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Networking the Oracle Private Cloud Appliance and Oracle Private Cloud at Customer

A guide to connecting Oracle Private Cloud X8-2 solutions into the datacenter.

PURPOSE STATEMENT

This document provides an overview of features and enhancements included in release Oracle Private Cloud Appliance X8-2 and Oracle Private Cloud at Customer X8-2 Release 2.4.2 . It is intended solely to help you assess the business benefits and plan for the installation of Oracle Private Cloud Release Oracle Private Cloud Appliance X8-2 and Oracle Private Cloud at Customer X8-2 Release 2.4.2 within your I.T. projects.

DISCLAIMER

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INTRODUCTION

The Oracle Private Cloud Appliance (PCA) has emerged as the premier platform for WebLogic, Fusion Middleware and general applications tier software, often in conjunction with Oracle Exadata - the premier database platform. Many of those applications, previously deployed on Oracle Exalogic or commodity x86 servers, are now being deployed on PCA for increased performance, scale, and manageability. This white paper describes the network connectivity of the Oracle PCA, deployment methods and best practices.

ADVANTAGES OF THE PRIVATE CLOUD APPLIANCE

The Oracle Private Cloud Appliance (PCA) is an Oracle Engineered System designed for the application tier. PCA is an integrated hardware and software system that reduces infrastructure complexity and deployment time for virtualized workloads in private clouds. It is a complete platform providing excellent performance and other system properties for a wide range of application types and workloads, with built-in management, compute, storage and networking resources.

The Private Cloud Appliance is also available as the Private Cloud at Customer (PCC), a solution for on-premises private cloud that includes the PCA and Oracle services. Customers acquire PCC on a subscription basis, with Oracle operating the infrastructure so the customer can focus on applications. Except where noted, 'PCA' will be used in this document to describe either form of the product.

The PCA platform is valuable for many application types, endowing benefits to any application tier product. There are several reasons why this is so effective:

- Private Cloud Appliance provides 'quick time to value' for a robust virtualization platform, going from first power-up to operational VMs in a matter of hours. PCA automatically discovers hardware components, configures them to work with one another, reducing design and administrative effort, eliminating potential errors, and speeding time to application deployment. PCA's automated configuration implements Oracle best practices for optimal performance and availability.

- Private Cloud Appliance provides high performance high speed 100Gb Ethernet, a ZS7-2 mid range storage array, and up to 25 Oracle Server X8-2 compute nodes, providing performance and scale improvements over previous product generations. See sections below for further description of the physical infrastructure.

- Private Cloud Appliance design avoids single points of failure on management, network, storage, and compute resource, and permits 'zero-downtime' rolling upgrades to system infrastructure.

- Pre-built Oracle VM virtual appliances and templates quickly stand up application instances. This is complementary to Private Cloud Appliance quickly provisioning physical infrastructure. You can see a list of pre-built virtual appliances at https://www.oracle.com/virtualization/technologies/virtual-appliances.html

- High performance inter-VM networking using the Private Cloud Appliance internal networks permits low-latency, high bandwidth, private communication between VMs in a clustered application. This is especially useful for clustered applications like WebLogic and Coherence, and frameworks like Kubernetes. Multiple private networks can be established using VLANs or custom PCA networks. This provides independent isolated networks, and is ideal for hosting multiple application clusters on the same PCA. Each network carries traffic private to each cluster, without need to prevent IP address collision or data leakage between applications.

- Private Cloud Appliance provides load balancing (Dynamic Resource Scheduling - DRS) and High Availability (HA) features that provide higher performance and automates recovery from outage.

- Private Cloud Appliance can provide Infrastructure as a Service (IaaS) cloud function via Oracle Enterprise Manager 13c.

- Application orchestration and automated workload deployment can be performed with Ansible or the Oracle VM API and scriptable command line interface.

- Customers can use Trusted Partitioning (PCA only) or Hard Partitioning (PCC) to manage software license costs.

Oracle Private Cloud Appliance and Oracle Private Cloud at Customer fully support Oracle Linux Cloud Native Environment, including Oracle Container Runtime for Docker and Oracle Container Services for Use with Kubernetes.

The Private Cloud Appliance includes the following components.

Management nodes

PCA uses two latest generation Oracle Server X8-2 systems as the management nodes for Oracle Private Cloud Appliance X8. They operate in an active-passive cluster for management operations, providing resiliency in case of planned outage or server failure. Oracle VM Manager and other management functions run on the active management node. When a management node assumes the active role, it takes over a virtual IP address (VIP) address, so clients of the management interface don't need to know which management node is currently active.

Integrated ZS7-2 Storage

Oracle Private Cloud Appliance features a fully integrated, enterprise-grade Oracle ZFS Storage Appliance ZS7-2 for centrally storing the management environment, virtual machine images and application data, providing superior performance and efficiency.

With dual ZS7-2 controllers in a high-availability (HA) configuration and one high-capacity DE-24C storage shelf, Oracle Private Cloud Appliance now includes 100 TB of customer usable storage capacity in the rack. This storage can scale to a total of 24 trays, presenting, as of this writing, almost 3.3 PB (useable, 6.7PB raw) using a combination of DE3-24C or all-flash DE3-24P expansion storage trays depending on capacity and performance requirements.

Compute Nodes

Oracle Server X8-2 compute nodes in the Private Cloud Appliance provide the virtualization platform. Compute nodes run Oracle VM Server and provide processing power and memory capacity for virtual machines under Oracle VM Manager's control.

Each X8-2 compute node server has two 24 core Intel Xeon 8260 processors, and can be ordered in three different memory configurations - 384 GB, 768 GB, and 1.5 TB. With a 45% performance improvement over the previous compute node generation, Oracle Server X8-2 provides the optimal balance of CPU cores, memory, and I/O throughput for mission-critical enterprise applications. Customers can scale from 2 to 25 compute nodes in the same rack.

An automated provisioning process orchestrated by the active management node configures compute nodes into the Oracle VM environment. Private Cloud Appliance software installs Oracle VM Server software on each compute node, defines their network configurations, and places all compute nodes into an Oracle VM server pool.

PCA administrators can optionally define "tenant groups", which isolate compute, network, and storage resources in separate Oracle VM server pools that can be assigned to different customers, to provide dedicated resources. PCC administrators can achieve this functionality through the use of 'VM Groups'.

Network Infrastructure

The PCA X8 network is an important differentiator from previous systems. The Private Cloud Appliance relies on "wire once" Software Defined Networking (SDN) that permits multiple isolated virtual networks to be created on the same physical network hardware components. The physical networking consists of a pair of redundant network fabrics, each containing a single Cisco 9336 spine switch with a corresponding Cisco 9336 leaf switch. In addition, there is an administrative network utilizing a single Cisco 9348 switch. None of this switching is managed by or integrated into the customer data center network.

ORACLE PRIVATE CLOUD APPLIANCE NETWORKING

The PCA delivers high performance networking over an internal 100Gb Ethernet network in a leaf and spine 100Gb topology with redundancy to avoid any single point of failure. This network, based upon two pairs of Cisco 9336 100Gb ethernet switches and Oracle Software Defined Networking, provides connectivity at several levels: Private networks for hypervisor storage, heartbeat, and live migration; private internal-only networks for inter-VM connectivity; Public networks for VM connectivity to the data center; and a management network connected to the data center for hypervisor management. In addition, the PCA has a management and maintenance network deployed internally, connecting all of the lights-out management ports (iLOM) of every element of the system: Power Distribution Units, Management Nodes, Compute Nodes, Storage Nodes, and networking switches.

The 100Gb Ethernet network, as stated, is of a spine and leaf topology. Each Compute Node has a connection to both leaf switches. Each leaf, is in turn, connected to the spine switches. Each spine switch has connectivity to the Storage Nodes and the Management nodes, as well as a group of ports for external connectivity. Ports 1-4 are reserved for custom networking requirements specified by the customer, while port 5 is for the default uplink connection. Note: When referring to a port, such as 'Port 5', we are actually referring to both port 5 on the first spine switch located at Rack Unit 22 and the second spine switch, located at Rack Unit 23.

Each of the four customer reserved ports, numbered 1 through 4, may be configured in a number of ways. Each port may be broken down as:

- A single 100Gb Ethernet port.
- A single 40Gb Ethernet port.
- Four 25Gb Ethernet sub ports.
- Four 10Gb Ethernet sub ports.

