



ORACLE



# Database

## Level 100

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Oracle Cloud Infrastructure  
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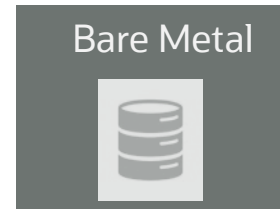
# Objectives

After completing this lesson, you should be able to:

- Describe the options of database systems available with Oracle Cloud Infrastructure
- Describe the features of Database Service
- Launch a one-node database system

# OCI Database Service

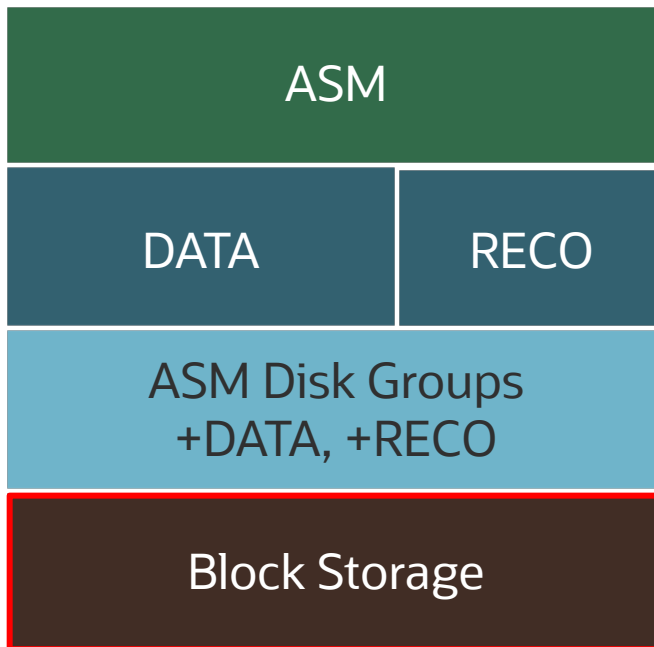
- Mission critical, enterprise grade cloud database service with comprehensive offerings to cover all enterprise database needs
  - Exadata, RAC, Bare Metal, VM
- Complete Lifecycle Automation
  - Provisioning, Patching, Backup & Restore
- High Availability and Scalability
  - RAC & Data Guard
  - Dynamic CPU and Storage scaling
- Security
  - Infrastructure (IAM, Security Lists, Audit logs)
  - Database (TDE, Encrypted RMAN backup / Block volume encryption)
- OCI Platform integration
  - Tagging, Limits and Usage integration
- Bring Your Own License (BYOL)



# Virtual Machine (VM) Database (DB) Systems

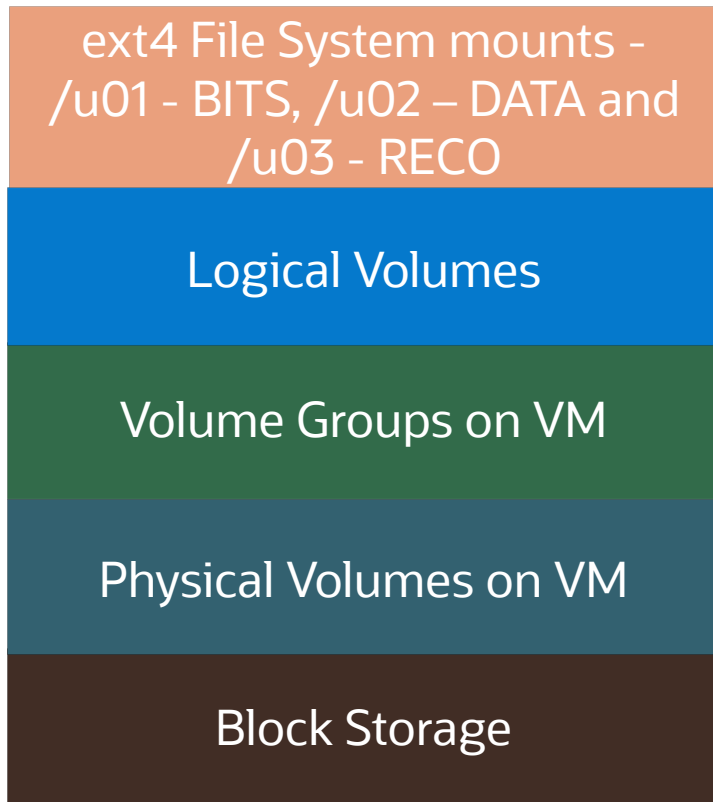
- There are 2 types of DB systems on virtual machines:
  - A 1-node VM DB system consists of one VM.
  - A 2-node VM DB system consists of two VMs clustered with RAC enabled.
- VM DB systems can have only a single database home, which in turn can have only a single database.
- Amount of memory allocation for the VM DB system depends on the VM shape selected during the provisioning process.
- Size of storage is specified when you launch a VM DB system and you scale up the storage as needed at any time.
- The number of CPU cores on an existing VM DB system cannot be changed.
- If you are launching a DB system with a virtual machine shape, you have option of selecting an older database version. Check Display all database versions to include older database versions in the drop-down list of database version choices.
- When a 2-node RAC VM DB system is provisioned, the system assigns each node to a different fault domain by default.
- Data Guard within and across ADs is available for VM DB systems (requires DB Enterprise Edition).

