

# Cloud Engineering

Week 7 Intro



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## Typical Week

### Typical Week

Watch Lecture Videos for the week before your first class

Attend every Q&A session – useful assessment tips

Attend every Lab

- Read Entire Instructions before Class
- Can get ahead on labs using Lab Reports to free up time

Start working on assignments and preparing for tests early

## Typical Week

### Typical Week

#### Consultation

- Every Teaching Week
- Underutilised

#### Discussion Board on Swinburne Canvas

- General questions

## Lectures to watch

### Lectures to watch

#### Swinburne Lectures

- High Level Overview
- Needed to pass

#### Oracle Lecture Videos

- Deep Dive
- More Topics and More Depth
- Aiming for high marks
- Prepare for certification

# Week 7 Intro

This presentation:

- Introduction to Oracle Cloud Infrastructure
- Free Tier Account Creation
- Free Documentation available



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# Introduction to Oracle Cloud Infrastructure

# Week 7 Intro

## Cloud Providers

We have learnt AWS.

Now we will learn Oracle Cloud Infrastructure



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# Why learn a second Cloud provider?

- Different Strengths/Weaknesses
- Customers want to use a specific cloud provider
- Employment opportunities
- Multi-Cloud

Week 7 Intro – What is Oracle?

Oracle?

Java

VirtualBox

MySQL

Enterprise Oracle Databases

# Free Tier Account Creation

## Creating an OCI Free Tier Account

- Lab – Create Oracle Cloud Infrastructure Account
  - Email Invite sent to student email
  - \$450 Free Credits, up to 365 days
- Use free tier resources where possible
- No Separate Sandbox and Assignment Environments
  - We will use compartments
- **CRITICALLY IMPORTANT – SELECT “US East (Ashburn) Region”**
- **NOTE:** Students who miss this step and choose a wrong Home Region will not be able to finish their assignments correctly  
**(marks will be deducted accordingly).**

## Week 7 Intro – Free Account Creation

# Creating an OCI Free Tier Account

The screenshot shows an email inbox interface with a blue header bar. The header bar displays the text "Create your Oracle Academy Student Cloud Account - Inbox" and an email address ending in "@student.swin.edu.au". Below the header is a toolbar with various icons for managing emails, such as Delete, Archive, Reply, Forward, Attachment, Move, Junk, Rules, Read/Unread, Categorise, Follow Up, Share to Teams, Send to OneNote, and Report Phishing.

**Create your Oracle Academy Student Cloud Account**

oracleacademy-noreply@oracle.com <oracleacademy-noreply@oracle.com>  
To: MATTHEW MULVANEY

Dear Student:

Bijan Raminzad from SWINBURNE UNIVERSITY OF TECHNOLOGY has registered you for the Oracle Academy Cloud Program, which provides you with free access to learn and develop in the Oracle Cloud.

1. [Click here](#)
2. Complete the sign up process.
3. Allow up to one day to receive your confirmation email.

Please direct any questions about this program to your instructor.

Kind regards,  
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# Getting Started with Oracle Cloud Infrastructure

Separate Video – provides Quick Demo of Creating OCI Account

Remember to select "**US East – Ashburn**" region

Free  
Documentation  
Available



# Free Documentation Available

OCI Documentation: <https://docs.oracle.com/en/cloud/get-started/index.html>

Oracle Cloud: <https://oracle.com/cloud>

OCI Blog: <https://blogs.oracle.com/cloud-infrastructure/>

Oracle YouTube Channel: <https://youtube.com/user/OracleLearning>

OCI Live Labs: <https://apexapps.oracle.com/pls/apex/dbpm/r/livelabs/livelabs-workshop-cards?c=Y>

# This Week's Lecture

## This Week's Lecture

- Oracle Cloud Infrastructure Overview
- OCI Differentiation from Other Offerings
- Getting Started with Oracle Cloud Infrastructure
- Introduction to OCI VCN Service

# Next week

### Next Week

- Compute services
  - OCI Compute Services
  - VM Images
- OCI Functions – Serverless platforms
- Network
  - CIDR
  - IP Addresses
  - Routing and Gateways
  - VPN & FastConnect

# Lecture References

## References

# Recommend Viewing

# Swinburne Lecture – High Level Overview

## Oracle Academy – Deeper dive

# Cloud Engineering

Oracle Cloud Infrastructure Overview



Image licensed under creative commons

# Oracle Cloud Infrastructure Overview

This video:

- Global Footprint
- OCI Regions
- Availability Domains
- Off-box Network Virtualisation
- Oracle Cloud Infrastructure Services



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# Recap - Virtualisation and Cloud Computing

# What is Cloud Computing?

## Quick recap

# What is Cloud Computing?

### Definitions:

**“...on-demand ... via the internet with *pay-as-you-go* pricing.”**

### **Computing as a Service**

Economies of scale

Provisioning and maintaining IT infrastructure vs infrastructure owned and maintained by 3<sup>rd</sup> party



Image from:  
[https://upload.wikimedia.org/wikipedia/commons/d/dc/Cloud-Computing\\_services.png](https://upload.wikimedia.org/wikipedia/commons/d/dc/Cloud-Computing_services.png)

# What is Virtualisation in Cloud Computing?

## Virtualisation in Cloud Computing:

Virtual version of physical resource

Efficient use of resources

Share same underlying physical resources

Key Technology for Cloud Computing

Dynamic allocation of resources

## Oracle Cloud Infrastructure Overview – What is Oracle?

Oracle?

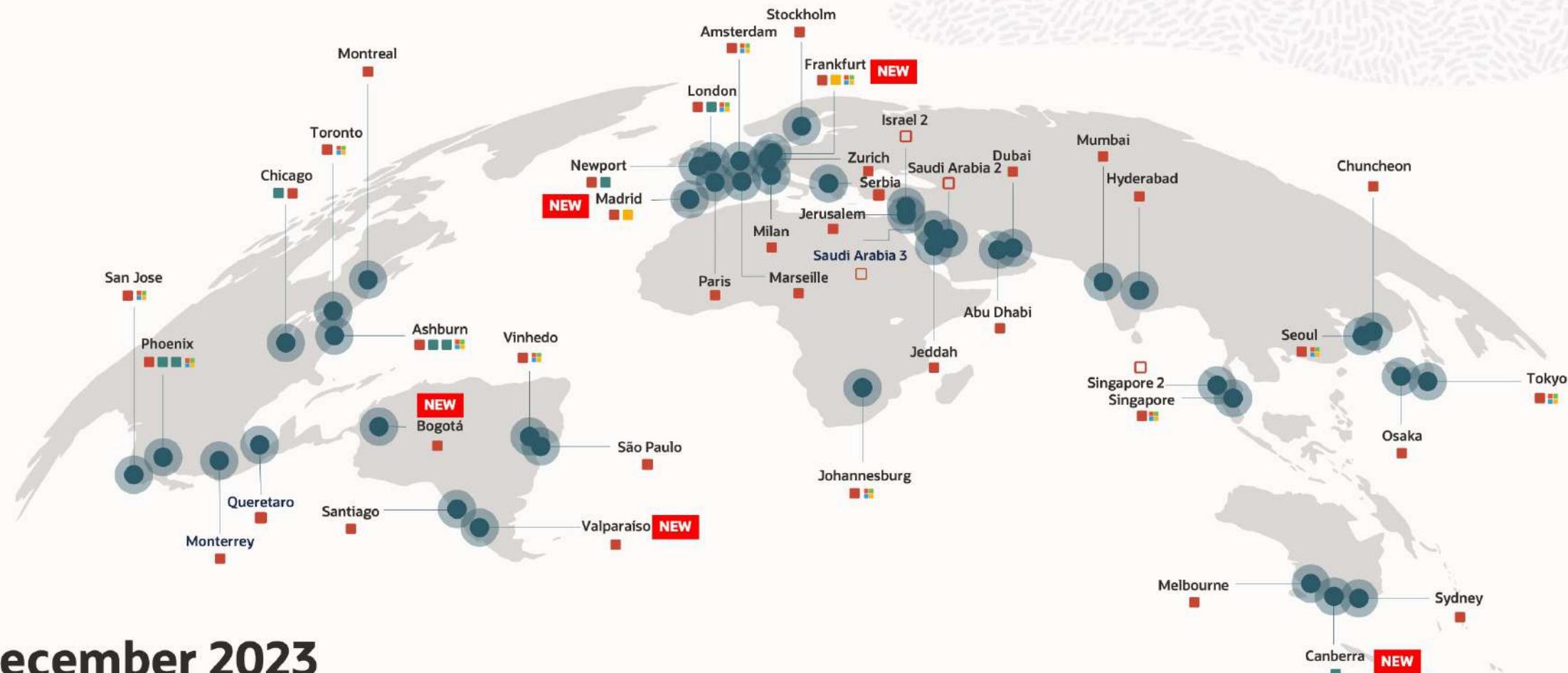
# Java

# VirtualBox

MySQL

# Enterprise Oracle Databases

# Oracle Cloud Infrastructure Global Footprint



December 2023



## Oracle Cloud Infrastructure Overview – What is Oracle?

### Oracle Region Trends

More Regions Added Over Time

Number More than doubled in Less than 18 months

More Countries with Multiple Regions

## Oracle Cloud Infrastructure Overview – What is Oracle?

### Oracle Home Region

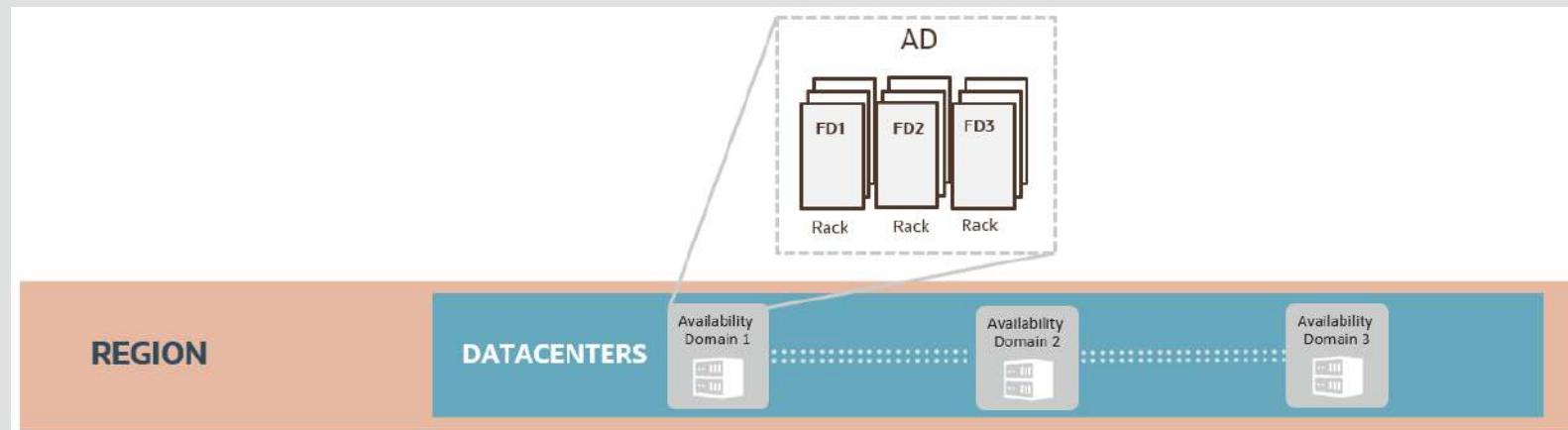
Region when creating an account

IAM Resources primarily stored in home Region

Free Trial accounts limited to one Region by default

# OCI Region – HA Building Blocks

- Multiple fault de-correlated, completely independent datacenters: Availability Domain (AD)
- Grouping of hardware and infrastructure within an AD: Fault Domain
- Predictable low latency & high speed, encrypted interconnect between ADs



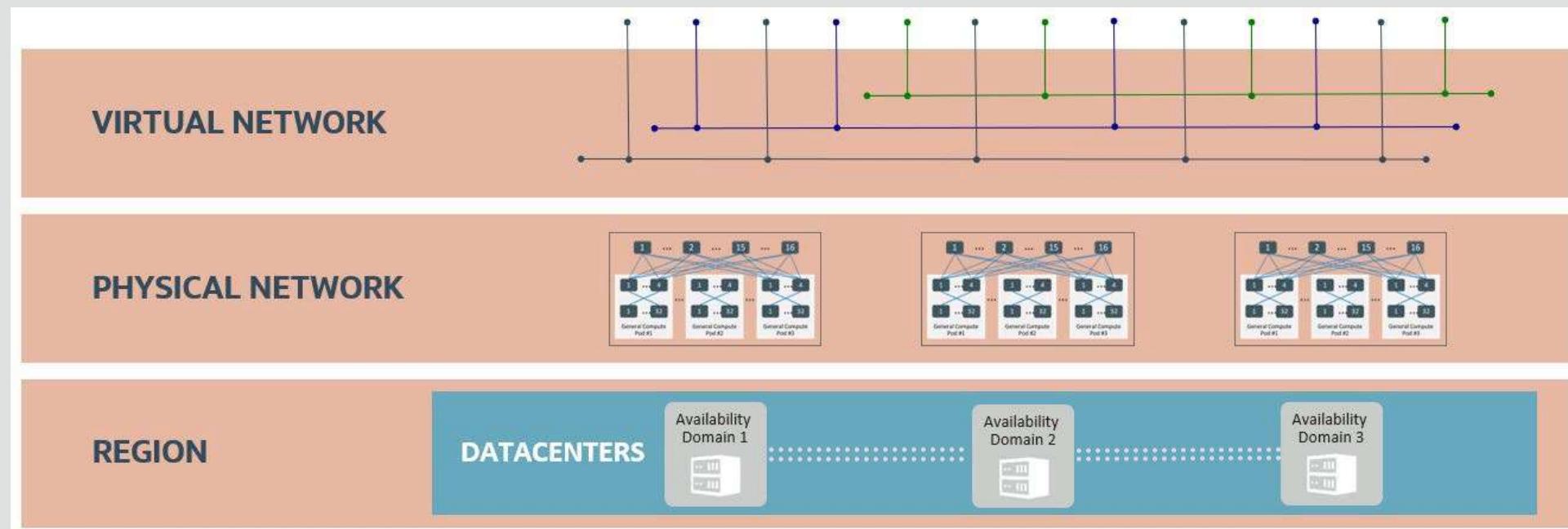
# One AD Regions

- OCI has chosen to launch regions in new geographies with one AD (to increase our global reach quickly)
- For any region with one AD, a second AD or region in the same country or geo-political area will be made available within a year to enable further options for DR and data residency

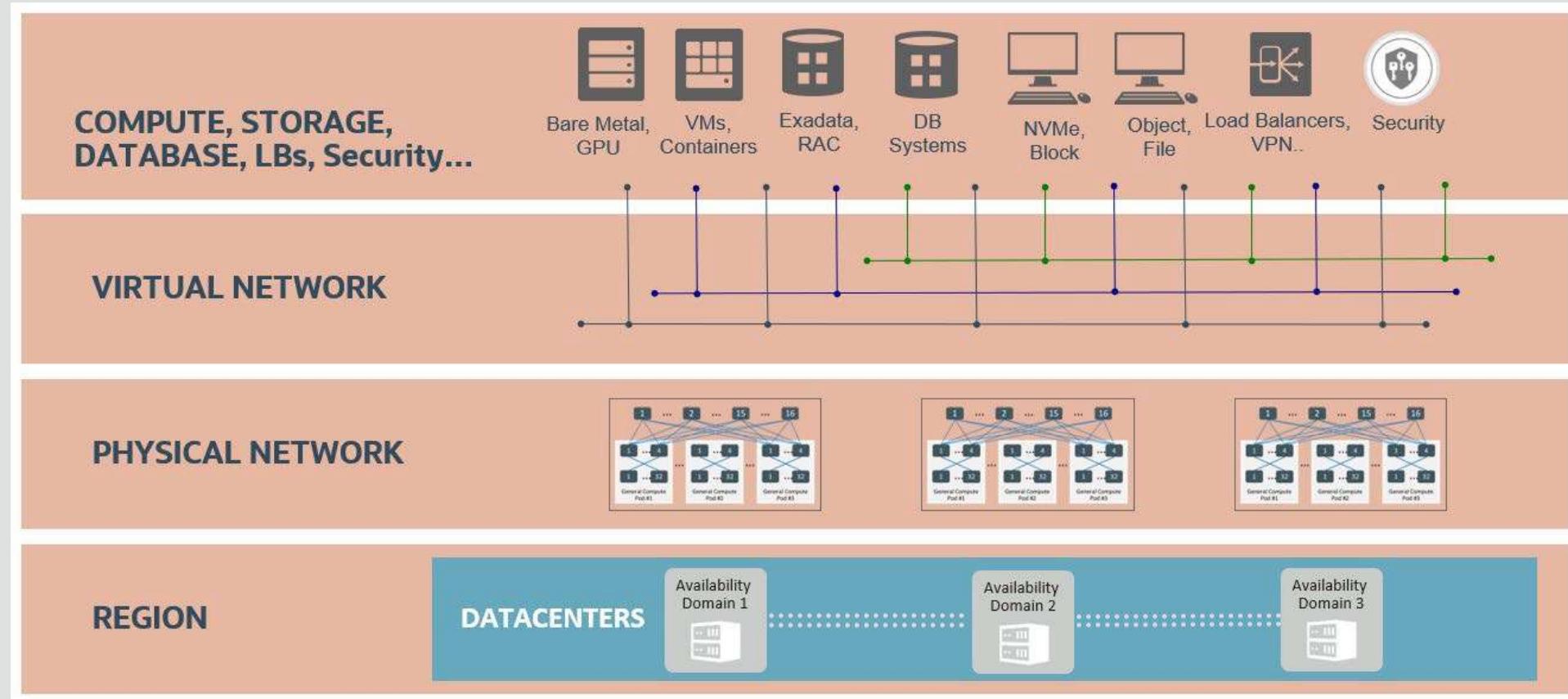
OCI Region (current)	# Availability Domains
US West (Phoenix)	3
US East (Ashburn)	3
UK South (London)	3
Germany Central (Frankfurt)	3
Australia East (Sydney)	1
Brazil East (Sao Paulo)	1
Canada Southeast (Toronto)	1
India West (Mumbai)	1
Japan East (Tokyo)	1
South Korea Central (Seoul)	1
Switzerland North (Zurich)	1

# Off-box Network Virtualization

- Off Box Network Virtualization – moves storage and network IO out of the hypervisor and enables lower overhead and bare metal instances