The default uplink ports, located on Ports 5/1 and 5/2 are configured as 10Gb Ethernet ports and cannot be changed. Ports 5/3 and 5/4 are reserved for future use, and may not be used at this time.

PCA uses redundant physical network hardware components, pre-cabled at the factory, to help ensure continuity of service during maintenance or in case of a failure.

Network connectivity

The Private Cloud Appliance provides external network access for connectivity to a datacenter's networks. The PCA connects to the datacenter network via a pair of next-level switches, also referred to TOR (top of rack) switches. This provides resiliency against a single point of failure. Software Defined Networks (SDN) based on the physical network devices connect virtual machines to networks, storage and other virtual machines, maintaining the traffic separation traditionally provided by hard-wired connections. Optional custom external networks further isolate traffic and maximize bandwidth.

The PCA uses private, "internal" networks that are not exposed to the customer's datacenter network. This provides isolation, security, and the ability to use pre-defined IP address ranges for each networked component without conflict with existing datacenter network addresses. PCA uses internal networks for appliance management, storage access, and inter-VM communication. Every PCA rack component has a predefined IP address. Oracle storage, management and compute nodes have a second IP address for Oracle Integrated Lights Out Manager (ILOM) connectivity.

Compute nodes connect to the internal networks and to the customer datacenter networks. Oracle VM Server on each compute node communicates over Private Cloud Appliance internal networks for management, storage, heartbeat and live migration. By default, compute nodes do not have IP addresses on the customer datacenter network, which increases their isolation and reduces attack surface. Custom networks can be created to give compute nodes IP addresses on the customer network, for additional bandwidth, traffic separation, and to present Ethernet-based storage to each compute node.

A word on internal network addressing

The PCA Installation Guide states the following:

> To avoid network interference and conflicts, you must ensure that the data center network does not overlap with any of the infrastructure networks of the Oracle Private Cloud Appliance internal configuration. These are the subnets and VLANs you should keep clear:
>
> **Subnets:**
>
> 192.168.4.0/24 – internal machine administration network: connects ILOMs and physical hosts
>
> 192.168.32.0/21 – internal management network: traffic between management and compute nodes
>
> 192.168.64.0/21 – underlay network for east/west traffic within the appliance environment
>
> 192.168.72.0/21 – underlay network for north/south traffic, enabling external connectivity
>
> 192.168.40.0/21 – storage network: traffic between the servers and the ZFS storage appliance

Each `/21` subnet comprises the IP ranges of eight `/24` subnets or over 2000 IP addresses. For example: `192.168.32.0/21` corresponds with all IP addresses from `192.168.32.1` to `192.168.39.255`.

In practice, this means that the data center should not utilize any of the aforementioned RFC1918 non-routable addresses (those starting with 192.168 in the above list) for any purpose that the management nodes need to communicate with. These address ranges should not be routed to the PCA (they will be filtered at ingress/egress by the management nodes, as is appropriate per RFC 1918) or leak from the PCA they are internal only. However, if any of these ranges need to be reached on the customer data center network by the PCA, it will be unable to reach them due to specific, pre-configured routing and egress filtering within the PCA. They may, of course, be used in the enterprise data center, but be aware of this limitation.

The Installation Guide goes on to state the same about the following VLANs:

VLANs:

1 – the Cisco default VLAN

3040 – the default service VLAN

3041-3072 – a range of 31 VLANs reserved for customer VM and host networks

3073-3099 – a range reserved for system-level connectivity

Note

VLANs 3090-3093 are already in use for tagged traffic over the `/21` subnets listed above.

3968-4095 – a range reserved for Cisco internal device allocation

These VLANs are not exposed outside of the PCA in any way, however avoiding the use of these VLANs internal to the PCA is strongly advised. The PCA uses a default VPC ID of 1, but this too is unexposed outside of the PCA.

Virtual Machine Networking

Guest virtual machines access the customer datacenter network using the Oracle VM network named "`default_external`", an additional virtual machine network named "`default_internal`" is internal to the Private Cloud Appliance and used for private network traffic between virtual machines. These networks are pre-defined in Oracle VM Manager with the "Virtual Machine" function (also called a "channel") - indicating they are used for guest VM TCP/IP traffic and not cluster management, storage, or live migration. This ensures that guest VMs do not see infrastructure network traffic.

PCA administrators can define VLANs on top of the interfaces used for these networks, to comply with a datacenter's network standards and to permit traffic isolation. For example, a datacenter standard might require VM traffic be on VLANs 100 to 150, and separate networks could be defined with those VLAN tags. Private VLANs can also be built to isolate traffic between different virtual machines.

Additional Networks

The PCA contains a number of additional networks that it may prove useful to understand:

Administration Network

The administration network provides internal access to the management interfaces of all appliance components. These have Ethernet connections to the Cisco Nexus 9348GC-FXP Switch, and all have a predefined IP address in the `192.168.4.0/24` range. In addition, all management and compute nodes have a second IP address in this range, which is used for Oracle Integrated Lights Out Manager (ILOM) connectivity. It is only accessible through physical connections to the administrative switch, and cannot be accessed from the VMs or outside of the PCA by design.

While the appliance is initializing, the data network is not accessible, which means that the internal administration network is temporarily the only way to connect to the system. Therefore, the administrator should connect a workstation to the reserved Ethernet port 48 in the Cisco Nexus 9348GC-FXP Switch, and assign the fixed IP address `192.168.4.254` to the workstation.

From this workstation, the administrator opens a browser connection to the web server on the master management node at `https://192.168.4.216`, in order to monitor the initialization process and perform the initial configuration steps when the appliance is powered on for the first time.

If desired, a bastion host may be placed on the Administration network at the fixed IP address of 192.168.4.199. More detail on this may be found in the Installation and Administration Guides for the PCA.

Management Network

The management network provides outside access to the PCA management interfaces, namely the PCA Dashboard, and the OVM Manager interface. The PCA dashboard is used to set the base system configuration such as IP addresses for the management nodes, the IP addresses for DNS and NTP servers and what VLAN to place the management network on. The PCA dashboard is initially accessed through the Administration Network to perform the initial configuration by Oracle Field Service personnel. Once used to configure the IP addresses on the customer data center network, the dashboard and OVM interface are available through the external facing ports on 5/1 and 5/2 of the spine switches. More on this ahead.

Data Network

The appliance data connectivity is built on redundant Cisco Nexus 9336C-FX2 Switches in a leaf-spine design. In this two-layer design, the leaf switches interconnect the rack hardware components, while the spine switches form the backbone of the network and perform routing tasks. Each leaf switch is connected to all the spine switches, which are also interconnected. The main benefits of this network architecture are extensibility and path optimization. An Oracle Private Cloud Appliance rack contains two leaf and two spine switches.

The Cisco Nexus 9336C-FX2 Switch offers a maximum throughput of 100Gbit per port. The spine switches use 5 interlinks (500Gbit); the leaf switches use 2 interlinks (200Gbit) and 2x2 crosslinks to the spines. Each compute node is connected to both leaf switches in the rack, through the `bond1` interface that consists of two 100Gbit Ethernet ports in link aggregation mode. The two storage controllers are connected to the spine switches using 4x40Gbit connections.

For external connectivity, 5 ports are reserved on each spine switch, four ports are available for custom network configurations; one port is required for the default uplink. This **default external uplink** requires that port 5 on both spine switches is split using a QSFP-to-SFP+ four way splitter or breakout cable. Two of those four 10GbE SFP+ breakout ports per spine switch, ports 5/1 and 5/2, must be connected to a pair of next-level data center switches, also called top-of-rack or ToR switches. Ports 5-3 and 5-4 are reserved for future expansion.

Software Defined Networking

While the physical data network described above allows the data packets to be transferred, the true connectivity is implemented through Software Defined Networking (SDN). Using VxLAN encapsulation and VLAN tagging, thousands of virtual networks can be deployed, providing segregated data exchange. Traffic can be internal between resources within the appliance environment, or external to network storage, applications, or other resources in the data center or on the internet. SDN maintains the traffic separation of hard-wired connections, and adds better performance and dynamic (re-allocation). From the perspective of the customer network, the use of VxLANs in Oracle Private Cloud Appliance is transparent: encapsulation and de-encapsulation take place internally, without modifying inbound or outbound data packets. In other words, this design extends customer networking, tagged or untagged, into the virtualized environment hosted by the appliance.

