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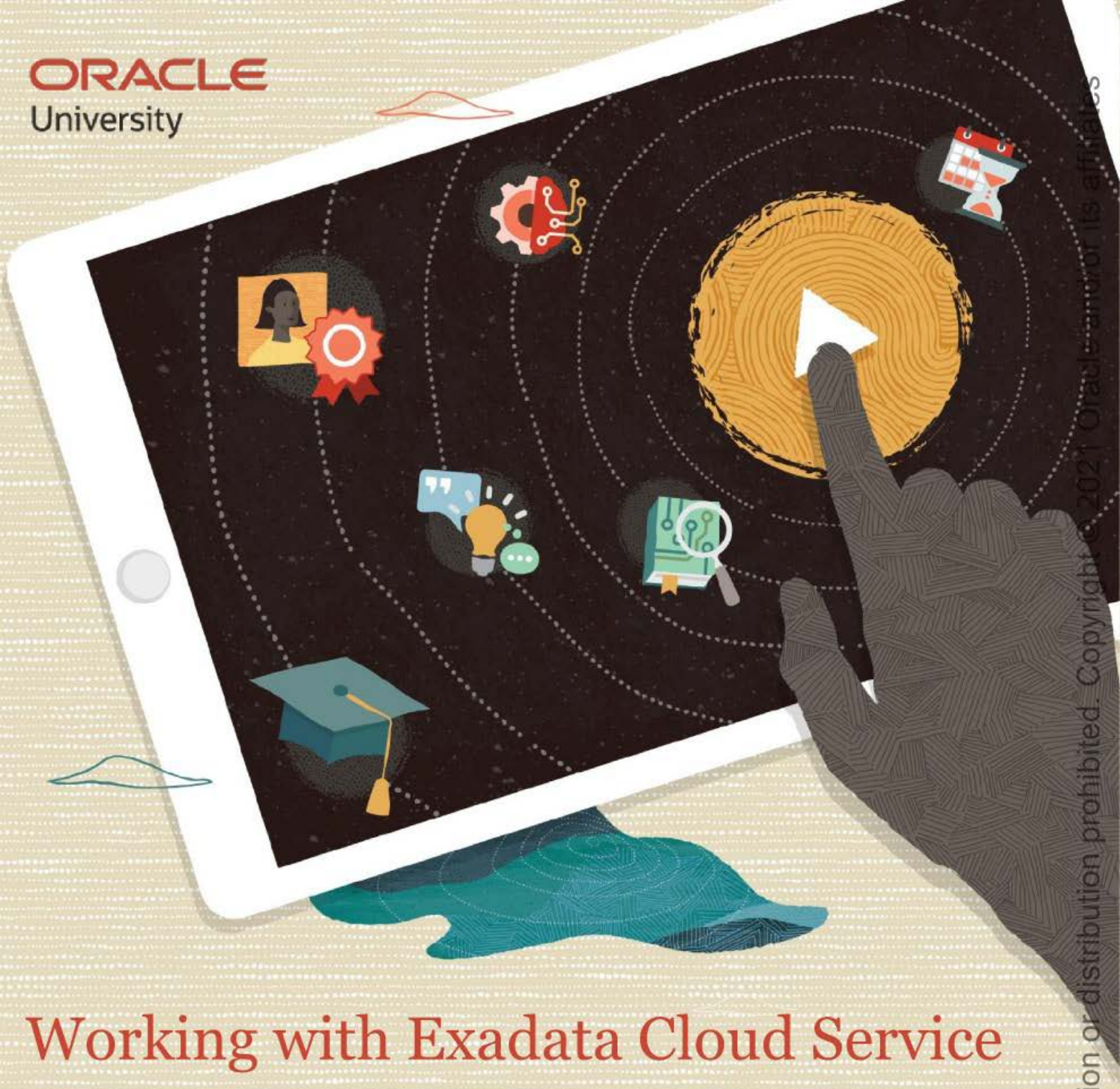

Working with Exadata Cloud Service

Student Guide

S1102501GC10

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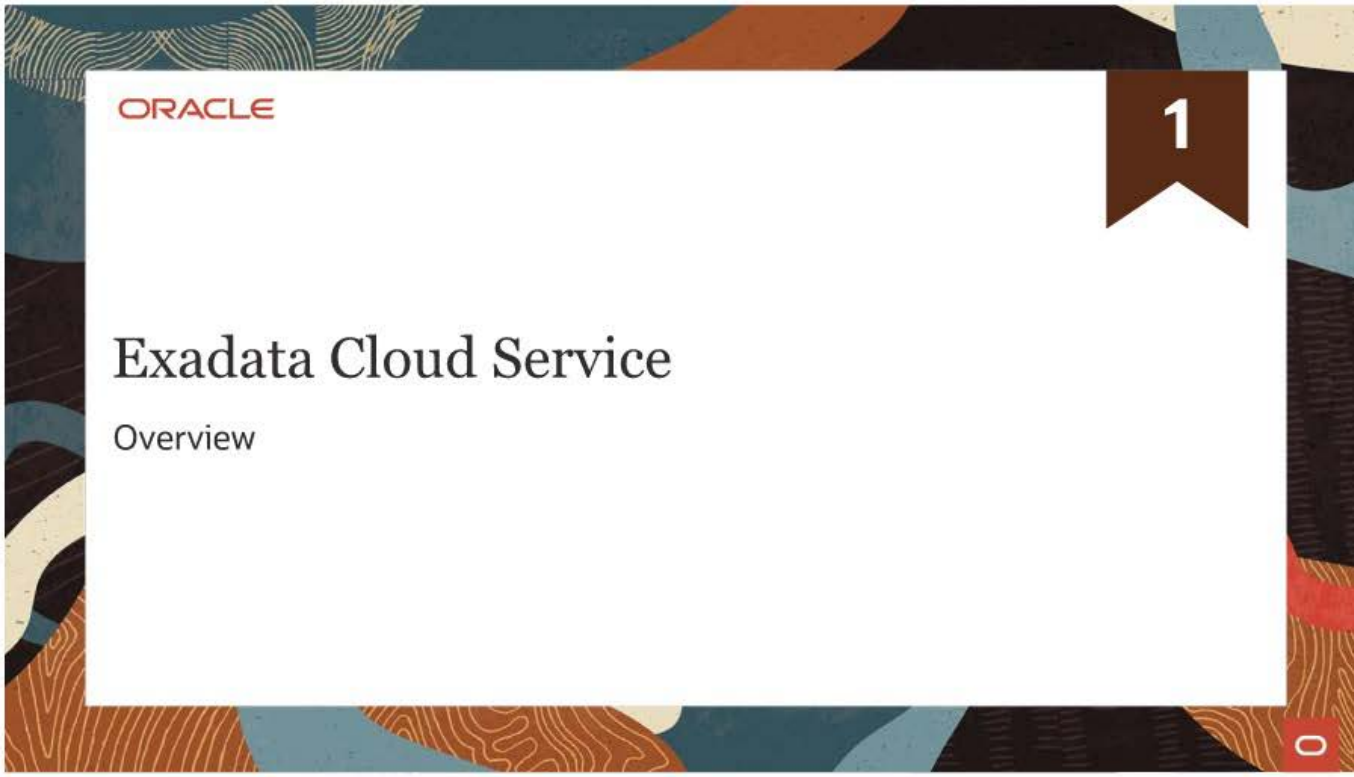
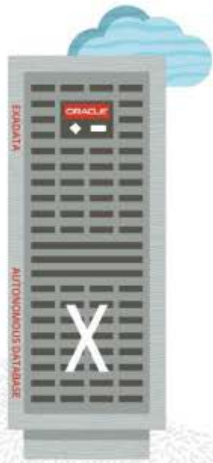


Exadata Vision

Extreme Performance and Availability at Lowest Cost

- Ideal Database Hardware – scale-out, database-optimized compute, networking, and storage for fastest performance and lowest cost
- Database Aware System Software – specialized algorithms vastly improve OLTP, analytics, consolidation
- Automated Management – fully automated and optimized configuration, performance, fault-tolerance, updates

Identical On Premises and in the Cloud



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Exadata is the best platform for running the Oracle database. It provides superior performance, scalability, security, and availability at the lowest cost. Deep engineering integrates the hardware and software to create this optimized database platform. We use the best hardware available on the market, but what makes Exadata special is the smart database-aware system software. This software implements specialized algorithms to improve all types of workloads including OLTP, analytics, batch processing, and of course, consolidation. We then combine that with smart management tools to make Exadata easy to manage and to ensure that it is always deployed and configured consistent with best practices. Exadata is available both on premises and in the cloud. It's the Exadata deployment in Oracle Cloud known as Exadata Cloud Service.

Oracle Exadata Cloud Service

Oracle Database as a service running on Exadata:

- With all advanced database options or bring your own license
- 100 percent compatible with existing applications that use Oracle Database

With simplicity and elasticity benefits of Public Cloud:

- Elastic scaling
- Pay per use
- Oracle experts manage all infrastructure
- User-controlled database automation

Production since 2016

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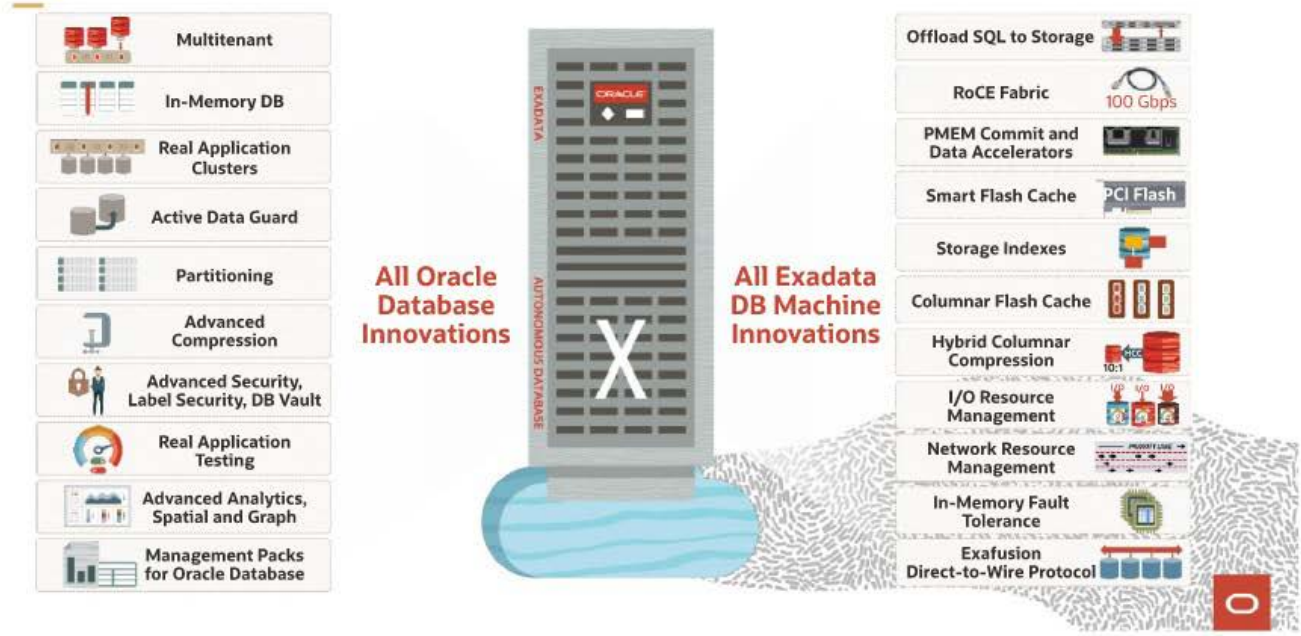
What is Exadata Cloud Service? It's the Oracle database running as a service on an Exadata, in Oracle Cloud Infrastructure. It includes all the advanced database features and options available for the Oracle database. You can license everything as a service or bring your on-premises licenses to the cloud. Since it runs the same Oracle database you run on premises, it is 100 percent compatible with any existing applications. For all practical purposes, it looks exactly like an Oracle Database running on an Exadata on-prem. The big difference is the public cloud features and benefits—specifically, the simplicity and elasticity. Elastic scaling means you can grow and shrink your service to match your workload requirements. This means you only pay for what you use, and this pay-per-use capability is how you can really lower your total cost of ownership. In addition, Oracle will manage all the infrastructure for you, so you can focus on your business, and not on infrastructure. And, for those operations you do continue to manage, Exadata Cloud Service provides sophisticated automation, making most operations as easy as pushing a button.

Exadata Cloud: Most Powerful Database + Platform



This is just a quick summary of some of the capabilities you get with Exadata Cloud Service. On the left are all the features available in the Oracle database. On the right are all the Exadata innovations available with the platform. Everything you expect from Exadata is available with the Exadata Cloud Service.

Exadata Cloud Service Shapes

Shapes	Base System*	X8M
Minimum Configuration	Quarter Rack	**Quarter Rack**
Minimum # of Database Servers	2	**2**
Minimum # of Storage Servers	3	**3**
OCPUs per Database Server	24	**50**
Memory per Database Server	360 GB	**1,390 GB**
Usable Capacity per Storage Server	25 TB	**50 TB**
Fabric Network	InfiniBand	**RoCE**
Persistent Memory (PMEM)	No	**Yes**
Shape Options	Quarter	**Multi-Rack**
Shape Expansion	Not Expandible Requires migration to a different shape	**Elastic Server Expansion**

* Base System is hardware generation agnostic and could be based on Exadata Cloud Service X6, X7, or X8 hardware

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Currently, Exadata Cloud Service is available in multiple shapes. Customers can choose an entry-level base system that is not expandible or subscribe to the Exadata Cloud Service X8M. The X8M shapes start with a Quarter Rack and allow elastic expansion by adding additional database and storage servers to enable higher compute and storage capacity. As you can see from the table, the individual database and storage servers in the base system also have only a fraction of the OCPU and memory resources as well as storage capacity that is available in Exadata Cloud Service X8M. And Exadata Cloud Service X8M benefits from the performance improvements associated with persistent memory (PMEM) and RoCE. More on that in a minute . . .

Introducing Exadata Cloud Service X8M

State-of-the-art hardware improvements over previous generations:

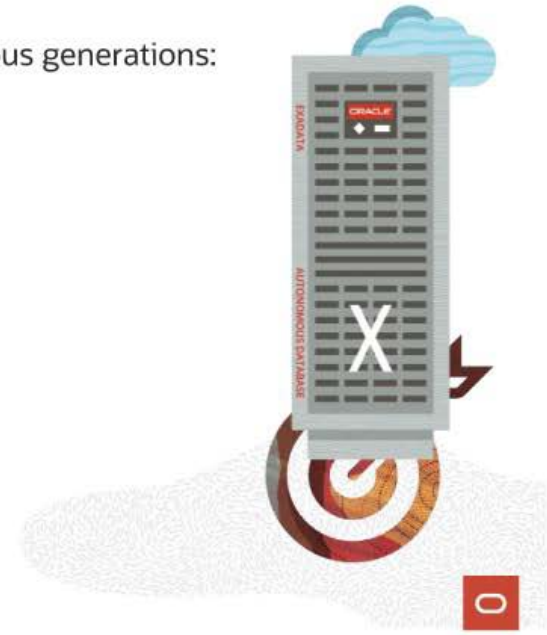
- PMEM
- RoCE

Elasticity built into the platform from the start:

- Configure what you need
- Pay only for what you use

KVM-based virtualization:

Available in OCI data centers around the globe



What is new with Exadata Cloud Service X8M? We've adopted the hardware innovations of Exadata X8M, specifically the persistent memory, or PMEM, and a new secure network fabric based on RDMA or Remote Direct Memory Access, over Converged Ethernet, known as RoCE. As we will see in a minute, this gives Exadata Cloud Service some great performance benefits. But, perhaps even more interesting, this new Exadata Cloud Service supports elastic configurations, just like its on-premises cousin. This allows you to build arbitrary configurations, independently adding database servers and storage servers. You configure only what you need, which means you pay for only what you need. We also switched from Xen virtualization to KVM virtualization, which means Exadata Cloud Service is now using the same virtualization technology as the rest of the Oracle Cloud.

Cloud-Automated Extreme Performance and Availability

Unique new-generation RAC scale-out for any workload:

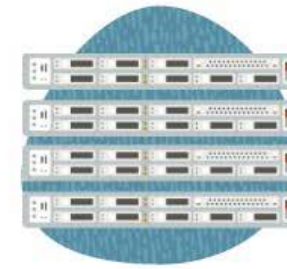
- Application-transparent database scalability and availability

Unique database RDMA accelerates OLTP messaging.

Unique Smart Storage offloads queries and columnizes data for fast analytics.

Unique Fully Active Remote DB Copy:

- Disaster protection, allows SQL read/write, prevents corruptions



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One of the advanced features supported on Exadata Cloud Service is Oracle Real Application Cluster, also known as Oracle RAC. RAC allows you to scale database instances across multiple database servers for greater performance AND higher availability. With Exadata Cloud Service, you can provision Oracle RAC with a single click using Oracle Cloud Infrastructure automation.

Second, we use remote direct memory access, or RDMA, to accelerate OLTP messaging along with SQL reads and writes – more on that in a minute.

Third, one of the really great features of Exadata in general is what we call Smart Scan, which offloads basic operations like SQL queries, analytics processing, and machine-learning algorithms from database server cores to the CPU cores in intelligent storage servers. This has three major effects: It accelerates run times, it frees up database server cores to work on other processing, and it reduces costs – particularly on Exadata Cloud Service – because the CPU cores in intelligent storage servers do not require Oracle Database licenses so you get more work done per database OCPU you enable.

And finally, Exadata Cloud Service offers fully active remote database copies that are typically created for disaster recovery purposes but can also be used for secondary processing such as reporting, QA, or development and testing.

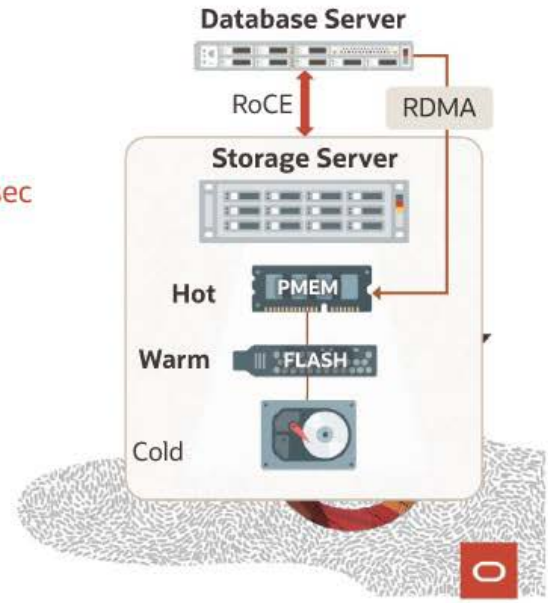
Latency and Throughput

New leading-edge RDMA fabric:

- Based on 100 Gb/sec Converged Ethernet

Persistent memory in storage accessed using RDMA:

- 10X better transaction processing IO latency – 19 usec
- 2.5X higher transaction processing IOs



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RDMA allows the Database CPU cores to read data from and write data directly into the memory of intelligent storage servers, without involving operating system or networking stack overhead.

This combines with the extremely low latency of persistent memory located in intelligent storage servers to lower both SQL read and write latencies, which are two of the most critical factors impacting OLTP performance on a database system. With the combination of RDMA, fast networking, and persistent memory, SQL write latencies are reduced by up to a factor of 8X, read latencies are 10X better – as low as 19 microseconds, and overall transaction processing IOPS are increased by up to 2.5X.

Effectively, this makes Exadata Cloud Service X8M the best place for OLTP in the cloud, with the lowest latencies, highest throughput, and lowest costs (because your workloads consume fewer resources – which is what you're actually paying for).

Fully Elastic Expansion

Start small with a minimum size HA configuration:

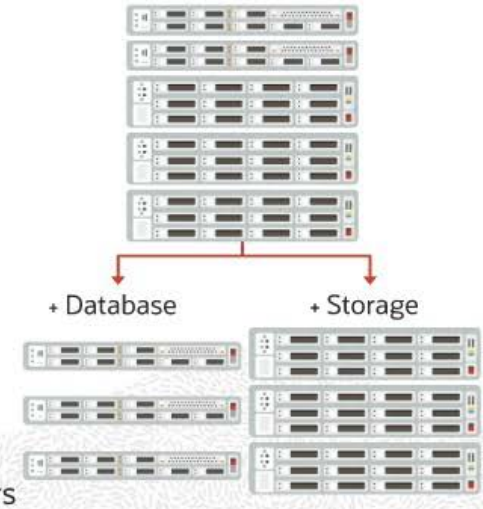
- 2 database servers, 3 storage servers:
  - 100 maximum OCPUs, 2,780 GB DRAM
  - 149 TB usable storage, 76.8 TB Flash, 4.5 TB PMEM

Add database or storage servers as needed.

- Each database server adds:
  - 50 maximum OCPUs, 1,390 GB DRAM
- Each storage server adds:
  - 49.9 TB usable storage, 25.6 TB Flash, 1.5 TB PMEM

Expansion is fully online.

Dedicated infrastructure – no noisy or malicious neighbors



Exadata Cloud Service X8M allows fully elastic expansion. You start out with a small minimum-size configuration with two compute servers and three storage servers that provide full high availability against compute, storage, and networking component failure and allow you to use up to 100 OCPUs and roughly 150TB of storage.

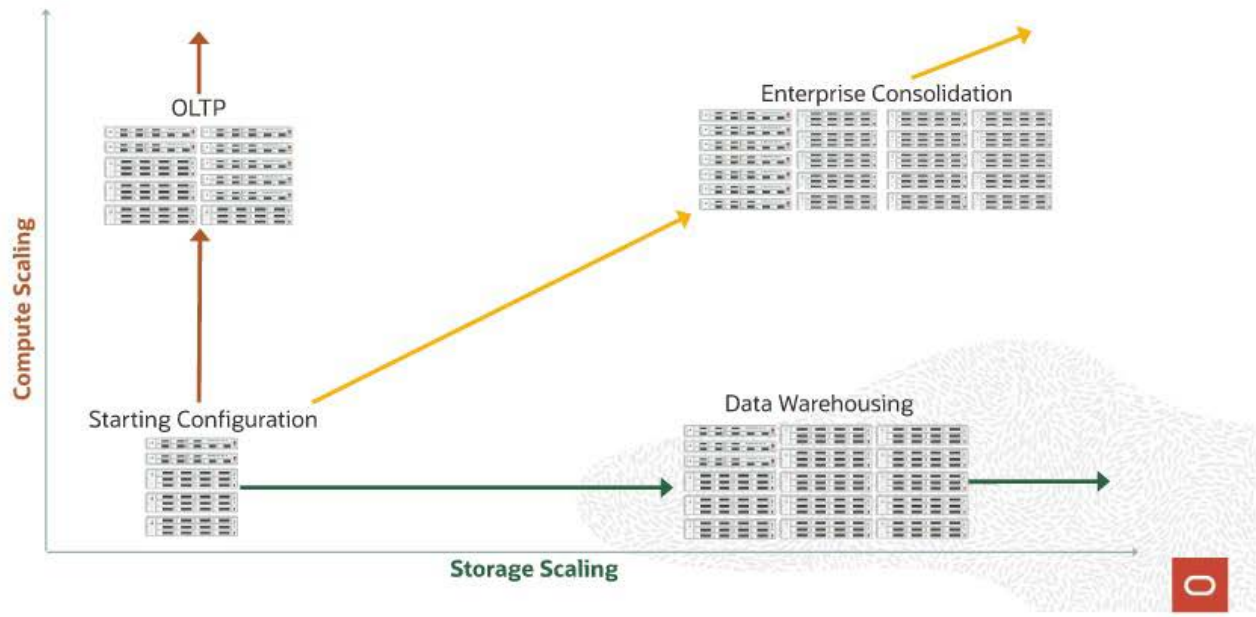
These systems are DEDICATED to you; they aren't shared with other users, so you don't have to worry about noisy neighbor databases impacting performance or malicious attacks from somebody running on a VM on the same system.

