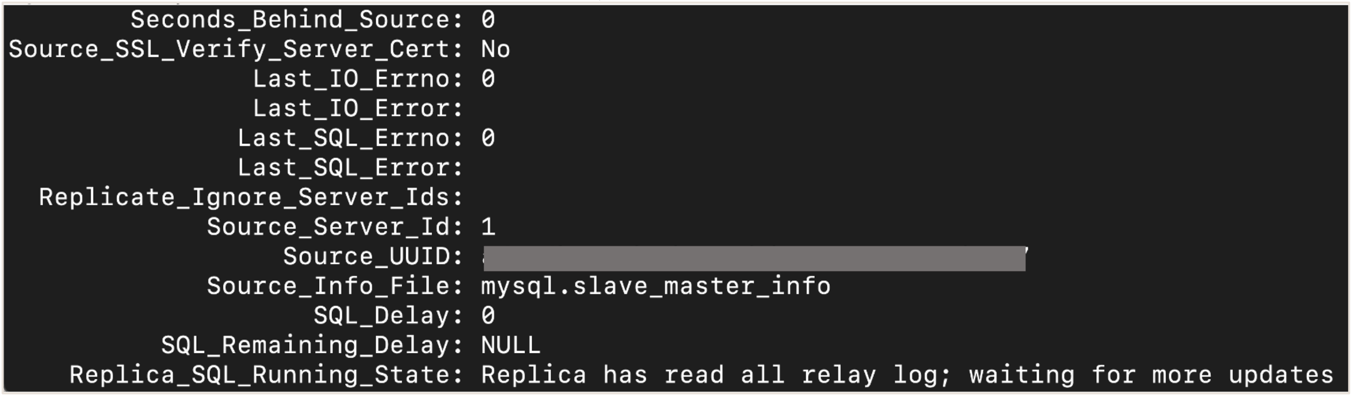
    ```
    MySQL JS> \sql
    MySQL SQL> SHOW REPLICA STATUS\G
    ```



```
 MySQL  10.0.1.73:33060+ ssl  SQL > SHOW REPLICA STATUS\G
*************************** 1. row ***************************
             Replica_IO_State: Waiting for source to send event
                  Source_Host: 172.27.232.25
                  Source_User: repl
                  Source_Port: 3306
                Connect_Retry: 60
              Source_Log_File: binlog.000114
          Read_Source_Log_Pos: 508
               Relay_Log_File: relay-log-replication_channel.000003
                Relay_Log_Pos: 323
        Relay_Source_Log_File: binlog.000114
           Replica_IO_Running: Yes
          Replica_SQL_Running: Yes
```

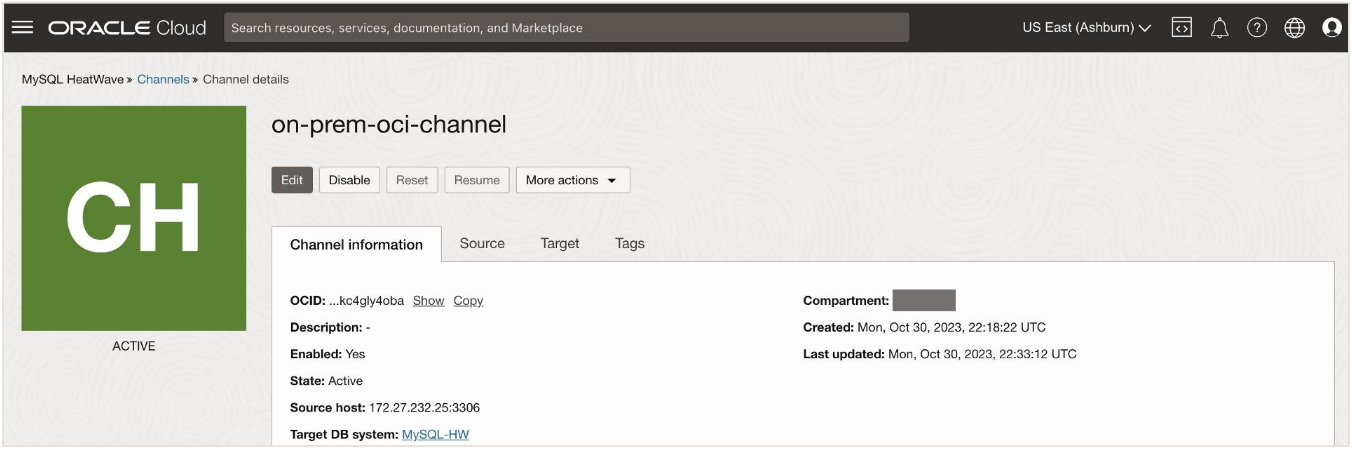
89. If the replication is successfully ongoing from on-premises MySQL to HeatWave MySQL, you should see the status of `Replica_IO_Running` and `Replica_SQL_Running` as `Yes`. If one or the other shows an output different than `Yes`, your replication has failed or encountered an error.

90. When executing the above SQL statement `SHOW REPLICA STATUS\G`, also look for `Seconds_Behind_Source` and `Replica_SQL_Running_State` values. If you see a value of `0` for `Seconds_Behind_Source` and a value string of `Replica has read all relay log; waiting for more updates` for `Replica_SQL_Running_State` - this suggests that HeatWave MySQL instance has fully caught up with the on-premises MySQL instance and there are no pending transactions on MySQL on-premises that needs to be replicated to HeatWave MySQL.



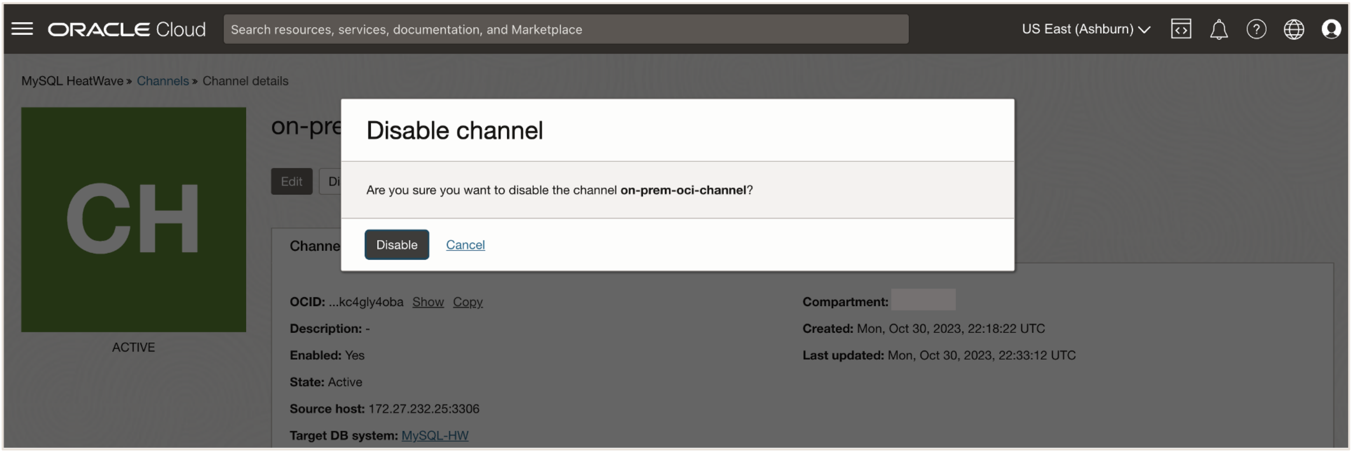
```
        Seconds_Behind_Source: 0
Source_SSL_Verify_Server_Cert: No
                Last_IO_Errno: 0
                Last_IO_Error: 
               Last_SQL_Errno: 0
               Last_SQL_Error: 
  Replicate_Ignore_Server_Ids: 
             Source_Server_Id: 1
                  Source_UUID: [redacted]
             Source_Info_File: mysql.slave_master_info
                    SQL_Delay: 0
          SQL_Remaining_Delay: NULL
    Replica_SQL_Running_State: Replica has read all relay log; waiting for more updates
```

