ORACLE

Private Cloud Appliance

PCA X9 Technical Features and Architecture Storyboard

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Agenda

Hardware Overview
- Physical infrastructure including data center integration

System architecture
- Software architecture
- Logical partitioning (enclaves)

Infrastructure services
- IAM
- Compute
- Containers (Cloud-NAtive)
- Storage
- Network

Engineered for Mission Critical Private Cloud

Image portability to OCI
OCI compatible APIs

Tools and Services
CI/CD
SDK

Business Continuity
Fault Domains
Disaster Recovery

Monitoring and Management
Grafana, Prometheus

Security and Governance
Identity and Access
Policy
Tagging
Encryption

Storage
Block
File
Object

Network
Virtual Cloud Network
Network Services
Security Lists
Gateway Services
Datacenter Connectivity

Compute
Virtual Machines

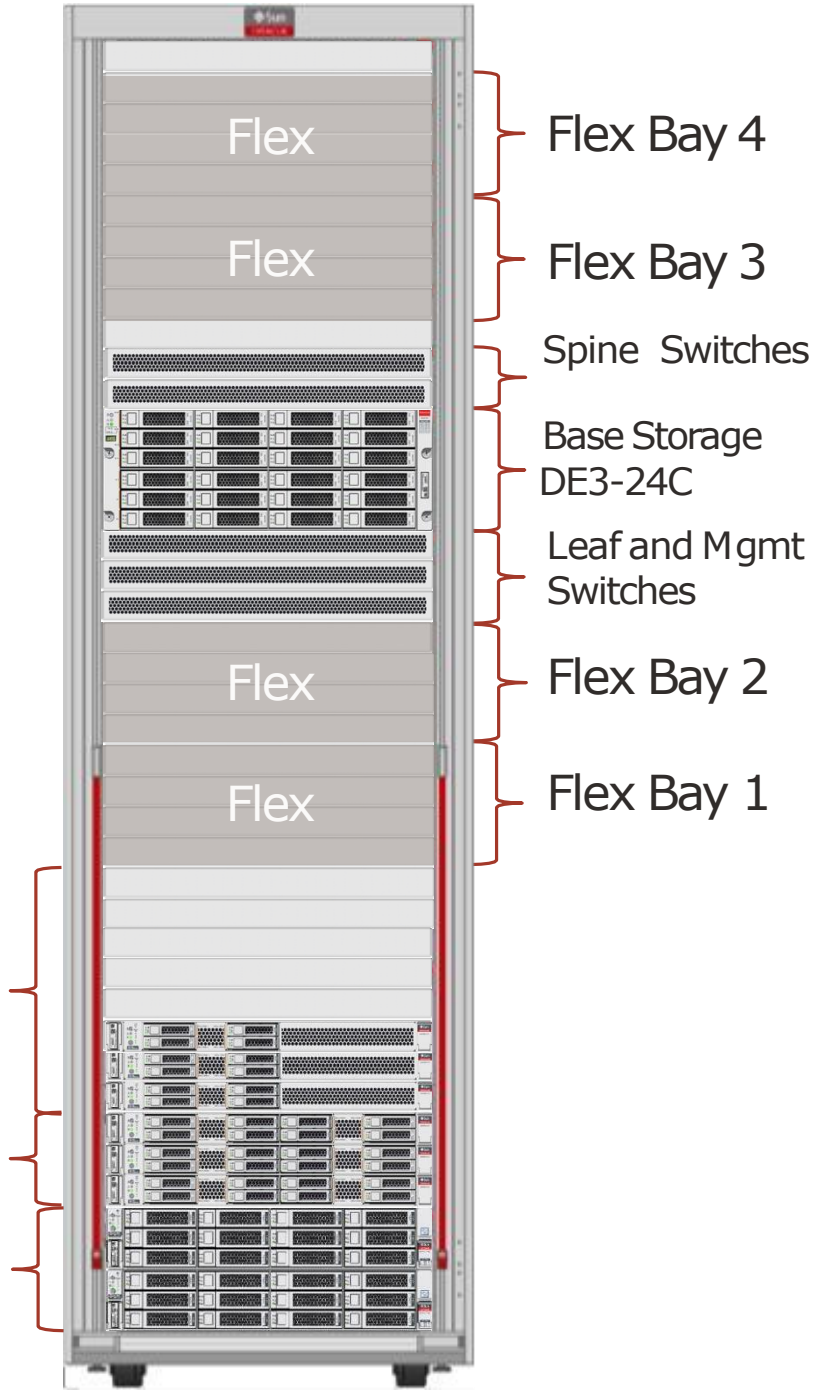
PCA Base Rack

Base Rack configuration includes:

- 3x Management Nodes
- 3x Compute Nodes populated in three reserved rack units
  - 8x RU pre-cabled for compute
- 2x ZFSSA Controllers
- 1x DE3-24C
- 4x Cisco 9336C 100GbE switches
  - 2x Access, 2x Aggregation
- 1x Cisco 9348GC management switch

Remaining rack space can accommodate 4 additional flex bays

- Up to 18 compute nodes total
- Up to 2.1 PB raw storage capacity
  - Using 18TB HDDs; 1.7 PB with 14TB HDDs



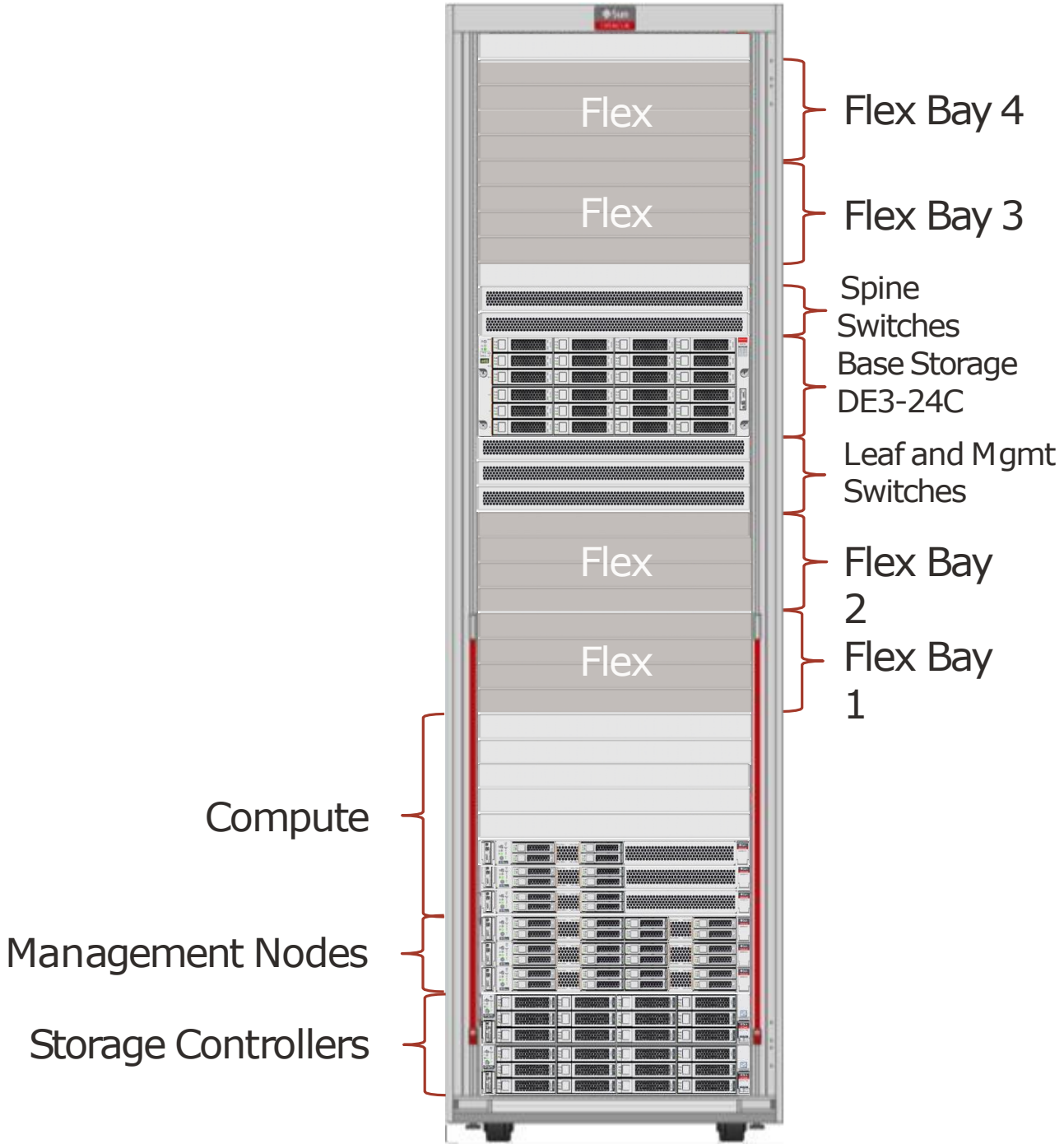
PCA Base Rack – Flex Bays

Flex Bays reserved as 4RU areas in the rack that can accommodate various combinations of rack components

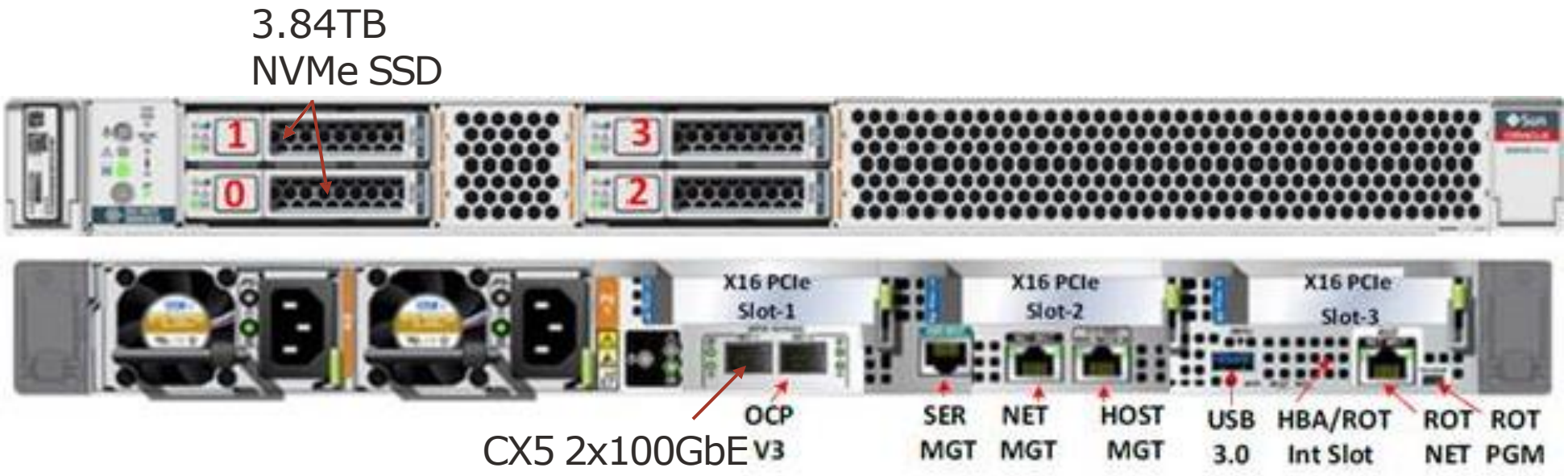
- 1 to 4x Compute Nodes
- 1 to 2x DE3-24P drive enclosures
- 1x DE3-24C drive enclosure

Once a bay type is selected, the 4RU area is set for that purpose

- Compute Node bay will accommodate only compute nodes
  - Additional compute nodes added until 4RU bay is completely populated
- DE3-24P bay accommodates only DE3-24P
  - 2nd enclosure added to fully populate bay before adding additional DE3-24P bays. Otherwise, 2RU populated with solid filler panels