During the initialization process of the Oracle Private Cloud Appliance, several essential default networks are configured. While these networks are not visible to the administrator or end user, they are detailed here for completeness. Those internally defined networks are:

- The **Internal Storage Network** is a redundant 40Gbit Ethernet connection from the spine switches to the ZFS storage appliance. All four storage controller interfaces are bonded using LACP into one datalink. Management and compute nodes can reach the internal storage over the `192.168.40.0/21` subnet on VLAN 3093. This network also fulfills the heartbeat function for the clustered Oracle VM server pool.

- The **Internal Management Network** provides connectivity between the management nodes and compute nodes in the subnet `192.168.32.0/21` on VLAN 3092. It is used for all network traffic inherent to Oracle VM Manager, Oracle VM Server and the Oracle VM Agents.
- The **Internal Underlay Network** provides the infrastructure layer for data traffic between compute nodes. It uses the subnet `192.168.64.0/21` on VLAN 3091. On top of the internal underlay network, internal VxLAN overlay networks are built to enable virtual machine connectivity where only internal access is required.

One such internal VxLAN is configured in advance: the *default internal VM network*, to which all compute nodes are connected with their `vx2` interface. Untagged traffic is supported by default over this network. Customers can add VLANs of their choice to the Oracle VM network configuration, and define the subnet(s) appropriate for IP address assignment at the virtual machine level.

- The **External Underlay Network** provides the infrastructure layer for data traffic between Oracle Private Cloud Appliance and the data center network. It uses the subnet `192.168.72.0/21` on VLAN 3090. On top of the external underlay network, VxLAN overlay networks with external access are built to enable public connectivity for the physical nodes and all the virtual machines they host.

One such public VxLAN is configured in advance: the `default_external` *network*, to which all compute nodes and management nodes are connected with their `vx13040` interface. Both tagged and untagged traffic are supported by default over this network. Customers can add VLANs of their choice to the Oracle VM network configuration, and define the subnet(s) appropriate for IP address assignment at the virtual machine level.

The `default_external` network also provides access to the management nodes from the data center network and allows the management nodes to run a number of system services. The management node external network settings are configurable through the Network Settings tab in the Oracle Private Cloud Appliance Dashboard. If this network is a VLAN, its ID or tag must be configured in the Network Setup tab of the Dashboard.

For the appliance default networking to be configured successfully, the default external uplink must be in place before the initialization of the appliance begins. At the end of the initialization process, the administrator assigns three reserved IP addresses from the data center (public) network range to the management node cluster of the Oracle Private Cloud Appliance: one for each management node, and an additional Virtual IP shared by the clustered nodes. From this point forward, the Virtual IP is used to connect to the master management node's web server, which hosts both the Oracle Private Cloud Appliance Dashboard and the Oracle VM Manager web interface.

Considering network segregation

The segregation of management network traffic from VM traffic has been a matter of some discussion. While the concept of network segregation by the use of separate physical networks is easily grasped, segregation using VLANs can be more difficult to grasp. The PCA offers both methods in conjunction with each other. Before considering the default ports, let us examine the case of the ports which may be used for expansion, ports 1-4 and their sub-ports.

These 'expansion' port may be used to carry traffic from VMs to the world outside of the PCA. Each port, or port/subport, allocated in pairs, may carry native VLAN traffic or VLAN traffic tagged by the SDN subsystem or Oracle VM. We will look at the creation process in detail later on in this paper.

These ports may also carry 'host network' traffic, used to present storage from storage devices external to the PCA containing iSCSI LUNS or OVM Repositories to the Compute Nodes. The use of host networks is beyond the scope of this document; however, it is detailed in the Installation and Administration Guides for the PCA.

The default configuration of the PCA places both the default networks for VM traffic and PCA Management traffic on the physical ports 5/1 and 5/2 of the two spine switches, with no overlying VLANs to segregate the traffic, as has been previously mentioned. This configuration is almost always certain to function; hence it is the default. However, it is not recommended or best practice due to the   co-mingling of administrative traffic and VM 'user' traffic on the same network, potentially opening up the management channel to attack or other compromise.

These choices present us with six possible scenarios.

1. Ports 5/1 and 5/2 are used for unsegregated VM and Management traffic. No VLANs are assigned to either. **Not Recommended.**
2. Ports 5/1 and 5/2 are used for segregated VM and management traffic by assigning a single VLAN for management traffic through the dashboard. **Recommended**
3. Ports 5/1 and 5/2 are used for segregated VM and management traffic by assigning one or more VLANs for VM client traffic on top of the `default_external` network through OVM Manager. **Recommended**.
4. Ports 5/1 and 5/2 are used for segregated VM and management traffic by assigning both a single VLAN for management traffic through the dashboard and assigning one or more VLANs for VM client traffic on top of the `default_external` network through OVM Manager. **Best Practice.**
5. Ports 5/1 and 5/2 are used for management traffic only without an VLAN. All customer network traffic is through a new custom network, with or without VLANs on a port group residing on one or more of the physical ports 1-4. The default_external network is unused. **Recommended**.
6. Ports 5/1 and 5/2 are used for management traffic only with a VLAN assigned through the dashboard. All customer network traffic is through a new custom network, with or without VLANs on a port group residing on one or more of the physical ports 1-4. The default_external network is unused. **Best Practice.**

## CONNECTING TO THE DATA CENTER NETWORK

As previously stated, at a minimum, the Oracle X8-2 PCA system requires four 10Gb Ethernet connections to the data center network. These four connections deliver the `default_external` and the `default_management` networks to the data center. When designing a PCA implementation, one of the first things to consider is the segregation of the management and VM networks using VLANs. It is best practice, for security purposes, to keep all management traffic separate from the VM networks, though some may choose not to do this due to legacy network architectures.

Physical Connection to the Data Center Network

Typically, the PCA is connected to the data center network using 2 'splitter' cables, each breaking out port 5 into 4 sub ports, 5/1, 5/2, 5/3, and 5/4 on both switch 22 and 23. Ports 5/1 and 5/2 should be connected to the upstream switches. The 40GBase-SR4 transceivers (part number X2124A-N) required for port 5 of each spine switch are included in the bill of materials for the PCA rack.

The upstream connection can be of several configurations, however the two most common are: a pair of upstream TOR switches supporting MLAG between them; or a single upstream TOR switch with 4 ports in a single LAG configuration. See the figure below.
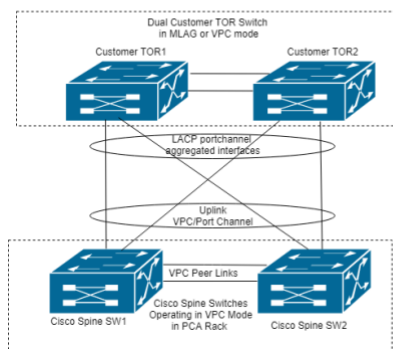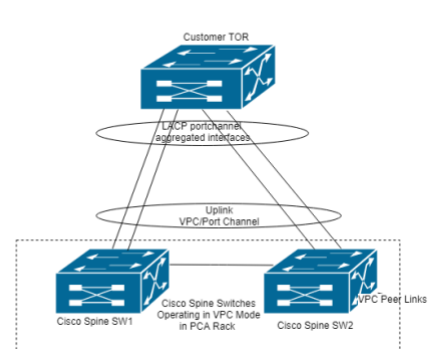
Note that connections upstream are in a Port Channel, or Virtual Port Channel (VPC) configuration, utilize LAG, are cross connected in the case of the 2 TOR switch scenario, and are fixed at 10Gb.

Once connected, a simple 'ping' from a management node should reach the default gateway, and a browser on a system connected to the data center management network should be able to see the PCA dashboard at:

> https://<management-vip-ip>:7002/dashboard

Once management connectivity is verified, OVM Manager, which may be opened at

> https://<management-vip-ip>:7002/ovm/console

can be used to create additional VLAN based networks as required through the 'Networks' tab.

Creating Custom Networks

If additional physical networks are required, they may be built by first connecting to a pair of ports on the spine switches. Ports 1 through 4 are set aside for this purpose. Each of these four ports may be configured to operate in the following subport configurations:

- One 100Gb port (Port N)
- Four 25Gb Ports (Port N / 1-4)
- One 40Gb port (Port N)
- Four 10Gb ports (Port N / 1-4)

When operating at 100Gb or 25Gb, QSFP28 transceivers, such as Oracle Part Number 7119728 QSFP28 short-range transceiver, in conjunction with either a splitter cable (for 25Gb), or an MPO to MPO cable (for 100Gb) such as those listed below in Table 1 are appropriate.