Then you can add storage and compute servers as needed.

Each compute server adds 50 usable OCPU cores and nearly 1.4 TB of DRAM for database operations.

Each storage server adds just under 50 TB of database storage, 25 TB of Flash, 1.5 of PMEM, and 48 CPU cores for SQL queries, analytics, etc. – and without requiring database licensing.

Elastic Server Expansion



Let's look at some scaling examples that can be achieved with Exadata Cloud Service X8M.

You can start out "small" with a balanced configuration for general-purpose workloads.

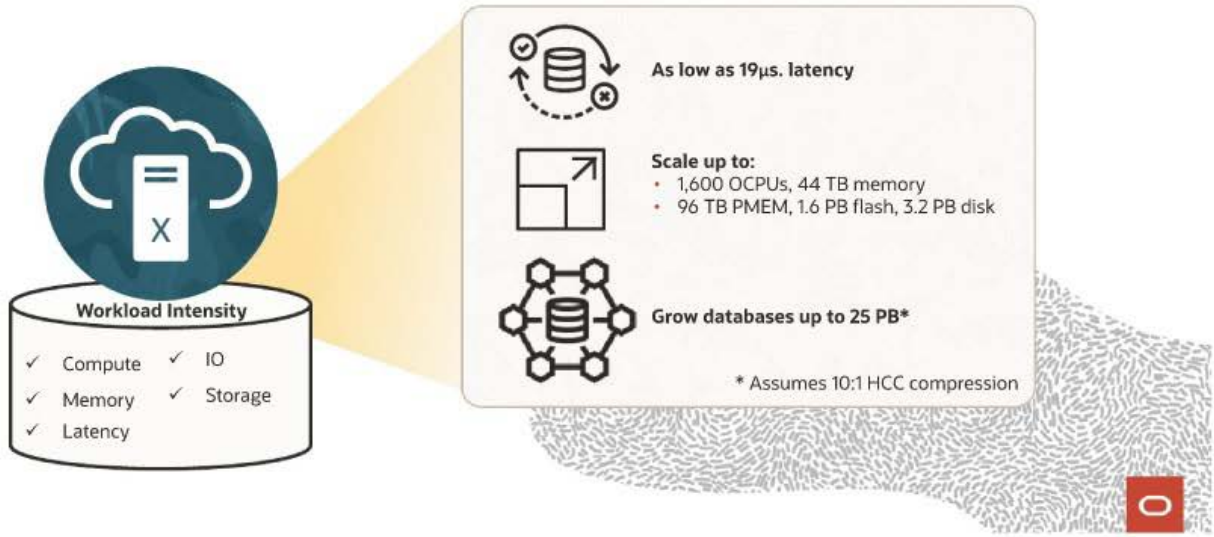
You can choose to add a lot of compute with a little storage to create a system that's highly tuned for OLTP.

Or you can dramatically increase storage capacity without growing compute power for Petabyte data warehouses.

Or you could maintain a balance of compute and storage for consolidating a variety of Oracle Database Workloads.

Ultimately, you run thousands of databases in a single service, creating what amounts to a private cloud using public cloud resources and economics.

Exadata Cloud Service Delivers Massive Performance and Scale



Exadata is co-engineered with the Oracle Database enabling Exadata Cloud Service to provide the best data management platform in the cloud. On top of that, Exadata Cloud Service delivers massive scalability built on a maximum availability architecture supporting up to 1,600 OCPU and databases as large as 25 PB compressed assuming a 10:1 ratio with HCC.

Imagine the costs and efficiencies you could save by consolidating databases on to one service.

Simply stated – no database is too demanding or workload too large for ExaCS.

Service Overview

Service Operation:

- Oracle owns and manages the Exadata Infrastructure; customers configure and manage the OS and databases.
- Releases support Exadata hardware and software.
- Oracle Database 19c, 18c, 12.2.0.1, 12.1.0.2, 11.2.0.4

Deployment:

- Available in Oracle Cloud Infrastructure (OCI) data center regions
- Choose OCI region, configure private software-defined network (VCN), configure ExaCS, and deploy databases

Life Cycle:

- Automated UI, CLI, SDK, API-provisioning, scaling, patching, backup, disaster recovery

Subscription and Licensing:

- Pay for the infrastructure with minimum 48-hour usage
- Pay-per-use OCPU scaling with per second billing
- Choice of license included or Bring Your Own License (BYOL)
- Support for both UCM and pay as you go (PAYG)

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In terms of service operation, Oracle manages the Exadata infrastructure. And as I just mentioned, customers manage everything running in the database VM.

As you would expect, both the Exadata hardware and software releases are supported with Exadata Cloud Service, and the service currently supports Oracle Database versions 11.2.0.4 to 19c.

Exadata Cloud Service simplifies life cycle tasks such as provisioning, scaling, patching, backup, and disaster recovery through cloud automation.

And with Exadata Cloud Service, customers benefit from cloud economics and only pay for what they use. Customers pay for database and storage server infrastructure with a 48-hour minimum. Customers also pay for the OCPUs with per second billing, and they have a choice of a license included or bring your own license pricing model. More on that in a minute …

Management Interfaces

Oracle Cloud Web-Based UI:

- Browser access via https: great for one-time actions and ad hoc tasks

Oracle Cloud REST APIs:

- Programmatic access via https

Software Development Kit (SDK):

- Build and deploy apps that integrate with Oracle Cloud Infrastructure services
- Java SDK, Python SDK, Ruby SDK, Go SDK

Command-Line Interface (CLI):

- Extend the console's functionality
- Convenient for developers and others to automate tasks through scripting

Terraform:

- Programmatically manage, version, and persist your IT infrastructure as code

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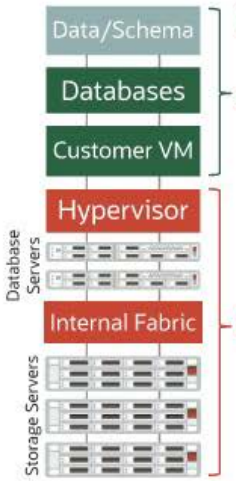
Exadata Cloud Service provides a wide choice of management interfaces. The easiest to use is the web-browser interface, which allows you to use a browser to graphically configure and initiate operations. This is great for one-time actions, but most customers prefer a more programmatic interface for things done repeatedly, such as provisioning and patching databases. Anything you can do with the browser you can also do with a corresponding REST API. Similar to the browser, the REST APIs transit the Internet via https and require no special software installed on the local system. All interfaces are also exposed via a command-line interface that can be used for scripting, and for building custom tooling, there is a software development kit to integrate with common languages such as Java, Python, Ruby, and Go. If you prefer to manage your infrastructure as code, there is also a Terraform interface.

Simple Cloud Management Model



Customer owns everything inside database:

- Data, schema, encryption keys

Customer subscribes to database services:

- Customer manages VMs, GI, and databases using Cloud Automation (UI / APIs).
- Automation to create, delete, patch, back up, scale up/down, etc.
- Customer controls access to customer VM.
- Customer can install and manage additional software in customer VM.
- Oracle staff are not authorized to access customer VM.

Oracle owns and manages infrastructure:

- Database servers/VM hosts, storage servers, fabric network
- Patching, security scans, security updates
- Monitoring and maintenance
- Customer not authorized to access Oracle infrastructure

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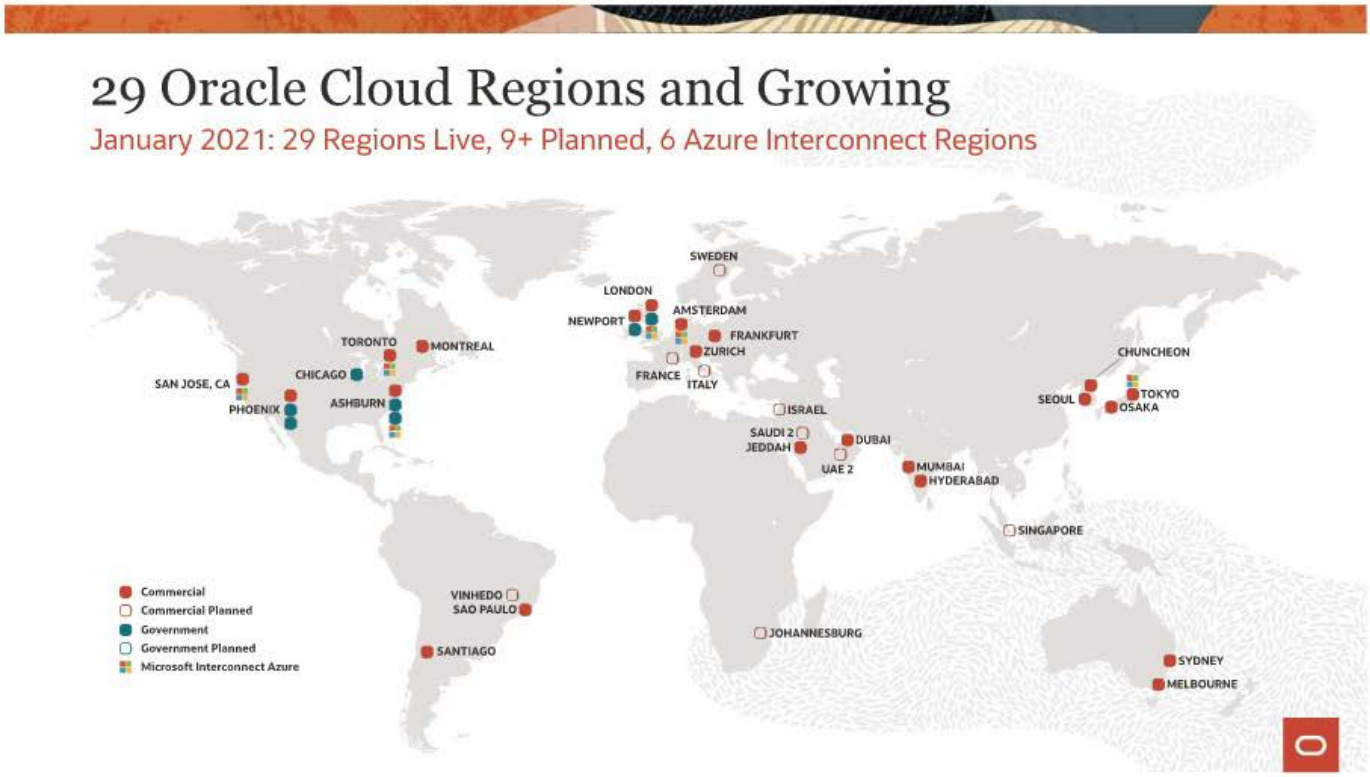
Exadata Cloud Service follows a simple cloud management model.

Oracle owns and manages the infrastructure. This includes the database servers, VM hosts, storage servers, and the fabric network. Customers can schedule maintenance windows for Oracle to performance infrastructure maintenance.

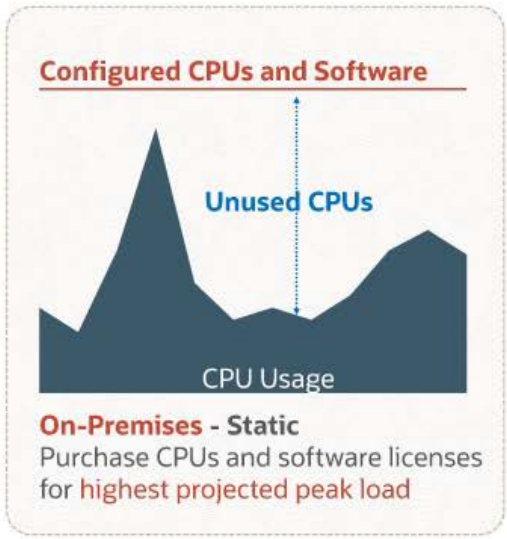
When customers subscribe to Exadata Cloud Service, they are responsible for managing everything running in the database VMs. They manage the VMs, grid infrastructure, and the databases using the cloud automation tools.

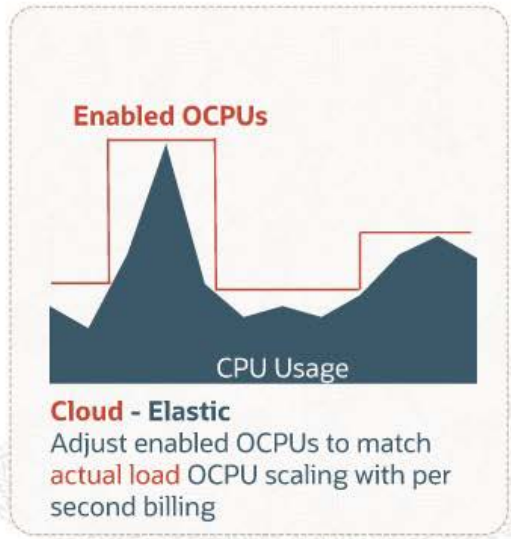
Customers own everything inside the database. This includes data, schema, and encryption keys.



Exadata Cloud Service is available in Oracle Cloud Infrastructure. Here's the latest map of Oracle Cloud Infrastructure regions around the world where Exadata Cloud Service is available.

OCPU Scaling to Reduce Costs





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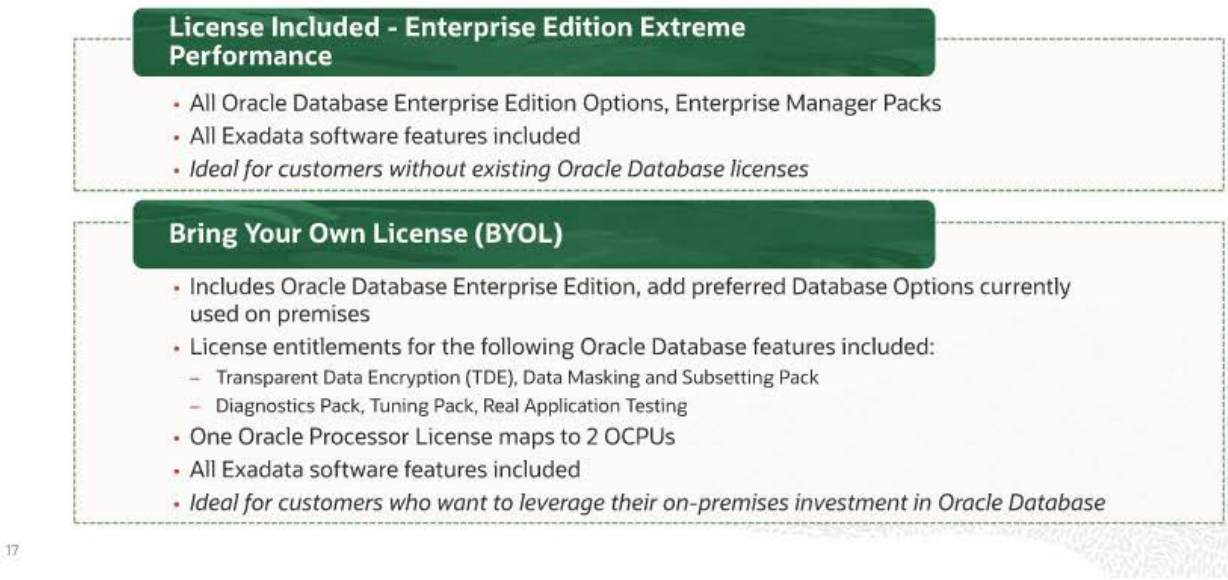
Let's take a minute to look at the importance of vertically scaling your virtual machines. Scaling your VMs as your workload scales up and down is important for reducing your costs and is one of the greatest advantages of cloud over on-premises deployments. When you deploy an on-prem system, you must size it to handle the peak workload, as on-prem deployments do not support scaling up and down. In fact, you probably oversize it a little as it is difficult to scale an on-prem system, and you want to ensure capacity for workload spikes. However, during most normal operations, the system is underutilized, and you are paying licensing fees on unused CPUs. Contrast that with a cloud deployment, where you can scale the service up and down depending on demand. If you have a workload spike, simply scale up to accommodate. If demand drops, scale the system down. Unlike most cloud database services, Exadata allows you to scale online, with no disruption to the database service.

Licensing Is Different in the Cloud – Exadata Cloud Service



Customers have a choice of license models in the cloud. You can subscribe to our Enterprise Edition Extreme Performance service, which includes a license to use all Oracle database features and options as well as all database management packs. It also includes all Exadata software features. This is the best option if you are without existing licenses or have databases with variable workloads that can really benefit from pay-for-use pricing. If you already have all the licenses you need, you can also bring your own licenses to the cloud. Through an inexpensive BYOL platform service, we will provide you entitlements to use Transparent Data Encryption, which is mandatory in the cloud, the Data Masking and Subsetting management pack, Diagnostics pack, Tuning pack, and Real Application Testing. In addition, all Exadata software features are included. Finally, you can switch between the two models at any time, as often as you like. This means, for example, you could use BYOL most of the time, but switch over to the license service to handle infrequent spikes on workload that require more capacity than you have licensed via BYOL.

End-to-End Data Protection

- IAM policy-based access:
  - Customer operations are controlled by defined security policies.
- SSH key pair authentication to the OS:
  - No password-based authentication
- Only SSH permitted by default:
  - All other port accesses must be permitted by customer
- VCN access controls:
  - Private subnet with security lists, route tables, and no public IPs
- Separate networks for client and backup
- All databases have TDE enabled by default
- Database backups are encrypted
- Oracle Native Network Encryption connections are encrypted to and from the database
- Support for Oracle Database Security Options

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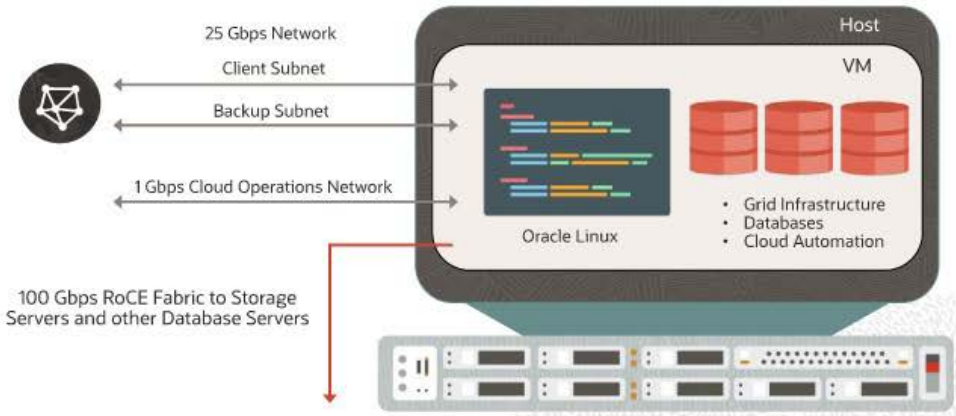
Identity management, network controls, and encryption are built into Exadata Cloud Service to ensure end-to-end data protection. It should also come as no surprise that Exadata Cloud Service supports all Oracle Database Security Options and can be used with Oracle Data Safe.

Objectives

After completing this lesson, you should be able to:

- Describe the network
- Describe and create the Exadata Infrastructure
- Describe and create the VM Cluster
- Describe the storage configuration

Network Architecture



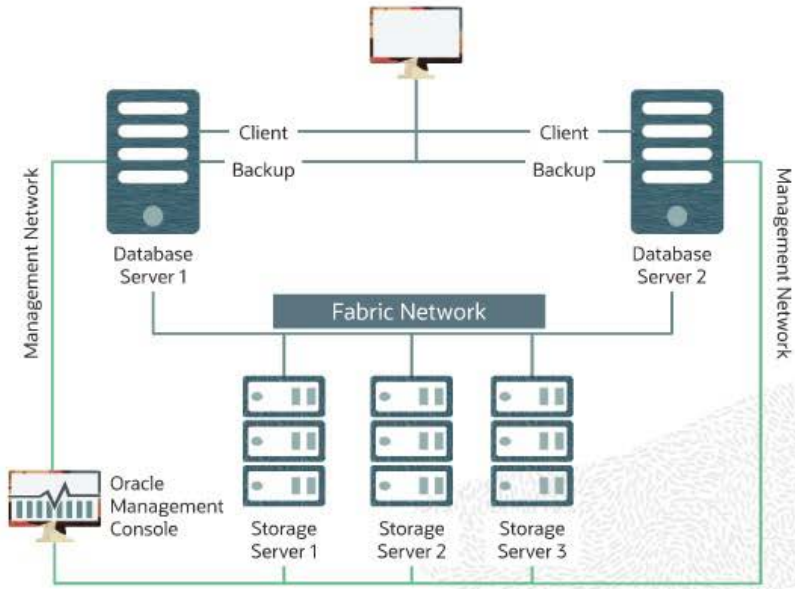
The diagram in the slide outlines the high-level network architecture for Exadata Cloud Service.

Each Exadata Cloud Service instance is hosted on an Exadata, located inside Oracle Cloud Infrastructure. Each Exadata Cloud Service instance provides two networks for customer access:

- You use the **client network** to connect directly to Exadata Cloud Service. This includes client applications connecting through Oracle Net (SQL*Net) running on Oracle Cloud Infrastructure (OCI) Compute instances or clients located outside of Oracle Cloud, such as your on-premises applications. On Exadata Cloud Service, Oracle Native Network Encryption is configured by default to secure data in transit.
- The **backup network** is also provided. This network separates backup traffic from application connections and is used when Exadata Cloud Service database deployments are backed up to Oracle Cloud Object storage.
- **Oracle Cloud Operations Network** is a dedicated network connection used to perform infrastructure management tasks. This network is solely for infrastructure management purposes by Oracle Operations and cannot be accessed by you.

The networks (client and backup) use a Virtual Cloud Network that is defined in OCI. You must use the OCI console or APIs to configure the VCN you plan to use with Exadata Cloud Service.

Service Architecture



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The diagram in the slide illustrates the Exadata Cloud Service architecture for a Quarter Rack containing two database servers and three storage servers. The database servers are clustered together with Real Application Clusters and ASM triple-mirrors the data across the storage servers. The architecture provides redundancy for high availability. Larger service instances are principally the same, except that they contain additional database and storage servers.

The architecture is also essentially the same as for an on-premises implementation of Exadata, with clustered database servers connected to storage servers through a high-speed, low-latency, fabric network.

Application users and administrators can connect only to the database servers, using the supplied client and backup network interfaces.

Oracle owns and manages the infrastructure. This includes the database servers, VM hosts, storage servers, and the fabric network using the separate cloud operations network mentioned earlier. Customers can schedule maintenance windows for Oracle to performance infrastructure maintenance.