PCA X9 Management Node Configuration



CPU: 2x Ice Lake 24C/2.0GHz/165W

DRAM: 1TB, 16x 64GB DDR4-3200

Boot: 2x M.2 SATA 240GB

Storage: 2x NVMe 3.84TB

IO: CX5 2x100Gb Ethernet OCP v3 module

Mgmt: NET0 +Sideband

System Network Interfaces

Customer Interface

- Application
- Client/User
- Data load
- Local Archive

Intra-region Interface

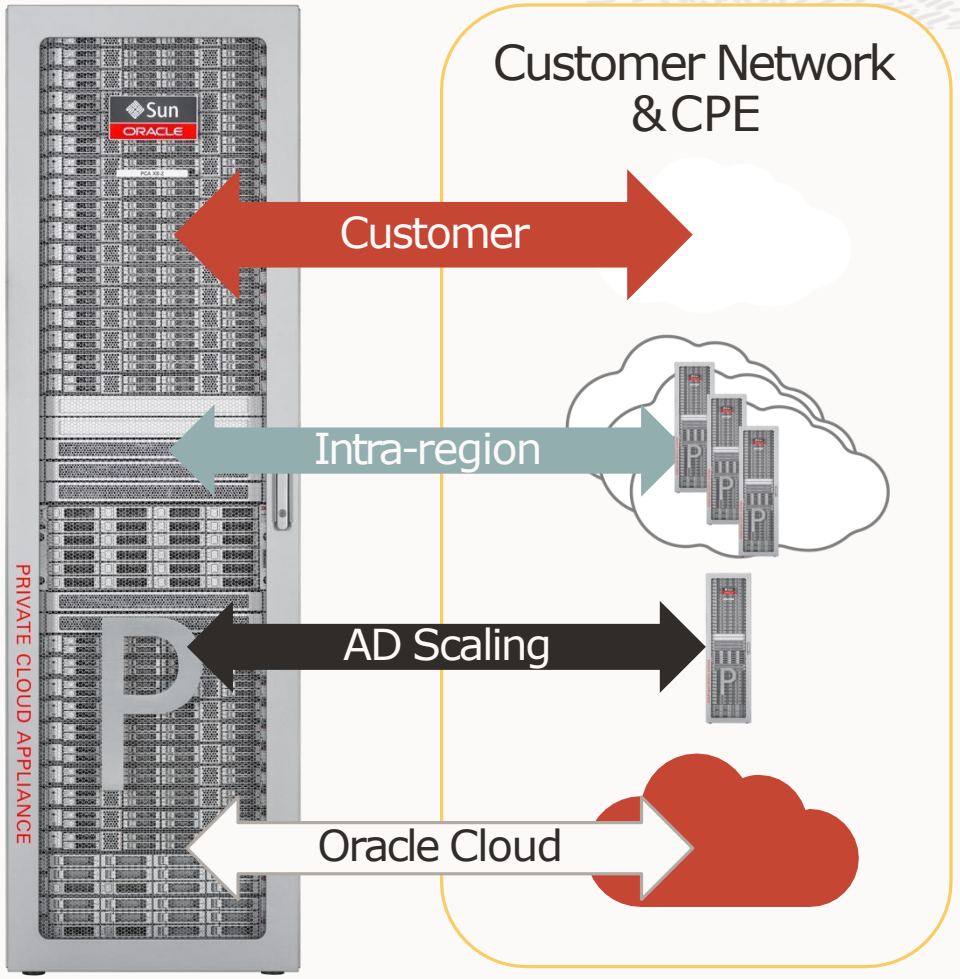
- Backup, Disaster Recovery
- AD – AD service communication

Availability Domain scaling

- Scaling AD compute/storage/services with additional infrastructure racks
- Exadata/Exa-CC connectivity

Oracle Cloud Interface

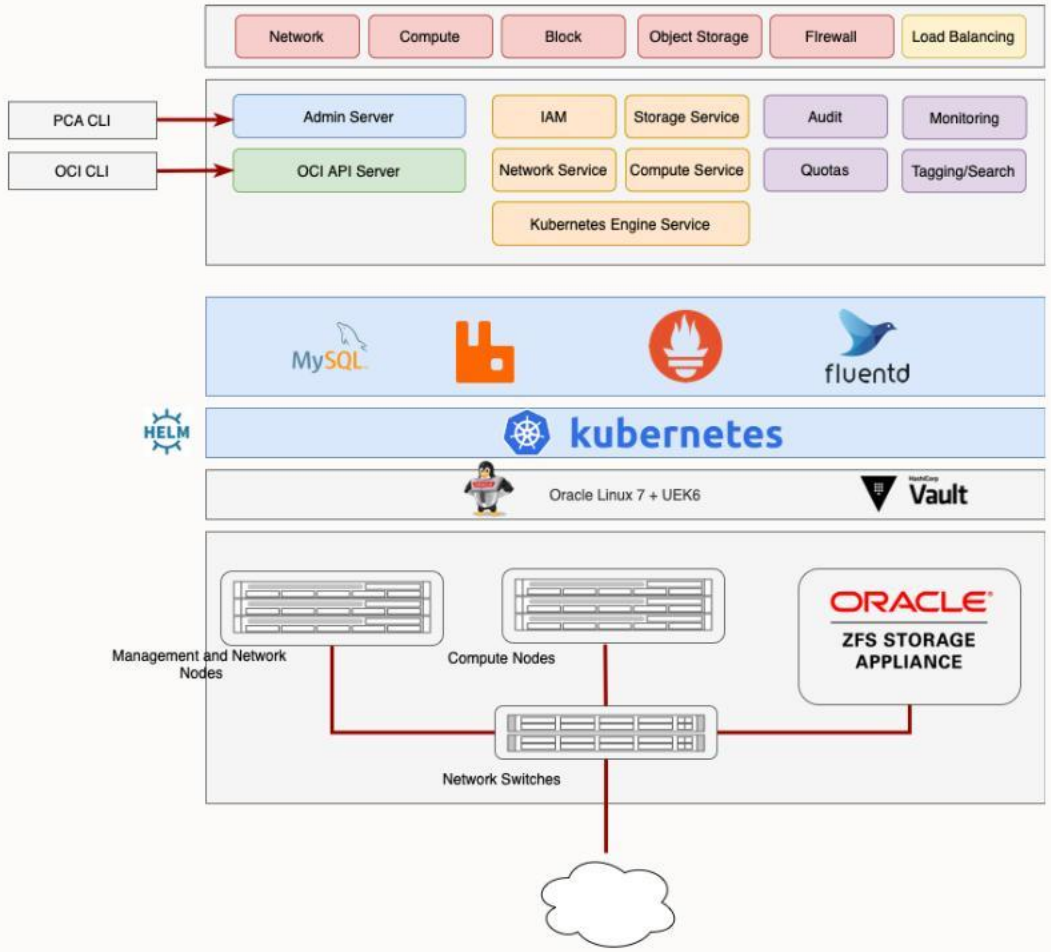
- Service delivery
- Management, monitoring, maintenance