When operating at 40Gb or 10Gb, the X2124A transceiver may be used with the cables listed in Table 1, MPO to MPO for 40Gb and splitter cables for 10Gb.

7102869	Optical cable assembly: 10 meters, MT ferrule terminated, 12-fiber, multimode, MPO connectors
7102870	Optical cable assembly: 20 meters, MT ferrule terminated, 12-fiber, multimode, MPO connectors
7102871	Optical cable assembly: 50 meters, MT ferrule terminated, 12-fiber, multimode, MPO connectors
7119868	Optical cable assembly: 100 meters, 12-fiber, OM4, multimode, MPO connectors
2127A-10M	MPO to 4 LC Optical Splitter Cable 10 meters
2127A-20M	MPO to 4 LC Optical Splitter Cable 20 meters
2127A-50M	MPO to 4 LC Optical Splitter Cable 50 meters

Table 1. 100Gb, 40Gb, 25Gb, and 10Gb Optical Cables

Configuration of the Data Center Switch Ports

Perhaps the most oft asked question when installing a PCA it 'What is the proper configuration of the upstream switches?' Due to the varied nature of data center networks, equipment vendors, and possible configurations required by specific policies and guidelines, this is a difficult question to answer. The uplink port for the PCA Spine switches are configured in **LACP/VPC mode**, i.e for a given **uplink port pair/speed** configuration, we would have a max of **4 physical uplink connectivity** (2 from each spine) towards the customer TOR switch. The following are provided as examples of working upstream network port connections that match up with subports 5/1 and 5/2 on the spine switches, are configured in a LACP/VPC mode, for External Management and default_external VM network connectivity with the following mandatory guidelines:

- The **speeds** supported for uplink port connectivity are **10G, 25G, 40G and 100G. Ports 5/1 and 5/2 must be configured at 10Gb**
- The **max mtu size** is configured for the uplink port configuration is **9216** (for purpose of jumbo frames)

- The PCA spine switches operate in MST (Multiple Instance Spanning Tree) mode, which is backward compatible with other legacy stp such as RSTP, PVST etc.

Cisco UPLINK ToR Configuration

```
interface port-channel221
  switchport mode trunk
  switchport trunk native vlan 313
  spanning-tree port type normal
  no negotiate auto

interface Ethernet1/19
  description "Rack22 9336 RU22 P5"
  channel-group 221 mode active

interface Ethernet1/20
  description "Rack22 9336 RU22 P5"
  channel-group 221 mode active

interface Ethernet1/21
  description "Rack22 9336 RU23 P5"
  channel-group 221 mode active

interface Ethernet1/22
  description "Rack22 9336 RU23 P5"
  channel-group 221 mode active
```

Juniper Uplink ToR Configuration

Below is an example of how the configuration looks for a Juniper TOR Switch connecting to Cisco Spine switches for Uplink Ports 1,2

```
root@myjuniperTOR> show configuration interfaces ae2
native-vlan-id 201;
mtu 9216;
aggregated-ether-options {
    lacp {
        active;
        periodic fast;
    }
}
unit 0 {
    family ethernet-switching {
        interface-mode trunk;
        vlan {
            members [ 201 storage ];
        }
    }
}
```

```
        et-0/0/20 {
                ether-options {
                    802.3ad ae2;
                }
                inactive: unit 0 {
                    family ethernet-switching {
                        vlan {
                            members default;
                        }
                        storm-control default;
                    }
                }
        }
        et-0/0/21 {
                ether-options {
                    802.3ad ae2;
                }
                inactive: unit 0 {
                    family ethernet-switching {
                        vlan {
                            members default;
                        }
                        storm-control default;
                    }
                }
        }
        et-0/0/22 {
                ether-options {
                    802.3ad ae2;
                }
                inactive: unit 0 {
                    family ethernet-switching {
                        vlan {
                            members default;
                        }
                        storm-control default;
                    }
                }
        }
        et-0/0/23 {
                ether-options {
                    802.3ad ae2;
                }
                inactive: unit 0 {
                    family ethernet-switching {
```
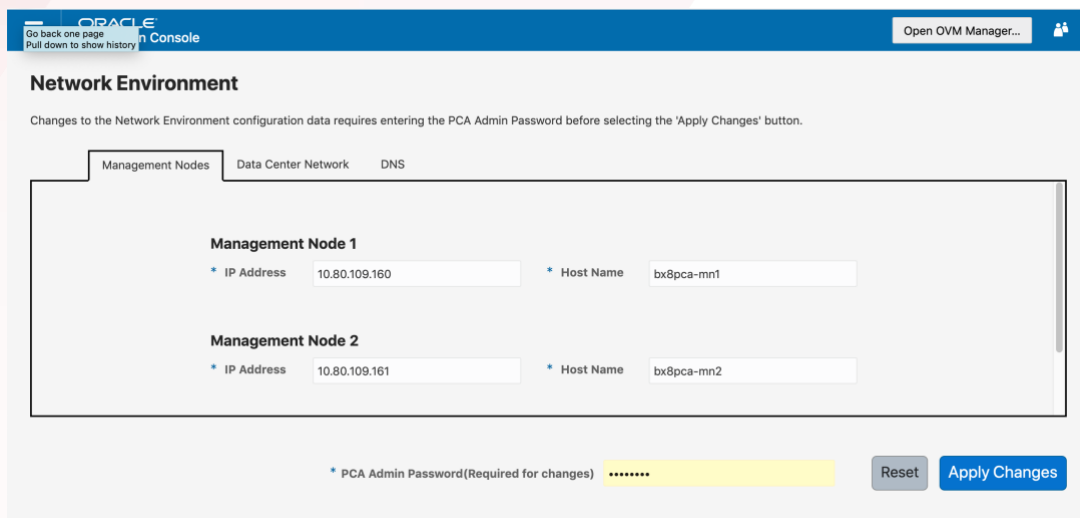
```
                    vlan {
                        members default;
                    }
                    storm-control default;
                }
            }
        }
```

Required Information and Configuring the PCA.

In order to connect to the data center network, the following information will be required:

- IP address and external facing domain name for Management Node 05.
- IP address and external facing domain name for Management Node 06.
- IP address for the floating, or virtual IP, of the management interface.
- The default gateway and subnet mask to be used.
- The DNS domain to be used.
- A VLAN ID, if so chosen, for the management VLAN.
- IP addresses for a minimum of one, preferably two or more DNS servers.
- IP address of an NTP server used by the datacenter.
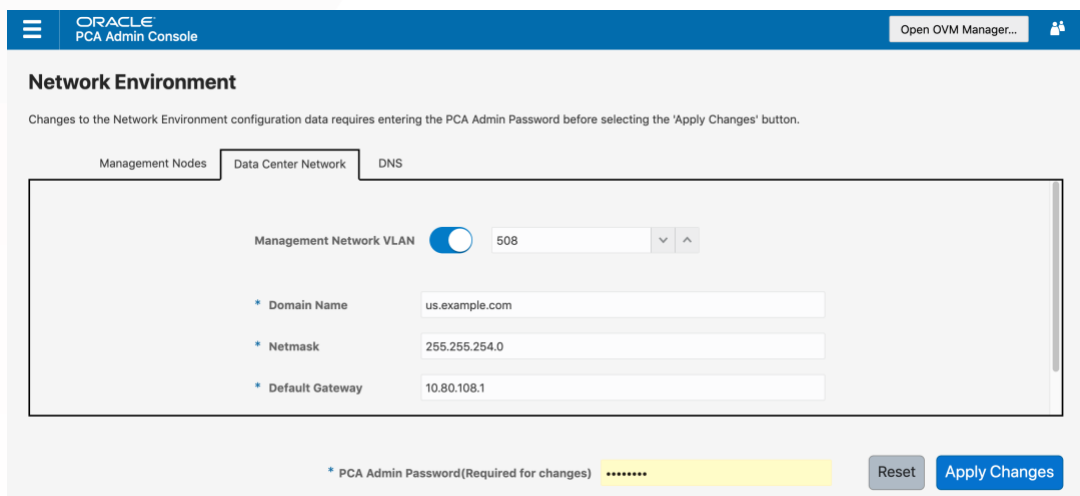
Once this information is gathered and used by the installer to configure the PCA through the PCA dashboard as seen below, the machine may be physically connected to the datacenter network.

The PCA dashboard may also be used if it is necessary to change the networking information at a later time.

CREATING CUSTOM NETWORKS

The PCA can support up to 7 additional custom networks.