Using VCNs and Subnets

- To launch an Exadata Cloud service, you need to set up a Virtual Cloud Network (VCN) and additional networking components.
- VCN should be in the region where you want to provision Exadata Cloud Service.
- Two subnets are required:
  - Client Subnet
  - Backup Subnet
- Regional subnet is recommended, but availability specific domain can also be used.
- Custom route tables are needed for each subnet.

Before you provision Exadata Cloud Service, you will need to configure a dedicated VCN along with networking components such as subnets, route tables, security rules, gateways, and so on.

The Virtual Cloud Network must be in the same region where you want to launch Exadata Cloud Service. Two subnets are required in the VCN for the client subnet and backup subnet. Regional subnets spanning across all the availability domains (ADs) in a region are recommended. However, AD specific subnets can also be created with both client and backup subnets in the same AD.

The client subnet requires 2 IP addresses per node + 3 SCAN IP addresses + 3 IP addresses reserved in the subnet. So, for a 2-database server cluster, that's 10 IP addresses. For a 4-database server cluster, that's 14 IP addresses.

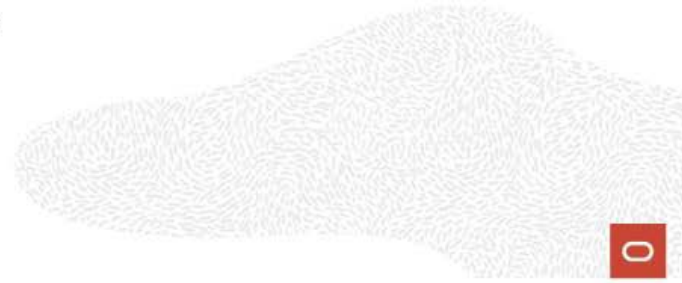
The backup subnet requires 1 IP address per node + 3 IP Addresses reserved in the subnet. So, for a 2-database server cluster, that's 5 IP addresses. For a 4-database server cluster, that's 7 IP addresses.

Custom route tables are required for each subnet along with the security rules to control the traffic to and from the client network and backup network.

You can also configure the VCN with an optional Internet Gateway required for a public subnet to handle public traffic, though this is not recommended. You can also use an optional Service Gateway to privately access Oracle services such as object storage and YUM repositories, an optional NAT Gateway to reach public endpoints not supported by the service gateway, or an optional dynamic routing gateway (DRG) to establish a connection with your on-premises network via IPSec VPN or FastConnect.

Security Rules

- Security rules control the type of the traffic allowed for the client network and backup network.
- Security rules are applied to the database servers
- Security rules are applied to:
  - Both the client and backup network
  - Specifically for the client network
  - Specifically for the backup network



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Security rules control the types of traffic allowed for the client network and backup network. Security rules can be applied to both the client and backup network or specifically for the client network or specifically for the backup network.

If you use security lists to implement your security rules, be aware that the rules that follow are included by default in the default security list. You can update or replace the list to meet your particular security needs. Security rules can be configured in the VCN in two ways by using network security groups or security lists.

DNS in Virtual Cloud Network

- For the nodes to communicate, the VCN must use the Internet and VCN resolver.
  - Enables hostname assignment to the nodes and DNS resolution of those hostnames by resources in the VCN
  - Enables round robin resolution of database SCANs
- When you create the VCN, subnets, and Exadata VM Cluster, you must carefully set the following identifiers, which are related to DNS in the VCN:
  - VCN domain label
  - Subnet domain label
  - Hostname prefix for the Exadata VM cluster

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Domain Name Resolution (DNS) is used to resolve hostnames of the instances without using IP addresses. For the nodes to communicate, the VCN must use the Internet and VCN resolver. It enables hostname assignment to the nodes and DNS resolution of those hostnames by resources in the VCN. It also enables round robin resolution of database SCANs.

When you create the VCN, subnets, and Exadata VM Cluster, you must carefully set the following identifiers, which are related to DNS in the VCN:

- VCN domain label
- Subnet domain label
- Hostname prefix for the Exadata VM cluster

For more information on OCI networking, refer to the OCI training courses and documentation.

New Resource Model

- New resource model separates the Exadata Infrastructure and VM Cluster into separate resources.
- Cloud Exadata Infrastructure resource:
  - Manages the infrastructure – database and storage servers
  - Schedule infrastructure maintenance
  - Enables the expansion of Exadata Cloud Service X8M database and storage servers
- Cloud VM Cluster resource:
  - Manages networking, grid infrastructure, OS, database homes, databases, IORM
  - Enables the scale up and down of OCPUs
- Replaces DB System resource for Exadata Cloud Service

10

You need two resources, a cloud Exadata Infrastructure and a cloud VM Cluster, when you provision Exadata Cloud Service.

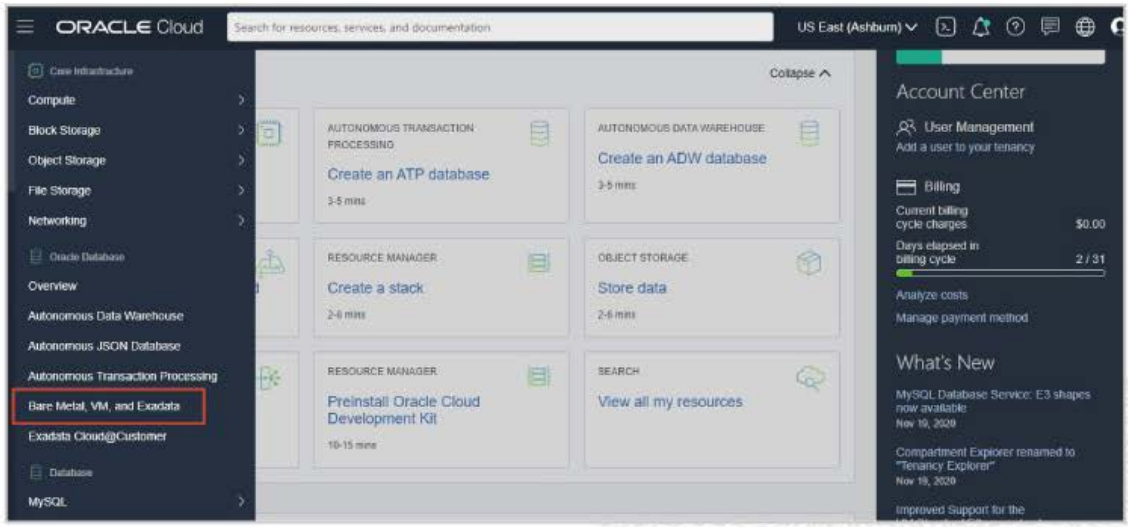
Exadata Cloud Service was historically offered in fixed configuration shapes and used the DB System as the resource in OCI. Even though this approach was easy to use, it didn't offer much flexibility. With the release of Exadata Cloud Service X8M, a new resource model was released that separates the Exadata Infrastructure and VM Cluster into separate resources. All previous generation hardware Exadata Cloud Service shapes can switch to the new resource model.

Exadata Cloud Service provisioning starts with the Exadata Infrastructure resource. It enables the management of the infrastructure itself, that is, the database and storage servers. Because the Infrastructure resource acts as a top-level resource, its provisioning is done first. Database and Storage server expansion as well as scheduling Infrastructure maintenance is done with the Exadata Infrastructure resource.

The VM Cluster resource manages the networking, OCPUs, grid infrastructure, OS, database homes, databases. This is also where you define details of client and backup subnets, OCPUs, IORM, database maintenance, and so on.

At the time when this course was created, Exadata Cloud Service only supports a single VM cluster.

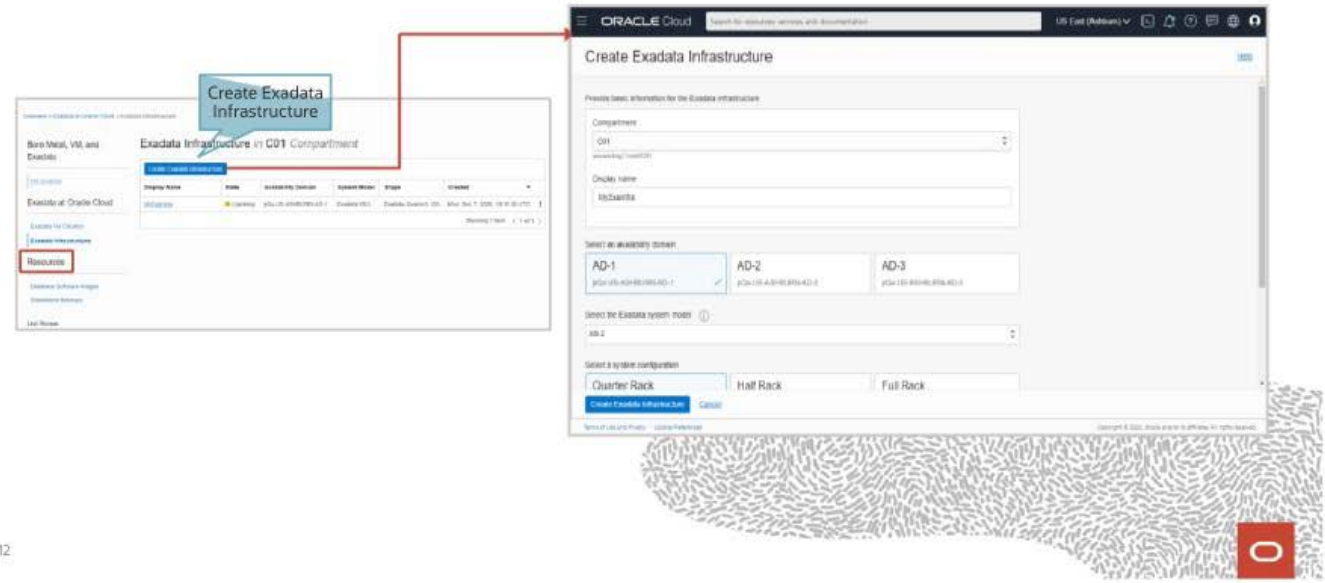
Oracle Cloud Infrastructure Console



The Oracle Cloud Infrastructure (OCI) console enables access to web consoles for various OCI cloud services, including Exadata Cloud Service. You can use the navigation menu in the upper-left corner to navigate to the service pages where you can create, manage, and view your cloud resources. Exadata Cloud Service is located in the Exadata at Oracle Cloud section under Bare Metal, VM, and Exadata.

In order to create and manage Exadata Cloud Service, the appropriate IAM policies must be granted, and the tenancy needs to have the appropriate service limits.

Creating Exadata Infrastructure Resource



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As you would expect, the Exadata Create Infrastructure page allows you to create the Exadata Infrastructure resource.

Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.

Under **Exadata at Oracle Cloud**, click **Exadata Infrastructure**.

Click **Create Exadata Infrastructure**.

Compartment: Select a compartment for the Exadata infrastructure.

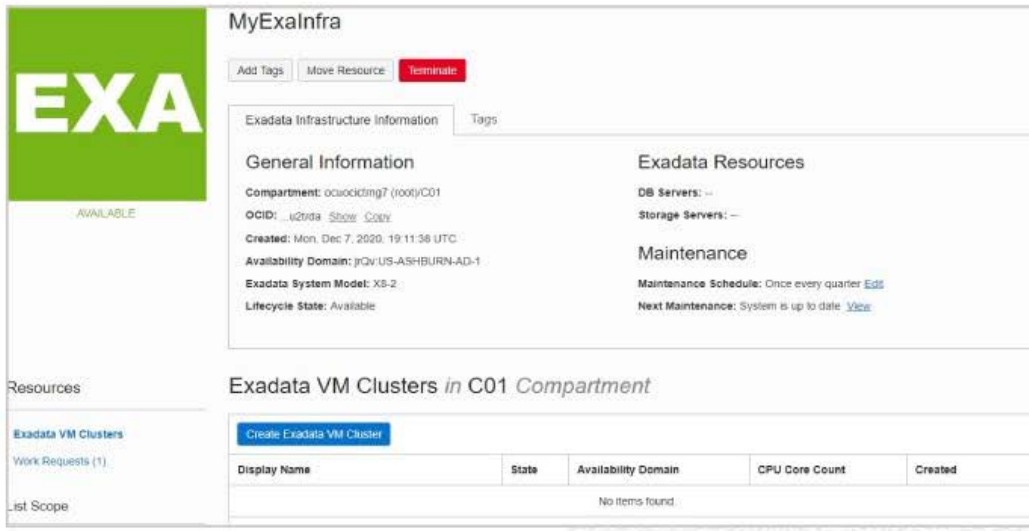
Display name: Enter a display name for the Exadata infrastructure. The name doesn't need to be unique. An Oracle Cloud Identifier (OCID) will uniquely identify the cloud Exadata infrastructure resource.

Select an availability domain: The **availability domain** in which the Exadata infrastructure resides

Select the Exadata system model: Select either a fixed-shape system (quarter, half, or full rack X7-2 or X8-2 shapes) or a scalable system (X8M-2).

If you select the flexible X8M-2 system model, your initial Exadata Cloud Service instance will have two database servers and three storage servers (the equivalents of an X8 quarter rack shape). After provisioning, you can scale the service instance as needed by adding additional database and storage servers.

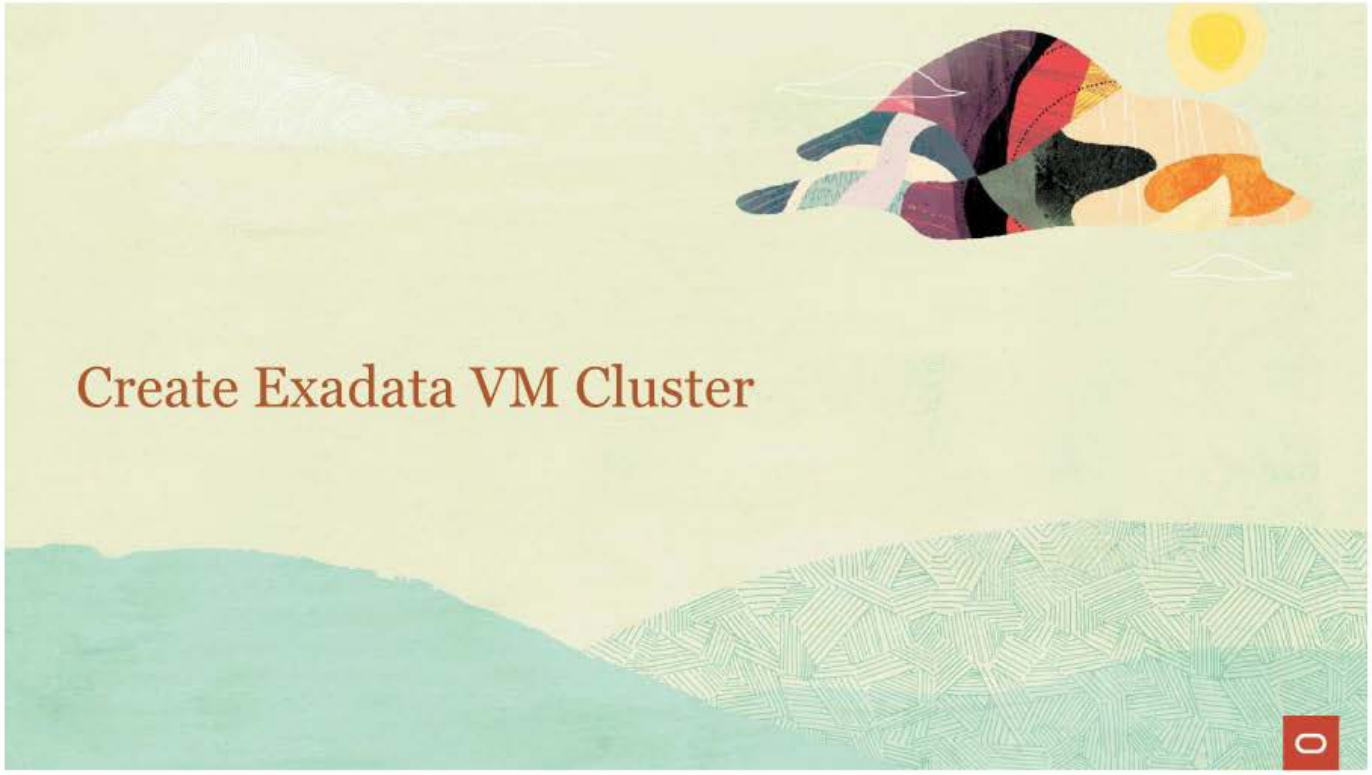
Exadata Infrastructure Resource Details



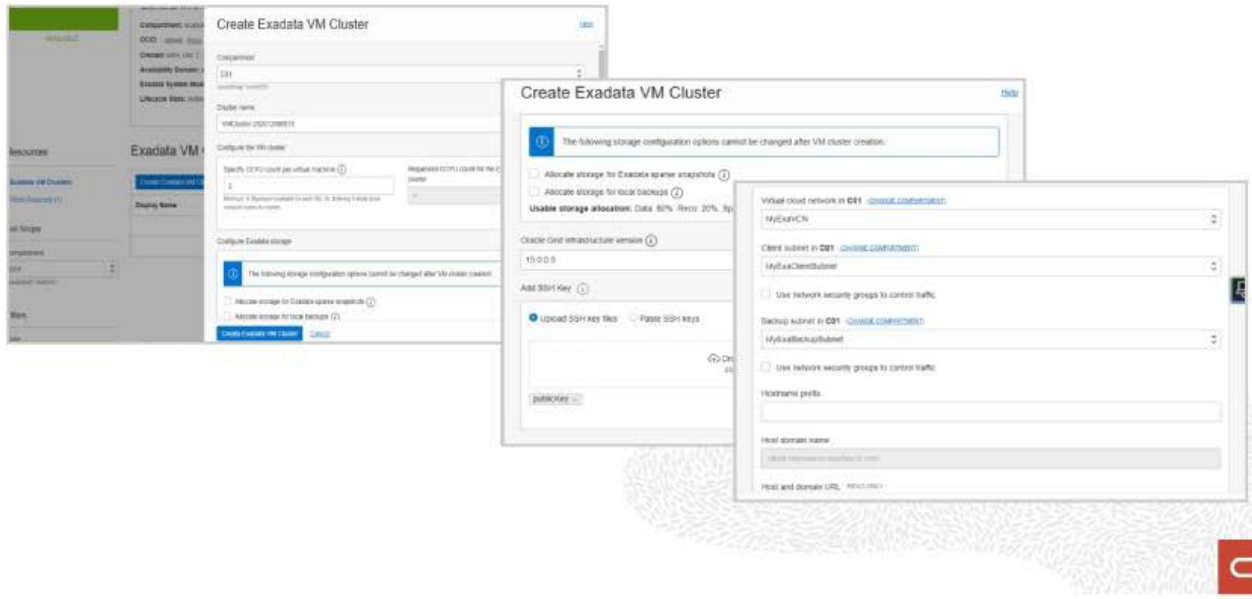
13

Once the infrastructure resource is ready, you can see the details of it.

Because this is just the infrastructure, you need to provision the VM Cluster resource. This can be done using the Create Exadata VM Cluster button as shown in the next couple of slides.



Creating Exadata VM Cluster Resource



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In the navigation menu, under **Oracle Database**, click **Bare Metal, VM**, and **Exadata**.

Under **Exadata at Oracle Cloud**, click **Exadata VM Cluster**.

Click **Create Exadata VM Cluster**.

The Create Exadata VM Cluster page is displayed. Provide the required information to configure the VM cluster.

- **Compartment:** Select a compartment for the VM cluster resource.
- **Display name:** Enter a user-friendly display name for the VM cluster. The name doesn't need to be unique. An Oracle Cloud Identifier (OCID) will uniquely identify the VM Cluster.
- Select **Exadata infrastructure**: Select the infrastructure resource that will contain the VM cluster.

Configure the VM cluster:

- Specify the number of OCPU you want to allocate to each of the VM cluster database servers.
- Configure Exadata storage:
  - Allocate storage for Exadata sparse snapshots
  - Allocate storage for local backups

Add SSH key

Configure the network settings by specifying the following:

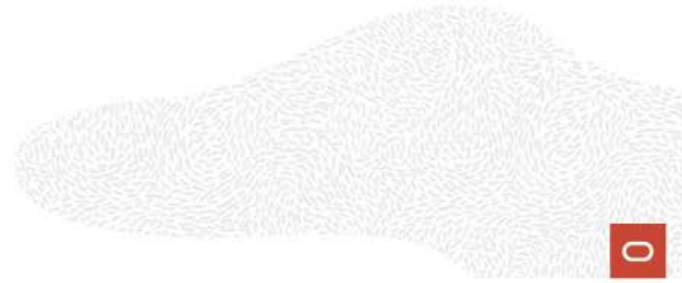
- Virtual Cloud Network
- Client subnet
- Backup subnet
- Network Security Groups
- Hostname prefix

Choose a license type: License Included or Bring Your Own License (BYOL).

Click **Create Exadata VM Cluster.**

Storage Configuration Options

- Configuration options for space allocation:
  - **Allocate storage for local backups**
    - Select this option to allocate more space to the RECO disk group.
  - **Allocate storage for Exadata sparse snapshots**
    - Select this option to create the SPARSE disk group.
- Take care in choosing these options because they cannot be changed.



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When you create an Exadata Cloud Service VM Cluster, you must make decisions that determine how storage space in the Exadata Storage Servers is allocated to the ASM disk groups. The following configuration options are available:

- **Allocate storage for local backups:** Select this option if you intend to perform database backups to the local Exadata storage within your Exadata Cloud Service instance. If you select this option, more space is allocated to the RECO disk group, which is used to store backups on Exadata storage. If you do not select this option, more space is allocated to the DATA disk group, which enables you to store more information in your databases.
- **Allocate storage for Exadata sparse snapshots:** Select this configuration option if you intend to use snapshot functionality within your VM cluster. If you select this option, the SPARSE disk group is created, which enables you to use VM cluster snapshot functionality for PDB sparse cloning. If you do not select this option, the SPARSE disk group is not created, and snapshot functionality will not be available on any database deployments that are created in the environment.

It is important to carefully consider the option you choose. You cannot change the storage allocation once the VM Cluster is provisioned.