System Architecture

PCA X9

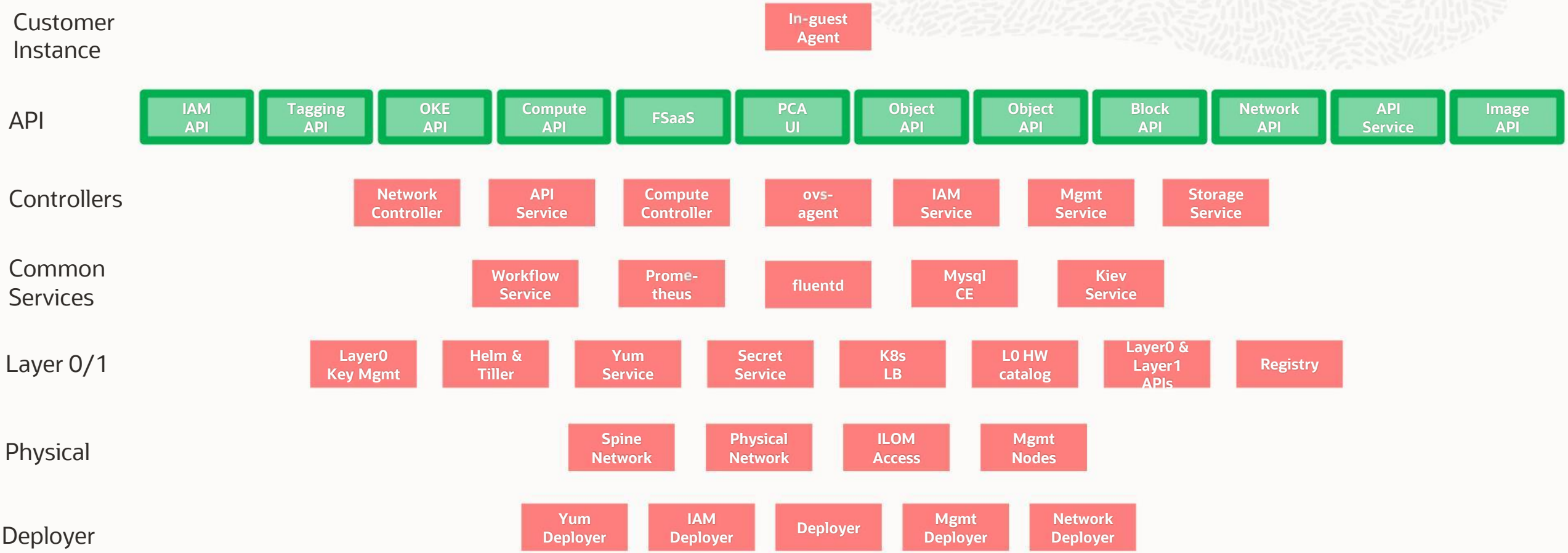
Software Architecture



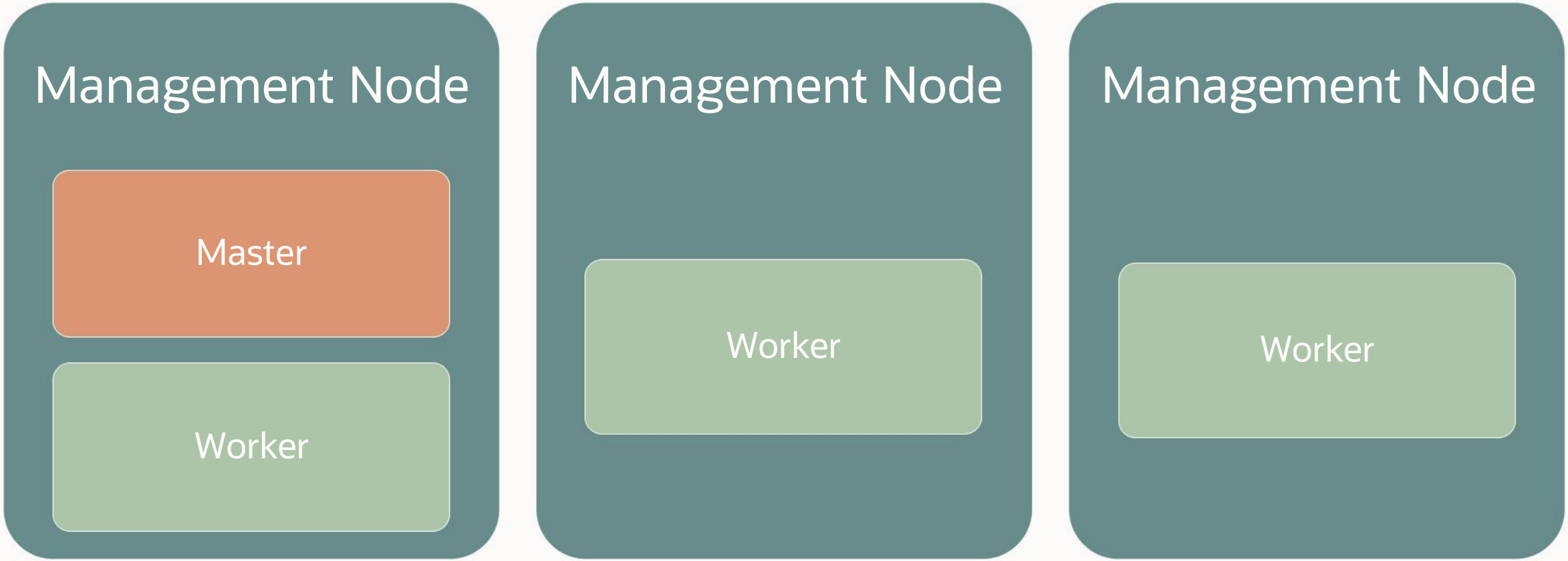
Microservices-based architecture

- Maximizes Availability
- Enables non-disruptive upgrade
- Hardware independent

Software Architecture

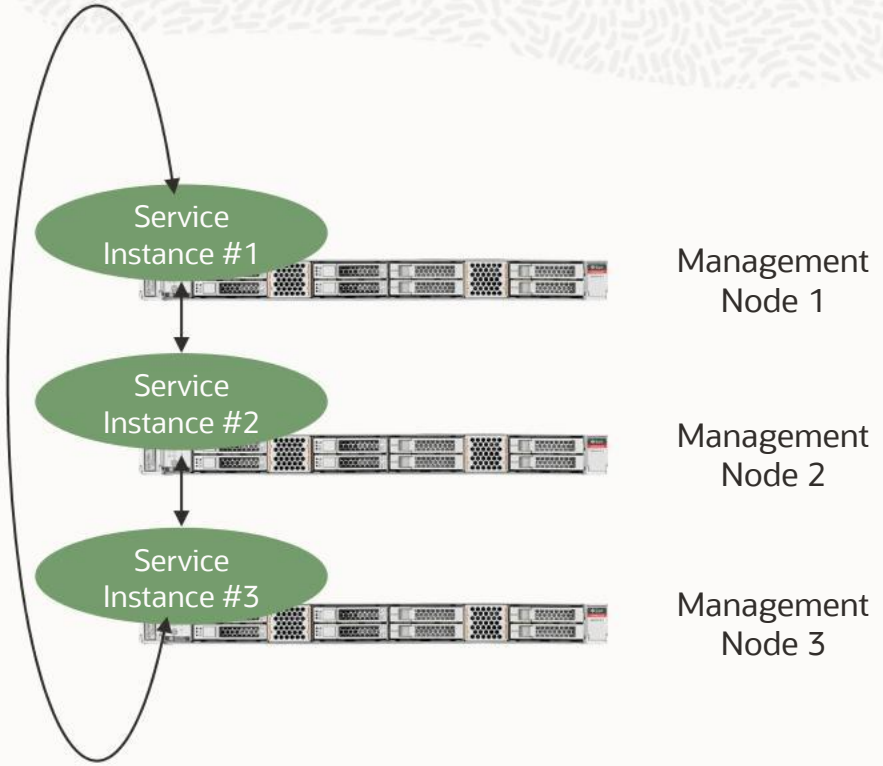


Platform Strategy – Kubernetes Cluster

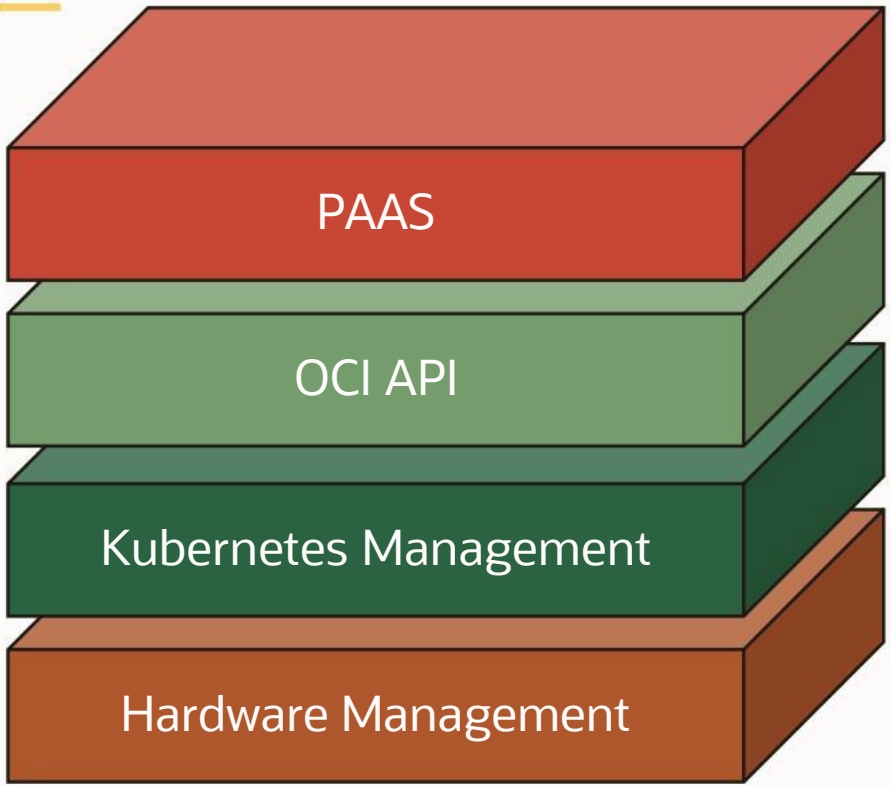


PCA Microservices

- Packaged within a Docker container that is managed & deployed via Kubernetes
- HA is attained by running one container on each of three Management Nodes
- RabbitMQ is used to communicate with other microservices within the PCA system
- Loki used for log aggregation
- Prometheus used for statistics collection



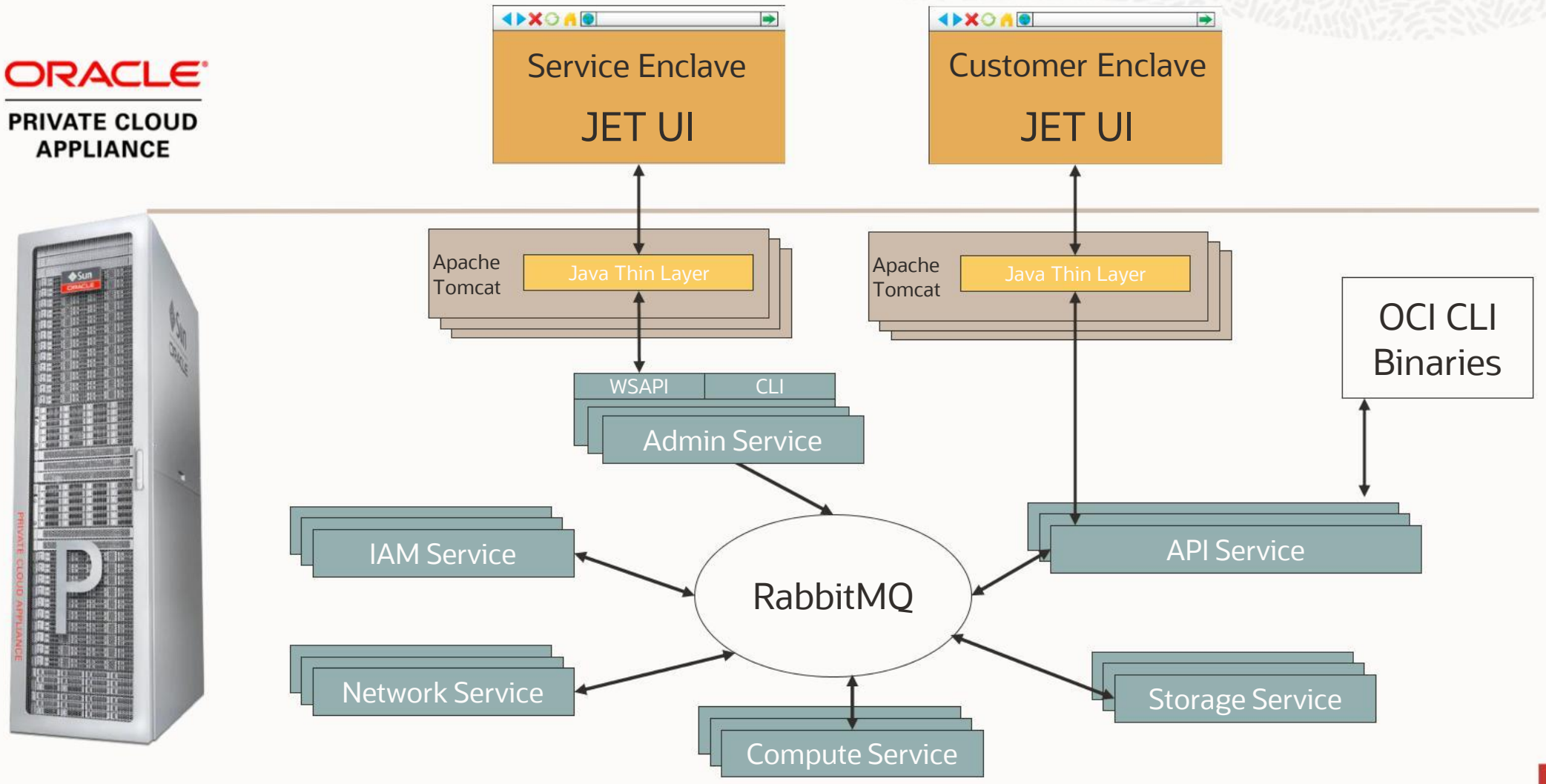
Upgrades - System Platform Services



- Upgrades to micro-services done by deploying newer version to the registry
- Kubernetes determines when and how to replace older apps
- Rollback built into Kubernetes

- OS, kernel, and PCA L1 stack updated with yum
- Yum repo managed by pca-upgrader
- Firmware upgrades can be synchronized with OS upgrades to minimize reboots
- Firmware HMP and OS modules can always be on the same version
- Unified utility simplifies patching for Platinum and PCC

User Interfaces and Service Communication



Infrastructure Services

Services supported at release

OCI IaaS – Initial Release

OCI Service	Features
Identity and Access Management	SAML 2.0 Federation
Compute	Fixed Virtual Machine Shapes (X9)
VCN	Subnets, vnics, gateways, routing tables, security lists, …
Block Storage	Balanced and Performance
Object Storage	OCI
File Storage	NFS, SMB

Infrastructure Services

IAM

IAM

Identity and access management features such as authentication, single sign-on (SSO), and identity lifecycle management

IAM Components

RESOURCE

- The cloud objects that your company's employees create and use when interacting with Oracle Cloud Infrastructure (for example, compute instances, block instances, block storage volumes, virtual cloud networks, subnets, etc.), third-party applications, Software-as-a-Service (SaaS) applications, on-premises software, and retail web applications.

USER

- An individual employee or system that needs to manage or use your company's Oracle Cloud Infrastructure resources. Users might need to launch instances, manage remote disks, work with your virtual cloud network, etc. End users of your application are not typically IAM users. Users have one or more IAM credentials (see User Credentials).

GROUP

- A collection of users who all need the same type of access to a particular set of resources or compartment.

NETWORK SOURCE

- A group of IP addresses that are allowed to access resources in your tenancy.

COMPARTMENT

- A collection of related resources. Compartments are a fundamental component of Oracle Cloud Infrastructure for organizing and isolating your cloud resources. You use them to clearly separate resources for the purposes of measuring usage and billing, access (through the use of policies), and isolation (separating the resources for one project or business unit from another). A common approach is to create a compartment for each major part of your organization.

TENANCY

- The root compartment that contains all of your organization's Oracle Cloud Infrastructure resources.

POLICY

- A document that specifies who can access which resources, and how. You can write policies to control access to all of the services within Oracle Cloud Infrastructure. Access is granted at the group and compartment level, which means you can write a policy that gives a group a specific type of access within a specific compartment, or to the tenancy itself. If you give a group access to the tenancy, the group automatically gets the same type of access to all the compartments inside the tenancy.

FEDERATION

- A relationship that an administrator configures between an identity provider and a service provider.

IAM Service: Overview

- Supports two main OCI features
  - Policies
  - Tagging
- Authenticates and uses policies to authorize all incoming requests
- Supports other OCI objects and operations
  - Users
  - UserGroups, UserGroupMemberships
  - Compartments
  - ApiKeys
- Supports federation with IdPs supporting SAML 2.0
  - Active Directory federation

Infrastructure Services

Compute

Compute

Virtual Machine

- A virtual machine (VM) is an independent computing environment that runs on top of physical bare metal hardware. The virtualization makes it possible to run multiple VMs that are isolated from each other. VMs are ideal for running applications that do not require the performance and resources (CPU, memory, network bandwidth, storage) of an entire physical machine.

Virtual Machine

Compute - Supported VM Shapes

VM Shapes

- Fixed 1:16 ratio (OCPU:GB Memory)

Resources reserved for the hypervisor

- 4 cores
- 40 GB memory

OCI Portability

- OCI supports shapes up to 18 OCPUs on X9 (VM.Optimized3.Flex)

Shape	OCPUs	Memory (GB)	OCI Portable
VM.PCAStandard1.1	1	16	✓
VM.PCAStandard1.2	2	32	✓
VM.PCAStandard1.4	4	64	✓
VM.PCAStandard1.8	8	128	✓
VM.PCAStandard1.16	16	256	✓
VM.PCAStandard1.24	24	384	✗
VM.PCAStandard1.32	32	512	✗
VM.PCAStandard1.48	48	768	✗
VM.PCAStandard1.Max	60	960	✗

PCA X9 – Guest OS Matrix

Guest Operating System	Platform Image	Custom Image
Oracle Linux Release 8.x	✓	✓
Oracle Linux Release 7.x	✓	✓
Red Hat Enterprise Linux 8.x		✓
Red Hat Enterprise Linux 7.x		✓
CentOS 8.x		✓
CentOS 7.x		✓
SUSE Linux Enterprise Server 12 SP5		✓
SUSE Linux Enterprise Server 15 SP1		✓
Ubuntu 20.04 and later		✓
Ubuntu 18.04 and later		✓
Oracle Solaris 11		✓
Microsoft Windows Server 2019		✓
Microsoft Windows Server 2016		✓
Microsoft Windows Server 2012 R2		✓
Microsoft Windows Server 2012		✓

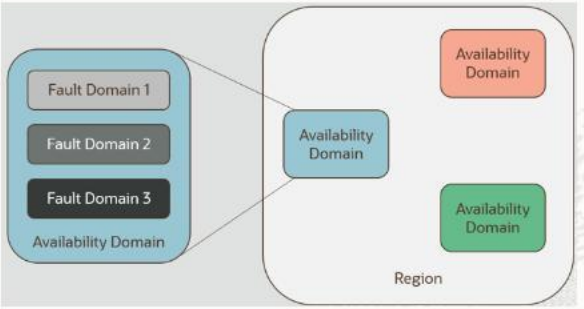
Compute - Recommended System Sizing to Support Zero Down Time Upgrade