The Oracle Private Cloud Appliance controller software allows you to add custom networks at the appliance level. This means that the necessary spine Cisco Nexus 9336C-FX2 Switch ports must be configured and cabled. Other hardware components also require configuration changes to enable the additional connectivity. These networks are then configured automatically in your Oracle VM environment, where they can be used for isolating and optimizing network traffic beyond the capabilities of the default network configuration. All custom networks, both internal and public, are VLAN-capable. The following is taken directly from the PCA 2.4 Administration Guide:

Warning

Custom networks must never be deleted in Oracle VM Manager. Doing so would leave the environment in an error state that is extremely difficult to repair. To avoid downtime and data loss, always perform custom network operations in the Oracle Private Cloud Appliance CLI.

Caution

The following network limitations apply:

- The maximum number of custom external networks is 7 per tenant group or per compute node.
- The maximum number of custom internal networks is 3 per tenant group or per compute node.
- The maximum number of VLANs is 256 per tenant group or per compute node.
- Only one host network can be assigned per tenant group or per compute node.

Caution

When configuring custom networks, make sure that no provisioning operations or virtual machine environment modifications take place. This might lock Oracle VM resources and cause your Oracle Private Cloud Appliance CLI commands to fail.

Creating custom networks requires use of the CLI. The administrator chooses between three types: a network internal to the appliance, a network with external connectivity, or a host network. Custom networks appear automatically in Oracle VM Manager. The internal and external networks take the *virtual machine* network role, while a host network may have the *virtual machine* and *storage* network roles.

The host network is a particular type of external network: its configuration contains additional parameters for subnet and routing. The servers connected to it also receive an IP address in that subnet, and consequently can connect to an external network device. The host network is particularly useful for direct access to storage devices.

For all networks with external connectivity the spine Cisco Nexus 9336C-FX2 Switch ports must be specified so that these are reconfigured to route the external traffic. These ports must be cabled to create the physical uplink to the next-level switches in the data center.

Creating a Custom Network

Using SSH and an account with superuser privileges, log into the active management node.

Note

The default `root` password is *Welcome1*. For security reasons, you must set a new password at your earliest convenience.

```
# ssh root@10.100.1.101
root@10.100.1.101's password:
root@ovcamn05r1 ~]#
```
Launch the Oracle Private Cloud Appliance command line interface.

```
# pca-admin
Welcome to PCA! Release: 2.4.2
```

```
       PCA>
```
If your custom network requires public connectivity, you need to use one or more spine switch ports. Verify the number of ports available and carefully plan your network customizations accordingly. The following example shows how to retrieve that information from your system:

```
    PCA> list network-port

    Port      Switch        Type                    State         Networks
    ----      ------        ----                    -----         --------
    1:1       ovcasw22r1    10G                     down          None
    1:2       ovcasw22r1    10G                     down          None
    1:3       ovcasw22r1    10G                     down          None
    1:4       ovcasw22r1    10G                     down          None
    2         ovcasw22r1    40G                     up            None
    3         ovcasw22r1    auto-speed              down          None
    4         ovcasw22r1    auto-speed              down          None
    5:1       ovcasw22r1    10G                     up            default_external
    5:2       ovcasw22r1    10G                     down          default_external
    5:3       ovcasw22r1    10G                     down          None
    5:4       ovcasw22r1    10G                     down          None
    1:1       ovcasw23r1    10G                     down          None
    1:2       ovcasw23r1    10G                     down          None
    1:3       ovcasw23r1    10G                     down          None
    1:4       ovcasw23r1    10G                     down          None
    2         ovcasw23r1    40G                     up            None
    3         ovcasw23r1    auto-speed              down          None
    4         ovcasw23r1    auto-speed              down          None
    5:1       ovcasw23r1    10G                     up            default_external
    5:2       ovcasw23r1    10G                     down          default_external
    5:3       ovcasw23r1    10G                     down          None
    5:4       ovcasw23r1    10G                     down          None
    -----------------
    22 rows displayed

           Status: Success
```

For a custom network with external connectivity, configure an uplink port group with the uplink ports you wish to use for this traffic. Select the appropriate breakout mode

```
PCA> create uplink-port-group MyUplinkPortGroup '1:1 1:2' 10g-4x
    Status: Success
```
Note

The port arguments are specified as `'x:y'` where `x` is the switch port number and `y` is the number of the breakout port, in case a splitter cable is attached to the switch port. The example above shows how to retrieve that information.

You must set the breakout mode of the uplink port group. When a 4-way breakout cable is used, all four ports must be set to either 10Gbit or 25Gbit. When no breakout cable is used, the port speed for the uplink port group should be either 100Gbit or 40Gbit, depending on connectivity requirements. See the section "create uplink-port-group" for command details.

Network ports cannot be part of more than one network configuration.

Create a new network and select one of these types:

- `rack_internal_network`
- `external_network`
- `host_network`

Use the following syntax:

For an internal-only network, specify a network name.

```
    PCA> create network MyInternalNetwork rack_internal_network
```

```
Status: Success
```

For an external network, specify a network name and the spine switch port group to be configured for external traffic.

```
PCA> create network MyPublicNetwork external_network MyUplinkPortGroupp
Status: Success
```

For a host network, specify a network name, the spine switch ports to be configured for external traffic, the subnet, and optionally the routing configuration.

```
PCA> create network MyHostNetwork host_network MyUplinkPortGroup \
10.10.10 255.255.255.0 10.1.20.0/24 10.10.10.250
Status: Success
```

Note

In this example the additional network and routing arguments for the host network are specified as follows, separated by spaces:

`10.10.10` = subnet prefix

`255.255.255.0` = netmask

`10.1.20.0/24` = route destination (as subnet or IPv4 address)

`10.10.10.250` = route gateway

The subnet prefix and netmask are used to assign IP addresses to servers joining the network. The optional route gateway and destination parameters are used to configure a static route in the server's routing table. The route destination is a single IP address by default, so you must specify a netmask if traffic could be intended for different IP addresses in a subnet.

Note:

PCA does not support host networks smaller than /24.

Caution

Network and routing parameters of a host network *cannot* be modified. To change these settings, delete the custom network and re-create it with updated settings.

Connect the required servers to the new custom network. You must provide the network name and the names of the servers to connect.

```
PCA> add network MyPublicNetwork ovcacn07r1
Status: Success
PCA> add network MyPublicNetwork ovcacn08r1
Status: Success
PCA> add network MyPublicNetwork ovcacn09r1
Status: Success
```

Verify the configuration of the new custom network.

```
PCA> show network MyPublicNetwork

----------------------------------------
Network_Name          MyPublicNetwork
Trunkmode             None
Description           None
Ports                 ['1:1', '1:2']
vNICs                 None
Status                ready
Network_Type          external_network
```

```
Compute_Nodes          ovcacn07r1, ovcacn08r1, ovcacn09r1
Prefix                 None
Netmask                None
Route Destination      None
Route Gateway          None
----------------------------------------

Status: Success
```

As a result of these commands, a VxLAN interface is configured on each of the servers to connect them to the new custom network. These configuration changes are reflected in the **Networking** tab and the **Servers and VMs** tab in Oracle VM Manager.

Note

If the custom network is a host network, the compute node is assigned an IP address based on the prefix and netmask parameters of the network configuration, and the final octet of the compute node's internal management IP address.

For example, if the compute node with internal IP address 192.168.4.9 were connected to the host network used for illustration purposes in this procedure, it would receive the address 10.10.10.9 in the host network.

The figure below shows a custom network named *MyPublicNetwork*, which is VLAN-capable and uses the compute node's `vx13041` interface.
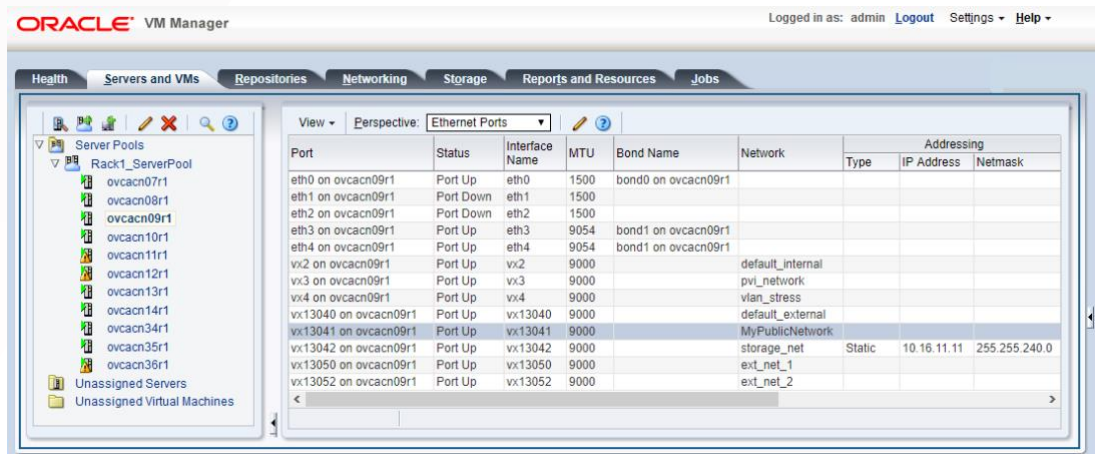
To disconnect servers from the custom network use the *remove network* command.