# Oracle Cloud Infrastructure Services



# Oracle Cloud Infrastructure Overview

# Tenancy

## Renter

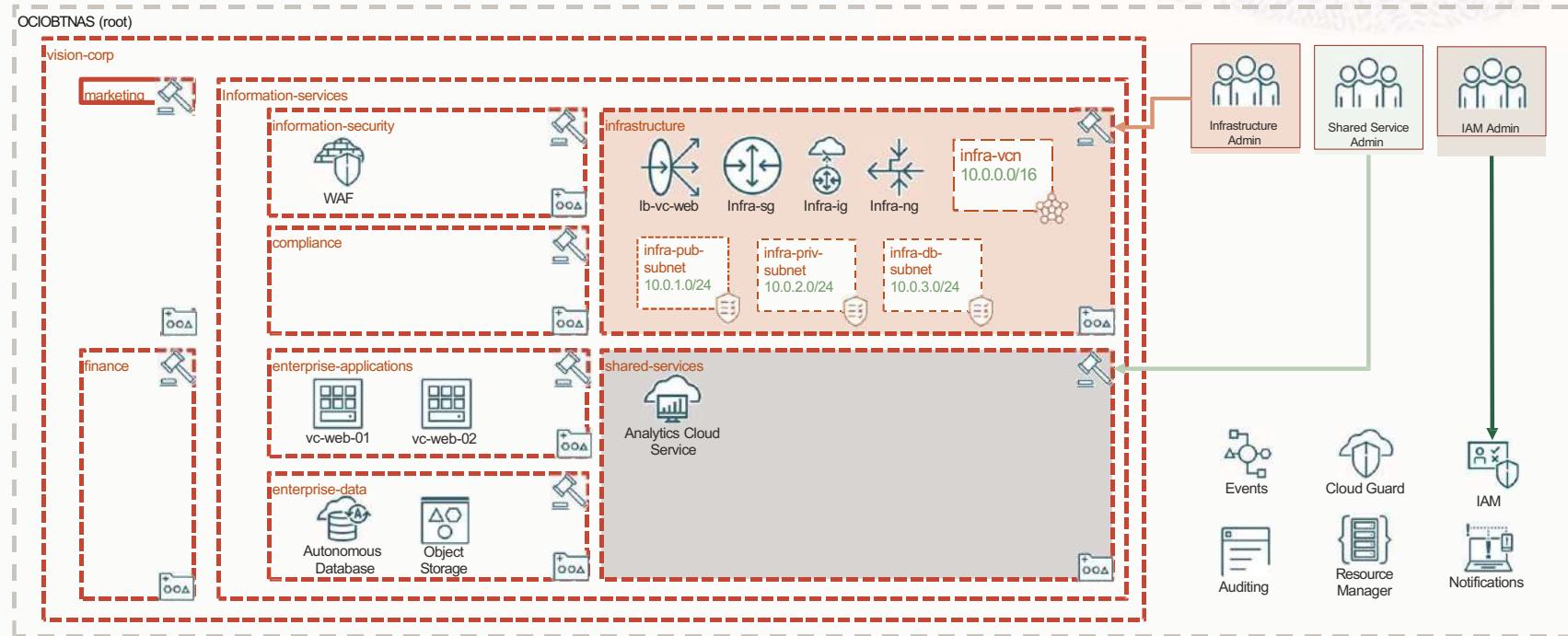
## Company has in OCI

# Root compartment

Can add more

# Compartments

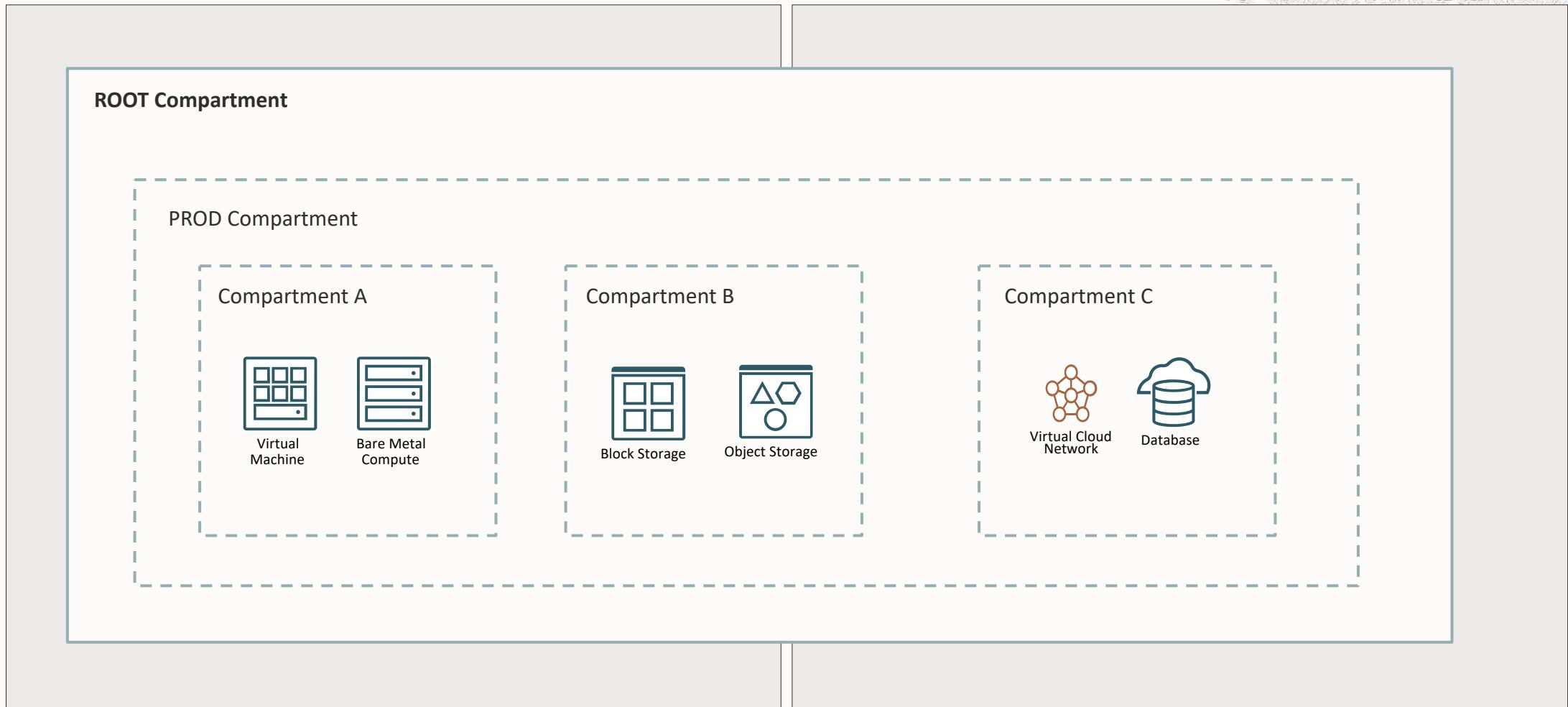
A compartment is a logical grouping of related resources that can be accessed only by groups that have been given permission



# Compartment Schematic

OCI Region Melbourne  
ap-melbourne-1

OCI Region Sydney  
ap-sydney-1



# Oracle Cloud Infrastructure Overview

# Compartments

## Labs\_Compartment

## Assignments\_Compartment

# No Sandbox & No Learner Lab

# Traditional On-Prem or Private Datacentre vs Cloud

	<b>Traditional</b>	<b>Cloud</b>	•	•	•	•
Security	Firewall, ACLs	Security Groups, Security Lists, IAM	•	•	•	•
Databases	Oracle Database Servers	Enterprise database in cloud: BM, VM, Exadata, RAC	•	•	•	•
Compute	Servers	OCI Compute, OCI Container Instances, Functions (Serverless)	•	•	•	•
Networking	Router, switch	OCI VCN, Load Balancers	•	•	•	•
Storage	NAS, SAN, DAS	Object Storage, Block Volume, File Storage	•	•	•	•

# Oracle Cloud Infrastructure Services

## IDENTITY

### Identity and Access Management

Granular, role based access control to cloud resources

## NETWORKING

### VCN, VPN, FastConnect, LB

Isolated software defined private networks

## COMPUTE

### Bare Metal, Dedicated Hosts, VMs

Bare Metal, Dedicated Hosts, VMs with same APIs; Managed Kubernetes

## STORAGE

### Local, Block, File, Object, Archive

Local, Block, File, Object and Archive storage options

## DATABASE

### Bare Metal, VMs, RAC, Exadata

Bare Metal, VM, Exadata, RAC and Active Data Guard support

## AUTONOMOUS DATABASE

### ADW, ATP

Only autonomous database in the cloud

## SERVERLESS

### Functions, Autonomous-Serverless

Log APIs calls for audit, bring your own keys

## ANALYTICS

### Streaming, Oracle Analytics Cloud

Software NAS Gateway, Data Transfer Appliance

## NEXT LAYER SERVICES

### Monitoring, Logging, Audit

Global DNS, global private connectivity at up to 97% less cost

## SECURITY

### Audit, Key Management

Log APIs calls for audit, bring your own keys

## DATA MOVEMENT

### Storage appliance, Data Transfer

Software NAS Gateway, Data Transfer Appliance

## EDGE

### DNS, Other Edge, Email

Global DNS, global private connectivity at up to 97% less cost

# References

# References

Oracle Cloud Academy Foundations | Section I

Week 1 Lecture

Day One and Beyond - Season 4 - Oracle Cloud Technical Quick Start:

<https://www.youtube.com/watch?v=8kYEYNMK4zg>

<https://docs.oracle.com/en-us/iaas/Content/Identity/Tasks/managingregions.htm>

[https://docs.oracle.com/en/cloud/foundation/cloud\\_architecture/governance/tenancy.html](https://docs.oracle.com/en/cloud/foundation/cloud_architecture/governance/tenancy.html)

# Cloud Engineering

Getting Started with Oracle Cloud Infrastructure



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# Getting Started with Oracle Cloud Infrastructure

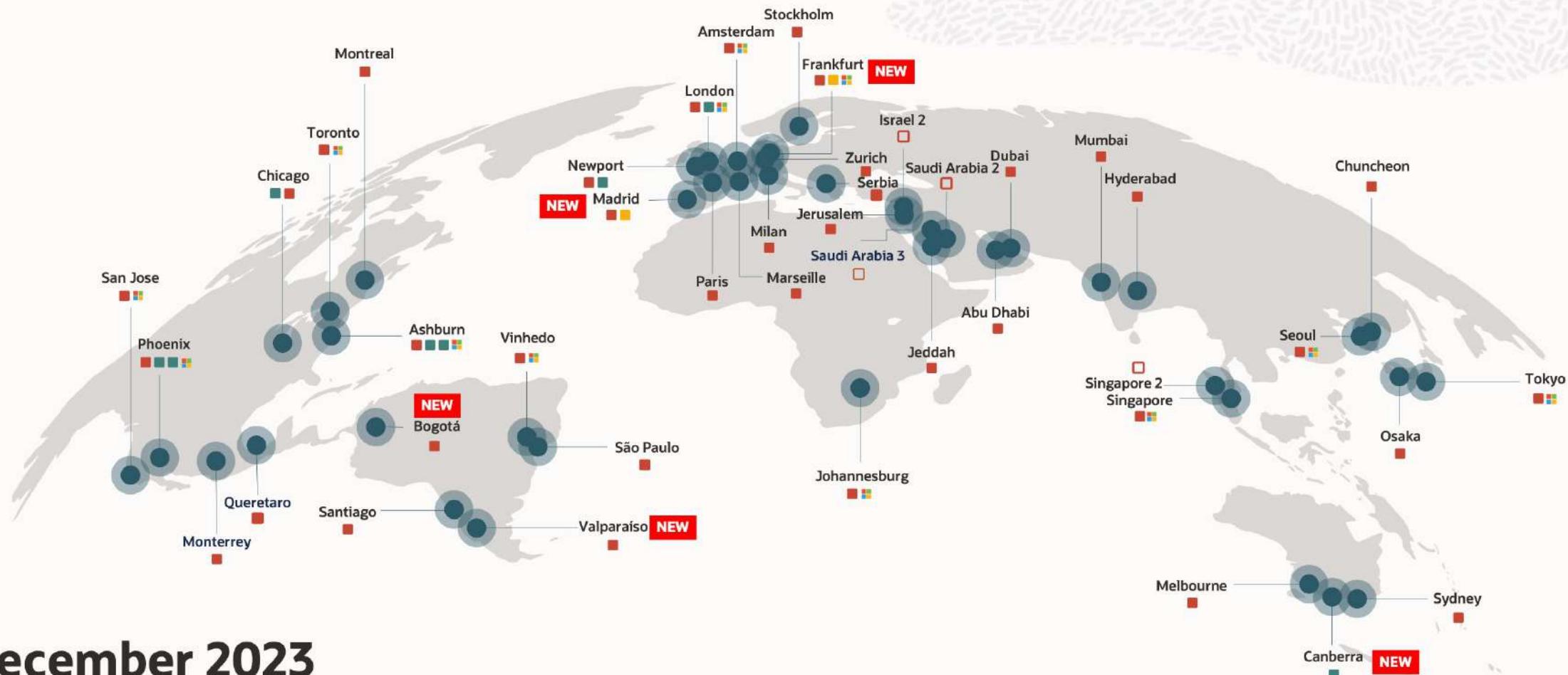
This video:

- Setting up your free trial of Oracle Cloud Infrastructure
- Quick Tour of OCI



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# Oracle Cloud Infrastructure Global Footprint



December 2023



### Setting up an account

Use the Oracle Academy Cloud invite for free credits for 365 days

Standard offer is free credits for just 30 days

Use free tier and always free resources where possible

Use account every 90 days to keep active

## Create your Oracle Academy Student Cloud Account - Inbox [REDACTED]@student.swin.edu.au



## Message



## Create your Oracle Academy Student Cloud Account



oracleacademy-noreply@oracle.com &lt;oracleacademy-noreply@oracle.com&gt;

Friday, 20 January 2023 at 3:23 am

To: MATTHEW MULVANEY

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# Creating Compartments

## Creating Compartments

Create two compartments

Labs\_Compartment

Assignments\_Compartment

You have **A\$378.76** left in your Free Trial. When your trial is over, your account is limited to Always Free resources. [Upgrade](#) at any time. [Learn more](#)

**ORACLE Cloud** Search resources, services, documentation, and Marketplace US East (Ashburn) [View health dashboard](#) [Bell](#) [Help](#) [Global](#) [Profile](#)

**Get started** **Dashboard**

**Service links**

- PINNED**
  - Instances Compute
  - Virtual cloud networks Networking
- RECENTLY VISITED**
  - Compartments Identity
  - Users Identity
- RECOMMENDED - [\(Update\)](#)**
  - Logging Logging
  - Autonomous Database Autonomous Database
  - Buckets Object Storage & Archive Storage
  - Policies Identity
  - Groups Identity
  - Tenancies Organization Management

**Quickstarts**

- FEATURED**

Predict the result of the next race  25-30 mins
- APPLICATION DEVELOPMENT**

Deploy a WordPress website  6-8 mins
- APPLICATION DEVELOPMENT**

Deploy a low-code app on Autonomous Database using APEX  3-5 mins **Always Free eligible**
- APPLICATION DEVELOPMENT**

Deploy RStudio in a container  10-12 mins
- APPLICATION DEVELOPMENT**

Deploy a baseline landing zone  7-9 mins
- DATABASE**

Visualize and analyze Strava data on Autonomous Database  2-4 mins **Always Free eligible**

**All services operational** [View health dashboard](#)

**Usage** [Analyze costs](#)  
Subscription 29678876  
A\$400.00 Free Trial credits  
A\$21.27 used A\$378.73 left  
57 of 365 days

**Cost savings opportunities**  
Estimated savings: 0  
[View recommendations \(0\)](#)

**OCI mobile app**  
Review alarms, access billing and usage data, and manage resources on the go.  
[Install now](#)

**Get early access to OCI features**  
Try out upcoming features and share your feedback  
[Join preview program](#)

**What's new** 

# References

# References

OCI Foundations | Section I

Day One and Beyond - Season 4 - Oracle Cloud Technical Quick Start:

<https://www.youtube.com/watch?v=8kYEYNMK4zg>

# Cloud Engineering

Introduction to OCI VCN Service



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# Introduction to OCI VCN Service

This presentation:

- VCN
- Subnets
- VCN Peering



Images licensed under creative commons.

# Introduction to OCI VCN Service

## OCI VCN vs AWS VPC

## OCI Virtual Cloud Network vs AWS Virtual Private Cloud

# Introduction to OCI VCN Service

What is a VCN?

Your Virtual Cloud.

VCN is in one region

Cloud version of traditional network

# Introduction to OCI VCN Service

Choosing a region

Low Latency

Availability of services and features e.g. 1 AD Region vs 3 AD Region

Legal and compliance reasons

NOT Pricing

# Introduction to OCI VCN Service

## Choosing a region

Two Regions in Australia

Melbourne and Sydney

High Availability across Regions

Disaster Recovery within Australia

# Introduction to OCI VCN Service

What is an AD?

One/More datacentres

Geographically isolated from other ADs

Early regions - 3

Newer regions start with 1

# Introduction to OCI VCN Service

How many availability domains

1 – Temporary use, data easily recreate, performance >> durability

2 – some redundancy, minimise downtime, manage cost

3 – critical databases and critical applications

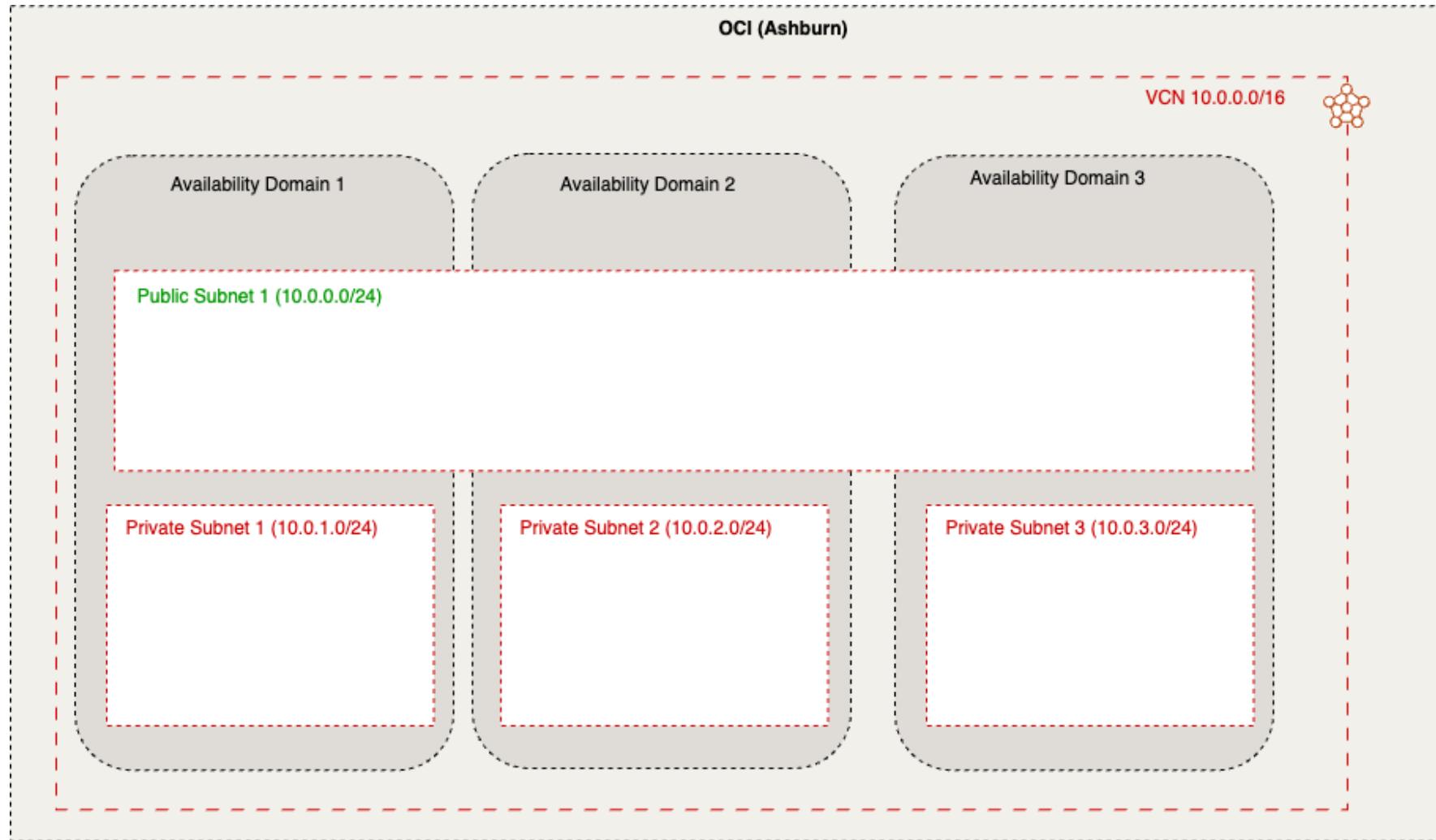
# Introduction to OCI VCN Service

What is a Subnet?

Subnetwork

Can be multiple subnets in a VCN

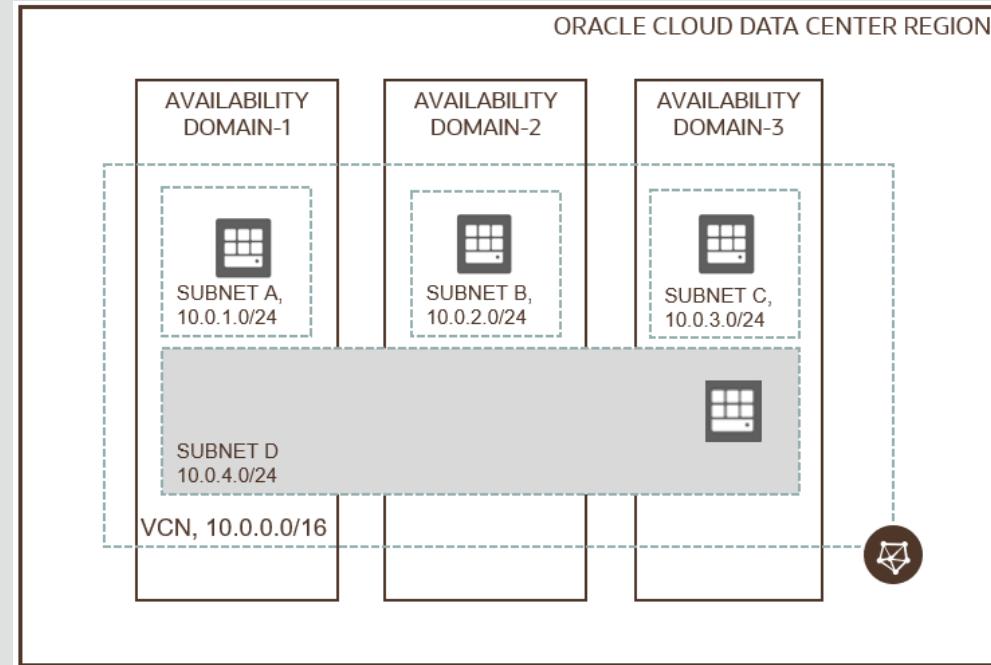
# Introduction to OCI VCN Service



# Subnet

Each VCN network is subdivided into subnets

- Each subnet can be AD-specific or **Regional (recommended)**
  - AD specific subnet is contained within a single AD in a multi-AD region
  - Regional subnet spans all three ADs in a multi-AD region
- Each subnet has a contiguous range of IPs, described in CIDR notation
- Subnet IP ranges cannot overlap



# Introduction to OCI VCN Service

Subnets - Regional vs AD Specific

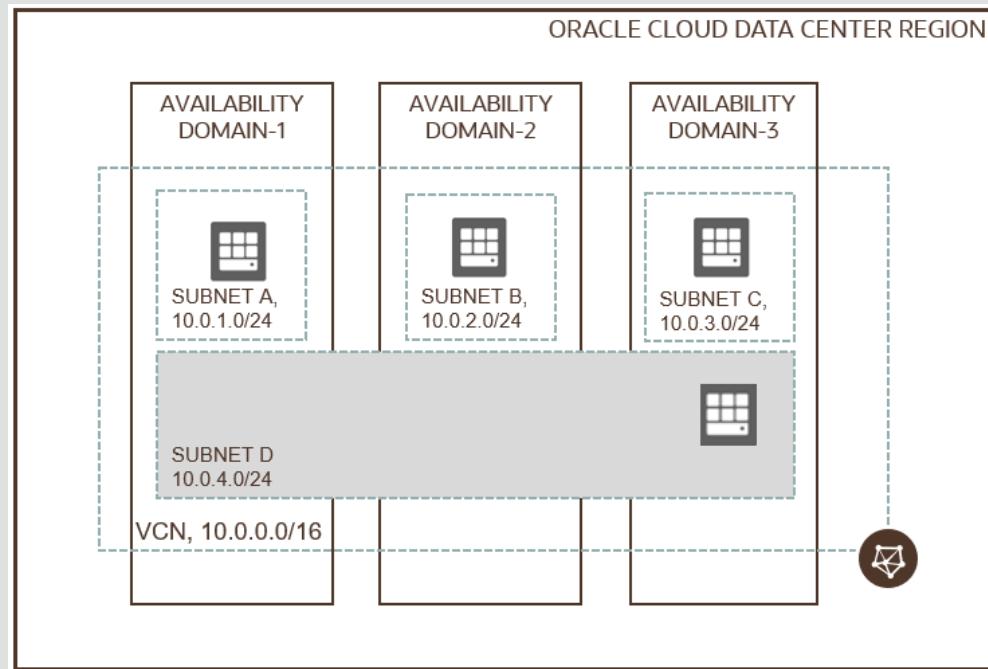
Why would you choose one over the other?

