MySQL HeatWave on AWS Service Guide
## Contents

### 1 Overview

- MySQL Database 1-1
- HeatWave 1-1
- Integration with Oracle Cloud Infrastructure (OCI) 1-2
- Region Availability 1-2
- Identity and Access Management 1-3
- Security 1-3

### 2 Getting Started

- Accessing MySQL HeatWave on AWS 2-1
- Signing Up 2-1
  - Sign-up Overview 2-1
  - Sign-up Procedure 2-2
- Signing In 2-4
- Using the Console 2-4
  - Console Overview 2-5

### 3 DB Systems

- About DB Systems 3-1
- DB System Components 3-1
- MySQL Server 3-2
  - Server Versioning 3-2
  - Server Upgrades 3-3
  - Server Error Logging 3-3
- Unsupported MySQL Server Features 3-5
- MySQL Storage Engines 3-5
- Plugins and Components 3-5
- MySQL HeatWave on AWS Service Restrictions 3-6
- MySQL HeatWave on AWS Service Limitations 3-6
- Default MySQL Privileges 3-7
- Reserved User Names 3-9
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating a DB System</td>
<td>3-9</td>
</tr>
<tr>
<td>Managing a DB System</td>
<td>3-13</td>
</tr>
<tr>
<td>Stopping, Starting, or Restarting a DB System</td>
<td>3-13</td>
</tr>
<tr>
<td>Editing a DB System</td>
<td>3-14</td>
</tr>
<tr>
<td>Update Networking</td>
<td>3-15</td>
</tr>
<tr>
<td>Update MySQL Configuration</td>
<td>3-16</td>
</tr>
<tr>
<td>Upgrade MySQL Version</td>
<td>3-16</td>
</tr>
<tr>
<td>Increasing DB System Storage</td>
<td>3-17</td>
</tr>
<tr>
<td>Deleting a DB System</td>
<td>3-18</td>
</tr>
<tr>
<td>Viewing DB System Details</td>
<td>3-18</td>
</tr>
<tr>
<td>MySQL DB System Details</td>
<td>3-19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>HeatWave Clusters</td>
<td>4-1</td>
</tr>
<tr>
<td>Creating a HeatWave Cluster</td>
<td>4-1</td>
</tr>
<tr>
<td>Estimating Cluster Size with MySQL Autopilot</td>
<td>4-2</td>
</tr>
<tr>
<td>Managing a HeatWave Cluster</td>
<td>4-4</td>
</tr>
<tr>
<td>Starting, Stopping, or Restarting a HeatWave Cluster</td>
<td>4-4</td>
</tr>
<tr>
<td>Editing a HeatWave Cluster</td>
<td>4-4</td>
</tr>
<tr>
<td>Deleting a HeatWave Cluster</td>
<td>4-5</td>
</tr>
<tr>
<td>Viewing HeatWave Cluster Details</td>
<td>4-5</td>
</tr>
<tr>
<td>HeatWave Cluster Details</td>
<td>4-5</td>
</tr>
<tr>
<td>HeatWave Cluster Failure and Recovery</td>
<td>4-9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecting to a DB System</td>
<td>5-1</td>
</tr>
<tr>
<td>Connecting from the Console</td>
<td>5-1</td>
</tr>
<tr>
<td>Connecting from a Client</td>
<td>5-1</td>
</tr>
<tr>
<td>Connecting with MySQL Shell</td>
<td>5-2</td>
</tr>
<tr>
<td>Connecting with MySQL Command-Line Client</td>
<td>5-3</td>
</tr>
<tr>
<td>Connecting with MySQL Workbench</td>
<td>5-4</td>
</tr>
<tr>
<td>MySQL Connectors</td>
<td>5-5</td>
</tr>
<tr>
<td>Enabling Host Name Identity Verification</td>
<td>5-5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importing Data</td>
<td>6-1</td>
</tr>
<tr>
<td>Exporting Data</td>
<td>6-1</td>
</tr>
<tr>
<td>About MySQL Shell</td>
<td>6-1</td>
</tr>
<tr>
<td>MySQL Server Compatibility</td>
<td>6-2</td>
</tr>
<tr>
<td>Exporting Data Using MySQL Shell</td>
<td>6-3</td>
</tr>
<tr>
<td>Importing Data</td>
<td>6-4</td>
</tr>
<tr>
<td>Data Import Feature</td>
<td>6-5</td>
</tr>
</tbody>
</table>
7 Manage Data in HeatWave with Workspaces

Loading or Unloading Data into HeatWave  
7-1

8 Running Queries

Running HeatWave Queries  
8-1

9 HeatWave AutoML

HeatWave AutoML Requirements  
9-1
Create a HeatWave AutoML model  
9-1
Evaluate a HeatWave AutoML model  
9-2

10 System Variables

System Variables  
10-1

11 Performance Monitoring

HeatWave Cluster Performance  
11-1
  HeatWave Cluster Performance Data  
11-1
Workload Performance  
11-2
  HeatWave Workload Performance Data  
11-2
Autopilot Shape Advisor  
11-2
  Autopilot Shape Advisor with MySQL HeatWave Console  
11-3
  Auto Shape Prediction Data  
11-4
  Autopilot Shape Advisor with MySQL  
11-5

12 Backups

Creating a Backup  
12-1
Editing a Backup  
12-1
Viewing Backup Details  
12-2
  Backup Details  
12-2
13 Configuration

Creating a MySQL Configuration 13-1
System Initialization Variables 13-2
User Configurable System Variables 13-2
User Configurable Shape Dependent System Variables 13-5
Service Specific System Variables 13-7
Shape Dependent System Variables 13-7
Session Variables 13-9

14 User and Group Management

Groups and Permissions 14-1
Groups and Policies 14-3
User Management 14-3

15 Account Management

Manage Regions 15-1
Service Limits 15-1
Billing 15-2
Viewing OCID of the Tenancy 15-2
Manage AWS Access 15-2
Creating an IAM Policy to Access an Amazon S3 Bucket 15-3
Creating an IAM Role to Access an Amazon S3 Bucket 15-4

16 Maintenance

17 Release Notes

Release Notes for MySQL HeatWave on AWS (2023-09-13, General Availability) 17-1
Release Notes for MySQL HeatWave on AWS (2023-08-08, General Availability) 17-1
Release Notes for MySQL HeatWave on AWS (2023-07-31, General Availability) 17-1
Release Notes for MySQL HeatWave on AWS (2023-06-08, General Availability) 17-2
Preface and Legal Notices

This is the MySQL HeatWave on AWS Service Guide.

Legal Notices

Copyright © 1997, 2023, Oracle and/or its affiliates.

This software and related documentation are provided under a license agreement containing restrictions on use and disclosure and are protected by intellectual property laws. Except as expressly permitted in your license agreement or allowed by law, you may not use, copy, reproduce, translate, broadcast, modify, license, transmit, distribute, exhibit, perform, publish, or display any part, in any form, or by any means. Reverse engineering, disassembly, or decompilation of this software, unless required by law for interoperability, is prohibited.

The information contained herein is subject to change without notice and is not warranted to be error-free. If you find any errors, please report them to us in writing.

If this is software or related documentation that is delivered to the U.S. Government or anyone licensing it on behalf of the U.S. Government, then the following notice is applicable:

U.S. GOVERNMENT END USERS: Oracle programs (including any operating system, integrated software, any programs embedded, installed or activated on delivered hardware, and modifications of such programs) and Oracle computer documentation or other Oracle data delivered to or accessed by U.S. Government end users are "commercial computer software" or "commercial computer software documentation" pursuant to the applicable Federal Acquisition Regulation and agency-specific supplemental regulations. As such, the use, reproduction, duplication, release, display, disclosure, modification, preparation of derivative works, and/or adaptation of i) Oracle programs (including any operating system, integrated software, any programs embedded, installed or activated on delivered hardware, and modifications of such programs), ii) Oracle computer documentation and/or iii) other Oracle data, is subject to the rights and limitations specified in the license contained in the applicable contract. The terms governing the U.S. Government's use of Oracle cloud services are defined by the applicable contract for such services. No other rights are granted to the U.S. Government.

This software or hardware is developed for general use in a variety of information management applications. It is not developed or intended for use in any inherently dangerous applications, including applications that may create a risk of personal injury. If you use this software or hardware in dangerous applications, then you shall be responsible to take all appropriate fail-safe, backup, redundancy, and other measures to ensure its safe use. Oracle Corporation and its affiliates disclaim any liability for any damages caused by use of this software or hardware in dangerous applications.

Oracle, Java, and MySQL are registered trademarks of Oracle and/or its affiliates. Other names may be trademarks of their respective owners.

Intel and Intel Inside are trademarks or registered trademarks of Intel Corporation. All SPARC trademarks are used under license and are trademarks or registered trademarks of SPARC International, Inc. AMD, Epyc, and the AMD logo are trademarks or registered trademarks of Advanced Micro Devices. UNIX is a registered trademark of The Open Group.
This software or hardware and documentation may provide access to or information about content, products, and services from third parties. Oracle Corporation and its affiliates are not responsible for and expressly disclaim all warranties of any kind with respect to third-party content, products, and services unless otherwise set forth in an applicable agreement between you and Oracle. Oracle Corporation and its affiliates will not be responsible for any loss, costs, or damages incurred due to your access to or use of third-party content, products, or services, except as set forth in an applicable agreement between you and Oracle.

This documentation is NOT distributed under a GPL license. Use of this documentation is subject to the following terms:

You may create a printed copy of this documentation solely for your own personal use. Conversion to other formats is allowed as long as the actual content is not altered or edited in any way. You shall not publish or distribute this documentation in any form or on any media, except if you distribute the documentation in a manner similar to how Oracle disseminates it (that is, electronically for download on a Web site with the software) or on a CD-ROM or similar medium, provided however that the documentation is disseminated together with the software on the same medium. Any other use, such as any dissemination of printed copies or use of this documentation, in whole or in part, in another publication, requires the prior written consent from an authorized representative of Oracle. Oracle and/or its affiliates reserve any and all rights to this documentation not expressly granted above.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at https://www.oracle.com/corporate/accessibility/.

Access to Oracle Support for Accessibility

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit https://www.oracle.com/corporate/accessibility/learning-support.html#support-tab.
Overview

MySQL HeatWave on AWS is a fully managed service, developed and supported by the MySQL team at Oracle. Oracle automates tasks such as database and operating system patching. You are responsible for managing your data, schema designs, and access.

With MySQL HeatWave on AWS, you can create and manage a MySQL DB System with a HeatWave Cluster to use with AWS applications.

MySQL Database

The MySQL Database is built on the MySQL Enterprise Edition Server, which allows developers to quickly create and deploy secure cloud native applications using the world’s most popular open source database. It is the only MySQL database that supports HeatWave. For MySQL Server documentation, refer to the MySQL Reference Manual.

MySQL HeatWave on AWS supports MySQL Enterprise Edition 8.0. You can choose from the latest MySQL 8.0 releases when creating a DB System. See Creating a DB System.

HeatWave

HeatWave is a massively parallel, high performance, in-memory query accelerator that accelerates MySQL performance by orders of magnitude for analytics and mixed workloads.

With MySQL HeatWave on AWS, you can provision DB Systems and HeatWave Clusters. HeatWave consists of a MySQL DB System and one or more HeatWave nodes. The MySQL DB System node is responsible for cluster management, query scheduling, and returning query results. HeatWave nodes store data in memory and process analytics queries.

When a HeatWave Cluster is enabled, queries that meet certain prerequisites are automatically offloaded from the MySQL DB System to the HeatWave Cluster for accelerated processing. Queries are issued from Query Editor in the MySQL HeatWave Console or from a MySQL client or application that interacts with the HeatWave Cluster by connecting to the MySQL DB System.

Tip:

This MySQL HeatWave on AWS Service Guide covers what you need to know to set up and use DB Systems and HeatWave Clusters on AWS, mainly using the MySQL HeatWave Console. For more detailed information about using HeatWave and related utilities, refer to the MySQL HeatWave User Guide. Some of that information does not apply to MySQL HeatWave on AWS, so be sure to check the MySQL HeatWave on AWS Service Guide first for the most relevant information.
Integration with Oracle Cloud Infrastructure (OCI)

MySQL HeatWave on AWS is integrated with Oracle Cloud Infrastructure (OCI) for identity and access management, and for billing and cost management.

When you sign up for MySQL HeatWave on AWS, you are directed to OCI where you must sign up for an Oracle Cloud Account if you do not have one. After signing up, you are directed to the OCI Console to complete the sign-up process. When signing in to the MySQL HeatWave Console, you are seamlessly directed to OCI for authentication and then back to the MySQL HeatWave Console.

Identity and access management and billing for MySQL HeatWave on AWS is managed in OCI. For more information, see Billing.

The following diagram illustrates MySQL HeatWave on AWS integration with Oracle Cloud Infrastructure (OCI).

**Figure 1-1   MySQL HeatWave on AWS and OCI Integration**

**Region Availability**

MySQL HeatWave on AWS is currently available in five regions. Each AWS Region maps to an OCI region, and requires a subscription to that OCI region.

**Table 1-1   OCI and AWS Regions**

<table>
<thead>
<tr>
<th>OCI Region name</th>
<th>OCI Region identifier</th>
<th>AWS Region name</th>
<th>AWS Region code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany Central</td>
<td>eu-frankfurt-1</td>
<td>Europe (Frankfurt)</td>
<td>eu-central-1</td>
</tr>
<tr>
<td>(Frankfurt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India West (Mumbai)</td>
<td>ap-mumbai-1</td>
<td>Asia Pacific (Mumbai)</td>
<td>ap-south-1</td>
</tr>
<tr>
<td>Japan East (Tokyo)</td>
<td>ap-tokyo-1</td>
<td>Asia Pacific (Tokyo)</td>
<td>ap-northeast-1</td>
</tr>
<tr>
<td>UK South (London)</td>
<td>uk-london-1</td>
<td>Europe (London)</td>
<td>eu-west-2</td>
</tr>
<tr>
<td>US East (Ashburn)</td>
<td>us-ashburn-1</td>
<td>US East (N. Virginia)</td>
<td>us-east-1</td>
</tr>
</tbody>
</table>
Identity and Access Management

MySQL HeatWave on AWS integrates with Oracle Cloud Infrastructure (OCI) for identity and access management.

MySQL HeatWave on AWS uses predefined OCI Identity and Access Management (IAM) groups to control access to the MySQL HeatWave Console. For example, predefined group membership determines who can create DB Systems and HeatWave Clusters and who can use them. An Administrator in your organization is responsible for adding users to the appropriate groups. For more information, see User and Group Management.

MySQL HeatWave on AWS also supports federation with third-party Identity Providers (IdPs). See Federating with Identity Providers.

If you are a regular user (not an Administrator) who needs access to MySQL HeatWave on AWS, contact your Administrator to set up an account. An OCI IAM user account is required to access the MySQL HeatWave Console, and that user must be added to one of the predefined OCI IAM groups. For more information, see User and Group Management.

A separate MySQL user account is required to access MySQL HeatWave on AWS from a MySQL client or application. This can be the MySQL Administrator user specified when creating the DB System (see Creating a DB System) or a MySQL user account created on the DB System using CREATE USER. If you are not the MySQL Administrator and you do not have a MySQL user account, have your MySQL Administrator create one for you.

Security

Oracle considers cloud security its highest priority. The following security features help keep your data safe and secure.

- Database access control and account management
  MySQL provides security features to control access and manage your account. See Access Control and Account Management.

- Connection Control
  MySQL HeatWave on AWS supports a plugin library that enables Administrators to introduce an increasing delay in server response to connection attempts after a configurable number of consecutive failed attempts. This capability provides a deterrent that slows down brute force attacks against MySQL user accounts. The default connection control settings, which cannot be modified, are as follows:
  - connection_control_failed_connections_threshold
  - connection_control_max_connection_delay
  - connection_control_min_connection_delay
  See The Connection-Control Plugins.

- Encryption at rest
  Your data is always encrypted at rest. MySQL HeatWave on AWS uses Amazon EBS encryption. Boot volumes are encrypted on MySQL DB System and HeatWave nodes, and the database volume is encrypted on the MySQL DB System. For information about
EBS encryption, see Amazon EBS Encryption, in the Amazon EC2 User Guide for Linux Instances.

- **Encryption in transit**
  Your data is always encrypted while in transit. MySQL HeatWave on AWS supports TLSv1.2 and requires that all MySQL client and application connections are encrypted. For added security, download a signed certificate bundle to enable host name identity verification for connecting clients and applications. For more information, see Enabling Host Name Identity Verification.

- **MySQL Enterprise Data Masking and De-Identification**
  Use data masking and de-identification to protect your sensitive data. MySQL HeatWave on AWS supports various MySQL data masking functions that mask data to remove identifying characteristics and generate random data with specific characteristics. The following data masking functions are supported:
  - gen_range()
  - gen_rnd_email()
  - gen_rnd_ssn()
  - gen_rnd_us_phone()
  - mask_inner()
  - mask_outer()
  - mask_pan()
  - mask_pan_relaxed()
  - mask_ssn()

  For more information, see MySQL Enterprise Data Masking and De-Identification.

- **Password Validation**
  MySQL HeatWave on AWS enforces strong passwords with the validate_password component, serves to improve security by requiring account passwords and enabling strength testing of potential passwords. The default value of the variables of the validate_password component are as follows, and you cannot change the default values:
  - validate_password.check_user_name
  - validate_password.length
  - validate_password.mixed_case_count
  - validate_password.number_count
  - validate_password.policy
  - validate_password.special_char_count

  Make sure your applications comply with the password requirements. For more information, see The Password Validation Component.

- **MySQL Enterprise Firewall**
  MySQL Enterprise Firewall enables database Administrators to permit or deny SQL statement execution based on matching against lists of accepted statement patterns. This helps harden MySQL against attacks such as SQL injection or
attempts to exploit applications by using them outside of their legitimate query workload characteristics. For more information, see MySQL Enterprise Firewall.
2
Getting Started

This chapter describes how to access MySQL HeatWave on AWS, how to sign up for the MySQL HeatWave on AWS service, how to sign in, and provides an introduction to the MySQL HeatWave Console.

Accessing MySQL HeatWave on AWS

Access MySQL HeatWave on AWS with the MySQL HeatWave Console which is a browser-based interface. Access the MySQL HeatWave Console at the following address:

https://cloud.mysql.com/

If necessary, first register for MySQL HeatWave on AWS, see: Signing Up. Then sign-in to MySQL HeatWave on AWS, see Signing In.

For instructions to use the MySQL HeatWave Console, see: Using the Console.

After signing in and creating a DB System, access MySQL HeatWave on AWS from a MySQL client or application. A MySQL user account is required, see Connecting from a Client.

Signing Up

This procedure describes how to sign up for the MySQL HeatWave on AWS Service.

Sign-up Overview

After the initial Oracle Cloud Account setup, use the MySQL HeatWave on AWS Administration page on the OCI console for these items:

- Request an OCI account upgrade from the Oracle Cloud Free Tier to a paid account.
- Subscribe to an OCI region, see: Region Availability.
- Enable the MySQL HeatWave on AWS service in one or more AWS regions.

The MySQL HeatWave on AWS Administration page shows the current status of the sign-up process, and the status of each request.

Tip:

An Oracle Cloud Account has a single region limit by default. For the Home Region, choose the OCI region that maps to the preferred AWS region to avoid the need for a region increase. This would require a support request, and can take some time. See: Region Availability and Subscribed Region Limits.
NOT_SUPPORTED:

Do not change the Oracle Cloud Account name after enabling the MySQL HeatWave on AWS service, as it can cause a loss of access to the MySQL HeatWave on AWS service, and require assistance from Customer Support.

Note:

After upgrading to a paid account, any credits from the Oracle Cloud Free Tier free trial remain eligible for use with MySQL HeatWave on AWS for the duration of the trial period.

The OCI user account created during the sign-up process is added to the Administrators group in the OCI Default identity domain. See: The Default Identity Domain.

To sign up for MySQL HeatWave on AWS, the registered user must either be a member of the Administrators group in the OCI Default identity domain or have the following permissions:

• manage heatwave-registration
• manage policies
• manage domains
• manage groups
• read limits
• update tenancies

For information on creating policies, see Getting Started with Policies.

Sign-up Procedure

For the Home Region, choose the OCI region that maps to the preferred AWS region. See: Region Availability.

To sign up for MySQL HeatWave on AWS:

1. Start here to create an Oracle Cloud Account, or proceed to Step 2 to start the sign-up process.
   b. Enter an email address and click Continue.
   c. Enter the Account Information and click Verify my email.
   d. From the verification email, click Verify email to verify the email address and continue the account setup process.
   e. Complete the Account Information and click Continue. This includes an OCI subscription to the Home Region.
f. Complete the **Address Information** and click **Continue**.

g. Click **Add payment verification method** and complete **Payment Verification**.

h. Select **Agreement**, and click **Start my free trial**.

i. Click **Go to service**. Proceed to step 3.

2. Existing Oracle Cloud account subscribers start here.


   b. Enter the Cloud Account name and click **Next**.

   c. Enter the user credentials and click **Sign In**.

   d. From the OCI Console, open the navigation menu, and select **Databases**. Under MySQL HeatWave on AWS, click **Administration**.

3. Request an account upgrade, if necessary.

   a. Click **Request Upgrade**.

   b. From the **Payment Method** page, choose an **Account Type**, and click **Select**.

   c. Complete the payment information, select **terms and conditions**, and click **Start Paid Account**.

   d. From the **Upgrade Confirmation** dialog box, click **Continue**.

   e. From the OCI Console, open the navigation menu, and select **Databases**. Under MySQL HeatWave on AWS, click **Administration**.

   The account upgrade might take some time.

4. Enable the MySQL HeatWave on AWS service. The MySQL HeatWave on AWS **Administration** page shows **MySQL HeatWave on AWS Region Management**. If the OCI region that maps to the preferred AWS region shows **Subscribed**, do the following to enable the MySQL HeatWave on AWS service:

   a. Click **Enable** next to the preferred AWS region.

   b. From the **Enable Service** dialog box, click **Enable**.

   If the OCI region that maps to the preferred AWS region does not show **Subscribed**, do the following to subscribe to an OCI region, and then enable the MySQL HeatWave on AWS service:

   a. Click **Subscribe** next to the OCI region that maps to the preferred AWS region. If a region limit increase is required, do the following to request an increase:

      i. From the **Limit increase needed** dialog box, click **Open Service Options**.

      ii. Follow these steps: **Requesting a Limit Increase to the Subscribed Region Count**.

      iii. When the region limit increase is complete, click **Subscribe** next to the OCI region that maps to the preferred AWS region.

   b. From the **Subscribe to New Region** dialog box, read the privacy notice, and then click **Subscribe**.

   c. Click **Enable** next to the preferred AWS region.

   d. From the **Enable Service** dialog box, click **Enable**.

Choose one of these options:

- **Click Open MySQL HeatWave on AWS Console** to create a DB System and HeatWave Cluster. See: **DB Systems**, and **HeatWave Clusters**.
• Select **Users and Groups** to create and manage users or integrate with an identity provider. See User and Group Management.

• Select **Billing** to monitor usage and expenses for MySQL HeatWave on AWS in OCI. See Billing.

## Signing In

This procedure assumes that you are an Oracle Cloud Account customer registered to use MySQL HeatWave on AWS. If you are not registered, see Signing Up.

Signing in to MySQL HeatWave on AWS requires:

• An Oracle Cloud Account name. This is the Oracle Cloud Account you registered with, chosen during account signup, or that was provided to you by an Account Administrator. In either case, you can find your Oracle Cloud Account name in your Oracle Cloud Account welcome email.

• Your user name and password.

If you forgot your Oracle Cloud Account name, click **Get help** in the sign-in dialog and enter the email address associated with the Cloud Account. Oracle will send you an email with a summary of your account information.

To sign in to your account:

   You are directed to the MySQL HeatWave on AWS welcome page.

2. Enter your Oracle Cloud Account name.

3. Click **Continue**.
   You are directed to the **Oracle Cloud Account Sign In** dialog.

4. Enter your user name and password and click **Sign In**.
   Once your user name and password are authenticated, you are directed to the MySQL HeatWave Console.

## Using the Console

The MySQL HeatWave Console supports browser platforms supported by Oracle Jet. See Platforms supported by Oracle JET, in the JavaScript Extension Toolkit documentation.

Firewalls, proxy servers, or other devices that control access to the internet can affect the ability to connect to the MySQL HeatWave Console and OCI Console.

To allow network access to both the MySQL HeatWave Console and OCI Console, add the following URLs to the allowlist for firewalls and proxy servers:

- *.mysql.com
- *.oracle.com
- *.oraclecloud.com
- *.oracleinfinity.io
- oracle.112.2o7.net
- consent.trustarc.com
The last URL is for OCI Console cookie preferences.