Warning

Before removing the network connection of a server, make sure that no virtual machines are relying on this network.

When a server is no longer connected to a custom network, make sure that its port configuration is cleaned up in Oracle VM.

```
PCA> remove network MyPublicNetwork ovcacn09r1
************************************************************
 WARNING !!! THIS IS A DESTRUCTIVE OPERATION.
************************************************************
Are you sure [y/N]:y
Status: Success
```

Deleting a Custom Network

Caution

Before deleting a custom network, make sure that all servers have been disconnected from it first.

Using SSH and an account with superuser privileges, log into the active management node.

Note

The default root password is *Welcome1*. For security reasons, you must set a new password at your earliest convenience.

```
# ssh root@10.100.1.101
root@10.100.1.101's password:
root@ovcamn05r1 ~]#
```

Launch the Oracle Private Cloud Appliance command line interface.

```
# pca-admin
Welcome to PCA! Release: 2.4.2
PCA>
```

Verify that all servers have been disconnected from the custom network. No vNICs or nodes should appear in the network configuration.

Caution

Related configuration changes in Oracle VM must be cleaned up as well.

```
PCA> show network MyPublicNetwork

----------------------------------------
Network_Name        MyPublicNetwork
Trunkmode           None
Description         None
Ports               ['1:1', '1:2']
vNICs               None
Status              ready
Network_Type        external_network
Compute_Nodes       None
Prefix              None
Netmask             None
Route_Destination   None
Route_Gateway       None
----------------------------------------
```

Delete the custom network.

```
PCA> delete network MyPublicNetwork
***********************************************************
 WARNING !!! THIS IS A DESTRUCTIVE OPERATION.
***********************************************************
Are you sure [y/N]:y
Status: Success
```

Caution

If a custom network is left in an invalid or error state, and the delete command fails, you may use the --force option and retry.

CREATING OVM NETWORKS

The PCA software defined networking architecture within Oracle VM allows the use of VLANs to layer many logical networks on top of the custom networks. The following is taken from the OVM Manager 3.4 documentation.

When creating VLAN based networks in OVM, the first step is to create VLAN interfaces on the underlying custom networks, then to create the networks utilizing those VNICs. The following sections detail those processes.

Creating and Managing VLAN Interfaces

The **VLAN Interfaces** tab allows you to define and manage VLAN interfaces on the Compute Nodes inside your PCA. If your data center network is configured to support VLANs, you should define interfaces for your different VLAN IDs on each of your compute nodes, so that you are able to define Oracle VM networks that take advantage of VLAN separation.

The **VLAN Interfaces** tab is divided into two sections, a Navigation Pane and a Management Pane displaying a tabular view of the VLAN Interfaces associated with the item selected in the navigation pane.

Navigation Pane

The Navigation Pane displayed on the **VLAN Interfaces** tab is used to control the VLAN interfaces that are displayed in the Management Pane. The Navigation Pane presents a tree view of the compute nodes that have been discovered within your environment. Compute Nodes are grouped by **Server Pools** or are automatically presented beneath the node titled **Unassigned Servers**.

Expanding the **Server Pools** node, allows you to see each of the server pools configured within your environment. Selecting a particular server pool from the list presented, updates the Management Pane to show only the VLAN interfaces configured for that server pool.

Clicking on the **Unassigned Servers** node is equivalent to selecting an individual server pool. The Management Pane is updated to show only the VLAN interfaces configured for servers that do not belong to a server pool.

Both the **Unassigned Servers** node and any of the server pool nodes can be further expanded to list the servers that belong to these nodes. The VLAN interfaces displayed in the Management Pane can be further limited to each individual server listed.

Finally, you are able to expand server nodes to list the ports or bonds that are available for each server. By selecting a particular port for any server in the Navigation Pane, the list of VLAN interfaces presented in the Management Pane is limited to those interfaces configured for that specific port or bond.

Management Pane

The Management Pane on the **VLAN Interface** tab allows you to create, edit or delete VLAN interfaces configured within Oracle VM Manager. VLAN interfaces are listed in a tabular view that includes a toolbar providing options to manage interfaces. The VLAN Interfaces that are displayed in the table at any point in time are controlled using the Navigation Pane.

The **VLAN Interface** tab includes a toolbar in the management pane that consists of the following options:

VLAN Interface Subtab Toolbar Icon Options

Toolbar Icon Option	Icon	Description
Create VLAN Interface...	➕	Displays the **Create VLAN Interface(s)** dialog box. Use this option to create a new VLAN Interface within Oracle VM Manager.
Edit Selected VLAN Interface...	✏️	Displays the **Edit VLAN Interface(s)** dialog box. Use this option to change the description, MTU settings or IP address assignment options for an existing VLAN Interface.
Delete Selected VLAN Interface	❌	Displays the **Delete Confirmation** dialog box. Use this option to delete the selected VLAN Interface.
Help	❓	Displays context sensitive help.

The table view in the **VLAN Interface** subtab includes the following fields:

- **Name:** The name of the VLAN interface as defined in Oracle VM Manager.
- **VLAN ID:** The VLAN ID that is assigned to the VLAN interface.
- **Server Pool:** The server pool where this VLAN interface is located (if any).
- **Server:** The server where the VLAN interface is located.
- **Port:** The network port on which the VLAN interface is assigned.
- **MTU:** The MTU value for the VLAN interface.
- **Network:** The network that the VLAN interface is attached to (if any).
- **Addressing:** A grouping of fields to display IP address assignment.
    - **Type:** Describes the network address assignment type (either Static, Dynamic or blank if None).
    - **IP Address:** The IP address allocated to the VLAN interface (if any).
    - **Netmask:** The netmask applied to the VLAN interface (if any).
- **Description:** The description of the VLAN interface as defined in Oracle VM Manager.

Create VLAN Interfaces

The PCA environment is configured to use only VLANs, so you will need to configure VLAN interfaces within Oracle VM Manager before you are able to use them within a network configuration.

To Create A VLAN Interface

1. On the **Networking** tab, click the **VLAN Interfaces** subtab link.

2. Click the ✚ **Create VLAN Interface** icon in the toolbar.

3. The **Create VLAN Interface(s)** dialog is displayed.

4. A navigation tree similar to the one shown in the Navigation Pane is displayed in the pane on the right of the dialog. Use the navigation tree to identify server ports or bonds that are configured for your VLANs. You are able to expand nodes in the navigation tree to identify individual servers, and then expand each server to identify the ports that are available. Alongside each port, listed for a server, is a check box that allows you to enable the port to configure VLAN interfaces that are attached to it. You must select at least one port. Be careful not to select a port that is already in use or which is part of a bond. The user interface does not filter the ports to allow you to only select unused ports.

5. Once you have selected the ports for which you wish to create VLAN interfaces, you can click **Next** to continue to the next stage of the wizard, or click **Cancel** to exit the wizard without making any changes.

6. The **Select VLAN IDs** stage is displayed in the wizard. In the panel on the right, you are able to select a VLAN ID range. Using the two fields available you can specify a range of VLAN IDs that are configured on the network ports for which you are creating VLAN interfaces. Use the Add, Delete and Delete All buttons to manage the VLAN IDs for which VLAN interfaces should be created. A VLAN interface is created for each VLAN ID specified in the list provided here. You must select at least one VLAN ID.

7. When you have finished selecting VLAN IDs, you can click **Next** to continue to the next stage of the wizard, or click **Cancel** to exit the wizard without making any changes.