91. You can go back to the OCI MySQL Channels page and **Disable** the Channel.



on-prem-oci-channel

OCID: ...kc4gly4oba Show Copy
Description: -
Enabled: Yes
State: Active
Source host: 172.27.232.25:3306
Target DB system: MySQL-HW
Compartment: [redacted]
Created: Mon, Oct 30, 2023, 22:18:22 UTC
Last updated: Mon, Oct 30, 2023, 22:33:12 UTC



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Search resources, services, documentation, and Marketplace
US East (Ashburn)
MySQL HeatWave » Channels » Channel details
CH
ACTIVE
Disable
Cancel

Disable channel

Are you sure you want to disable the channel **on-prem-oci-channel**?

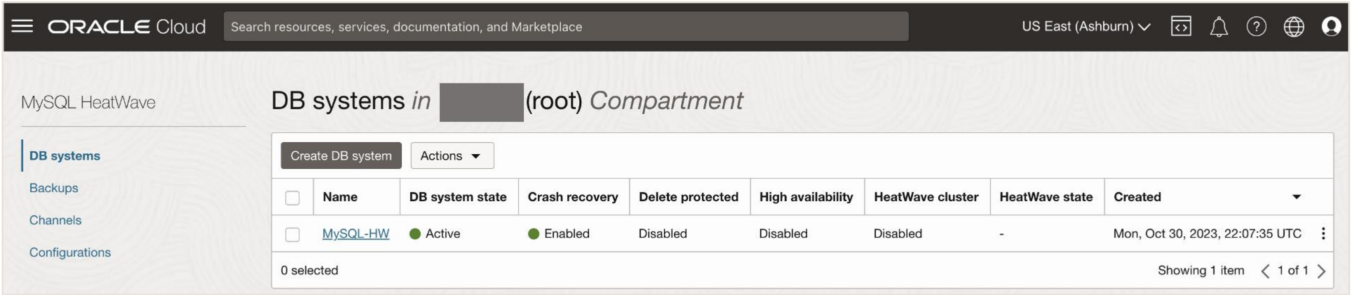
OCID: ...kc4gly4oba Show Copy
Description: -
Enabled: Yes
State: Active
Source host: 172.27.232.25:3306
Target DB system: MySQL-HW
Compartment: [redacted]
Created: Mon, Oct 30, 2023, 22:18:22 UTC
Last updated: Mon, Oct 30, 2023, 22:33:12 UTC

92. Once the channel is disabled, you may enable HA for your HeatWave MySQL instance.

IX) At this point, the live migration process for the database is complete. The database applications can now point to HeatWave MySQL on OCI.

X) (Optional) On OCI, if the HeatWave option was enabled during HeatWave MySQL DB creation, add the HW Cluster and load data from MySQL InnoDB storage into the HW Cluster using automation.

93. Login to OCI. Click on the navigation menu, go to **Databases**, and click **HeatWave MySQL**.
94. Click on the name of your HeatWave MySQL instance to go to the **DB System Details** page.

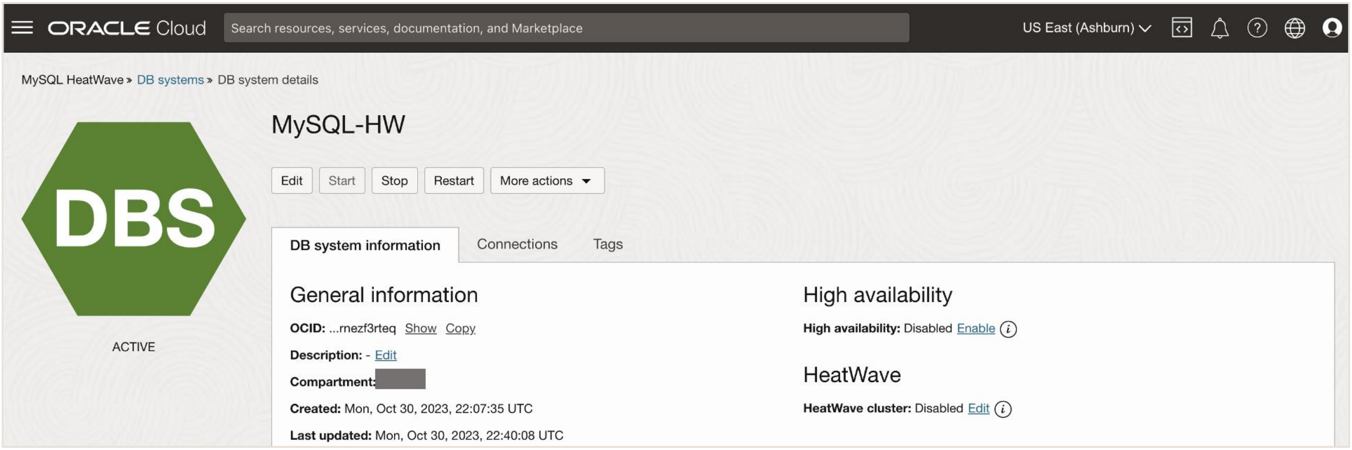


DB systems *in* [redacted] (root) *Compartment*

☐	Name	DB system state	Crash recovery	Delete protected	High availability	HeatWave cluster	HeatWave state	Created
☐	MySQL-HW	● Active	● Enabled	Disabled	Disabled	Disabled	-	Mon, Oct 30, 2023, 22:07:35 UTC

0 selected

Showing 1 item 1 of 1



MySQL-HW

General information

OCID: ...rnezf3rteq Show Copy

Description: - Edit

Compartment: [redacted]