# VM DB Systems Storage Architecture



- ASM relies on OCI Block Volume (based on NVMe) for mirroring data
- Block volumes are mounted using iSCSI
- ASM uses external redundancy relying on the triple mirroring of the Block Storage
- Different Block Storage volumes are used for DATA and RECO
- Monitors the disks for hard and soft failures
- These actions ensure highest level availability and performance at all times
- This storage architecture is required for VM RAC DB systems

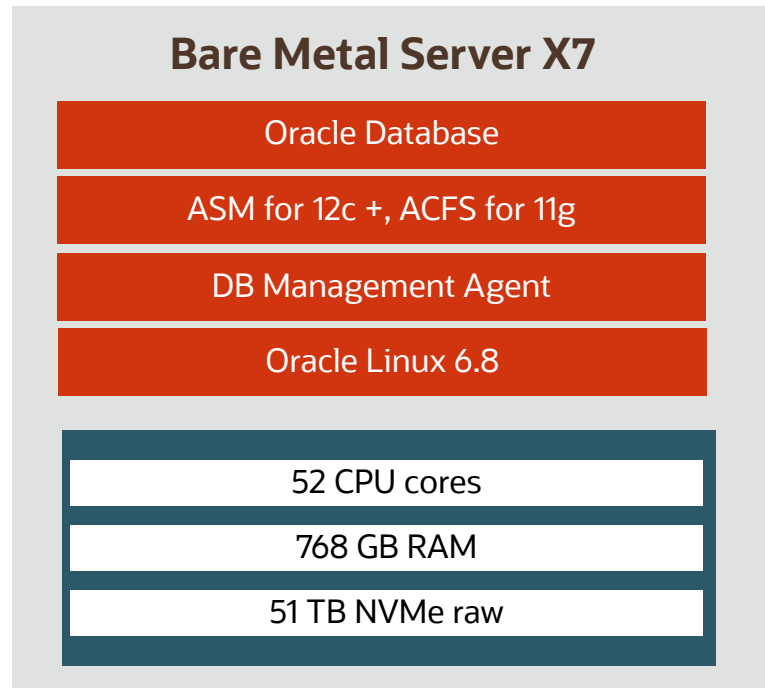
# VM DB Systems Storage Architecture – Fast Provisioning Option



- Linux Logical Volume Manager manages the filesystems used by the database for storing database files, redo logs, etc.
- Block volumes are mounted using iSCSI
- The available storage value you specify during provisioning determines the maximum total storage available through scaling\*\*
- VM RAC DB Systems cannot be deployed using this option
- Currently supports Oracle Database 18c and 19c releases

\*\*Please refer to <https://docs.cloud.oracle.com/iaas/Content/Database/References/fastprovisioningstorage.htm> for more information