8. The **Configure IP Address** stage is displayed in the wizard. On the panel on the right, a table is presented listing each of the VLAN interfaces that have been created. For each VLAN interface listed, you are able to edit the MTU setting, the IP Address assignment settings and the description. The **Addressing** field provides a drop-down selector that allows you to choose either None, Static or Dynamic to specify how IP Addressing should be configured on this interface. If you select Static here, the IP Address and Mask fields become available to edit, otherwise they remain uneditable.

A **Filter By VLAN ID** drop-down selector is provided at the top of the table, to allow you to quickly limit the VLAN interfaces displayed in the table to make changes in a more orderly fashion.

9. Click **Finish** when you have finished editing VLAN interfaces to save the changes, or click **Cancel** to exit.

Edit VLAN Interfaces

To Edit A VLAN Interface

1. On the **Networking** tab, click the **VLAN Interfaces** subtab link.
2. Use the navigation pane to locate filter the list of VLAN interfaces displayed in the management pane.
3. Select the VLAN interface that you wish to edit from the interfaces listed in the management pane.
4. Click the ✏️ **Edit VLAN Interface** icon in the toolbar.
5. The **Edit VLAN Interface(s)** dialog is displayed.
6. For each VLAN interface listed, you are able to edit the MTU setting, the IP Address assignment settings and the description. The **Addressing** field provides a drop-down selector that allows you to choose either None, Static or Dynamic to specify how IP Addressing should be configured on this interface. If you select Static here, the IP Address and Mask fields become available to edit, otherwise they remain uneditable.
7. Click **OK** when you have finished editing VLAN interfaces to save the changes, or click **Cancel** to exit.

Delete VLAN Interfaces

To Delete A VLAN Interface

1. On the **Networking** tab, click the **VLAN Interfaces** subtab link.
2. Use the navigation pane to locate filter the list of VLAN interfaces displayed in the management pane.
3. Select the VLAN interfaces that you wish to remove from Oracle VM Manager from the interfaces listed in the management pane.
4. Click the ❌ **Delete VLAN Interface(s)** icon at the top of the table displayed in the management pane.
5. The **Delete Confirmation** dialog box is displayed. Click **OK** to delete the VLAN interface from Oracle VM Manager.

Creating and Managing Networks

Begin by opening the Oracle VM Manager for your PCA in a browser and navigating to the Networks subtab to add, edit and delete networks. This presents a tabular view of the networks that are currently configured within the Oracle VM environment. Configuration options can be accessed using the toolbar at the top of the tab.

The toolbar at the top of the tab consists of the following options:

Networks Subtab Toolbar Icon Options

Toolbar Icon Option	Icon	Description
Create New Network...	➕	Displays the **Create Network** dialog box. Use this option to create a new network within Oracle VM Manager.
Edit Selected Network...	✏️	Displays the **Edit Network** dialog box. Use this option to change the network configuration for an existing network.
Delete Selected Network	❌	Displays the **Delete Confirmation** dialog box. Use this option to delete the selected network.

The table view in the **Networks** subtab includes the following fields:

- **ID:** The UUID for the network.
- **Name:** The name defined for the network within Oracle VM Manager.
- **Intra-Network Server:** The name of the server on which a local network is defined, if the network is of this type.
- **Network Channels:** A grouping of the different network channels or roles that a network may support.
- **Server Management:** A check box item to indicate whether or not the network is a member of the Server Management channel.
- **Cluster Heartbeat:** A check box item to indicate whether or not the network is a member of the Cluster Heartbeat channel.
- **Live Migrate:** A check box item to indicate whether or not the network is a member of the Live Migrate channel.
- **Storage:** A check box item to indicate whether or not the network is a member of the Storage channel.
- **Virtual Machine:** A check box item to indicate whether or not the network is a member of the Virtual Machine channel.
- **Description**: A field to present the text description defined for the network within Oracle VM Manager.

Caution

Note that in PCA, we only edit or add networks of type Virtual Macine. All others are pre-defined and should never be changed.

To create a new Network

1. On the **Networking** tab, click the **Networks** subtab.

2. Click the **Create New Network** icon   . A dialog is displayed, choose the following option:
   - **Create a Network with Ports/Bond Ports/VLAN Interfaces:** Use this option to create a normal network that makes use of physical ports, bond ports or VLAN Interfaces defined on your servers.

Note

If you have not already defined any VLAN interfaces as described in "VLAN Interfaces", you are unable to add any VLAN interfaces to the network. In other words, you must define your VLAN interfaces on the VLAN Interfaces subtab before attempting to add any VLAN interfaces to a network.

3. Click **Next** and select: **Create a Network with Ports/Bond Ports/VLAN Interfaces**

Create a Network with Ports/Bond Ports/VLAN Interfaces

1. After you select a network configuration, the **Create Network** wizard displays the following fields to configure your network:
   - **Name:** The name of the network in Oracle VM Manager.
   - **Description:** Optional information you would like to add about this network.
   - **Network Uses:** A set of check boxes that allow you to define the various network roles or channels that are enabled on the network.
     - o **Management:** Used to manage the physical Oracle VM Servers in a server pool, for example, to update the Oracle VM Agent on the different Oracle VM Servers. This network function is assigned to at least one network by default.
     - o **Live_Migrate:** Used to migrate virtual machines from one Oracle VM Server to another in a server pool, without changing the status of the virtual machine.
     - o **Cluster_Heartbeat:** Used to verify if the Oracle VM Servers in a clustered server pool are up and running.
     - o **Virtual_Machine:** Used for the network traffic between the different virtual machines in a server pool.

o   **Storage:** Enables you to associate specific networks with storage use.

Warning:

The only network type valid for creation in PCA is the **Virtual Machine** type. .Do not attempt to create any other type of network.

Click **Next** to continue to the next stage of the wizard, or click **Cancel** to exit the wizard without making any changes.

2.   The **Select Ports** stage of the wizard is displayed. This dialog allows you to define which ports or bonds on each Oracle VM Server are attached to the network and presents a tabular view of ports and bonds that are attached to the network.

Warning:

PCA networks should **only** contain VLAN interfaces, there is no requirement for you to add any network ports to the network in this dialog. You are able to add VLAN interfaces to the network in the next stage of the wizard.

At the top of the table is a toolbar containing options to:

➕Add New Ports, 🖉 Edit Port(s), or ❌Delete Port(s).

Select Add A Port To The Network

1.   Click the   ➕   **Add New Ports** icon at the top of the table.
2.   The **Add Ports to Network** dialog is displayed.
3.   PCA does not use the underlying physical ports for virtual networking. **DO NOT** add networks to physical ports.
4.   Click **Next** to continue to the next stage of the wizard. Note that your network on PCA should only contain VLAN interfaces, therefore there is no requirement for you to add any network ports to the network in this dialog, as you are able to add VLAN interfaces to the network in the next stage of the wizard.

3.   The **Select VLAN Interfaces** stage of the wizard is displayed. This dialog allows you to define which VLAN interfaces on each Compute Node are attached to the network and presents a tabular view of VLAN interfaces that are attached to the network. **Note that in order to add a VLAN interface to a network it must have been defined prior to starting this wizard, as described in "VLAN Interfaces".**

At the top of the table is a toolbar containing options to:

➕Add VLAN Interfaces, 🖉 Edit VLAN Interface(s), or ❌Delete VLAN Interface(s).

4.   Click the   ➕   **Add VLAN Interfaces** icon in the toolbar.
5.   The **Add VLAN Interfaces to Network** dialog is displayed. In the panel on the left, you are able to expand nodes showing servers assigned to different server pools, or unassigned servers. By clicking on the different nodes in this panel, you are able to update the tabular view of the different available VLAN interfaces on the right.

If you have not already defined any VLAN interfaces as described in "VLAN Interfaces", no VLAN interfaces are displayed in this view and you are unable to add any VLAN interfaces to the network. In other words, you must define your VLAN interfaces on the VLAN Interfaces subtab, before attempting to add any VLAN interfaces to a network.

    a. Identify the VLAN interfaces that you wish to add to the network and check the check box alongside them.
    b. Click **OK** to add the selected VLAN interfaces to the network, or click **Cancel** to exit without making any changes.

To Edit A VLAN Interface Within The Network

    c. Select the VLAN interface that you wish to edit within the network.
    d. Click the ✎ **Edit VLAN Interface(s)** icon in the toolbar.
    e. The **Edit VLAN Interface(s)** dialog is displayed.
    f. For each VLAN interface listed, you are able to edit the MTU setting, and the IP Address assignment settings.
    g. Click **OK** when you have finished editing VLAN interfaces to save the changes, or click **Cancel** to exit.