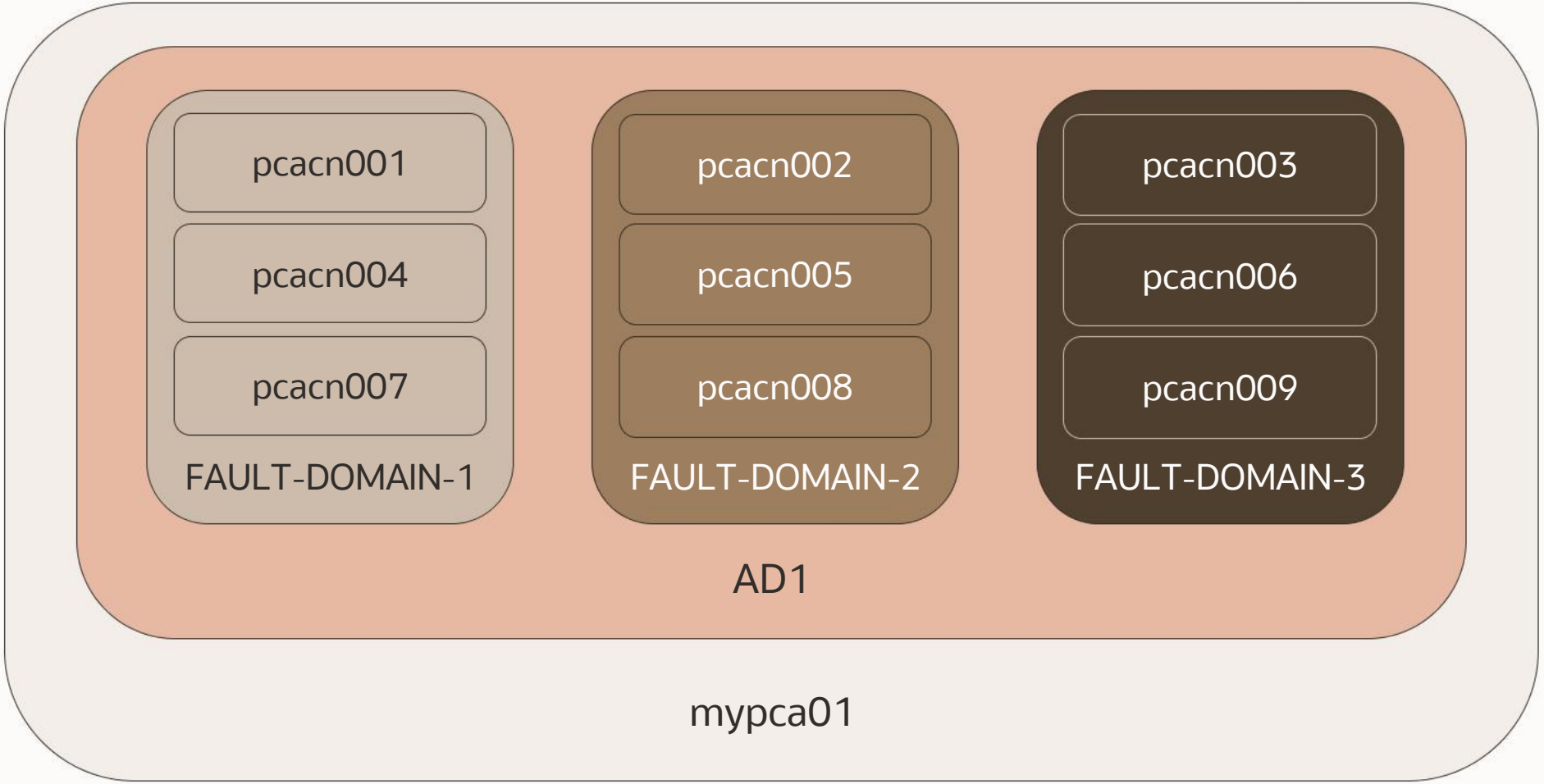
1. Calculate required system OCPU capacity leveraging supported VM shapes
2. Select system size which provides “Available Capacity” greater than required OCPU capacity
3. When using large VM shapes (OCPU 16 or greater), increase ”reserve capacity” to ensure that large VMs can be moved during upgrade.
4. When configuring the system set alerts to ensure that desired “reserve capacity” is available

System Size		Reserve Capacity		Available Capacity	
Compute Nodes	OCPUs	%	OCPUs	%	OCPUs
3	180	33%	60	67%	120
6	360	17%	60	83%	300
9	540	11%	60	89%	480
12	720	8%	60	92%	660
15	900	7%	60	93%	840
18	1,080	6%	60	94%	1,020

Note: ~~Reserve Capacity~~ is simply 20 cores per fault domain.

PCA X9 Architecture In Practice



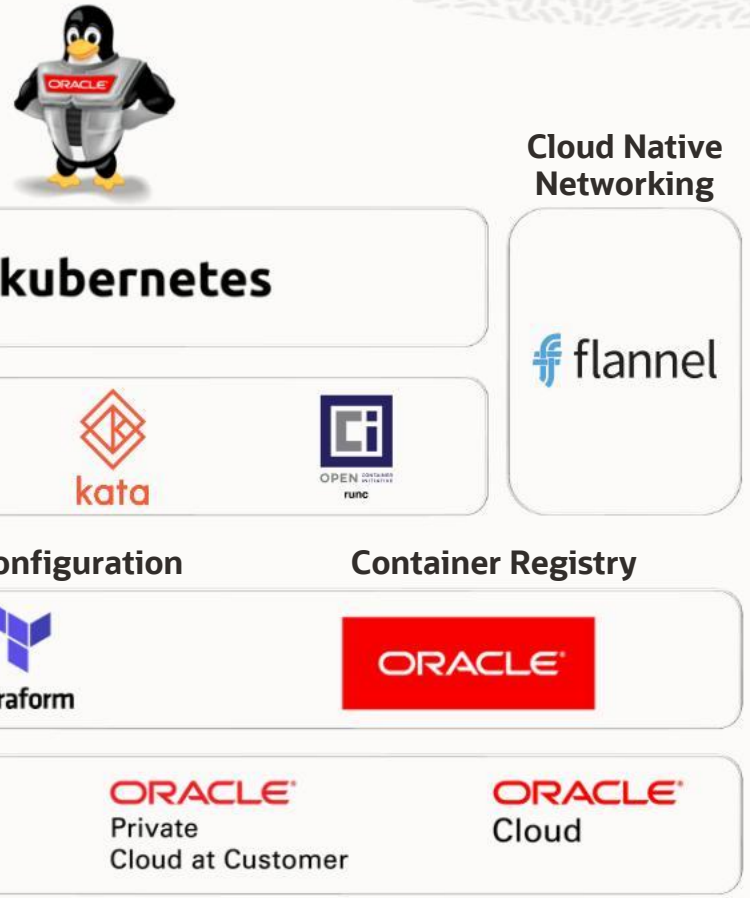


Infrastructure Services

Containers – Cloud Native

Cloud Native Environment for Private Cloud

- Oracle Linux Cloud Native Environment included
- An open, integrated operating environment that is popular with developers and easy for IT operations to deliver:
  - Containers and orchestration
  - Management tools
  - Development tools
- Supports the open standards, specifications, and APIs defined by the Cloud Native Computing Foundation (CNCF)



Oracle Products currently supported inside Docker containers

Available on Oracle Container Registry

- Oracle Linux
  6 and 7 with slim variants
- MySQL Community Server
- MySQL Server Enterprise Edition
- Oracle Java SE
- Oracle NoSQL Database
- Oracle Database
- Oracle GoldenGate

- Oracle Business Intelligence
- Oracle Coherence
- Oracle Fusion Middleware Infrastructure
- Oracle Data Integrator
- Oracle SOA Suite
- Oracle Tuxedo
- Oracle WebLogic Server
- Oracle HTTP Server

….more

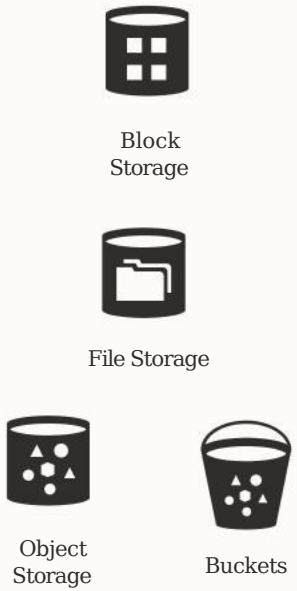
Infrastructure Services

Storage

Storage Overview

Support for fundamental storage services

- **Block**
  - Performance tiers dependent upon disk enclosure hardware
    - “Balanced” and “Performance”
- **File**
  - NFS (v3/v4)
  - SMB
  - **Note** - file is “very expensive” in public clouds
- **Object**
  - OCI object store



Storage

Base storage

- **Base includes a single high-capacity tray**
  - 140 TB user storage
  - 40 TB reserved capacity (system use)

High Capacity Storage

- Storage services supported: balanced block, file, object

High Performance Storage (optional)

- Storage services supported: performance block

Sizing Considerations

- Include the following in sizing calculations: data storage, user storage, VM images, backups, snapshots, clones, …

	Min	Max
High Capacity Tray	1	48
High Performance Tray (optional)	0	47

Infrastructure Services

Networking

PCA-X9 Networking – Core Components

PCA-X9 Networking functionality consists of the following Kubernetes (K8s) controllers and Management services:

- A Network Controller (NC/nwctrl)
- A Load Balancing Controller (LBC/lbctrl)
- Ethernet Switches - underlay network
- OVN/OVS - Overlay network
- DNS, and Switch Manager micro-service modules
- PCA management nodes
- A ZFSSA.
- MySql Data Base (DB)

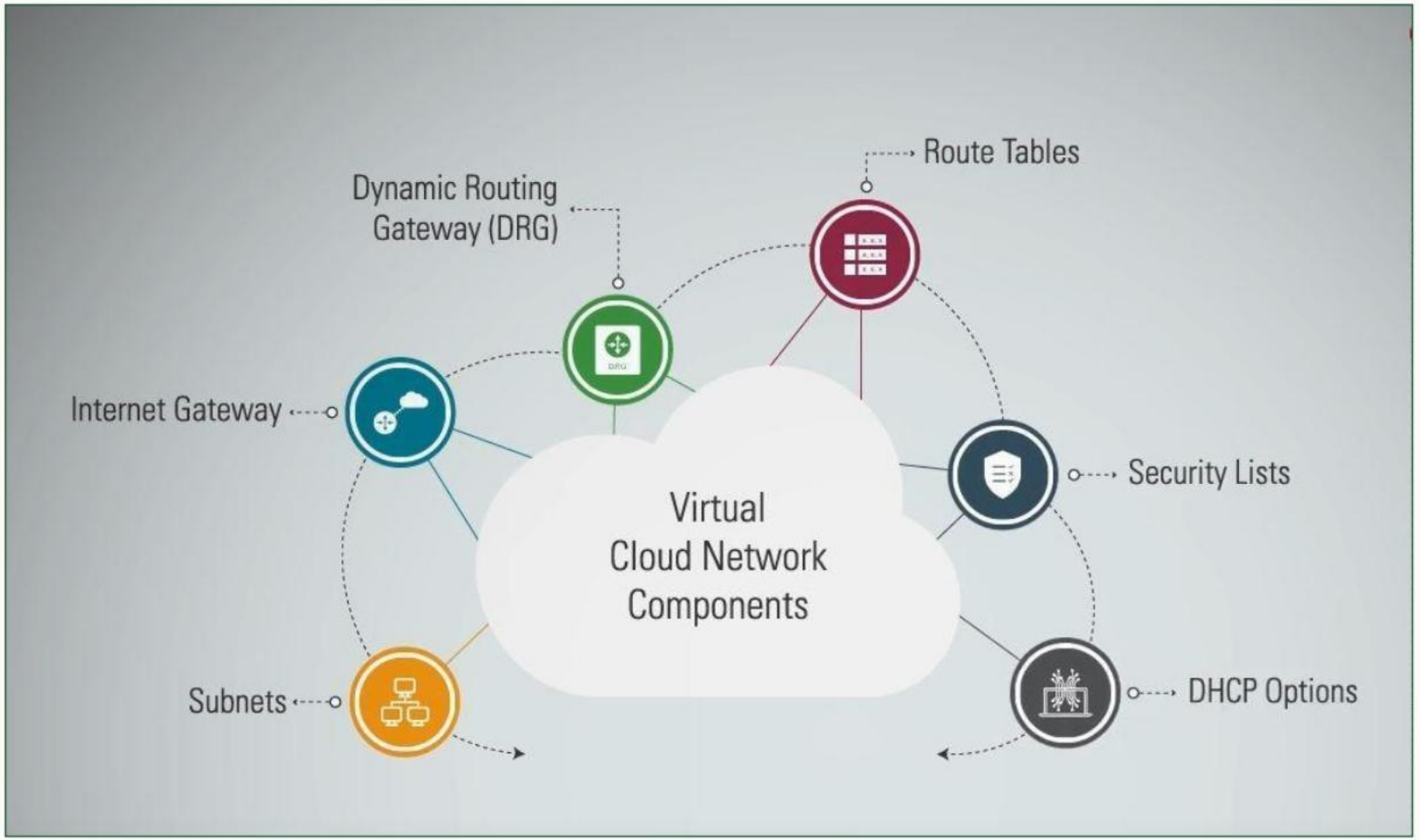
Functionality provided by PCA-X9 networking include:

- Supporting the OCI networking CLI/APIs
- Conforming with OCI networking model:
  - OCI VCN, subnet, VNIC constructs,
  - Private and public IP address,
  - Private and public subnets, and
  - Various L3 services
- Providing DHCP, firewall, DNS, and Load Balancing networking services,
- Supporting management and storage network traffic.
- Creating MySQL DB objects for OCI objects (VCN, Subnet etc) and any related PCA specific objects.