**Console Overview**

When you sign in to the MySQL HeatWave Console, you are directed to the **Introduction** page.

**Figure 2-1   MySQL HeatWave Console Introduction Page**

The profile menu on the MySQL HeatWave Console shows the account you are logged in to.

**Figure 2-2   Profile Menu on the MySQL HeatWave Console**

The navigation tabs allow you to navigate the pages of the MySQL HeatWave Console. The MySQL HeatWave Console pages include:

- **Introduction**
  
  This is the landing page where users are directed after signing in. It describes MySQL Database and HeatWave. The **Getting Started** region of the page provides a **Create**
MySQL DB System button that directs you to the DB Systems tab on the MySQL page and launches the Create MySQL DB System dialog.

- **MySQL**
  Displays the MySQL page, where you can create and manage MySQL DB Systems and backups.

- **HeatWave Clusters**
  Displays the HeatWave Clusters page, where you can create and manage HeatWave Clusters.

- **Workspaces**
  Displays the Workspaces page, where you can connect to a DB System, manage HeatWave Cluster data, and run DB System and HeatWave queries using the Query Editor.

- **Performance**
  Displays the Performance page, where you can monitor HeatWave and MySQL performance metrics.

**Signing Out**

To sign out of the MySQL HeatWave Console, open the profile menu and click Sign Out.
This chapter covers how to create and manage MySQL DB Systems.

About DB Systems

A DB System is a logical container for the MySQL instance. It provides an interface enabling management of tasks such as provisioning, backup, monitoring, and so on. It also provides a read/write endpoint enabling you to connect to the MySQL instance using the standard MySQL protocols.

DB System Components

A DB System consists of the following components:

- An Amazon EC2 instance type (with resources defined by the associated shape. See Supported Shapes for more information.)
- Oracle Linux Operating System

Note:

It is not possible to access the operating system. Only the MySQL instance is exposed through the DB System endpoint.

- MySQL Server Enterprise Edition 8.0. For more information, see MySQL Server.
- Virtual Network Interface Card (VNIC) which attaches the DB System to a subnet of the Virtual Private Cloud (VPC). For connections to the DB System, a public endpoint is exposed as a fully-qualified domain name (FQDN). Specific IP addresses in CIDR format can be specified to limit access to the public endpoint.
- Network-attached block storage. MySQL HeatWave on AWS uses Amazon EBS block storage. For more information, see Amazon Elastic Block Store (Amazon EBS) in the Amazon EC2 User Guide for Linux Instances.

DB System Storage

Storage size should be determined based on your data size and performance requirements.

For information about increasing the storage available to the DB System, see Increasing DB System Storage.

Supported Shapes

MySQL HeatWave on AWS supports the following MySQL and HeatWave node shapes.
### Table 3-1  MySQL Shapes

<table>
<thead>
<tr>
<th>Shape Name</th>
<th>vCPUs</th>
<th>Memory (GiB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>32</td>
<td>256</td>
</tr>
</tbody>
</table>

### Table 3-2  HeatWave Node Shapes

<table>
<thead>
<tr>
<th>Shape Name</th>
<th>Memory (GiB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HeatWave.16GB</td>
<td>16</td>
</tr>
<tr>
<td>HeatWave.256GB</td>
<td>256</td>
</tr>
</tbody>
</table>

- If you intend to use HeatWave AutoML functionality, the HeatWave.256GB node shape is recommended when creating a HeatWave Cluster. The HeatWave.16GB node shape may not have enough memory for training on large data sets. If you see error messages about this (such as ML003024), use the larger shape instead.

## MySQL Server

This section describes various aspects of MySQL Server including versioning, upgrades, error logging, unsupported features, and limitations.

### Server Versioning

The MySQL Server included in the MySQL HeatWave on AWS uses a versioning system consisting of three numbers, an update version, and the -cloud suffix. For example: `8.0.30-u1-cloud`.

- **First number**: The major release number.
- **Second number**: The minor release number. Taken together, the major and minor numbers constitute the release series number.
- **Third number**: The version number within the release series. This is incremented for each new release.
- **uN**: The MySQL Server-specific update number. Fixes and feature development for the cloud version of MySQL Server are delivered according to a different schedule than the on-premise version.
- **cloud**: suffix indicating this version of MySQL Server was built for the cloud, only.

To retrieve the MySQL Server version number, connect to your DB System using a MySQL client, and run `SELECT @@version;`. The following example shows the command and typical output:

```
mysql> SELECT @@version;
+-----------------+
| @@version       |
+-----------------+
- +-----------------+
```


Server Upgrades

MySQL HeatWave on AWS supports the most recent release version of MySQL.

- Minor versions, such as 8.0.nn, must be applied manually. See Upgrade MySQL Version for information.
- Upgrade versions, such as 8.0.nn-un, are applied automatically and according to the maintenance window defined on the DB System.

For more information about MySQL Server versioning, see Server Versioning.

It is not possible to roll back (downgrade) an upgrade. It is recommended to perform a full backup before upgrading your DB System.

Server Error Logging

MySQL HeatWave on AWS logs MySQL Server diagnostic information such as errors, warnings, and status updates to the Performance Schema error_log table. You can use a command-line client such as MySQL Client or MySQL Shell to view this data. For information about connecting to the DB System from a client, see Connecting from a Client. If connecting from MySQL Shell, you must switch to SQL mode by typing \sql at the MySQL Shell prompt.

To view logs in the error_log table, run the following statement:

mysql> SELECT * FROM performance_schema.error_log;

You get a response similar to the following, which displays the event timestamp, the thread ID, the event priority, the event error code (if present), subsystem in which the event occurred, and text describing the event:

<table>
<thead>
<tr>
<th>8.0.30-u1-cloud</th>
</tr>
</thead>
</table>

*************************** 1. row ***************************
| LOGGED: 2022-04-07 19:17:03.981201 |
| THREAD_ID: 0 | PRIO: Warning |
| ERROR_CODE: MY-011068 | SUBSYSTEM: Server |
| DATA: The syntax 'skip_slave_start' is deprecated and will be removed in a future release. Please use skip_replica_start instead. |

*************************** 2. row ***************************
| LOGGED: 2022-04-07 19:17:03.98388 |
| THREAD_ID: 0 | PRIO: Note |
| ERROR_CODE: MY-010096 | SUBSYSTEM: Server |
| DATA: Ignoring --secure-file-priv value as server is running with --initialize(-insecure). |

*************************** 3. row ***************************
| LOGGED: 2022-04-07 19:17:03.983921 |
| THREAD_ID: 0 | PRIO: Note |
To filter the logs to show only errors, run this statement:

```sql
mysql> SELECT * FROM performance_schema.error_log
    WHERE PRIO='error';
```

To filter the logs to only show errors from the RAPID, HeatWave, subsystem, run this statement:

```sql
mysql> SELECT * FROM performance_schema.error_log
    WHERE SUBSYSTEM IN ('RAPID');
```

You can select from the following subsystems:

- Server
- InnoDB
- RAPID

To filter on the RAPID (HeatWave) subsystem over a 2 hour time interval, run the following command:

```sql
mysql> SELECT * FROM performance_schema.error_log
    WHERE SUBSYSTEM IN ('RAPID');
```

To retrieve a count of how many instances of a specific error occurred in a single day, run the following command:

```sql
mysql> SELECT HOUR(LOGGED), count(*)
    FROM performance_schema.error_log
    WHERE ERROR_CODE = 'MY-010914'
    AND LOGGED > DATE_SUB(NOW(),INTERVAL 1 DAY)
    GROUP BY HOUR(LOGGED);
```

To retrieve a count of how many instances of a specific error occurred in a week, run the following command:

```sql
mysql> SELECT DAY(LOGGED), count(*)
    FROM performance_schema.error_log
    WHERE ERROR_CODE = 'MY-010914'
    AND LOGGED > DATE_SUB(NOW(),INTERVAL 1 WEEK)
    GROUP BY DAY(LOGGED);
```
Unsupported MySQL Server Features

The following features of MySQL Server are currently unsupported in MySQL HeatWave on AWS:

- Authentication plugins other than Native Pluggable Authentication (mysql_native_password), SHA-256 Pluggable Authentication (sha256_password), and Caching SHA-2 Pluggable Authentication (caching_sha2_password).
- Modification of system tables
- Binary log access
- Group Replication plugin
- InnoDB Tablespace Encryption
- Setting global variables
- Persisted system variables
- Replication filters
- Semisynchronous replication
- Transportable tablespaces

MySQL Storage Engines

MySQL HeatWave on AWS supports only the InnoDB storage engine.

If you intend to migrate to MySQL HeatWave on AWS, and are not currently using the InnoDB storage engine, your data must be converted to use the InnoDB storage engine before the data is imported.

You can manually convert tables to InnoDB using the following `ALTER TABLE` statement:

```
mysql> ALTER TABLE table_name ENGINE=InnoDB;
```

The recommended method for migrating data is to use the MySQL Shell client. MySQL Shell dump utilities provide a `ocimds` option that checks for various incompatibilities, including tables defined with unsupported storage engines. Should incompatibilities exist, the MySQL Shell `compatibility` option can be used to alter MySQL Shell dump files to fix the incompatibilities, including changing the storage engine to InnoDB. For more information, see Importing Data.

Plugins and Components

The following MySQL Server plugins and components are loaded by default. You do not need to install any of these plugins.

- MySQL Enterprise Thread Pool
Implements a thread pool that increases server performance by efficiently managing statement execution threads for large numbers of client connections. For more information, refer to MySQL Enterprise Thread Pool, in the MySQL Reference Manual.

- **Connection Control Plugins**
  Introduces an increasing delay in server response to connection attempts after a number of consecutive failed attempts. This capability provides a deterrent that slows down brute force attacks against MySQL user accounts. For more information, refer to The Connection-Control Plugins, in the MySQL Reference Manual.

- **Password Validation Component**
  Improves security by requiring account passwords and enabling strength testing of potential passwords. For more information, refer to The Password Validation Component, in the MySQL Reference Manual.

- **MySQL Enterprise Data Masking and De-Identification**
  Helps protect sensitive data from unauthorized uses by hiding and replacing real values with substitutes. For more information, refer to MySQL Enterprise Data Masking and De-Identification, in the MySQL Reference Manual.

- **MySQL Enterprise Firewall**
  Protects your data by monitoring, alerting, and blocking unauthorized database activity. For more information, refer to MySQL Enterprise Firewall, in the MySQL Reference Manual.

- **MySQL Enterprise Encryption**
  Provides built-in, server-side asymmetric encryption, key generation, digital signatures, and other cryptographic features to help protect confidential data using public and private keys. Only the MySQL Enterprise Encryption component functions are supported. The MySQL Enterprise Encryption plugin functions are deprecated and not supported by MySQL HeatWave on AWS. For more information, refer to MySQL Enterprise Encryption, in the MySQL Reference Manual.

**MySQL HeatWave on AWS Service Restrictions**

The following items are currently not permitted in MySQL HeatWave on AWS:

- Custom TLS certificates.
- Changing the shape associated with a DB System. To change a shape, you must restore a backup of the DB System to a new DB System, and change the shape as part of that process. See Restoring a Backup to a New DB System for more information.

**MySQL HeatWave on AWS Service Limitations**

MySQL HeatWave on AWS does not support inbound replication.

Inbound replication is only supported with MySQL Database Service on OCI.
Default MySQL Privileges

This section lists the MySQL privileges granted to the MySQL Administrator user on the DB System and those explicitly revoked on the mysql and sys schemas. Revoked privileges cannot be granted to any MySQL user. For more information, see MySQL Privileges.

- **Global Privileges Granted**
  - ALTER
  - ALTER ROUTINE
  - CREATE
  - CREATE ROLE
  - CREATE ROUTINE
  - CREATE TEMPORARY TABLES
  - CREATE USER
  - CREATE VIEW
  - DELETE
  - DROP
  - DROP ROLE
  - EVENT
  - EXECUTE
  - INDEX
  - INSERT
  - LOCK TABLES
  - PROCESS
  - REFERENCES
  - REPLICATION CLIENT
  - REPLICATION SLAVE
  - SELECT
  - SHOW DATABASES
  - SHOW VIEW
  - TRIGGER
  - UPDATE

- **Global Dynamic Privileges Granted**
  - APPLICATION_PASSWORD_ADMIN
  - BACKUP_ADMIN
  - CONNECTION_ADMIN
  - FIREWALL_ADMIN
– FIREWALL_USER
– FLUSH_OPTIMIZER_COSTS
– FLUSH_STATUS
– FLUSH_TABLES
– FLUSH_USER_RESOURCES
– REPLICATION_APPLIER
– ROLE_ADMIN
– XA_RECOVER_ADMIN

• Privileges Revoked from mysql Schema
  – ALTER
  – ALTER ROUTINE
  – CREATE
  – CREATE ROUTINE
  – CREATE TEMPORARY TABLES
  – CREATE VIEW
  – DELETE
  – DROP
  – EVENT
  – EXECUTE
  – INDEX
  – INSERT
  – LOCK TABLES
  – REFERENCES
  – TRIGGER
  – UPDATE

• Privileges Revoked from sys Schema
  – ALTER
  – ALTER ROUTINE
  – CREATE
  – CREATE ROUTINE
  – CREATE TEMPORARY TABLES
  – CREATE VIEW
  – DROP
  – EVENT
  – INDEX
Reserved User Names

The following user names are reserved and cannot be used for the MySQL Administrator user name:

- administrator
- ociadmin
- ocimonitor
- ocirpl
- mysql.sys
- mysql.session
- mysql.infoschema

Creating a DB System

Check that the correct AWS region is shown at the top of the MySQL HeatWave Console. If it is not, see: Manage Regions

Creating a DB System requires administrator credentials, a hardware configuration, an AWS Availability Zone, a MySQL configuration and version, a maintenance window, network settings, backup policy, and a HeatWave Cluster configuration.

- Administrator credentials.
  MySQL HeatWave on AWS grants a specific set of MySQL Server privileges to an administrator. See Default MySQL Privileges. The administrator user name can have up to 32 characters. Certain names are reserved. See Reserved User Names.

  The administrator password must be between 8 and 32 characters, and include at least one number, one uppercase letter, one lowercase letter, and one character from ,.-+*;:_! #%&/()=?><

- Hardware configuration.
  The shape determines the resources that MySQL HeatWave on AWS allocates to the DB System. See Supported Shapes.

Note:

MySQL HeatWave on AWS does not support changes to the MySQL shape. To use a different shape requires a new DB System with the new shape. Restore the data from a backup of the old DB System to the new DB System.

MySQL uses the data storage for all data, logs, and temporary files. Binaries are not stored in this block storage. The maximum storage allocation is 65536 GiB.
Note:
Ensure that the data storage capacity is sufficient for any data import.

- AWS Availability Zone.
  An Availability Zone ID, AZ ID, identifies the physical Availability Zone. See Availability Zone IDs for your AWS resources, in the AWS RAM User Guide.

Note:
To maximize performance, place the DB System in the same Availability Zone as the applications that will use the DB System.

- MySQL configuration.
  Use a MySQL configuration to determine the values of global system variables. See Configuration.

Note:
Not all MySQL configurations support HeatWave. Make sure to select a MySQL configuration that does support HeatWave to attach a HeatWave Cluster to the DB System. The default configuration will support HeatWave.

- Maintenance Window.
  The maintenance window is a two-hour period specified in Coordinated Universal Time, UTC. When an update is available, MySQL HeatWave on AWS initiates it during this window. The time required to apply patches and updates may extend beyond the maintenance window and require a DB System restart. For more information, see Maintenance.

  Modify the Maintenance Window later by editing the DB System. See Editing a DB System.

- Network settings: allowed client addresses.
  Specify the public-facing client IPv4 addresses that are permitted to connect to the DB System endpoint. These must all be public IP addresses that are capable of accessing the Internet, and not private IP addresses. For example:

  - The public IP address for the system you are using to set up MySQL HeatWave on AWS.
  - The public IP address for a system that an administrator will use to manage the HeatWave Cluster.
  - The public IP addresses of application servers where client applications that will use the HeatWave Cluster are running.
  - A public IP address range assigned to your organization.

  The IP addresses are specified in Classless Inter-Domain Routing, CIDR format; for example: 1.2.3.4/24. Multiple addresses in CIDR format can be specified in a semicolon-separated list; for example: 1.2.3.4/24; 1.2.3.4/32.
CIDR notation permits specifying a range of IP addresses in a single address. A CIDR address looks like a regular IP address but is suffixed with a forward slash followed by a number. The number is a compact representation of the subnet mask; for example, /24 is equivalent to 255.255.255.0, where 24 is the number of bits in the binary representation of 255.255.255.0 (11111111.11111111.11111111.00000000). 1.2.3.4/24 is equivalent to 1.2.3.4/255.255.255.0, which permits this IP address range: 1.2.3.0 to 1.2.3.255.

The following table shows common subnet masks, the equivalent CIDR notation, and the number of IP addresses in the range.

<table>
<thead>
<tr>
<th>Subnet Mask</th>
<th>CIDR Notation</th>
<th>Number of IP Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>255.0.0.0</td>
<td>/8</td>
<td>16777216</td>
</tr>
<tr>
<td>255.255.0.0</td>
<td>/16</td>
<td>65536</td>
</tr>
<tr>
<td>255.255.255.0</td>
<td>/24</td>
<td>256</td>
</tr>
<tr>
<td>255.255.255.128</td>
<td>/25</td>
<td>128</td>
</tr>
<tr>
<td>255.255.255.192</td>
<td>/26</td>
<td>64</td>
</tr>
<tr>
<td>255.255.255.224</td>
<td>/27</td>
<td>32</td>
</tr>
<tr>
<td>255.255.255.240</td>
<td>/28</td>
<td>16</td>
</tr>
<tr>
<td>255.255.255.248</td>
<td>/29</td>
<td>8</td>
</tr>
<tr>
<td>255.255.255.252</td>
<td>/30</td>
<td>4</td>
</tr>
<tr>
<td>255.255.255.254</td>
<td>/31</td>
<td>2</td>
</tr>
<tr>
<td>255.255.255.255</td>
<td>/32</td>
<td>1</td>
</tr>
</tbody>
</table>

Specify a combination of CIDR addresses to permit a specific range of IP address. For example, to permit five IP addresses in the range of 192.0.2.0 to 192.0.2.4, specify these CIDR addresses: 192.0.2.0/30; 192.0.2.4/32. To permit a single IP address such as 192.0.2.10, specify 192.0.2.10/32. More information about CIDR notation including IP range to CIDR calculators can be found by searching online.

- **Backup policy.**
  Automatic backups are optional. The retention period is from 1 to 35 days for automatic backups, with a default of 7 days. An automatic backup will start during the hour following the **Backup start time**, if this is set. The default time to start an automatic backup is a time between 11:00 and 07:00 UTC, and will be the same time every day.

- **HeatWave Cluster configuration.**
  The HeatWave Cluster shape determines the resources allocated to each HeatWave node. See **Supported Shapes**.

  The cluster size is the number of HeatWave nodes, and can be between 1 and 128. Because the new DB System does not yet contain any data, MySQL Autopilot cannot estimate the required cluster size, see: **Estimating Cluster Size with MySQL Autopilot**.

  **Tip:**
  To make an estimate after loading the data to the DB System, delete the HeatWave Cluster and create a new one following the instructions in **Creating a HeatWave Cluster**.
MySQL HeatWave on AWS does not support changes to the HeatWave Cluster shape. To use a different shape requires removing the existing HeatWave Cluster and creating a new one.

Note:

For HeatWave AutoML functionality, the HeatWave.256GB node shape is recommended when creating a HeatWave Cluster. The HeatWave.16GB node shape may not have enough memory for training on large data sets. If error messages appear, such as ML003024, use the larger shape.

1. In the MySQL HeatWave Console, select the MySQL tab.
2. On the DB Systems page, click Create MySQL DB System to open the Create MySQL DB System and HeatWave Cluster dialog.
3. Basic information: Provide a name and description for the DB System:
   - Display Name: Specify a display name for the DB System or use the generated default name.
   - Description: Specify a user friendly description for the DB System.
4. Administrator credentials: Specify the administrator credentials.
   - Username: Specify a user name for the administrator.
   - Password: Specify a password for the administrator.
   - Confirm Password: Re-enter the administrator password.
5. Hardware configuration: Select a suitable hardware configuration.
   - Shape: Select a shape for the DB System.
   - Data Storage Size (GiB): Specify the amount of block storage, in GiB, to allocate to the DB System.
6. Availability zone: This determines the physical location of the DB System:
   - Automatic: AWS selects the physical AWS Availability Zone.
   - Manual: Select a physical AWS Availability Zone.
7. MySQL Configuration: Select a MySQL configuration.
   - Click Change to change the default configuration.
   - Select a configuration from the list.
   - Click Apply MySQL Configuration.
8. Database Version: Select the MySQL Server version to deploy. The latest MySQL Server version is selected by default.
9. Maintenance Window: Select the start time for the maintenance window.
   - Select Automatic for MySQL HeatWave on AWS to choose the Start day and Start time.
   - Select Manual to specify the maintenance window Start day and Start time.
10. Networking: Configure network settings:
• **Allowed Client Addresses**: Specify the public-facing client IPv4 addresses that are permitted to connect to the DB System endpoint.

• **Port**: The port on which the MySQL server listens. The default is port 3306. Specify a port number between 1024 and 65535.

• **X Protocol Port**: The X Protocol port on which the MySQL server listens, supported by clients such as MySQL Shell. The default port is 33060. Specify a port number between 1024 and 65535.

11. **Backup policy**: Select the backup retention period, and the start time for automatic backups.
   - Select **Enable Automatic Backups** for MySQL HeatWave on AWS to take backups.
   - Set a retention period between 1 and 35 days.
   - Select **Select Backup Window** to set a preferred time to start a backup.
   - Set the **Backup start time**.

12. **IAM roles**:
   - **Data Import role ARN**: If you want to import data with Console, specify the data import role ARN. See Creating an IAM Role to Access an Amazon S3 Bucket.

13. Click **Next**.

14. **Provision HeatWave Cluster**: Select whether to provision a HeatWave Cluster. This is only available if the chosen MySQL configuration supports HeatWave.
   - **Basic information**: Provide a name and description for the HeatWave Cluster:
     - **Display Name**: Specify a display name for the HeatWave Cluster or use the generated default name.
     - **Description**: Specify a user-friendly description of the HeatWave Cluster.
   - **HeatWave Cluster configuration**: Specify the shape and cluster size.
     - **Shape**: Select the shape to use for the HeatWave Cluster.
     - **Cluster Size**: Specify the size of the cluster between 1 and 128 HeatWave nodes.

15. Click **Create**.
    MySQL HeatWave Console returns to the **DB Systems** page to monitor the state of the operation, which may take some time to complete. The state will change from **Creating** to **Active** when the operation has completed successfully.

    Click the name of the DB System to open the **DB System Details** page, and review the **DB System Information**.

---

**Managing a DB System**

This section describes how to manage MySQL DB Systems using the Console.

**Stopping, Starting, or Restarting a DB System**

A DB System starts automatically after it is created, and the **Start** button is disabled. A running DB System shows the **Active** state. For information on DB System states, see **MySQL DB System Details**.
Restarting a DB System with the **Restart** button shuts down the DB System, and then restarts it immediately.

Stopping a DB System with the **Stop** button stops billing for it. However, billing continues for storage. Billing for the DB System resumes when the DB System starts again.

Start, stop, or restart operations on a DB System also affect an associated HeatWave Cluster. When a DB System restarts, the HeatWave Cluster also restarts, and it reloads data from the DB System. See: Data Load Progress and Status Monitoring.

To start, stop, or restart a DB System:

1. In the MySQL HeatWave Console, select the **MySQL** tab.
2. On the **DB Systems** tab, in the list of DB Systems, find the DB System you want to start, stop, or restart, and do one of the following:
   - Click on the row of the DB System to highlight it, and then click the **Start**, **Stop**, or **Restart** button.
   - Click the name of the DB System to open the **DB System Details** page, and then click the **Start**, **Stop**, or **Restart** button.
3. When you select **Stop** or **Restart**, the **Stop/Restart MySQL DB System** dialog is displayed for you to choose the shutdown type:
   - **Slow** flushes dirty pages and purges undo log pages for older transactions. The shutdown itself can take longer, but the subsequent startup is faster.
   - **Fast** flushes dirty pages before shutting down the DB System. Some flush operations must be performed during next startup, potentially increasing the duration of the startup process.
   - **Immediate** does not flush dirty pages and does not purge any undo log pages. Stops MySQL immediately. Page flushes and log purging will take place during the next startup, increasing the duration of the startup process.

Select a shutdown type and click the **Stop** or **Restart** button, depending on the action you are taking.

---

## Editing a DB System

Use the Console to edit a DB System, and update the details about the DB System, the maintenance window, the backup policy, or the data import role ARN.