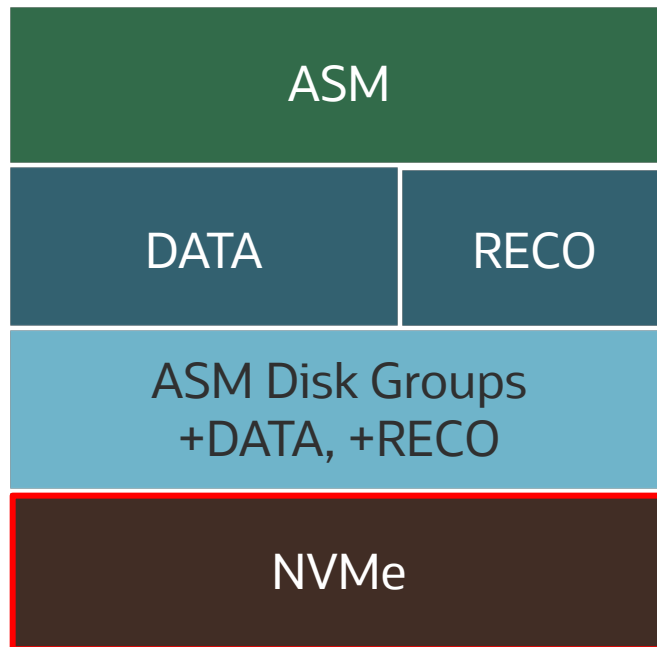
# Bare Metal DB Systems



- Bare Metal DB Systems rely on Bare Metal servers running Oracle Linux
- One-node database system:
  - Single Bare Metal server
  - Locally attached 51 TB NVMe storage (raw)
  - Start with 2 cores and scale up/down OCPUs based on requirement
  - Data Guard within and across ADs (requires DB Enterprise Edition)
  - If single node fails, launch another system and restore the databases from current backups



# Bare Metal DB Systems Storage Architecture



- ASM manages mirroring of NVMe disks
- Disks are partitioned – one for DATA and one for RECO
- Monitors the disks for hard and soft failures
- Proactively offlines disks that failed, predicted to fail, or are performing poorly & performs corrective actions, if possible
- On disk failure, the DB system automatically creates an internal ticket and notifies internal team to contact the customer
- These actions ensure highest level availability and performance at all times

# Exadata DB Systems

- Full Oracle Database with all advanced options
- On fastest and most available database cloud platform
  - Scale-Out Compute, Scale-Out Storage, Infiniband, PCIe flash
  - Complete Isolation of tenants with no overprovisioning
- All Benefits of Public Cloud
  - Fast, Elastic, Web Driven Provisioning
  - Oracle Experts Deploy and Manage Infrastructure



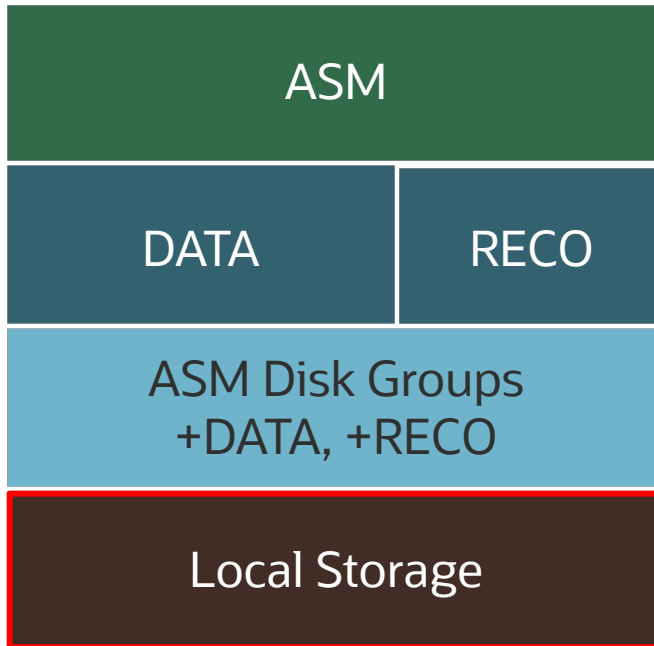
# Exadata DB Systems

- Oracle manages Exadata infrastructure - servers, storage, networking, firmware, hypervisor, etc.
- You can specify zero cores when you launch Exadata; this provisions & immediately stops Exadata
- You are billed for the Exadata infrastructure for the first month, and then by the hour after that. Each OCPU you add to the system is billed by the hour from the time you add it
- Scaling from ¼ to a ½ rack, or from ½ to a full rack requires that the data associated with database deployment is backed up and restored on a different Exadata DB system

Resource	Base System	Quarter Rack		Half Rack		Full Rack	
		X6	X7	X6	X7	X6	X7
Number of Compute Nodes	2	2	2	4	4	8	8
Total Minimum (Default) Number of Enabled CPU Cores	0	22	0	44	0	88	0
Total Maximum Number of Enabled CPU Cores	48	84	92	168	184	336	368
Total RAM Capacity	720 GB	1440 GB		2880 GB		5760 GB	
Number of Exadata Storage Servers	3	3	3	6	6	12	12
Total Raw Flash Storage Capacity	38.4 TB	38.4 TB	76.8 TB	76.8 TB	153.6 TB	153.6 TB	307.2 TB
Total Raw Disk Storage Capacity	252 TB	288 TB	360 TB	576 TB	720 TB	1152 TB	1440 TB
Total Usable Storage Capacity	74.8 TB	84 TB	106 TB	168 TB	212 TB	336 TB	424 TB