Networking language of the Cloud (OCI)

Overview

Virtual Cloud Network (VCN)



- Virtual Cloud Network is a software-defined version of a traditional physical network including subnets, route tables, gateways, and firewall rules. Essentially a “Virtual Data Centre”.
- VCN covers a single, contiguous IPv4 CIDR block of your choice
  - Oracle recommends using one of the private IP address ranges in RFC 1918 (10.0.0.0/8, 172.16/12, and 192.168/16) for VCN address space. However, you can also use a publicly routable range
- Allowable VCN size range is from /16 to /30 (VCN reserves the first two IP addresses and the last one in each subnet's CIDR)

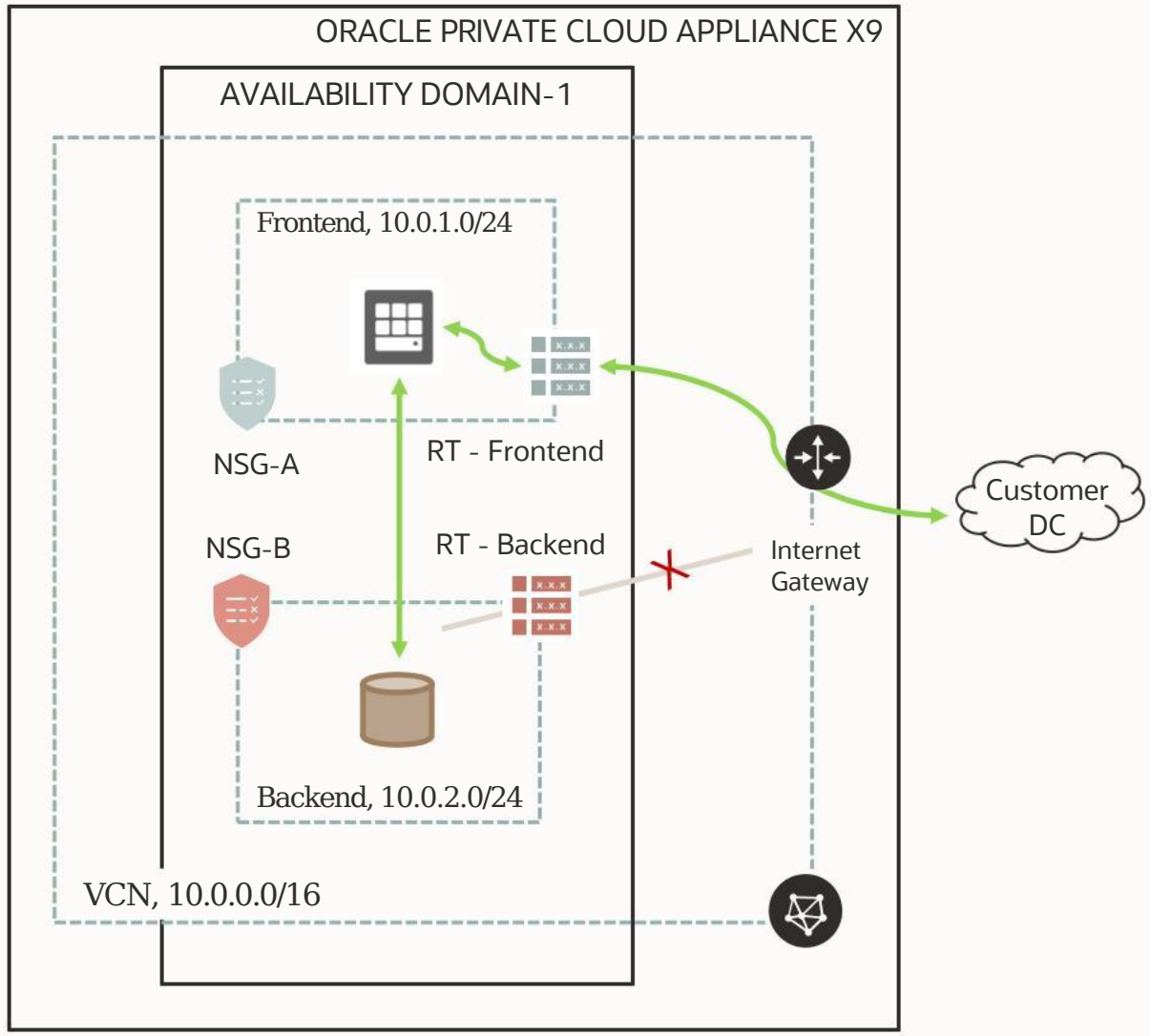
Securing your VCN

- **Public vs Private Subnets** - designate a subnet to be private, which means instances in the subnet cannot have public IP addresses
- **Security Lists -** To control packet-level traffic in/out of an instance by defining security rules in your VCN
- **Firewall Rules -** configure firewall rules directly on the instance itself to control packet-level traffic in/out of an instance
- **Gateways and Route Tables -** Control general traffic flow from your cloud network to outside destinations (the internet, your on-premises network, or another VCN)
- **IAM Policies -** control who has access to the PCA-X9 customer tenancies or console

VCN Definitions

- Subnets can have one Route Table and multiple 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)
- PCA-X9 follows a white-list model (i.e. you must manually specify whitelisted 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 Deployment Architecture



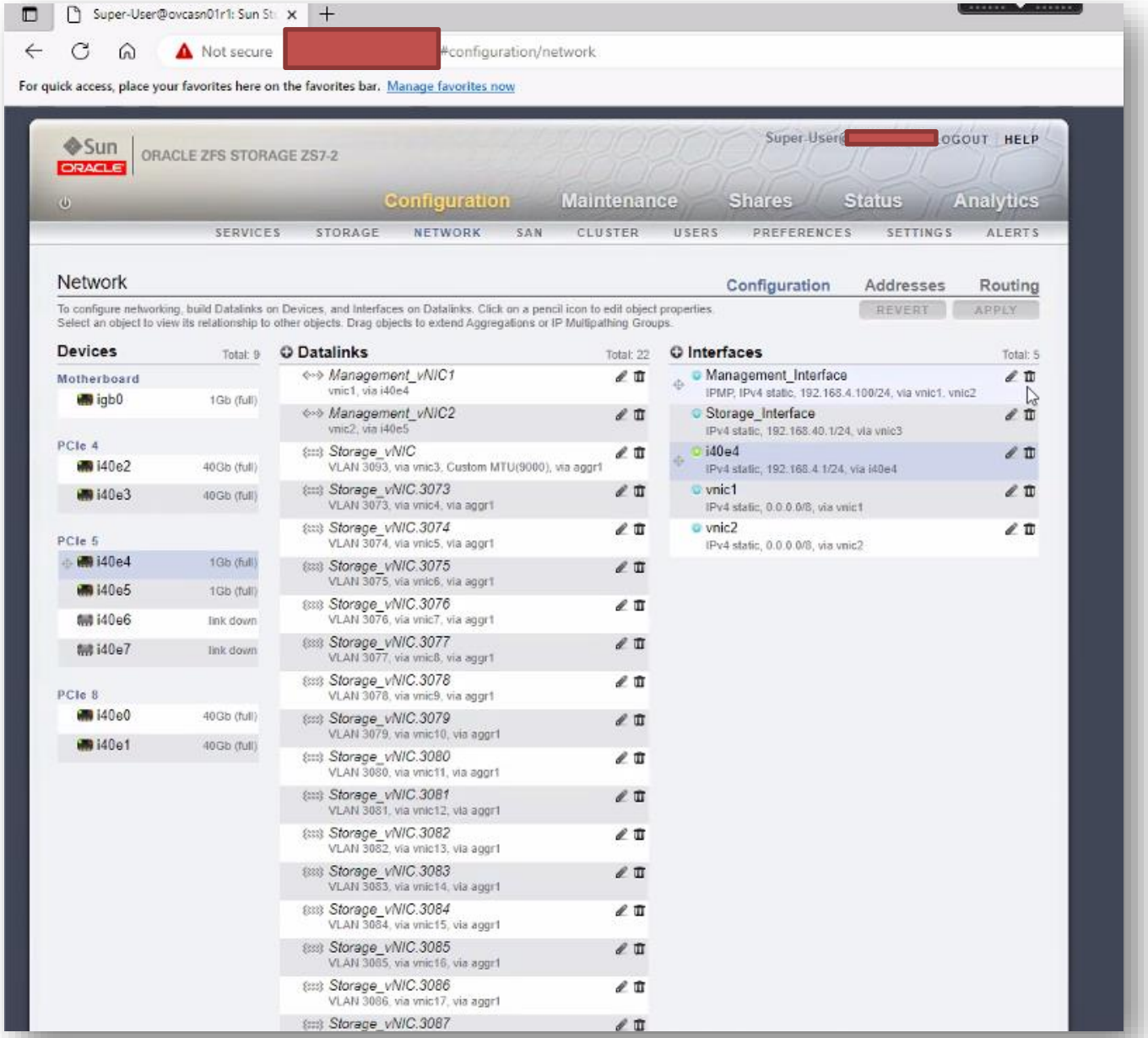
Destination CIDR	Route Target
0.0.0.0/0	Internet Gateway

	Type	CIDR	Protocol	Source Port	Dest Port
Stateful	Ingress	0.0.0.0/0	TCP	All	80
Stateful	Egress	NSG-B	TCP	All	1521

Destination CIDR	Route Target
0.0.0.0/0	NAT/ Service gateway /DRG

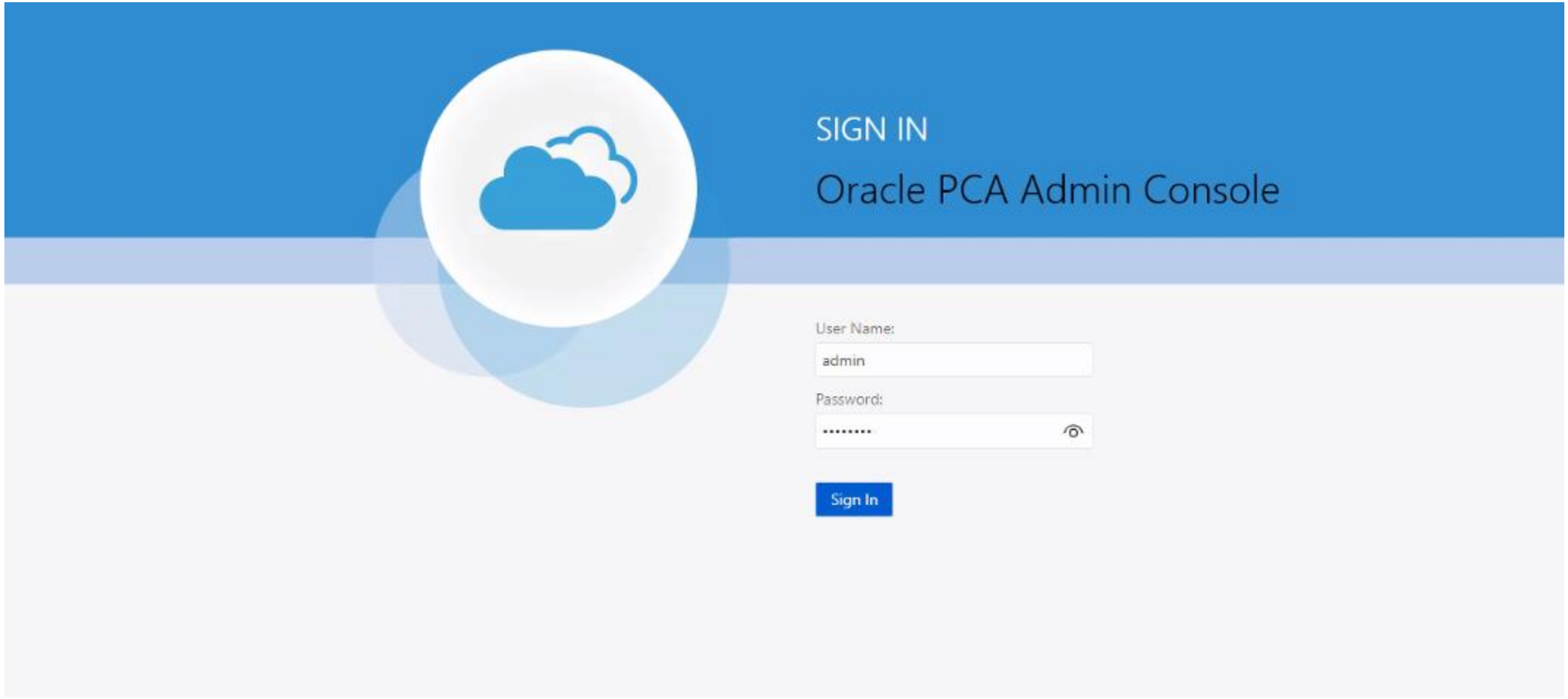
	Type	CIDR	Protocol	Source Port	Dest Port
Stateful	Ingress	NSG-A	TCP	All	1521
~~Stateful~~	~~Egress~~		~~All~~	~~All~~	