Created: Mon, Oct 30, 2023, 22:07:35 UTC

Last updated: Mon, Oct 30, 2023, 22:40:08 UTC

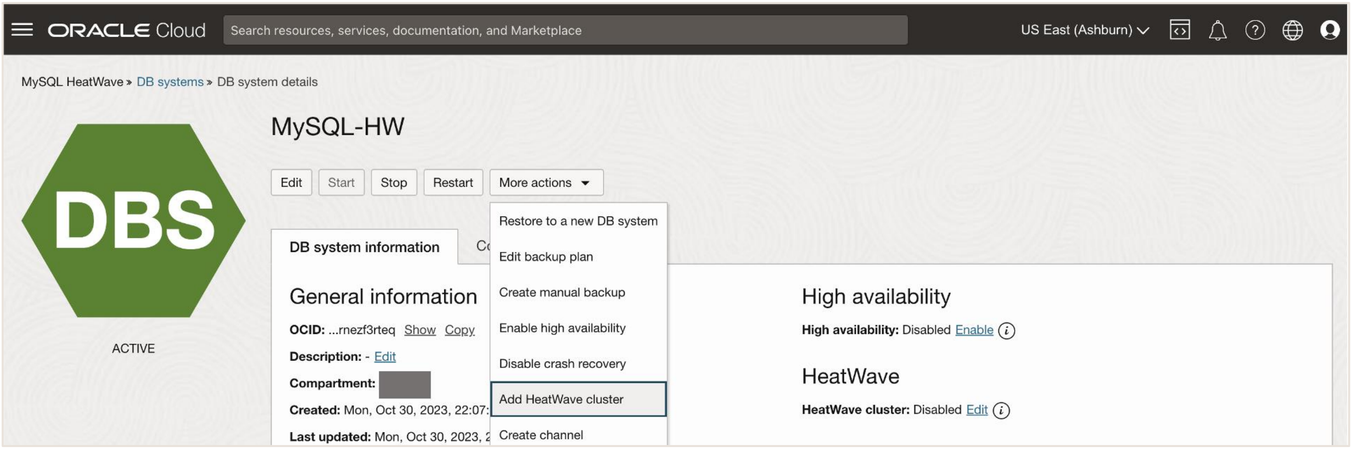
High availability

High availability: Disabled Enable

HeatWave

HeatWave cluster: Disabled Edit

95. Click **More actions** and click **Add HeatWave cluster**.



MySQL-HW

General information

OCID: ...rnezf3rteq Show Copy

Description: - Edit

Compartment: [redacted]

Created: Mon, Oct 30, 2023, 22:07:

Last updated: Mon, Oct 30, 2023, 2

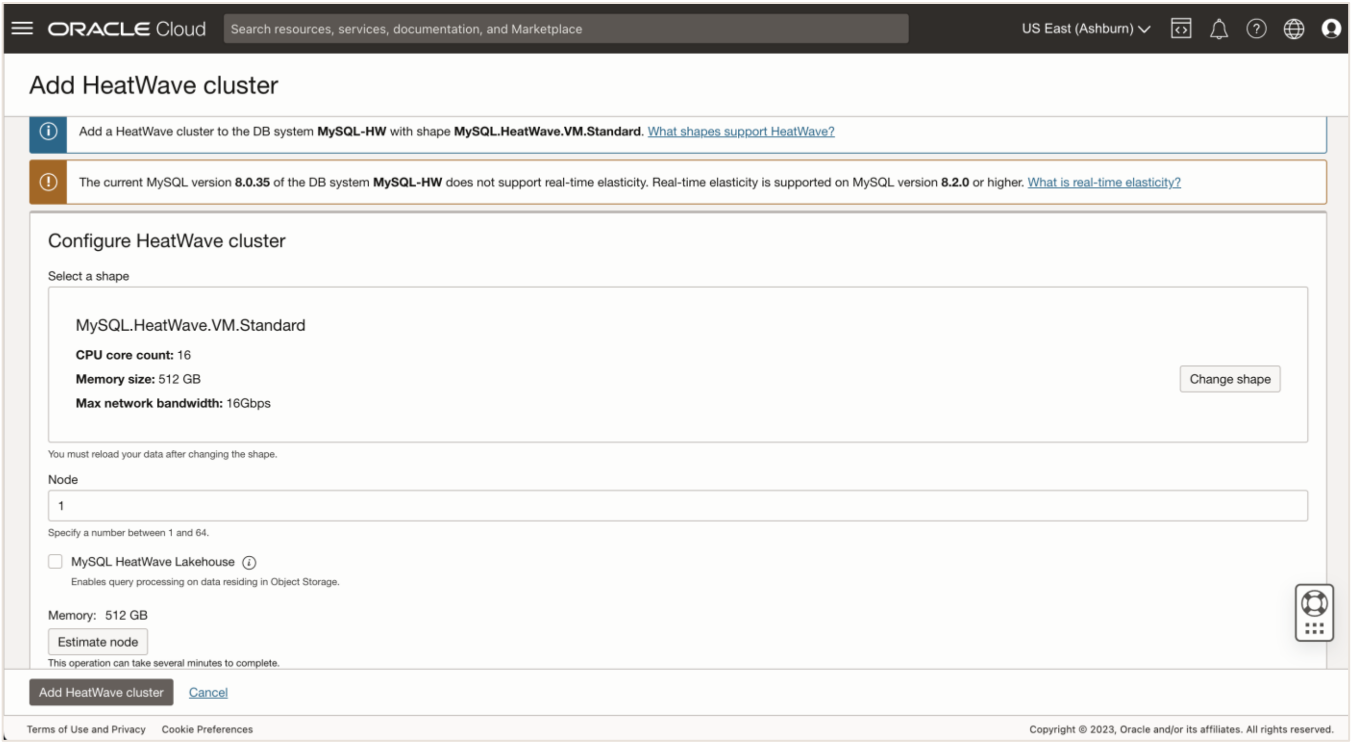
High availability

High availability: Disabled Enable

HeatWave

HeatWave cluster: Disabled Edit

96. Click **Estimate node**.



Add HeatWave cluster

Add a HeatWave cluster to the DB system **MySQL-HW** with shape **MySQL.HeatWave.VM.Standard**. What shapes support HeatWave?

The current MySQL version **8.0.35** of the DB system **MySQL-HW** does not support real-time elasticity. Real-time elasticity is supported on MySQL version **8.2.0** or higher. What is real-time elasticity?

Configure HeatWave cluster

Select a shape

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

Change shape

You must reload your data after changing the shape.

Node

1

Specify a number between 1 and 64.

□ MySQL HeatWave Lakehouse

Enables query processing on data residing in Object Storage.

Memory: 512 GB

Estimate node

This operation can take several minutes to complete.

Add HeatWave cluster Cancel

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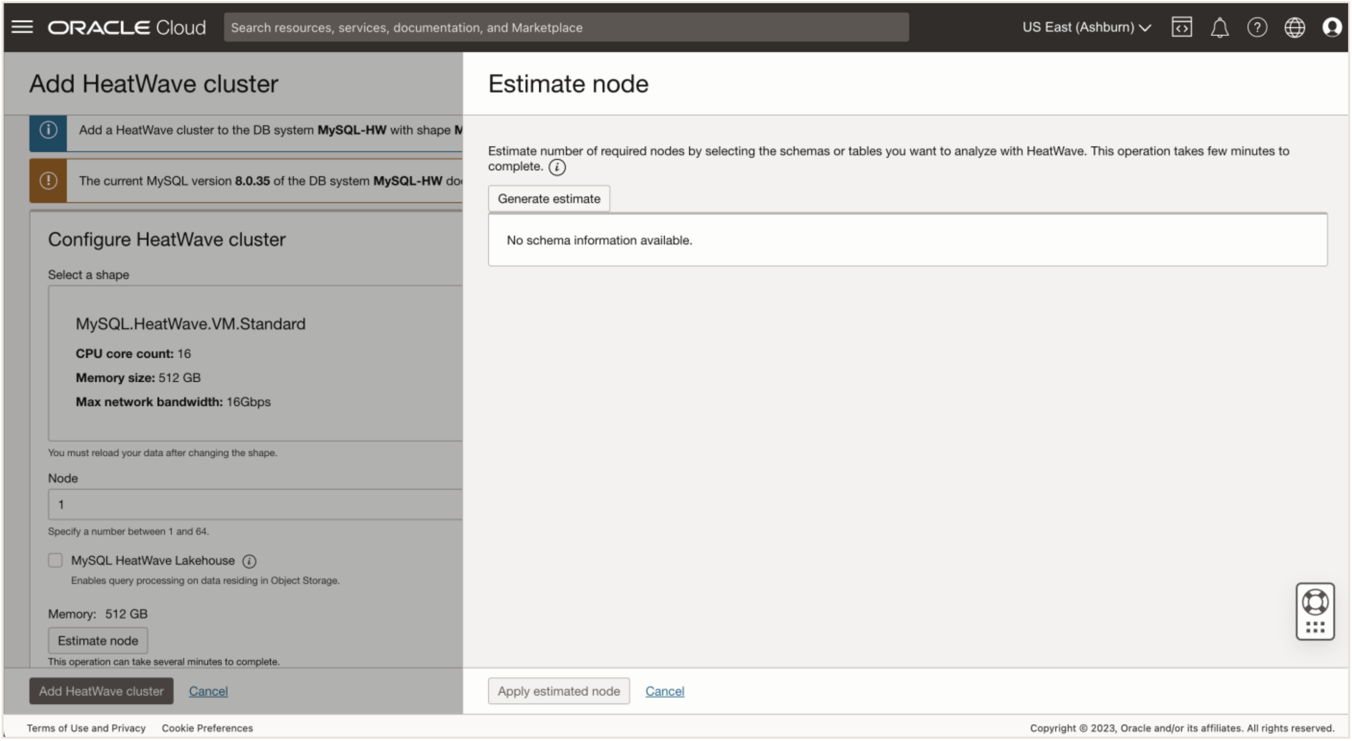
97. Click **Generate estimate**. This step will estimate the number of HeatWave nodes required by selecting the schemas or tables you want to analyze with HeatWave.