Regional – more flexible

Some resources/services – require same AD

# Subnet

- Instances are placed in subnets and draw their internal IP address and network configuration from their subnet
- Subnets can be designated as either:
  - **Private** (instances contain private IP addresses assigned to VNICs)
  - **Public** (contain both private and public IP addresses assigned to VNICs)
- **VNIC** is a component that enables a compute instance to connect to a VCN
- The **VNIC** determines how the instance connects with endpoints inside and outside the VCN



# VCN Peering (Local)

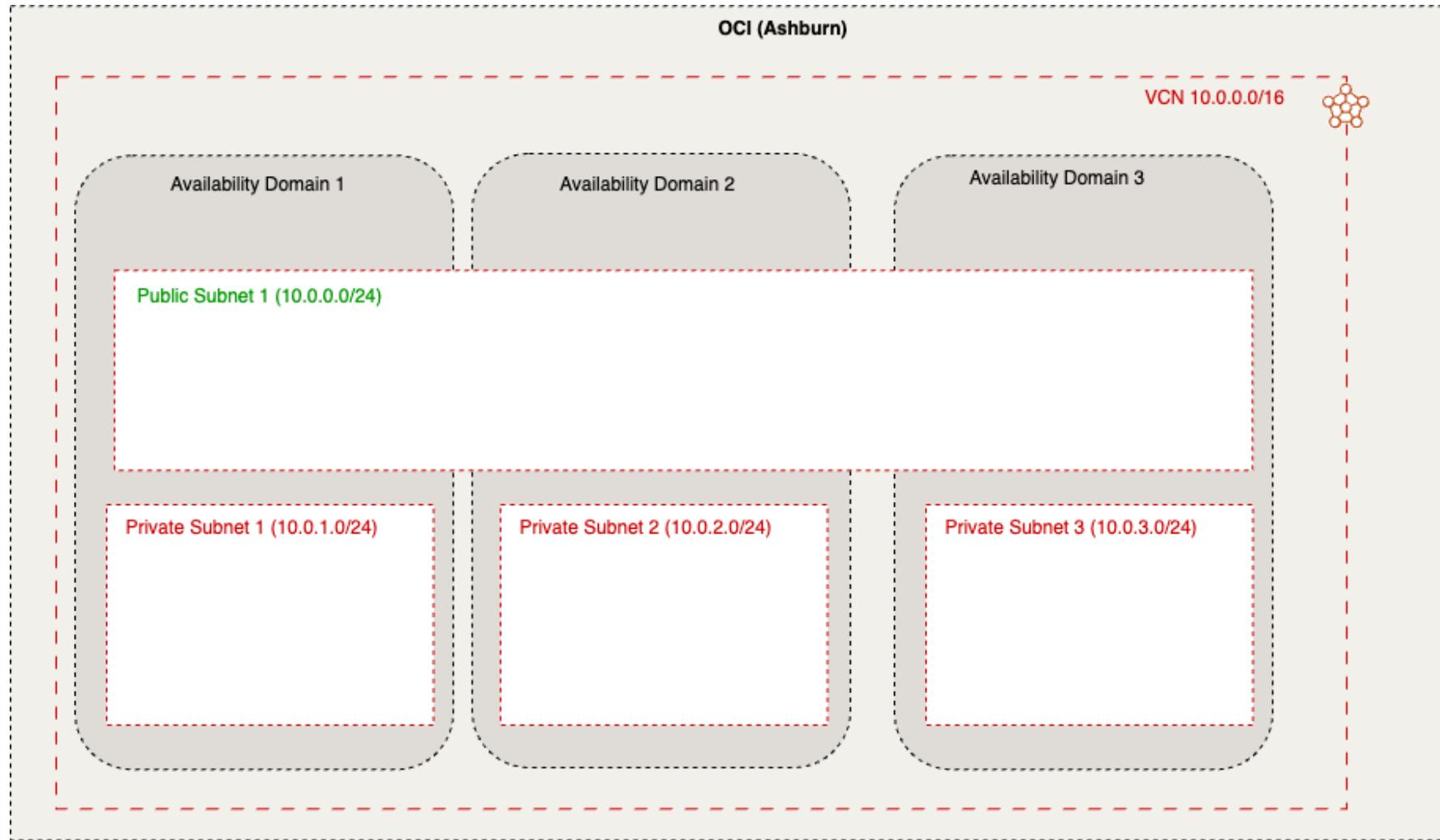
# Introduction to OCI VCN Service

## VCN Peering

Connect two VCNs together e.g.

- Disaster Recovery
- Separate teams managing separate VCNs
- Copy Production Database for Development or Testing

# Our first VCN Diagram



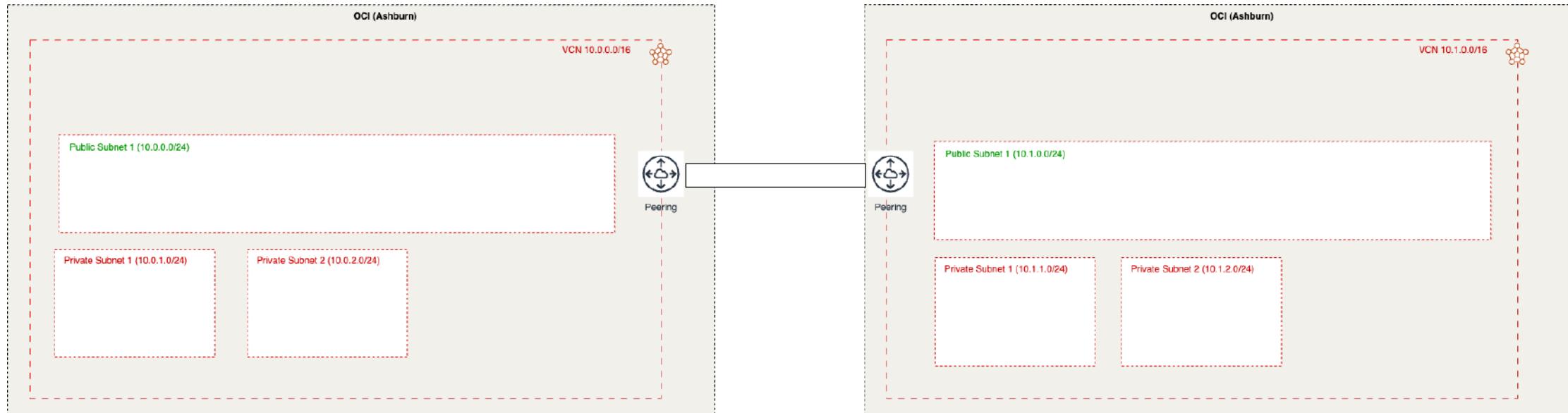
# Our first VCN Diagram



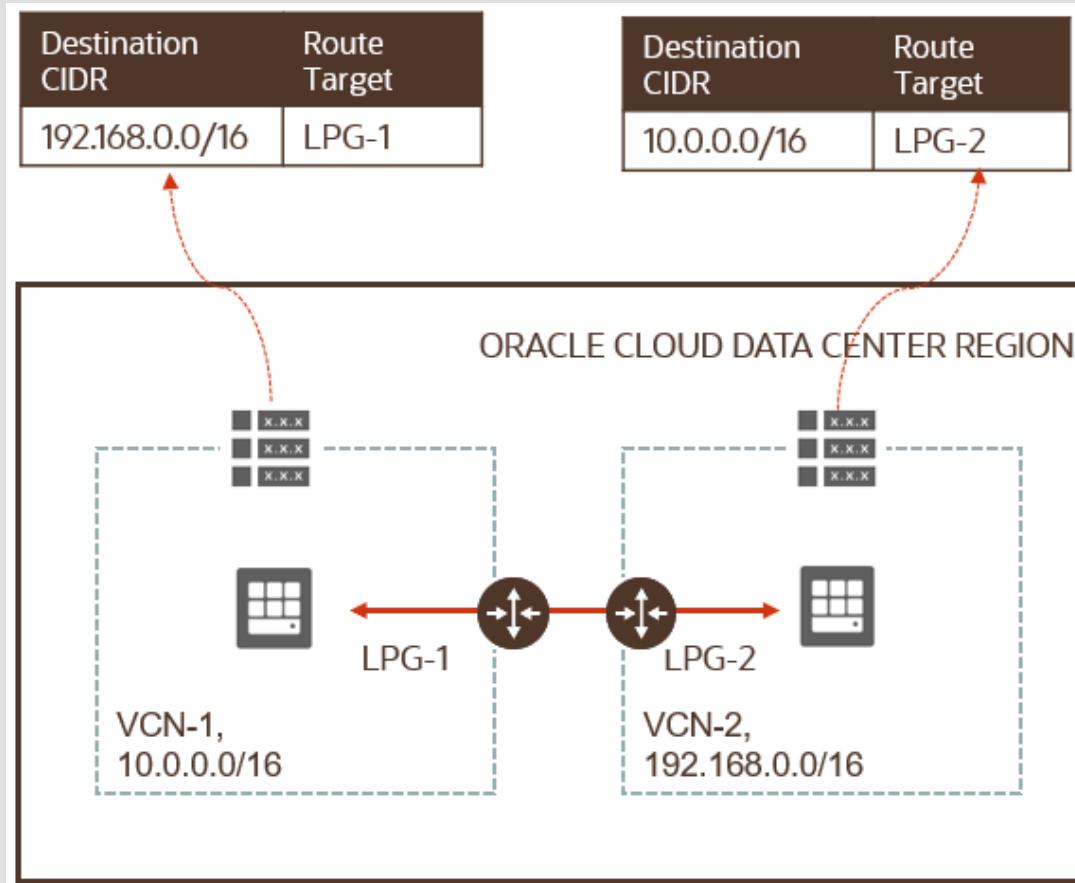
# Our first VCN Diagram



# VCN Peering (Local)



# Local Peering (within region)



- VCN peering is the process of connecting multiple VCNs
- Local VCN peering is the process of connecting two VCNs in the **same region** so that their resources can communicate using private IP addresses
- A local peering gateway (LPG) is a component on a VCN for routing traffic to a locally peered VCN
- The two VCNs in the peering relationship shouldn't have overlapping CIDRs

# References

# References

Oracle Cloud Academy Foundations I Section 2

Networking in The Cloud EP.01 Virtual Cloud Networks: <https://youtu.be/mIYSgeX5FkM>

Networking in the Cloud EP.05: Interconnecting (Peering) VCNs: <https://youtu.be/u3BssXJzRjk>

Oracle Cloud Infrastructure Networking: Overview: <https://www.youtube.com/watch?v=DljGGhidUrl>

draw.io starter template for OCI: <https://maximilian.tech/2020/11/27/draw-io-starter-template-for-oci-oracle-cloud-infrastructure/>

# Cloud Engineering

OCI Differentiation from Other Offerings



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# OCI Differentiation from Other Offerings

This presentation:

Why choose Oracle Cloud Infrastructure?

Technical and Business Differences



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# OCI Differentiation from Other Offerings

Why choose Oracle Cloud Infrastructure?

Marketing / Sales Engineer

IT Decision Maker

Competitive Advantages



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# OCI Differentiation from Other Offerings

# Why not just use AWS?

It depends

Benchmark against older well known cloud provider

# OCI Differentiation from Other Offerings

Open Source Software

Uses Open Source Software where possible

Don't reinvent the wheel

Flexibility to change cloud providers

Incentive to innovate

# OCI Differentiation from Other Offerings

## Technical Differences

### Technical

- A bit like Tech Specs of a PC
- Features of what the cloud can do



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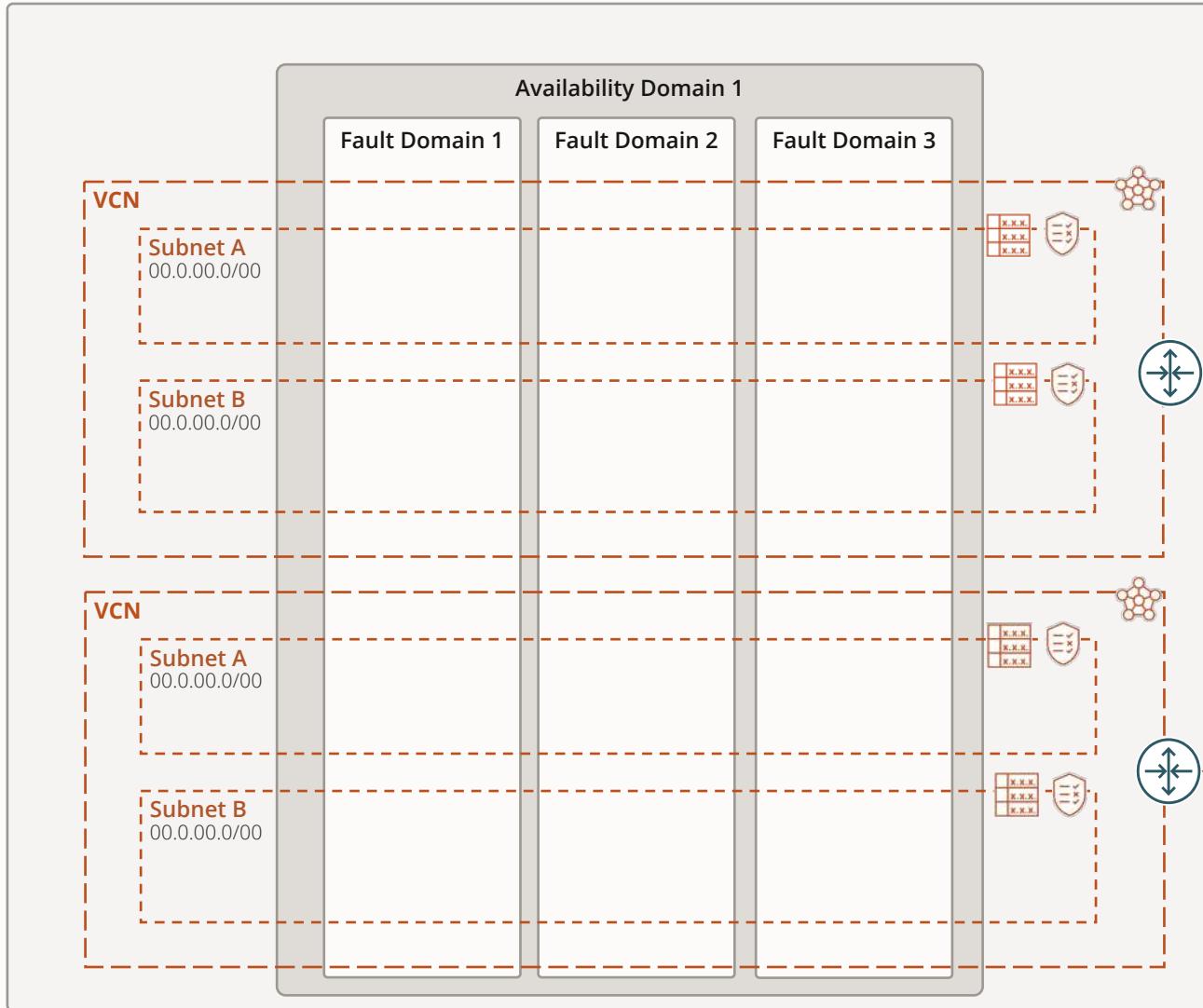
# Comparing to other Clouds

	Oracle Cloud VMware Solution BM.DenseIO2.52	Oracle Cloud VMware Solution BM.DenseIO.E4.32/64/128	VMware Cloud on AWS i3.metal	VMware Cloud on AWS i3en.metal	Google Cloud VMware Engine ve1-standard-72	Azure VMware Solution av36
VMware Software	vSphere, vSAN, vCenter, NSX-T, HCX					
Hardware	<ul style="list-style-type: none"> <li>• 52 Core</li> <li>• 768 GB RAM</li> <li>• 6.4 TB NVMe Cache</li> <li>• 44.8 TB NVMe Data</li> <li>• 3 to 64 Nodes</li> </ul>	<ul style="list-style-type: none"> <li>• 32/64/128 Core</li> <li>• 2 TB RAM</li> <li>• 6.8 TB NVMe Cache</li> <li>• 47.6 TB NVMe Data</li> <li>• 3 to 64 Nodes</li> </ul>	<ul style="list-style-type: none"> <li>• 36 Core (Broadwell)</li> <li>• 512 GB RAM</li> <li>• 3.8 TB NVMe Cache</li> <li>• 11.4 TB NVMe Data</li> <li>• 2 to 16 Nodes</li> </ul>	<ul style="list-style-type: none"> <li>• 48 Core</li> <li>• 768 GB RAM</li> <li>• 7.2 TB NVMe Cache</li> <li>• 45.8 TB NVMe Data</li> <li>• 3 to 16 Nodes</li> </ul>	<ul style="list-style-type: none"> <li>• 36 Core</li> <li>• 768 GB RAM</li> <li>• 3.2 TB NVMe Cache</li> <li>• 19.2 TB NVMe Data</li> <li>• 3 to 64 Nodes</li> </ul>	<ul style="list-style-type: none"> <li>• 36 Core</li> <li>• 576 GB RAM</li> <li>• 3.2 TB NVMe Cache</li> <li>• 15.36 TB SSD Data</li> <li>• 3 to 16 Nodes</li> </ul>
Root & Administrative Access	<ul style="list-style-type: none"> <li>• Customer owns root password and access, No Oracle access after provisioning</li> <li>• Customer can edit vSAN cluster settings</li> <li>• Customer can set VM-Host affinity rule</li> <li>• Customer can set encryption policy and key</li> </ul>		<ul style="list-style-type: none"> <li>• Vendor retains root password and access</li> <li>• Limited administrative access</li> </ul>			
VMware Lifecycle	<ul style="list-style-type: none"> <li>• Customer controls upgrade policy (version, time, defer)</li> <li>• Stay compliant with third-party add-ons</li> </ul>		<ul style="list-style-type: none"> <li>• Vendor decides VMware version</li> <li>• Customer negotiates upgrade window</li> </ul>			
N-1 Version Support	<b>Yes</b> 6.5, 6.7, 7.0	<b>Yes</b> 6.7, 7.0	<b>No, vendor decides</b> 7.0	<b>No, vendor decide</b> 7.0	<b>No, vendor decides</b> ?	
Networking	<ul style="list-style-type: none"> <li>• Running inside customer's virtual cloud network</li> <li>• No gateway, no bandwidth throttling</li> <li>• Full control over network security policy</li> </ul>		<ul style="list-style-type: none"> <li>• Co-lo</li> <li>• Via transit gateway, bandwidth may be throttled</li> <li>• No control over Tier-0 gateway</li> </ul>	<ul style="list-style-type: none"> <li>• ?</li> </ul>	<ul style="list-style-type: none"> <li>• ?</li> </ul>	
Support	Oracle		VMware & AWS	Google	Microsoft	
Regions	39		19	15	23	