ZFS Storage Management

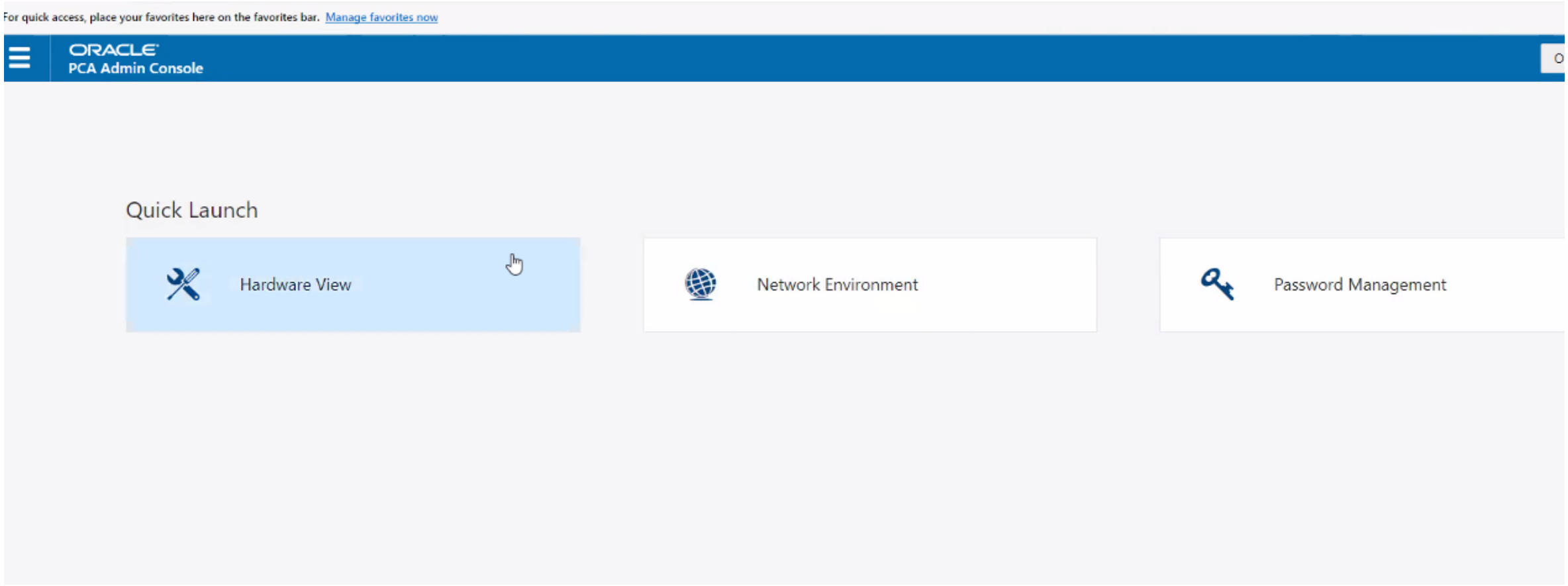


Storage Pools

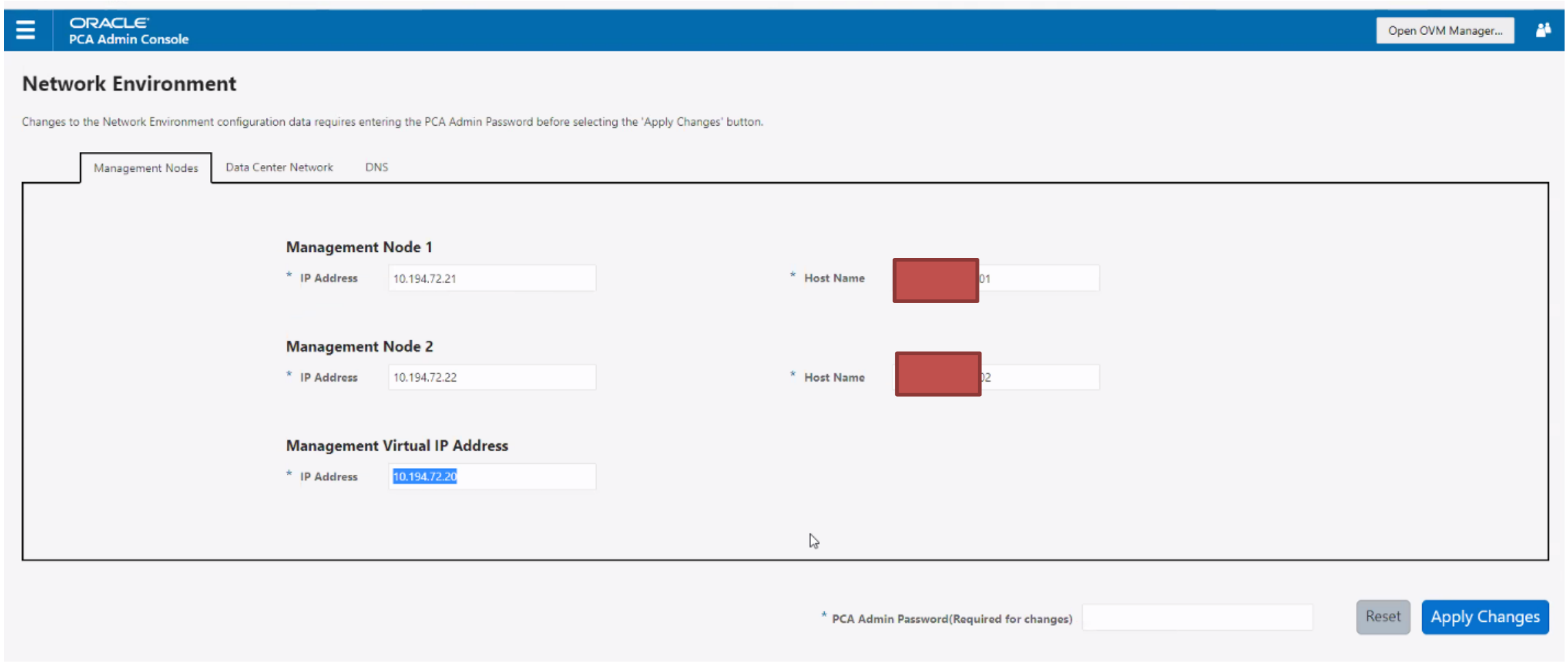
PCA Admin Console



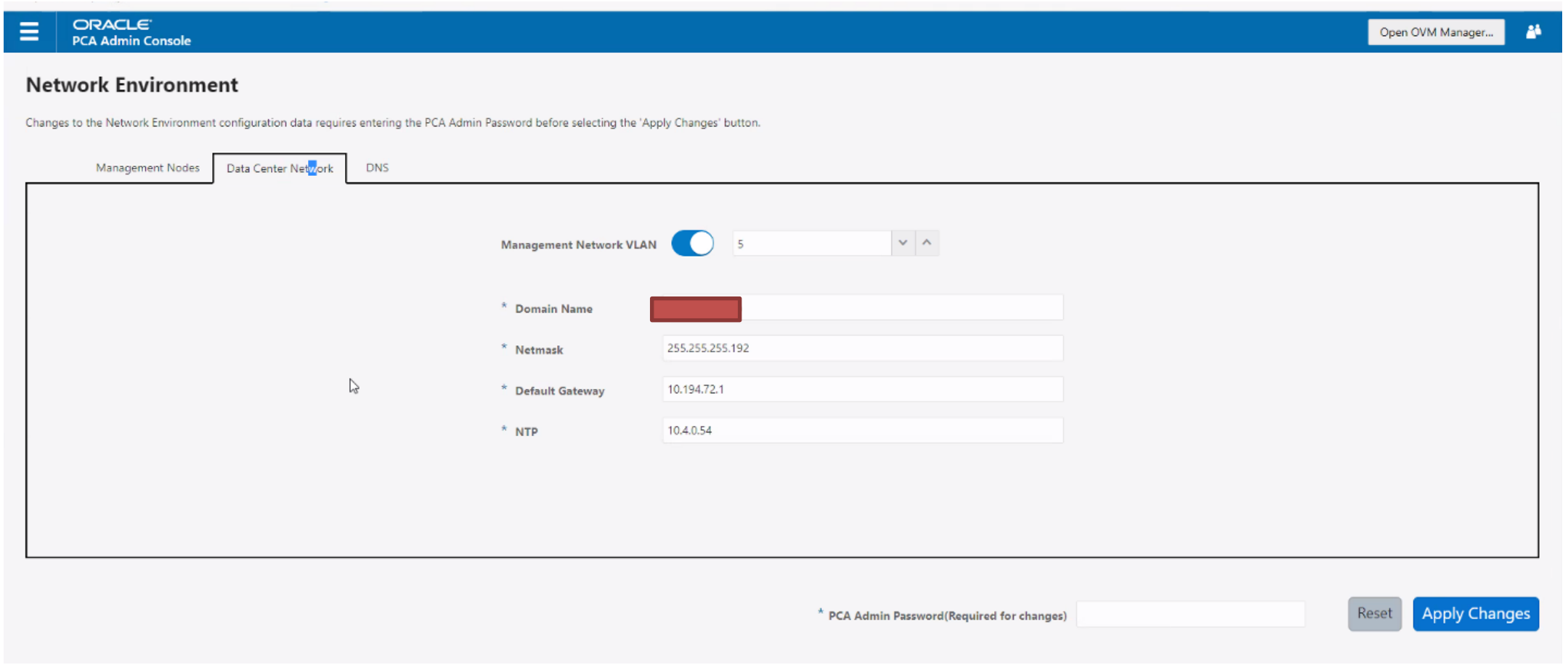
Networking Configurations



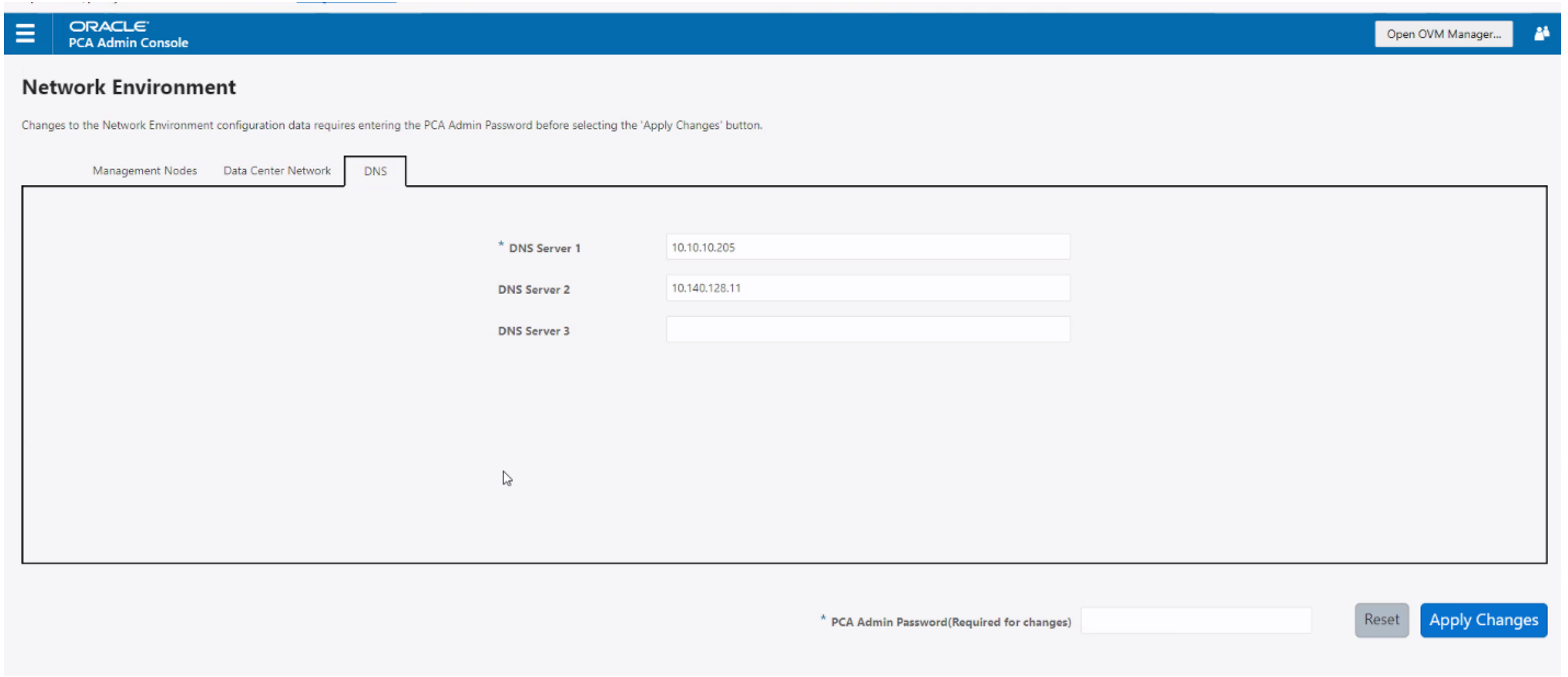
Network Setup



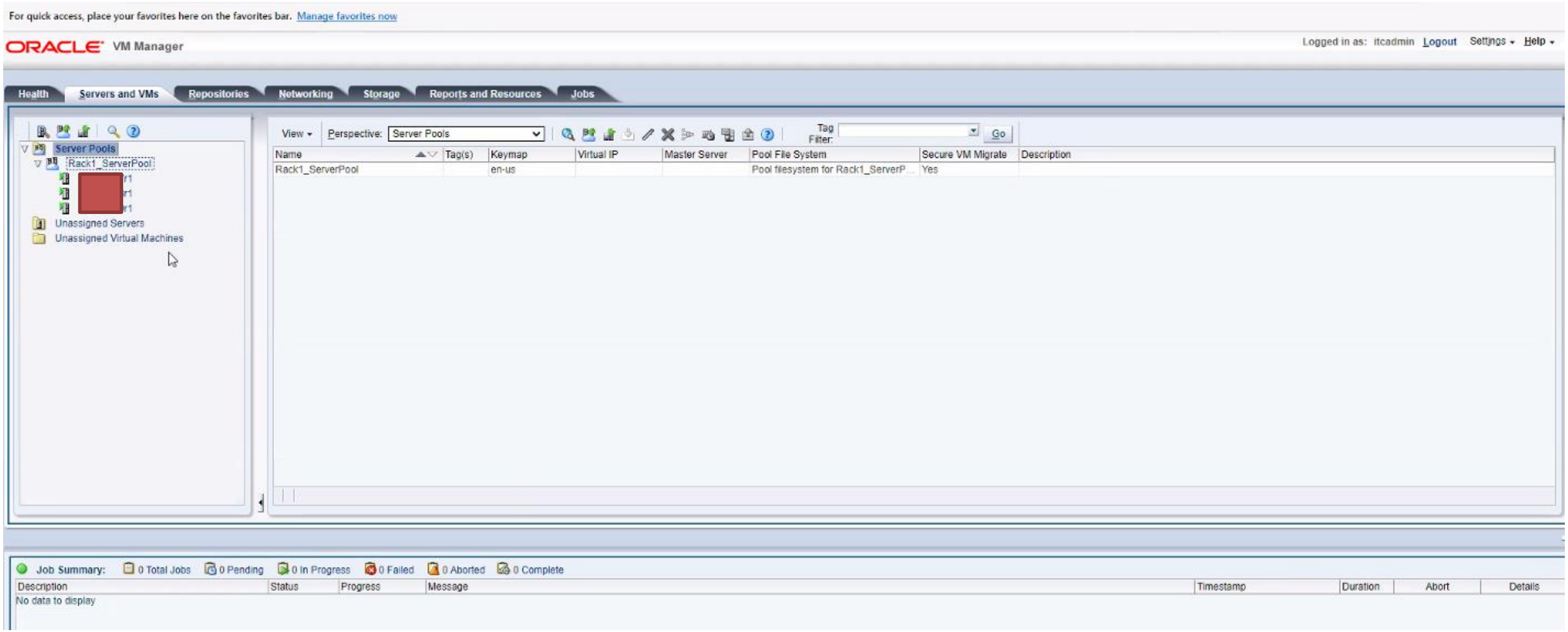
Network Setup – DNS, Netmask, Default Gateway



Networking DNS



OVM Manager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ORACLE VM Manager
Logged in as: itcadmin Logout Settings Help
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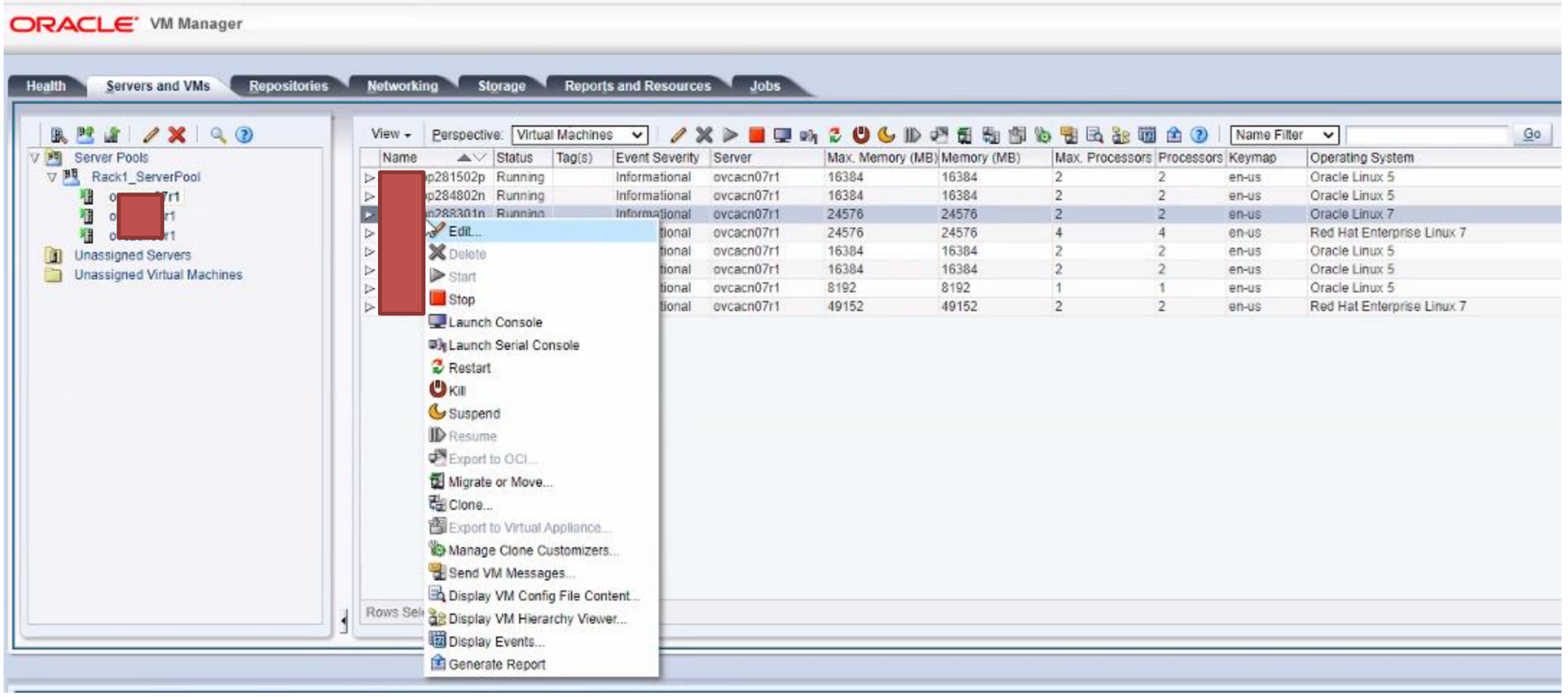