This task requires the following:

- (For data import feature only) Permissions to assume the data import role.

Do the following to edit a DB System:

1. In the MySQL HeatWave Console, select the **MySQL** tab.
2. On the **DB Systems** tab, in the list of DB Systems, find the DB System to edit, and do one of the following:
   - Click on the row of the DB System to highlight it, and choose **Edit DB System** from the **Actions** menu.
   - Click the name of the DB System to open the **DB System Details** page. Click the **Edit DB System** button.
3. **Basic information**: Edit the name and description of the DB System:
   - **Display Name**: Edit the display name for the DB System.
   - **Description**: Edit the user friendly description for the DB System.

4. **Maintenance Window**: Edit the start time for the maintenance window. The maintenance window is a two-hour period specified in Coordinated Universal Time, UTC. When an update is available, MySQL HeatWave on AWS initiates it during this window. The time required to apply patches and updates may extend beyond the maintenance window and require a DB System restart. See Maintenance.
   - Select **Automatic** for MySQL HeatWave on AWS to choose the **Start day** and **Start time**.
   - Select **Manual** to specify the maintenance window **Start day** and **Start time**.

5. **Backup policy**: Edit the backup retention period, and the start time for automatic backups.
   - Select **Enable Automatic Backups** for MySQL HeatWave on AWS to take backups. Automatic backups are optional. The retention period is from 1 to 35 days for automatic backups, with a default of 7 days. An automatic backup will start during the hour following the **Backup start time**, if this is set. The default time to start an automatic backup is a time between 11:00 and 07:00 UTC, and will be the same time every day.
   - Set a retention period between 1 and 35 days.
   - Select **Select Backup Window** to set a preferred time to start a backup.
   - Set the **Backup start time**.

6. **IAM roles**:
   - **Data Import role ARN**: If you want to import data with Console, specify the data import role ARN. See Creating an IAM Role to Access an Amazon S3 Bucket.

7. **Click Save**.

### Update Networking

For the allowed client addresses, specify public-facing client IPv4 addresses that are permitted to connect to the DB System endpoint. Use CIDR format, for example: `1.2.3.4/24`. Specify multiple addresses in CIDR format with a semicolon-separated list, for example: `1.2.3.4/24; 1.2.3.4/32`. For information about the CIDR format, see Creating a DB System.

To update the network for a DB System:

1. In the MySQL HeatWave Console, select the **MySQL** tab.
2. On the **DB Systems** tab, in the list of DB Systems, find the DB System to edit, and do one of the following:
   - Click on the row of the DB System to highlight it, and choose **Update Networking** from the **Actions** menu.
   - Click the name of the DB System to open the **DB System Details** page. Click the **Update Networking** button.
3. **Edit the Allowed Client Addresses**.
4. **Click Save** to save the changes.
Update MySQL Configuration

Update the MySQL configuration for a DB System. This will change the user configurable system variables for the DB System to the values in the new configuration. See User Configurable System Variables.

Note:
Any change to the configuration for a DB System cannot change the system initialization variables. See System Initialization Variables.

The MySQL HeatWave Console only shows alternative configurations that support the DB System shape. If a DB System has a HeatWave Cluster attached, MySQL HeatWave Console only shows configurations that support HeatWave. To change the configuration to one that does not support HeatWave, first remove the HeatWave Cluster.

If the new configuration changes any system variables that are not dynamic, then the MySQL database process, mysqld, will require a restart. If the DB System has an attached HeatWave Cluster, it will restart and reload data from the DB System.

To update the MySQL configuration for a DB System:

1. In the MySQL HeatWave Console, select the MySQL tab.
2. On the DB Systems tab, in the list of DB Systems, find the DB System to edit, and do one of the following:
   - Click on the row of the DB System to highlight it, and choose Update MySQL Configuration from the Actions menu.
   - Click the name of the DB System to open the DB System Details page. Click the Update MySQL Configuration button.
3. Click Change.
4. Select the preferred MySQL configuration, and click Apply MySQL Configuration.
5. Click Update to save the changes.

If any problems occur updating the configuration, the DB System will roll back to the previous configuration.

Upgrade MySQL Version

Note:
It is not possible to roll back a DB System upgrade. It is recommended to perform a full backup of the DB System before upgrading. See Creating a Backup.
See Server Versioning. The available options will depend upon the current version. These include:

- **Do not change**
  
  This option is always available, and shows the current version. For instance: `8.0.27-u2-cloud`.

- **Update**
  
  This option is only available if the current version is still supported. Updates happen automatically during the Maintenance Window, see Editing a DB System. This option provides a manual update.

- **A more recent MySQL version**
  
  This option is only available if a more recent version, or versions, is available. It shows the version number, for instance, `8.0.28` or `8.0.29`.

To upgrade the MySQL version:

1. In the MySQL HeatWave Console, select the **MySQL** tab.

2. On the **DB Systems** tab, in the list of DB Systems, find the DB System to edit, and do one of the following:
   - Click on the row of the DB System to highlight it, and choose **Upgrade MySQL Version** from the **Actions** menu.
   - Click the name of the DB System to open the **DB System Details** page. Click the **Upgrade MySQL Version** button.

3. Choose one of the options:
   - **Do not change**: Choose this option to ignore any update or upgrade option.
   - **Update**: Choose this option to update the current version.
   - **A more recent MySQL version**: Choose this option to upgrade to a more recent version.

### Increasing DB System Storage

You can increase the DB System storage by updating the data storage size of an active DB System, by backup and restore, or by export and import.

**Increasing Storage by Updating the Data Storage Size of an Active DB System**

Use the Console to increase the data storage size of an active DB System. If the DB System is active and healthy, updating the data storage size of the DB System does not restart the DB System, and you can continue to query it while the storage is being increased.

You can increase the data storage size once every six hours. It is recommended to create a backup of the DB System before updating the data storage size. See Creating a Backup.

1. In the MySQL HeatWave Console, select the **MySQL** tab.

2. On the **DB Systems** tab, in the list of DB Systems, find the DB System for which you want to update the data storage size, and do either of the following:
   - Click on the row of the DB System to highlight it, click **Actions**, and then click **Update Data Storage Size**.
   - Click the name of the DB system to open the **DB System Details** page. Click **Actions**, and then click **Update Data Storage Size**.
3. In the **Update Data Storage Size** dialog, enter the required storage size in GiB. You can only increase the storage size, and the maximum storage size is 65536.

4. Click **Update**.

**Increasing Storage by Backup and Restore**

1. Create a backup of the DB System. See [Creating a Backup](#).
2. Create a new DB System from the backup, and define a larger storage in the new DB System. See [Restoring a Backup to a New DB System](#).

**Increasing Storage by Export and Import**

1. Export the data from your current DB System using MySQL Shell. See [Exporting Data Using MySQL Shell](#).
2. Use the MySQL HeatWave Console to create a new DB System with a larger storage size. See [Creating a DB System](#).
3. Import the data into the new DB System using MySQL Shell. See [Importing Data](#).

**Deleting a DB System**

Deleting a DB System permanently deletes it, along with all of the data in the database. Ensure all the data is appropriately backed up before deleting a DB System (see [Backups](#)).

To delete a DB System:

1. In the MySQL HeatWave Console, select the **MySQL** tab.
2. On the **DB Systems** tab, in the list of DB Systems, find the DB System you want to delete, and do one of the following:
   - Click on the row of the DB System to highlight it, and choose the **Delete** action from the **Actions** menu.
   - Click the name of the DB System to open the **DB System Details** page. Click the **Delete** button.

   The **Delete MySQL DB System** dialog is displayed.

3. Click **Delete MySQL DB System** to go ahead with the deletion.

**Viewing DB System Details**

Do the following to view DB System details:

1. In the MySQL HeatWave Console, select the **MySQL** tab.
2. On the **DB Systems** tab, in the list of DB System, find the DB System you want to view details for, and do one of the following:
   - Click the row of the DB System to highlight it. The DB System details appear below the list of DB Systems.
   - Click the name of the DB System to open the **MySQL DB System Details** page for the selected DB System.

For descriptions of DB System details, see [MySQL DB System Details](#).
MySQL DB System Details

The MySQL DB System Details page is divided into the following sections:

Table 3-4  MySQL DB System Details Page

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>DB System summary details. See Table 3-5.</td>
</tr>
<tr>
<td>DB System Information</td>
<td>DB System general information, configuration, endpoint, and HeatWave Cluster details. See Table 3-6.</td>
</tr>
<tr>
<td>Backups</td>
<td>DB System backup details. See Table 3-7.</td>
</tr>
</tbody>
</table>

Table 3-5  MySQL DB System Summary Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>The state of the DB System.</td>
</tr>
<tr>
<td></td>
<td>• CREATING: Resources are being reserved for the DB System, the system is booting, and the initial database is being created. Creating can take several minutes. The system is not ready to use yet.</td>
</tr>
<tr>
<td></td>
<td>• ACTIVE: The DB System was successfully created and is ready to be used.</td>
</tr>
<tr>
<td></td>
<td>• STARTING: The DB System is being started.</td>
</tr>
<tr>
<td></td>
<td>• STOPPING: The DB System is being stopped.</td>
</tr>
<tr>
<td></td>
<td>• RESTARTING: The DB System is being restarted.</td>
</tr>
<tr>
<td></td>
<td>• INACTIVE: The DB System is powered off.</td>
</tr>
<tr>
<td></td>
<td>• UPDATING: The DB System is in the process of being updated.</td>
</tr>
<tr>
<td></td>
<td>• UPGRADING: The DB System is in the process of being upgraded.</td>
</tr>
<tr>
<td></td>
<td>• DELETING: The DB System is being deleted.</td>
</tr>
<tr>
<td></td>
<td>• DELETED: The DB System has been deleted and is no longer available.</td>
</tr>
<tr>
<td></td>
<td>• FAILED: An error condition prevented the creation or continued operation of the DB System.</td>
</tr>
<tr>
<td></td>
<td>• STARTING_ERROR: An attempt to start the DB System failed.</td>
</tr>
<tr>
<td></td>
<td>• STOPPING_ERROR: An attempt to stop the DB System failed.</td>
</tr>
<tr>
<td></td>
<td>• RESTARTING_ERROR: An attempt to restart the DB System failed.</td>
</tr>
<tr>
<td></td>
<td>• UPDATING_ERROR: An attempt to update the DB System failed.</td>
</tr>
<tr>
<td></td>
<td>• UPGRADING_ERROR: An attempt to upgrade the DB System failed.</td>
</tr>
<tr>
<td></td>
<td>• DELETING_ERROR: An attempt to delete the DB System failed.</td>
</tr>
</tbody>
</table>
Table 3-5  (Cont.) MySQL DB System Summary Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host Name</td>
<td>The host name of the DB System. The host name is a fully qualified domain name (FQDN).</td>
</tr>
<tr>
<td>Resource ID</td>
<td>The unique resource identifier assigned to the DB System when it is created.</td>
</tr>
<tr>
<td>Shape</td>
<td>The resource template for the MySQL instance. For information about shapes, see Supported Shapes.</td>
</tr>
</tbody>
</table>

Table 3-6  DB System Information Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
</table>
| General Information | • Description: The user-defined description of the DB System.  
                      • Created: The date and time the DB System was created.  
                      • Last Updated: The date and time the DB System was last updated. |
| DB System Configuration | • Storage Size: The amount of storage available to the DB System.  
                           • MySQL Version: The MySQL Server version used by the DB System.  
                           • Maintenance Window: When updates are available, they are initiated during the maintenance window, which is a two-hour period starting at this time. The time required to apply patches and updates may extend beyond the maintenance window and require DB System restarts. For more information, see Maintenance. |
| Endpoint           | • Availability Zone: The physical Availability Zone where the DB System resides.  
                      • MySQL Port: The port on which the MySQL Server listens.  
                      • MySQL Port X: The port on which the MySQL Server listens for clients using MySQL’s X Protocol.  
                      • Allowed Client Addresses: The public-facing client IPv4 addresses that are permitted to connect to the DB System endpoint, specified in CIDR format. For information about how IP addresses are specified in CIDR format, see Creating a DB System. |
### Table 3-6  (Cont.) DB System Information Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HeatWave Cluster</td>
<td>• <strong>State</strong>: The state of the HeatWave Cluster.</td>
</tr>
<tr>
<td></td>
<td>- <strong>CREATING</strong>: Resources are being reserved for the HeatWave Cluster, and the cluster is being created. Creating can take several minutes. The system is not ready to use yet.</td>
</tr>
<tr>
<td></td>
<td>- <strong>ACTIVE</strong>: The HeatWave Cluster was successfully created and is ready to be used.</td>
</tr>
<tr>
<td></td>
<td>- <strong>STARTING</strong>: The HeatWave Cluster is being started.</td>
</tr>
<tr>
<td></td>
<td>- <strong>STOPPING</strong>: The HeatWave Cluster is being stopped.</td>
</tr>
<tr>
<td></td>
<td>- <strong>RESTARTING</strong>: The HeatWave Cluster is being restarted.</td>
</tr>
<tr>
<td></td>
<td>- <strong>INACTIVE</strong>: The HeatWave Cluster is powered off.</td>
</tr>
<tr>
<td></td>
<td>- <strong>UPDATING</strong>: The HeatWave Cluster is in the process of being updated.</td>
</tr>
<tr>
<td></td>
<td>- <strong>UPGRADING</strong>: The HeatWave Cluster is in the process of being upgraded.</td>
</tr>
<tr>
<td></td>
<td>- <strong>DELETING</strong>: The HeatWave Cluster is being deleted.</td>
</tr>
<tr>
<td></td>
<td>- <strong>DELETED</strong>: The HeatWave Cluster has been deleted and is no longer available.</td>
</tr>
<tr>
<td></td>
<td>- <strong>FAILED</strong>: An error condition prevented the creation or continued operation of the HeatWave Cluster.</td>
</tr>
<tr>
<td></td>
<td>- <strong>STARTING_ERROR</strong>: An attempt to start the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>- <strong>STOPPING_ERROR</strong>: An attempt to stop the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>- <strong>RESTARTING_ERROR</strong>: An attempt to restart the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>- <strong>UPDATING_ERROR</strong>: An attempt to update the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>- <strong>UPGRADING_ERROR</strong>: An attempt to upgrade the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>- <strong>DELETING_ERROR</strong>: An attempt to delete the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>Name</strong>: The name of the HeatWave Cluster.</td>
</tr>
<tr>
<td></td>
<td>• <strong>Cluster Size</strong>: The number of HeatWave Cluster nodes.</td>
</tr>
</tbody>
</table>

### Table 3-7  MySQL DB System Backup Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>The name of the backup</td>
</tr>
<tr>
<td>Field</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>State</strong></td>
<td>The state of the backup</td>
</tr>
<tr>
<td></td>
<td>• <strong>CREATING:</strong> Resources are being reserved for the DB System backup and</td>
</tr>
<tr>
<td></td>
<td>the backup is being created. Creating can take several minutes. The</td>
</tr>
<tr>
<td></td>
<td>backup is not ready to use yet.</td>
</tr>
<tr>
<td></td>
<td>• <strong>ACTIVE:</strong> The backup was successfully created.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPDATING:</strong> The backup is in the process of being updated.</td>
</tr>
<tr>
<td></td>
<td>• <strong>INACTIVE:</strong> The backup is not available.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETING:</strong> The backup is being deleted.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETED:</strong> The backup has been deleted and is no longer available.</td>
</tr>
<tr>
<td></td>
<td>• <strong>FAILED:</strong> An error condition prevented the creation or continued</td>
</tr>
<tr>
<td></td>
<td>availability of the backup.</td>
</tr>
<tr>
<td><strong>MySQL DB System</strong></td>
<td>The name of the MySQL DB System used to create the backup.</td>
</tr>
<tr>
<td><strong>Size (GiB)</strong></td>
<td>The size of the backup - note that a backup is the size of the whole</td>
</tr>
<tr>
<td></td>
<td>storage allocation for the DB System from which it was created, even if</td>
</tr>
<tr>
<td></td>
<td>the volume does not contain that much data.</td>
</tr>
<tr>
<td><strong>Created</strong></td>
<td>The date and time the backup was created.</td>
</tr>
</tbody>
</table>
HeatWave Clusters

This chapter describes how to create and manage HeatWave Clusters.

A HeatWave Cluster consists of a MySQL DB System and one or more HeatWave nodes. The MySQL DB System includes a HeatWave plugin that is responsible for cluster management, query scheduling, and returning query results to the MySQL DB System. HeatWave nodes store data in memory and process queries.

When a HeatWave Cluster is enabled and data is loaded, queries that meet certain prerequisites are automatically offloaded from the MySQL DB System to the HeatWave Cluster for accelerated processing.

Creating a HeatWave Cluster

A HeatWave Cluster must be associated with an active DB System, and a DB System can have only one HeatWave Cluster. Before you create a HeatWave Cluster, ensure that you have created a DB System and that the DB System does not already have a HeatWave Cluster. With MySQL HeatWave on AWS, you create a DB System and HeatWave nodes at the same time, but you can delete the HeatWave Cluster afterwards if you want to re-create it. See Creating a DB System for instructions.

When you create a HeatWave Cluster, you are presented with an option to estimate the required HeatWave Cluster size based on data that is loaded on your DB System (see Estimating Cluster Size with MySQL Autopilot). If you have not loaded data into your DB System, and you want to estimate the optimal HeatWave Cluster size, load data into the DB System before you create a HeatWave Cluster. See Importing Data.

Note:
Changing the number of nodes in an existing HeatWave Cluster is not supported. If you require a larger or smaller cluster, you must delete the existing cluster and create a new one with the desired number of nodes.

To create a HeatWave Cluster, do the following:

1. In the MySQL HeatWave Console, select the HeatWave Clusters tab.
2. Click Create HeatWave Cluster. The Create HeatWave Cluster dialog is displayed.
3. On the Create HeatWave Cluster dialog, provide the following information:
   - Basic Information
     - Display Name: Specify a user-friendly display name for the HeatWave Cluster.
     - Description: Specify a user-friendly description of the HeatWave Cluster.
   - DB System Name: Select a DB System from the drop down menu.
– Shape: Select a HeatWave node shape. For information about supported shapes, see Supported Shapes.

Note:
If you intend to use HeatWave AutoML functionality, the HeatWave.256GB node shape is recommended when creating a HeatWave Cluster. The HeatWave.16GB node shape may not have enough memory for training on large data sets. If you see error messages about this (such as ML003024), use the larger shape instead.

– Cluster Size: The number of HeatWave nodes to create. Enter a number between 1 and 128. Optionally, click Estimate Cluster Size to estimate the required cluster size using MySQL Autopilot. For instructions, see Estimating Cluster Size with MySQL Autopilot.

4. Click Create to create the HeatWave Cluster.

You are returned to the HeatWave Clusters page where you can monitor the state of the operation, which may take some time to complete. The state changes from Creating to Active when the operation has completed successfully.

Estimating Cluster Size with MySQL Autopilot

This topic describes how to estimate the optimal HeatWave Cluster size for your data.

A cluster size estimate is generated using MySQL Autopilot machine learning techniques. MySQL Autopilot analyzes the data on your MySQL DB System and recommends a cluster size. If you have not loaded data into your DB System, and you want to estimate the optimal HeatWave Cluster size, load data into the DB System before you create a HeatWave Cluster. See Importing Data.

Prerequisites:
• The data you intend to load into the HeatWave Cluster must be available on the DB System.
• Optionally, log into your DB System and run ANALYZE TABLE on tables you intend to load into the HeatWave Cluster. Estimates should generally be valid without running ANALYZE TABLE, but running ANALYZE TABLE ensures that estimates are as accurate as possible.

To estimate a cluster size:
1. Click Estimate Cluster Size.

The Estimate Cluster Size with Autopilot dialog is displayed.

2. Select the schemas and tables you want to include in the estimate. Schemas are displayed in the Schemas pane. Tables belonging to the selected schema appear in the Tables from selected schemas pane.

When schemas and tables are selected, the Summary details are adjusted automatically.

The Schemas pane provides the following information:
• Name: The schema name.
• **HeatWave Cluster Memory Usage (GiB):** The estimated amount of HeatWave Cluster memory used by the schema.

• **Tables Selected:** The number of tables selected expressed as a fraction of the total number of tables.

• **Warnings:** The number of table warnings.

The **Tables from selected schemas** pane provides the following information:

• **Name:** The table name.

• **Warnings:** The number of table warnings. For a description of table warnings, see **Cluster Size Estimate Table Warnings**.

• **Memory Size Estimate (GiB):** The estimated amount of HeatWave Cluster memory required for the table.

• **Rows Estimate:** The estimated number of table rows.

3. Review the **Summary** details, which include memory required by the schemas and tables selected, memory provided per node, HeatWave Cluster nodes required, and memory provided by the cluster.

4. To apply the cluster size estimate, click **Apply Cluster Size Estimate**. You are returned to the **Create HeatWave Cluster** dialog where the estimate is applied to the **Cluster Size** field.

---

### Cluster Size Estimate Table Warnings

This topic describes table warnings that may appear in the **Tables from selected schemas** pane, in the **Estimate Cluster Size with MySQL Autopilot** dialog.

**Table 4-1    Cluster Size Table Warnings**

<table>
<thead>
<tr>
<th>Table Status Issue</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOO MANY COLUMNS TO LOAD</td>
<td>The table has too many columns. The column limit is 1017.</td>
</tr>
<tr>
<td>ALL COLUMNS MARKED AS NOT SECONDARY</td>
<td>There are no columns to load. All table columns are defined as NOT SECONDARY. Columns defined as NOT SECONDARY are excluded from the estimate. For more information, see <strong>Excluding Table Columns</strong>, in the MySQL HeatWave User Guide.</td>
</tr>
<tr>
<td>CONTAINS VARLEN COLUMN WITH &gt;65532 BYTES</td>
<td>A VARLEN column exceeds the 65532 byte limit. For more information on VARLEN, see <strong>Variable-length Encoding</strong> in the MySQL HeatWave User Guide.</td>
</tr>
<tr>
<td>ESTIMATION COULD NOT BE CALCULATED</td>
<td>The estimate could not be calculated. For example, a table estimate may not be available if statistics for VARLEN columns are unavailable.</td>
</tr>
<tr>
<td>UNABLE TO LOAD TABLE WITHOUT PRIMARY KEY</td>
<td>A table must be defined with a primary key before it can be loaded into HeatWave.</td>
</tr>
</tbody>
</table>
Managing a HeatWave Cluster

Starting, Stopping, or Restarting a HeatWave Cluster

A HeatWave Cluster starts automatically after it is created, and the Start button is disabled. A running HeatWave Cluster shows the Active state. For information on HeatWave Cluster states, see HeatWave Cluster Details.

Restarting a HeatWave Cluster with the Restart button shuts down the HeatWave Cluster and then restarts it immediately. Stopping a HeatWave Cluster with the Stop button stops it without restarting.

When a HeatWave Cluster is stopped through a stop or restart action, the data loaded in HeatWave Cluster memory is unloaded. When a HeatWave Cluster restarts, data is reloaded from AWS S3, and includes any changes that occur on the DB System while the HeatWave Cluster is offline.

Start, stop, or restart actions on a HeatWave Cluster have no effect on the DB System with which the HeatWave Cluster is associated.

To start, stop, or restart a HeatWave Cluster:

1. In the MySQL HeatWave Console, select the HeatWave Clusters tab.

2. In the list of HeatWave Clusters, find the HeatWave Cluster you want to start, stop, or restart, and do one of the following:
   - Click on the row of the HeatWave Cluster to highlight it, and then click the Start, Stop, or Restart button.
   - Click the name of the HeatWave Cluster to open the HeatWave Cluster Details page, and then click the Start, Stop, or Restart button.

Editing a HeatWave Cluster

Use the Console to edit the display name and description of a HeatWave cluster.

1. In the MySQL HeatWave Console, click the HeatWave Clusters tab.

2. In the list of HeatWave Clusters, find the HeatWave Cluster you want to edit, and do one of the following:
   - Click the row of the HeatWave Cluster to highlight it, and click Edit HeatWave Cluster from the Actions menu.
   - Click the name of the HeatWave Cluster to open the Details page and click Edit HeatWave Cluster from the Actions menu.

3. On the Edit HeatWave Cluster panel, provide the following information:
   - Display Name: Specify a name of the HeatWave Cluster.
   - Description: Specify a description of the HeatWave Cluster.

4. Click Save.

The details of the selected HeatWave Cluster is updated.
Deleting a HeatWave Cluster

Deleting a HeatWave Cluster removes the HeatWave Cluster nodes permanently. The DB System with which the HeatWave Cluster is associated is unaffected.

To delete a HeatWave Cluster:

1. In the MySQL HeatWave Console, select the **HeatWave Clusters** tab.
2. In the list of HeatWave Clusters, find the HeatWave Cluster you want to delete, and do one of the following:
   - Click on the row of the HeatWave Cluster to highlight it, and choose the **Delete** action from the **Actions** menu.
   - Click the name of the HeatWave Cluster to open the **HeatWave Cluster Details** page. Click the **Delete** button.