# Exadata DB Systems Storage Architecture



- Backups provisioned on Exadata storage: ~ 40% of the available storage space allocated to DATA disk group and ~ 60% allocated to the RECO disk group
- Backups not provisioned on Exadata storage: ~ 80% of the available storage space allocated to DATA disk group and ~ 20% allocated to the RECO disk group
- After the storage is configured, the only way to adjust the allocation without reconfiguring the whole environment is by submitting a service request to Oracle

# DB Systems – VM, BM, Exadata

	Virtual Machine (VM)	Bare Metal (BM)	Exadata
Scaling	Storage (number of CPU cores on VM DB cannot be changed)	CPU (amount of available storage cannot be changed)	CPU can be scaled within a ¼, ½ and Full rack. Storage cannot be scaled
Multiple Homes/Databases	No, single DB and Home only**	Yes (one edition, but different versions possible)	Yes
Storage	Block Storage	Local NVMe disks	Local spinning disks and NVMe flash cards
Real Application Clusters (RAC)	Available (2-node)	Not Available	Available
Data Guard	Available	Available	Available*

\*You can manually configure Data Guard on Exadata DB systems using native Oracle Database utilities and commands. dbcli is not available on Exadata DB systems

\*\*The database can be a container database with multiple pluggable databases, if the edition is High Performance or Extreme Performance.

# Database Editions and Versions

	VM DB Systems	BM DB Systems	Exadata DB Systems	DB Versions
Standard Edition	Yes	Yes	No	11.2.0.4 12.1.0.2 12.2.0.1 18.1.0.0 19.3*
Enterprise Edition	Yes	Yes	No	
High Performance	Yes	Yes	No	
Extreme Performance	Yes	Yes	Yes	
BYOL			Yes	

\*Note that Oracle Database 19c is only available on VM DB and Exadata DB Systems (as of September 2019)

# Database Editions and Options

## Standard Edition

- Full database instance
- Includes Transparent Data Encryption

## Enterprise Edition

Adds...

- All standard EE features
- Data Masking and Subsetting
- Diagnostics and Tuning
- Real Application Testing

## EE High Performance

Adds...



Multitenant



Partitioning



Advanced Compression



Advanced Security, Label Security, Database Vault



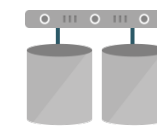
OLAP, Advanced Analytics, Spatial and Graph



Management Packs

## EE Extreme Performance

Adds...



Real Application Clusters (RAC)



In-Memory



Active Data Guard

Note that all editions include Oracle Database Transparent Data Encryption (TDE)

# Managing DB Systems

You can use the console to perform the following tasks:

- Launch a DB System: You can create a database system
  - Status check: You can view the status of your database creation and after that, you can view the runtime status of the database
- Start, stop, or reboot DB Systems
  - Billing continues in stop state for BM DB Systems (but not for VM DB)
- Scale CPU cores: scale up the number of enabled CPU cores in the system (BM DB systems only)
- Scale up Storage: increase the amount of Block Storage with no impact (VM DB systems only)
- Terminate: terminating a DB System permanently deletes it and any databases running on it



# Patching DB Systems

- **Automated Applicable Patch Discovery:** Automatic patch discovery and pre-flight checks/tests
- **On demand patching:** N-1 patching (previous patch is available if it hasn't been applied), pre-check and patching at the click of a button
- **Availability during patching:** For Exadata and RAC shapes, patches are rolling. For single node systems if Active Data Guard is configured this can be leveraged by the patch service.
- **2 step process** – patching is a 2 step process, one for DB System and one for the database. DB System needs to be patched first before the database is patched
- **Identity and Access Controls:** Granular Permissions – its possible to control who can list patches, apply them, etc.

The screenshot displays the Oracle patching interface. It features two sections, each titled "Patches".