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Add HeatWave cluster
Configure HeatWave cluster
Add HeatWave cluster
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Estimate node

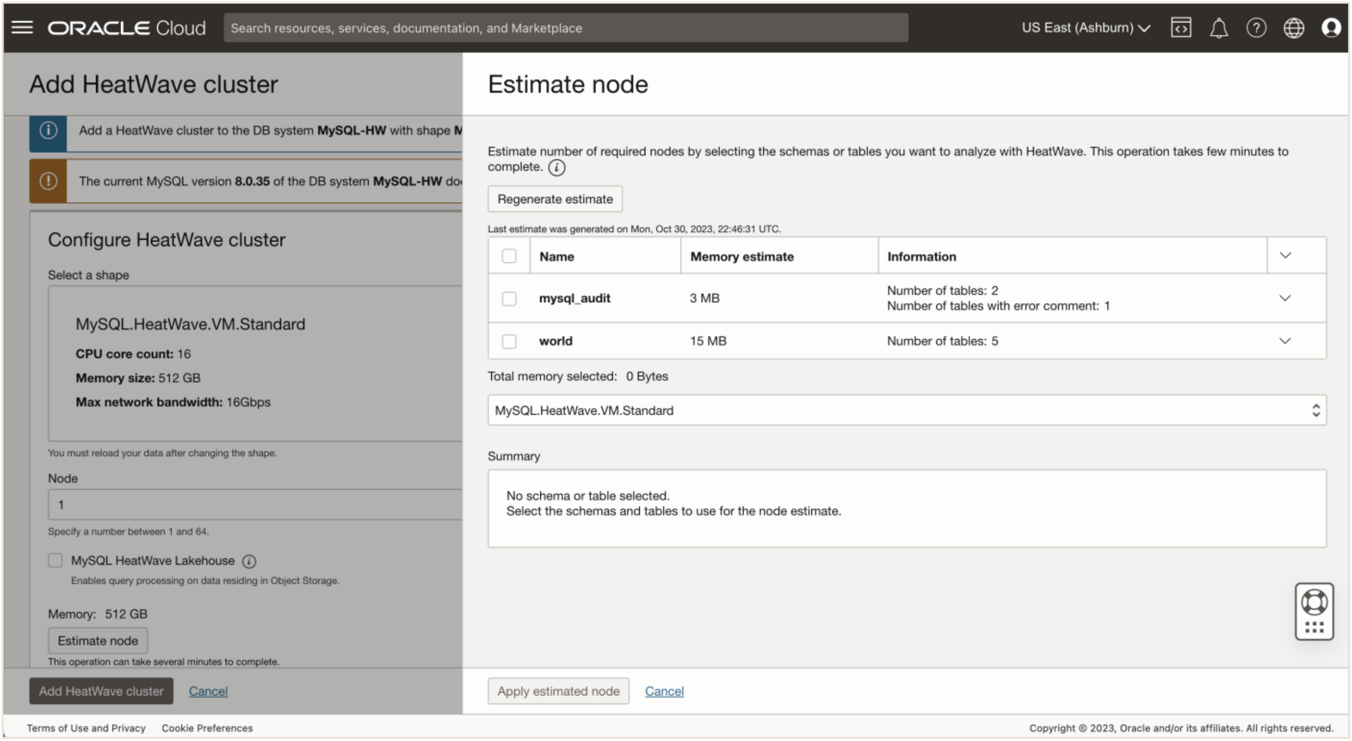
Estimate number of required nodes by selecting the schemas or tables you want to analyze with HeatWave. This operation takes few minutes to complete.

Generate estimate

No schema information available.

Apply estimated node Cancel

98. Within a few minutes, the list of your schemas that are in the MySQL InnoDB storage engine will be listed. **Check the box** next to the schema or table name that you wish to load in HeatWave for query acceleration and to run OLAP and ML workloads - alongside OLTP.



Add HeatWave cluster

Add a HeatWave cluster to the DB system **MySQL-HW** with shape M

The current MySQL version **8.0.35** of the DB system **MySQL-HW** do

Configure HeatWave cluster

Select a shape

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

You must reload your data after changing the shape.

Node: 1

Specify a number between 1 and 64.

□ MySQL HeatWave Lakehouse

Enables query processing on data residing in Object Storage.

Memory: 512 GB

Estimate node

This operation can take several minutes to complete.

Estimate node

Estimate number of required nodes by selecting the schemas or tables you want to analyze with HeatWave. This operation takes few minutes to complete.

Regenerate estimate

Last estimate was generated on Mon, Oct 30, 2023, 22:46:31 UTC.

□	Name	Memory estimate	Information
□	mysql_audit	3 MB	Number of tables: 2 Number of tables with error comment: 1
□	world	15 MB	Number of tables: 5