Storage Configuration Space Allocation

Configuration settings	DATA disk group	RECO disk group	SARSE disk group
• **DATABASE BACKUPS ON EXADATA STORAGE :** No • **CREATE SPARSE DISK GROUP :** No	80%	20%	0% The SPARSE disk group is not created.
• **DATABASE BACKUPS ON EXADATA STORAGE :** Yes • **CREATE SPARSE DISK GROUP :** No	40%	60%	0% The SPARSE disk group is not created.
• **DATABASE BACKUPS ON EXADATA STORAGE :** No • **CREATE SPARSE DISK GROUP :** Yes	60%	20%	20%
• **DATABASE BACKUPS ON EXADATA STORAGE :** Yes • **CREATE SPARSE DISK GROUP :** Yes	35%	50%	15%

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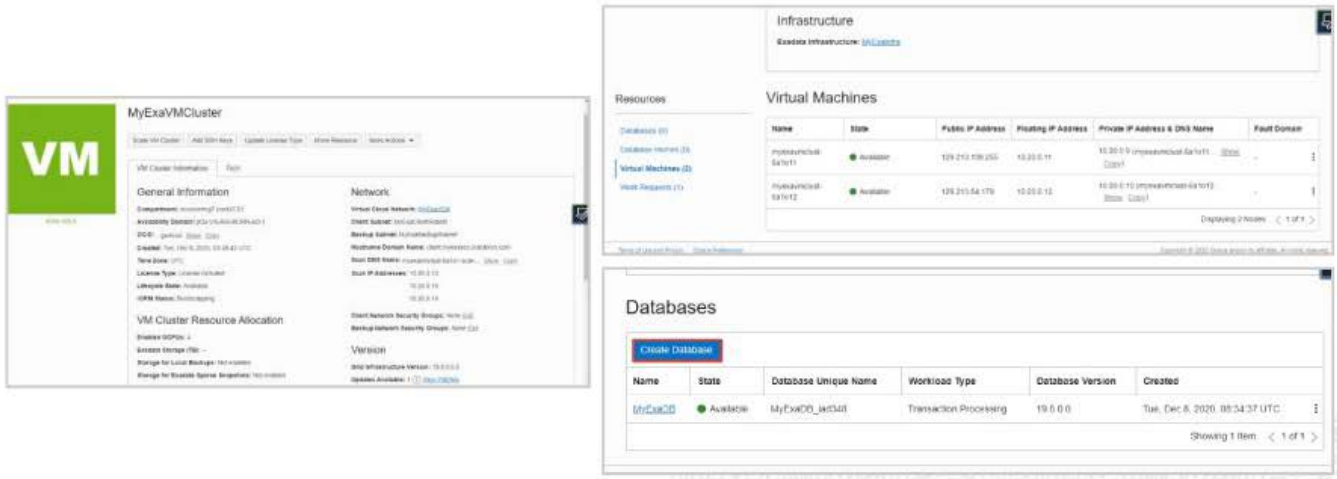
The table in the slide outlines the allocation of storage among the DATA, RECO, and SPARSE disk groups for each possible configuration. Notice the storage allocation change between the DATA, RECO, and SPARSE disk groups when you select Allocate storage for local backups and Allocate storage for Exadata sparse snapshots options.

Exadata VM Cluster Details



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Finally, when the resource is ready, you can see the details in the OCI console.

Now, because you have both the resources available, you can create databases from **Create Database**.

You can also connect to Exadata Cloud Service VM Cluster virtual machines using SSH by following a similar process outlined in the earlier lesson that discussed connecting to Bare Metal and Virtual Machine DB Systems via SSH.

Summary

In this lesson, you should have learned to:

- Describe the network
- Describe and create the Exadata Infrastructure
- Describe and create the VM Cluster
- Describe the storage configuration

Objectives

After completing this lesson, you should be able to:

- Scale Exadata Infrastructure with Elastic Server Expansion
- Schedule infrastructure maintenance
- Manage the VM Cluster
- Explain and enable I/O Resource Management (IORM)

Managing Exadata Cloud Service

- Exadata Cloud Service management is done with the resources:
  - Cloud Exadata Infrastructure
  - Cloud VM Cluster
- Most management operations occur with the VM Cluster resource.
- Management is done via Console, REST API with an SDK, CLI, or other tools.
- Security access must be granted with the appropriate policies to perform management operations.

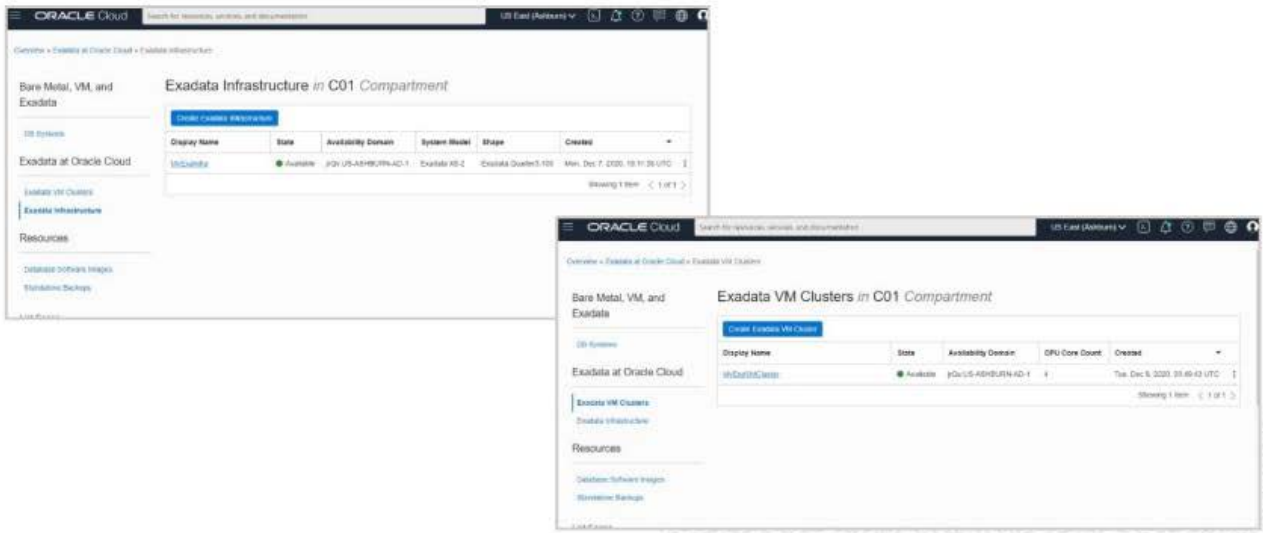
4

After you have created the Exadata Infrastructure and the VM Cluster resource, you can perform management operations. With the new Exadata Cloud Service resource model, most of the management operations discussed take place in the VM Cluster resource. However, some operations, including those related to infrastructure maintenance, take place in the Exadata Infrastructure resource

To use Oracle Cloud Infrastructure, you must be granted security access with the appropriate IAM policies. This access is required whether you're using the Console or the REST API with an SDK, CLI, or other tools. If you get a message that you don't have permission or are unauthorized, verify with your access with a tenancy administrator.

For more details on identity and access management, refer to the OCI courses and documentation.

Checking Status of Exadata Cloud Service Resources



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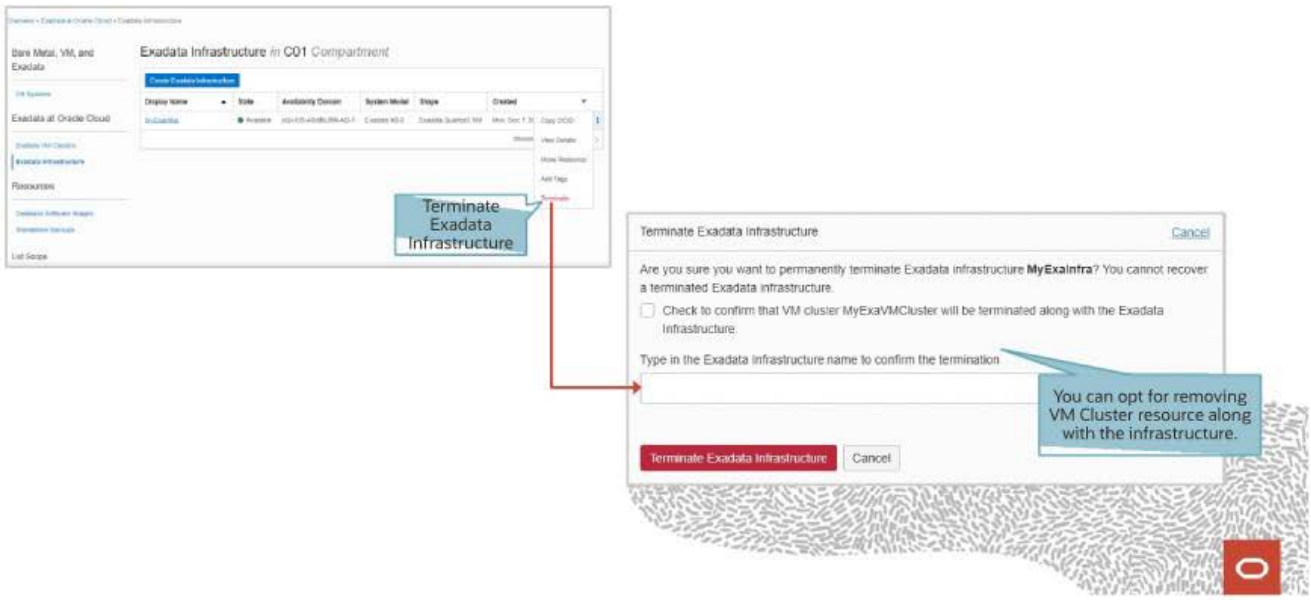
In order to check the status of the Exadata Cloud Service Resources:

1. Open the navigation menu. Under **Oracle Database,** click **Bare Metal, VM,** and **Exadata**.
2. Choose your **Compartment**.
3. Click **Exadata Infrastructure** under **Exadata at Oracle Cloud**.

In the list of cloud Exadata Infrastructure resources (or VM Cluster resource), click the name of the Infrastructure (or VM Cluster) you're interested in and check its icon. The icon text indicates the status of the system. The following life cycle states apply to resource:

- **Provisioning:** Resources are being reserved for the cloud Exadata Infrastructure resource. Provisioning can take several minutes. The resource is not ready to use yet.
- **Available:** The Exadata Infrastructure was successfully provisioned. You can create a VM cluster on the resource once the Infrastructure provisioning is complete.
- **Updating:** The Exadata Infrastructure is being updated. The resource goes into the updating state during management tasks, for example, when moving the resource to another compartment or creating a VM Cluster resource.
- **Terminating:** The Exadata Infrastructure is being deleted via the terminate action in the Console or API.
- **Terminated:** The Exadata Infrastructure has been deleted and is no longer available.
- **Failed:** An error condition prevented the provisioning or continued operation of the cloud Exadata Infrastructure.

Terminating Exadata Infrastructure

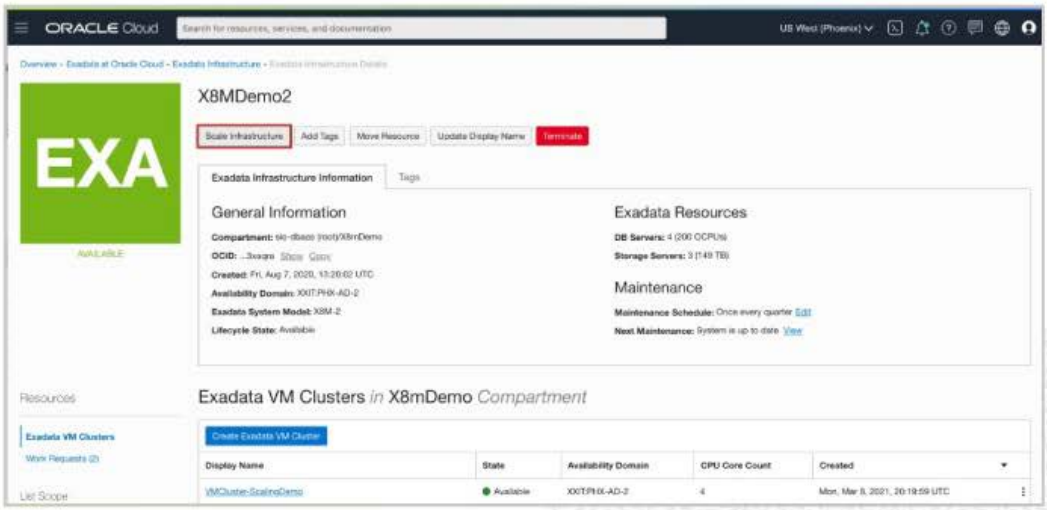


To terminate an Exadata Infrastructure:

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.
2. Choose your **Compartment**.
3. Navigate to the cloud Exadata infrastructure, cloud VM cluster, or DB system.
4. *Cloud Exadata infrastructure:* Under **Exadata at Oracle Cloud**, click **Exadata Infrastructure**. In the list of infrastructure resources, find the infrastructure you want to terminate and click the three dots action menu. From the menu, click Terminate.
5. In the Terminate Exadata Infrastructure dialog box, type in the infrastructure resource name to confirm its termination. You can also opt for removing the VM cluster resource termination by selecting the check box for the same.
6. Click **Terminate Exadata Infrastructure.**

If you are terminating a cloud Exadata Infrastructure resource that contains a VM Cluster, you must check the box labeled **Also delete the VM cluster associated with this infrastructure** to confirm that you intend to delete the VM cluster. Once you terminate the Exadata Infrastructure, you cannot connect to the system, and any open connections are terminated.

Elastic Server Expansion



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With Exadata Cloud Service X8M, use the Oracle Cloud Infrastructure Console to scale an Exadata Infrastructure resource. You cannot scale the infrastructure on previous generation Exadata Cloud Service hardware or on the Base System. Server expansion on previous generation Exadata Cloud Service hardware requires migration to another shape and cannot be done by simply adding servers to the Exadata Infrastructure. Only Exadata Cloud Service X8M supports elastic server expansion.

Open the navigation menu. Click **Oracle Database** and then click **Exadata at Oracle Cloud**.

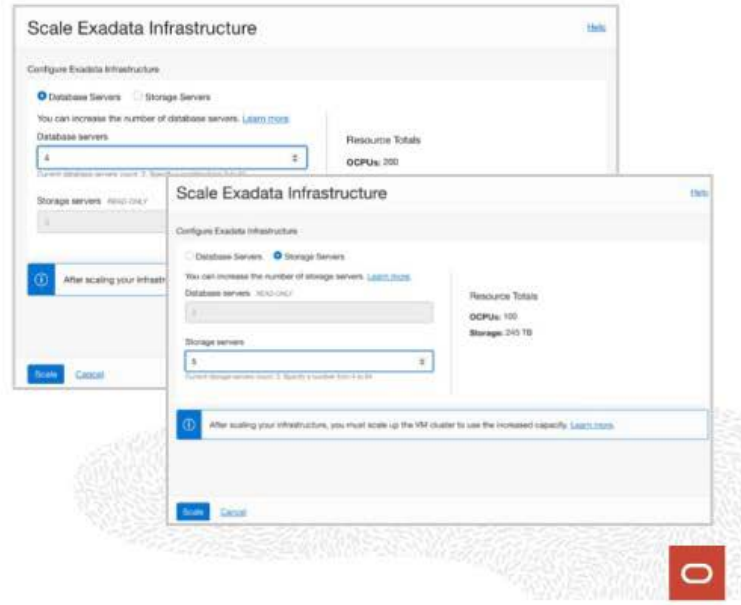
Under **Exadata at Oracle Cloud**, click **Exadata Infrastructure**.

In the list of **Exadata infrastructure** resources, click the name of the resource you want to scale.

Click **Scale Infrastructure**.

Scale Database and Storage Servers

- Select the number of database and storage servers independently.
- VM with database homes is automatically copied to database servers.
- ASM disk groups are rebalanced across additional storage servers.



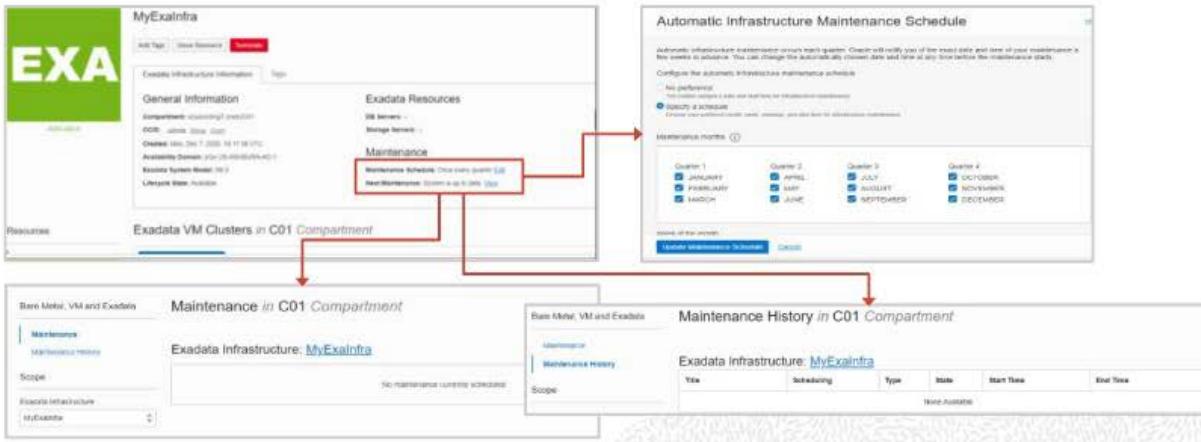
Adding database servers: To add database servers to the infrastructure resource, select the Database Servers radio button and then enter the number of servers you want to add in the Database servers field.

Adding storage servers: To add storage servers to the infrastructure resource, select the Storage Servers radio button and then enter the number of servers you want to add in the Storage servers field.

Click Scale.

The database and storage servers are selected independently and added one server at a time. VMs with database homes are automatically copied to the database servers and ASM disk groups are rebalanced across the additional storage servers.

Scheduling Infrastructure Maintenance



In addition to the maintenance tasks you perform, Oracle manages the patching and updating of all other infrastructure components, including the physical database and storage servers, as well as the network fabric. This is referred to as infrastructure maintenance.

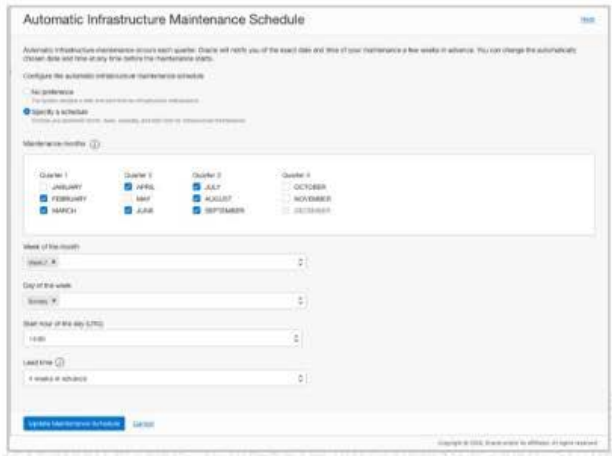
Exadata Cloud Service infrastructure updates are released on a quarterly basis. You can set a maintenance window to determine the time your quarterly infrastructure maintenance will begin. The infrastructure maintenance is scheduled within the Exadata Infrastructure resource. You can also view scheduled maintenance and the maintenance history of your Exadata Cloud Service Infrastructure in the Oracle Cloud Infrastructure Console on the Exadata Infrastructure details page.

Three options are available from the maintenance section of the Exadata Infrastructure:

- Set the automatic infrastructure maintenance schedule for Exadata Cloud Service infrastructure.
- View or edit the time of the next scheduled maintenance for Exadata Cloud Service infrastructure.
- View the maintenance history of an Exadata Cloud Service infrastructure resource.

Automatic Infrastructure Maintenance Schedule

- Choose your quarterly infrastructure maintenance window to align with business requirements.
  - Choose month, week, day, and time
  - Receive lead time notification prior to maintenance window
- Subscribe to notifications at the beginning and ending of the maintenance window.
- Infrastructure maintenance is done in a rolling manner.



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Configure automatic maintenance: Click this button to specify a schedule for the quarterly automatic infrastructure maintenance. In the Automatic Infrastructure Maintenance Schedule dialog box that opens, do the following:

- Click the **Specify a schedule** option button to choose your preferred month, week, weekday, and start time for infrastructure maintenance.
- Under **Maintenance months**, specify at least one month for each quarter during which Exadata infrastructure maintenance will take place. You can select more than one month per quarter. If you specify a long lead time for advanced notification (for example, four weeks), then you may want to specify two or three months per quarter during which maintenance runs can occur. This will ensure that your maintenance updates are applied in a timely manner after accounting for your required lead time.
- Under **Week of the month**, specify which week of the month maintenance will take place. Weeks start on the 1st, 8th, 15th, and 22nd days of the month and have a duration of seven days. Weeks start and end based on calendar dates, not days of the week. Maintenance cannot be scheduled for the fifth week of months that contain more than 28 days.
- *Optional.* Under **Day of the week**, specify the day of the week on which the maintenance will occur. If you do not specify a day of the week, then Oracle will run the maintenance update on a weekend day to minimize disruption.
- *Optional.* Under **Start hour**, specify the hour during which the maintenance run will begin. If you do not specify a start hour, then Oracle will choose the least disruptive time to run the maintenance update.
- Under **Lead Time**, specify the number of weeks ahead of the maintenance event you would like to receive a notification message. Your lead time ensures that a newly released maintenance update is scheduled to account for your required period of advanced notification.
- Click **Update Maintenance Schedule**.

Infrastructure Maintenance Process

- Infrastructure maintenance is mandatory.
- Once infrastructure maintenance is scheduled, customers will be notified via an announcement in the control plane and/or configured event.
  - If the customer has not specified a preference for the maintenance, a default schedule will be selected, which will be at least two weeks after the availability of the update.
  - Customer can choose to reschedule infrastructure maintenance to date no more than 180 days since their prior infrastructure maintenance.
- Database server maintenance is done in a rolling manner across the cluster.
  - It will shut down the virtual machines and restart them when the maintenance is completed
- Storage server maintenance is done in a rolling manner to ensure database availability.
  - ASM high redundancy ensures data protection during maintenance.

13

Oracle performs regularly scheduled updates to all cloud services. In addition, there may be a requirement to perform emergency updates from time to time.

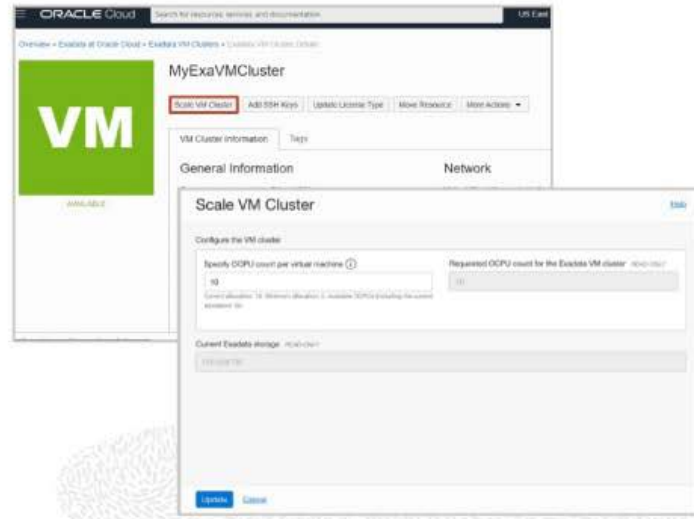
You will receive advance communication about these updates to help you plan for them. If there are corresponding recommended updates for your database server virtual machine environment, then Oracle will provide notification about these. Infrastructure maintenance is mandatory, and there is no option to opt out of any updates.

Wherever possible, scheduled updates are performed in a manner that preserves service availability throughout the update process. However, there may be some noticeable impact on performance and throughput as individual system components are unavailable for a period of time during the update process.

For example, the database servers may need to be rebooted when a service is updated. In such cases, the database servers are rebooted in a rolling manner, one at a time, to ensure that the service, and the Oracle databases contained therein, remains available throughout the process. However, while each database server is being rebooted, it is not available for a short period of time. Consequently, the service may not be able to cater to the same workload while each individual server is unavailable.