The top section, labeled "Patches" and "Displaying 1 Data", shows a single patch card. The card includes a green square with a white "P" and the word "AVAILABLE" below it. The patch details are: OCID: ...oydy7a, Version: 12.2.0.1.180417, Patch Description: Apr 2018 12.2.0.1 Db System patch, and Release Date: Wed, 25 Apr 2018 01:00:00 GMT. Action buttons for "Pre-check" and "Apply" are visible on the right.

The bottom section, also labeled "Patches" and "Displaying 2 Da", shows a similar patch card. The details are: OCID: ...fp34sa, Version: 12.2.0.1.180417, Patch Description: Apr 2018 12.2.0.1 Database patch, and Release Date: Wed, 25 Apr 2018 01:00:00 GMT. Action buttons for "Pre-check" and "Apply" are visible on the right.

# Backup / Restore

- Managed backup and restore feature for VM/BM DB Systems; Exadata backup process requires creating a backup config file
- Backups stored in Object or Local storage (recommended: Object storage for high durability)
- DB System in private subnets can leverage Service Gateway
- Backup options
  - Automatic incremental – runs once/day, repeats the cycle every week; retained for 30 days
  - On-demand, standalone/ full backups
- Restore a DB

RESTORE TO THE LATEST

The service will restore to the last known good state with the least possible data loss.

RESTORE TO THE TIMESTAMP

The service will restore to the timestamp specified.

2018-08-06 18:29:35 GMT

RESTORE TO SYSTEM CHANGE NUMBER (SCN)

The restore operation will use the backup with SCN (System Change Number) specified. The SCN must be valid for the operation to succeed.

# Automatic Backups

- By default, automatic backups are written to Oracle owned object storage (customers will not be able to view the object store backups)
- Default policy cannot be changed at this time
- Automatic backups enabled for the first time after November 20, 2018 on any database will run between midnight and 6:00 AM in the time zone of the DB system's region
- You can optionally specify a 2-hour scheduling window for your database during which the automatic backup process will begin
- These are the preset retention periods for automatic backups: 7 days, 15 days, 30 days, 45 days and 60 days.
- Backup jobs are designed to be automatically re-tried
- Oracle automatically gets notified if a backup job is stuck
- All backups to cloud Object Storage are encrypted
- Link to troubleshooting backup issues <https://docs.us-phoenix-1.oraclecloud.com/Content/Database/Troubleshooting/Backup/backupfail.htm>

# High Availability and Scalability

- Robust Infrastructure
  - Region with 3 Availability Domains architecture
  - Fully redundant and non-blocking Networking Fabric
  - 2-way or 3-way mirrored storage for Database
  - Redundant Infiniband Fabric (Exadata) for cluster networking
- Database Options to enable HA
  - Database RAC Option in VMs and Exadata
  - Automated Data Guard within and across ADs
- Dynamic CPU and Storage Scaling

# Oracle Data Guard

- Robust Infrastructure
- Supported on both Virtual Machine and Bare Metal DB Systems.
- Limited to one Standby database per Primary database on OCI.
- Standby database used for queries, reports, test, or backups (only for Active Data Guard)
- Switchover
  - Planned role reversal, never any data loss
  - No database re-instantiation required
  - Used for database upgrades, tech refresh, data center moves, etc.
  - Manually invoked via Enterprise Manager, DGMGRL, or SQL\*Plus
- Failover
  - Unplanned failure of Primary
  - Flashback Database used to reinstate original Primary
  - Manually invoked via Enterprise Manager, DGMGRL, or SQL\*Plus
  - May also be done automatically: Fast-Start Failover

# OCI Security Features Overview for Database Service

## Security capability

Instance security isolation

Network security and access control

Secure and Highly-available  
Connectivity

User authentication & authorization

Data encryption

End-to-end TLS

Auditing

## Features

BM DB Systems

VCN, Security Lists, VCN Public and Private subnets, Route Table, Service Gateway

VPN DRGs, VPN and FastConnect

IAM Tenancy, Compartments and security policies, console password, API signing key, SSH keys

DBaaS TDE, RMAN encrypted back-ups, Local storage and Object storage encryption at rest

LBaaS with TLS1.2, Customer-provided certificates

OCI API audit logs

# DB Systems Demo

# Pricing – Virtual Machines

Virtual Machines	Metric	Pay as You Go	Monthly Flex
Database Standard Edition	OCPU Hour	\$0.4032	\$0.2688
Database Enterprise Edition	OCPU Hour	\$0.8064	\$0.5376
Database Enterprise Edition High Performance	OCPU Hour	\$1.6634	\$1.1089
Database Enterprise Edition Extreme Performance	OCPU Hour	\$2.5202	\$1.6801
BYOL - Database All Editions - Additional Capacity - BYOL	OCPU Hour	\$0.2903	\$0.1935