   The **Delete HeatWave Cluster** dialog is displayed.
3. Click **Delete HeatWave Cluster** to go ahead with the deletion.

Viewing HeatWave Cluster Details

To view HeatWave Cluster Details:

1. In the MySQL HeatWave Console, select the **HeatWave Clusters** tab.
2. In the list of HeatWave Clusters, find the HeatWave Cluster you want to view details for, and do one of the following:
   - Click on the row of the HeatWave Cluster to highlight it. The HeatWave Cluster details appear below the list of HeatWave Clusters. Click on the arrow icon to display or hide the details.
   - Click the name of the HeatWave Cluster to open the **HeatWave Cluster Details** page for the selected HeatWave Cluster.

For descriptions of HeatWave Cluster details, see **HeatWave Cluster Details**.

HeatWave Cluster Details

The **HeatWave Cluster Details** page is divided into the following sections:

<table>
<thead>
<tr>
<th>Table 4-2  HeatWave Cluster Details Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
</tr>
<tr>
<td><strong>General Information</strong></td>
</tr>
<tr>
<td><strong>MySQL DB System</strong></td>
</tr>
<tr>
<td><strong>HeatWave Nodes</strong></td>
</tr>
</tbody>
</table>
Table 4-3  HeatWave Cluster Summary Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>The state of the HeatWave Cluster.</td>
</tr>
<tr>
<td></td>
<td>• <strong>CREATING</strong>: Resources are being reserved for the HeatWave Cluster, and the cluster is being created. Creating can take several minutes. The system is not ready to use yet.</td>
</tr>
<tr>
<td></td>
<td>• <strong>ACTIVE</strong>: The HeatWave Cluster was successfully created and is ready to be used.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STARTING</strong>: The HeatWave Cluster is being started.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STOPPING</strong>: The HeatWave Cluster is being stopped.</td>
</tr>
<tr>
<td></td>
<td>• <strong>RESTARTING</strong>: The HeatWave Cluster is being restarted.</td>
</tr>
<tr>
<td></td>
<td>• <strong>INACTIVE</strong>: The HeatWave Cluster is powered off.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPDATING</strong>: The HeatWave Cluster is in the process of being updated.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPGRADING</strong>: The HeatWave Cluster is in the process of being upgraded.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETING</strong>: The HeatWave Cluster is being deleted.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETED</strong>: The HeatWave Cluster has been deleted and is no longer available.</td>
</tr>
<tr>
<td></td>
<td>• <strong>FAILED</strong>: An error condition prevented the creation or continued operation of the HeatWave Cluster.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STARTING_ERROR</strong>: An attempt to start the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STOPPING_ERROR</strong>: An attempt to stop the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>RESTARTING_ERROR</strong>: An attempt to restart the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPDATING_ERROR</strong>: An attempt to update the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPGRADING_ERROR</strong>: An attempt to upgrade the HeatWave Cluster failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETING_ERROR</strong>: An attempt to delete the HeatWave Cluster failed.</td>
</tr>
<tr>
<td>Cluster Size</td>
<td>The number of HeatWave Cluster nodes.</td>
</tr>
<tr>
<td>Resource ID</td>
<td>The unique resource identifier assigned to the HeatWave Cluster when it is created.</td>
</tr>
<tr>
<td>Shape</td>
<td>The shape used for HeatWave Cluster nodes. See Supported Shapes.</td>
</tr>
</tbody>
</table>
### Table 4-4  General Information

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>A user-specified description of the HeatWave Cluster.</td>
</tr>
<tr>
<td>Created</td>
<td>The date and time the HeatWave Cluster was created.</td>
</tr>
<tr>
<td>Last Updated</td>
<td>The date and time the HeatWave Cluster was last updated.</td>
</tr>
</tbody>
</table>

### Table 4-5  MySQL DB System Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>The name of the DB System that the HeatWave Cluster is associated with.</td>
</tr>
<tr>
<td>State</td>
<td>The state of the DB System that the HeatWave Cluster is associated with.</td>
</tr>
<tr>
<td>• CREATING: Resources are being reserved for the DB System, the system is booting, and the initial database is being created. Creating can take several minutes. The system is not ready to use yet.</td>
<td></td>
</tr>
<tr>
<td>• ACTIVE: The DB System was successfully created and is ready to be used.</td>
<td></td>
</tr>
<tr>
<td>• STARTING: The DB System is being started.</td>
<td></td>
</tr>
<tr>
<td>• STOPPING: The DB System is being stopped.</td>
<td></td>
</tr>
<tr>
<td>• RESTARTING: The DB System is being restarted.</td>
<td></td>
</tr>
<tr>
<td>• INACTIVE: The DB System is powered off.</td>
<td></td>
</tr>
<tr>
<td>• UPDATING: The DB System is in the process of being updated.</td>
<td></td>
</tr>
<tr>
<td>• UPGRADING: The DB System is in the process of being upgraded.</td>
<td></td>
</tr>
<tr>
<td>• DELETING: The DB System is being deleted.</td>
<td></td>
</tr>
<tr>
<td>• DELETED: The DB System has been deleted and is no longer available.</td>
<td></td>
</tr>
<tr>
<td>• FAILED: An error condition prevented the creation or continued operation of the DB System.</td>
<td></td>
</tr>
<tr>
<td>• STARTING_ERROR: An attempt to start the DB System failed.</td>
<td></td>
</tr>
<tr>
<td>• STOPPING_ERROR: An attempt to stop the DB System failed.</td>
<td></td>
</tr>
<tr>
<td>• RESTARTING_ERROR: An attempt to restart the DB System failed.</td>
<td></td>
</tr>
<tr>
<td>• UPDATING_ERROR: An attempt to update the DB System failed.</td>
<td></td>
</tr>
<tr>
<td>• UPGRADING_ERROR: An attempt to upgrade the DB System failed.</td>
<td></td>
</tr>
<tr>
<td>• DELETING_ERROR: An attempt to delete the DB System failed.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 4-5  MySQL DB System Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The user-defined description of the DB System</td>
</tr>
</tbody>
</table>

### Table 4-6  HeatWave node Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node ID</td>
<td>The HeatWave node ID</td>
</tr>
<tr>
<td>State</td>
<td>The state of the HeatWave node.</td>
</tr>
<tr>
<td></td>
<td>• <strong>CREATING</strong>: Resources are being reserved for the HeatWave node, and the cluster is being created. Creating can take several minutes. The system is not ready to use yet.</td>
</tr>
<tr>
<td></td>
<td>• <strong>ACTIVE</strong>: The HeatWave node was successfully created and is ready to be used.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STARTING</strong>: The HeatWave node is being started.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STOPPING</strong>: The HeatWave node is being stopped.</td>
</tr>
<tr>
<td></td>
<td>• <strong>RESTARTING</strong>: The HeatWave node is being restarted.</td>
</tr>
<tr>
<td></td>
<td>• <strong>INACTIVE</strong>: The HeatWave node is powered off.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPDATING</strong>: The HeatWave node is in the process of being updated.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPGRADING</strong>: The HeatWave node is in the process of being upgraded.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETING</strong>: The HeatWave node is being deleted.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETED</strong>: The HeatWave node has been deleted and is no longer available.</td>
</tr>
<tr>
<td></td>
<td>• <strong>FAILED</strong>: An error condition prevented the creation or continued operation of the HeatWave node.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STARTING_ERROR</strong>: An attempt to start the HeatWave node failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>STOPPING_ERROR</strong>: An attempt to stop the HeatWave node failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>RESTARTING_ERROR</strong>: An attempt to restart the HeatWave node failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPDATING_ERROR</strong>: An attempt to update the HeatWave node failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPGRADING_ERROR</strong>: An attempt to upgrade the HeatWave node failed.</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETING_ERROR</strong>: An attempt to delete the HeatWave node failed.</td>
</tr>
</tbody>
</table>
HeatWave Cluster Failure and Recovery

HeatWave triggers the recovery process whenever the HeatWave cluster is in an unhealthy state.

The HeatWave cluster status is being monitored regularly and if the cluster does not get a response from the cluster node, the cluster becomes unhealthy due to a node failure and error recovery is triggered.

During the recovery process, HeatWave automatically attempts to bring the node online, and reload data that was previously loaded. HeatWave reloads data from the HeatWave Storage layer, which is created when you enable the HeatWave cluster for the first time. To facilitate recovery, data is persisted to AWS S3 when data is loaded into HeatWave and when data changes is propagated from the DB system to HeatWave. Loading data from AWS S3 is faster because the data does not need to be converted to the HeatWave storage format, as is required when loading data from the DB system.

When you unload a table, the data is removed from HeatWave, and in a background operation, it is removed from AWS S3 too.
Connecting to a DB System

Clients and applications interact with a HeatWave Cluster by connecting to the MySQL DB System. This chapter describes how to connect to the MySQL DB System from the MySQL HeatWave Console and from MySQL clients including MySQL Shell, MySQL Command-Line-Client, and MySQL Workbench. For connecting from applications, refer to the MySQL Connectors documentation. See MySQL Connectors.

Connecting from the Console

Connecting to a DB System from the MySQL HeatWave Console requires a Oracle Cloud Account user name and password for signing into the MySQL HeatWave Console, and a MySQL user account for connecting to the DB System.

Use the MySQL Administrator user specified when creating the DB System, see Creating a DB System, or use a MySQL user account created on the DB System using CREATE USER. Otherwise, ask the MySQL Administrator to create an account.

Use the Workspaces page to connect to a DB System, and then manage HeatWave Cluster data and use the Query Editor to run DB System and HeatWave queries. For more information, see Manage Data in HeatWave with Workspaces, and Running Queries.

To connect to a DB System from the MySQL HeatWave Console:

1. Sign-in to the MySQL HeatWave Console. For instructions, see Signing In.
2. Select the Workspaces tab in the MySQL HeatWave Console, and then click Connect to MySQL DB System.
3. Select a DB System from the drop-down menu.
4. Enter a MySQL user name and password for the DB System.
5. Click Connect.

To disconnect, click Disconnect.

Connecting from a Client

Connecting to a DB System from a MySQL client requires a MySQL user account on the MySQL DB System. You can use the MySQL Administrator user that you specified when creating the DB System (see Creating a DB System) or a MySQL user account created on the DB System using CREATE USER. If you are not the MySQL Administrator and you do not have a MySQL user account, have your MySQL Administrator create one for you.

You cannot connect from a MySQL client to a DB System using the Oracle Cloud Account user name and password used to access the MySQL HeatWave Console.

For MySQL client connections to the DB System, a public endpoint is exposed as a fully qualified domain name (the host name of the DB System). The host name is found on the MySQL DB System Details page. See Viewing DB System Details.
The MySQL HeatWave on AWS Administrator may have restricted access to your DB System to certain public-facing IPv4 client IP addresses or address ranges. Allowed client addresses are specified in CIDR format and are found on the MySQL DB System Details page. See Viewing DB System Details. To edit allowed client addresses, see Editing a DB System. Specifying IP addresses in CIDR format is discussed in Creating a DB System.

If you are connecting from a MySQL client that resides in a private subnet, you have the option of connecting to a DB System through a public Network Address Translation (NAT) gateway, which permits clients and applications in a private subnet to access services outside of the private subnet while preventing external services from initiating inbound connections. When establishing a NAT gateway, ensure that the elastic IP address of the NAT gateway is added as an Allowed Client Address, as described above. For example, if your NAT gateway elastic IP address is 1.2.3.4, edit your DB System to add 1.2.3.4/32 (the address in CIDR notation) to your DB System's Allowed Client Addresses. See Editing a DB System. For more information about NAT gateways, refer to NAT Gateways, in the Amazon VPC User Guide.

MySQL HeatWave on AWS supports TLSv1.2 and requires that all connections are encrypted. For added security, you can download a signed certificate bundle and enable host name identity verification. For more information, see Enabling Host Name Identity Verification.

To reduce network costs and avoid potential latency issues and bandwidth fluctuations, it is recommended that connecting clients reside in the same Region as the MySQL HeatWave on AWS instance. Latency and bandwidth fluctuations experienced by connections from outside the MySQL HeatWave on AWS Region are outside of the control MySQL HeatWave on AWS service managers. Connecting from the same Availability Zone is also recommended to avoid potential latency issues.

Connecting with MySQL Shell

This topic describes how to connect to a MySQL DB System using MySQL Shell.

Prerequisites:

- A machine or compute instance with internet connectivity for connecting to the MySQL DB System.
- A MySQL Shell command-line utility installed on the machine or compute instance. For installation instructions, refer to Installing MySQL Shell.
- A MySQL user account on the MySQL DB System to connect with. You can use the MySQL Administrator user that you specified when creating the DB System or a MySQL user account created on the DB System using CREATE USER .
- A public-facing IP address for your machine or compute instance that is permitted to connect to the DB System. Allowed Client Addresses information is available on the MySQL DB System Details page. See Viewing DB System Details.
- The host name of the MySQL DB System as defined on the MySQL DB System Details page. See Viewing DB System Details.

To connect to a DB System:
1. Start MySQL Shell and connect to the MySQL DB System using the following command:

```
$> mysqlsh Username@HostNameOfMySQLDBSystem
```

Please provide the password for 'Username@HostNameOfMySQLDBSystem':

This command starts a global session. MySQL Shell attempts to connect to port 33060 by default and, if that port is not available, falls back to port 3306.

The connection is made and message similar to the following is displayed:

```
MySQL Shell 8.0.30
```

Connecting with MySQL Command-Line Client

This topic describes how to connect to a MySQL DB System using a MySQL Command-Line Client.

Prerequisites:

- A machine or compute instance with internet connectivity for connecting to the MySQL DB System.
- A MySQL Command-Line Client installed on the machine or compute instance.
- A MySQL user account on the MySQL DB System to connect with. You can use the MySQL Administrator user that you specified when creating the DB System or a MySQL user account created on the DB System using `CREATE USER`.
- A public-facing IP address for your machine or compute instance that is permitted to connect to the DB System. **Allowed Client Addresses** information is available on the MySQL DB System Details page. See Viewing DB System Details.
- The host name of the MySQL DB System as defined on the MySQL DB System Details page. See Viewing DB System Details.

To connect to a DB System:

1. Start MySQL client and connect to the MySQL DB System using the following command:

```
$> mysql --host HostNameOfMySQLDBSystem -u Username -p
```
Connecting with MySQL Workbench

This topic describes how to connect to a MySQL DB System with MySQL Workbench.

Prerequisites:

- A machine or compute instance with internet connectivity for connecting to the MySQL DB System.
- A MySQL Workbench client installed on your machine or compute instance. For instructions, refer to the MySQL Workbench Reference Manual.
- A MySQL user account on the MySQL DB System to connect with. You can use the MySQL Administrator user that you specified when creating the DB System or a MySQL user account created on the DB System using `CREATE USER`.
- A public-facing IP address for your machine or compute instance that is permitted to connect to the DB System. Allowed Client Addresses information is available on the MySQL DB System Details page. See Viewing DB System Details.
- The host name of the MySQL DB System as defined on the MySQL DB System Details page. See Viewing DB System Details.

To connect to a DB System from MySQL Workbench:

1. In MySQL Workbench, select Database > Connect to Database to open the Connect to Database dialog.

2. Enter the connection details.

   - **Connection Method**: The connection method. Select Standard (TCP/IP).
   - **Hostname**: The host name of the MySQL DB System
   - **Port**: The port address that the MySQL DB System is listening on. Use the default 3306 port.
   - **Username**: The user name of the MySQL user that will connect to the DB System
   - **Password**: The password of the MySQL user
   - **Default Schema**: Optionally, specify a default schema. Leave blank to select it later.
3. Click **OK** to establish the connection.

**MySQL Connectors**

You can use MySQL Connectors to connect your application to a DB System. The following list provides links to the MySQL Connectors documentation:

The requirements outlined for connecting from a MySQL client also apply when connecting from an application. See Connecting from a Client.

- Connector/J
- Connector/Python
- Connector/C++
- Connector/NET
- Connector/Node.js

**Enabling Host Name Identity Verification**

MySQL HeatWave on AWS supports TLSv1.2 and requires that all MySQL client and application connections are encrypted. For added security, you can download a signed certificate bundle and enable host name identity verification for your connecting clients and applications.

When a DB System is provisioned, a TLS certificate is installed on the MySQL Server. The certificate, which defines the DB System host name as the **Common Name**, is signed by a regional Certificate Authority (CA). When a client connects to the DB System with host name identity verification enabled and a CA certificate matching the one used by the server, the server and client place their trust in the same CA certificate and the client verifies that the host to which it connected is the one intended.

To obtain a CA certificate file, you must download a MySQL HeatWave on AWS certificate bundle. Store the certificate bundle in a secure location that is accessible to the client or application. The bundle is a regional CA certificate file in PEM format. You can download the regional certificate bundle for the supported regions:

- **AWS US East (N. Virginia) Region** ([us-east-1](https://cloud.mysql.com/us-east-1/aws-us-east-1-cabundle.pem))
- **Germany Central (Frankfurt) Region** ([eu-central-1](https://cloud.mysql.com/eu-central-1/aws-eu-central-1-cabundle.pem))
- **India West (Mumbai) Region** ([ap-south-1](https://cloud.mysql.com/ap-south-1/aws-ap-south-1-cabundle.pem))
- **Japan East (Tokyo) Region** ([ap-northeast-1](https://cloud.mysql.com/ap-northeast-1/aws-ap-northeast-1-cabundle.pem))
- **UK South (London) Region** ([eu-west-2](https://cloud.mysql.com/eu-west-2/aws-eu-west-2-cabundle.pem))
MySQL HeatWave on AWS is currently supported in the regions mentioned in Region Availability. Certificate bundles for other regions will be made available as support for MySQL HeatWave on AWS is extended to other regions.

Alternatively, you can download the regional certificate bundle from the Console using cURL as shown below:

```bash
$> curl -o aws-us-east-1-cabundle.pem \
https://cloud.mysql.com/us-east-1/aws-us-east-1-cabundle.pem

$> curl -o aws-ap-south-1-cabundle.pem \
https://cloud.mysql.com/ap-south-1/aws-ap-south-1-cabundle.pem

$> curl -o aws-eu-central-1-cabundle.pem \
https://cloud.mysql.com/eu-central-1/aws-eu-central-1-cabundle.pem

$> curl -o aws-ap-northeast-1-cabundle.pem \
https://cloud.mysql.com/ap-northeast-1/aws-ap-northeast-1-cabundle.pem

$> curl -o aws-eu-west-2-cabundle.pem \
https://cloud.mysql.com/eu-west-2/aws-eu-west-2-cabundle.pem
```

It is recommend that you update your MySQL HeatWave on AWS certificate bundle quarterly to ensure that you always have the latest version. Issues connecting with `--ssl-mode` may indicate that your certificate bundle is outdated.

To establish an encrypted connection, launch the MySQL client with the `--ssl-ca` and `--ssl-mode` options; for example:

MySQL Shell:

```bash
$> mysqlsh --host HostNameOfMySQLDBSystem \
  --user=user1 \
  --password \
  --port=3306 \
  --ssl-mode=VERIFY_IDENTITY \
  --ssl-ca=aws-us-east-1-cabundle.pem
```
MySQL Command-Line Client:

```
$> mysql --host=HostNameOfMySQLDBSystem \
   --user=user1 \
   --password \
   --protocol=TCP \
   --port 3306 \
   --ssl-mode=VERIFY_IDENTITY \
   --ssl-ca=aws-us-east-1-cabundle.pem
```

where:

- **--host** specifies the host name of the DB System. The host name is found on the MySQL DB System Details page. See Viewing DB System Details.
- **--user** specifies the user name of the MySQL account to use for connecting to the server.
- **-p** specifies the password of the MySQL account used for connecting to the server. The password value is optional. If not given as in the examples above, mysql prompts for one.
- **--protocol** specifies transport protocol to use for connecting to the server. This option is not applicable to MySQL Shell.
- **--ssl-mode** is the security state of the connection to server. The VERIFY_IDENTITY mode ensures that an encrypted connection is established, that the TLS certificate is verified against the configured CA certificate, and that the host name identity is verified by checking the host name the client uses for connecting to the server against the identity in the certificate that the server sends to the client.
- **--ssl-ca** specifies the fully qualified path to the CA certificate file.

For more information about ssl-* connection options, see Command Options for Connecting to the Server.
6

Importing Data

You can import data to a DB System in MySQL HeatWave on AWS. If your data is present in a MySQL instance running on-premises, in other cloud vendors as managed or unmanaged services, or a MySQL HeatWave on AWS instance, you have to first export the data. See Exporting Data.

You can import data using either of the following:

- **Data import feature**: Use the data import feature in the Console to import MySQL Shell dump and text files from an Amazon S3 bucket. See Data Import Feature.
- **Bulk ingest feature**: Connect to the DB System and use the bulk ingest feature to import text files such as CSV and TSV from an Amazon S3 bucket. This method is the fastest and most efficient in terms of computing and memory consumption. This method is ideal for importing large tables. See Bulk Ingest Feature.
- **Dump loading utility**: Use the dump loading utility of MySQL Shell to import a MySQL Shell dump manually. See Importing Data Using the Dump Loading Utility.

After importing data to a DB System in MySQL HeatWave on AWS, load data into HeatWave. See Loading or Unloading Data into HeatWave.

Exporting Data

Use the dump utility of MySQL Shell to export a logical dump of the data from a MySQL instance. Connect to the MySQL instance containing the data you want to dump using MySQL Shell. You can dump all schemas in the instance, a selected schema, or selected tables and views.

Use either of the following dump utility:

- `util.dumpInstance(outputUrl[, options])`: MySQL instance export utility that exports all compatible schemas to an Object Storage bucket or to local files. By default, this utility exports users, events, routines, and triggers. See Dump Utilities.
- `util.dumpSchemas(schemas, outputUrl[, options])`: MySQL schema export utility that exports selected schemas to an Object Storage bucket or to local files.
- `util.dumpTables(schema, tables, outputUrl[, options])`: MySQL table export utility that exports selected tables of a schema to an Object Storage bucket or to local files.

The source and destination MySQL instances can be in different MySQL versions.

The MySQL Shell dump utility performs compatibility checks and transformations to ensure the data can be later successfully imported and the potential data import issues can be identified and fixed as early as possible. See MySQL Server Compatibility.

About MySQL Shell

MySQL Shell dump and load utilities are built for use with MySQL DB Systems. To get the best functionality, always use the most recent version of MySQL Shell that is available to you.
The MySQL Server version used by MySQL HeatWave on AWS is fully supported by MySQL Shell. The minimum supported source MySQL Server versions supported by MySQL Shell are:

- MySQL 8.0.11
- MySQL 5.7.9

MySQL Shell provides the following utilities:

- `dumpInstance()`: MySQL instance export utility that dumps all compatible schemas to an Amazon S3 bucket, OCI Object Storage, or local files. By default, this utility dumps users, events, routines, and triggers. See MySQL Shell Instance and Schema Dump Utilities.

- `dumpSchemas()`: A schema export utility that dumps selected schemas to an Amazon S3 bucket, OCI Object Storage, or local files. See MySQL Shell Instance and Schema Dump Utilities.

- `dumpTables()`: A table export utility that dumps selected tables of a schema to an Amazon S3 bucket, OCI Object Storage, or local files.

- `loadDump()`: An import utility that imports schemas to a DB System. See MySQL Shell Dump Loading Utility. To import a schema to a DB System, MySQL Shell must be installed on a machine with access to the DB System. See Connecting with MySQL Shell.

MySQL Shell dump files are exported as DDL files specifying the schema structure and tab-separated value (.tsv) files containing the data. The .tsv files are compressed using zstd, by default, but gzip is also available as an option. You can also choose no compression.

To improve performance, large tables are chunked by default. The default chunk size is 32MB. Chunking can be disabled, but this is not recommended for large databases. During import, the chunks can be imported by parallel threads, which can greatly improve import performance.

For more information about MySQL Shell, refer to the MySQL Shell User Guide.

### MySQL Server Compatibility

MySQL HeatWave on AWS has several security-related restrictions that are not present in an on-premise instance of MySQL. To make it easier to load existing databases into the Service, the dump commands in MySQL Shell can detect potential issues and, in some cases, automatically adjust your schema definition to be compliant.

The `ocimds` option, when set to true, performs compatibility checks on the schemas for these issues and aborts the dump if any are found, while producing a detailed list of those issues and suggests additional steps to correct those issues. The `loadDump` command only allows import of dumps created with the `ocimds` option enabled.