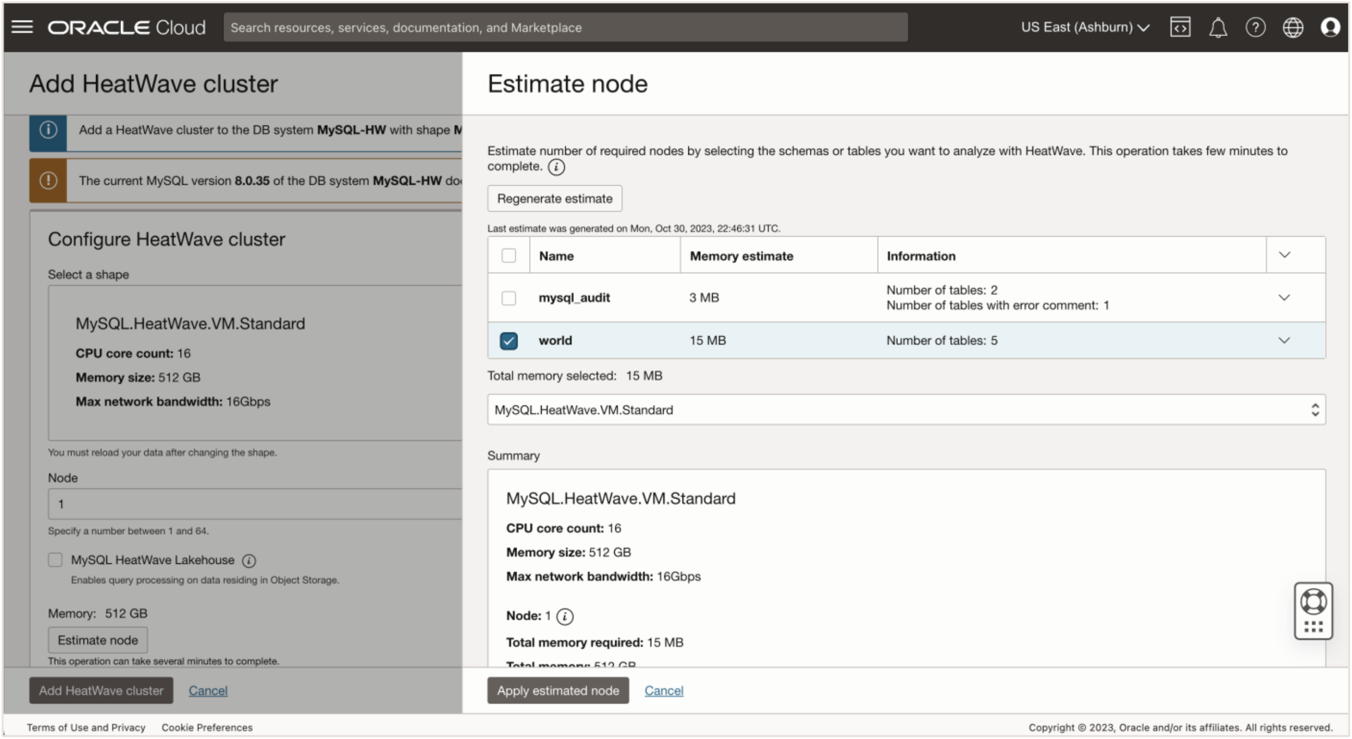
Total memory selected: 0 Bytes

MySQL.HeatWave.VM.Standard

Summary

No schema or table selected.
Select the schemas and tables to use for the node estimate.

99. After selecting the schemas or tables, scroll down on that page until you see the **Show load command**.



Add HeatWave cluster

Add a HeatWave cluster to the DB system **MySQL-HW** with shape M

The current MySQL version **8.0.35** of the DB system **MySQL-HW** do

Configure HeatWave cluster

Select a shape

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

You must reload your data after changing the shape.

Node: 1

Specify a number between 1 and 64.

□ MySQL HeatWave Lakehouse

Enables query processing on data residing in Object Storage.

Memory: 512 GB

Estimate node

This operation can take several minutes to complete.

Estimate node

Estimate number of required nodes by selecting the schemas or tables you want to analyze with HeatWave. This operation takes few minutes to complete.

Regenerate estimate

Last estimate was generated on Mon, Oct 30, 2023, 22:46:31 UTC.

□	Name	Memory estimate	Information
□	mysql_audit	3 MB	Number of tables: 2 Number of tables with error comment: 1
☑	world	15 MB	Number of tables: 5

Total memory selected: 15 MB

MySQL.HeatWave.VM.Standard

Summary

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

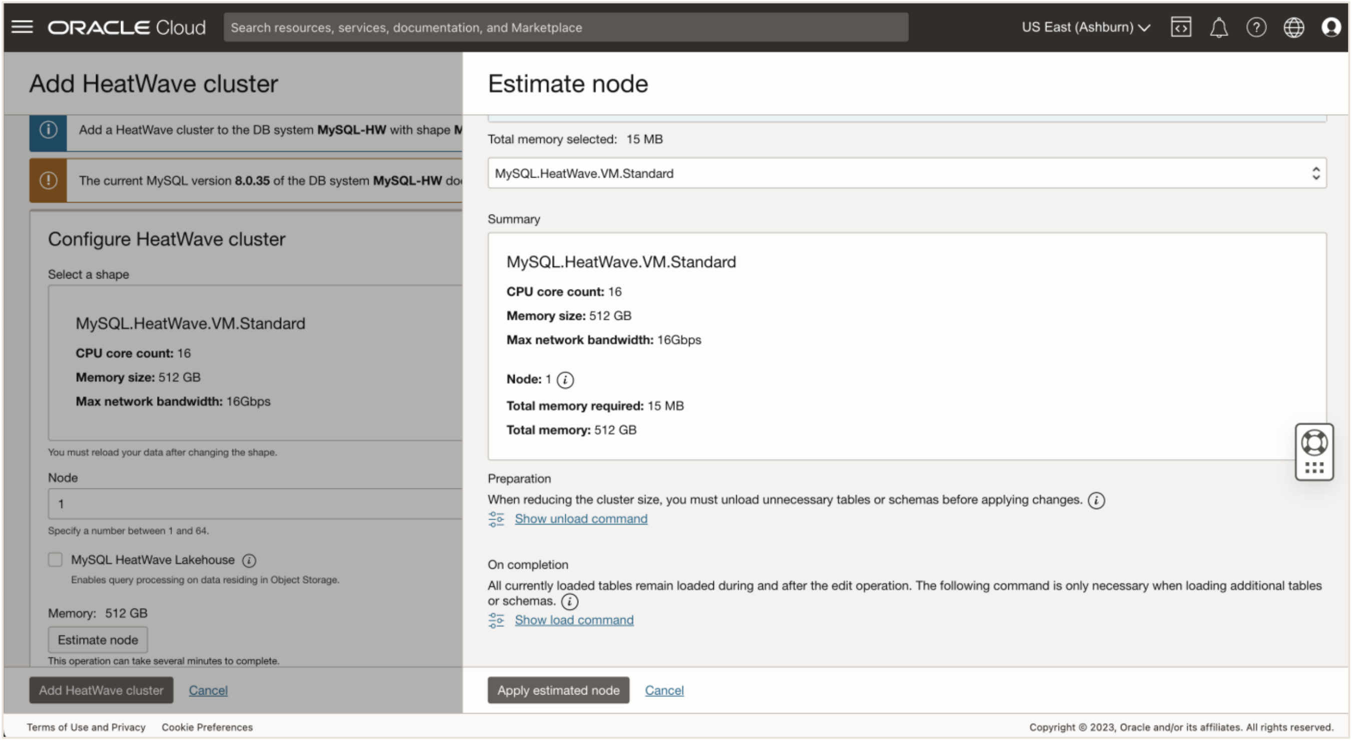
Max network bandwidth: 16Gbps

Node: 1

Total memory required: 15 MB

Total memory: 512 GB

100. Click **Show load command**, copy the `CALL sys.heatwave_load` command, and save it. Click **Apply estimated node**.



Add a HeatWave cluster to the DB system **MySQL-HW** with shape **M**

The current MySQL version **8.0.35** of the DB system **MySQL-HW** do

Configure HeatWave cluster

Select a shape

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

You must reload your data after changing the shape.

Node: 1

Specify a number between 1 and 64.

□ MySQL HeatWave Lakehouse

Enables query processing on data residing in Object Storage.

Memory: 512 GB

This operation can take several minutes to complete.