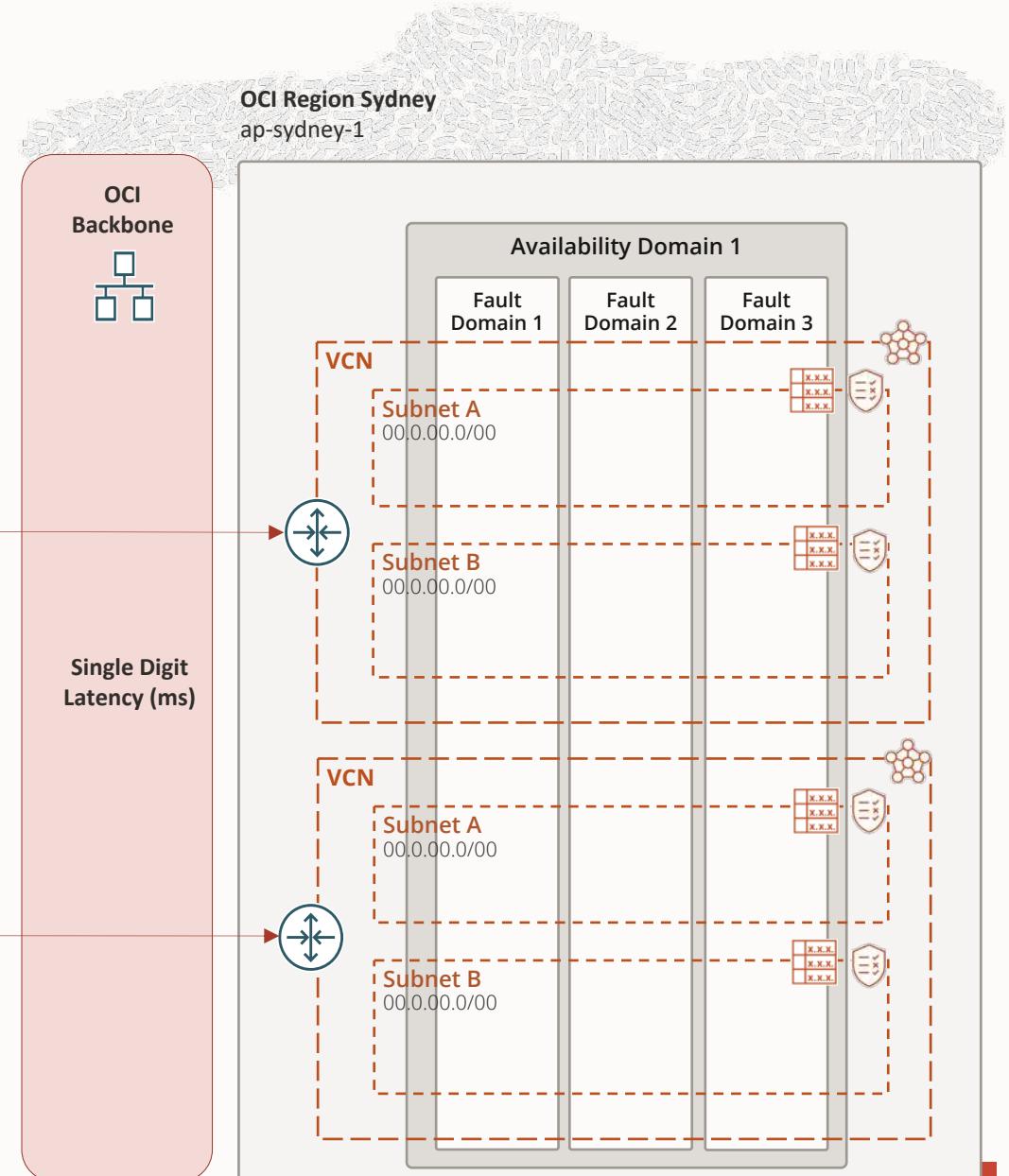


# OCI Networking across Regions

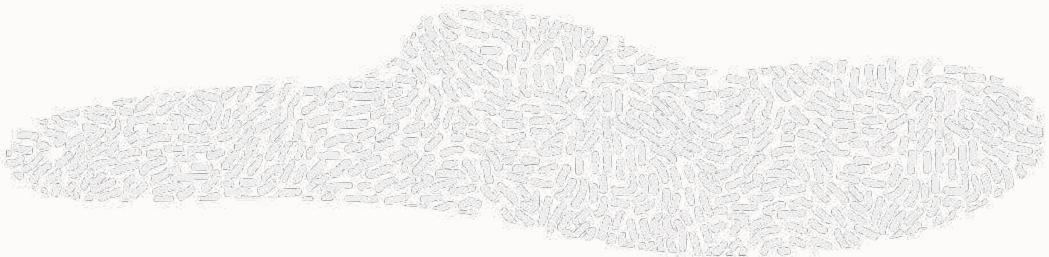
OCI Region Melbourne  
ap-melbourne-1



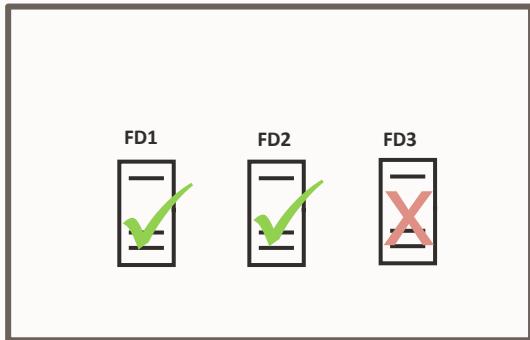
OCI Region Sydney  
ap-sydney-1



# OCI Regions - Fault Tolerant Architecture



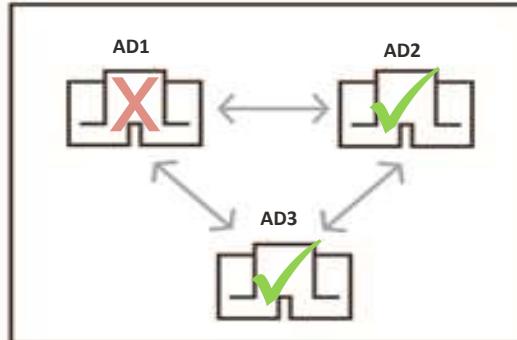
AVAILABILITY DOMAIN



## Fault Domains

Protection against failures within an Availability Domain

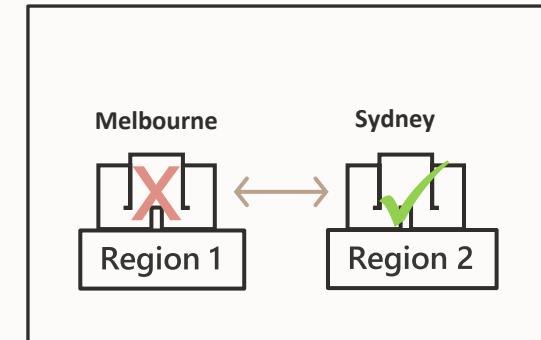
REGION



## Availability Domains

Protection from entire Availability Domain failures (multi-AD region)

REGION PAIR



## Region Pair

Protection from disaster with data residency & compliance

SLAs on Availability, Management and Performance

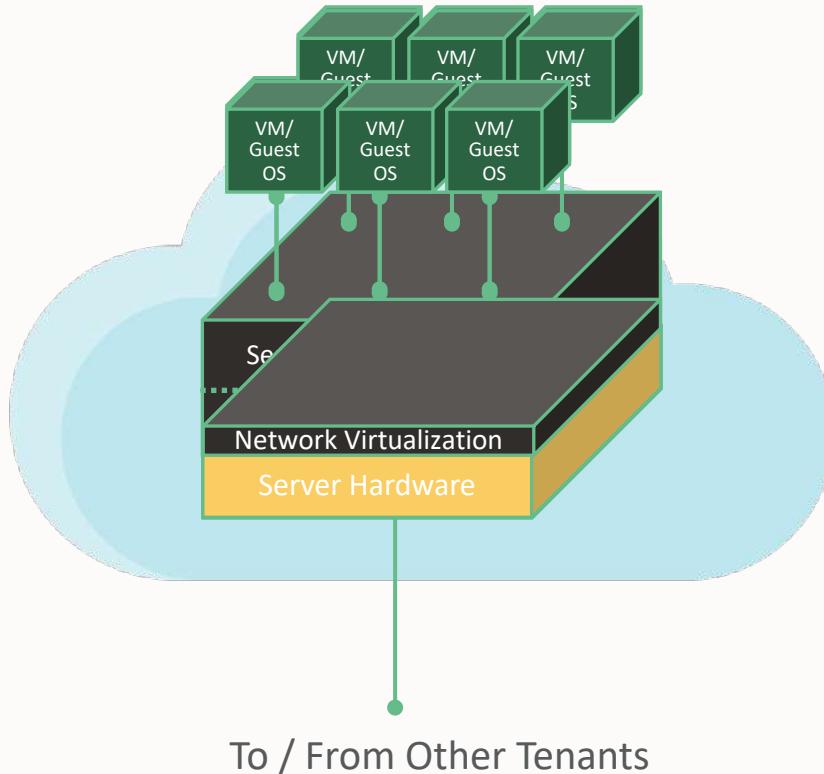
# Oracle Generation 2 Cloud Security

Built on Security and Performance

## 1<sup>st</sup> Generation Clouds:

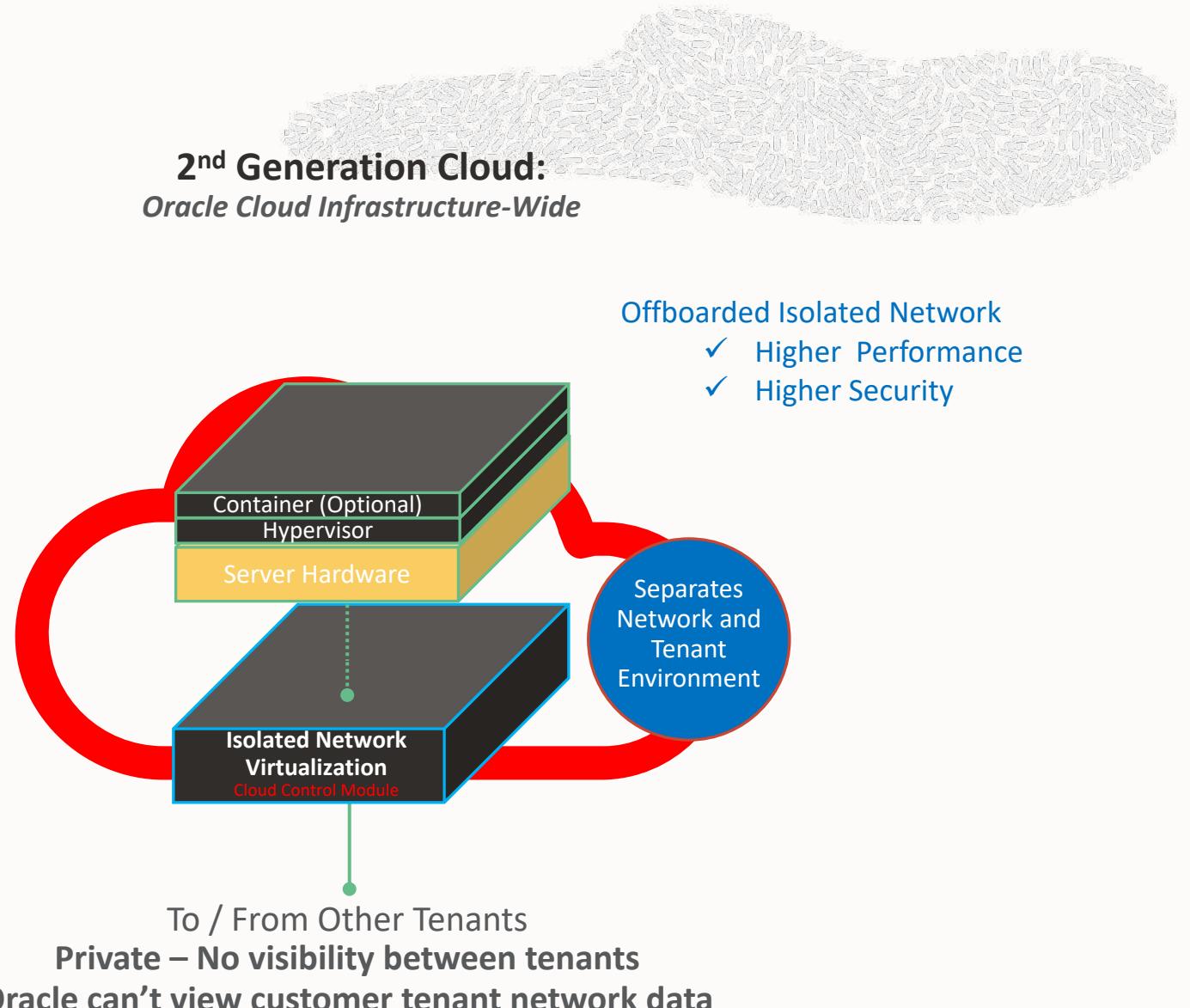
*Most Prevalent Today*

Azure / AWS / GCP / IBM / Alibaba



## 2<sup>nd</sup> Generation Cloud:

*Oracle Cloud Infrastructure-Wide*



# OCI Differentiation from Other Offerings

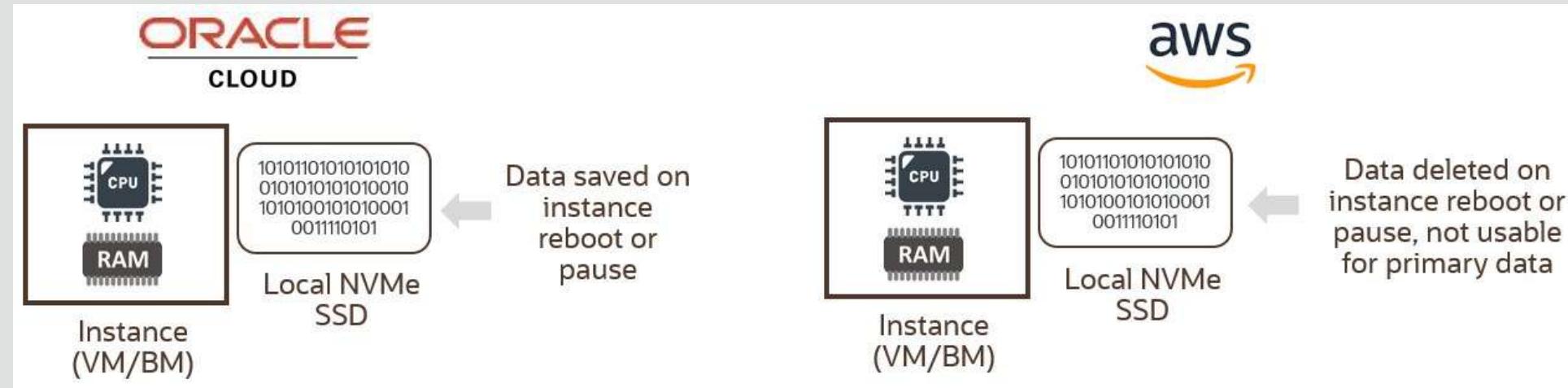
## Technical - Performance

- Bare Metal + Local NVMe storage
- All SSD Storage
- No Network, CPU, or Memory oversubscription



Images licensed under creative commons.

# NVMe SSD Persisted - Reboot/Pause



“With Oracle Cloud Infrastructure, companies can leverage NVMe for persistent storage to host databases and applications. However, other cloud providers typically do not offer such a capability. In cases where NVMe storage was an option with other vendors, it was not persistent. This meant that the multi-terabyte database that researchers loaded to this storage was lost when the server stopped.”

- Accenture

# OCI Differentiation from Other Offerings

Technical - Battle-tested

Oracle NetSuite and other SaaS apps run on OCI



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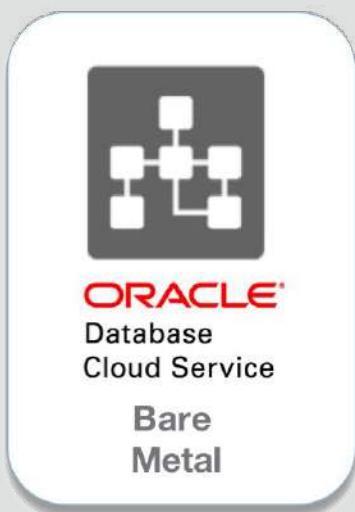
# OCI Differentiation from Other Offerings

Technical - Database Offerings

BM, VM, Exadata and RAC

# Oracle Cloud – Bare Metal

- Oracle Cloud is the only Cloud providing dedicated bare metal servers for the Oracle Database, offering the best in class performance.



<b>Memory</b>	Up to 768 Gb of RAM
<b>Cores</b>	Scale up to 52 Cores
<b>Storage</b>	Up to 51.2 TB of local NVMe SSD Database Storage
<b>Database</b>	Standard or Enterprise Edition   11.2, 12.1, 12.2, 18c, 19c
<b>Migration Solutions</b>	ZDM, SQL Developer, RMAN, Data Pump, MAA, Plug/Unplug, Remote Cloning

# References

## OCI Differentiation from Other Offerings - References

## References

Oracle Cloud Academy Foundations | Section I

Oracle Cloud Academy Foundations I Section 5

Oracle Cloud Academy Foundations II Section 10

# ORACLE

## Academy

# Oracle Cloud Infrastructure Foundations I

**Section 1**

**Getting Started with Oracle Cloud Infrastructure**

**Level 100**

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# Objectives

- This lesson covers the following objectives:
  - Oracle Cloud Infrastructure Overview
  - Understand the global footprint of the Oracle Cloud Infrastructure
  - Identify the components of a Region
  - Physical Network
  - Oracle Cloud Infrastructure Services Overview
  - Describe how OCI is differentiated from other offerings

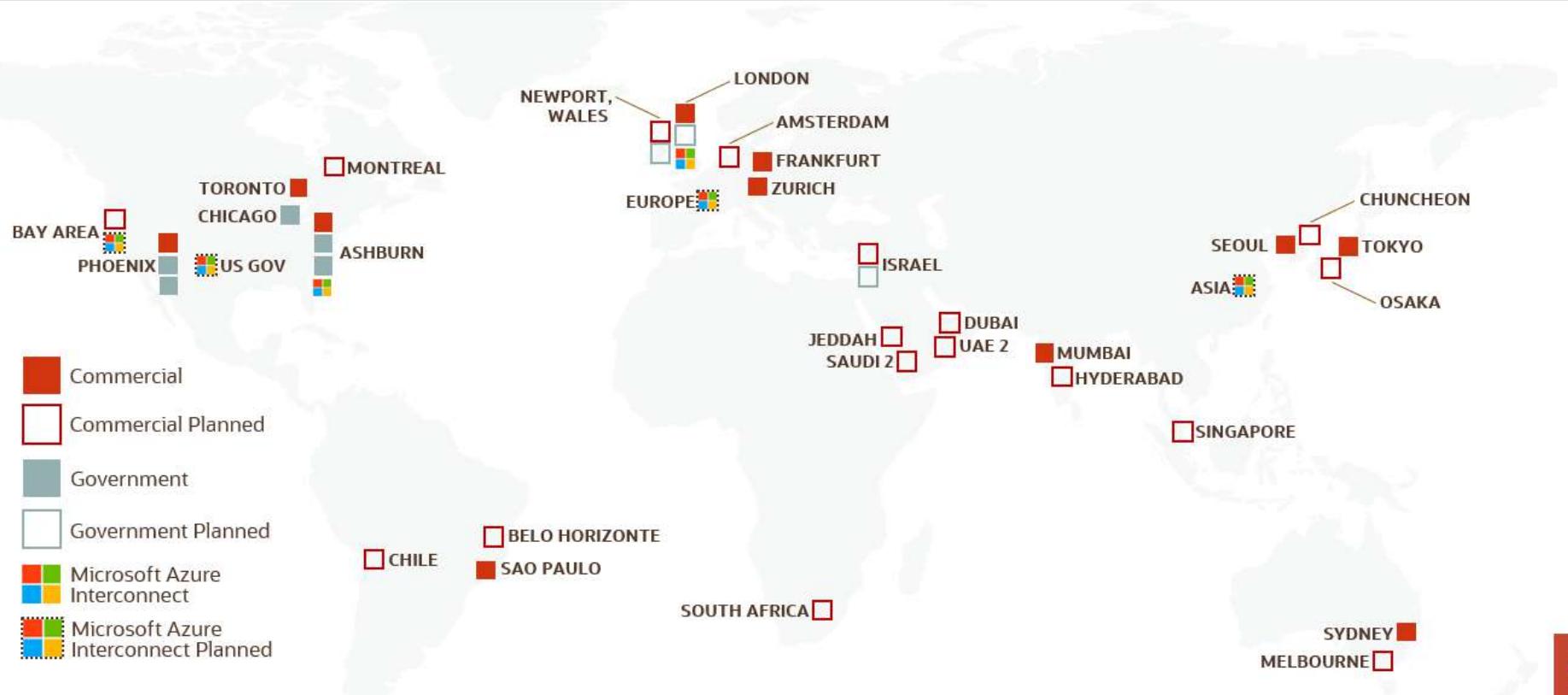
# Oracle Cloud Infrastructure Global Footprint

October 2019: 16 Regions Live



# Oracle Cloud Infrastructure Global Footprint

October 2019: 16 Regions Live, 20 Planned



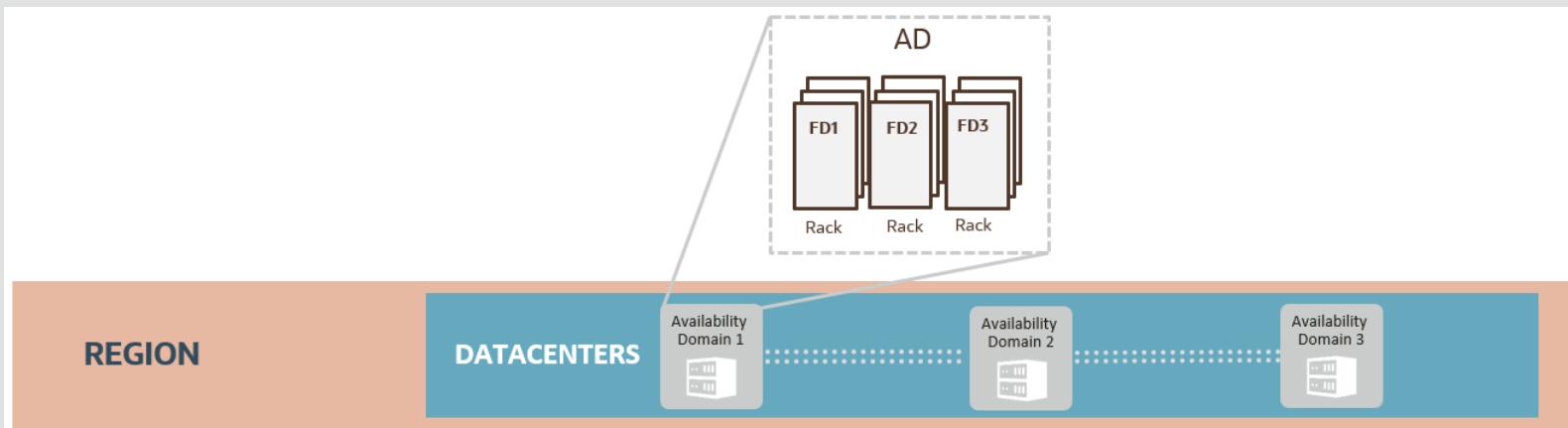
# Oracle Cloud Infrastructure Global Footprint

End of CY2020: 36 Oracle Regions



# OCI Region – HA Building Blocks

- Multiple fault de-correlated, completely independent datacenters: Availability Domain (AD)
- Grouping of hardware and infrastructure within an AD: Fault Domain
- Predictable low latency & high speed, encrypted interconnect between ADs



# One AD Regions

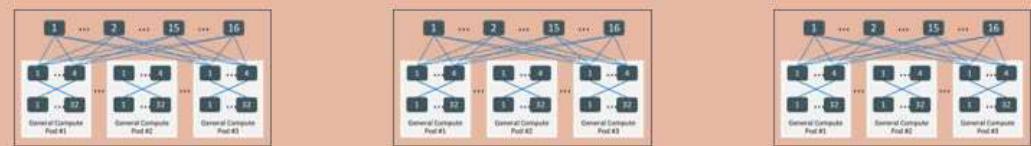
- OCI has chosen to launch regions in new geographies with one AD (to increase our global reach quickly)
- For any region with one AD, a second AD or region in the same country or geo-political area will be made available within a year to enable further options for DR and data residency

OCI Region (current)	# Availability Domains
US West (Phoenix)	3
US East (Ashburn)	3
UK South (London)	3
Germany Central (Frankfurt)	3
Australia East (Sydney)	1
Brazil East (Sao Paulo)	1
Canada Southeast (Toronto)	1
India West (Mumbai)	1
Japan East (Tokyo)	1
South Korea Central (Seoul)	1
Switzerland North (Zurich)	1