Some issues found by the `ocimds` option may require you to manually edit your schema before it can be loaded into the MySQL HeatWave on AWS. The MySQL Shell compatibility option can be used to automatically modify the dumped schemas, resolving some of these compatibility issues. You can pass one or more modifiers to the MySQL Shell compatibility option in a comma-separated list.
The MySQL Shell compatibility option applies the specified requirements for compatibility with MySQL HeatWave on AWS for all tables in the dump output, altering the dump files as necessary. From MySQL Shell 8.0.23, this option is available for all MySQL Shell utilities, and before that release, it is only available for the instance dump utility and schema dump utility.

MySQL Shell compatibility option modifiers include:

**force_innodb**
MySQL HeatWave on AWS supports the InnoDB storage engine, only. This option modifies the `ENGINE=` clause of `CREATE TABLE` statements to specify `INNODB` for tables that do not already use the InnoDB storage engine.

**skip_invalid_accounts**
Skips user accounts created with external authentication plugins that are not supported in MySQL HeatWave on AWS. From MySQL Shell 8.0.26, this option also removes user accounts that do not have passwords set, except where an account with no password is identified as a role, in which case it is dumped using the `CREATE ROLE` statement.

**strip_definers**
Removes the `DEFINER=account` clause from views, routines, events, and triggers. MySQL HeatWave on AWS requires special privileges to create these objects with a definer other than the user loading the schema. By removing the `DEFINER` clause, these objects will be created with that default definer. Views and routines have their `SQL SECURITY` clause changed from `DEFINER` to `INVOKER`. This ensures that the access permissions of the account querying or calling these objects are applied, instead of the user that created them. If your database security model requires views and routines have more privileges than their invoker, you must manually modify the schema before loading it. For more information, see The DEFINER Attribute and The SQL SECURITY Characteristic.

**strip_restricted_grants**
Certain privileges are restricted in MySQL HeatWave on AWS, such as `RELOAD`, `FILE`, `SUPER`, `BINLOG_ADMIN`, and `SET_USER_ID`. It is not possible to create users granting these privileges. This option removes those privileges from dumped `GRANT` statements.

**strip_tablespaces**
MySQL HeatWave on AWS has some restrictions on tablespaces. This modifier removes the `TABLESPACE` clause from `GRANT` statements, so all tables are created in their default tablespaces.

Additionally, `DATA DIRECTORY`, `INDEX DIRECTORY`, and `ENCRYPTION` options in `CREATE TABLE` statements are always commented out in DDL scripts if the MySQL Shell `ocimds` option is enabled.

---

**Note:**
If you intend to export data from an older version of MySQL, you should run the MySQL Shell Upgrade Checker Utility to generate a report of all potential issues with your migration. For more information, see MySQL Shell User Guide - Upgrade Checker Utility.

### Exporting Data Using MySQL Shell

Use MySQL Shell to export data from a source MySQL Server to an Amazon S3 bucket.
This task requires the following:

- The MySQL Shell command-line utility. The commands in this task use the JS (JavaScript) execution mode of MySQL Shell. For installation instructions, refer to Installing MySQL Shell.

**Note:**

Exports created by MySQL Shell 8.0.27, or higher, cannot be imported by earlier versions of MySQL Shell. Using the latest version of MySQL Shell is always recommended.

- You have run the dumpSchema command with the `dryRun` and `ocimds` parameters set to true:

  ```javascript
  util.dumpSchemas("<Schema>", {s3bucketName: "<BucketName>", dryRun: true, ocimds: true})
  ```

This performs a test run of the export checking for compatibility issues. The compatibility issues and remediation steps are listed in the output. See MySQL Shell Instance and Schema Dump Utilities.

To export a schema from a source MySQL Server:

1. Start a MySQL Shell session and connect to the source MySQL Server:

   ```
   mysqlsh <user>@<HostNameOfSourceMySQLServer>
   ```

   For information about different MySQL Shell session and connection options, refer to the MySQL Shell User Guide.

2. Export schema to an Amazon S3 bucket:

   ```javascript
   util.dumpInstance("<Schema>", {s3bucketName: "<BucketName>",
   threads: <ThreadSize>,
   compatibility: ["strip_restricted_grants",
   "strip_definers", "ignore_missing_pks"]})
   ```

   - `<Schema>`: The name of the schema being exported. For example, `tpch`.
   - `<BucketName>`: The Amazon S3 bucket to which the dump is to be written.
   - `<ThreadSize>`: The number of processing threads to use for this task. The default is 4. For best performance, it is recommended to set this parameter to twice the number of CPUs used by the target DB System.
   - `compatibility`: Specify compatibility modifiers that modify the exported data for compatibility with MySQL HeatWave on AWS. See MySQL Server Compatibility.

See Options for S3-compatible Services.
Use either of the following features to import data from an Amazon S3 bucket:

- **Data import**: Use the data import feature in the Console to import MySQL Shell dump and text files from Amazon S3 bucket. See Data Import Feature.
- **Bulk ingest**: Connect to the DB System and use the bulk ingest feature to import text files such as CSV and TSV from Amazon S3 bucket. This method is the fastest and most efficient in terms of computing and memory consumption. This method is suitable for importing large tables. See Bulk Ingest Feature, and Connecting to a DB System.
- **Dump loading utility**: Use the dump loading utility of MySQL Shell to import a MySQL Shell dump manually. See Importing Data Using the Dump Loading Utility.

### Data Import Feature

Use the data import feature in MySQL HeatWave Console to import data in a variety of formats such as MySQL dump files and text files from an Amazon S3 bucket to a DB System in MySQL HeatWave on AWS in the same region.

This task requires the following:

- Access to AWS Management Console.

Do the following to import data to a DB System:

1. Create an IAM policy to access the Amazon S3 bucket. See Creating an IAM Policy to Access an Amazon S3 Bucket.
2. Create an IAM role that grants the DB System access to read data from the desired Amazon S3 bucket. See Creating an IAM Role to Access an Amazon S3 Bucket.
3. Create a new DB System or edit an existing DB System, and enter the data import role ARN details. See Creating a DB System and Editing a DB System.
4. Import data from an Amazon S3 bucket. See Importing Data Using the Data Import Feature.

### Importing Data Using the Data Import Feature

Use the data import feature in MySQL HeatWave Console to import data from an Amazon S3 bucket to a DB System in the same region.

This task requires the following:

- A DB System with properly configured data import role ARN. See Creating an IAM Role to Access an Amazon S3 Bucket, Creating a DB System, and Editing a DB System.
- Data, which you want to import, in an Amazon S3 bucket. See Exporting Data.

Do the following to import data from an Amazon S3 bucket:

1. In the MySQL HeatWave Console, click the Workspaces tab, and then click the Data Imports tab.
2. Click the Connect to MySQL DB System button.
3. In the Connect to MySQL DB System dialog, select the DB System to which you want to import data, and enter the administrator credentials that you had provided while creating the DB System.
4. Click **Connect**.
5. Click **Import Data**.
6. In the **Import data into DB System** dialog, enter the following details:
   - **Basic information**:
     - **Display name**: Specify a name for the data import operation. By default, a name a generated for you in the format, `dataImportYYYYMMDDHHMMSS`.  
     - **Description**: (Optional) Specify a description of the data import operation.
   - **Source**:
     - **S3 URI**: Specify the Amazon S3 URI. The Amazon S3 bucket and DB System must be in the same region.

   🔄 **Note**: You are responsible for managing the Amazon S3 bucket. Once you finish the data import, it is recommended to review the Amazon S3 access permissions.

     - **Authentication method**: Select either of the following authentication methods:
       * **IAM role**: Specify the data import role ARN while creating or editing the DB System. See Creating a DB System and Editing a DB System.
       * **User access key**: Enter the **Access key ID** and **Secret access key**. See Managing Access Keys.

     - **File type**: Select either of the following file types:
       * **MySQL dump files**: Specify the **File parsing settings**:
         * **Character set**: Enter the character set to import data. The default character set is `utf8mb4`. See Character Sets and Collations in MySQL.
         * **Update GTID set**: Apply the `gtid_executed` GTID set from the source MySQL instance, as recorded in the dump metadata, to the `gtid_purged` GTID set on the target MySQL instance using one of the following options:
           * **OFF**: (Default) Do not update the GTID set.
           * **APPEND**: Append the `gtid_executed` GTID set from the source MySQL instance to the `gtid_purged` GTID set on the target MySQL instance.
           * **REPLACE**: Replace the `gtid_purged` GTID set on the target MySQL instance with the `gtid_executed` GTID set from the source MySQL instance.

         See updateGtidSet.
       * **Text files**:
         * **Names of data files in S3 bucket**: Specify the names of data files in the Amazon S3 bucket. Apart from text files, you can specify text files in compressed formats such as gzip (.gz) and
zstd (.zst). You can specify ranges of files using wildcard pattern matching. To match any single character, use ?; and to match any sequence of characters, use *. For example, `data_c?`, and `/backup/replica/2021/*.*.tsv`.

**File parsing settings:**

* **Character set:** Enter the character set to import data to the target MySQL instance. It must correspond to the character set given in the dump metadata that was used when the MySQL dump was created by MySQL Shell instance dump utility, schema dump utility, or table dump utility. The character set must be permitted by the `character_set_client` system variable and supported by the MySQL instance. The default character set is utf8mb4. See [Character Sets and Collations in MySQL](#).

* **Dialect:** Select the dialect of the imported data file. You can select CSV (Unix), CSV, or TSV. The default dialect is CSV (Unix). The dialect selects the default values of the following parsing settings: **Fields terminated by**, **Fields enclosed by**, **Fields escaped by**, and **Fields optionally enclosed**. To view the default settings per dialect, see [Dialect settings](#).

* **Skip rows:** Specify the number of rows that is skipped from the beginning of the imported data file, or in the case of multiple import files, at the beginning of every file included in the file list. By default, no rows are skipped.

* **Lines terminated by:** Specify one or more characters (or an empty string) with which each of the lines are terminated in the imported data file. For example, `
`. The default is as per the specified dialect.

* **Fields terminated by:** Specify one or more characters (or an empty string) with which each of the fields are terminated in the imported data file. For example, `	`. The default is as per the specified dialect.

* **Fields enclosed by:** Specify a single character (or an empty string) with which the utility encloses each of the fields in the imported data file. For example, `"`. The default is as per the specified dialect.

* **Fields escaped by:** Specify the character that is to begin escape sequences in the exported data file. For example, `\`. The default is as per the specified dialect.

* **Fields optionally enclosed:** Select the option to enclose a field only if it has a string data type such as CHAR, BINARY, TEXT, or ENUM, and deselect the option to enclose all of the fields in the imported data file.

* **Destination:** Select the Schema and the Table in the DB System to which you want to import data.

  – Click **Import**.

The status of the data import changes to **In Progress**. When the import is complete, the status changes to **Succeeded**. You can click the name of the data import operation to view the import details. If required, while the data import operation is in progress, you can cancel the import.
Bulk Ingest Feature

Use the bulk ingest feature to import text files in bulk from an Amazon S3 bucket to a
DB System in MySQL HeatWave on AWS in the same region. Bulk import is ideal for
importing large tables.

This task requires the following:

• Access to AWS Management Console.
• Access to MySQL HeatWave Console.
• A client that is connected to the DB system. See Connecting to a DB System.

Do the following to bulk ingest data to a DB System:

1. Create an IAM policy to access the Amazon S3 bucket. See Creating an IAM
   Policy to Access an Amazon S3 Bucket.
2. Create an IAM role that grants the DB System access to read data from the
desired Amazon S3 bucket. See Creating an IAM Role to Access an Amazon S3
   Bucket.
3. (Optional) If a MySQL user (and not a DB System administrator) is importing data
   using the bulk ingest feature, grant the LOAD_FROM_S3 privilege. See Granting
   Privileges to Bulk Ingest Data From Amazon S3.
4. Create a new DB System or edit an existing DB System, and enter the data import
   role ARN details. See Creating a DB System and Editing a DB System.
5. Bulk ingest data from an Amazon S3 bucket. See Importing Data Using the Bulk
   Ingest Feature.

Granting Privileges to Bulk Ingest Data From Amazon S3

By default, a DB System administrator has the LOAD_FROM_S3 privilege. However, if a
user is importing data using the bulk ingest feature, the LOAD_FROM_S3 privilege is
required.

This task requires the following:

• A running DB System. See Creating a DB System.

Do the following to grant the LOAD_FROM_S3 privilege to a user:

1. Connect to the DB System. See Connecting to a DB System.
2. Grant the LOAD_FROM_S3 privilege to the user:

   GRANT LOAD_FROM_S3 ON <Schema.Table> TO <User>

Importing Data Using the Bulk Ingest Feature

Connect to a DB System and bulk ingest data from an Amazon S3 bucket to a DB
System in the same region.

This task requires the following:

• A client that is connected to the DB System. See Creating a DB System.
Do the following to bulk ingest data from an Amazon S3 bucket:

1. Connect to a DB System. See Connecting to a DB System.

2. Create a new database or use an existing database to bulk ingest data. For example, the following query creates a new database, airportdb, and selects the database for further actions:

```sql
CREATE DATABASE airportdb;
USE airportdb;
```

3. Use an existing empty table or create a new table. For example, the following query creates a new table, booking:

```sql
CREATE TABLE IF NOT EXISTS `booking`
(`booking_id` int NOT NULL AUTO_INCREMENT,
 `flight_id` int NOT NULL,
 `seat` char(4) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci DEFAULT NULL,
 `passenger_id` int NOT NULL,
 `price` decimal(10,2) NOT NULL,
 PRIMARY KEY (`booking_id`)) ENGINE=InnoDB AUTO_INCREMENT=55099799
DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_unicode_ci COMMENT='Verifying bulk ingest';
```

4. Bulk ingest data from an Amazon S3 bucket into the table you created using the LOAD DATA query with the BULK algorithm:

```sql
LOAD DATA FROM S3 '<Amazon-S3-URL>' INTO TABLE <Table-name>
COLUMNS TERMINATED BY '	' LINES TERMINATED BY '
' ALGORITHM=BULK;
```

- `<Amazon-S3-URL>`: Specify the Amazon S3 bucket URL present in the same region as the DB System in the following format:

  ```sql
  s3-<Region>://<Bucketname>/<FilenameOrPrefix>
  ```

  - `<Region>`: The AWS region that contains the Amazon S3 bucket to load.
  - `<Bucketname>`: The name of the Amazon S3 bucket that contains the data to load.
  - `<FilenameOrPrefix>`: The filename or prefix of one or more text files to load.

- `<Table-name>`: Specify an already existing empty table or create a new table.

It is recommended to split the data into multiple files to improve the performance of bulk ingest. For example, the following query loads data from an Amazon S3 bucket that is
split across 25 files. The files are named, booking.tsv1, booking.tsv2, ..., booking.tsv25:

```
LOAD DATA FROM S3 's3-us-east-1://mysql-heatwave-data-us-east-1/
airportdb/booking.tsv'
  COUNT 25 IN PRIMARY KEY ORDER INTO TABLE booking
  COLUMNS TERMINATED BY '\t' LINES TERMINATED BY '\n'
ALGORITHM=BULK;
```

### Dump Loading Utility

The dump loading utility is an import utility that imports schemas to a DB System. See [MySQL Shell Dump Loading Utility](#). To import a schema to a DB System, MySQL Shell must be installed on a machine with access to the DB System.

### Importing Data Using the Dump Loading Utility

Use the dump loading utility of MySQL Shell to load a dump from an Amazon S3 bucket to a DB System in MySQL HeatWave on AWS.

This task requires the following:

- MySQL Shell 8.0.27, or higher. Exports created by MySQL Shell 8.0.27, or higher, cannot be imported by earlier versions of MySQL Shell.
- Data exported from a source MySQL Server following the instructions described in [Exporting Data Using MySQL Shell](#).
- Enough storage space on your DB System for the data you intend to import. To check DB System storage space, see [Viewing DB System Details](#).
- You have run the `loadDump()` command in dryrun mode to check that there are no issues when the dump files are loaded from an Amazon S3 bucket into the connected DB System:

```
util.loadDump("<Schema>", {s3bucketName: "<BucketName>", dryRun: 
  true, ocimds: true})
```

This performs a test run of the import checking for compatibility issues. The compatibility issues and remediation steps are listed in the output. See [MySQL Shell Instance and Schema Dump Utilities](#).

Do the following to import data using the dump loading utility:

1. Start a MySQL Shell session and connect to the DB System:

   ```
   mysqlsh <Username>@<HostNameOfMySQLDBSystem>
   ```

   See [Connecting with MySQL Shell](#).

2. Import data using the dump loading utility:

   ```
   util.loadDump("<Prefix>",{s3BucketName: "<BucketName>", threads: <ThreadSize>})
   ```
• **<Prefix>**: (Optional) Adds a prefix to the files uploaded to the bucket. If you specify this option, the files are uploaded to the defined bucket with the prefix in the following format: `<BucketPrefix>/filename`, similarly to a file path. For example, if `<BucketPrefix>` is set to `test`, every file uploaded to the defined bucket, `<BucketName>`, is done so as `test/<filename>`. If you download the file, the prefix is treated as a folder in the download. For local exports, this parameter is the path to the local directory you want to export to.

• **<BucketName>**: The an Amazon S3 bucket from which the dump is to be loaded.

• **<ThreadSize>**: The number of processing threads to use for this task. The default is 4. For best performance, it is recommended to set this parameter to twice the number of CPUs used by the target DB System.
Manage Data in HeatWave with Workspaces

The **Workspaces** page in the MySQL HeatWave Console enables you to perform the following:

- **Loading data into or unloading data from a HeatWave Cluster**: Load operations are performed using *Auto Parallel Load*, which optimizes operation time and memory usage by predicting an using an optimal degree of parallelism. Data is loaded into HeatWave from the associated DB System. If you have not loaded data into the DB System, see **Importing Data**. Unload operations are performed using *Auto Unload*.

### Loading or Unloading Data into HeatWave

Use MySQL HeatWave Console to load data into or unload data from a HeatWave Cluster.

This task requires the following MySQL privileges:

- The **PROCESS** privilege.
- The **EXECUTE** privilege on the `sys` schema.
- The **SELECT** privilege on the Performance Schema.

The time required to load data from the DB System into the HeatWave Cluster depends on the data size.

**Note:**

HeatWave Cluster data can also be managed using SQL or the Auto Parallel Load interface from a MySQL client. See **Loading Data**, in the *MySQL HeatWave User Guide*.

To load data, do the following:

1. Connect to a DB System that has a HeatWave Cluster. See **Connecting from the Console**.

2. You can view the following information about schemas and tables:
   - **Name**: The name of the schema or table.
   - **Source**: The source of the schema or table. For example, InnoDB.
   - **Memory Size Estimate (GiB)**: An estimate of the memory required on the HeatWave Cluster for the schema or table.
   - **Loaded**: The number of tables loaded into HeatWave. You can click the **Refresh** icon to refresh the load status.
   - **Rows Estimate**: The estimated number of rows in the table.
• **String Column Encoding**: The number of columns to be encoded as `VARLEN` (variable-length) columns, expressed as a fraction of the total number of table columns. For information about HeatWave string column encoding, see Encoding String Columns, in the *HeatWave User Guide*.

• **Predicted Load Time (s)**: The predicted load time in seconds.

3. Select the schemas and tables that you want to load by clicking the check box present in front of the schema or table name. If you select a schema, all the tables in the schema are selected. Expanding a schema using the drop-down control displays the table in the schema. The Load Status column provides the load status as a percentage value.

4. After you have selected the tables you want to load or unload, click **Load** or **Unload**.
   If loading data, the **MySQL Auto Parallel Load tables into HeatWave** dialog appears, providing a summary of the load operation to be executed. The following information is shown:
   • **DB System**: The DB System name
   • **Estimated load size**: The estimated size of the data to be loaded
   • **Estimated load time**: The estimated time required to load the data
   • **Selected schemas and tables**: The selected schemas and tables to be loaded
     – **Name**: Name of the schema or table
     – **Memory Size Estimate (GiB)**: The memory size estimate for the schema or table on the HeatWave Cluster
   • **Estimated total memory footprint**: A pie chart showing the estimated percentage of HeatWave Cluster memory required for each table
   • **Estimated load times (seconds)**: A pie chart showing estimated load times for each table
   
   If unloading data, the **MySQL Auto Parallel Unload tables from HeatWave** dialog appears, providing a summary of the unload operation to be executed. The following information is shown:
   • **DB System**: The name of the DB System
   • **Estimated unload size**: The estimated size of the data to be unloaded
   • **Selected schemas and tables**: The selected schema and tables to be unloaded
     – **Name**: Name of the schema or table
     – **Memory Size Estimate (GiB)**: The memory size estimate for the schema or table on the HeatWave Cluster
   • **Estimated memory footprint (GiB)**: The estimated HeatWave Cluster memory footprint showing occupied memory, current free memory, and additional available free memory after the unload operation

5. Click **Confirm Load** or **Confirm Unload** to start the load or unload operation.

The **Cluster Memory Snapshot** shows the amount of HeatWave Cluster memory used.
Running Queries

The Workspaces tab in the MySQL HeatWave Console provides a Query Editor for running MySQL and HeatWave queries.

Note:
Queries can also be run from a MySQL client. See Connecting from a Client.

To run a query using the Query Editor:
1. Connect to a DB System. For instructions, see Connecting from the Console.
2. Enter a query into the Query Editor.
3. Click Run Query.

The query results are displayed in tabular format by default. You can select the JSON tab to view results in JSON format.

For multi-statement queries, only the results of the last query are displayed.

The Job Information tab provides the Job ID, the number of rows returned, and the query statement that was processed.

Running HeatWave Queries

When a HeatWave Cluster is enabled and the data you want to query is loaded in HeatWave, queries that qualify are automatically offloaded from the MySQL DB System to the HeatWave Cluster for accelerated processing. No special action is required. Simply run the query from the Query Editor, as described above, or from a MySQL client that is connected to the DB System.

Before running a query, you can use EXPLAIN to determine if the query will be offloaded to HeatWave; for example:

```sql
mysql> EXPLAIN SELECT O_ORDERPRIORITY, COUNT(*) AS ORDER_COUNT FROM tpch.orders WHERE O_ORDERDATE => DATE '1994-03-01' GROUP BY O_ORDERPRIORITY ORDER BY O_ORDERPRIORITY;
```

If the query can be offloaded to HeatWave, the Extra column of EXPLAIN output shows "Using secondary engine RAPID". If that information does not appear, the query cannot be offloaded.

For more information about running HeatWave queries, see Running Queries, in the MySQL HeatWave User Guide. You can also refer to the HeatWave Quickstarts in the MySQL HeatWave User Guide.
HeatWave User Guide, which show how to import data into a DB System, load data into HeatWave, and run queries.

- tpch Analytics Quickstart
- AirportDB Analytics Quickstart

Query Editor Limitations

The Query Editor has the following limitations:

- It is not intended for loading data into a DB System. The most efficient method of loading data into a DB System is using MySQL Shell, which provides parallel load capabilities. For more information, see Importing Data.
- Only results for the last executed query are displayed.
- Creating or calling stored procedures is not supported.
- SQL code comments are not accepted.
- Long query results might be truncated.
HeatWave AutoML

Use the MySQL HeatWave Console to create and evaluate HeatWave AutoML models. For more information about HeatWave AutoML, see: HeatWave AutoML.

HeatWave AutoML Requirements

HeatWave AutoML has the following requirements:

- An operational DB System with sufficient resources and a HeatWave Cluster. See the following:
  - Supported Shapes.
  - Creating a DB System
  - Creating a HeatWave Cluster

- The MySQL account for the user who will train a model does not have a period character (".") in the username. For example, the username 'joesmith'@'domain' can train a model, but the username 'joe.smith'@'domain' cannot. For more information about this requirement, see Limitations.

- The MySQL account that will use HeatWave AutoML has been granted the following privileges:
  - SELECT and ALTER privileges on the schema that contains the machine learning datasets; for example:

    ```
    mysql> GRANT SELECT, ALTER ON schema_name.* TO 'user_name'@'\%';
    ```

  - SELECT and EXECUTE on the MySQL sys schema where HeatWave AutoML routines reside; for example:

    ```
    mysql> GRANT SELECT, EXECUTE ON sys.* TO 'user_name'@'\%';
    ```

Create a HeatWave AutoML model

Use the MySQL HeatWave Console to create a new HeatWave AutoML model.

Create a HeatWave AutoML model includes an advanced option to choose one or more algorithms. HeatWave AutoML uses the selected algorithms as a pool of algorithms, and will choose the most applicable algorithm from this pool to evaluate the model. By default, all algorithms are selected. To use a single, specific algorithm to evaluate the model, deselect all the other algorithms.