Total memory selected: 15 MB

MySQL.HeatWave.VM.Standard

Summary

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

Node: 1

Total memory required: 15 MB

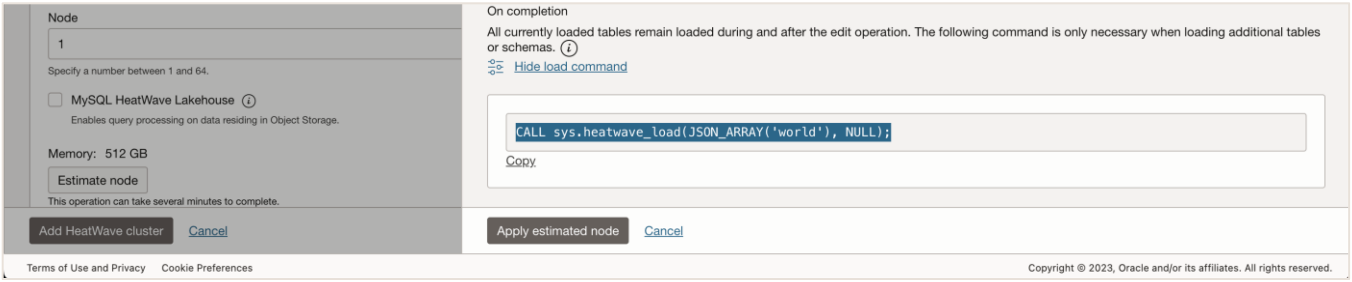
Total memory: 512 GB

Preparation

When reducing the cluster size, you must unload unnecessary tables or schemas before applying changes.

On completion

All currently loaded tables remain loaded during and after the edit operation. The following command is only necessary when loading additional tables or schemas.



Node: 1

Specify a number between 1 and 64.

□ MySQL HeatWave Lakehouse

Enables query processing on data residing in Object Storage.

Memory: 512 GB

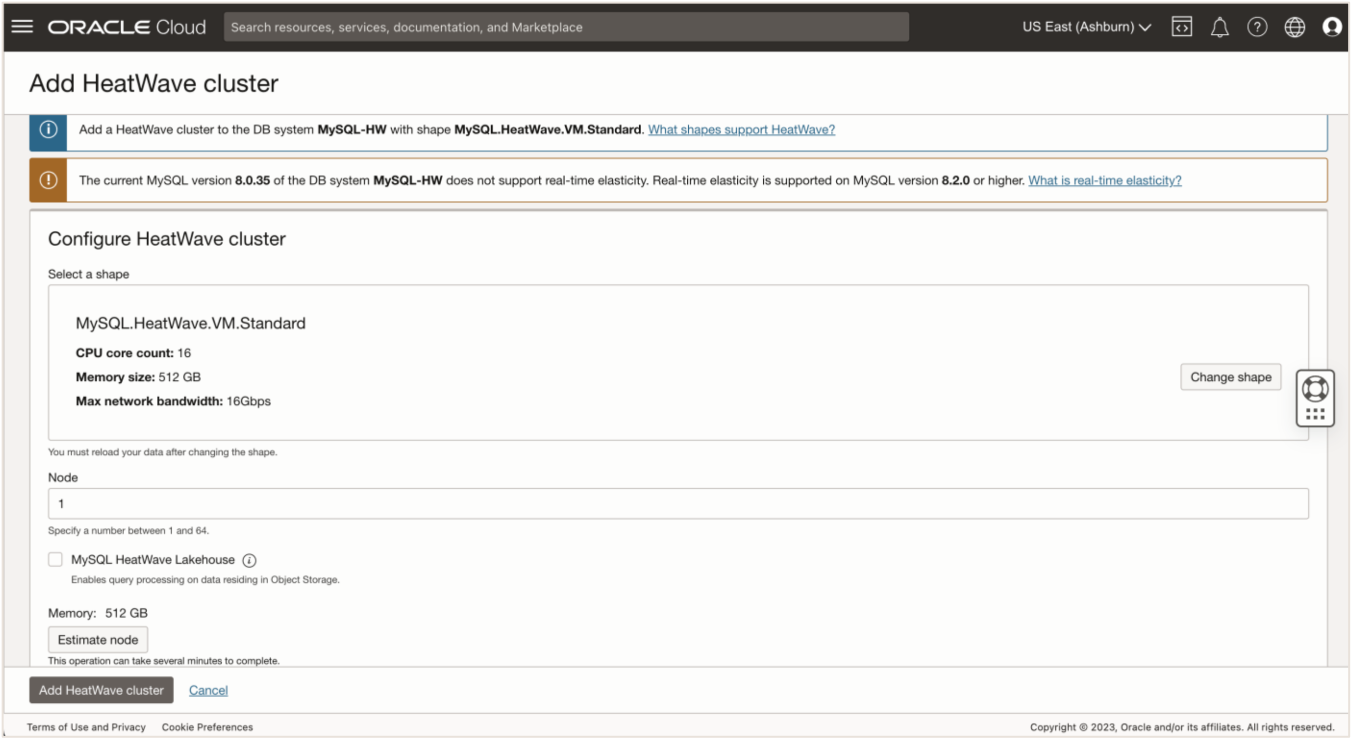
This operation can take several minutes to complete.

On completion

All currently loaded tables remain loaded during and after the edit operation. The following command is only necessary when loading additional tables or schemas.

```
CALL sys.heatwave_load(JSON_ARRAY('world'), NULL);
```

101. Executing the previous step will change the HeatWave node count depending on the data you have selected to load into the HeatWave in-memory engine. Click **Add HeatWave cluster** to finish adding the HeatWave cluster creation process.



Add HeatWave cluster

Add a HeatWave cluster to the DB system **MySQL-HW** with shape **MySQL.HeatWave.VM.Standard**. What shapes support HeatWave?

The current MySQL version **8.0.35** of the DB system **MySQL-HW** does not support real-time elasticity. Real-time elasticity is supported on MySQL version **8.2.0** or higher. What is real-time elasticity?

Configure HeatWave cluster

Select a shape

MySQL.HeatWave.VM.Standard

CPU core count: 16

Memory size: 512 GB

Max network bandwidth: 16Gbps

You must reload your data after changing the shape.

Node: 1

Specify a number between 1 and 64.

□ MySQL HeatWave Lakehouse

Enables query processing on data residing in Object Storage.

Memory: 512 GB

This operation can take several minutes to complete.