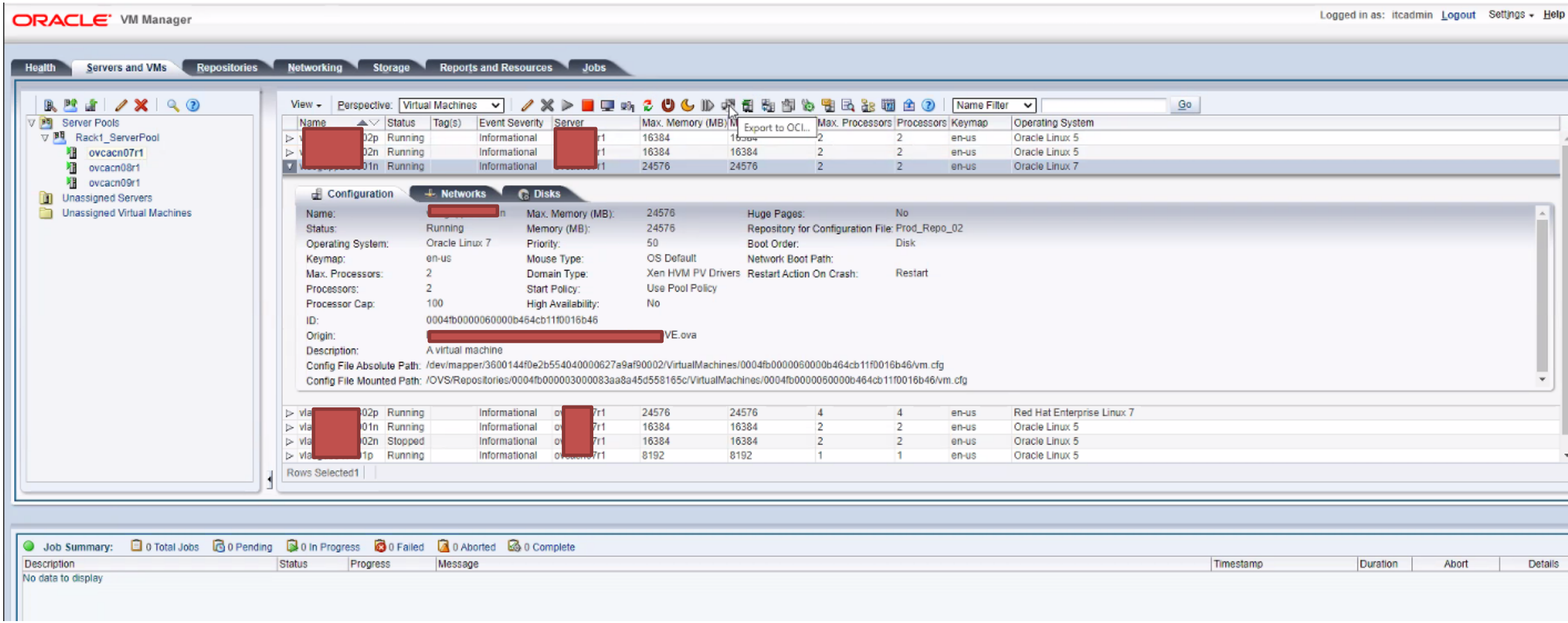
Servers and VMs
Repositories
Networking
Storage
Reports and Resources
Jobs
Server Pools
Rack1_ServerPool
Unassigned Servers
Unassigned Virtual Machines
View
Perspective: Server Pools
Tag Filter:
Go
Name
Tag(s)
Keymap
Virtual IP
Master Server
Pool File System
Secure VM Migrate
Description
Rack1_ServerPool
en-us
Pool filesystem for Rack1_ServerP...
Yes
Job Summary:
0 Total Jobs
0 Pending
0 In Progress
0 Failed
0 Aborted
0 Complete
Description
Status
Progress
Message
Timestamp
Duration
Abort
Details
No data to display