1. Select the HeatWave AutoML tab in the MySQL HeatWave Console, and then click Connect to MySQL DB System.
2. Select a DB System from the drop-down menu.
3. Enter a MySQL user name and password for the DB System.
4. Click **Connect**.
5. Click **Create Model**
6. **Name**: Specify a name for the model or use the generated default name.
7. **Description**: Specify a user friendly description for the model.
8. **Training table**: Select a training dataset.
9. **Columns to include in the model**: Select the **Target column**, and then choose which columns to **Include in model**.
10. **Machine learning task**: Choose a task.
11. **Advanced**:
   - **Optimization metric**: Choose an optimization metric.
   - **Algorithms to evaluate**: Choose which algorithms HeatWave AutoML should consider to evaluate the model.
12. Click **Create**.
    The MySQL HeatWave Console returns to the **HeatWave AutoML** page, and shows the new model at the top of the page.

---

**Evaluate a HeatWave AutoML model**

Evaluate a HeatWave AutoML model includes scores for the model, predictions and explanations. What if analysis compares the baseline results to alternative values.

During testing, the model can include a column of known values. After evaluation, if a prediction does not match the known value, MySQL HeatWave Console marks the prediction in red.

1. Select the **HeatWave AutoML** tab in the MySQL HeatWave Console, and then click **Connect to MySQL DB System**.
2. Select a DB System from the drop-down menu.
3. Enter a MySQL user name and password for the DB System.
4. Click **Connect**.
5. Select a model from the list. The lower pane shows details for the model: **Training table**, **Target column**, **Description**, **Selected algorithm**, **Machine learning task**, and **Training score**.
6. Click **Evaluate**.
7. **Select table**: The prompt has a reminder of the name of the training table. Select a test table compatible with the training table, and click **Next**.
   The **Evaluate Model: model name** dialog opens.
8. **Model score**:
   - Select one of the **Scoring metrics**, and click **Calculate score**. The **Results** shows the score.
9. **Explain model**:
• **Feature Importance**: Shows the names of each feature and their relative importance to the model.

10. **Predictions**:

• Click **Generate Predictions** to create a table of predictions for each row in the test table.

• Select a prediction row from the table, and click **Explain Prediction**.

  The dialog shows the **Selected row**, and **Feature Importance. Notes** explains which feature had the largest impact on the prediction, and might also include the feature that had the largest impact against the prediction.

• Click **Back** to return to the predictions table.

• Select a prediction row from the table, and click **What If**.

• **Values for comparison from included features**: Click the i to show information for that feature column.

  This includes **Minimum**, **Mean** and **Maximum**, and a bar chart of values.

• Click **Back** to return to the predictions table.

• Select a prediction row from the table, and click **What If**.

• **Values for comparison from included features**: Adjust the values, and click **Create**.

  The dialog shows the **Comparison data**, and **Feature Importance. Notes** has explanations for the Baseline and the Comparison. Both explain which feature had the largest impact on that prediction, and might also include the feature that had the largest impact against that prediction.

• Click **Back** to return to the predictions table.
The following global system variables are specific to MySQL HeatWave on AWS and are not available in the on-premise version of MySQL Server.

- `telemetry_log_disable`

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduced</td>
<td>8.0.32</td>
</tr>
<tr>
<td>System Variable</td>
<td><code>telemetry_log_disable</code></td>
</tr>
<tr>
<td>Scope</td>
<td>Global</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Yes</td>
</tr>
<tr>
<td>SET_VAR Hint Applies</td>
<td>No</td>
</tr>
<tr>
<td>Type</td>
<td>Boolean</td>
</tr>
<tr>
<td>Default Value</td>
<td>OFF</td>
</tr>
</tbody>
</table>

Whether to disable the telemetry log.
Performance Monitoring


HeatWave Cluster Performance

To view HeatWave Cluster performance data:

1. In the MySQL HeatWave Console, select the Performance tab.
2. Select a DB System and HeatWave Cluster from the drop-down.

   The Cluster tab shows cluster performance data for HeatWave and for the DB System.

   Click the Refresh icon to refresh the performance data.

3. To see performance data for another DB System and HeatWave Cluster, select them from the drop-down, and click the Refresh icon.

For descriptions of HeatWave Cluster performance data, see HeatWave Cluster Performance Data.

HeatWave Cluster Performance Data

- **HeatWave**
  - **Cluster Memory Utilization**
    The percentage of total HeatWave Cluster memory that is currently utilized.
  - **Node Memory Utilization**
    The percentage of memory utilized on each cluster node. Select from the drop-down menu to view data in order of node ID or Memory Utilization.
  - **Data Dictionary**
    The total data dictionary size. Dictionaries for dictionary-encoded string columns are stored on the MySQL DB System node. For more information, see String Column Encoding Reference, in the MySQL HeatWave User Guide.
  - **Dataset**
    The size of the dataset loaded on the HeatWave Cluster.

- **MySQL**
  - **CPU Utilization**
    The percentage of CPU utilization on the MySQL DB System.
  - **Memory Utilization**
    The percentage of memory utilization on the MySQL DB System,
  - **Buffer Pool**
The buffer pool size on the MySQL DB System.

- **Disk Operations**
The number of disk operations on the MySQL DB System (write, read, and miscellaneous).

- **Connections**
The number of idle and active client connections on the MySQL DB System.

**Workload Performance**

To view HeatWave workload performance data:

1. On the MySQL HeatWave Console, select the **Performance** tab.
2. Select a DB System and HeatWave Cluster from the drop-down.
   The **Workload** tab shows workload performance data for HeatWave and for the MySQL node.
   Click the **Refresh** icon to refresh the performance data.
3. To see workload performance data for another DB System and HeatWave Cluster, select them from the drop-down, and click the **Refresh** icon.

For HeatWave workload performance data descriptions, see HeatWave Workload Performance Data.

**HeatWave Workload Performance Data**

Information is shown for the last 1000 query executions.

- **Executions**
The number of query executions on a time scale.

- **Recent Queries**
Displays recently executed queries with the **Query Text**, the query **Start Time**, and the **Duration (ms)** of the query.

  You are provided with options to **Search by Query Text** for specific queries and to **Aggregate Executions** to view aggregated **Start Time** and **Duration (ms)** data for the same query.

**Autopilot Shape Advisor**

As of MySQL 8.0.32, use the Auto Shape Prediction feature in MySQL Autopilot for MySQL HeatWave on AWS to analyze the workload and assess the suitability of the current MySQL shape. The Auto Shape Prediction feature is available prior to MySQL 8.0.32, but not enabled by default.

The Auto Shape Prediction feature begins to collect MySQL statistics that reflect the current workload. It collects statistics at varying intervals, and Auto Shape Prediction creates a prediction every five minutes while it is active. If there is insufficient or no activity in a five minute interval, or if buffer pool usage is growing, Auto Shape Prediction cannot make a prediction for that interval.
Auto Shape Prediction looks at buffer pool usage, workload activity, and access patterns, and bases its recommendation on those factors. Choose a shape that will accommodate the recommended buffer pool size. If the buffer pool is too small, although MySQL will generally be able to run the workload with stability, the performance of the DB System will suffer through excessive disk I/O.

Tip:

If Auto Shape Prediction suggests a possible downsize, consider the DB System CPU usage and memory usage before downsizing. For heavy CPU utilization, downsizing to a shape with fewer CPUs is not recommended.

When Auto Shape Prediction is running it keeps a rotating history for just over seven days. While there is a monitoring overhead from periodic statistics collection and prediction events, for most workloads and shape combinations the overhead is negligible. If necessary, it is possible to disable Auto Shape Prediction.

When Auto Shape Prediction is disabled it clears the internal statistics tables, but keeps the predictions.

An upgrade to the DB System drops and re-installs the `mysql_autopilot` schema, which removes the predictions.

As of MySQL 8.0.32, there are two ways to access the Autopilot Shape Advisor, with the MySQL HeatWave Console or with MySQL statements. Prior to MySQL 8.0.32, use MySQL statements.

Note:

The SQL output can only provide hints. The MySQL HeatWave Console can provide much more information, and can recommend an improved shape. See: Autopilot Shape Advisor with MySQL HeatWave Console.

Autopilot Shape Advisor with MySQL HeatWave Console

To view the Autopilot Shape Advisor:

1. In the MySQL HeatWave Console, select the **Performance** tab.
2. Select a DB System and HeatWave Cluster from the drop-down.
   
   The **Autopilot Shape Advisor** tab shows Auto Shape Prediction data for the DB System. Click the **Refresh** icon to refresh the performance data.

3. To see performance data for another DB System and HeatWave Cluster, select them from the drop-down.

For descriptions of Auto Shape Prediction data, see Auto Shape Prediction Data.
Auto Shape Prediction Data

Auto Shape Prediction data shows data for the last seven days and contains the following information:

- **Time Periods**
  - **Selected**
    The two dates selected in Buffer Pool Insights.
  - **Available**
    Auto Shape Prediction data is available between these two dates a week apart.

- **MySQL Shape Prediction**
  This uses the Selected dates.
  - **Current**
    The current shape size, with Shape Name, Memory Size, and Buffer Pool Size.
  - **Recommended**
    The recommended shape size, with Shape Name, Memory Size, and Buffer Pool Size.

- **Recommended Action**
  This uses the Selected dates, and has five possible recommendations:
  - **Upsize**: Move the DB System to a larger MySQL shape.
  - **Downsize**: Move the DB System to a smaller MySQL shape.
  - **No Change**: No need to change the MySQL shape.
  - **Not Enough Data**: There is not enough workload activity, or Auto Shape Prediction cannot make a prediction.
  - **Prediction Data Not Available**: Auto Shape Prediction is disabled, or it is enabled but has not produced the first prediction, or the MySQL HeatWave Console data has not been refreshed within the last 5 minutes.

Instructions to follow to adopt the recommended size.

- **Buffer Pool Insights**
  - **Average Statistics**
    - **Buffer Pool**
      A graph that shows Average Buffer Pool Usage and Current Buffer Pool Size. This uses the Selected dates.
    - **Buffer Pool Hit Rate**
      A percentage value calculated between the Selected dates.
  - **Recent Statistics**
    Use the left and right slider controls on one of the two time series graphs to adjust the Selected dates.
A detailed graph that shows Buffer Pool Size, Buffer Pool Usage, and Recommended Buffer Pool Size. The graph uses the Selected dates.

* Buffer Pool Hit Rate

A detailed graph that shows the Buffer Pool Hit Rate Between the Selected dates.

* Workload markers on the two time series graphs. These markers indicate recent activity:
  * Green markers: The workload is running and stable. Good predictions.
  * Orange markers: The workload is running, but it is not stable. Difficult to predict.
  * No markers: No recent activity, and no predictions.

Autopilot Shape Advisor with MySQL

Auto Shape Prediction records predictions in the shape_predictions table in the mysql_autopilot schema. This is a system schema that is always present even if Auto Shape Prediction is not active. The schema also contains tables for the statistics used to calculate the predictions.

Note:
The SQL output can only provide hints. The MySQL HeatWave Console can provide much more information, and can recommend an improved shape. See: Autopilot Shape Advisor with MySQL HeatWave Console.

This example shows output from the shape_predictions table with predictions made over the course of an hour:

```
mysql> SELECT * FROM mysql_autopilot.shape_predictions;
+---------------------+-----------------+----------------------------+
<table>
<thead>
<tr>
<th>prediction_time</th>
<th>current_bp_size</th>
<th>hit_rate</th>
<th>prediction_value</th>
<th>outcome</th>
</tr>
</thead>
</table>
+---------------------+-----------------+----------|------------------|---------|
| 2022-10-28 09:46:48 | 5               | NULL     | 0                | NOT     |
| 2022-10-28 09:51:48 | 5               | 0.866    | 4.97363          |
| 2022-10-28 09:56:48 | 5               | 0.8665   | 4.97778          |
| 2022-10-28 10:01:48 | 5               | 0.866    | 25.08            |
| 2022-10-28 10:06:48 | 5               | 0.86425  | 25.63            |
| 2022-10-28 10:11:48 | 5               | 0.8675   | 26.1             |
| 2022-10-28 10:16:48 | 5               | 0.8675   | 26.52            |
```
The `shape_predictions` table has these columns:

- **prediction_time**: The timestamp for this prediction. A prediction is attempted every five minutes.
- **current_bp_size**: The current buffer pool size in GB.
- **hit_rate**: The current buffer pool hit rate.
- **prediction_value**: The predicted buffer pool size for optimal performance with this workload in GB.
- **outcome**: A recommendation to upsize, downsize, or stay with your current shape, or information on why a prediction cannot be made for that interval.

To use Auto Shape Prediction, follow these steps:

1. Connect to the DB System for the HeatWave Cluster, using the MySQL client (`mysql`) or MySQL Shell in SQL mode. For instructions to connect to MySQL HeatWave on AWS as a client, see Connecting from a Client.

2. Prior to MySQL 8.0.32, while a typical workload is running, enable Auto Shape Prediction by issuing the following statement using the client:

   ```sql
   mysql> CALL mysql_autopilot.shape_prediction(JSON_OBJECT("enable", TRUE));
   ```

3. Wait at least five minutes for the first prediction to be attempted, then start to check the results with this statement from the SQL client:

   ```sql
   mysql> SELECT * FROM mysql_autopilot.shape_predictions
       ORDER BY prediction_time DESC LIMIT 20;
   ```

Auto Shape Prediction attempts a new prediction every five minutes. Re-issue the statement every so often while a typical workload is running, until the prediction has stabilized.

4. When the prediction has stabilized, make a note of the maximum `prediction_value` and `outcome`.
5. Choose whether to leave Auto Shape Prediction running to monitor other workloads or disable Auto Shape Prediction with this statement:

```sql
mysql> CALL mysql_autopilot.shape_prediction(JSON_OBJECT("enable", FALSE));
```

6. To move to a different DB System shape, follow the steps in Creating a Backup and Restoring a Backup to a New DB System.

The Auto Shape Prediction Data includes Recommended Action, which recommends a shape, and provides instructions.
12

Backups

This section describes how to create, restore, and manage MySQL DB System backups. Only manual backups are supported; that is, you must create your backups following the instructions in **Creating a Backup**. Backups are not created automatically.

DB System backups are Amazon EBS snapshots which are automatically saved to Amazon Simple Storage Service (Amazon S3). MySQL HeatWave on AWS limits the maximum number of backups that you can retain across all DB System instances. If you reach the limit, remove the oldest backups before creating new ones.

It is recommended to create backups on a regular schedule. Backups are incremental, but if the period between backups is too long, a backup operation may take a long time to complete due to the volume of changes.

**Creating a Backup**

Use the Console to create a backup.

1. In the MySQL HeatWave Console, click the **MySQL** tab.
2. On the **DB Systems** tab, in the list of DB Systems, find the DB System you want to create a backup for, and do one of the following:
   - Click the row of the DB System to highlight it, and click **Create Backup** from the **Actions** menu.
   - Click the name of the DB System to open the **Details** page and click **Create Backup** from the **Actions** menu.
3. In the **Create MySQL Backup** panel, edit the following fields:
   - **Display name**: Specify a name of the backup. If you do not define a name, one is generated for you in the format **NameOfTheBackup - Backup - Day, Date Time**.
   - **Description**: Specify a description of the backup. If you do not provide a description, one is generated for you in the format **NameOfTheBackup - Manual Backup - Day, Date Time**.
   - **Backup Retention Policy**: Specify how many days you want to retain the user initiated backup. By default, the backups are retained for 365 days.
4. Click **Create** to create the backup.

Under MySQL, click the **Backups** tab to view the backup you created. When the backup is created successfully, the backup state changes from **Creating** to **Active**.

**Editing a Backup**

Use the Console to edit the display name, description, and backup retention policy of a DB system backup.

1. In the MySQL HeatWave Console, click the **MySQL** tab.
2. On the **Backups** tab, in the list of DB Systems, find the backup you want to edit, and do one of the following:
   - Click the row of the backup to highlight it, and click **Edit Backup**.
   - Click the name of the backup to open the **Details** page and click **Edit Backup**.

3. In the **Edit MySQL Backup** panel, edit the following:
   - **Display Name**: Specify a name of the backup. If you do not define a name, one is generated for you in the format, `NameOfTheBackup - Backup - Day, Date Time`.
   - **Description**: Specify a description of the backup. If you do not provide a description, one is generated for you in the format, `NameOfTheBackup - Manual Backup - Day, Date Time`.
   - **Backup Retention Policy**: (Only for user initiated backups) Specify how many days you want to retain the user initiated backup. By default, the backups are retained for 365 days.

4. Click **Save**.

The details of the selected backup is updated.

### Viewing Backup Details

To view backup details:

1. In the MySQL HeatWave Console, select the **MySQL** tab.

2. Select the **Backups** tab. In the list of backups, find the backup you want to view details for and click the name of the backup to open the **MySQL Backup Details** page.

For descriptions of MySQL backup details, see **Backup Details**.

### Backup Details

Use the Console to view the **Backup Details** page.

**Table 12-1 Backup Details Page**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
<td>Backup summary. See <strong>Table 12-2</strong>.</td>
</tr>
<tr>
<td><strong>General information</strong></td>
<td>General backup. See <strong>Table 12-3</strong>.</td>
</tr>
<tr>
<td><strong>MySQL DB System snapshot</strong></td>
<td>MySQL DB System snapshot. See <strong>Table 12-4</strong>.</td>
</tr>
</tbody>
</table>
Table 12-2  Backup Summary

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>The state of the backup.</td>
</tr>
<tr>
<td></td>
<td>• <strong>CREATING</strong>: Resources are being reserved for the backup, and the backup is being created. Creating a backup can take several minutes. The backup is not ready to use yet.</td>
</tr>
<tr>
<td></td>
<td>• <strong>ACTIVE</strong>: The backup was successfully created</td>
</tr>
<tr>
<td></td>
<td>• <strong>UPDATING</strong>: The backup is in the process updating</td>
</tr>
<tr>
<td></td>
<td>• <strong>INACTIVE</strong>: The backup is unavailable</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETING</strong>: The backup is being deleted by a delete action in the Console</td>
</tr>
<tr>
<td></td>
<td>• <strong>DELETED</strong>: The backup has been deleted and is no longer available</td>
</tr>
<tr>
<td></td>
<td>• <strong>FAILED</strong>: An error condition prevented the creation or continued availability of the backup</td>
</tr>
<tr>
<td>Resource ID</td>
<td>The unique resource identifier assigned to the backup</td>
</tr>
<tr>
<td>Storage size</td>
<td>The size of the backup</td>
</tr>
</tbody>
</table>

Table 12-3  General information

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>A description of the backup</td>
</tr>
<tr>
<td>Created</td>
<td>The date and time the backup was created</td>
</tr>
<tr>
<td>Last Updated</td>
<td>The date and time the backup was last updated</td>
</tr>
<tr>
<td>Retention in days</td>
<td>The number of days the user initiated backup is retained</td>
</tr>
<tr>
<td>Expiry time</td>
<td>The date and time when the backup expires</td>
</tr>
<tr>
<td>Backup type</td>
<td>The type of the backup: User initiated or scheduled</td>
</tr>
</tbody>
</table>

Table 12-4  MySQL DB System snapshot

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>The name of the DB System used to create the backup</td>
</tr>
<tr>
<td>Description</td>
<td>The user-specified description of the DB System used to create the backup</td>
</tr>
<tr>
<td>MySQL version</td>
<td>The MySQL version used to create the backup</td>
</tr>
<tr>
<td>Shape</td>
<td>The resource template applied to the DB System used to create the backup</td>
</tr>
<tr>
<td>MySQL Configuration</td>
<td>The configuration of the DB System</td>
</tr>
<tr>
<td>Availability Zone</td>
<td>The physical Availability Zone of the DB System used to create the backup</td>
</tr>
</tbody>
</table>
Table 12-4  (Cont.) MySQL DB System snapshot

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance window</td>
<td>The time when the two-hour maintenance window begins for the DB System used to create the backup</td>
</tr>
<tr>
<td>Automatic backups</td>
<td>The status of the automatic backups: Enabled or Disabled</td>
</tr>
</tbody>
</table>

**Restoring a Backup to a New DB System**

When you restore a backup, you create a new DB System and restore the backup to it. You can change the shape and the amount of data storage for the new DB System.

A restored DB System uses the same MySQL Administrator user name and password that was in effect when the backup was created.

DB System backups are Amazon EBS snapshots which are automatically saved to Amazon Simple Storage Service (Amazon S3).

**Tip:**

Amazon EBS snapshots are loaded asynchronously. You can use the new DB System as soon as it is active, while data continues to load in the background. If you access data that has not been loaded yet, the DB System downloads the requested data (which can therefore take longer than usual to access), then resumes asynchronous loading. If you want to download your frequently accessed data immediately, run a full-table scan such as `SELECT *` on the relevant tables.

To restore a backup to a new DB System:

1. In the MySQL HeatWave Console, select the MySQL tab.
2. Select the Backups tab. In the list of backups, find the backup you want to restore to a new DB System, and do one of the following:
   - Click on the row of the backup to highlight it, and click Restore Backup.
   - Click the name of the backup to open the MySQL Backup Details page. Click Restore Backup.

   The Restore Backup to new MySQL DB System dialog is displayed.
3. Provide basic information for the new DB System:
   - **Display Name**: Specify a display name for the new DB System or use the generated default name.
   - **Description**: Specify a description for the new DB System or use the generated description.
4. Select the **Hardware shape**. If you are using this process to get a different shape or more storage for the DB System, choose the shape that you want the new DB System to have.
   - **Shape**: Select the shape to use for your DB System. The shape determines the resources allocated to the system. For information about shapes, see Supported Shapes. Selecting a shape for a DB System also selects the configuration associated with that shape. See Configuration.
   - **Data Storage Size (GiB)**: Specify the amount of block storage, in GiB, to allocate to the DB System. This block storage stores all data, logs, and temporary files. Binaries are not stored in this block storage. Enter a number between 50 and 16384.

   **Note:**
   A restored DB System uses the same MySQL Administrator user name and password that was in effect when the backup was created.

   Ensure that the specified Data Storage Size is greater than or equal to the size of the backup you are restoring.

   - **Database Version**: Select the MySQL Server version you want to deploy. The latest MySQL Server version is selected by default.

5. Configure the **Availability zone**, which determines the physical location of the DB System:
   - Select **Automatically** to have the physical AWS Availability Zone selected for you.
   - Set **Manually** to select the physical AWS Availability Zone where the MySQL DB System will be created.

   **Note:**
   A physical Availability Zone is identified by an Availability Zone ID (AZ ID). For information about AZ IDs and how to view them, see Availability Zone IDs for your AWS resources, in the AWS RAM User Guide.

6. Configure **Networking** settings:
   - **Allowed Client Addresses**: Specify public-facing client IPv4 addresses that are permitted to connect to the DB System endpoint. Addresses are specified in CIDR format; for example: 1.2.3.4/24. Multiple addresses in CIDR format can be specified in a semicolon-separated list; for example: 1.2.3.4/24; 1.2.3.4/32. For information about specifying IP addresses in CIDR format, see Creating a DB System.
   - **Port**: The port on which the MySQL server listens. The default is port 3306. You can specify a port number between 1024 and 65535.
   - **X Protocol Port**: The X Protocol port on which the MySQL server listens, supported by clients such as MySQL Shell. The default port is 33060. You can specify a port number between 1024 and 65535.
7. Click **Next** to proceed to creating a HeatWave Cluster.

8. Provide basic information for the new HeatWave Cluster:
   - **Display Name**: Specify a display name for the new HeatWave Cluster or use the generated default name.
   - **Description**: Specify a description for the new HeatWave Cluster.

9. Under **HeatWave Cluster Configuration**, select a node shape and number of nodes.
   - **Shape**: Select a HeatWave node shape. For information about supported shapes, see **Supported Shapes**.

   - **Cluster Size**: The number of HeatWave nodes to create. Enter a number between 1 and 128.

   **Note:**
   If you intend to use HeatWave AutoML functionality, the **HeatWave.256GB** node shape is recommended when creating a HeatWave Cluster. The **HeatWave.16GB** node shape may not have enough memory for training on large data sets. If you see error messages about this (such as ML003024), use the larger shape instead.

   **Tip:**
   Because the new DB System does not yet contain any data, you cannot use MySQL Autopilot to estimate the required cluster size (as described in **Estimating Cluster Size with MySQL Autopilot**). If you want to make an estimate, after loading the data to the DB System, you can delete the HeatWave Cluster and create a new one following the instructions in **Creating a HeatWave Cluster**.

10. Click **Restore** to restore the backup to the new DB System.

    You are returned to the DB Systems page where you can monitor the state of the operation, which may take some time to complete. The state will change from **Creating** to **Active** when the operation has completed successfully.

---

### Deleting a Backup

Deleting a backup permanently deletes it.

To delete a backup:

1. In the MySQL HeatWave Console, select the **MySQL** tab.
2. Select the **Backups** tab. In the list of backups, find the backup you want to restore to a new DB System, and do one of the following:
   - Click on the row of the backup to highlight it, and click **Delete**.
• Click the name of the backup to open the MySQL Backup Details page. Click Delete.

The Delete MySQL DB System Backup dialog is displayed for you to confirm the deletion.