Online Elastic Scaling of a VM Cluster

- Specify the OPU count per VM to scale up or down the VM Cluster OCPUs to meet workload demands.
- OCPUs will be added or removed instantly.
- If you scale down a VM Cluster OCPU count to zero, then the VMs in the VM Cluster will be shut down.



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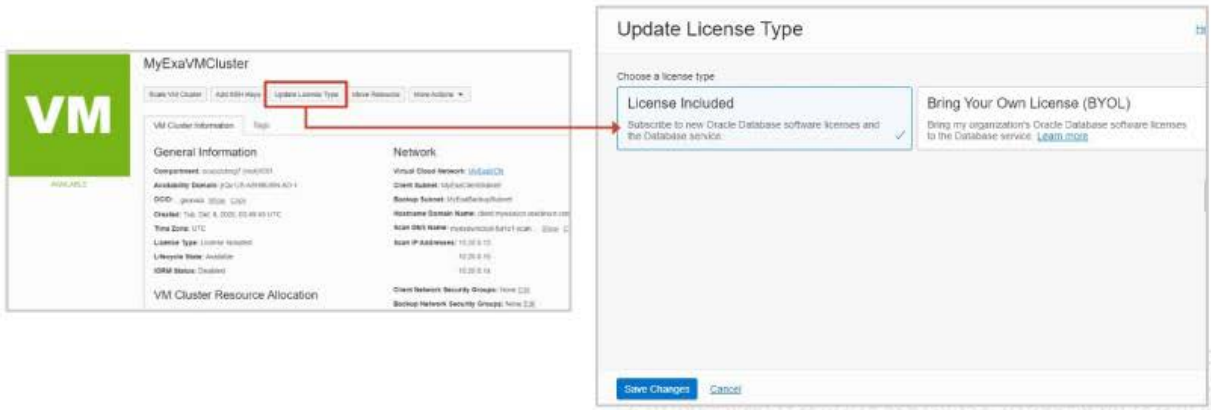
If an Exadata Cloud Service instance requires more or less processing power, you can scale the number of VM Cluster OCPUs up and down symmetrically across all the nodes in the system

For example, if you have four database servers provisioned, you can add OCPU cores in multiples of four across all the VMs in the cluster.

You will only be charged for the Exadata Infrastructure until you create a VM Cluster and scale up the OCPUs. You can scale the VM Cluster OCPUs down to zero cores and the VMs will stop. To restart the VMs, scale the OCPUs back up.

Updating License Type



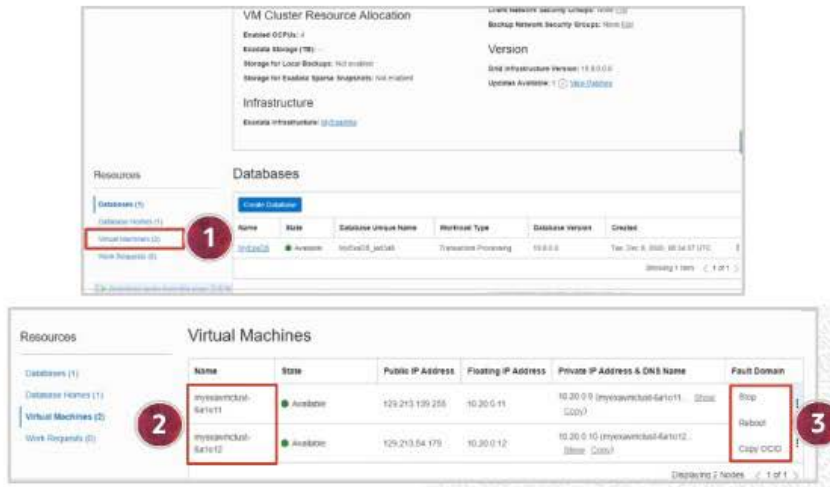
As was already discussed, Exadata Cloud Service enables customers to choose from License Included or opt to bring their own license.

The License Included subscription model includes all of the features of Oracle Database Enterprise Edition, plus all of the Oracle Database Enterprise Manager Packs and all Database Enterprise Edition Options. This subscription model is ideal for customers without existing Oracle database licenses or for customers seeking to use Oracle database features beyond those currently licensed.

Bring Your Own License (BYOL) is designed to minimize costs when migrating to the cloud. In a BYOL model, customers can deploy their existing Oracle Enterprise Edition and Database Option licenses on Exadata Cloud Service. When a customer brings a Database Enterprise Edition license entitlement to Oracle Exadata Cloud Service, they are granted the rights to use Oracle Transparent Data Encryption (TDE), Diagnostics Pack, Tuning Pack, Data Masking and Subsetting Pack, and Real Application Testing without having on-premises license entitlements for those Database Options. The Exadata System software is also included in a BYOL subscription, so BYOL customers do not have to bring a license entitlement for the Exadata System Software. Oracle Standard Edition is not supported on any Exadata Cloud Service.

You can switch between the two license models at any time, as often as you like. This means, for example, you could use BYOL most of the time, but switch over to License Included to handle infrequent spikes on workload that require more capacity than you have licensed via BYOL.

Power Management of Resources



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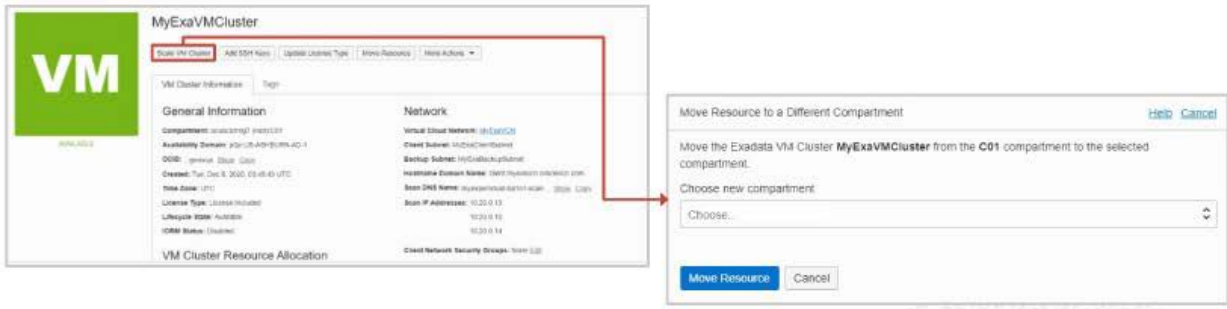
You can power cycle the individual VMs in the VM Cluster.

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.
2. Choose your **Compartment**.
3. Navigate to the VM cluster you want to start, stop, or reboot.
4. Under **Resources**, click **Virtual Machines** to display the virtual machines of the VM Cluster. Click the Actions icon (three dots) for a node and then click one of the following actions:
   - **Start:** Restarts a stopped node. After the node is restarted, the **Stop** action is enabled.
   - **Stop:** Shuts down the node. After the node is powered off, the **Start** action is enabled.
   - **Reboot:** Shuts down the node and then restarts it.

Moving Exadata Cloud Service to Another Compartment



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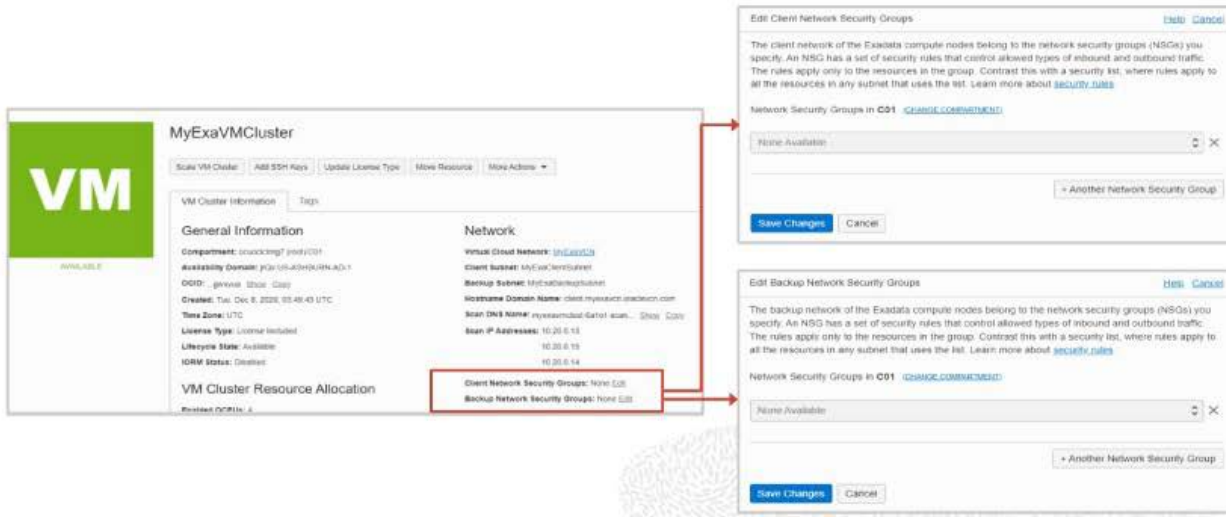
To move an Exadata Infrastructure or VM Cluster resource to a different compartment, follow the steps as given:

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM**, and **Exadata**.
2. Choose your **Compartment**.
3. Navigate to the Exadata infrastructure or VM Cluster you want to move.
4. Exadata infrastructure: Under **Exadata at Oracle Cloud**, click **Exadata Infrastructure**. In the list of infrastructure resources, find the infrastructure you want to access and click its highlighted name to view its details page.
5. VM clusters : Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
6. Click **Move Resource.**
7. Select the new compartment.
8. Click **Move Resource.**

Dependent resources that move with the VM Cluster include Database Homes and databases, as well as the metadata for automatic backups. To verify the compartment of a dependent resource, check the compartment of the VM Cluster.

It's important to note that to move resources between compartments, resource users must have sufficient access permissions on the compartment that the resource is being moved to, as well as the current compartment.

Editing Network Security Groups



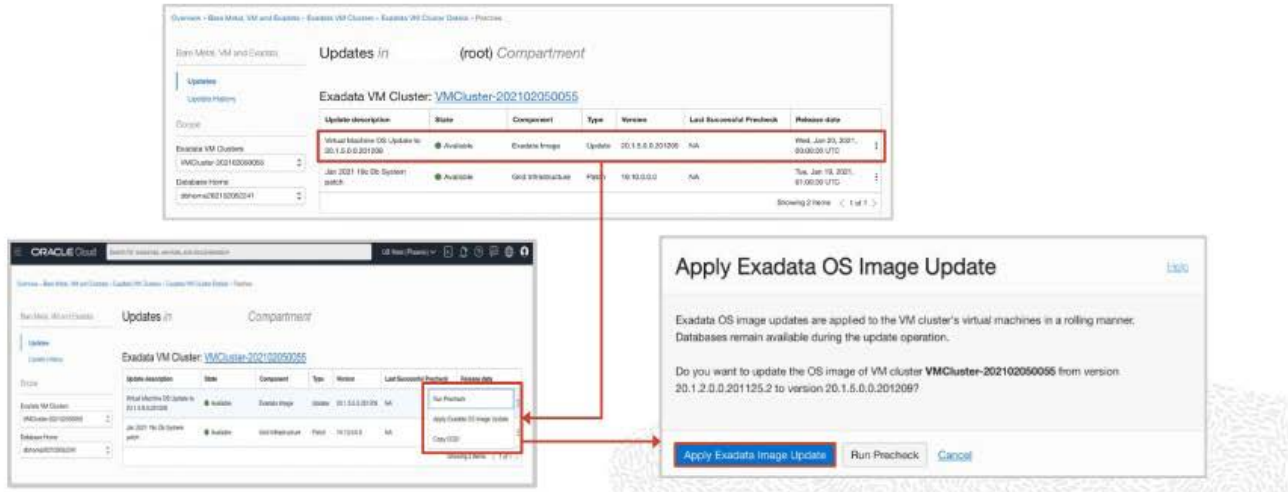
A Network Security Groups (NSG) consists of a set of ingress and egress security rules. The rules only apply to the resources in that group. Contrast this with a security list, where the rules apply to all the resources in any subnet that uses that list.

Your client and backup networks can each use up to five network security groups (NSGs). Note that if you choose a subnet with a security list, the security rules for the VM cluster will be a union of the rules in the security list and the NSGs.

To edit the network security groups (NSGs) for your client and backup network:

1. Open the navigation menu. Click **Oracle Database** and then click **Exadata at Oracle Cloud.**
2. Choose your **Compartment**.
3. Navigate to the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
4. In the **Network** details, click the **Edit** link to the right of the **Client Network Security Groups** or **Backup Network Security Groups** field.
5. In the **Edit Network Security Groups** dialog, click **+ Another Network Security Group** to add an NSG to the network.
6. To change an assigned NSG, click the drop-down menu displaying the NSG name and then select a different NSG.
7. To remove an NSG from the network, click the **X** icon to the right of the displayed NSG name.
8. Click **Save**.

Apply Exadata OS Image Update



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Exadata VM cluster image updates allow you to update the OS image on your VM cluster nodes in an automated manner. This feature greatly simplifies and speeds up the process, makes it less error prone, and eliminates the need to use Patch Manager. When you apply a patch, the system runs a precheck operation to ensure your VM Cluster meets the requirements for that patch. If the precheck is not successful, the patch is not applied, and the system displays a message that the patch cannot be applied because the precheck failed.

To update the operating system:

- Open the navigation menu. Click **Oracle Database** and then click **Exadata at Oracle Cloud**.
- Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**.
- In the list of cloud VM clusters, click the name of the cluster that you want to patch to display the details page.
- In the **Version** section, to the right of the **Updates Available**, click **View Updates** to display the **Updates** page.
- Review the list of available software updates and locate the OS patch you are applying.
- Click the Actions icon (three dots) at the end of the row listing the patch you are interested in and then click one of the following actions:

You can run Precheck in advance. Precheck checks the prerequisites to ensure that the patch can be successfully applied.

If the precheck is successful, Apply Exadata OS Image Update. This link displays the Apply Exadata Image Update dialog box that you use to apply the patch. The dialog box shows the name of the VM Cluster you are updating and the current version as well as the version you are updating to. To start the process, click **Apply Exadata OS Image Update**.

I/O Resource Management (IORM): Overview

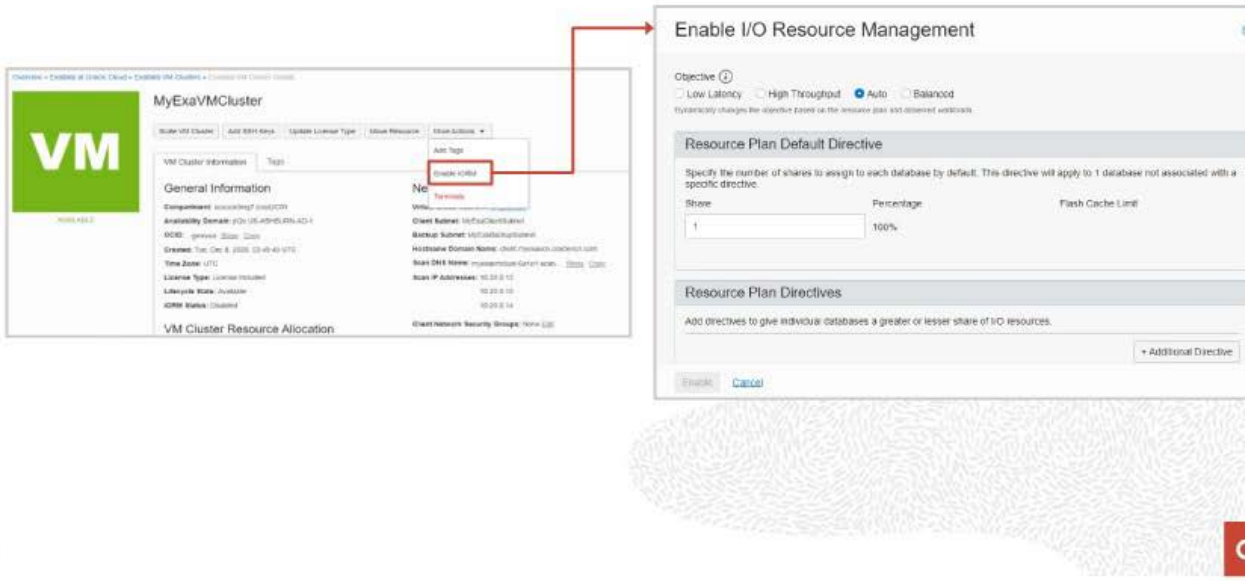
- IORM allows you to manage shared I/O resources since all databases share the same dedicated storage servers in Exadata Cloud Service.
- IORM allows prioritizing IO for critical databases to ensure they receive sufficient IO resources based on defined policies.
- To manage workloads within a database, the Oracle Database Resource Manager has been enhanced to work with IORM to provide database resource management.

The I/O Resource Management (IORM) feature allows you to manage how multiple databases share the I/O resources of an Exadata Cloud Service VM cluster.

On an Exadata VM cluster, all databases share dedicated storage servers that include flash storage. By default, the databases are given equal priority with respect to these resources. The Exadata storage management software uses a first-come, first-serve approach for query processing. If a database executes a major query that overloads I/O resources, overall system performance can be slowed down.

IORM allows you to assign priorities to your databases to ensure critical queries are processed first when workloads exceed their resource allocations. You assign priorities by creating directives that specify the number of shares for each database. The number of shares corresponds to a percentage of resources given to that database when I/O resources are stressed.

Enable IORM on Exadata VM Cluster



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Enabling IORM includes specifying an optimization objective and configuring your resource plan directives.

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.
2. Choose your **Compartment**.
3. Click **Exadata VM Clusters** under **Exadata at Oracle Cloud**.
4. In the list of VM clusters, find the VM cluster for which you want to enable IORM and click its highlighted name. The cluster's details are displayed, showing the IORM status as "Disabled."
5. Click **More Actions** and then **Enable IORM**.
6. It might take a minute for the Enable I/O Resource Management dialog to retrieve the VM cluster information.
7. Select the objective to apply to the resource plan:
    1. **Auto:** (Recommended) Dynamically changes the objective based on the resource plan and observed workloads
    2. **Balanced:** Weighs high throughput and low latency evenly
    3. **High throughput:** Provides the best throughput for DSS workloads
    4. **Low latency:** Provides the best latency for critical OLTP workloads
8. Configure the resource plan default directive by setting the number of shares. This number of shares is assigned to each database not associated with a specific directive.
9. In the Resource Plan Directives section, add a directive for each database you want to assign a greater or lesser number of shares than the default directive.

8. To add a directive, click **+ Additional Directive** and then specify the database and the number of shares for that database.
9. When you are done adding directives, click **Enable**.
10. While the IORM configuration settings are being applied, the VM cluster details page shows the IORM status as "Updating." The update might take several minutes to complete but should have no impact on your ability to perform normal operations on your VM cluster. After a successful update, the IORM status shows as "Enabled."

Summary

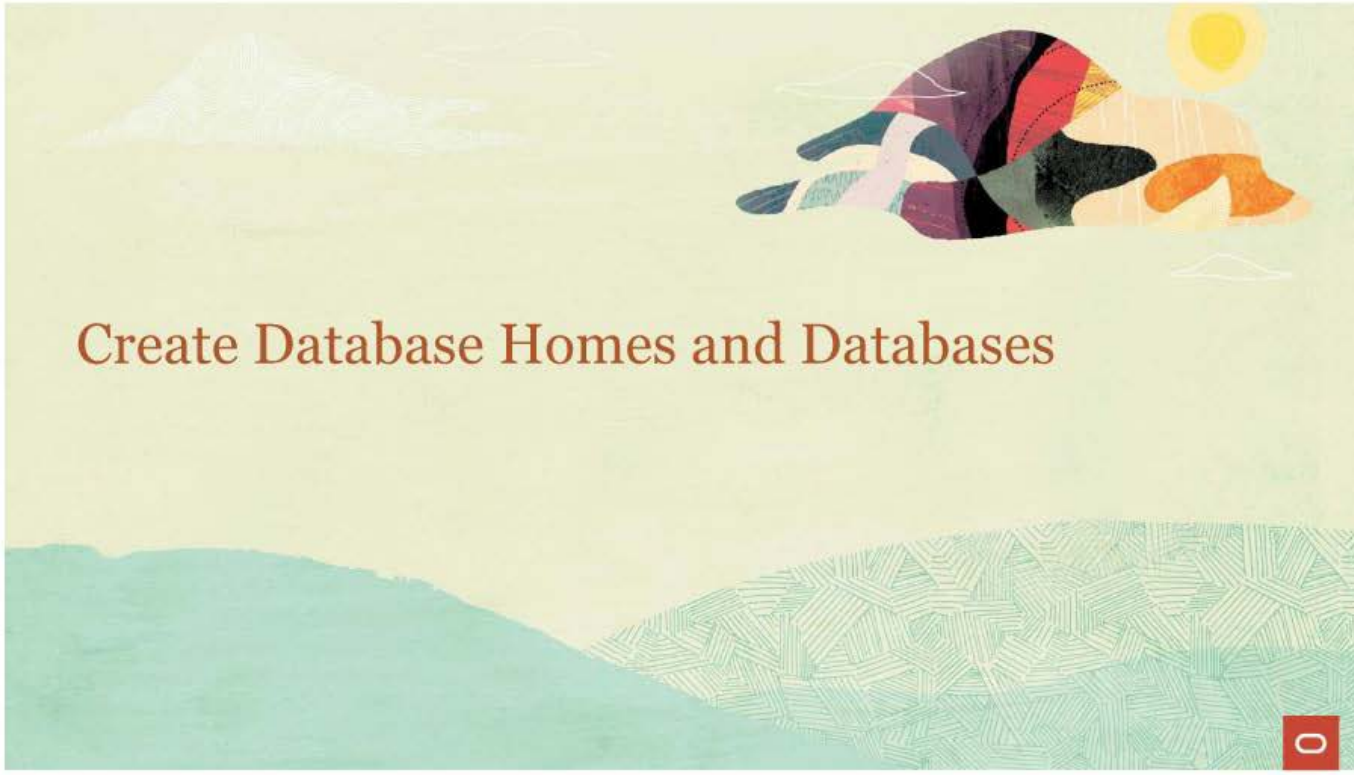
In this lesson, you should have learned to:

- Scale Exadata Infrastructure with elastic server expansion
- Schedule infrastructure maintenance
- Manage the VM Cluster
- Explain and enable I/O Resource Management (IORM)

Objectives

After completing this lesson, you should be able to:

- Create Database Homes and Databases
- Back up and restore Databases
- Update Grid Infrastructure and Databases



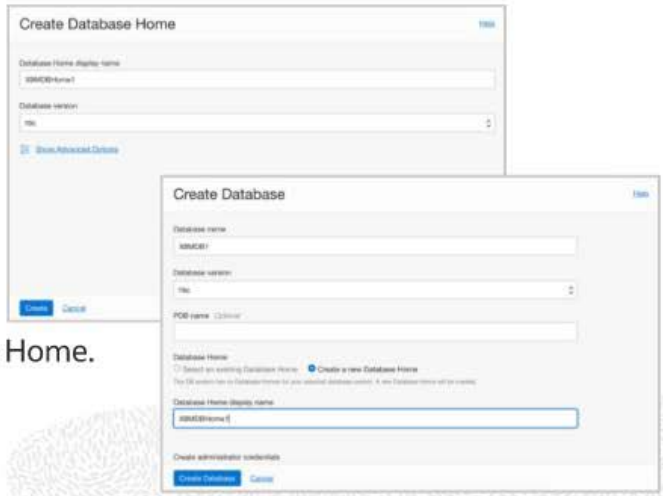
Create a Database Home and Database

Create a Database Home:

- Provide the Database Home name.
- Select the Database Image.