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Change shape
Estimate node
Add HeatWave cluster
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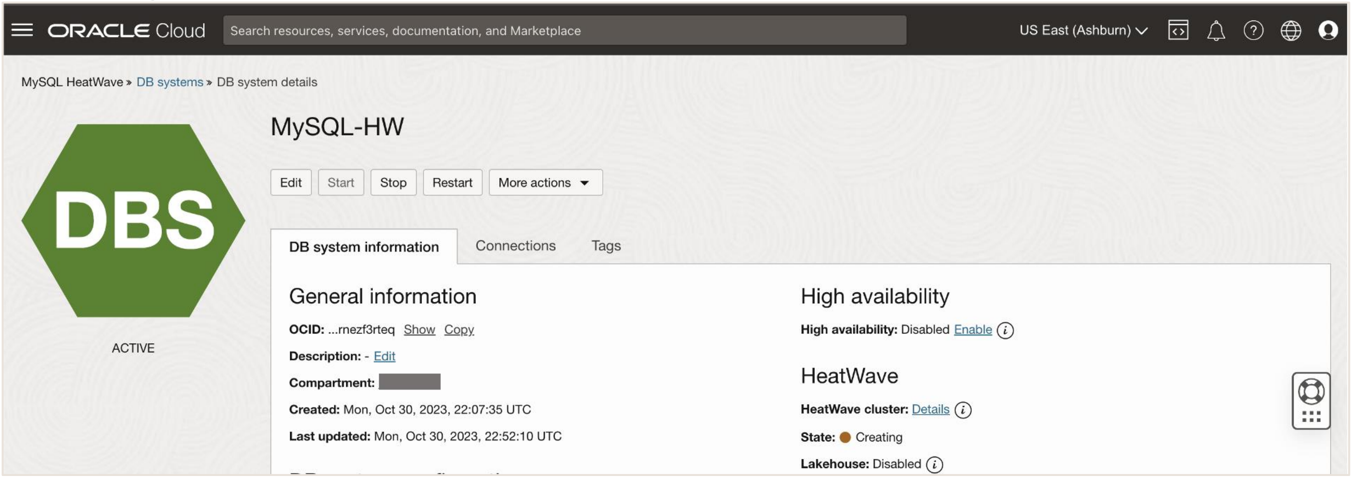
102. The HeatWave cluster will be ready within a few minutes. You should see the HeatWave state change from Creating to **Active**.



MySQL HeatWave » DB systems » DB system details

MySQL-HW

General information

OCID: ...rnezf3rteq Show Copy

Description: - Edit

Compartment: [redacted]

Created: Mon, Oct 30, 2023, 22:07:35 UTC

Last updated: Mon, Oct 30, 2023, 22:52:10 UTC

High availability

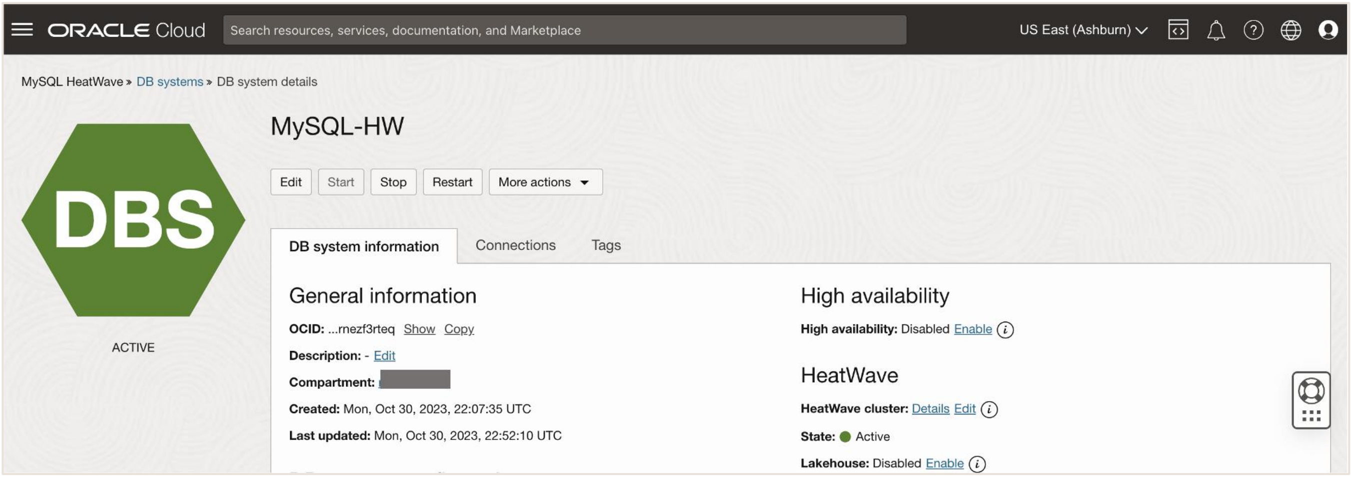
High availability: Disabled Enable

HeatWave

HeatWave cluster: Details

State: ● Creating

Lakehouse: Disabled



MySQL-HW

General information

OCID: ...rnezf3rteq Show Copy

Description: - Edit

Compartment: [redacted]

Created: Mon, Oct 30, 2023, 22:07:35 UTC

Last updated: Mon, Oct 30, 2023, 22:52:10 UTC

High availability

High availability: Disabled Enable

HeatWave

HeatWave cluster: Details Edit

State: ● Active

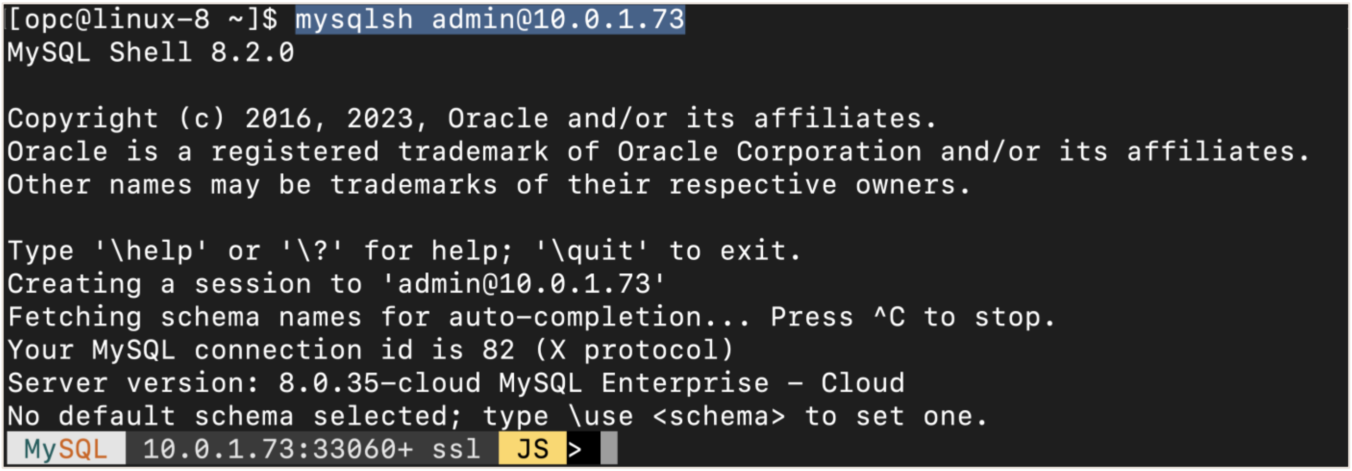
Lakehouse: Disabled Enable

103. Connect to your HeatWave MySQL instance using MySQL Shell that is installed on your on-premises environment.

```
$ mysqlsh <user>@<hostname>:<port-number>
```