3. Click Delete MySQL Backup to go ahead with the deletion.
The MySQL configuration comprises global system variables and session variables, which define its operation.

Creating a MySQL Configuration

Use the MySQL HeatWave Console to create a new MySQL configuration. It is not possible to change the values of any variables once a configuration has been created.

Review the default values for the MySQL global system variables, and choose preferred values. See System Initialization Variables, and User Configurable System Variables.

Certain MySQL global system variables define whether a configuration can support HeatWave. See: User Configurable Shape Dependent System Variables.

1. In the MySQL HeatWave Console, select the MySQL tab, and then click Configurations to open the Configurations page.
2. On the Configurations page, click Create MySQL Configuration to open the Create MySQL Configuration dialog.
3. Basic information: Provide a name and description for the configuration:
   - Display Name: Specify a display name for the configuration or use the generated default name.
   - Description: Specify a user friendly description for the configuration.
4. Select MySQL shape: Select a shape to create a configuration for.
5. Click Next.
6. Support HeatWave: Select this option to ensure that the configuration supports HeatWave.
7. Initialization variables: Set preferred values for initialization variables.
   - Click Select a variable name, and select the variable from the drop-down list.
   - Click Select a value, and select the value from the drop-down list, or enter the preferred value.
8. User variables: Set preferred values for user variables.
   - Click Select a variable name, and select the variable from the drop-down list.
   - Click Select a value, and select the value from the drop-down list, or enter the preferred value.
   - Click Add new variable, and repeat these steps to create the full configuration.
9. Review all the variables, and their values. Edit the values, or if any are incorrect, click X to remove the variable.
10. Click Create.
The MySQL HeatWave Console checks the values for each variable. If any fail validation, `Could not create MySQL Configuration` appears, with the name of the failed variable. Edit the value, and click Create.

The MySQL HeatWave Console returns to the Configurations page, and shows the new configuration at the top of the page.

11. Click on the configuration to view the Details page. This shows the variables and their values associated with the configuration.

Click the Associated DB Systems tab to see all the DB Systems that use the configuration.

Click Delete if no DB System uses the configuration, and it is not required.

System Initialization Variables

System initialization variables are global system variables that must be set during DB system initialization. They apply for the life span of the DB system and, once applied, you cannot change them.

Configure the following variables with the MySQL HeatWave Console. See Creating a MySQL Configuration.

Note:
Any change to the configuration of a DB system cannot change the system initialization variables.

Table 13-1  Initialization Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower_case_table_names</td>
<td>• CASE_SENSITIVE: (Default) Table and schema name comparisons are case-sensitive and are stored as you specify them. Selecting CASE_SENSITIVE sets the system variable, lower_case_table_names, to 0.</td>
</tr>
<tr>
<td></td>
<td>• CASE_INSENSITIVE_LOWERCASE: Table and schema name comparisons are not case-sensitive and stored in lowercase. Selecting CASE_INSENSITIVE_LOWERCASE sets the system variable, lower_case_table_names, to 1.</td>
</tr>
</tbody>
</table>

User Configurable System Variables

Configure the following global system variables with the MySQL HeatWave Console. See Creating a MySQL Configuration.

Table 13-2  User Configurable System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>autocommit</td>
<td>ON</td>
</tr>
<tr>
<td>Name</td>
<td>Default Value</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>big_tables</td>
<td>OFF</td>
</tr>
<tr>
<td>binlog_expire_logs_seconds</td>
<td>3600</td>
</tr>
<tr>
<td>binlog-row-metadata</td>
<td>MINIMAL</td>
</tr>
<tr>
<td>binlog_row_value_options</td>
<td>PARTIAL_JSON</td>
</tr>
<tr>
<td>binlog_transaction_compression</td>
<td>OFF</td>
</tr>
<tr>
<td>completion_type</td>
<td>NO_CHAIN</td>
</tr>
<tr>
<td>connect_timeout</td>
<td>10</td>
</tr>
<tr>
<td>connection_memory_chunk_size</td>
<td>8912</td>
</tr>
<tr>
<td>connection_memory_limit</td>
<td>9223372036854775807</td>
</tr>
<tr>
<td>cte_max_recursion_depth</td>
<td>1000</td>
</tr>
<tr>
<td>default_authentication_plugin</td>
<td>CACHING_SHA2_PASSWORD</td>
</tr>
<tr>
<td>foreign_key_checks</td>
<td>ON</td>
</tr>
<tr>
<td>global_connection_memory_limit</td>
<td>OFF</td>
</tr>
<tr>
<td>global_connection_memory_tracking</td>
<td>EVENTUAL</td>
</tr>
<tr>
<td>information_schema_stats_expiry</td>
<td>86400</td>
</tr>
<tr>
<td>innodb_buffer_pool_dump_pct</td>
<td>25</td>
</tr>
<tr>
<td>innodb_buffer_pool_instances</td>
<td>Shape dependent, see User Configurable Shape Dependent System Variables</td>
</tr>
<tr>
<td>innodb_buffer_pool_size</td>
<td>Shape dependent, see User Configurable Shape Dependent System Variables</td>
</tr>
<tr>
<td>innodb_ddl_buffer_size</td>
<td>1048576</td>
</tr>
<tr>
<td>innodb_ddl_threads</td>
<td>4</td>
</tr>
<tr>
<td>innodb_ft_enable_stopword</td>
<td>ON</td>
</tr>
<tr>
<td>innodb_ft_max_token_size</td>
<td>84</td>
</tr>
<tr>
<td>innodb_ft_min_token_size</td>
<td>3</td>
</tr>
<tr>
<td>innodb_ft_num_word_optimize</td>
<td>2000</td>
</tr>
<tr>
<td>innodb_ft_result_cache_limit</td>
<td>20000000000</td>
</tr>
<tr>
<td>innodb_ft_server_stopword_table</td>
<td>NULL</td>
</tr>
<tr>
<td>innodb_lock_wait_timeout</td>
<td>50</td>
</tr>
<tr>
<td>innodb_log_writer_threads</td>
<td>ON</td>
</tr>
<tr>
<td>innodb_max_purge_lag_delay</td>
<td>300000</td>
</tr>
<tr>
<td>innodb_max_purge_lag</td>
<td>0</td>
</tr>
<tr>
<td>innodb_stats_persistent_sample_pages</td>
<td>20</td>
</tr>
<tr>
<td>innodb_stats_transient_sample_pages</td>
<td>8</td>
</tr>
<tr>
<td>interactive_timeout</td>
<td>28800</td>
</tr>
<tr>
<td>--local-infile</td>
<td>OFF</td>
</tr>
<tr>
<td>mandatory_roles</td>
<td>Empty string</td>
</tr>
<tr>
<td>max_allowed_packet</td>
<td>67108864</td>
</tr>
<tr>
<td>max_binlog_cache_size</td>
<td>4294967296</td>
</tr>
<tr>
<td>max_connect_errors</td>
<td>18,446,744,073,709,551,615</td>
</tr>
</tbody>
</table>
Table 13-2  (Cont.) User Configurable System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>max_connections</td>
<td>Shape dependent, see <a href="#">User Configurable Shape Dependent System Variables</a></td>
</tr>
<tr>
<td>max_execution_time</td>
<td>0</td>
</tr>
<tr>
<td>max_heap_table_size</td>
<td>16777216</td>
</tr>
<tr>
<td>max_prepared_stmt_count</td>
<td>Shape dependent, see <a href="#">User Configurable Shape Dependent System Variables</a></td>
</tr>
<tr>
<td>mysql_firewall_mode</td>
<td>ON</td>
</tr>
<tr>
<td>mysqlx_connect_timeout</td>
<td>30</td>
</tr>
<tr>
<td>mysqlx_deflate_default_compression_level</td>
<td>3</td>
</tr>
<tr>
<td>mysqlx_deflate_max_client_compression_level</td>
<td>5</td>
</tr>
<tr>
<td>mysqlx_interactive_timeout</td>
<td>28800</td>
</tr>
<tr>
<td>mysqlx_lz4_default_compression_level</td>
<td>2</td>
</tr>
<tr>
<td>mysqlx_lz4_max_client_compression_level</td>
<td>8</td>
</tr>
<tr>
<td>mysqlx_max_allowed_packet</td>
<td>67108864</td>
</tr>
<tr>
<td>mysqlx_read_timeout</td>
<td>28800</td>
</tr>
<tr>
<td>mysqlx_wait_timeout</td>
<td>28800</td>
</tr>
<tr>
<td>mysqlx_write_timeout</td>
<td>60</td>
</tr>
<tr>
<td>mysqlx_zstd_default_compression_level</td>
<td>3</td>
</tr>
<tr>
<td>mysqlx_zstd_max_client_compression_level</td>
<td>11</td>
</tr>
<tr>
<td>net_read_timeout</td>
<td>30</td>
</tr>
<tr>
<td>net_write_timeout</td>
<td>60</td>
</tr>
<tr>
<td>parser_max_mem_size</td>
<td>18446744073709551615</td>
</tr>
<tr>
<td>regexp_time_limit</td>
<td>32</td>
</tr>
<tr>
<td>sort_buffer_size</td>
<td>262144</td>
</tr>
<tr>
<td>sql_mode</td>
<td>ERROR_FOR_DIVISION_BY_ZERO, NO_ENGINE_SUBSTITUTION, NO_ZERO_DATE, NO_ZERO_IN_DATE, ONLY_FULL_GROUP_BY, STRICT_TRANS_TABLES</td>
</tr>
<tr>
<td>sql_require_primary_key</td>
<td>OFF</td>
</tr>
<tr>
<td>sql_warnings</td>
<td>OFF</td>
</tr>
<tr>
<td>telemetry_log_disable</td>
<td>OFF</td>
</tr>
<tr>
<td>thread_pool_dedicated_listeners</td>
<td>OFF</td>
</tr>
<tr>
<td>thread_pool_max_transactions_limit</td>
<td>Shape dependent, see <a href="#">User Configurable Shape Dependent System Variables</a></td>
</tr>
<tr>
<td>thread_pool_query_threads_per_group</td>
<td>Shape dependent, see <a href="#">User Configurable Shape Dependent System Variables</a></td>
</tr>
<tr>
<td>time_zone</td>
<td>UTC</td>
</tr>
<tr>
<td>tmp_table_size</td>
<td>16777216</td>
</tr>
</tbody>
</table>
Table 13-2  (Cont.) User Configurable System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>transaction_isolation</td>
<td>REPEATABLE-READ</td>
</tr>
<tr>
<td>wait_timeout</td>
<td>28800</td>
</tr>
</tbody>
</table>

User Configurable Shape Dependent System Variables

Shape dependent global system variables are linked to, and tuned for, a specific MySQL shape. See Supported Shapes. Configure the following variables with the MySQL HeatWave Console. See Creating a MySQL Configuration.

innodb_buffer_pool_instances, innodb_buffer_pool_size, max_connections, and max_prepared_stmt_count have different default, minimum and maximum values for each shape and for HeatWave support.

thread_pool_max_transactions_limit and thread_pool_query_threads_per_group have different default values for each shape.

Table 13-3  innodb_buffer_pool_instances

<table>
<thead>
<tr>
<th>Shape</th>
<th>Supports HeatWave</th>
<th>Default</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>No</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.2.16GB</td>
<td>Yes</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>No</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>Yes</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>No</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>Yes</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>No</td>
<td>8</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>Yes</td>
<td>4</td>
<td>1</td>
<td>64</td>
</tr>
</tbody>
</table>

Table 13-4  innodb_buffer_pool_size

<table>
<thead>
<tr>
<th>Shape</th>
<th>Supports HeatWave</th>
<th>Default</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>No</td>
<td>10737418240</td>
<td>5242880</td>
<td>10737418240</td>
</tr>
<tr>
<td>MySQL.2.16GB</td>
<td>Yes</td>
<td>5368709120</td>
<td>5242880</td>
<td>5368709120</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>No</td>
<td>21474836480</td>
<td>5242880</td>
<td>21474836480</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>Yes</td>
<td>16106127360</td>
<td>5242880</td>
<td>16106127360</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>No</td>
<td>51539607552</td>
<td>5242880</td>
<td>61203283968</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>Yes</td>
<td>45097156608</td>
<td>5242880</td>
<td>45097156608</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>No</td>
<td>206158430208</td>
<td>5242880</td>
<td>246960619520</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>Yes</td>
<td>21474836480</td>
<td>5242880</td>
<td>21474836480</td>
</tr>
</tbody>
</table>
### Table 13-5  max_connections

<table>
<thead>
<tr>
<th>Shape</th>
<th>Supports HeatWave</th>
<th>Default</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>No</td>
<td>1000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.2.16GB</td>
<td>Yes</td>
<td>1000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>No</td>
<td>2000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>Yes</td>
<td>2000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>No</td>
<td>4000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>Yes</td>
<td>4000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>No</td>
<td>8000</td>
<td>1</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>Yes</td>
<td>2000</td>
<td>1</td>
<td>100000</td>
</tr>
</tbody>
</table>

### Table 13-6  max_prepared_stmt_count

<table>
<thead>
<tr>
<th>Shape</th>
<th>Supports HeatWave</th>
<th>Default</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>No</td>
<td>16382</td>
<td>16382</td>
<td>20000</td>
</tr>
<tr>
<td>MySQL.2.16GB</td>
<td>Yes</td>
<td>16382</td>
<td>16382</td>
<td>20000</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>No</td>
<td>16382</td>
<td>16382</td>
<td>40000</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>Yes</td>
<td>16382</td>
<td>16382</td>
<td>40000</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>No</td>
<td>16382</td>
<td>16382</td>
<td>80000</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>Yes</td>
<td>16382</td>
<td>16382</td>
<td>80000</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>No</td>
<td>16382</td>
<td>16382</td>
<td>160000</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>Yes</td>
<td>16382</td>
<td>16382</td>
<td>40000</td>
</tr>
</tbody>
</table>

### Table 13-7  thread_pool_max_transactions_limit

<table>
<thead>
<tr>
<th>Shape</th>
<th>Default</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>8</td>
<td>0</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>16</td>
<td>0</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>32</td>
<td>0</td>
<td>100000</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>512</td>
<td>0</td>
<td>100000</td>
</tr>
</tbody>
</table>

### Table 13-8  thread_pool_query_threads_per_group

<table>
<thead>
<tr>
<th>Shape</th>
<th>Default</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL.2.16GB</td>
<td>16</td>
<td>1</td>
<td>4096</td>
</tr>
<tr>
<td>MySQL.4.32GB</td>
<td>16</td>
<td>1</td>
<td>4096</td>
</tr>
<tr>
<td>MySQL.8.64GB</td>
<td>16</td>
<td>1</td>
<td>4096</td>
</tr>
<tr>
<td>MySQL.32.256GB</td>
<td>16</td>
<td>1</td>
<td>4096</td>
</tr>
</tbody>
</table>
Service Specific System Variables

MySQL HeatWave on AWS defines the following global system variables. It is not possible to edit them.

generated_random_password_length, query_alloc_block_size, and query_prealloc_size are also session variables. See Session Variables.

### Table 13-9  Service Specific Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>generated_random_password_length</td>
<td>20</td>
</tr>
<tr>
<td>mysqlx_document_id_unique_prefix</td>
<td>0</td>
</tr>
<tr>
<td>mysqlx_enable_hello_notice</td>
<td>ON</td>
</tr>
<tr>
<td>mysqlx_idle_worker_thread_timeout</td>
<td>60</td>
</tr>
<tr>
<td>mysqlx_min_worker_threads</td>
<td>2</td>
</tr>
<tr>
<td>query_alloc_block_size</td>
<td>8192</td>
</tr>
<tr>
<td>query_prealloc_size</td>
<td>8192</td>
</tr>
</tbody>
</table>

The **SHOW VARIABLES** statement with the **GLOBAL** modifier displays global system variable values:

```
mysql> SHOW GLOBAL VARIABLES;
```

To obtain the value for a specific variable, use a **LIKE** clause as shown:

```
mysql> SHOW GLOBAL VARIABLES LIKE 'max_join_size';
```

To get a list of variables whose name match a pattern, use the % wildcard character in a **LIKE** clause:

```
mysql> SHOW GLOBAL VARIABLES LIKE '%size%';
```

Shape Dependent System Variables

Shape dependent global system variables are linked to, and tuned for, a specific MySQL shape. See Supported Shapes. It is not possible to edit them.

innodb_parallel_read_threads is also a session variable. See: Session Variables.

### Table 13-10  MySQL.2.16GB Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>back_log</td>
<td>1000</td>
</tr>
</tbody>
</table>
### Table 13-10  MySQL.2.16GB Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>innodb_page_cleaners</td>
<td>4</td>
</tr>
<tr>
<td>innodb_parallel_read_threads</td>
<td>1</td>
</tr>
<tr>
<td>innodb_read_io_threads</td>
<td>1</td>
</tr>
<tr>
<td>innodb_redo_log_capacity</td>
<td>2</td>
</tr>
<tr>
<td>replica_parallel_workers &gt; 0</td>
<td>4</td>
</tr>
<tr>
<td>temptable_max_ram</td>
<td>1073741824</td>
</tr>
<tr>
<td>thread_pool_size</td>
<td>8</td>
</tr>
</tbody>
</table>

### Table 13-11  MySQL.4.32GB Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>back_log</td>
<td>2000</td>
</tr>
<tr>
<td>innodb_page_cleaners</td>
<td>4</td>
</tr>
<tr>
<td>innodb_parallel_read_threads</td>
<td>2</td>
</tr>
<tr>
<td>innodb_read_io_threads</td>
<td>2</td>
</tr>
<tr>
<td>innodb_redo_log_capacity</td>
<td>4</td>
</tr>
<tr>
<td>replica_parallel_workers &gt; 0</td>
<td>8</td>
</tr>
<tr>
<td>temptable_max_ram</td>
<td>1073741824</td>
</tr>
<tr>
<td>thread_pool_size</td>
<td>16</td>
</tr>
</tbody>
</table>

### Table 13-12  MySQL.8.64GB Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>back_log</td>
<td>4000</td>
</tr>
<tr>
<td>innodb_page_cleaners</td>
<td>4</td>
</tr>
<tr>
<td>innodb_parallel_read_threads</td>
<td>4</td>
</tr>
<tr>
<td>innodb_read_io_threads</td>
<td>4</td>
</tr>
<tr>
<td>innodb_redo_log_capacity</td>
<td>8</td>
</tr>
<tr>
<td>replica_parallel_workers &gt; 0</td>
<td>16</td>
</tr>
<tr>
<td>temptable_max_ram</td>
<td>2147483648</td>
</tr>
<tr>
<td>thread_pool_size</td>
<td>32</td>
</tr>
</tbody>
</table>

### Table 13-13  MySQL.32.256GB Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>back_log</td>
<td>2000</td>
</tr>
<tr>
<td>innodb_page_cleaners</td>
<td>8</td>
</tr>
<tr>
<td>innodb_parallel_read_threads</td>
<td>32</td>
</tr>
<tr>
<td>innodb_read_io_threads</td>
<td>2</td>
</tr>
<tr>
<td>innodb_redo_log_capacity</td>
<td>8</td>
</tr>
<tr>
<td>replica_parallel_workers &gt; 0</td>
<td>16</td>
</tr>
</tbody>
</table>
Table 13-13  (Cont.) MySQL.32.256GB Global System Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>temptable_max_ram</td>
<td>1073741824</td>
</tr>
<tr>
<td>thread_pool_size</td>
<td>32</td>
</tr>
</tbody>
</table>

Session Variables

Session variables remain in effect during the session until the variable changes or the session ends. The change has no effect on other sessions. For new connections, a session variable value is initialized with the corresponding global system variable value. Many of the following session variables are also available as user configurable variables. See: User Configurable System Variables.

To assign a value to a session variable, precede the variable name with the SESSION or LOCAL keyword, or with the @@SESSION., @@LOCAL., or @@ qualifier, or with no keyword or modifier. For example:

```
mysql> SET SESSION sql_mode = 'TRADITIONAL';
mysql> SET LOCAL sql_mode = 'TRADITIONAL';
mysql> SET @@SESSION.sql_mode = 'TRADITIONAL';
mysql> SET @@LOCAL.sql_mode = 'TRADITIONAL';
mysql> SET @@sql_mode = 'TRADITIONAL';
mysql> SET sql_mode = 'TRADITIONAL';
```