Create Databases:

- Provide the Database name.
- Provide PDB name.
- Select the Database Version or Database Home.
- Click Create.



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To create a Database Home and Database:

Open the navigation menu. Click **Oracle Database** and then click **Exadata at Oracle Cloud.**

1. Choose your **Compartment**.
2. Navigate to the VM Cluster.
3. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
4. Under **Resources**, click **Database Homes**.
5. A list of Database Homes is displayed.
6. Click **Create Database Home**.
7. In the **Create Database Home** dialog, enter the following:
    1. **Database Home display name:** The display name for the Database Home. Avoid entering confidential information.
    2. **Database image:** Determines what Oracle Database version is used for the database. You can mix database versions on the VM Cluster. By default, the latest Oracle-published database software image is selected.

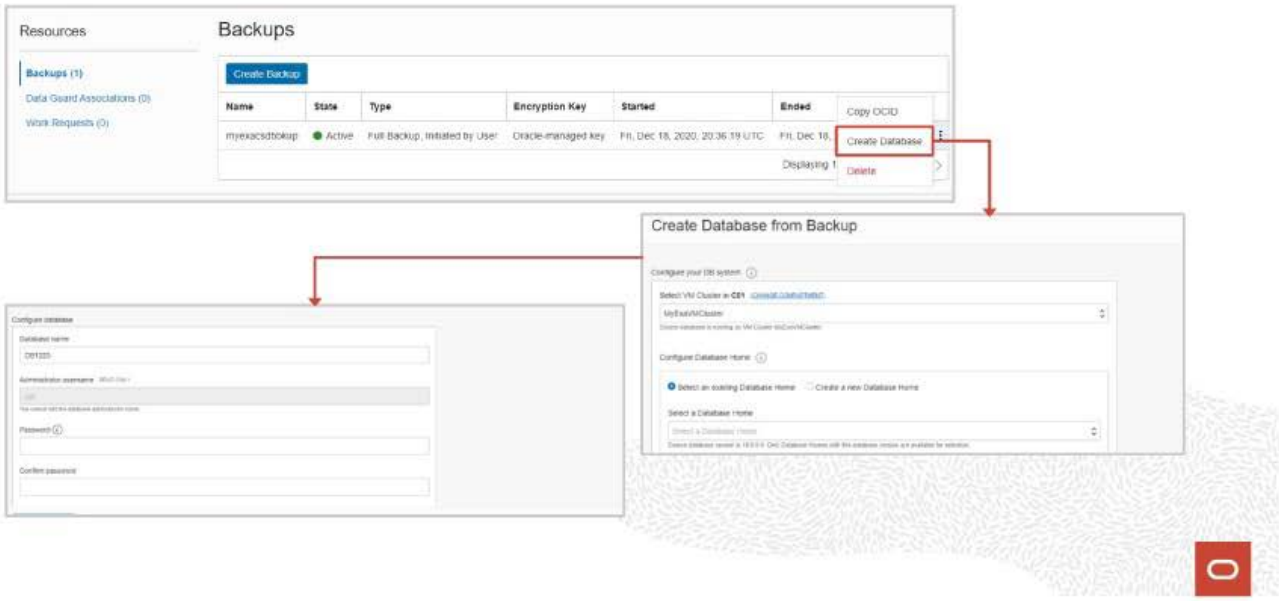
3. Click **Change Database Image** to use an older Oracle-published image or a custom database software image that you have created in advance and then select an **Image Type**:
   - **Oracle Provided Database Software Images:** These images contain generally available versions of Oracle Database software.
   - **Custom Database Software Images:** These images contain customized configurations of software updates and patches.
   - After choosing a software image, click **Select** to return to the Create Database dialog.

8. Click **Create**.

To create a database in an existing Exadata Cloud Service VM Cluster, proceed with the following steps:

1. Open the navigation menu. Under **Oracle Database**, click **Exadata at Oracle Cloud**.
2. Choose your **Compartment**.
3. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
4. Click **Create Database**.
5. In the **Create Database** dialog box, enter the following:
   1. **Database name:** The name of the database. The database name must begin with an alphabetic character and can contain a maximum of eight alphanumeric characters. Special characters are not permitted.
   2. **Database version:** The version of the database
   3. **PDB name:** *(Optional)* For Oracle Database 12c (12.1.0.2) and later, you can specify the name of the pluggable database.
   4. **Database Home:** The Oracle Database Home for the database. Choose the applicable option:
      1. **Select an existing Database Home:** The Database Home display name field allows you to choose the Database Home from the existing homes for the database version you specified. If no Database Home with that version exists, you must create a new one.
      2. **Create a new Database Home:** A database home will be created using the database version and the Database Home display name you specified.
6. **Create administrator credentials:** A database administrator SYS user will be created with the password you supply.
7. **Select workload type:** Online Transactional Processing (OLTP) or Decision Support System (DSS)
8. **Configure database backups:** Specify the settings for backing up the database to Object Storage
9. Choose **advanced options** include customer-managed encryption keys.
10. Click **Create**.

Create a Database from a Backup



You can also create a database from backup.

Open the navigation menu. Click **Oracle Database** and then click **Bare Metal, VM, and Exadata**.

Choose your **Compartment**.

Navigate to a backup.

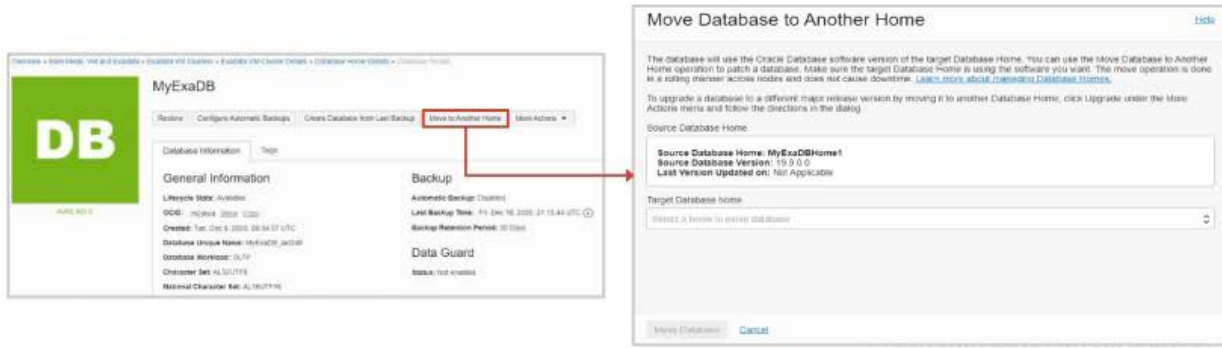
Click **Create Database** in the drop-down list.

On the **Create Database from Backup** page, follow the screens to configure the database.

Note that you need the password that matches either the Transparent Data Encryption (TDE) wallet password or the RMAN password for the source database.

The Oracle Database software version you specify must be the same or a later version as that of the backed-up database.

Moving an Existing Database to a New Database Home

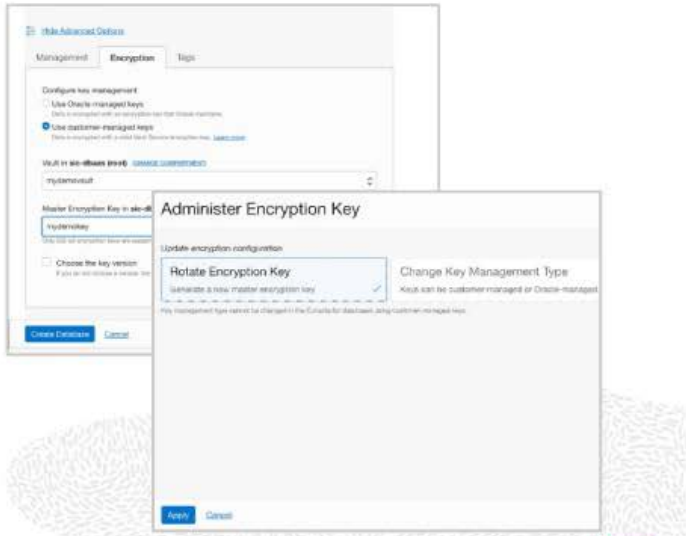


You can also move an existing database to a new database home. This is particularly useful and the easiest way to patch a database.

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.
2. Choose your **Compartment**.
3. Navigate to the database.
4. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
5. Click **Move to Another Home**.
6. Select the target Database Home.
7. Click **Move Database**.
8. Confirm the move operation.
9. While the database is being moved, the Database Home status displays as **Moving Database.** If the operation is unsuccessful, the status of the database is displayed as **Failed**, and the Database Home field provides information about the reason for the failure.

Customer-Managed Keys

- Centrally manage encryption keys with Oracle Cloud Infrastructure vault:
  - Customer-managed keys can be chosen at the time of database creation.
  - Change key management type from Oracle-managed to customer-managed keys post database provisioning.
- Control access for individual keys and vaults with IAM policies
- Rotate encryption keys at will



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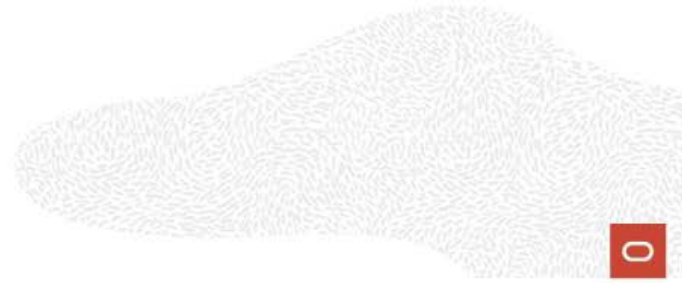
You can use Oracle Cloud Infrastructure Vault to centrally manage encryption keys. You can choose customer-managed keys when the database is created or change key management type from Oracle-managed to customer-managed keys post database provisioning. Individual keys and vault access are controlled with IAM policies. To ensure that your Exadata database uses the most current version of the Vault encryption key, rotate the key from the database details page on the Oracle Cloud Infrastructure Console. Do not use the Vault service. Do not delete any necessary encryption keys from the vault because this causes databases and backups protected by the key to become unavailable.

1. Open the navigation menu. Click **Oracle Database** and then click **Exadata at Oracle Cloud.**
2. Choose your compartment from the **Compartment** drop-down list.
3. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, locate the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
4. In the **Databases** section, click the name of the database for which you want to change encryption management or to rotate a key to display its details page.
5. Click the **More Actions** drop-down list.
6. Click **Administer Encryption Key**. To rotate an encryption key on a database using customer-managed keys:
   - Click **Rotate Encryption Key** to display a confirmation dialog.
   - Click **Rotate Key**.

7. To change key management type from Oracle-managed keys to customer-managed keys:
   - Click **Change Key Management Type**.
   - Select **Use customer-managed keys**. You must have a valid encryption key in Oracle Cloud Infrastructure Vault service.
   - Choose a vault from the **Vault in *compartment*** drop-down list.
   - Select an encryption key from the **Master encryption key in *compartment*** drop-down list.

Backup Options

- You can use the Oracle Cloud Infrastructure Console:
  - To enable automatic incremental backups
  - To create full backups on demand
  - To view the list of managed backups for a database
  - To delete manual (on-demand) backups
- All backups are encrypted with the same master key used for Transparent Data Encryption (TDE) wallet encryption.



You can use the Console to enable automatic incremental backups, create full backups on demand, and view the list of managed backups for a database. You can also use the Console to delete manual (on-demand) backups. All backups are encrypted with the same master key used for Transparent Data Encryption(TDE) wallet encryption.

The database and infrastructure (the VM cluster) must be in an "Available" state for a backup operation to run successfully. Oracle recommends that you avoid performing actions that could interfere with availability (such as patching operations) while a backup operation is in progress. If an automatic backup operation fails, the Database service retries the operation during the next day's backup window. If an on-demand full backup fails, you can try the operation again when the database availability is restored.

There must be connectivity for Exadata Cloud Service to the applicable Swift endpoint for Object Storage. To avoid backup failures, ensure that the database's archiving mode is set to ARCHIVELOG (the default).

Oracle recommends using a service gateway with the VCN to enable access to Object Storage. You can also use the bkup_api for backup and recovery operations.

Automatic Database Backup: Default Configuration

- Database backups occur daily.
- Archived redo log files are backed up every 30 minutes.
- There is a 7-day backup cycle:
  - With one full backup
  - And daily incremental backups
- The retention period choices are:
  - 7, 15, 30, 45, 60 days for backups to cloud storage
- For database deployments with Oracle Data Guard, automatic backups are always executed on the primary site.

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The following is an outline of the default automatic backup configuration settings:

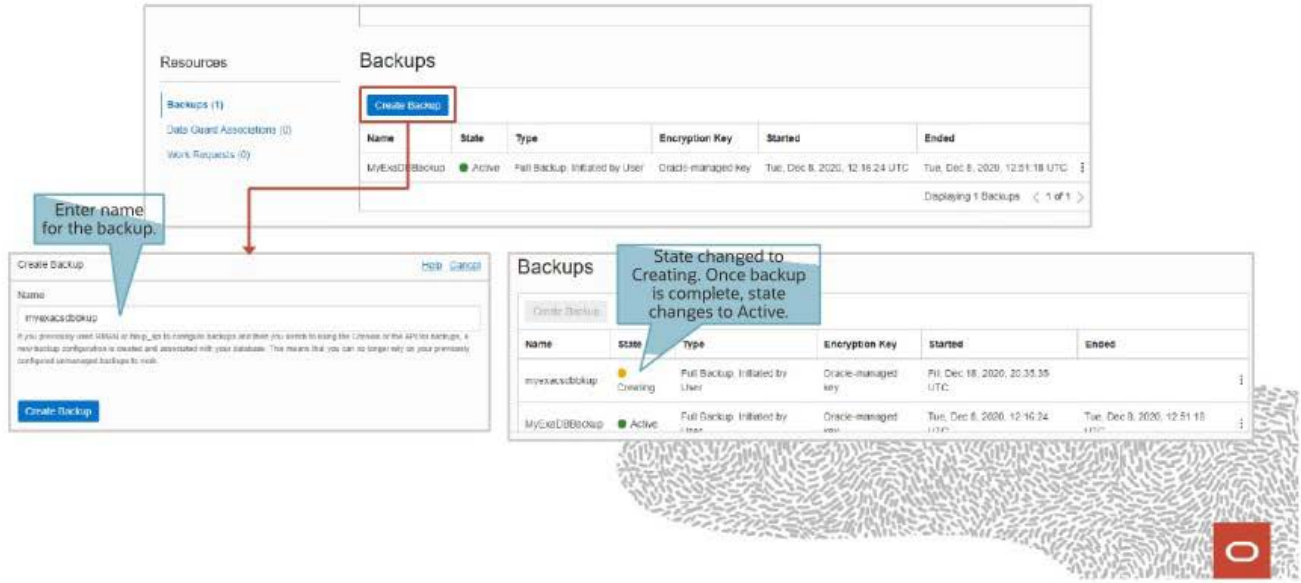
- Automatic backups are scheduled daily.
- Archived redo log files are backed up up every 30 minutes.
- Backups follow a 7-day cycle, consisting of one full backup of the database, followed by daily incremental backups.
- The retention period defines the period for which backups are maintained. Backups to cloud storage are maintained based on the retention choice of 7, 15, 30, 45, or 60 days.
- The backup data is automatically encrypted using Oracle Transparent Data Encryption.

Configure Automatic Backups for a Database

When you create an Exadata Cloud Service instance, you can optionally enable automatic backups for the initial database. Use the following steps.

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.
2. Choose your **Compartment**.
3. Navigate to the VM cluster containing the database you want to configure.
4. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
5. In the list of databases, find the database for which you want to enable or disable automatic backups and click its name to display database details. The details indicate whether automatic backups are enabled.
6. Click **Configure Automatic Backups**.
7. In the **Configure Automatic Backups** dialog, check or uncheck **Enable Automatic Backup**, as applicable. If you are enabling automatic backups, you can choose one of the following preset retention periods: The default selection is 30 days.
8. Click **Save Changes**.

Create an On-Demand Full Backup of a Database

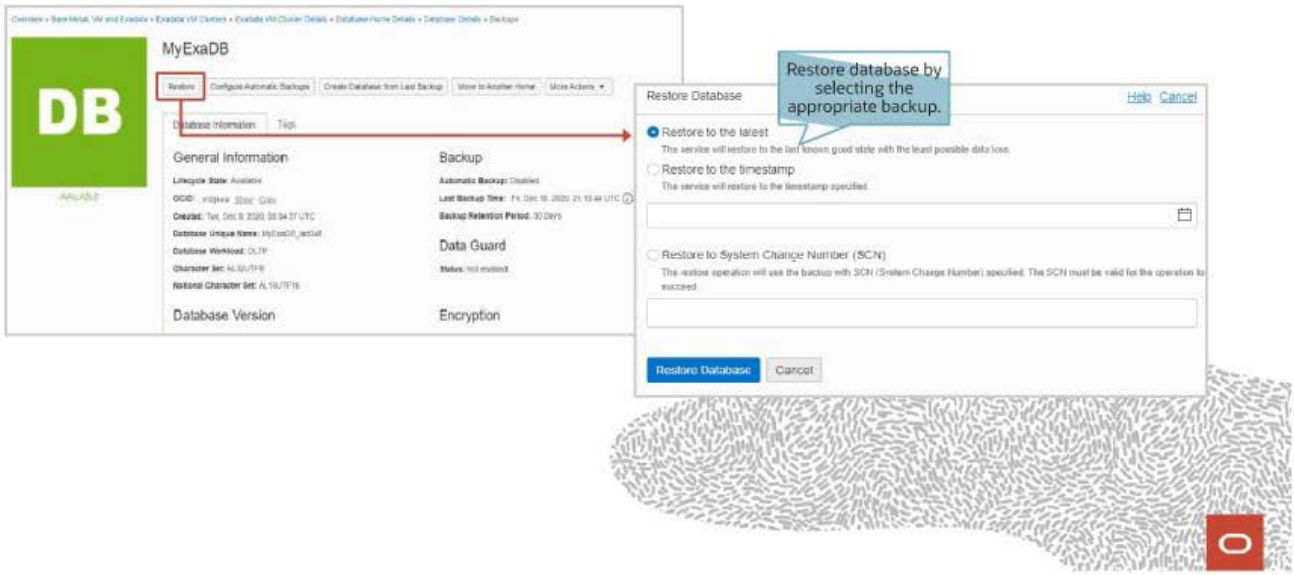


Use the following steps to create an on-demand full backup of a database.

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.
2. Choose your **Compartment**.
3. Navigate to the cloud VM cluster containing the database you want to back up.
4. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
5. In the list of databases, find the database for which you want to create an on-demand full backup and click its name to display database details.
6. Under **Resources**, click **Backups**.
7. A list of backups is displayed.
8. Click **Create Backup**.

You can also list the available backups under **Resources. To Delete a Backup**, click the Actions icon (three dots) for the backup you are interested in and then click **Delete.** The list of backups you see in the Console does not include any unmanaged backups (backups created directly by using bkup_api).

Restore Database



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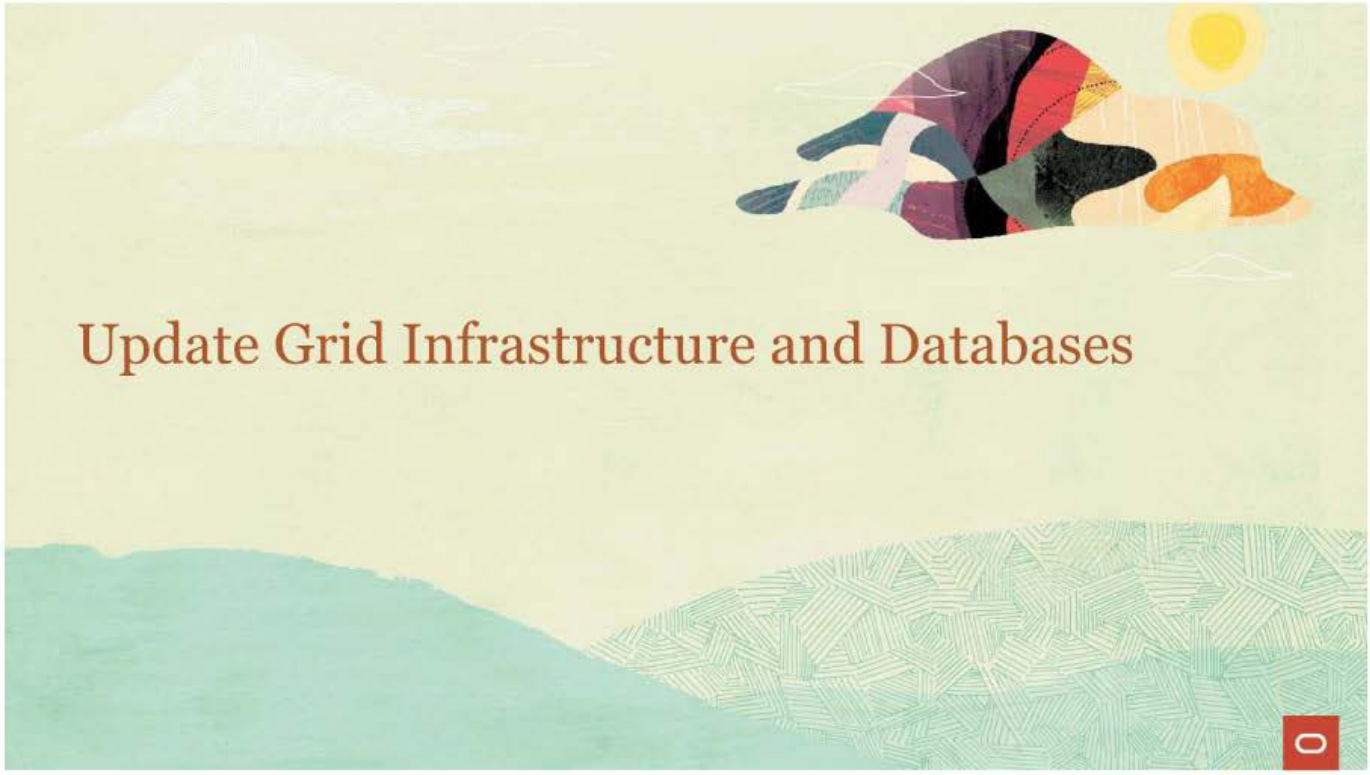
To restore a database, use the following steps:

Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata**.