# Inside an AD – High Scale, High Performance Network

- Non-oversubscribed network; no noisy-neighbors
- Very high scale – ~1 million network ports in an AD
- Predictable low latency & high speed interconnect between hosts in an AD

## PHYSICAL NETWORK



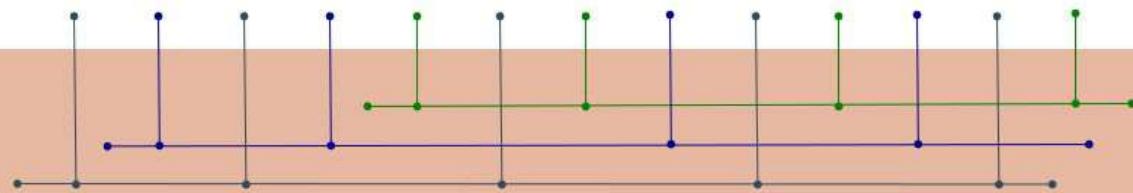
## REGION



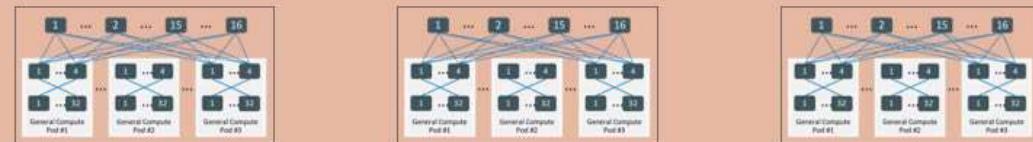
# Off-box Network Virtualization

- Off Box Network Virtualization – moves storage and network IO out of the hypervisor and enables lower overhead and bare metal instances

VIRTUAL NETWORK



PHYSICAL NETWORK



REGION

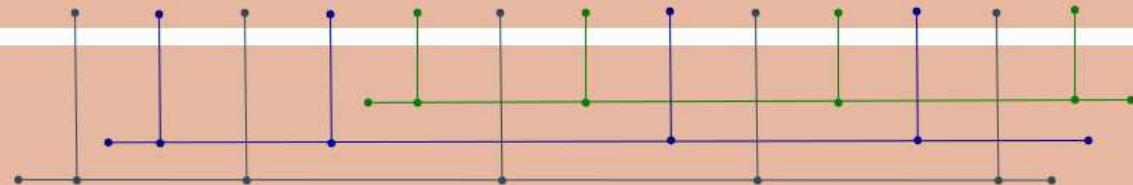


# Oracle Cloud Infrastructure Services

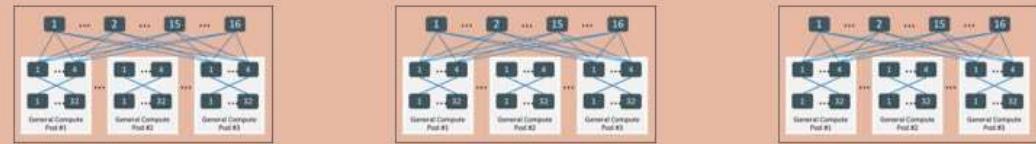
**COMPUTE, STORAGE,  
DATABASE, LBs, Security...**



**VIRTUAL NETWORK**



**PHYSICAL NETWORK**



**REGION**



# Oracle Cloud Infrastructure Services

## IDENTITY

### Identity and Access Management

Granular, role based access control to cloud resources

## NETWORKING

### VCN, VPN, FastConnect, LB

Isolated software defined private networks

## COMPUTE

### Bare Metal, Dedicated Hosts, VMs

Bare Metal, Dedicated Hosts, VMs with same APIs; Managed Kubernetes

## STORAGE

### Local, Block, File, Object, Archive

Local, Block, File, Object and Archive storage options

## DATABASE

### Bare Metal, VMs, RAC, Exadata

Bare Metal, VM, Exadata, RAC and Active Data Guard support

## AUTONOMOUS DATABASE

### ADW, ATP

Only autonomous database in the cloud

## SERVERLESS

### Functions, Autonomous-Serverless

Log APIs calls for audit, bring your own keys

## ANALYTICS

### Streaming, Oracle Analytics Cloud

Software NAS Gateway, Data Transfer Appliance

## NEXT LAYER SERVICES

### Monitoring, Logging, Audit

Global DNS, global private connectivity at up to 97% less cost

## SECURITY

### Audit, Key Management

Log APIs calls for audit, bring your own keys

## DATA MOVEMENT

### Storage appliance, Data Transfer

Software NAS Gateway, Data Transfer Appliance

## EDGE

### DNS, Other Edge, Email

Global DNS, global private connectivity at up to 97% less cost

# Differentiation

## Technical

### 1. Performance

- Off-box network virtualization
- Bare Metal + Local NVMe storage
- All SSD Storage
- No Network, CPU or Memory over-subscription

### 2. Battle tested (NetSuite and other SaaS apps run on OCI)

### 3. DB Options - BM, VM, Exadata, RAC

### 4. Enterprise Apps support (EBS, JDE..)

## Business

1. Aggressive and predictable pricing – cheaper than AWS
2. Industry's unique SLAs on Performance, Management and Availability
3. BYOL and Universal Cloud Credits
4. Support through one org

# Summary

- In this lesson, you should have learned:
  - Oracle Cloud Infrastructure Overview
  - Understand the global footprint of the Oracle Cloud Infrastructure
  - Identify the components of a Region
    - Describe Availability Domains
    - Describe Fault Domains
  - Physical Network
    - Network Virtualization
    - Virtual Network
    - Service
  - Oracle Cloud Infrastructure Services Overview
  - Describe how OCI is differentiated from other offerings
    - Technical Differentiation
    - Business Differentiation

# Resources

- Oracle Cloud always free tier:  
[oracle.com/cloud/free/](http://oracle.com/cloud/free/)
- OCI training and certification:  
<https://www.oracle.com/cloud/iaas/training/>  
<https://www.oracle.com/cloud/iaas/training/certification.html>  
[education.oracle.com/oracle-certification-path/pFamily\\_647](https://education.oracle.com/oracle-certification-path/pFamily_647)
- OCI hands-on labs:  
[ocitraining.gloudable.com/provider/oracle](https://ocitraining.gloudable.com/provider/oracle)
- Oracle learning library videos on YouTube:  
[youtube.com/user/OracleLearning](https://youtube.com/user/OracleLearning)

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# Oracle Cloud Infrastructure Foundations I

Section 2

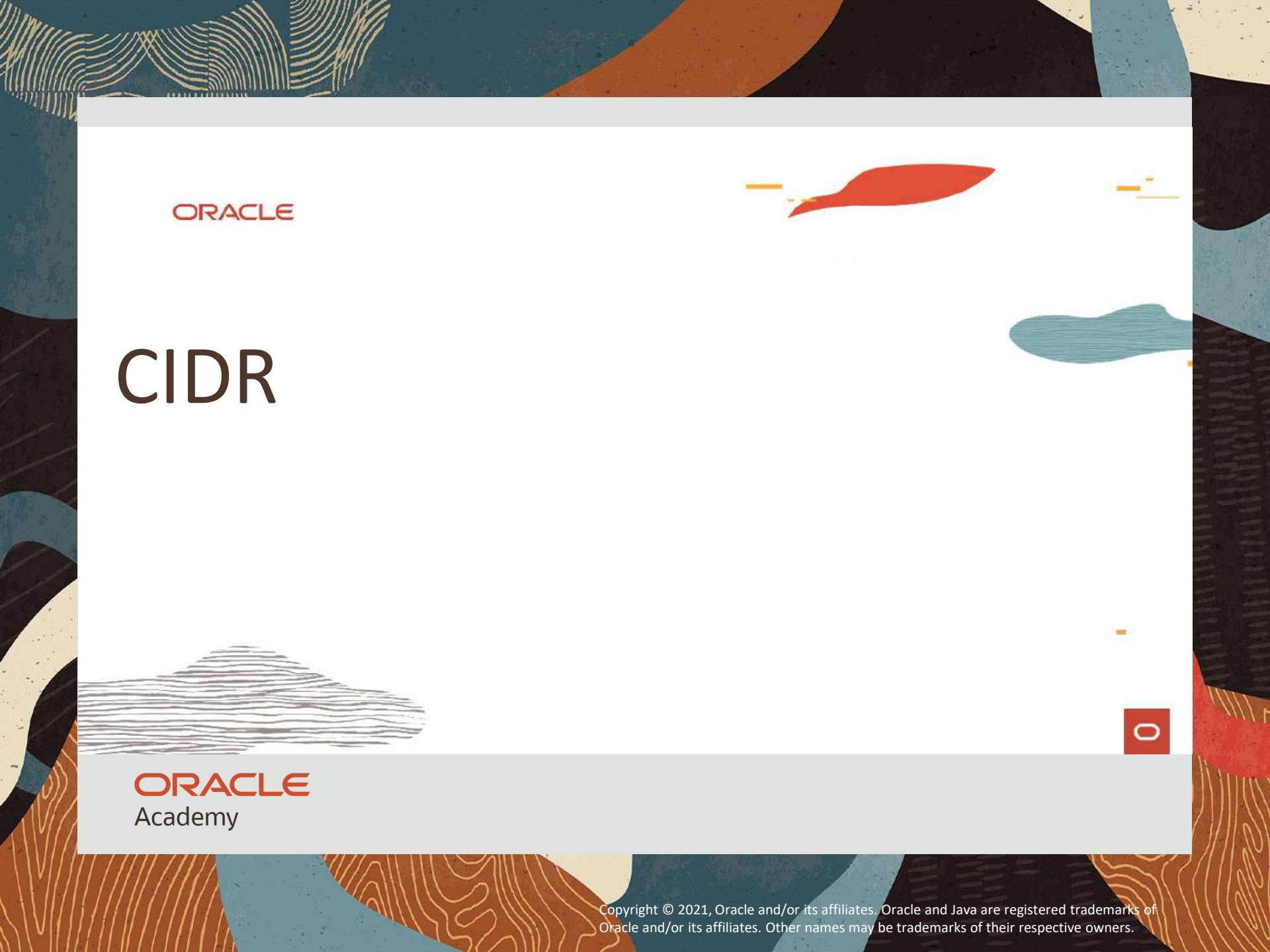
Virtual Cloud Network

Level 100

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# Objectives

- This lesson covers the following objectives:
  - Virtual Cloud Network (VCN) basics
  - IP addresses
  - Gateways and Routing
  - Peering
  - Transit Routing
  - Security
  - Putting it all together!



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# CIDR

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# CIDR Basics

CIDR (classless inter-domain routing) notation

- IP addresses are described as consisting of two groups of bits in the address: the most significant bits are the network prefix, which identifies a whole network (or subnet), and the least significant set forms the host identifier, which specifies a particular interface of a host on that network
- An IP address has two components, the network address and the host address: <network> <host>
- A subnet mask separates the IP address into the network and host addresses (<network><host>). Subnetting further divides the host part of an IP address into a subnet and host address (<network><subnet><host>)

# CIDR Basics

## CIDR (classless inter-domain routing) notation

- Subnet Mask is made by setting network bits to all "1"s and setting host bits to all "0"s. Within a given network, two host addresses cannot be assigned to hosts. The "0" address is assigned a network address and "255" is assigned to a broadcast address
- Notation is constructed from an IP address, a '/' character, and a decimal number.  $\text{xxx.xxx.xxx.xxx}/n$ , where n is the number of bits used for subnet mask. E.g. 192.168.1.0/24
- Examples of commonly used netmasks for classed networks are 8-bits (Class A), 16-bits (Class B) and 24-bits (Class C)

# CIDR Basics

192.168.1.0/24 would equate to IP range:

192.168.1.0 – 192.168.1.255

- 128 64 32 16 8 4 2 1 →  $2^7$   $2^6$   $2^5$   $2^4$   $2^3$   $2^2$   $2^1$   $2^0$
  - 192 is represented as: 1 1 0 0 0 0 0 0

192.168.1.0	1 1 0 0 0 0 0 0	1 0 1 0 1 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0
/24 subnet mask	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
Logical AND	1 1 0 0 0 0 0 0	1 0 1 0 1 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0

# CIDR Basics

192.168.1.0/27 would equate to IP range:

192.168.1.0 – 192.168.1.31

- Now same network divided in 8 subnets with 32 hosts each due to the /27 mask (255.255.255.224)

192.168.1.0	1   1   0   0   0   0   0   0	1   0   1   0   1   0   0   0	0   0   0   0   0   0   0   1	0   0   0   0   0   0   0   0
/27 subnet mask	1   1   1   1   1   1   1   1	1   1   1   1   1   1   1   1	1   1   1   1   1   1   1   1	1   1   1   0   0   0   0   0
Logical AND	1   1   0   0   0   0   0   0	1   0   1   0   1   0   0   0	0   0   0   0   0   0   0   1	0   0   0   0   0   0   0   0

# CIDR Basics

- Subnets
  - $2 \times 2 \times 2 = 8$ . Hosts –  $2 \times 2 \times 2 \times 2 \times 2 = 32$
- Subnetworks
  - 192.168.1.0/27, 192.168.1.32/27, 192.168.1.64/27...

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# Virtual Cloud Network Intro

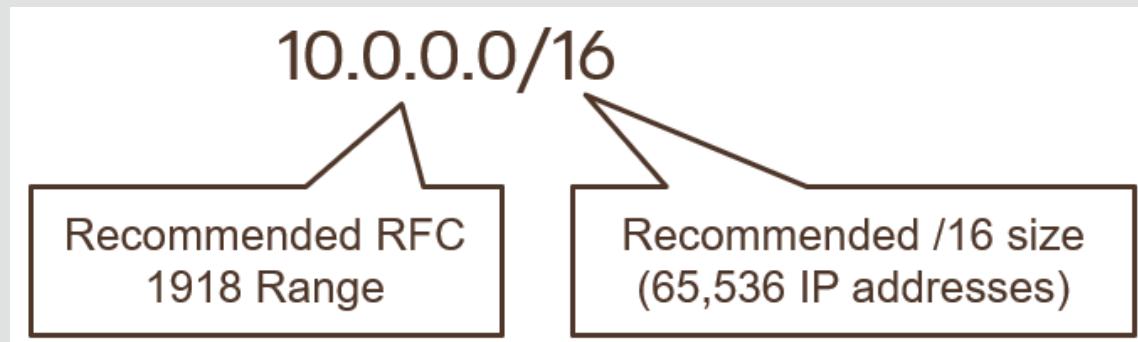
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# Virtual Cloud Network (VCN)

- A private network that you set up in the Oracle data centers, with firewall rules and specific types of communication gateways that you can choose to use
- A VCN covers a single, contiguous IPv4 CIDR block of your choice
- A VCN resides within a single region

# IP Address Range For Your VCN

- Avoid IP ranges that overlap with other on-premises or other cloud networks

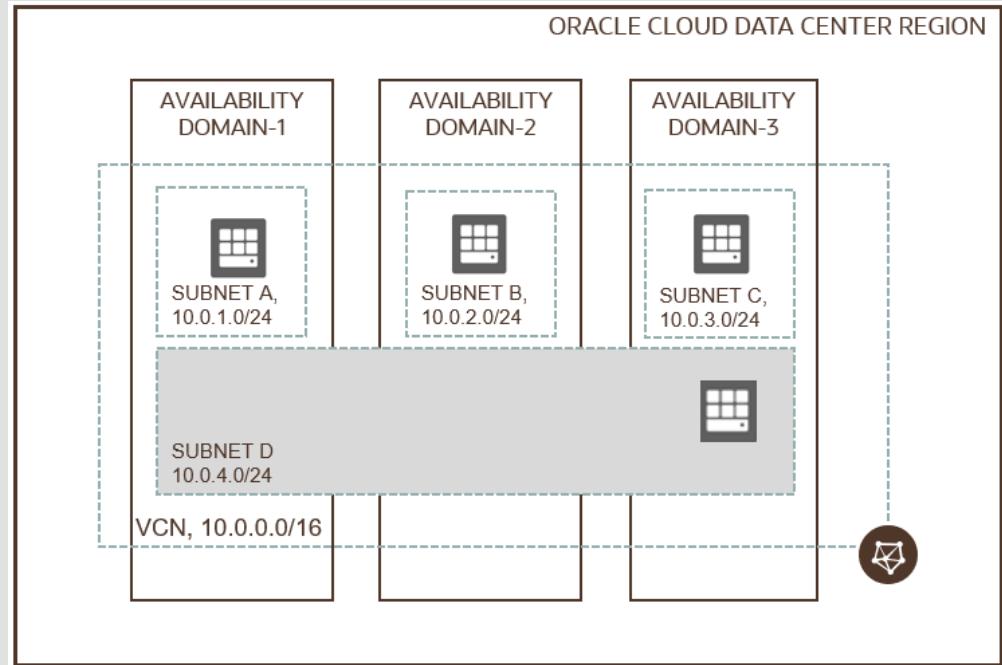


- Use private IP address ranges specified in RFC 1918 (**10.0.0.0/8**, **172.16/12**, **192.168/16**)
- Allowable OCI VCN size range is from **/16** to **/30**
- VCN reserves the first two IP addresses and the last one in each subnet's CIDR

# Subnet

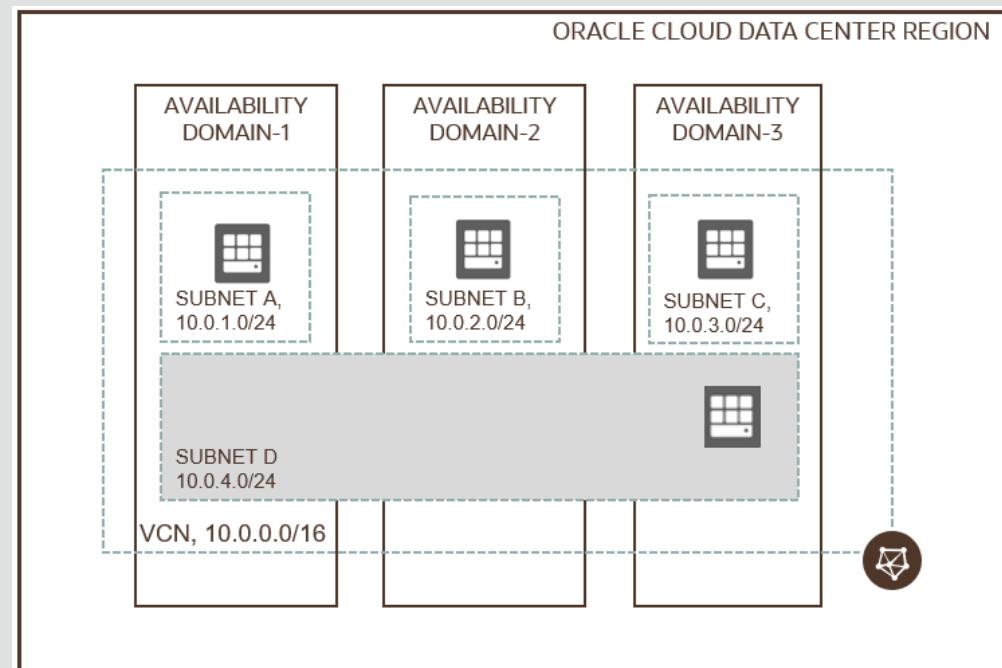
Each VCN network is subdivided into subnets

- Each subnet can be AD-specific or **Regional (recommended)**
  - AD specific subnet is contained within a single AD in a multi-AD region
  - Regional subnet spans all three ADs in a multi-AD region
- Each subnet has a contiguous range of IPs, described in CIDR notation
- Subnet IP ranges cannot overlap



# Subnet

- Instances are placed in subnets and draw their internal IP address and network configuration from their subnet
- Subnets can be designated as either:
  - **Private** (instances contain private IP addresses assigned to VNICs)
  - **Public** (contain both private and public IP addresses assigned to VNICs)
- VNIC is a component that enables a compute instance to connect to a VCN
- The VNIC determines how the instance connects with endpoints inside and outside the VCN





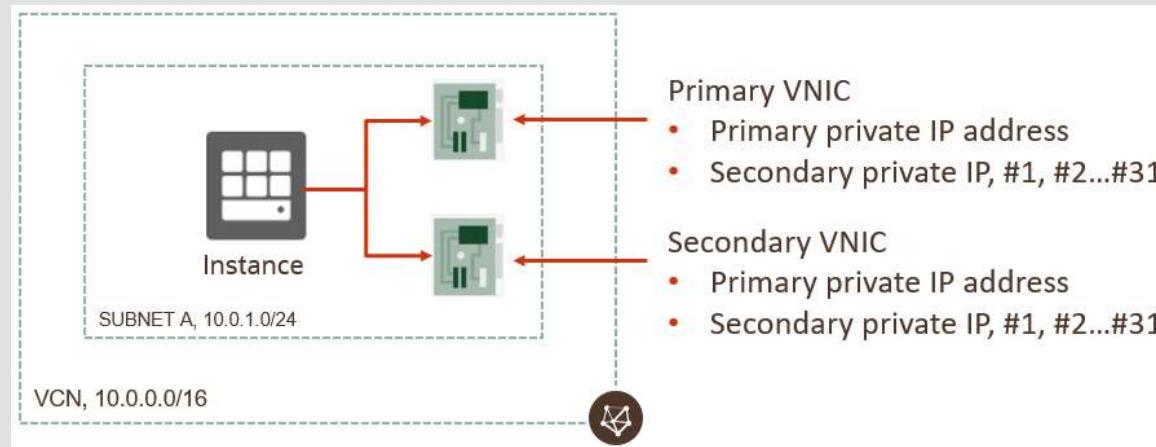
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# IP Addresses