-OR-

```
$ mysqlsh -u <user> -p -h <hostname> -P <port-number>
```



```
[opc@linux-8 ~]$ mysqlsh admin@10.0.1.73
MySQL Shell 8.2.0

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Type '\help' or '\?' for help; '\quit' to exit.
Creating a session to 'admin@10.0.1.73'
Fetching schema names for auto-completion... Press ^C to stop.
Your MySQL connection id is 82 (X protocol)
Server version: 8.0.35-cloud MySQL Enterprise - Cloud
No default schema selected; type \use <schema> to set one.
 MySQL  10.0.1.73:33060+ ssl  JS >
```
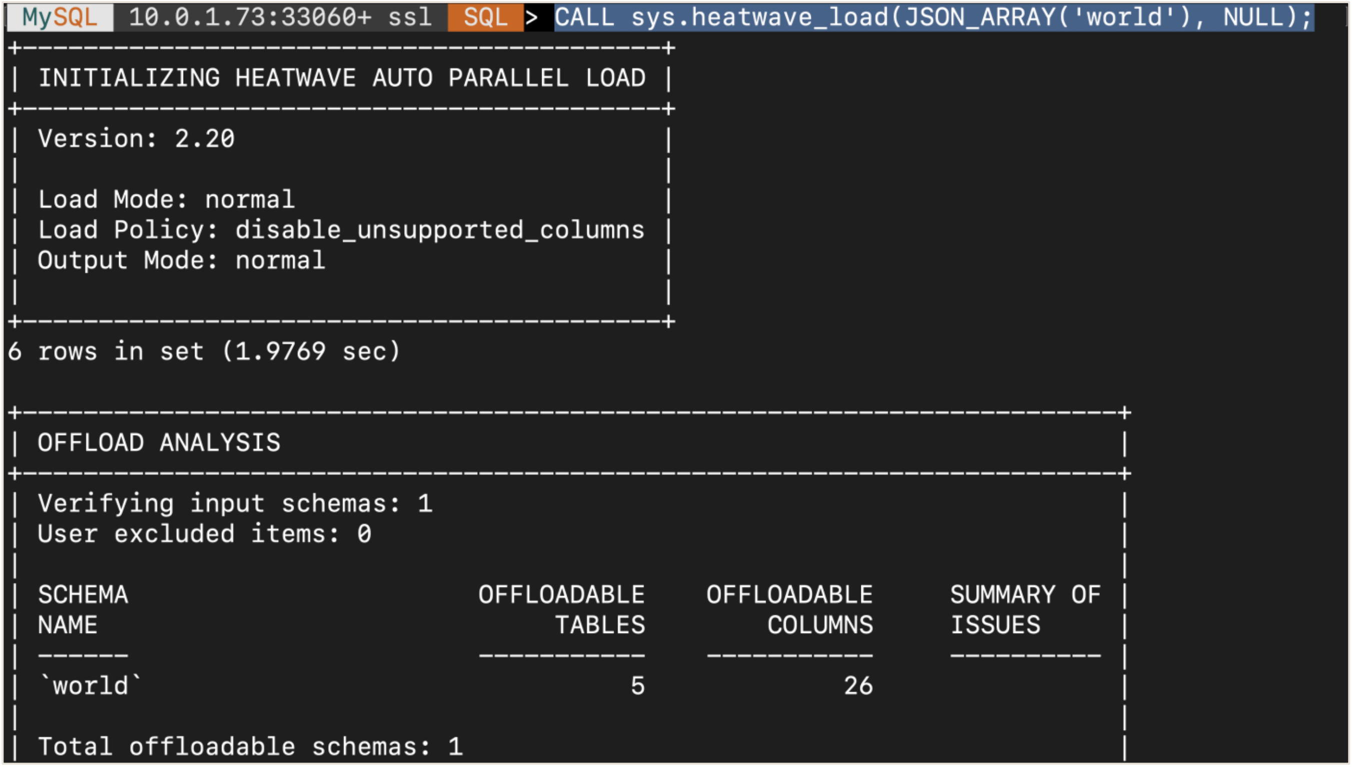

104. Switch to the SQL mode of MySQL Shell and execute the Load command that we had copied earlier to load data into HeatWave from the MySQL InnoDB storage engine.

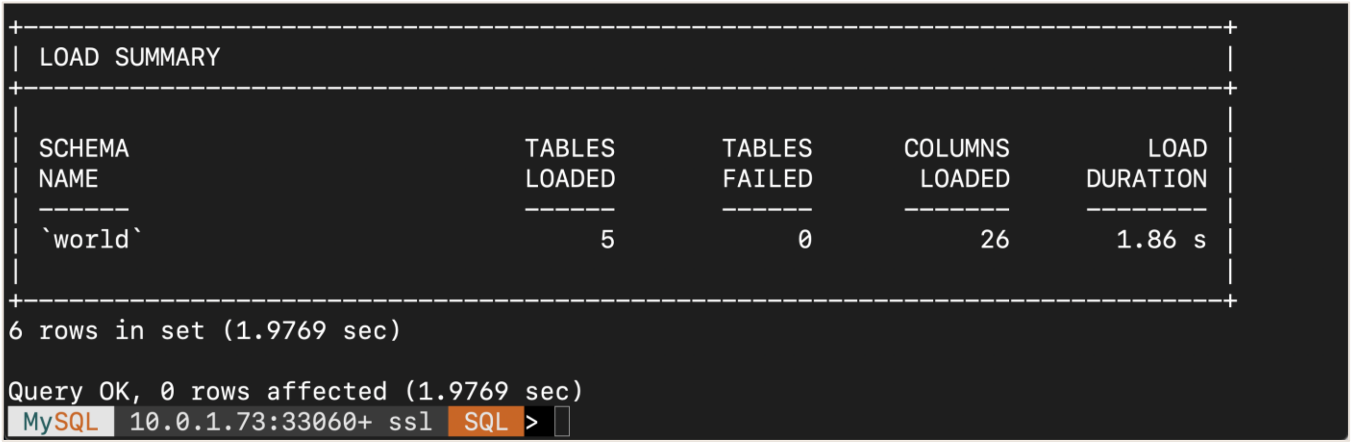
```
MySQL JS> \sql
MySQL SQL> CALL sys.heatwave_load(JSON_ARRAY('world'), NULL);
```

Note: replace the `sys.heatwave_load` command with what you have.



```
 MySQL  10.0.1.73:33060+ ssl  SQL > CALL sys.heatwave_load(JSON_ARRAY('world'), NULL);
+------------------------------------------+
| INITIALIZING HEATWAVE AUTO PARALLEL LOAD |
+------------------------------------------+
| Version: 2.20                            |
|                                          |
| Load Mode: normal                        |
| Load Policy: disable_unsupported_columns |
| Output Mode: normal                      |
|                                          |
+------------------------------------------+
6 rows in set (1.9769 sec)

+--------------------------------------------------------------------------+
| OFFLOAD ANALYSIS                                                         |
+--------------------------------------------------------------------------+
| Verifying input schemas: 1                                               |
| User excluded items: 0                                                   |
|                                                                          |
| SCHEMA                           OFFLOADABLE    OFFLOADABLE     SUMMARY OF |
| NAME                                  TABLES        COLUMNS     ISSUES     |
| -------                          ------------   ------------    ---------- |
| `world`                                    5             26                |
|                                                                          |
| Total offloadable schemas: 1                                             |
```

[…output truncated]



```
+--------------------------------------------------------------------------------+
| LOAD SUMMARY                                                                   |
+--------------------------------------------------------------------------------+
|                                                                                |
| SCHEMA                              TABLES        TABLES       COLUMNS         LOAD |
| NAME                                LOADED        FAILED        LOADED     DURATION |
| -------                             -------       -------      --------    --------- |
| `world`                                   5             0            26       1.86 s |
|                                                                                |
+--------------------------------------------------------------------------------+
6 rows in set (1.9769 sec)

Query OK, 0 rows affected (1.9769 sec)
 MySQL  10.0.1.73:33060+ ssl  SQL >
```

105. You now have a complete HeatWave MySQL cluster.

To learn more about using HeatWave, please visit our documentation.

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