Compute Nodes Options



Compute Nodes Setup Details

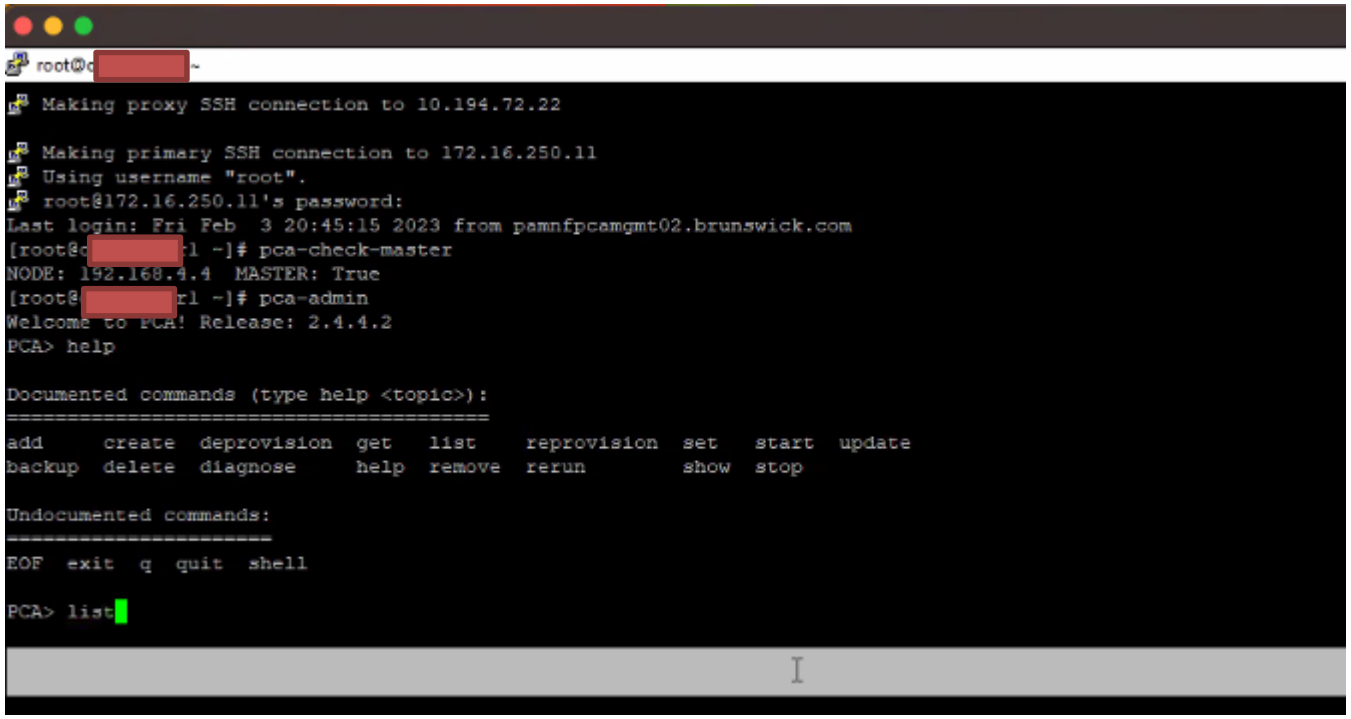


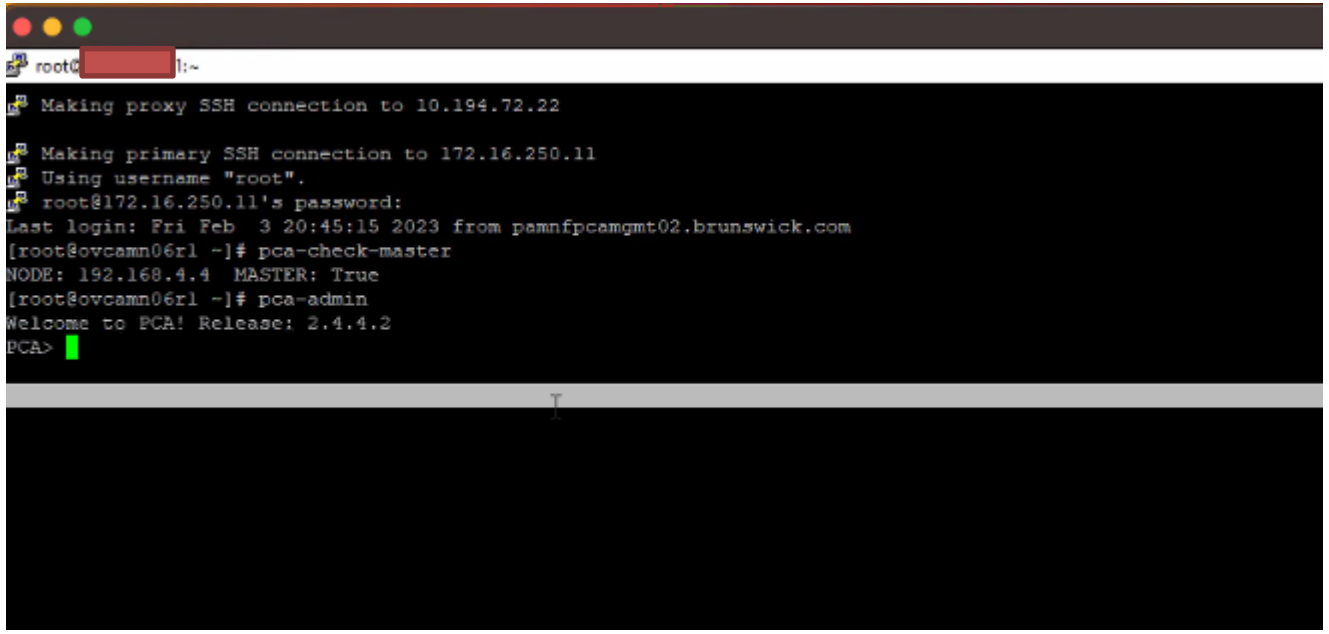
PCA Admin

```
[root@ov[redacted]1 ~]# pca-admin
Welcome to PCA! Release: 2.4.4.2
PCA> help

Documented commands (type help <topic>):
========================================
add     create  deprovision  get   list    reprovision  set   start  update
backup  delete  diagnose     help  remove  rerun        show  stop

Undocumented commands:
======================
EOF  exit  q  quit  shell

PCA> list help

Status: Failure
Error Message: Error (MISSING_TARGET_000): Missing command target for command: list. Command targets can be: ['management-node', 'iscsi-storage', 'lock', 'compute-node', '
er', 'backup-task', 'storage-profile', 'network-port', 'oci-backup', 'uplink-port', 'network-switch', 'mgmt-switch-port', 'update-task', 'uplink-port-group', 'task', 'oci-

PCA> list compute-node

Note: Provisioning_Status is unrelated to node status in Oracle VM Manager Web UI.

Compute_Node  IP_Address    Provisioning_Status  ILOM_MAC           Provisioning_State
------------  ----------    -------------------  --------           ------------------
ov[redacted]1  192.168.4.7   RUNNING              a8:69:8c:06:59:9f  running
ov[redacted]1  192.168.4.6   RUNNING              a8:69:8c:06:50:fb  running
ov[redacted]1  192.168.4.5   RUNNING              a8:69:8c:06:52:e3  running
------------------
3 rows displayed

Status: Success

PCA>
```

Command Line Interface

pca-check-master





Diagnose ILOM

```
PCA> diagnose-ilom
*** Unknown syntax: diagnose-ilom
PCA> diagnose ilom
Checking ILOM health; please wait.

IP_Address      Status          Health_Details
----------      ------          --------------
192.168.4.129   Not Connected   None
192.168.4.128   Not Connected   None
192.168.4.127   Not Connected   None
192.168.4.126   Not Connected   None
192.168.4.125   Not Connected   None
192.168.4.124   Not Connected   None
192.168.4.123   Not Connected   None
192.168.4.122   Not Connected   None
192.168.4.121   Not Connected   None
192.168.4.120   Not Connected   None
192.168.4.101   OK              None
192.168.4.103   OK              None
192.168.4.102   OK              None
192.168.4.105   OK              None
192.168.4.104   OK              None
192.168.4.107   Faulty
       Fri Jan 27 17:55:54 2023  System              MB (Motherboard)
       The Field Programmable Gate Array (FPGA) has detected a malfunctioning
       component and has powered-off the system. (Probability:100,
       UUID:432b473a-8409-c087-b374-ff41aa1b0ea9, Resource:/SYS/MB, Part
       Number:8207753, Serial Number:465136J+2152GA00BP, Reference
       Document:http://support.oracle.com/msg/SPENV-8000-D1)


192.168.4.106   OK              None
192.168.4.109   Not Connected   None
192.168.4.108   Not Connected   None
192.168.4.112   Not Connected   None
192.168.4.113   Not Connected   None
192.168.4.110   Not Connected   None
192.168.4.111   Not Connected   None
192.168.4.116   Not Connected   None
192.168.4.117   Not Connected   None
192.168.4.114   Not Connected   None
192.168.4.115   Not Connected   None
192.168.4.118   Not Connected   None
192.168.4.119   Not Connected   None
-----------------
29 rows displayed

Status: Success

PCA>
```

Diagnose Hardware RACK

```
PCA> diagnose hardware rack

Hostname                IP_Address      Last_Seen           Pingable        Status      Type
--------                ----------      ---------           --------        ------      ----
ovcasn01r1              192.168.4.1     02-03-2023 21:09:05 True            OK          zfs
ilom-[redacted]1r1      192.168.4.101   02-03-2023 21:09:05 True            OK          zfs-ilom
ilom-[redacted]2r1      192.168.4.102   02-03-2023 21:09:05 True            OK          zfs-ilom
ilom-[redacted]5r1      192.168.4.103   02-03-2023 21:09:05 True            OK          mn-ilom
ilom-[redacted]6r1      192.168.4.104   02-03-2023 21:09:05 True            OK          mn-ilom
ilom-[redacted]7r1      192.168.4.105   02-03-2023 21:09:05 True            OK          ilom
ilom-[redacted]8r1      192.168.4.106   02-03-2023 21:09:05 True            OK          ilom
ilom-[redacted]9r1      192.168.4.107   02-03-2023 21:09:05 True            OK          ilom
ov[redacted]1           192.168.4.2     02-03-2023 21:09:05 True            OK          zfs
ov[redacted]1           192.168.4.202   02-03-2023 21:09:05 True            OK          cisco_leaf
ov[redacted]1           192.168.4.203   02-03-2023 21:09:05 True            OK          cisco_leaf
ov[redacted]1           192.168.4.204   02-03-2023 21:09:05 True            OK          cisco_spine
ov[redacted]1           192.168.4.205   02-03-2023 21:09:05 True            OK          cisco_spine
ov[redacted]J-Ar1       192.168.4.210   02-03-2023 21:09:05 True            OK          pdu
ov[redacted]J-Br1       192.168.4.211   02-03-2023 21:09:05 True            OK          pdu
ov[redacted]1           192.168.4.230   02-03-2023 21:09:05 True            OK          cisco
ov[redacted]1           192.168.4.3     02-03-2023 21:09:05 True            OK          mn
ov[redacted]1           192.168.4.4     02-03-2023 21:09:05 True            OK          mn
ov[redacted]1           192.168.4.5     02-03-2023 21:09:05 True            OK          cn
ov[redacted]1           192.168.4.6     02-03-2023 21:09:05 True            OK          cn
ov[redacted]1           192.168.4.7     02-03-2023 21:09:05 True            OK          cn
-----------------
21 rows displayed

Status: Success

PCA>
```

Setup Details

```
[root@ov[redacted]rl ~]# fwupdate list all
-------------------------------------------------
SP
-------------------------------------------------
ID        Product Name                  System Firmware Version       ILOM Version                 BIOS/OBP Version                 Fallback Boot Version    XML Support
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
sp        ORACLE SERVER X8-2            -                             v5.1.0.20 r145377            51070400                         -                        N/A

-------------------------------------------------
CONTROLLER
-------------------------------------------------
ID    Type    Manufacturer    Model     Product Name                FW Version      BIOS Version    EFI Version    FCODE Version    Package Version    NVDATA Version    XML Support
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
c0    SAS     LSI Logic       0x00ce    Avago MegaRAID SAS 9361-1 4.740.00-8466   6.36.00.3       06.24.02.05    4.19.08.00       -                  -                 N/A

DISKS
===============
ID        Manufacturer    Model               ATA Model                    Chassis Slot    Type    Media    Size(GiB)    FW Version    ATA FW Ver    XML Support
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
c0d0      SEAGATE         ST1200IN9SUN1.2T    -                            -       0       sas     HDD      1118         ORAB          -             N/A
c0d1      SEAGATE         ST1200IN9SUN1.2T    -                            -       1       sas     HDD      1118         ORAB          -             N/A

-------------------------------------------------
CONTROLLER
-------------------------------------------------
ID    Type    Manufacturer    Model     Product Name                FW Version      BIOS Version    EFI Version    FCODE Version    Package Version    NVDATA Version    XML Support
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
c1    NET     Mellanox        0x1019    Oracle Dual Port 100Gb Ro   -               -               -              -                -                  -                 N/A

-------------------------------------------------
CONTROLLER
-------------------------------------------------
ID    Type    Manufacturer    Model     Product Name                FW Version      BIOS Version    EFI Version    FCODE Version    Package Version    NVDATA Version    XML Support
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
c2    NET     Broadcom        0x16d9    Oracle Dual Port 10Gb/25G   -               -               -              -                20.08.01.17        -                 N/A

-------------------------------------------------
CONTROLLER
-------------------------------------------------
ID    Type    Manufacturer    Model     Product Name                FW Version      BIOS Version    EFI Version    FCODE Version    Package Version    NVDATA Version    XML Support
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
c3    NET     Intel           0x1533    Intel(R) I210 Gigabit Net   -               -                                               80000690           -                 N/A
[root@o[redacted]rl ~]#
```

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