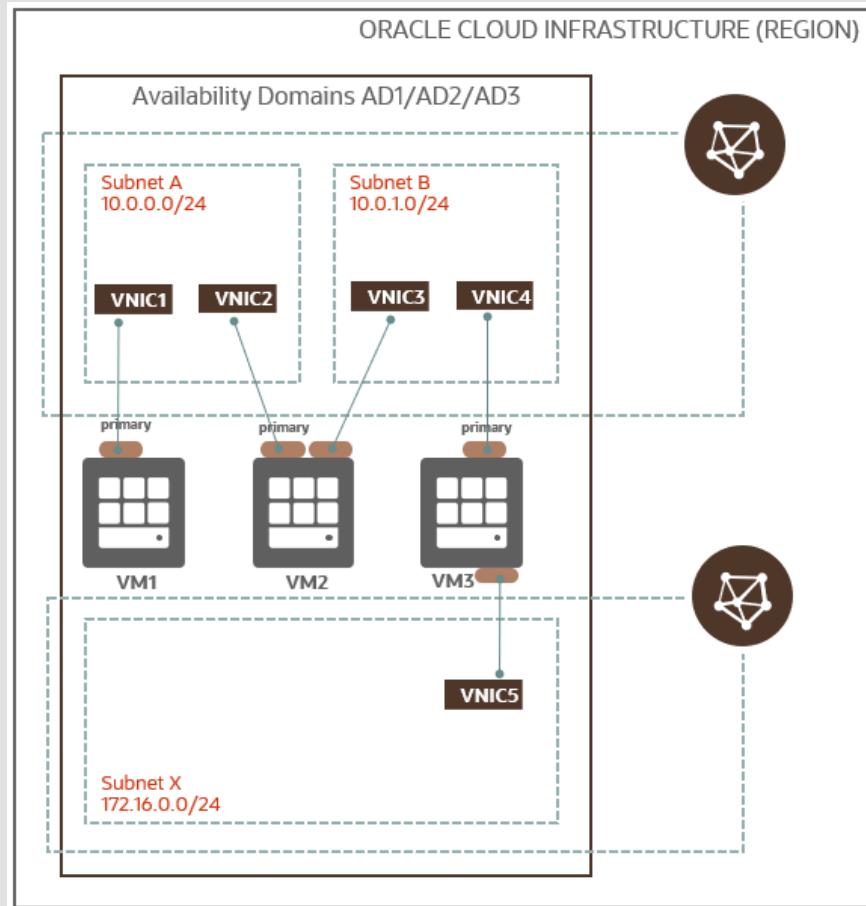
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# Private IP Addresses

- Each instance in a subnet has at least one primary private IP address
- Instances  $\geq 2$  VNICs (additional VNICs called secondary VNICs)
- Each VNIC has one primary private IP; can have additional private IPs called secondary private IPs
- A private IP can have an optional public IP assigned to it



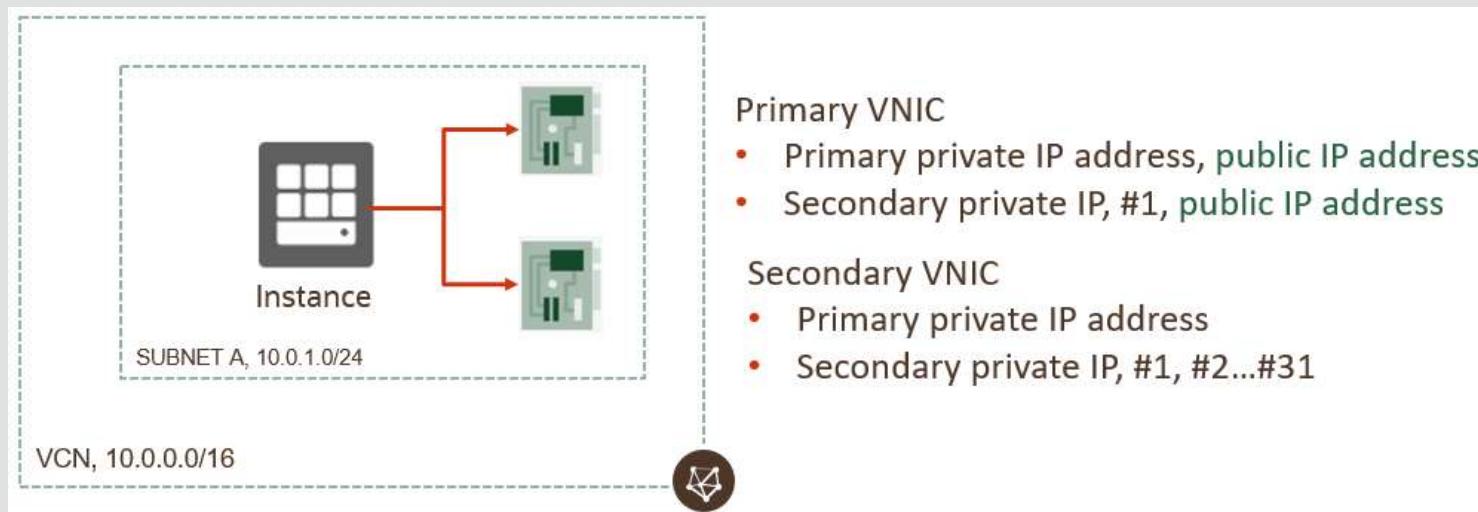
# Multiple VNICs On Virtual Machines



- Every VM has one primary VNIC created at launch, and a corresponding Ethernet device on the instance with the IP address configuration of the primary VNIC
- When a secondary VNIC is added, new Ethernet device is added and is recognized by the instance OS
  - VM1 - single VNIC instance
  - VM2 - connected to two VNICs from two subnets within the same VCN. Used for virtual appliance scenarios
  - VM3 - connected to two VNICs from two subnets from separate VCNs. Used to connect instances to a separate management network for isolated access

# Public IP

- Public IP address is an IPv4 address that is reachable from the internet; assigned to a private IP object on the resource (Instance, load balancer)
- Possible to assign a given resource multiple public IPs across one or more VNICs



# Public IP Addresses

- Public IP types: Ephemeral and Reserved
  - Ephemeral: temporary and existing for the lifetime of the instance
  - Reserved: Persistent and existing beyond the lifetime of the instance it's assigned to (can be unassigned and then reassigned to another instance)
  - Ephemeral IP can be assigned to primary private IP only (hence, only 1 per VNIC v/s a max 32 for Reserved IP)
- No charge for using Public IP, including when the Reserved public IP addresses are unassociated

# Public IP Addresses

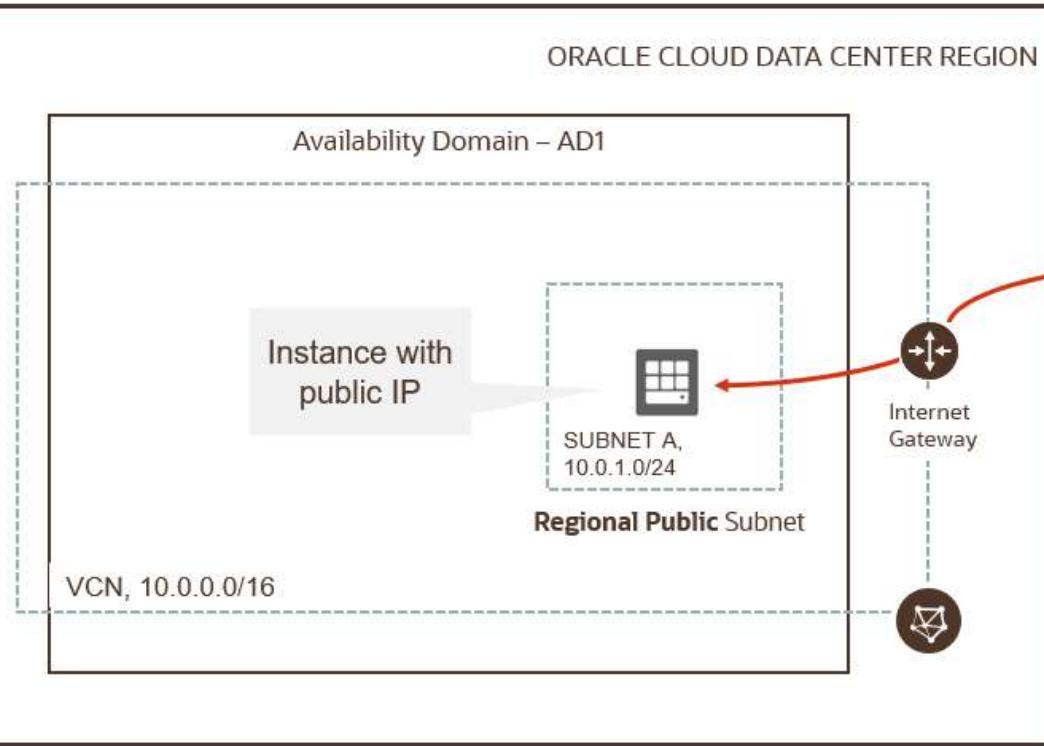
- Public IP assigned to
  - Instance (not recommended in most cases)
  - Oracle provided; cannot choose/edit, but can view
    - OCI Public Load Balancer, NAT Gateway, DRG - IPSec tunnels, OKE master/worker
  - Oracle provided; cannot choose/edit/view
    - Internet Gateway, Autonomous Database

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# Gateways and Routing

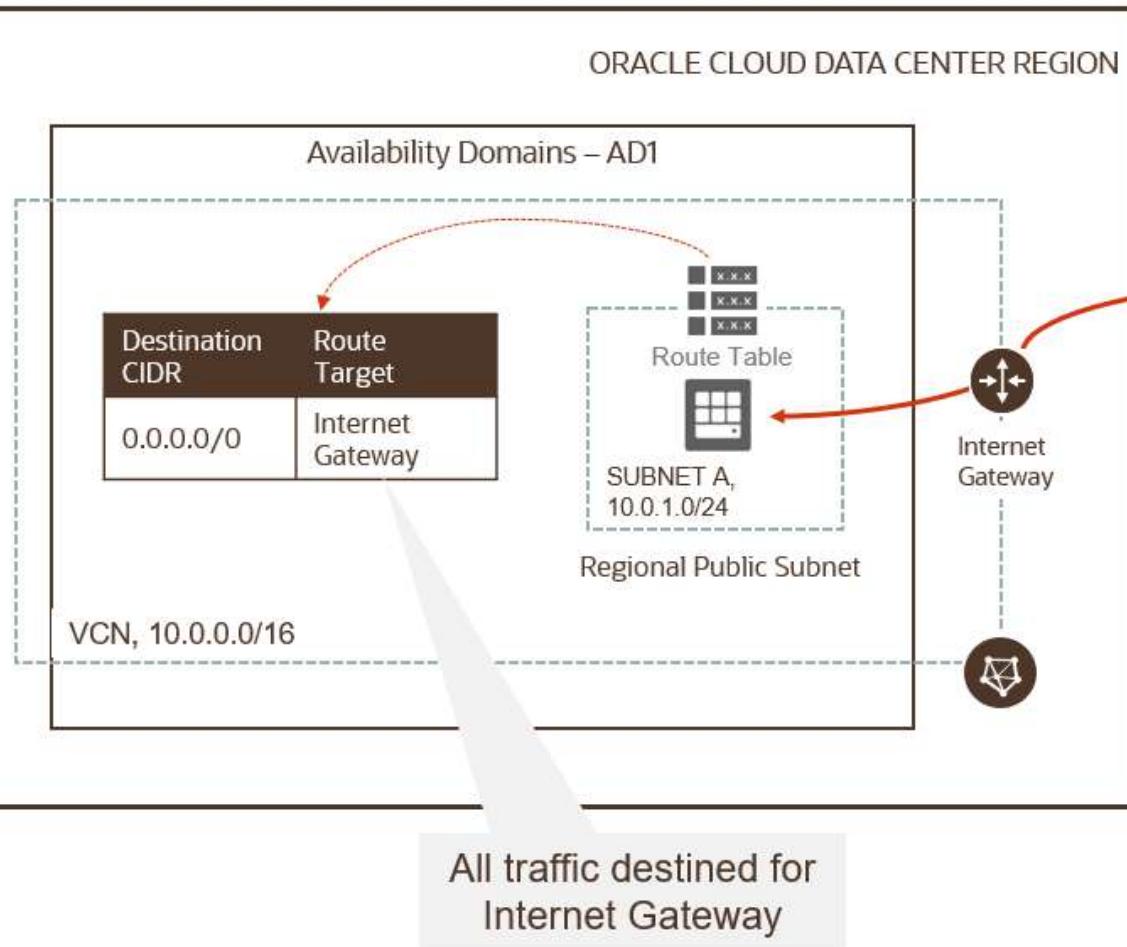
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# Internet Gateway



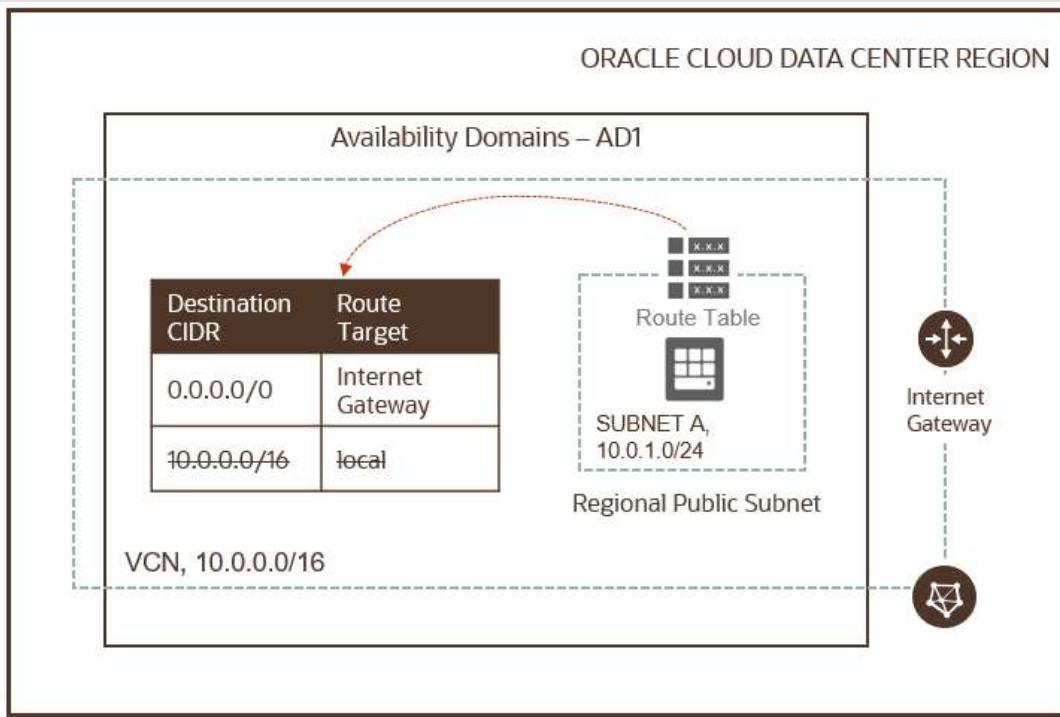
- Internet gateway provides a path for network traffic between your VCN and the internet
- You can have only one internet gateway for a VCN
- After creating an internet gateway, you must add a route for the gateway in the VCN's Route Table to enable traffic flow

# Route Table



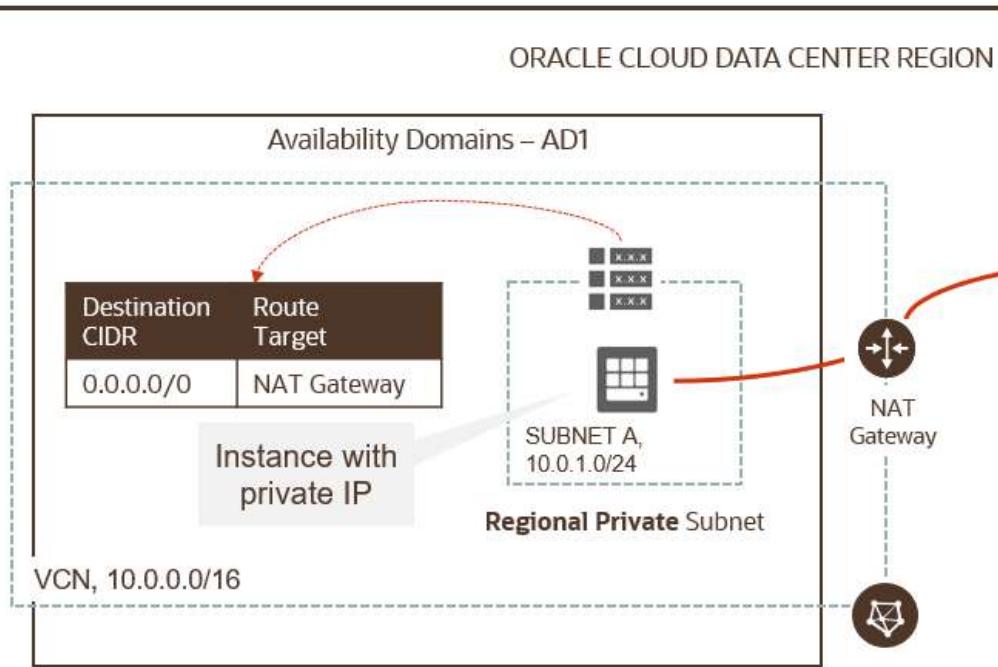
- Route Table is used to send traffic out of the VCN
- Consists of a set of route rules; each rule specifies
  - Destination CIDR block
  - Route Target (the next hop) for the traffic that matches that CIDR

# Route Table



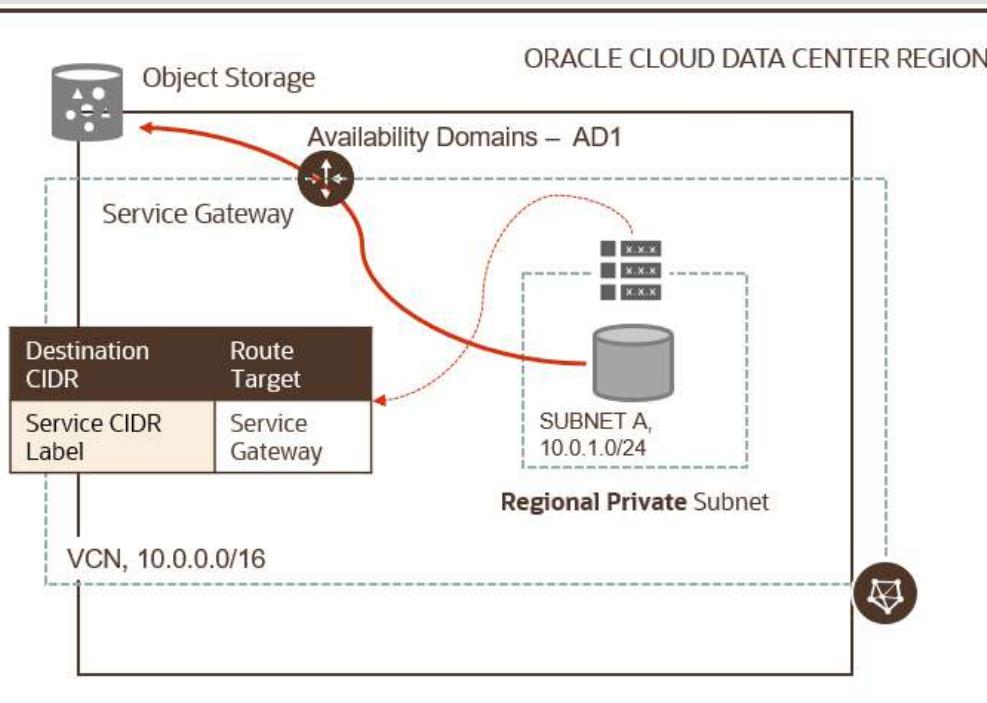
- Each subnet uses a single route table specified at time of subnet creation, but can be edited later
- Route table is used only if the destination IP address is not within the VCN's CIDR block
- No route rules are required in order to enable traffic within the VCN itself
- When you add an internet gateway, NAT gateway, service gateway, dynamic routing gateway or a peering connection, you must update the route table for any subnet that uses these gateways or connections

# NAT Gateway



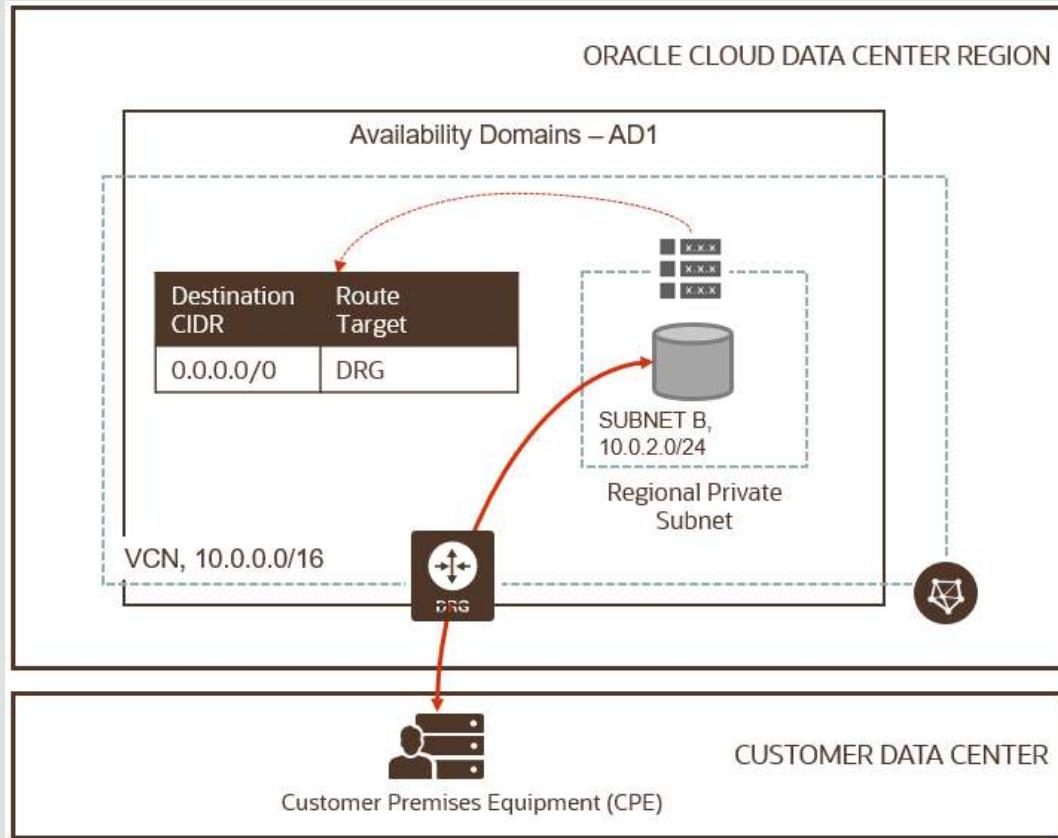
- NAT gateway gives an entire private network access to the internet without assigning each host a public IP address
- Hosts can initiate outbound connections to the internet and receive responses, but not receive inbound connections initiated from the internet. Use case: updates, patches)
- You can have more than one NAT gateway on a VCN, though a given subnet can route traffic to only a single NAT gateway