\*Prices in USD, Pricing information as of June 19, 2019. Please refer to <https://www.oracle.com/database/vm-cloud-pricing.html> for current pricing information



# Pricing – Bare Metal X7 – License Included

Bare Metal   BM.DenselO2.52 X7 Server	Metric	Pay as You Go	Monthly Flex
Standard Edition, 2 OCPU DB License (8 Max for Standard)	Hosted Environment Per Hour	\$10.746	\$7.1640
Enterprise Edition, 2 OCPUs enabled	Hosted Environment Per Hour	\$11.5524	\$7.7016
Enterprise Edition High Performance, 2 OCPUs enabled	Hosted Environment Per Hour	\$13.2661	\$8.8441
Enterprise Edition Extreme Performance, 2 OCPUs enabled	Hosted Environment Per Hour	\$14.9798	\$9.9865
Additional OCPUs - DB Standard Edition	OCPU Per Hour	\$0.4032	\$0.2688
Additional OCPUs - DB Enterprise Edition	OCPU Per Hour	\$0.8064	\$0.5376
Additional OCPUs - DB Enterprise Edition High Performance	OCPU Per Hour	\$1.6634	\$1.1089
Additional OCPUs - DB Enterprise Edition Extreme Performance	OCPU Per Hour	\$2.5202	\$1.6801

Additional OCPUs added must be in multiples of 2

\*Prices in USD, Pricing information as of June 19, 2019. Please refer to <https://www.oracle.com/database/bare-metal-cloud-pricing.html> for current pricing information



# Pricing – Bare Metal X7 – Bring Your Own License (BYOL)

Bare Metal   BM.DenselO2.52 X7 Database License	Metric	Pay as You Go	Monthly Flex
Database All Editions – BYOL (2 enabled OCPUs, 2 OCPU BYOL)	Hosted Environment Per Hour	\$10.5202	\$7.0135
Database All Editions – Additional Capacity - BYOL Additional OCPUs added must be in multiples of 2, Max 8 OCPUs for DB Standard Edition	OCPU Per Hour	\$0.2903	\$0.1935

\*Prices in USD, Pricing information as of June 19, 2019. Please refer to <https://www.oracle.com/database/bare-metal-cloud-pricing.html> for current pricing information



# Pricing - Exadata

	Metric	Monthly Flex (X6)	Monthly Flex (X7)
Base System	Hosted environment per hour	NA	\$20.1613**
Quarter Rack	Hosted environment per hour	\$63.8441	\$26.8817**
Half Rack	Hosted environment per hour	\$127.6882	\$53.7634**
Full Rack	Hosted environment per hour	\$255.3763	\$107.5269**
Additional OCPUs per month	OCPU hour	\$1.6801	\$1.6801

	Metric	Monthly Flex (X6)	Monthly Flex (X7)
Base System	Hosted environment per hour	NA	\$20.1613**
Quarter Rack – BYOL	Hosted environment per hour	\$33.9785	\$26.8817**
Half Rack – BYOL	Hosted environment per hour	\$67.957	\$53.7634**
Full Rack – BYOL	Hosted environment per hour	\$135.914	\$107.5269**
Additional OCPUs per month – BYOL	OCPU hour	\$.3226	\$1.6801

\*Pricing information as of June 19, 2019. Please refer to <https://www.oracle.com/database/exadata-cloud-service-pricing.html> for current pricing information

\*\* 0 enabled OCPUs

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# Summary

- Database service offers mission critical enterprise grade cloud database service with comprehensive offerings – Exadata, RAC, Bare Metal, VMs to cover every enterprise need
- Offers complete lifecycle automation – Provisioning, Patching, Backup, Restore
- Scalability from 1 core VM to Exadata and high-availability options – Data Guard, RAC
- Provides robust Security controls
- Supports BYOL model

**Oracle Cloud always free tier:**

[oracle.com/cloud/free/](https://www.oracle.com/cloud/free/)

**OCI training and certification:**

<https://www.oracle.com/cloud/iaas/training/>

<https://www.oracle.com/cloud/iaas/training/certification.html>

**OCI hands-on labs:**

[ocitraining.qcloudable.com/provider/oracle](https://ocitraining.qcloudable.com/provider/oracle)

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