1. Choose your **Compartment**.
2. Navigate to the VM cluster containing the database you want to restore:
3. Under **Exadata at Oracle Cloud**, click **Exadata VM Clusters**. In the list of VM clusters, find the VM cluster you want to access and click its highlighted name to view the details page for the cluster.
4. In the list of databases, find the database you want to restore and click its name to display details about it.
5. Click **Restore**.
6. Select one of the following options and click **Restore Database**:
    1. **Restore to the latest:** Restores the database to the last known good state with the least possible data loss
    2. **Restore to the timestamp:** Restores the database to the timestamp specified
    3. **Restore to System Change Number (SCN):** Restores the database using the SCN specified. This SCN must be valid.

You can determine the SCN number to use either by accessing and querying your database host or by accessing any online or archived logs.

Click Restore Database.



Best Practices for Updating (Patching) Exadata Cloud Service Databases

- Move the database to a new DB Home, if possible, instead of updating the DB Home
- Back up your databases before you apply any updates to the DB Home
- Update Grid Infrastructure before updating or creating a DB Home
- Before you apply any update, run the precheck operation
- Ensure all servers and database instances are up and running
- /u01/app/x.x.x.x/grid (GI Home) should have 10GB of free space before a Grid Infrastructure update
- /u02 should have 10GB free space before a DB Home update
- Use the OCI Management Interfaces to perform updating operations

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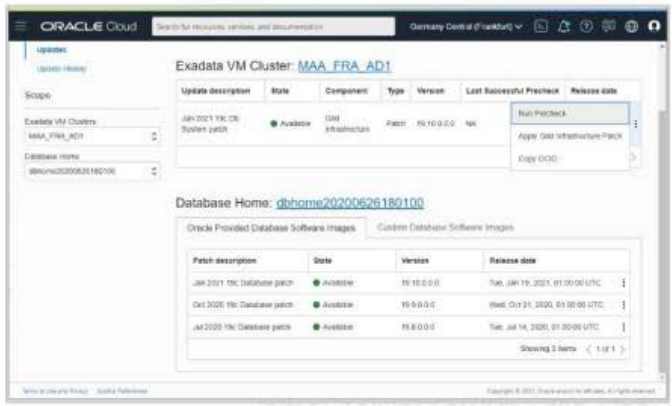
Before proceeding with the patching of Exadata Cloud Service databases, take a look at the best practices outlined in the slide.

Ensure that you:

- Move the database to a new DB Home, if possible, instead of updating the DB Home
- Back up your databases before you apply any updates to the DB Home
- Update Grid Infrastructure before updating or creating a DB Home
- Before you apply any update, run the precheck operation
- Ensure all servers and database instances are up and running
- /u01/app/x.x.x.x/grid (GI Home) should have 10GB of free space before a Grid Infrastructure update
- /u02 should have 10GB free space before a DB Home update
- Use the OCI Management Interfaces to perform updating operations

Grid Infrastructure Updates (Patching)

- Precheck ensures Grid Infrastructure readiness prior to updates.
- Updates are rolling for Grid Infrastructure.
- Database instances on the virtual machine undergoing Grid Infrastructure update will not be available.
- Update (patch) history is provided for Grid Infrastructure.



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To patch Oracle Grid Infrastructure on a VM cluster

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal**, **VM, and Exadata.**
2. Choose your **Compartment.**
3. Click **Exadata VM Clusters**.
4. In the list of VM clusters, click the name of the cluster you want to patch to display the cluster details.
5. Under **Version**, click the **View Patches** link beside the **Updates Available** field.
6. Review the list of available patches for the cloud VM cluster.
7. Click the Actions icon (three dots) for the patch and then click:
   - **Run Precheck:** To check for any prerequisites for the patch
   - **Update Grid Infrastructure:** To apply the selected patch
8. Confirm when prompted.

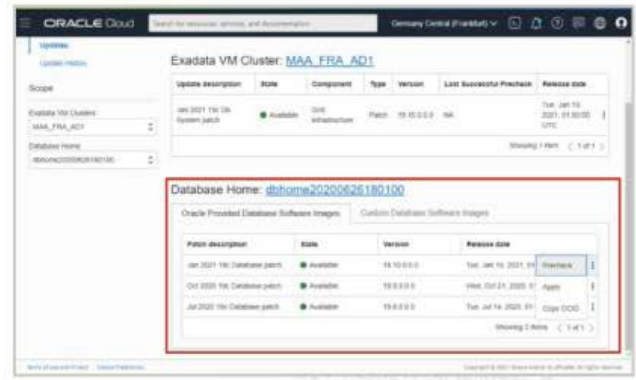
Updates are rolling for Grid Infrastructure.

Database instances on the virtual machine undergoing Grid Infrastructure update will not be available.

You can also view the patch history for Grid Infrastructure.

Database Updates (Patching)

- Precheck ensures Database Home readiness prior to updates.
- Updates are rolling across RAC databases:
  - Update all databases in an existing Database Home
  - Update one database at a time by moving it to a new Database Home
- Update (patch) history is provided for each Database Home.



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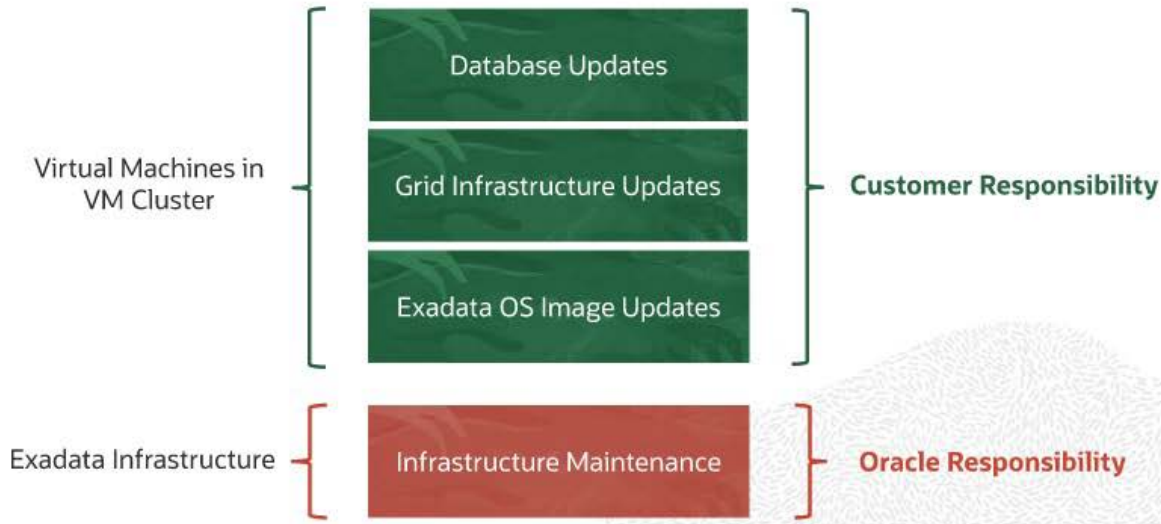
Follow these steps to update the database software for all databases located in the Database Home:

1. Open the navigation menu. Under **Oracle Database**, click **Bare Metal, VM, and Exadata.**
2. Choose your **Compartment.**
3. Click **Exadata VM Clusters.**
4. In the list of VM clusters, click the name of the cluster you want to patch to display the cluster details.
5. Under **Resources**, click **Database Homes.**
6. Click the name of the Database Home you want to patch to display the Database Home details.
7. Under **Latest Patch Available**, click **View**.
8. Review the list of available patches for the Database Home.
9. Click the Actions icon (three dots) and then click one of the following:
   1. **Precheck:** Check for any prerequisites to make sure that the patch can be successfully applied.
   2. **Apply:** Applies the selected patch. Oracle highly recommends that you run the precheck operation for a patch before you apply it.
10. Confirm when prompted.

Updates are rolling across RAC databases. This patching procedure updates the Oracle Database software for all databases located in the Database Home. To patch an individual database, you can move it to another Database home that uses the desired Oracle Database software configuration. You can also view the patch history for databases.

Summary of Maintenance Responsibilities



I want to finish this lesson by providing a summary of maintenance responsibilities for Exadata Cloud Service. You may remember from earlier that Oracle is responsible for infrastructure maintenance. This includes the physical database and storage servers, VM host, as well as the network fabric. Exadata Cloud Service infrastructure updates are released on a quarterly basis, and customers can schedule infrastructure maintenance with Oracle.

Updating the Exadata OS Image, Grid Infrastructure, and databases is the customer's responsibility. Oracle provides cloud user-controlled cloud automation to perform these updates.

Summary

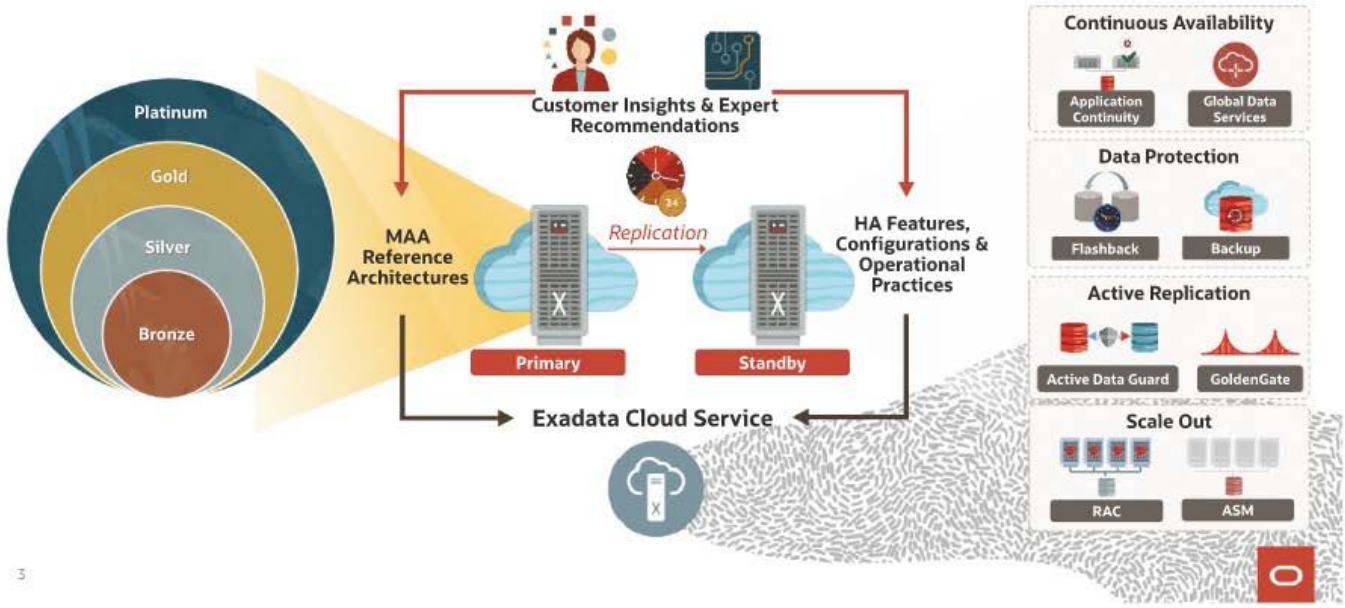
In this lesson, you should have learned to:

- Create Database Homes and Databases
- Back up and restore Databases
- Update Grid Infrastructure and Databases

Objectives

After completing this lesson, you should be able to describe the Maximum Availability Reference Architecture for Exadata Cloud Service.

Oracle Maximum Availability Architecture (MAA)



Availability of data and applications is an important element of every IT strategy. At Oracle, we've used our decades of enterprise experience to develop an all-encompassing framework that we call Oracle MAA, for Maximum Availability Architecture.

Oracle MAA starts with customer insights and expert recommendations. These have been collected from our huge pool of customers and community of database architects, software engineers, and database strategists. Over the years, this has helped the Oracle MAA development team to develop a deep and complete understanding of various kinds of events that can affect availability.

Through this, they have developed an array of availability reference architectures. These reference architectures acknowledge that not all data or applications require the same protection and that there are tradeoffs in terms of cost and effort. Whatever your availability goals may be, for a database or related applications, Oracle has the product functionality and guidance to ensure you can make the right decision with full knowledge of the tradeoffs in terms of downtime, potential data loss, and cost.

These reference architectures use a wide array of our HA features, configurations, and operational practices.

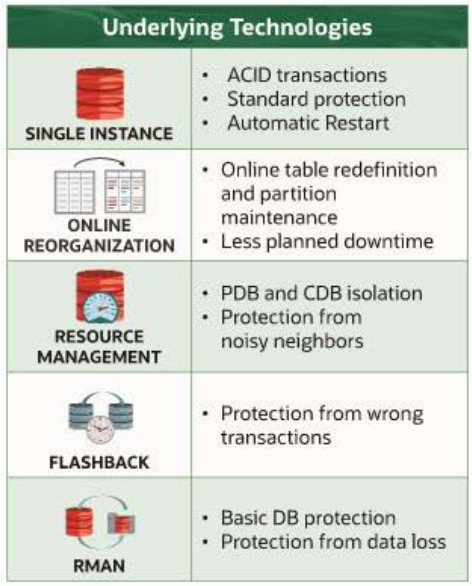
They help our end customers primarily achieve four goals –

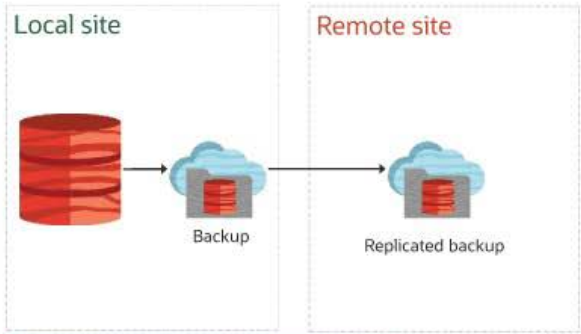
- **Data protection –** reduces data loss through Flashback and backup
- **Active Replication –** which allows customers connect their applications to replicated sites in an Active-Active HA solution through Active Data Guard and GoldenGate
- **Scale Out –** which allows customers the ability to scale compute nodes linearly through RAC and ASM
- **Continuous Availability –** which allows transparent failover of services across sites distributed locally or remote - through AC and GDS

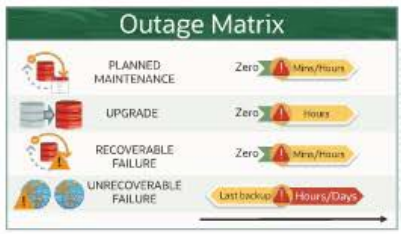
These features and solutions allow customers to mitigate not only planned events – such as software upgrades, data schema changes, and patching, but also unplanned events – such as hardware failures and software crashes due to bugs.

The insights, recommendations, reference architectures, features, configurations, best practices, and deployment choices combine to form a holistic blueprint, which allows customers to successfully achieve their high availability goals.

Single Instance Protection





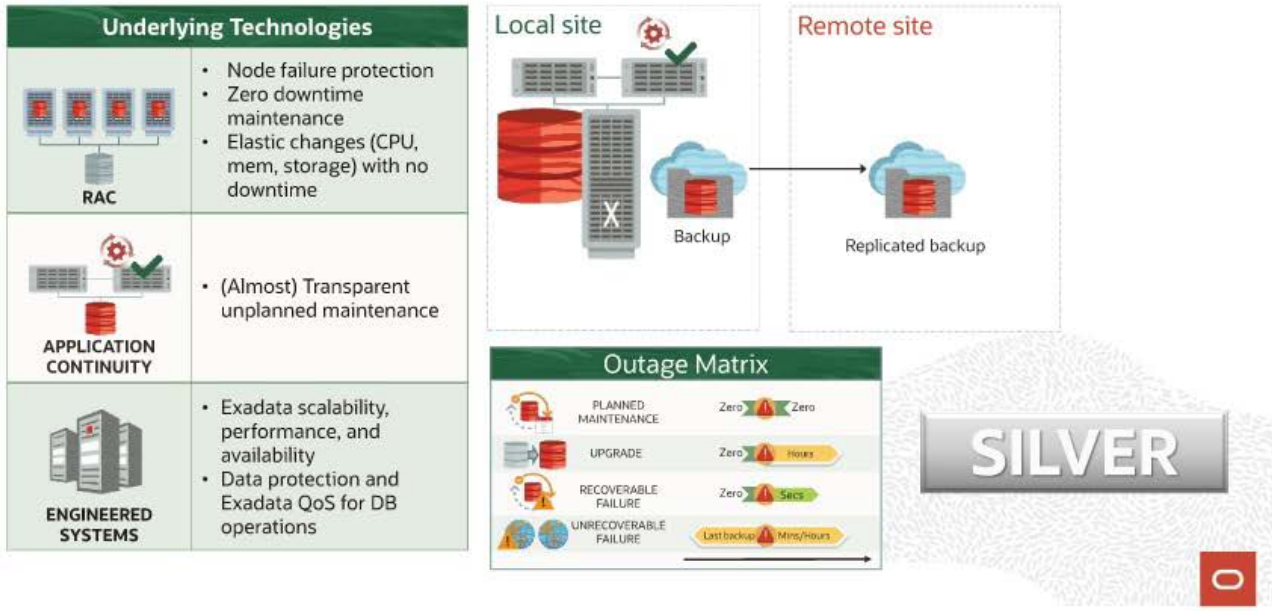


The Bronze protection level is what Oracle Database gives you out of the box.

A single Instance database already contains good protection from some failures.

- Its ACID compliance, the redo log protection, and its intrinsic robustness give basic protection.
- Online reorganization allows online table redefinition without impact for the application.
- Resource management protects against noisy neighbors, runaway statements, and host resource saturation (instance caging).
- Flashback (query, transaction, table, database) protects against wrong transactions from users, developers, or DBAs.
- RMAN is the recommended backup tool, which gives high manageability and protection against data loss, storage failures, etc.

Protection from Recoverable Failures



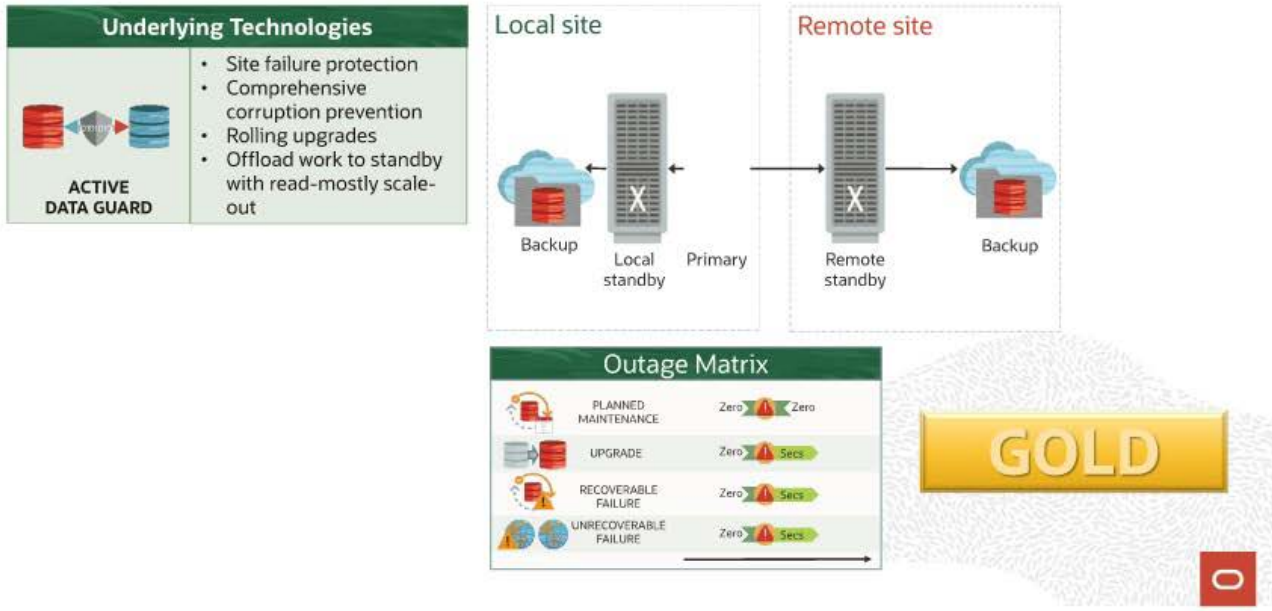
Moving up to Silver protection is achieved through real-application clusters (RAC) and application continuity and moving to Exadata-engineered systems.

RAC gives protection against node failures; this enables also rolling patches, service draining, and zero-downtime planned maintenance.

Application continuity protects transaction from failures, allowing safe transaction replay using JDBC replay driver and Transaction Guard.

Engineered systems give additional features for data protection, problem detection and resolution, etc.

Protection from Unrecoverable and Site Failures



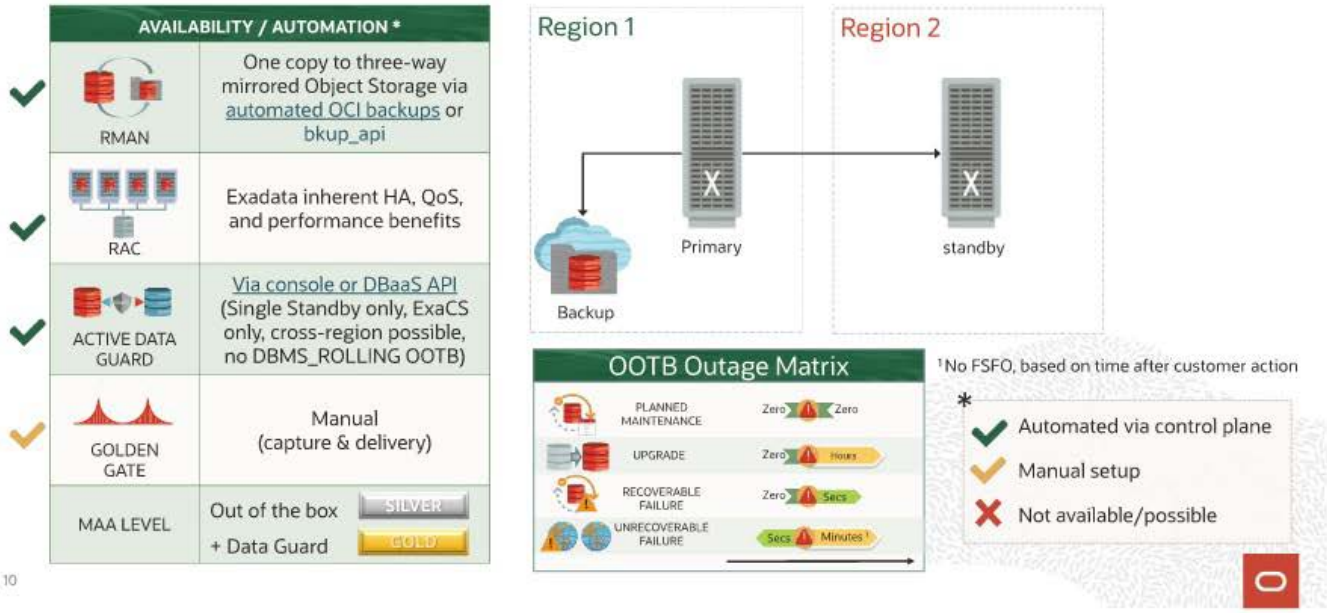
Moving up to Gold protection, Active Data Guard provides an automated replication and failover system.

ACTIVE DATA GUARD is the optimal solution to achieve protection from unrecoverable failures, including system corruption, site failures, and loss of the physical hardware for the database.