# Service Gateway



- Service gateway lets resources in VCN access public OCI services such as Object Storage, but without using an internet or NAT gateway
- Any traffic from VCN that is destined for one of the supported OCI public services uses the instance's private IP address for routing, travels over OCI network fabric, and never traverses the internet. Use case: back up DB Systems in VCN to Object Storage)
- Service CIDR labels represent all the public CIDRs for a given Oracle service or a group of Oracle services. E.g.
  - OCI <region> Object Storage
  - All <region> Services

# Dynamic Routing Gateway



- A virtual router that provides a path for private traffic between your VCN and destinations other than the internet
- You can use it to establish a connection with your on-premises network via IPsec VPN or FastConnect (private, dedicated connectivity)
- After attaching a DRG, you must add a route for the DRG in the VCN's route table to enable traffic flow
- DRG is a standalone object. You must attach it to a VCN. VCN and DRG have a 1:1 relationship

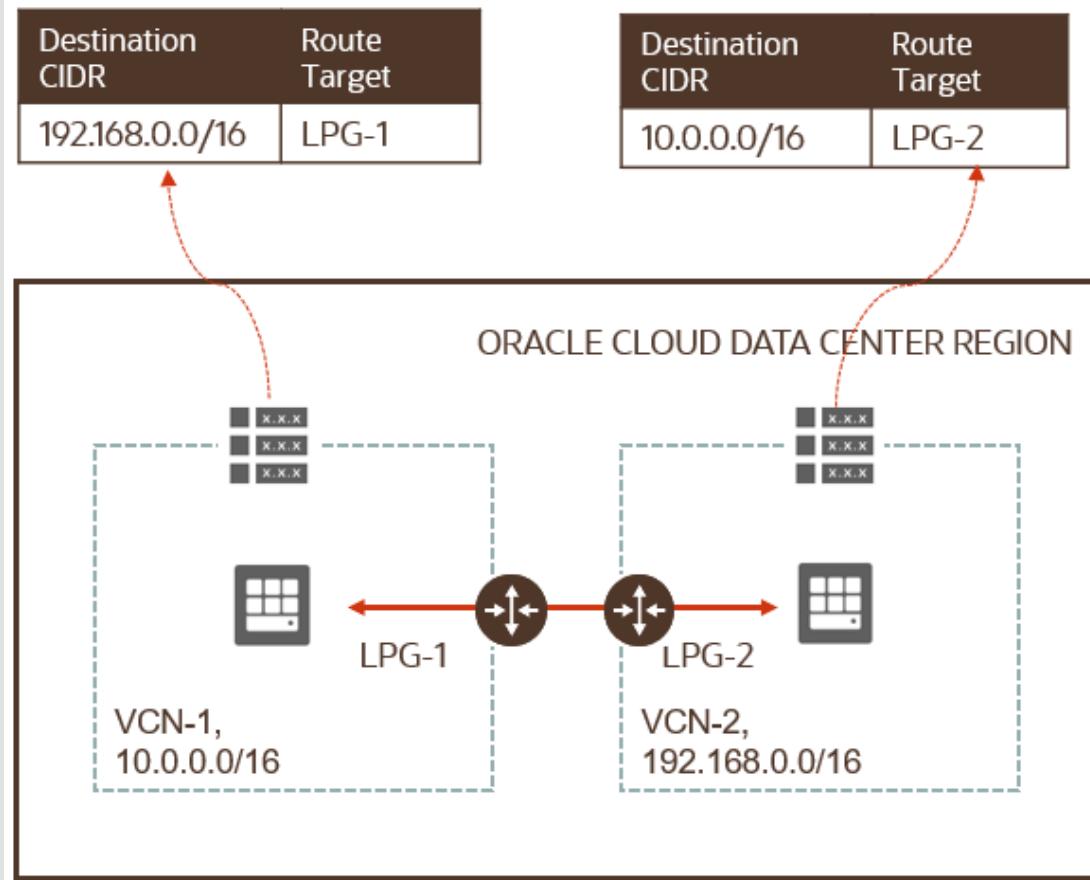


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# Peering

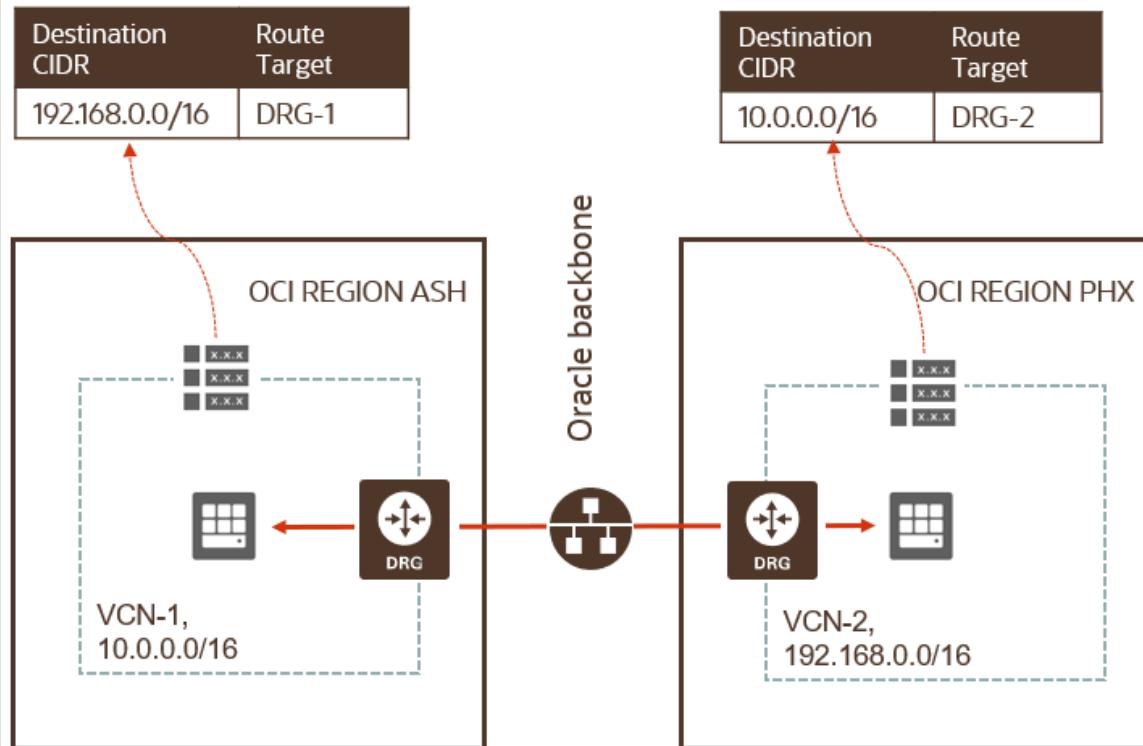
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# Local Peering (within region)



- VCN peering is the process of connecting multiple VCNs
- Local VCN peering is the process of connecting two VCNs in the **same region** so that their resources can communicate using private IP addresses
- A local peering gateway (LPG) is a component on a VCN for routing traffic to a locally peered VCN
- The two VCNs in the peering relationship shouldn't have overlapping CIDRs

# Remote Peering (across region)



- Remote VCN peering is the process of connecting two VCNs in **different regions** so that their resources can communicate using private IP addresses
- Requires a remote peering connection (RPC) to be created on the DRGs. RPC's job is to act as a connection point for a remotely peered VCN
- The two VCNs in the peering relationship must not have overlapping CIDRs

# Summary of OCI Network Connectivity Options

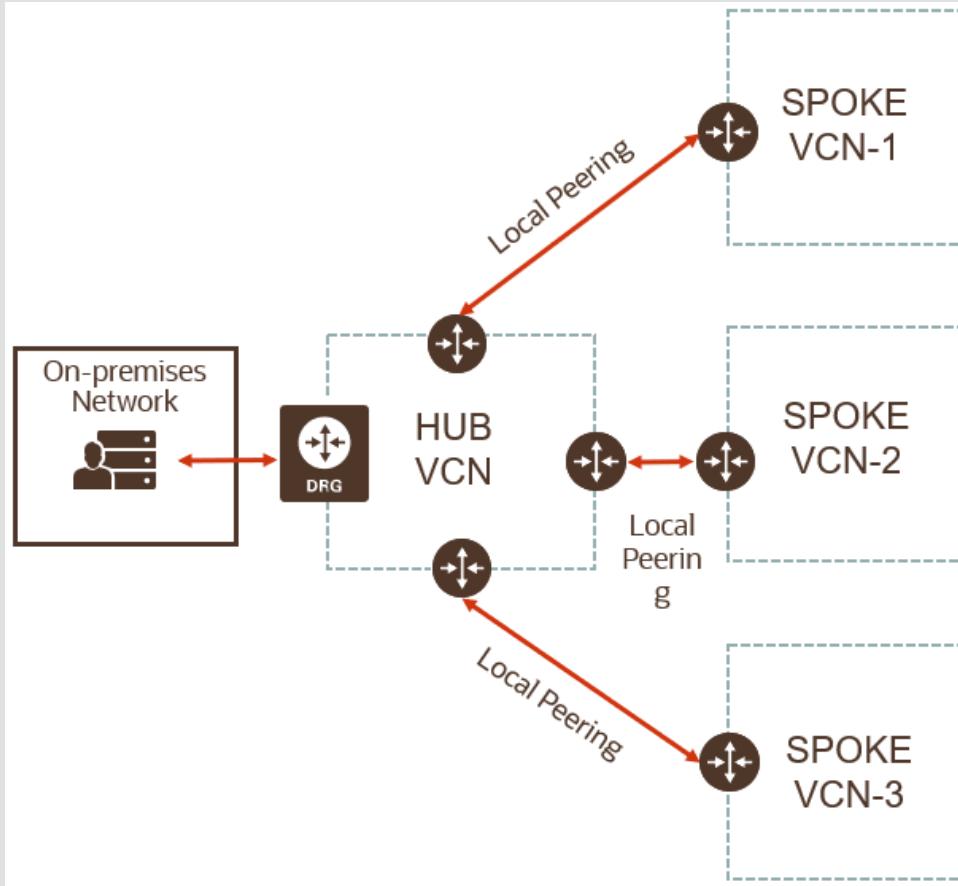
Scenario	Solution
Let instances connect to the Internet, and receive connections from it	Internet Gateway
Let instances reach the Internet without receiving connections from it	NAT Gateway
Let VCN hosts privately connect to object storage, bypassing the internet	Service Gateway
Make an OCI extend an on-premise network, with easy connectivity in both directions	IPsec VPN FastConnect
Privately connect two VCNs in a region	Local Peering Gateway
Privately connect two VCNs in different regions	Remote Peering Connection (DRG)

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# Transit Routing

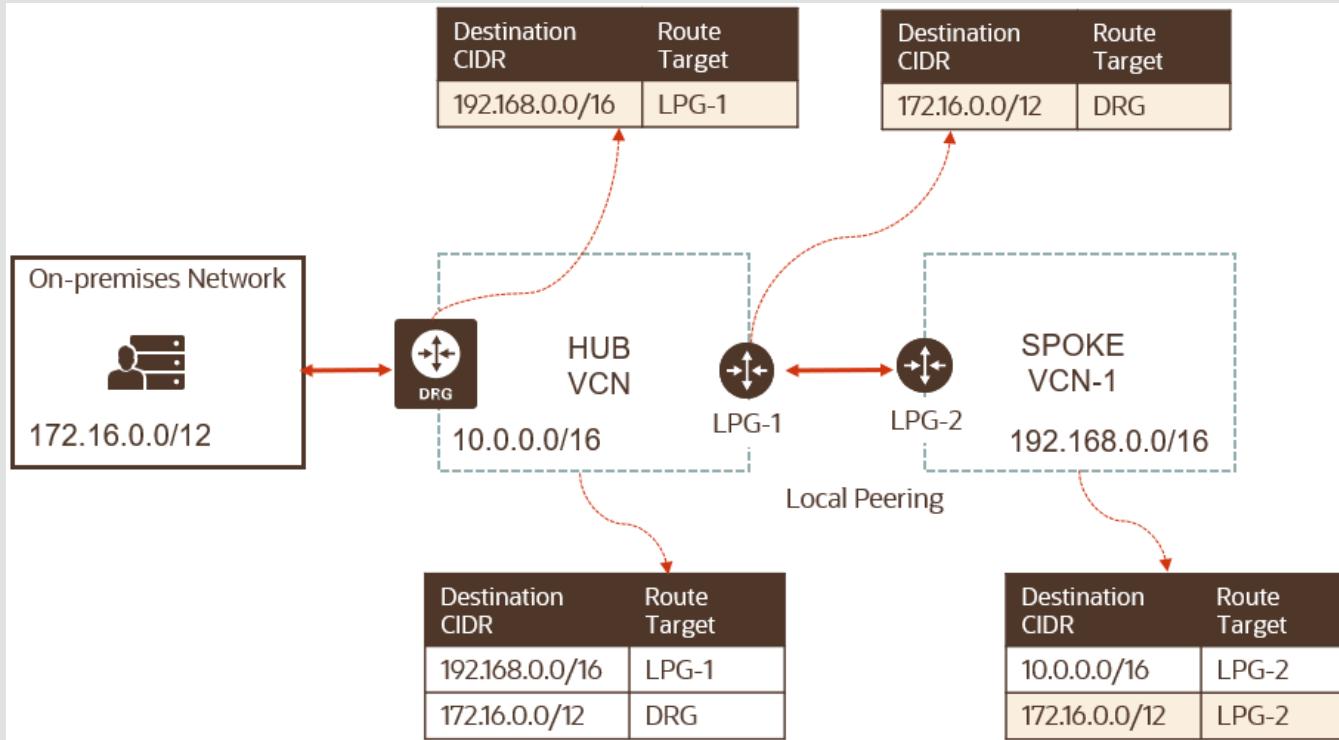
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# Transit Routing: Hub and Spoke



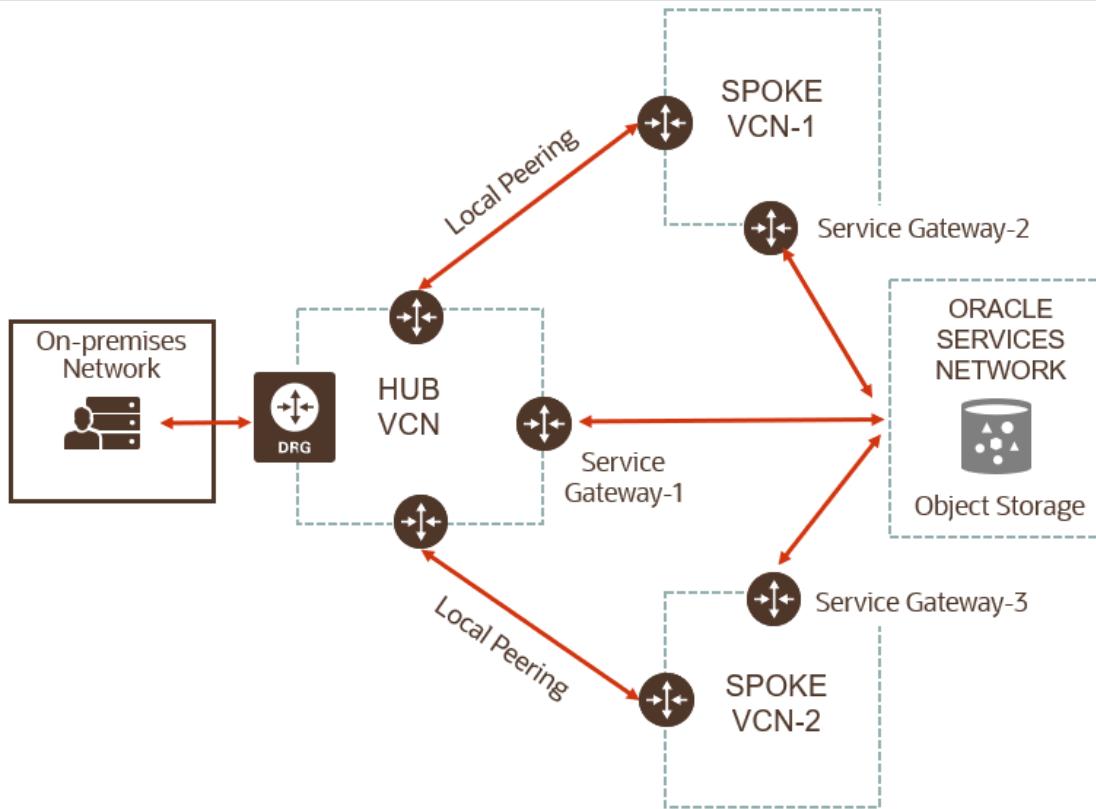
- Transit Routing refers to setting up in which an on-premises network uses a connected VCN to reach Oracle resources or services beyond that VCN. Two scenarios:
  - Access to multiple VCNs in the same region
  - Private access to Oracle services
- One of the VCNs acts as the Hub and connects to on-premises network. The other VCNs are locally peered with the Hub VCN. The traffic between the on-premises network and the peered VCNs transits through the Hub VCN.
- The VCNs must be in the same region but can be in different tenancies.

# Transit Routing: Hub and Spoke

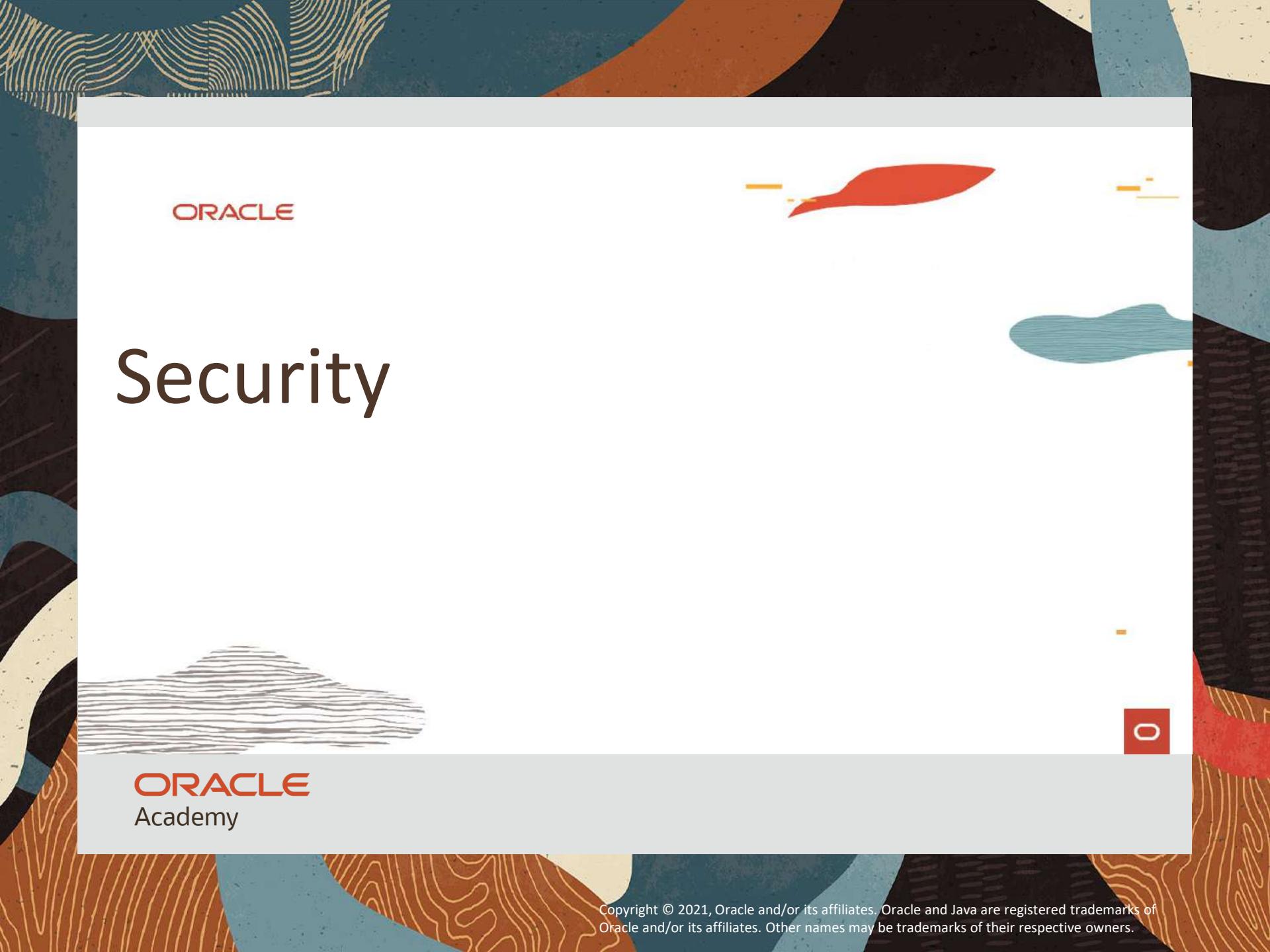


- A route table that is associated with a DRG can have only rules that target an LPG or a private IP
- A route table that is associated with an LPG can have only rules that target a DRG or a private IP
- DRG or LPG can exist without route table associated with it

# Transit Routing: Private Access to Oracle Services



- On-premises network has private access to Oracle services in the Oracle Services Network. The hosts in the on-premises network communicate with their private IP addresses
- The on-premises network can reach the Oracle services only through a single VCN's service gateway (the one dedicated for this purpose, SG-1) and not through the service gateways of the other VCNs (SG-2,3).
- For those other VCNs, only the resources inside those VCNs can reach Oracle services through their VCN's service gateway.