Table 13-14  User Settable Session Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>autocommit</td>
<td>ON</td>
</tr>
<tr>
<td>big_tables</td>
<td>OFF</td>
</tr>
<tr>
<td>block_encryption_mode</td>
<td>aes-128-ecb</td>
</tr>
<tr>
<td>character_set_client</td>
<td>utf8mb4</td>
</tr>
<tr>
<td>character_set_connection</td>
<td>utf8mb4</td>
</tr>
<tr>
<td>character_set_results</td>
<td>utf8mb4</td>
</tr>
<tr>
<td>character_set_server</td>
<td>utf8mb4</td>
</tr>
<tr>
<td>collation_connection</td>
<td>utf8mb4_0900_ai_ci</td>
</tr>
<tr>
<td>collation_database</td>
<td>utf8mb4_0900_ai_ci</td>
</tr>
<tr>
<td>collation_server</td>
<td>utf8mb4_0900_ai_ci</td>
</tr>
<tr>
<td>completion_type</td>
<td>NO_CHAIN</td>
</tr>
<tr>
<td>cte_max_recursion_depth</td>
<td>1000</td>
</tr>
<tr>
<td>default-storage-engine</td>
<td>InnoDB</td>
</tr>
<tr>
<td>--default_tmp_storage_engine</td>
<td>InnoDB</td>
</tr>
<tr>
<td>default_week_format</td>
<td>0</td>
</tr>
<tr>
<td>div_precision_increment</td>
<td>4</td>
</tr>
<tr>
<td>end_markers_in_json</td>
<td>OFF</td>
</tr>
</tbody>
</table>
Table 13-14  (Cont.) User Settable Session Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>eq_range_index_dive_limit</td>
<td>200</td>
</tr>
<tr>
<td>foreign_key_checks</td>
<td>ON</td>
</tr>
<tr>
<td>generated_random_password_length</td>
<td>20</td>
</tr>
<tr>
<td>group_concat_max_len</td>
<td>1024</td>
</tr>
<tr>
<td>group_replication_consistency</td>
<td>BEFORE_ON_PRIMARY_FAILOVER</td>
</tr>
<tr>
<td>information_schema_stats_expiry</td>
<td>86400</td>
</tr>
<tr>
<td>innodb_ddl_buffer_size</td>
<td>1048576</td>
</tr>
<tr>
<td>innodb_ddl_threads</td>
<td>4</td>
</tr>
<tr>
<td>innodb_ft_enable_stopword</td>
<td>ON</td>
</tr>
<tr>
<td>innodb_ft_user_stopword_table</td>
<td>NULL</td>
</tr>
<tr>
<td>innodb_lock_wait_timeout</td>
<td>50</td>
</tr>
<tr>
<td>innodb_parallel_read_threads</td>
<td></td>
</tr>
<tr>
<td>internal_tmp_mem_storage_engine</td>
<td>TempTable</td>
</tr>
<tr>
<td>join_buffer_size</td>
<td>262144</td>
</tr>
<tr>
<td>lc_messages</td>
<td>en_US</td>
</tr>
<tr>
<td>lc_time_names</td>
<td>en_US</td>
</tr>
<tr>
<td>lock_wait_timeout</td>
<td>86400</td>
</tr>
<tr>
<td>long_query_time</td>
<td>10</td>
</tr>
<tr>
<td>max_allowed_packet</td>
<td>67108864</td>
</tr>
<tr>
<td>max_execution_time</td>
<td>0</td>
</tr>
<tr>
<td>max_heap_table_size</td>
<td>16777216</td>
</tr>
<tr>
<td>max_join_size</td>
<td>18446744073709551615</td>
</tr>
<tr>
<td>max_length_for_sort_data</td>
<td>4096</td>
</tr>
<tr>
<td>max_points_in_geometry</td>
<td>65536</td>
</tr>
<tr>
<td>max_seeks_for_key</td>
<td>18446744073709551615</td>
</tr>
<tr>
<td>max_sort_length</td>
<td>1024</td>
</tr>
<tr>
<td>mysqlx_max_allowed_packet</td>
<td>67108864</td>
</tr>
<tr>
<td>mysqlx_read_timeout</td>
<td>30</td>
</tr>
<tr>
<td>mysqlx_wait_timeout</td>
<td>28800</td>
</tr>
<tr>
<td>mysqlx_write_timeout</td>
<td>60</td>
</tr>
<tr>
<td>net_buffer_length</td>
<td>16384</td>
</tr>
<tr>
<td>net_read_timeout</td>
<td>30</td>
</tr>
<tr>
<td>net_retry_count</td>
<td>10</td>
</tr>
<tr>
<td>net_write_timeout</td>
<td>60</td>
</tr>
<tr>
<td>new</td>
<td>OFF</td>
</tr>
<tr>
<td>old_alter_table</td>
<td>OFF</td>
</tr>
<tr>
<td>optimizer_prune_level</td>
<td>1</td>
</tr>
<tr>
<td>optimizer_search_depth</td>
<td>62</td>
</tr>
</tbody>
</table>
### Table 13-14  (Cont.) User Settable Session Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>optimizer_switch</code></td>
<td><code>index_merge_sort_union=on,</code>&lt;br&gt;<code>index_merge_intersection=on,</code>&lt;br&gt;<code>engine_condition_pushdown=on,</code>&lt;br&gt;<code>index_condition_pushdown=on, </code>mrr=on,<code>&lt;br&gt;</code>mrr_cost_based=on,<code>&lt;br&gt;</code>block_nested_loop=on,<code>&lt;br&gt;</code>batched_key_access=off,<code>&lt;br&gt;</code>materialization=on, <code>semijoin=on,</code>&lt;br&gt;<code>loosescan=on, </code>firstmatch=on,<code>&lt;br&gt;</code>duplicateweedout=on,<code>&lt;br&gt;</code>subquery_materialization_cost_based=on,<code>&lt;br&gt;</code>use_index_extensions=on,<code>&lt;br&gt;</code>condition_fanout_filter=on,<code>&lt;br&gt;</code>derived_merge=on,<code>&lt;br&gt;</code>use_invisible_indexes=off,<code>&lt;br&gt;</code>skip_scan=on, <code>hash_join=on,</code>&lt;br&gt;<code>subquery_to-derived=off,</code>&lt;br&gt;<code>prefer_ordering_index=on,</code>&lt;br&gt;<code>hypergraph_optimizer=off,</code>&lt;br&gt;`derived_condition_pushdown=on</td>
</tr>
<tr>
<td><code>optimizer_trace</code></td>
<td><code>enabled=off, one_line=off</code></td>
</tr>
<tr>
<td><code>optimizer_trace_features</code></td>
<td><code>greedy_search=on, range_optimizer=on,</code>&lt;br&gt;<code>dynamic_range=on, repeated_subselect=on</code></td>
</tr>
<tr>
<td><code>optimizer_trace_limit</code></td>
<td>1</td>
</tr>
<tr>
<td><code>optimizer_trace_max_mem_size</code></td>
<td>1048576</td>
</tr>
<tr>
<td><code>optimizer_trace_offset</code></td>
<td>-1</td>
</tr>
<tr>
<td><code>parser_max_mem_size</code></td>
<td>18446744073709551615</td>
</tr>
<tr>
<td><code>print_identified_with_as_hex</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>pseudo_replica_mode</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>pseudo_slave_mode</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>query_alloc_block_size</code></td>
<td>8192</td>
</tr>
<tr>
<td><code>query_prealloc_size</code></td>
<td>8192</td>
</tr>
<tr>
<td><code>range_alloc_block_size</code></td>
<td>4096</td>
</tr>
<tr>
<td><code>range_optimizer_max_mem_size</code></td>
<td>8388608</td>
</tr>
<tr>
<td><code>rbr_exec_mode</code></td>
<td>STRICT</td>
</tr>
<tr>
<td><code>read_buffer_size</code></td>
<td>131072</td>
</tr>
<tr>
<td><code>read_rnd_buffer_size</code></td>
<td>262144</td>
</tr>
<tr>
<td><code>resultset_metadata</code></td>
<td>FULL</td>
</tr>
<tr>
<td><code>secondary_engine_cost_threshold</code></td>
<td>100000.000000</td>
</tr>
<tr>
<td><code>session_track_gtid</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>session_track_schema</code></td>
<td>ON</td>
</tr>
<tr>
<td><code>session_track_state_change</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>session_track_system_variables</code></td>
<td>262144</td>
</tr>
<tr>
<td><code>session_track_transaction_info</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>show_create_table_skip_secondary_engine</code></td>
<td>OFF</td>
</tr>
<tr>
<td>Name</td>
<td>Default Value</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><code>show_create_table_verbosity</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>sort_buffer_size</code></td>
<td>262144</td>
</tr>
<tr>
<td><code>sql_auto_is_null</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>sql_big_selects</code></td>
<td>ON</td>
</tr>
<tr>
<td><code>sql_buffer_result</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>sql_mode</code></td>
<td><code>ONLY_FULL_GROUP_BY, STRICT_TRANS_TABLES, NO_ZERO_IN_DATE, NO_ZERO_DATE, ERROR_FOR_DIVISION_BY_ZERO, NO_ENGINE_SUBSTITUTION</code></td>
</tr>
<tr>
<td><code>sql_notes</code></td>
<td>ON</td>
</tr>
<tr>
<td><code>sql_quote_show_create</code></td>
<td>ON</td>
</tr>
<tr>
<td><code>sql_safe_updates</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>sql_select_limit</code></td>
<td>18446744073709551615</td>
</tr>
<tr>
<td><code>sql_warnings</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>thread_pool_high_priority_connection</code></td>
<td>0</td>
</tr>
<tr>
<td><code>time_zone</code></td>
<td>UTC</td>
</tr>
<tr>
<td><code>tmp_table_size</code></td>
<td>16777216</td>
</tr>
<tr>
<td><code>transaction_alloc_block_size</code></td>
<td>8192</td>
</tr>
<tr>
<td><code>transaction_isolation</code></td>
<td><code>REPEATABLE-READ</code></td>
</tr>
<tr>
<td><code>transaction_prealloc_size</code></td>
<td>4096</td>
</tr>
<tr>
<td><code>transaction_read_only</code></td>
<td>OFF</td>
</tr>
<tr>
<td><code>unique_checks</code></td>
<td>ON</td>
</tr>
<tr>
<td><code>updatable_views_with_limit</code></td>
<td>YES</td>
</tr>
<tr>
<td><code>use_secondary_engine</code></td>
<td>ON</td>
</tr>
<tr>
<td><code>wait_timeout</code></td>
<td>28800</td>
</tr>
<tr>
<td><code>windowing_use_high_precision</code></td>
<td>ON</td>
</tr>
</tbody>
</table>
User and Group Management

MySQL HeatWave on AWS uses predefined OCI IAM groups and policies to manage access to the MySQL HeatWave Console. Predefined groups and policies are created when the service is provisioned. Defining your own groups and policies for MySQL HeatWave on AWS is currently not supported.

An Administrator grants access to the MySQL HeatWave Console by adding users to the predefined OCI IAM groups. User management is performed in the OCI Console. The policies associated with each group determine which resources that users can access and the permissions associated with those resources. MySQL HeatWave on AWS resources include DB Systems, DB System Backups, and HeatWave Clusters.

Note:
MySQL HeatWave on AWS supports federation with third-party Identity Providers (IdPs). For more information, see Federating with Identity Providers, in the Oracle Cloud Infrastructure documentation.

Groups and Permissions

MySQL HeatWave on AWS has three predefined groups. The groups are created in the OCI Default identity domain. The predefined groups and associated permissions are described in the following tables.

- OracleMySQLHeatwaveDBUsers Group
- OracleMySQLHeatwaveDBAdmin Group
- OracleMySQLHeatwaveServiceAccountAdmin Group
### Table 14-1  OracleMySQLHeatwaveDBUsers Group

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Resources and Permissions</th>
</tr>
</thead>
</table>
| **OracleMySQLHeatwaveDBUsers**: Members of this group can use DB Systems and HeatWave Clusters resources. | DB Systems  
- View Supported Shapes  
- View DB Systems  
- View DB System Details  
- Start DB Systems  
- Restart DB Systems  
- Update DB Systems  
- Stop DB Systems  
- Run Queries  
- View Query Status  
- Stop Queries  
DB System Backups  
- Create DB System Backups  
HeatWave Clusters  
- View HeatWave Clusters  
- View HeatWave Cluster Details  
- Create HeatWave Clusters  
- Start HeatWave Clusters  
- Stop HeatWave Clusters |

### Table 14-2  OracleMySQLHeatwaveDBAdmin Group

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Resources and Permissions</th>
</tr>
</thead>
</table>
| **OracleMySQLHeatwaveDBAdmin**: Members of this group can manage all aspects of DB Systems, DB System Backups, and HeatWave Clusters resources. | In addition to **OracleMySQLHeatwaveDBUsers** group permissions, this group has these permissions:  
DB Systems  
- Create DB Systems  
- Delete DB Systems  
DB System Backups  
- View DB System Backups  
- View DB System Backup Details  
- Delete DB System Backups  
HeatWave Clusters  
- Delete HeatWave Clusters |

### Table 14-3  OracleMySQLHeatwaveServiceAccountAdmin Group

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Resources and Permissions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OracleMySQLHeatwaveServiceAccountAdmin</strong>: Members of this group can manage all aspects of DB Systems, DB System Backups, and HeatWave Clusters resources.</td>
<td>This group has the same permissions as the <strong>OracleMySQLHeatwaveDBAdmin</strong> group.</td>
</tr>
</tbody>
</table>
Groups and Policies

The predefined groups used to manage MySQL HeatWave Console access, described in Groups and Permissions, are created in the OCI Default identity domain. For information, see https://docs.oracle.com/en-us/iaas/Content/Identity/domains/overview.htm#the_default_domain, in the Oracle Cloud Infrastructure Documentation.

The predefined groups all start with OracleMySQLHeatWave. Policies are defined for each predefined group which enable the MySQL HeatWave on AWS resource permissions outlined in Groups and Permissions.

**NOT_SUPPORTED:**

The predefined OracleMySQLHeatWave groups and policies are static. You must not modify them, add to them, or remove them. If you do delete one of these groups, MySQL HeatWave on AWS will stop working. In this case, submit a My Oracle Support ticket to get the group re-added to your account, specifying "MySQL HeatWave on AWS" as the product.

Because the predefined groups are created in OCI, you can define further OCI policies using these groups to provide access to other OCI resources. For example, you can create an OCI policy that allows members of the OracleMySQLHeatwaveDBUsers group to access resources in an OCI tenancy. For information about OCI policies, see How Policies Work.

User Management

User management is performed in the Oracle Cloud Infrastructure (OCI) Console.

MySQL HeatWave on AWS uses predefined OCI IAM groups created in the OCI Default identity domain to manage access to the MySQL HeatWave Console, as described in Groups and Permissions. A MySQL HeatWave on AWS Administrator manages the users that belong to those groups.

To access the Oracle Identity Cloud Service from the Oracle Cloud Infrastructure (OCI) Console, open the navigation menu and click **Identity & Security**.

Alternatively, to access the Oracle Identity Cloud Service from the MySQL HeatWave Console:

1. Sign into the MySQL HeatWave Console as an Administrator. For sign-in instructions, see Signing In.
2. From the profile menu, select **Administration**.
3. Select **Identity Service**.
Refer to Managing Users, in the Oracle Cloud Infrastructure Documentation, for the following user management procedures.

- Creating a user
- Editing a user
- Resetting a user's password
- Deleting a user

Refer to Managing Groups, in the Oracle Cloud Infrastructure Documentation, for the following group-related user management procedures.

**Note:**

The predefined groups used by MySQL HeatWave on AWS are created in the OCI Default identity domain. For more information, see The Default Identity Domain, in the Oracle Cloud Infrastructure Documentation.

- Adding users to groups
- Removing users from groups

To add another user with Oracle Cloud Administrator permissions, see Add a User with Oracle Cloud Administrator Permissions, in the Oracle Cloud Infrastructure Documentation.
This chapter discusses region management, service limits, and billing for MySQL HeatWave on AWS.

Manage Regions

The AWS region is shown at the top of the MySQL HeatWave Console. To change regions, click on **AWS region name**, and select the preferred region.

To add a new region:

1. Click on **AWS region name**, and select **Manage Regions**.
2. Subscribe to an OCI region.
   a. Click **Subscribe** next to the OCI region that maps to the preferred AWS region. If a region limit increase is required, do the following to request an increase:
      i. From the **Limit increase needed** dialog box, click **Open Service Options**.
      ii. Follow these steps: Requesting a Limit Increase to the Subscribed Region Count.
      iii. When the region limit increase is complete, click **Subscribe** next to the OCI region that maps to the preferred AWS region.
   b. From the **Subscribe to New Region** dialog box, read the privacy notice, and then click **Subscribe**.
3. Enable the MySQL HeatWave on AWS service.
   a. Click **Enable** next to the preferred AWS region.
   b. From the **Enable Service** dialog box, click **Enable**.

Service Limits

A service limit is the quota or allowance set on a resource. MySQL HeatWave on AWS default service limits are shown below. Service limits are per region unless explicitly specified.

To request a service limit increase, submit a My Oracle Support ticket, specifying "MySQL HeatWave on AWS " as the product.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Default Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MySQL Database Block Storage</td>
<td>10 TB</td>
</tr>
<tr>
<td>MySQL Database Manual Backups</td>
<td>40 (for all DB System instances)</td>
</tr>
<tr>
<td>MySQL.32.256GB instances</td>
<td>2</td>
</tr>
<tr>
<td>MySQL.8.64GB instances</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 15-1  (Cont.) Service Limits

<table>
<thead>
<tr>
<th>Resource</th>
<th>Default Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMMySQL.4.32GB instances</td>
<td>1</td>
</tr>
<tr>
<td>MySQL.2.16GB instances</td>
<td>4</td>
</tr>
</tbody>
</table>

Billing

For information about managing service costs, see Billing, Cost Management, and Payments Overview.

Billing for MySQL HeatWave on AWS is managed in the OCI Console.

To access billing information in the Oracle Cloud Infrastructure (OCI) Console, open the navigation menu and select Billing & Cost Management.

Alternatively, to access billing information from the MySQL HeatWave Console:
1. Sign into the MySQL HeatWave Console as an Account Administrator.
2. From the profile menu, select Administration.

Viewing OCID of the Tenancy

Use the Oracle Cloud Infrastructure (OCI) Console to view and copy the OCID of the tenancy.

This task requires the following:
• Access to OCI Console.

Do the following to view and copy the OCID of the tenancy:
1. Open the Oracle Cloud Infrastructure (OCI) Console.
2. Sign in with your Cloud Account Name (sometimes referred to as your tenancy name), user name, and password.
3. In the Oracle Cloud Infrastructure Console home page, click the Navigation menu, and then click Governance & Administration. Under Account Management, click Tenancy Details.
4. In the Tenancy details page, in the Tenancy information tab, click Show or Copy present besides the OCID field to view or copy the OCID of the tenancy respectively.

Manage AWS Access

Use the AWS Management Console to manage AWS access.
Creating an IAM Policy to Access an Amazon S3 Bucket

Use the AWS Management Console to create an IAM policy to access an Amazon S3 bucket. This task requires the following:

• Access to AWS Management Console.
• The name of the Amazon S3 bucket you want to grant access to.

Do the following to create an IAM policy:

1. Open the AWS Management Console and sign in with your credentials.
2. In the AWS Management Console home page, click Services, and click Security, Identity, & Compliance, and then click IAM.
3. In the navigation pane of the Console, under Access management, click Policies, and then click Create policy.

It opens the Specify permissions page.

4. In the Specify permissions page, in the Policy editor section, click JSON, and enter the following Amazon S3 permissions as per the feature you use. For more information on policies, see Generate policies.

• For bulk ingest:

```json
{
    "Version": "2012-10-17",
    "Statement": [

    {
        "Effect": "Allow",
        "Action": [
            "s3:GetObject"
        ],
        "Resource": [
            "arn:aws:s3::<AmazonS3BucketName>/*"
        ]
    }
}
}
```

• For data import:

```json
{
    "Version": "2012-10-17",
    "Statement": [

    {
        "Effect": "Allow",
        "Action": [
            "s3:GetObject"
        ],
        "Resource": [
            "arn:aws:s3::<AmazonS3BucketName>/*"
        ]
    },
     {

```
"Effect": "Allow",
"Action": [  
  "s3:ListBucket"
],
"Resource": [  
  "arn:aws:s3:::<AmazonS3BucketName>"
]
}


• If the objects in the Amazon S3 bucket are encrypted with a customer-managed KMS key, add the following permission for the keys used for encrypting the objects:

```json
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [  
        "kms:Decrypt"
      ],
      "Resource": [  
        "<KmsKeyArn>"
      ]
    }
  ]
}
```

See Using IAM policies with AWS KMS.

5. Resolve any warnings or errors generated during permissions validation, and then click **Next**.

6. In the **Review and create** page, in the **Policy details** section, enter the following:
   - **Policy name**: Specify a name to identify this policy.
   - **Description**: (Optional) Specify a description of the policy.

7. Click **Create policy**.

## Creating an IAM Role to Access an Amazon S3 Bucket

Use the AWS Management Console to create an IAM role for accessing an Amazon S3 bucket.

This task requires the following:

- Access to AWS Management Console.
- IAM policy that specifies the Amazon S3 and/or KMS permissions required for the feature you want to use. See Creating an IAM Policy to Access an Amazon S3 Bucket.
- The tenancy Oracle Cloud Identifier (OCID).
If you want to grant access to a specific DB System, the resource ID of the DB System.

The name of the Amazon S3 bucket you want to grant access to.

Do the following to create an IAM role:

1. Open the AWS Management Console and sign in with your credentials.
2. In the AWS Management Console home page, click Services, and click Security, Identity, & Compliance, and then click IAM.
3. In the navigation pane of the Console, under Access management, click Roles, and then click Create role.
4. In the Select trusted entity panel, do the following:
   a. Select Custom trust policy.
   b. Specify the following trust policy:

   ```json
   {
     "Version": "2012-10-17",
     "Statement": [
       {
         "Effect": "Allow",
         "Action": "sts:AssumeRole",
         "Principal": {
           "AWS": "612981981079"
         },
         "Condition": {
           "StringLike": {
             "sts:ExternalId": "<IDDetails>"
           }
         }
       }
     ]
   }
   ```

   When you are editing a DB System, specify either of the following in <IDDetails>:
   - To grant access to a specific DB System in the tenancy: `<TenancyOCID>/<DBSystemResourceId>`.
   - To grant access to all DB Systems in the tenancy: `<TenancyOCID>/*`.

   When you are creating a DB System, specify the following in <IDDetails>:
   - To grant access to all DB Systems in the tenancy: `<TenancyOCID>/*`.

   Once the DB System is created, update the trust policy to limit access to a specific DB System.

To view the OCID of the tenancy, see Viewing OCID of the Tenancy and to view the resource ID of the DB System, see Viewing DB System Details.
For example:

ocid1.tenancy.oc1...axxxaaaat5j...famyhq/5281bb96-99a1-23fe-a65f-370cd85b979f

ocid1.tenancy.oc1...axxxaaaat5j...famyhq/*

See Using an external ID for third-party access.

5. Resolve any warnings or errors generated during policy validation, and then click Next.

6. In the Add permissions page, search for the policy you created, and select the check box to attach the policy to your new role. See Creating an IAM Policy to Access an Amazon S3 Bucket.

7. Click Next.

8. In the Name, review, and create page, in the Role details section, enter the following:

   • Role name: Enter a name to identify the role.

   • Description: (Optional) Specify a description of the policy.

9. Click Create role.

10. Click the role you just created.

11. In the Summary section, copy the ARN.

After you create the role, enter the role ARN in an existing DB System, or create a new DB System and enter the ARN details. See Editing a DB System and Creating a DB System.
Maintenance

This section describes the maintenance of DB Systems and HeatWave.

Essential patching and maintenance is an automatic process that may include patching the underlying operating system, updating the MySQL Server version, and updating underlying hardware. Maintenance is initiated during the maintenance window defined when creating a DB System. The maintenance window start day and time can be viewed on the **DB System Details** page in the MySQL HeatWave on AWS Console. The maintenance window is a two hour period during which maintenance is initiated. The time required to apply patches and updates may extend beyond the maintenance window and require DB System restarts. See **Viewing DB System Details**.

To change a DB System's Maintenance Window start day or start time, see **Editing a DB System**.

When maintenance is performed, your DB System's status changes to **UPDATING** and the DB System may be unavailable for a short time while the maintenance completes.

**Note:**

DB Systems maintenance is performed when the DB System is in an **ACTIVE** state or an **INACTIVE** state, and the DB System is returned to the same state after the maintenance completes.
Release Notes for MySQL HeatWave on AWS (2023-09-13, General Availability)

- MySQL HeatWave on AWS introduces a faster and easier feature to import data from an Amazon S3 bucket into a MySQL DB System. The data import feature enables you to import data in a variety of formats such as MySQL dump and text files (such as CSV and TSV).
  For more information on the data import feature, see Data Import Feature.

- MySQL HeatWave on AWS supports the bulk ingest feature to import text files (such as CSV and TSV) directly from an Amazon S3 bucket into a MySQL DB System. This method is faster and more efficient in terms of computing and storage consumption. To use the bulk ingest feature, first connect to the DB system, and then import data in an existing or new table using the BULK algorithm.
  For more information on the bulk ingest feature, see Bulk Ingest Feature.

Release Notes for MySQL HeatWave on AWS (2023-08-08, General Availability)

- You can now increase the data storage size of an active DB System online. When the DB System is active and healthy, updating the data storage size of the DB System does not restart the DB System, and you can continue to query it while the storage is being increased. You get elasticity without compromising uptime or performance.
  For more information, see Increasing DB System Storage.

Release Notes for MySQL HeatWave on AWS (2023-07-31, General Availability)

- MySQL HeatWave on AWS now supports auto error recovery. Whenever a HeatWave node fails because of a hardware or a software issue, the cluster becomes unhealthy and error recovery is triggered. During the recovery process, HeatWave automatically attempts to bring the node online and reload data that was previously loaded. This reduces manual intervention and improves service uptime.
  For more information, see HeatWave Cluster Failure and Recovery.
Release Notes for MySQL HeatWave on AWS (2023-07-13, General Availability)

- MySQL HeatWave on AWS is now available in the AWS Europe (Frankfurt) and Europe (London) region. See Region Availability.
- Fast data reload is now available when you pause and resume HeatWave on AWS. Besides storing the HeatWave formatted data in-memory, HeatWave also stores the formatted data in HeatWave storage layer on AWS S3. This enables reload of data in constant time regardless of data size. This capability is now available when you pause and resume the HeatWave cluster. You can now pause the HeatWave cluster when you don't need it to save cost, and resume the cluster very fast when you want to use HeatWave for query acceleration.

Release Notes for MySQL HeatWave on AWS (2023-06-08, General Availability)

- MySQL HeatWave on AWS is now available in the AWS Asia Pacific (Mumbai) region. See Region Availability.

Release Notes for MySQL HeatWave on AWS (2023-05-04, General Availability)

- MySQL HeatWave on AWS is now available in the AWS Asia Pacific (Tokyo) region. See Region Availability.

Release Notes for MySQL HeatWave on AWS (2023-04-27, General Availability)

- HeatWave Scale-out Data Management on AWS S3
  MySQL HeatWave on AWS now provides an optimized storage layer built on AWS S3 to store the HeatWave in-memory hybrid columnar representation of the data. This allows data to be reloaded to each HeatWave node independently and in parallel. This significantly improves the service uptime and performance of operations such as error recovery, maintenance, and system restart. See HeatWave Architectural Features.
- MySQL Autopilot: Auto Error Recovery from MySQL failure
  With Auto Error Recovery, now when MySQL fails and restarts, the HeatWave Cluster automatically restarts, identifies the tables which were loaded prior to the failure, and reloads those tables automatically from MySQL. This reduces the intervention by the user and also improves service uptime.
- Auto reload of data in HeatWave Cluster after MySQL upgrade
  HeatWave now automatically reloads data from MySQL InnoDB after a MySQL node restarts due to maintenance upgrades or planned restarts. With auto-reload capability, there are no more manual steps after maintenance or a restart.
operation. This reduces the operational overhead and improves service availability.

- **MySQL Autopilot for OLTP - Auto Shape Prediction**
  Auto shape prediction collects the most recent query execution metrics and uses advanced machine learning models to predict the MySQL database instance shape for optimal transactional processing performance. Auto shape prediction continuously monitors OLTP workload to provide a suggestion that will adapt to evolving workload patterns, allowing the MySQL DB System to maintain the best OLTP price performance over time. See Autopilot Shape Advisor.

Monitor MySQL statistics such as buffer pool usage, workload activity and access patterns, and recommendations for the optimal MySQL shape for the workload with MySQL HeatWave Console.

- **MySQL Configuration**
  Use MySQL HeatWave Console to view and configure user, system, initialization, and service-specific variables for the MySQL DB System shape with or without HeatWave support. Select a default configuration or create a custom configuration for the DB system. See Configuration.

- **Automatic Backup**
  MySQL HeatWave on AWS now support automatic backups. Choose a time for automatic backups during the creation of a MySQL DB System. The retention period can be between 1 and 35 days. The default retention period is 7 days. Scheduled backups are deleted when the DB System is deleted. See Creating a DB System.