It also enables unique features like rolling upgrades (through DBMS_ROLLING) and scale-out of read-only workloads.

Starting with 19c, DML redirection allows also to modify data when connected to the standby, making it suitable to scale out read-mostly workloads (write intensive applications must always connect to the primary).

Exadata Cloud Services: Protection Out of the Box



Out of the box, Exadata Cloud Service gives you Silver and Gold levels of protection.

Active Data Guard is a comprehensive solution to eliminate single points of failure for mission-critical Oracle Databases. It prevents data loss and downtime simply and economically by maintaining a synchronized physical replica (standby) of a production database (primary).

RMAN provides automated, comprehensive foundation for efficiently backing up and recovering the Oracle database.

Real Application Clusters allow customers to run a single Oracle Database across multiple servers in order to maximize availability and enable horizontal scalability, while accessing shared storage. User sessions connecting to Oracle RAC instances can fail over and safely replay changes during outages, without any changes to end-user applications, hiding the impact of the outages from end users.

Goldengate is also available for manual setup of capture and delivery of data from heterogeneous sources and targets.

For UPGRADEs, the RTO is minutes/hours because the DG setup done by the control plane does not allow for DBMS_ROLLING (it will be explained in the detail slides).

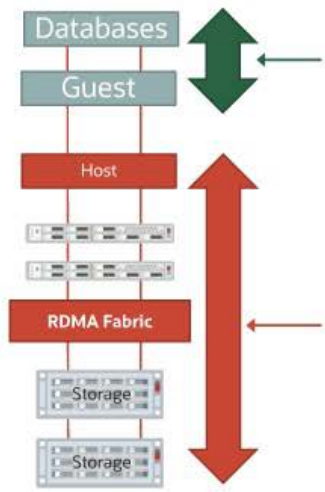
For unrecoverable failures, the DG setup done by the control plane does not implement FSFO.

https://docs.oracle.com/en-us/iaas/Content/Database/Tasks/exabackingup.htm

https://docs.oracle.com/en-us/iaas/Content/Database/Tasks/exabackingupBKUPAPI.htm

https://docs.cloud.oracle.com/en-us/iaas/Content/Database/Tasks/exausingdataguard.htm

Exadata Cloud Services: Responsibility Overview



Customer invokes Oracle automation for DB and OS life cycle operations:

- Automated: create, delete, patch, backup, scale up/down …
- Built-in: HA with automatic failover, Exadata MAA practices
- Runs all supported Oracle Database versions 11.2.0.4 to 19c
- Customer exclusively has DB Guest & DB administrator credentials.
- Customer can install and manage additional software in DomU (generally not recommended).

Oracle owns, manages, and controls hypervisor, DB servers, storage servers, Exadata network:

- No customer access
- Monitors disks, replaces disks
- HA and security built-in
- Inherent HA architecture with automatic failover
- Software updates with zero application and database downtime

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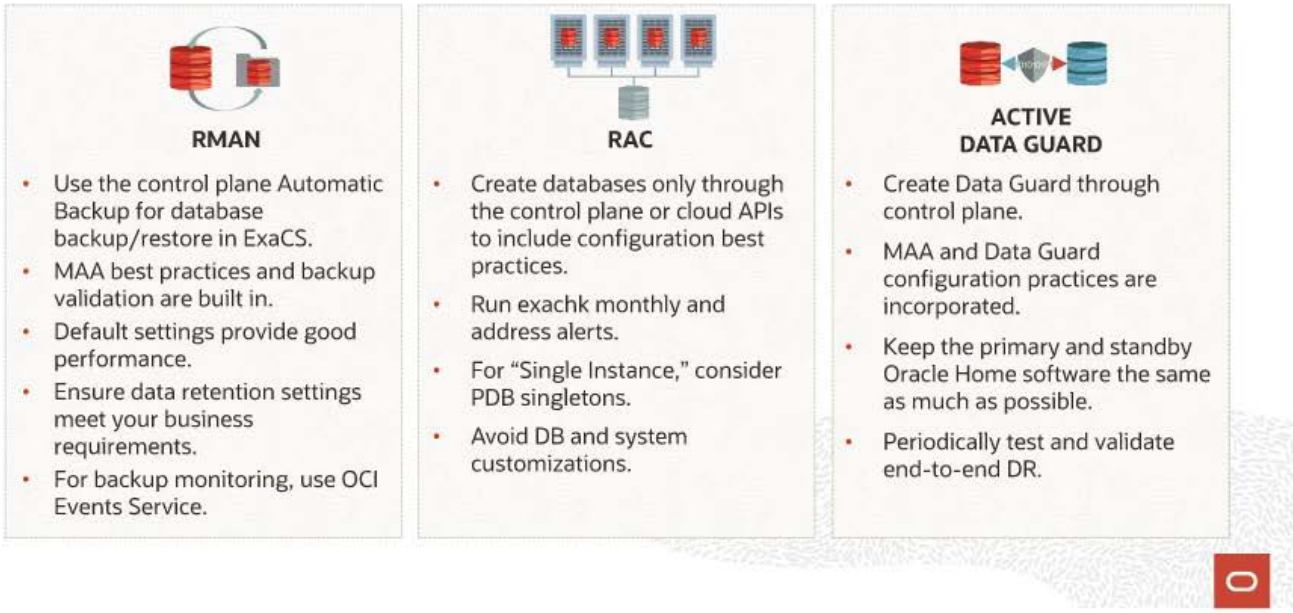
For Exadata Cloud Services, there is a clear delineation of responsibilities.

Oracle owns, manages, and patches the infrastructure. You can see from the list of activities this includes patching, security updates, maintenance, and in general, activities that require access to the Oracle infrastructure. Customers subscribe to database services in a Customer VM. They are responsible for patching and access to and activities within the VM itself. Oracle does not have access to the customer VM, and so the customer is responsible for these tasks.

ExaCS MAA Best Practices



As a best practice, use the control plane for RMAN, RAC, and Active Data Guard operations, as MAA best practices have been incorporated.

For RMAN, the default setting provides good performance; you may need to tune the data retention settings to meet your business needs (7, 15, 30, or 60 days) and use the OCI Events Service for backup monitoring.

For RAC, be sure to run exachk monthly and consider PDB singletons for single instance databases and avoid database customizations.

For Active Data Guard, keep the primary and standby Oracle homes the same and periodically test your disaster recovery end to end.

For additional recommendations, please refer to the documentation.

Summary

In this lesson, you should have learned to describe the Maximum Availability Reference Architecture for Exadata Cloud Service.

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ORACLE

6

Exadata Cloud Service

Management Tools

Objectives

After completing this lesson, you should be able to:

- Understand the different management tools
- Understand when to use the different OCI Management Interfaces
- Describe the additional utilities

Understanding the Various Management Tools

Two types of management tools:

- OCI Management Interfaces - Interfaces that use OCI API to perform operations
- Additional Utilities – Command-line utilities that run directly on Exadata Cloud Service database servers to perform operations

OCI Management Interfaces:

- Oracle Cloud Web based UI (Console), Oracle Cloud REST APIs, Software Development Kit (SDK), Command-Line Interface (CLI), Terraform

Additional Utilities:

- dbaascli, dbaasapi, exacli, bkup_api

It is recommended to use OCI management interfaces whenever possible.

3

There are two types of management tools available for Exadata Cloud Service. OCI Management Interfaces are interfaces that use the OCI API to perform operations. There are also additional command-line utilities that run directly on Exadata Cloud Service database servers to perform operations.

We'll discuss the OCI Management Interfaces and additional utilities in more detail in just a minute, but it's important to mention that we recommend you use the OCI Management Interfaces whenever possible.

OCI Management Interfaces

Oracle Cloud Web-Based UI (Console):

- Browser access via https - great for one-time actions and ad hoc tasks

Oracle Cloud REST APIs:

- Programmatic access via https

Software Development Kit (SDK):

- Build and deploy apps that integrate with Oracle Cloud Infrastructure services
- Java SDK, Python SDK, Ruby SDK, Go SDK

Command-Line Interface (CLI):

- Convenient for developers and others to automate tasks through scripting

Terraform

- Programmatically manage, version, and persist your IT infrastructure as code

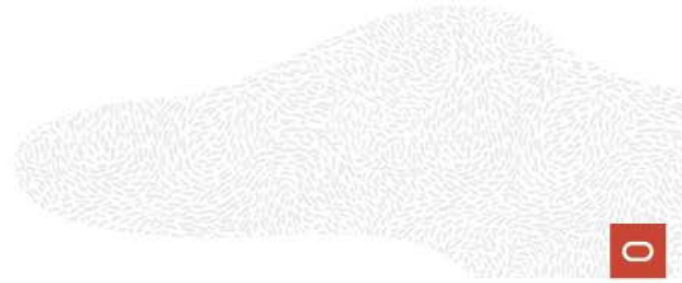
4

Exadata Cloud Service can take advantage of a wide choice of OCI management interfaces. The easiest to use is the web-browser interface, which we have discussed throughout this course. It allows you to use a browser to graphically configure and initiate operations. This is great for one-time actions, but most customers prefer a more programmatic interface for things done repeatedly, such as provisioning and patching databases. Anything you can do with the browser you can also do with a corresponding REST API. Similar to the browser, the REST APIs transit the Internet via https and require no special software installed on the local system. All interfaces are also exposed via a command-line interface that can be used for scripting, and for building custom tooling, there is a software development kit to integrate with common languages such as Java, Python, Ruby, and Go. If you prefer to manage your infrastructure as code, there is also a Terraform interface.

Additional Utilities

- dbaascli
- dbaasapi
- exacli
- bkup_api

The additional utilities are updated automatically, but you can also check for updates with a dbaascli command



5

There are also additional command-line utilities that can be used with Exadata Cloud Service. They are dbaascli, dbaasapi, exacli, and bkup_api and must be run on the actual database servers.

- **dbaascli:** Can be used to perform various life cycle operations including managing Oracle Homes, patching, managing pluggable databases, etc.
- **dbaasapi:** Can be used to create and delete databases. It reads a JSON request body and produces a JSON response body in an output file.
- **exacli:** Can be used to perform monitoring and management functions on the storage servers in Exadata Cloud Service. It offers a subset of the commands found in the on-premises Exadata command-line utility cellcli.
- **bkup_api:** Can be used for command-line backup and recovery operations

The additional utilities are updated automatically, but you can also check for updates with a dbaascli command. And finally, as I mentioned earlier, it's recommended that you use the OCI Management Interfaces whenever possible instead of these additional utilities.

Summary

In this lesson, you should have learned:

- About the different management tools
- When to use the different OCI Management Interfaces
- About the additional utilities

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7

Monitoring Options for Exadata Cloud Service

Objectives

After completing this lesson, you should be able to:

- Monitor with the OCI Metric Charts
- Monitor with Enterprise Manager
- Monitor storage servers with ExaCLI

Monitoring with OCI Metric Charts

- The Metrics feature relays metric data about the health, capacity, and performance of your cloud resources.
- Resources, services, and applications emit metrics to the Monitoring service.
- Such metrics can provide availability and performance, completed backups and where they are allocated, and network latency.
- To monitor resources, you must be given the required type of access in a policy written by an administrator that gives you access to the monitoring services as well as the resources being monitored.

4

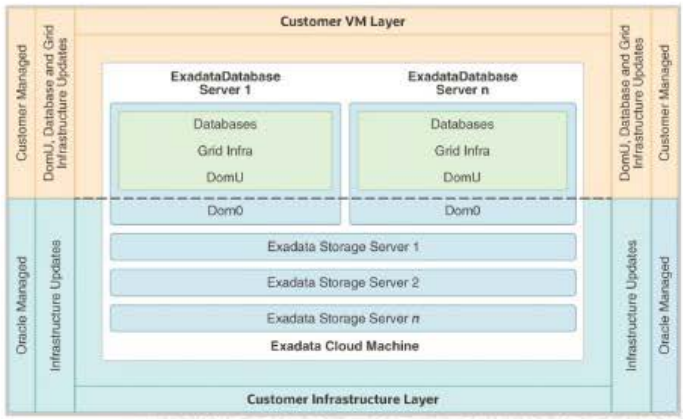
The OCI Metrics feature relays metric data about the health, capacity, and performance of your cloud resources. Resources, services, and applications emit metrics to the Monitoring service. Common metrics reflect data related to:

- Availability and latency
- Application uptime and downtime
- Completed transactions
- Failed and successful operations
- Key performance indicators (KPIs), such as sales and engagement quantifiers

By querying Monitoring for this data, you can understand how well the systems and processes are working to achieve the service levels you commit to your customers.

Enterprise Manager for Exadata Cloud

- Monitors and manages all Exadata, Exadata Cloud systems along with any other targets, from a single interface
- Automatically identifies and organizes related targets
- Provides a high-level integration point for Enterprise Manager framework features such as incident rules, groups, notifications, and monitoring templates
- Visualizes storage and compute data
- Views performance metrics of your Exadata components



Enterprise Manager provides a comprehensive monitoring and management solution for Oracle Database and Engineered Systems deployed in cloud and customer data centers.

You can run Enterprise Manager on premises and in Oracle Cloud Infrastructure.

One of the ways Enterprise Manager provides improved performance monitoring is by enabling the use of the same Maximum Availability Architecture (MAA) Key Performance Indicators (KPI) developed for Oracle Exadata Database Machine.

Enterprise Manager 13.4

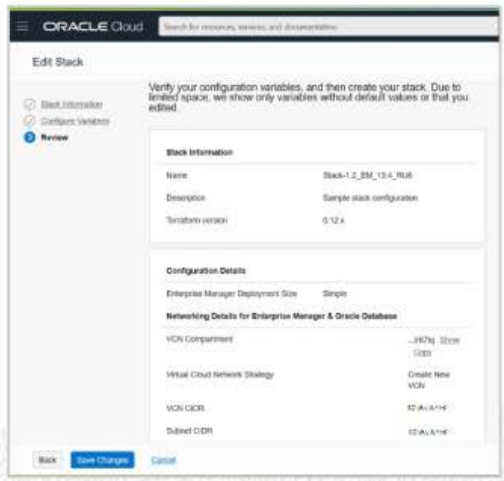
- Oracle Enterprise Manager 13.4 on Oracle Cloud Infrastructure can be deployed on both Single and Multi-Node configurations, allowing you to tailor Oracle Enterprise Manager to your specific infrastructure needs.
- Enterprise Manager 13.4 on Cloud Infrastructure uses the latest OCI Linux image: OL 8.
- It provides the ability to create and define your own OCI resources.
- Configure credentials for Enterprise Manager and databases at spin-up time.
- OMR is on the latest version of 19c Pluggable database that is also TDE (Transparent Data Encryption) enabled, ensuring safety on the cloud.
- OMS Nodes and Bastion can be scaled to fit your needs by re-running the stack and selecting a new shape for both. This applies for both Single and Multi-Node deployments.

7

Oracle Enterprise Manager 13.4 on Oracle Cloud Infrastructure can be deployed in both Single and Multi-Node configurations, allowing you to tailor Oracle Enterprise Manager to your specific infrastructure needs. This version of Enterprise Manager on Cloud Infrastructure uses the latest OCI Linux image: OL 8. It provides the ability to create and define your own OCI resources. OMR is on the latest version of 19c Pluggable database that is also TDE (Transparent Data Encryption) enabled, ensuring safety on the cloud.

Enterprise Manager 13.4 – Single Node Deployments

1. Before deploying Oracle Enterprise Manager, review and perform all prerequisite tasks such as shape recommendation to support number of targets, OCI Services limits to support the shape, and network requirements.
2. Log in to OCI Marketplace and search for Enterprise Manager.
3. Specify the Deployment type Simple and Number of OMS Nodes of 1.
4. Enter the VCN Network details, the OMS details (passwords, shape, storage size), WebLogic password, and the Oracle Database System details (password, license, shape, storage).
5. Click Save Changes to finalize editing the stack and initiate stack deployment automatically.



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To deploy Enterprise Manger 13.4 Single Node, you will need to :

1. Review and perform all prerequisite tasks such as shape recommendation to support number of targets, OCI Services limits to support the shape, and network requirements.
2. Log in to OCI Marketplace and search for Enterprise Manager.
3. Specify the Deployment type Simple and Number of OMS Nodes of 1.
4. Enter the VCN Network details, the OMS details, WebLogic password, and the Oracle Database System details.
5. Click Save Changes to finalize editing the stack and initiate stack deployment automatically.

Required Ports for Enterprise Manager 13.4 – Single Node

Port	Service
TCP/22	SSH for Bastion and Enterprise Manager
TCP/7799	Enterprise Manager Console
TCP/7101	Enterprise Manager Web Logic Console and Admin Server
TCP/7401	Enterprise Manager Node Manager
TCP/7301	Managed Server / Java Virtual Machine Diagnostics (JVMD)
TCP/4900	Enterprise Manager Agent Upload
TCP/3872	Enterprise Manager Agent Listen (OMS & Database Nodes)
TCP/9899	BI Publisher Console
TCP/1521	Database Listener
TCP/22	Database Node

This chart list the required ports to be open in order to use Enterprise Manager effectively. You should refer to the documentation to confirm the ports when you provision Enterprise Manager and how to open the ports on your Exadata Cloud Service.

Enterprise Manager 13.4 – Multi-Node Deployments

- Multi-node deployments can be set up for high availability.
- **Oracle Cloud Infrastructure Load Balancing service**: The Load Balancer nodes will be on different availability domains for high availability.
- **Oracle Management Service**: Choose different availability domains for each OMS node if you require high availability.
- **OMR**: The OCI Database System provides an option to have nodes on different fault domains but will be on the same availability domains.
- Oracle Cloud Infrastructure Load Balancing service can be placed in either public or private subnet.
- The bastion host is required and always deployed since both Enterprise Manager and Database are deployed in a private subnet.

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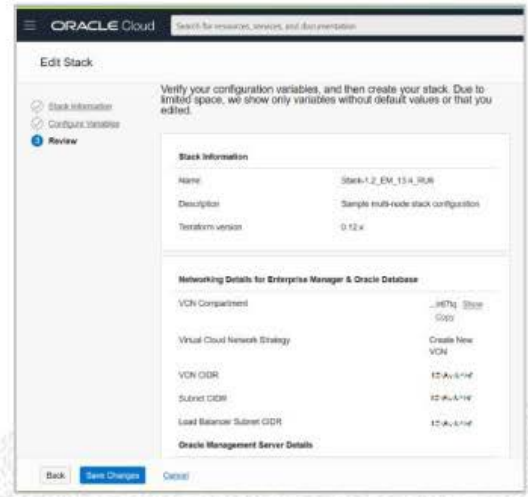
You want to use multi-node deployments to implement a high-availability strategy for Enterprise Manager. In the multi-node configuration, you will also add the following services.

- **Oracle Cloud Infrastructure Load Balancing service:** The Load Balancer nodes will be on different availability domains for high availability.
- **Oracle Management Service:** Choose different availability domains for each OMS node if you require high availability.
- **OMR:** The OCI Database System provides an option to have nodes on different fault domains but will be on the same availability domains.

A bastion host is required and always deployed since both Enterprise Manager and Database are deployed in a private subnet.

Enterprise Manager 13.4 – Multi-Node Deployments

1. Before deploying Oracle Enterprise Manager, review and perform all prerequisite tasks such as shape recommendation to support number of targets, OCI Services limits to support the shape, and network requirements.
2. Log in to OCI Marketplace and search for Enterprise Manager and filter by type *'Stack'*
3. Specify the Deployment type Multi-node.
4. EM Deployment Size: *Small, Medium, Large* and Number of OMS Naodes of 2.
5. Enter the VCN Network details, the OMS details (passwords, shape, storage size), WebLogic password, and the Oracle Database System details (password, license, shape, storage).
6. Click Save Changes to finalize editing the stack and initiate stack deployment automatically.



To deploy Enterprise Manager 13.4 in a multi-node configuration, you will:

1. Review and perform all prerequisite tasks such as shape recommendation to support number of targets, OCI Services limits to support the shape, and network requirements
2. Log in to OCI Marketplace and search for Enterprise Manager and filter by type 'Stack'
3. Specify the Deployment type Multi-node
4. Specify EM Deployment Size of Small, Medium, Large and Number of OMS Nodes of 2
5. Enter the VCN Network details, the OMS details, WebLogic password, and the Oracle Database System details
6. Click Save Changes to finalize editing the stack and initiate stack deployment automatically

Required Ports for Enterprise Manager 13.4 – Multi-Node

Port	Service
TCP/22	SSH for Bastion and Enterprise Manager, Database Node
TCP/443	Console Load Balancer
TCP/7799	Enterprise Manager Console
TCP/7101	Enterprise Manager Web Logic Console and Admin Console
TCP/7401	Enterprise Manager Node Manager
TCP/7301	Managed Server / Java Virtual Machine Diagnostics (JVMD)
TCP/4900	Enterprise Manager Agent Upload
TCP/3872	Enterprise Manager Agent Listen (OMS & Database Nodes)
TCP/5443	BI Publisher Console
TCP/3872	Agent Listen (OMS and Database Nodes)
TCP/1521	Database Listener
TCP/6200	DB Nodes (ONS/FanManager)
UDP/111 UDP/2048 TCP/111 TCP/2048-2050	NFS Service

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This chart list the required ports to be open in order to use Enterprise Manager effectively. You should refer to the documentation to confirm the ports when you provision Enterprise Manager and how to open the ports on your Exadata Cloud Service.

Monitoring Metrics

- Offers visualization of storage and compute performance for Oracle Exadata Cloud
- Provides a single pane of glass to view all of your Exadata targets
- Monitor the targets to obtain performance insights such as:
  - Aggregated Exadata FlashDisk and HardDisk
  - Exadata storage cell CPU and memory utilization
  - Disk I/O Objectives

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After the Exadata Cloud Service target and its member targets are discovered, you can use the Oracle Enterprise Manager Cloud Control environment to monitor the targets and obtain insights into their performance.

For a complete list of metrics available for Oracle Exadata, see *Oracle Exadata* in *Oracle® Enterprise Manager Oracle Database Plug-in Metric Reference Manual*.

The ExaCLI command-line utility allows you to perform monitoring and management functions on Exadata storage servers in an Exadata Cloud Service instance. The utility runs on the database compute nodes in the Exadata Cloud Service instance.

Monitoring Storage Servers with ExaCLI

- ExaCLI is a command-line tool allowing you to perform monitoring and management functions on Exadata storage servers.
  - Provides up-to-date information on your Exadata Cloud Service
- Execute ExaCLI commands from the database compute nodes.
- Connect to ExaCLI example:

```
[opc@exacs-node1 ~]$ exacli -l cloud_user_clustername -c 192.168.136.7
```

- Use the *list* command to view service and options such as objects in the flash cache and storage cell disk attributes.
- Diagnostic status and IORM plans can be viewed, created, and deleted.

You can execute various ExaCLI commands to monitor and manage Exadata Storage Servers. ExaCLI allows you to get up-to-date, real-time information about your Exadata Cloud Service.

After you have connected to the ExaCLI interface, use the LIST command to view all the options.

Refer to your Exadata Cloud Service documentation for more details.

Summary

In this lesson, you should have learned how to:

- Monitor with the OCI Metric Charts
- Monitor with Enterprise Manager
- Monitor storage servers with ExaCLI