To Delete A VLAN Interface From The Network

    h. Select the VLAN interfaces that you wish to remove from the network.
    i. Click the ❌**Delete VLAN Interface(s)** icon.
    j. The **Delete Confirmation** dialog box is displayed. Click **OK** to delete the VLAN interface from the network.

When you have finished adding any VLAN interfaces to the network, you are able to click **Finish** to save the new network configuration. Alternatively, you can click **Cancel** to exit the wizard without saving the network changes. Note that if you edited the configuration for a Port, Bond or VLAN interface in any of the sub-wizards, these changes have already been affected.

Edit Existing Network

It is possible to edit the configuration for an existing network. The steps and options to do so are described below.

To edit the configuration for an existing network:

1. On the **Networking** tab, click the **Networks** subtab link and select the network that you wish to edit.
2. Click the ✎ **Edit Network** icon in the toolbar.
3. A dialog opens to allow you to reconfigure the network. The dialog has three separate tabs:
   - **Configuration:**: A tab containing a form allowing you to edit the following information:
     - o **Name:** The name of the network in Oracle VM Manager.
     - o **Description:** Optional information you would like to add about this network.
     - o **Network Uses:** A set of check boxes that allow you to define the various network roles or channels that are enabled on the network.

Note

If the network is used by many servers, modifying this parameter may cause the edit operation to take several minutes to complete.

- **Management:** Used to manage the physical Oracle VM Servers in a server pool, for example, to update the Oracle VM Agent on the different Oracle VM Servers. This network function is assigned to at least one network by default.
- **Live_Migrate:** Used to migrate virtual machines from one Oracle VM Server to another in a server pool, without changing the status of the virtual machine.
- **Cluster_Heartbeat:** Used to verify if the Oracle VM Servers in a clustered server pool are up and running.
- **Virtual_Machine:** Used for the network traffic between the different virtual machines in a server pool.
- **Storage:** Reserved for future use and currently has no practical function or application.

Warning:

The only network type valid for creation in PCA is the **Virtual Machine** type. **Do not** attempt to create any other type of network.

- **Ports:** A tab allowing you to manage which ports or bonds on each Oracle VM Server are attached to the network. This feature is not used on PCA. Do not edit or add physical ports to networks.

- **VLAN Interfaces:** A tab allowing you to manage which VLAN interfaces are attached to the network. This tab contains a tabular view of VLAN interfaces that are already attached to the network. At the top of the table is a toolbar containing options :

 Add VLAN Interfaces, Edit VLAN Interface(s), or Delete VLAN Interface(s).

To Add A VLAN Interface To The Network

a. Click the **Add VLAN Interfaces** icon in the toolbar.
b. The **Add VLAN Interfaces to Network** dialog is displayed. In the panel on the left, you are able to expand nodes showing servers assigned to different server pools, or unassigned servers. By clicking on the different nodes in this panel, you are able to update the tabular view of the different available VLAN interfaces on the right.

Note:

If you have not already defined any VLAN interfaces as described in "VLAN Interfaces", no VLAN interfaces are displayed in this view and you are unable to add any VLAN interfaces to the network. In other words, you must define your VLAN interfaces on the VLAN Interfaces subtab, before attempting to add any VLAN interfaces to a network.

c. Identify the VLAN interfaces that you wish to add to the network and check the check box alongside them.

d.   Click **OK** to add the selected VLAN interfaces to the network, or click **Cancel** to exit without making any changes.

To Edit A VLAN Interface Within The Network

e.   Select the VLAN interface that you wish to edit within the network.

f.   Click the ✏️ **Edit VLAN Interface(s)** icon in the toolbar.
g.   The **Edit VLAN Interface(s)** dialog is displayed.
h.   For each VLAN interface listed, you are able to edit the MTU setting, and the IP Address assignment settings.
i.   Click **OK** when you have finished editing VLAN interfaces to save the changes, or click **Cancel** to exit.

To Delete A VLAN Interface From The Network

j.   Select the VLAN interfaces that you wish to remove from the network.

k.   Click the ❌**Delete VLAN Interface(s)** icon.
l.   The **Delete Confirmation** dialog box is displayed. Click **OK** to delete the VLAN interface from the network.
When you have finished editing the network, click **OK** to save the changes, or **Cancel** to exit out of the dialog without saving any changes.

Delete Existing Network

It is possible to delete a network. The steps and options to do so are described below.

To delete a network:

1.   On the **Networking** tab, click the **Networks** subtab link and select the network that you wish to delete.
2.   Click the ❌**Delete Network** icon in the toolbar.
3.   The **Delete Confirmation** dialog box is displayed. Click **OK** to delete the network.

BEST PRACTICES FOR PCA NETWORKING

The following summarizes PCA Networking Best Practices:

- Keep software levels up to date with current versions, to close security exposures and avoid prevent experiencing of fixed bugs.

- Install the Oracle VM Guest Additions to improve operational flexibility and to assist in tracking networking information within the VMs themselves. The Guest Additions are described at https://docs.oracle.com/cd/E64076_01/E64083/html/vmadm-guestadd.html

- Segregate VM traffic from PCA Management traffic using VLANs assigned to the VM traffic and the Management Network.

- Consider the use of a bastion host to connect the administrative network of the PCA to the administration and/or maintenance network of the data center for out of band access to the PCA if required. Do not, however, connect the administration network to any data center network.

- Use PCA internal networks for inter-VM communication. This provides better performance and isolation. Use different VLANs for independent applications so they can operate without interference or the need to coordinate network design.

- All network traffic placed on a network with external connections, either the `default_external` network, a custom external network, or VLANs on top of either of those, will exit the PCA. If that traffic was intended for another VM within the PCA, the external switch will simply return it to the PCA, an unnecessary use of external facing bandwidth. Use the `default_internal` network instead.

- Consider the implementation of Dynamic Resource Scheduler (DRS) policies not only on CPU utilization of your PCA Compute Nodes, but on networking thresholds to migrate VMs to Compute Nodes with lower network utilization and more available bandwidth.

- The 100Gb Ethernet networks on PCA provide substantially higher performance for applications with high network traffic between members of an application cluster. Isolate networks and traffic to as few compute nodes as possible to preserve backplane bandwidth.

- Use VLAN based networks on top of the `default_external`, `default_internal`, or custom external networks.

- The PCA provides you with up to 256 VLANs per Tenant Group (PCA) or VM Zone (PCC). This can allow for highly complex networking configurations which can lead to complex routing and debugging. Simplify wherever possible, but make no simpler than necessary.

- VLANs and custom internal/external networks make it possible to internalize functions such as load balancers and firewall previously principally implemented as black box physical appliances. By utilizing VMs as firewalls, load balancers, and even routers, (All functions which can be implemented in a simple Oracle Linux VM or using third party virtual appliances) significant cost reductions can be realized.

- Applications and VMs with high or dedicated bandwidth requirements to other VMs and associated applications should be considered candidate for dedicated intra-VM VLANs.

- For highly secure point to point intra-VM traffic use a VLAN with only the required endpoint VMs on it. A single application VM to database VM connection is but one example.

- Applications with high message traffic to external hosts benefit from the faster external connectivity PCA has to datacenter networks. PCA network connections can be 100, 40, 25 or 10 Gb Ethernet, and can use LACP for load balancing. If throughput between PCA and other hosts is a gating factor for performance, PCA provides the opportunity for custom networks that may be dedicated to a single network or group of VLANs. Possible uses include dedicated connectivity to database servers like Exadata, to backup and restore traffic, to external firewalls or load balancers.

Restrictions

- Oracle QSFP+ transceivers must be used in port 5.
- Oracle transceivers and cables should be used unless there is a requirement to support media other than multi-mode fiber. For connections to other media (for example, single mode fiber), Cisco transceivers which are supported by Cisco in the Nexus 9336 can be used in ports 1 – 4 of the spine switches.
- The customer cannot change any settings on the switches
- ACS must be engaged to configure the custom networks.

This paper has described best practices for applications networking the Oracle Private Cloud Appliance. While these are best practices gathered from years of experience with the PCA, they may not apply in all situations, when in doubt, consult with your Oracle Systems Engineer or Advanced Customer Services for additional information.

CONCLUSION

The Oracle Private Cloud Appliance has become the ideal platform to host applications which formerly were targeted for Exalogic and commodity servers. This paper describes the advantages of PCA and techniques to migrate applications from earlier platforms to PCA.