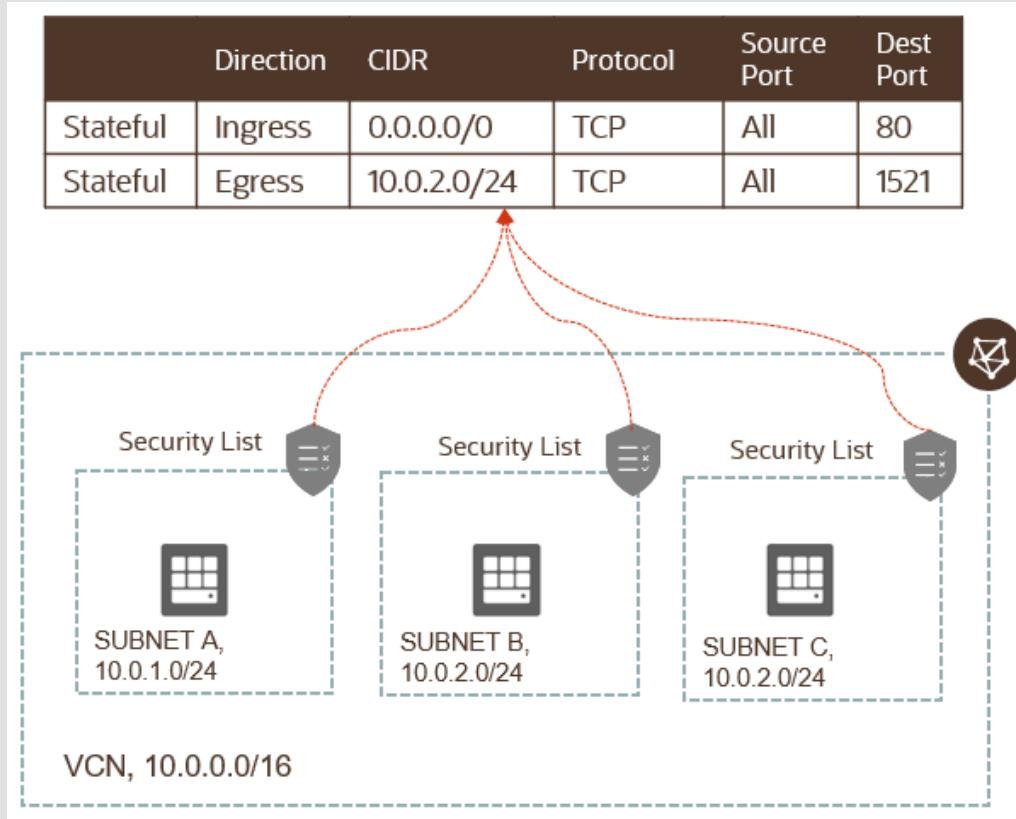


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# Security

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# Security List (SL)

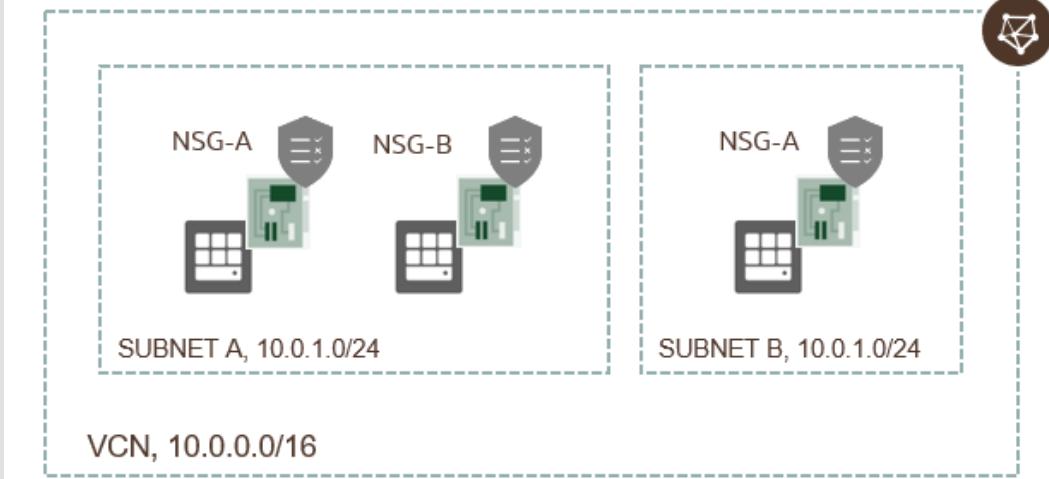


A common set of firewall rules associated with a subnet and applied to all instances launched inside the subnet

- Security list consists of rules that specify the types of traffic allowed in and out of the subnet
- To use a given security list with a particular subnet, you associate the security list with the subnet either during subnet creation or later.
- Security list apply to a given instance whether it's talking with another instance in the VCN or a host outside the VCN
- You can choose whether a given rule is stateful or stateless

# Network Security Group (NSG)

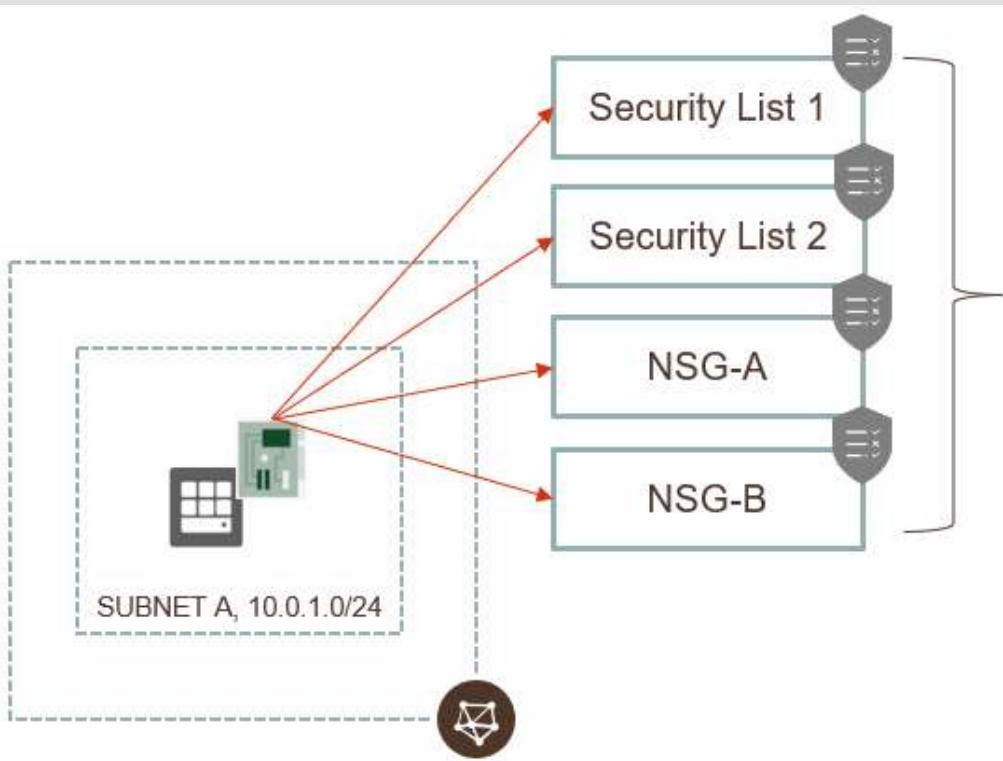
	Direction	CIDR	Protocol	Source Port	Dest Port	
NSG-A	Stateful	Ingress	0.0.0.0/0	TCP	All	80
NSG-B	Stateful	Ingress	0.0.0.0/0	TCP	All	22



A network security group (NSG) provides a virtual firewall for a set of cloud resources that all have the same security posture

- NSG consists of set of rules that apply only to a set of VNICs of your choice in a single VCN
- Currently, compute instances, load balancers and DB instances support NSG
- When writing rules for an NSG, you can specify an NSG as the source or destination. Contrast this with SL rules, where you specify a CIDR as the source or destination
- Oracle recommends using NSGs instead of SLs because NSGs let you separate the VCN's subnet architecture from your application security requirements

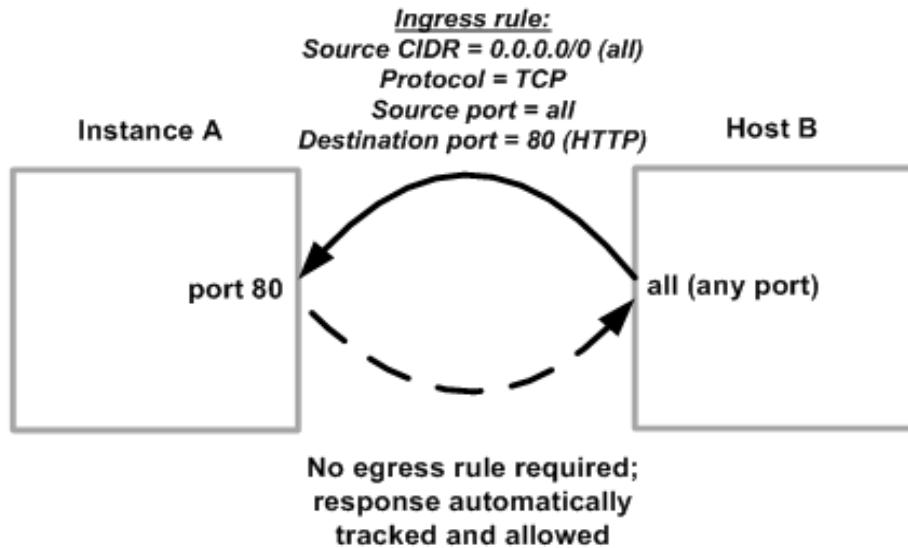
# SL + NSG



- You can use security lists alone, network security groups alone, or both together
- If you have security rules that you want to enforce for all VNICs in a VCN: the easiest solution is to put the rules in one security list, and then associate that security list with all subnets in the VCN
- If you choose to use both SLs and NSGs, the set of rules that applies to a given VNIC is the union of these items:
  - The security rules in the SLs associated with the VNIC's subnet
  - The security rules in all NSGs that the VNIC is in
  - A packet in question is allowed if any rule in any of the relevant lists and groups allows the traffic

# Stateful Security Rules

## Stateful Security List: Receive HTTP Traffic



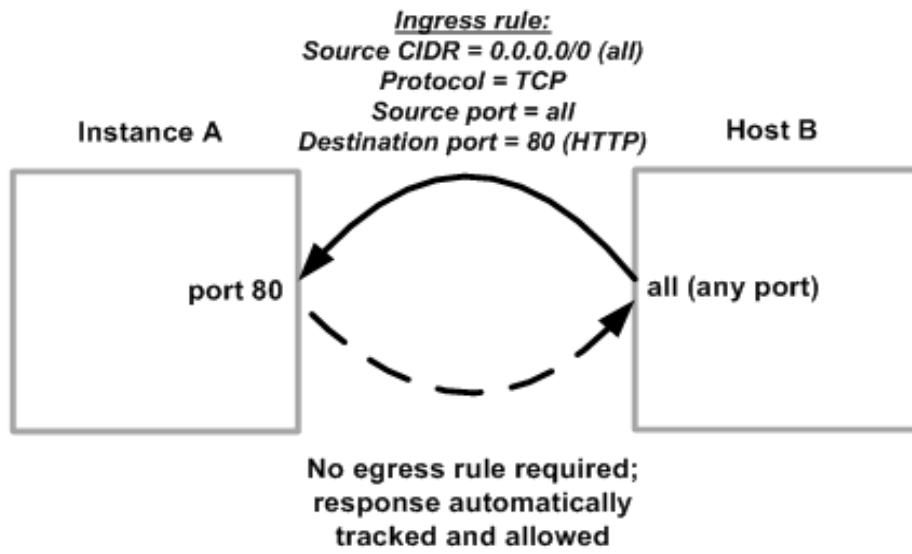
- Connection Tracking: when an instance receives traffic matching the stateful ingress rule, the response is tracked and automatically allowed regardless of any egress rules; similarly for sending traffic from the host
- Default Security List rules are stateful

SOURCE TYPE	SOURCE CIDR	IP PROTOCOL	SOURCE PORT RANGE (OPTIONAL)	DESTINATION PORT RANGE (OPTIONAL)
CIDR	0.0.0.0/0	TCP	All	80
<small>Specified IP addresses: 0.0.0.0-255.255.255.255 (4,294,967,296 IP addresses)</small>				
<small>(more information)</small>				
<small>Examples: 80, 20-22 or All</small>				
<small>(more information)</small>				
<small>Examples: 80, 20-22 or All</small>				
<small>(more information)</small>				

Hosts in this group are reachable from the internet on Port 80

# Stateless Security Rules

## Stateful Security List: Receive HTTP Traffic



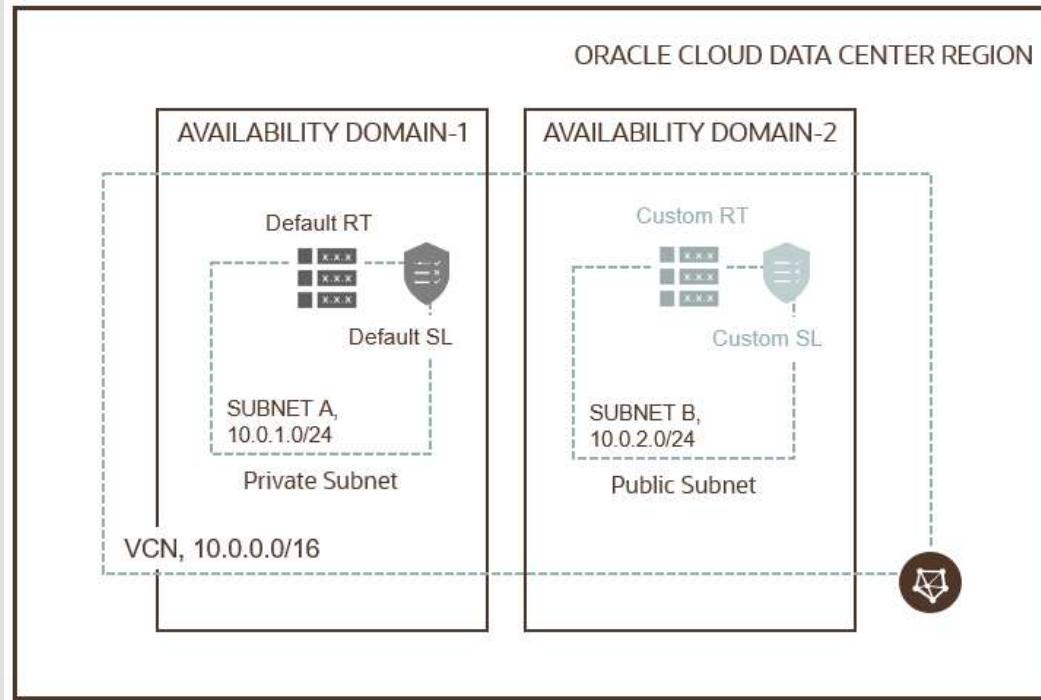
- With stateless rules, response traffic is not automatically allowed
- To allow the response traffic for a stateless ingress rule, you must create a corresponding stateless egress rule
- If you add a stateless rule to a security list, that indicates that you do NOT want to use connection tracking for any traffic that matches that rule
- Stateless rules are better for scenarios with large numbers of connections (Load Balancing, Big Data)

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# Default VCN, Internal DNS

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# Default VCN Components



- Your VCN automatically comes with some default components
  - Default Route Table
  - Default Security List
  - Default set of DHCP options
- You can't delete these default components; however, you can change their contents (e.g. individual route rules). And you can create more of each kind of component in your cloud network (e.g. additional route tables).

# Internal DNS

- The VCN Private Domain Name System (DNS) enables instances to use hostnames instead of IP addresses to talk to each other
- Options:
  - Internet and VCN Resolver: default choice for new VCNs
  - Custom Resolver: lets instances resolve the hostnames of hosts in your on-premises network through IPsec VPN/FastConnect
- Optionally specify a DNS label when creating VCN/subnets/instances
  - VCN: <VCN DNS label>.oraclevcn.com
  - Subnet: <subnet DNS label>.<VCN DNS label>.oraclevcn.com
  - Instance FQDN: <hostname>.<subnet DNS label>.<VCN DNS label>.oraclevcn.com
- Instance FQDN resolves to the instance's Private IP address
- No automatic creation of FQDN for Public IP addresses (e.g. cannot SSH using <hostname>.<subnet DNS label>.<VCN DNS label>.oraclevcn.com)



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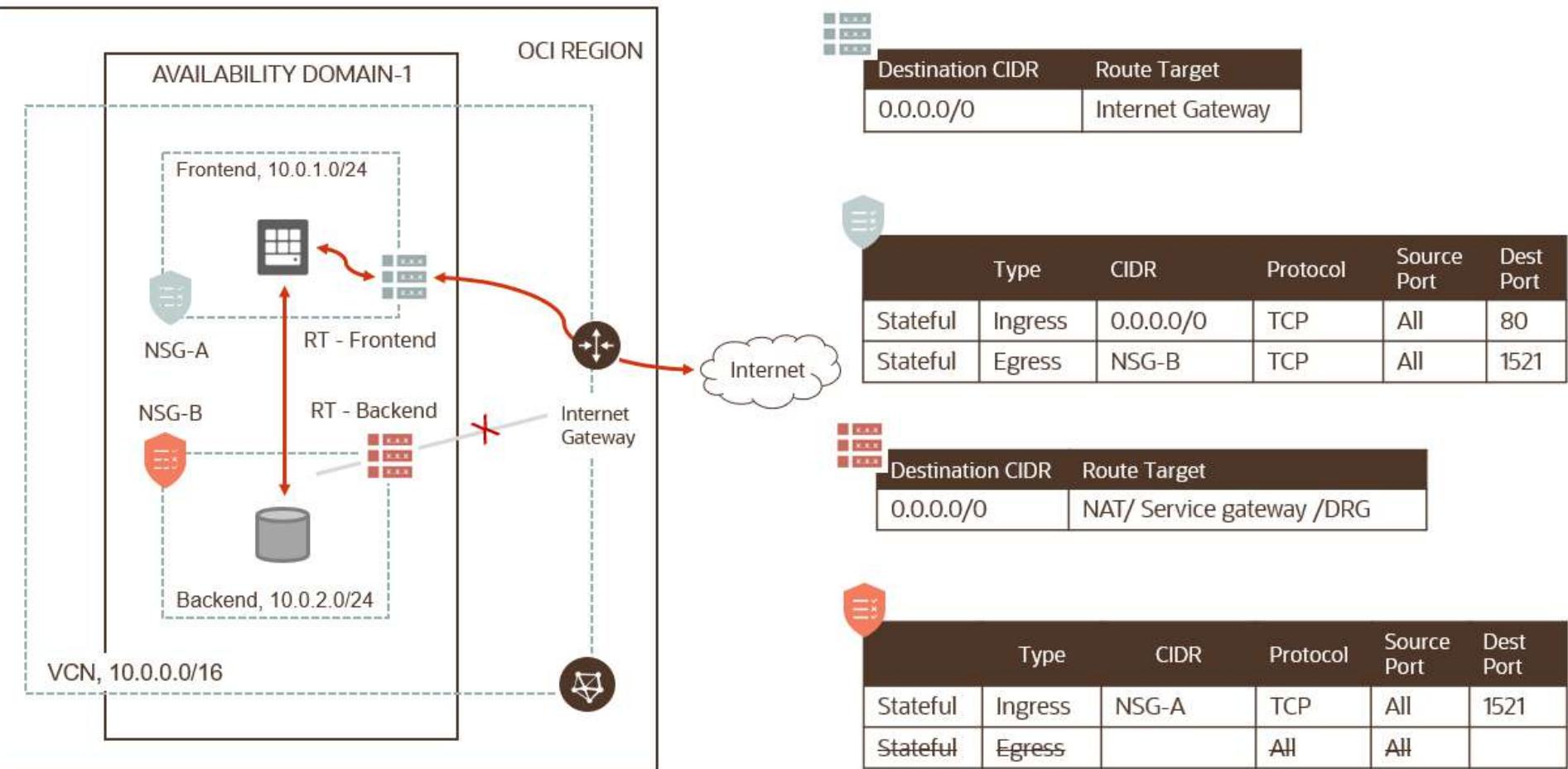
# Putting It All Together

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# VCN Review

- Subnets can have one Route Table and multiple (5\*) Security Lists associated to it
- Route table defines what can be routed out of VCN
- Private subnets are recommended to have individual route tables to control the flow of traffic outside of VCN
- All hosts within a VCN can route to all other hosts in a VCN (no local route rule required)
- Security Lists manage connectivity north-south (incoming/outgoing VCN traffic) and east-west (internal VCN traffic between multiple subnets)
- OCI follows a white-list model (you must manually specify white listed traffic flows); By default, things are locked down
- Instances cannot communicate with other instances in the same subnet, until you permit them to!
- Oracle recommends using NSGs instead of SLs because NSGs let you separate the VCN's subnet architecture from your application security requirements

# VCN Review



# Summary

- In this lesson, you should have learned:
  - Key Virtual Cloud Network (VCN) concepts
    - Subnets, Route Table, Private IP, Public IP, Internal DNS
  - Gateways and Routing
    - Internet Gateway, NAT Gateway, Service Gateway, Local and Remote Peering
    - Transit Routing
    - VPN, FastConnect (next module)
  - VCN Security
    - Security List, Network Security Groups

# Hands On Lab

- You can locate the hands-on-lab for this lesson [here](#)



# Resources

- Oracle Cloud always free tier:

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

- OCI training and certification:

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

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

[education.oracle.com/oracle-certification-path/pFamily 647](https://education.oracle.com/oracle-certification-path/pFamily_647)

- OCI hands-on labs:

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

- Oracle learning library videos on YouTube:

[youtube.com/user/OracleLearning](https://youtube.com/user/OracleLearning)

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