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Oracle Private Cloud Appliance X9-2 – Maximizing Availability

PCA X9-2 availability features and best practices

May 6, 2022 | Version 1.02

PURPOSE STATEMENT

This document describes availability features in Oracle Private Cloud Appliance (PCA) with software release ance (PCA) with software release and describes best practices for using them.

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TABLE OF CONTENTS

INTRODUCTION

This Technical Brief describes availability features and provides best practices and guidance for improving availability and resiliency on Oracle Private Cloud Appliance X9-2 (abbreviated to "PCA" in this document except when making distinction with previous PCA versions).

Oracle Private Cloud Appliance (PCA) X9-2 is the next-generation Oracle Engineered System optimized for mission-critical applications and middleware. This article describes the platform and describes how to plan and administer for availability.

PCA X9-2 is the latest member of the Oracle Price Cloud Appliance product family. PCA provides cloud and administrative services for general purpose IaaS (Infrastructure as a Service) for a broad range of workloads including modernized Cloud Native applications. It provides an excellent foundation to layer PaaS (Platform as a Service) and SaaS (Software as a Service) solutions on top of the infrastructure. Under the covers, it makes use of modern micro-services architecture, Kubernetes and related technologies, for a refreshed future-proofed software stack.

The key new feature of PCA X9-2 compared to previous PCA versions is that it delivers private cloud infrastructure and architecture consistent with Oracle Cloud Infrastructure (OCI). Core IaaS services use the same APIs, methods, tools and interfaces familiar to OCI users. This is delivered on a modernized infrastructure, capable of high levels of scale and performance.

The Oracle Private Cloud Appliance X9-2 (PCA) is an engineered system designed to deliver a comprehensive suite of cloud infrastructure services on a robust and scalable platform. PCA, a flexible IaaS (Infrastructure as a Service) solution, supports a broad variety of workloads. It provides an excellent foundation to layer PaaS (Platform as a Service) and SaaS (Software as a Service) solutions on top of the infrastructure.

This technical brief describes PCA X9-2 features for availability, and explains how to plan and administer to provide resilience and availability.

PCA DEFINITIONS AND FEATURES FOR RESILIENCY AND AVAILABILITY

Oracle Private Cloud Appliance complies with the highest business continuity and serviceability requirements. It has capabilities to monitor all components, detect or even predict potential problems, send out alerts, and automatically log service requests with detailed support data included. Subsequent troubleshooting and repair can be performed without affecting the uptime of the environment.

System upgrades are designed for minimum disruption and maximum availability. Health checks are performed before an upgrade to ensure that all components are in an acceptable state. The upgrade process is modular and allows components – such as firmware, operating systems, containerized services or the system's main database – to be upgraded individually or as an integrated multi-component workflow.

The architecture of Oracle Private Cloud Appliance uses a layered approach. At the foundation are the hardware components on which the core platform is built. This, in turn, provides a framework for administrative and operational services exposed to different user groups. The layers are integrated but not monolithic: they can be further developed at different rates as long as they maintain compatibility. For instance, supporting a new type of server hardware or extending storage functionality are enhancements that can be applied separately, and without redeploying the entire controller software stack.

Hardware resiliency

From the hardware perspective, a PCA system is based on the following physical system components:

- Three management nodes form a cluster that runs the base environment for the controller software.
- Compute nodes provide the processing capacity to host compute instances (virtual machines).
- A clustered Oracle ZFS Storage Appliance ZS-9 provides disk space for storage resources used by compute instances. It also provides the storage space required by the appliance for its operation.
- Network switches provide the physical connections between all components and the uplinks to the public (datacenter) network.

These hardware components may reside in one or more server racks depending on the compute and storage capacity obtained. All use redundant configurations to withstand individual component failures. For example, the management servers are deployed as a 3-way cluster, and the storage appliance uses clustered storage heads and ZFS RAID technology to detect and even correct data errors on disk. PCA automates recovery from management node, storage and network errors.

The PCA rack configuration contains redundant networking, storage and server components to ensure that failure of any single element does not affect overall system availability.

Data connectivity throughout the system is built on redundant pairs of leaf and spine switches. Link aggregation is configured on all interfaces: switch ports, host NICs and uplinks. The leaf switches interconnect the rack components using cross-cabling to redundant network interfaces in each component. Each leaf switch also has a connection to each of the spine switches, which are also interconnected. The spine switches form the backbone of the network and enable traffic external to the rack. Their uplinks to the data center network consist of two cable pairs, which are cross-connected to two redundant ToR (top-of-rack) switches.

The management cluster, which runs the controller software and system-level services, consists of three fully active management nodes. Inbound requests pass through the virtual IP of the management node cluster, and are distributed across the three nodes by a load balancer. If one of the nodes stops responding and fences from the cluster, the load balancer continues to send traffic to the two remaining nodes until the failing node is healthy again and rejoins the cluster.

Storage for the system as well as for the cloud resources in the environment is provided by the internal ZFS Storage Appliance. Its two controllers form an active-active cluster, providing high availability and excellent throughput at the same time. The ZFS pools are built on physical hard disks in a mirrored configuration with automatic sparing and error detection and correction for optimal data protection.

Architectural resiliency

The Oracle Private Cloud Appliance aligns with Oracle Cloud Infrastructure (OCI) architecture which includes the concept of an Availability Domain (AD). Every Oracle Private Cloud Appliance is an Availability Domain (AD), which consists of one or more server racks, independently managed from other PCA systems.

A Fault Domain is a grouping of infrastructure components within an Availability Domain. A PCA, and therefore an Availability Domain, contains three Fault Domains, each consisting of one or more physical compute nodes. Compute nodes are evenly distributed over the three Fault Domains.

Fault Domains are used to isolate downtime events due to failures or maintenance, and to ensure that resources in other Fault Domains are not affected. Fault domains provide anti-affinity, which lets you distribute your instances so that they are not on the same physical hardware. A hardware failure or compute hardware maintenance event that affects one fault domain does not affect instances in other fault domains.

Use fault domains to do the following things:

- Protect against unexpected hardware or software failures.
- Avoid need for service outages during hardware maintenance.

By properly leveraging fault domains, you can increase the availability of applications running on PCA. Your application's architecture determines whether you should separate or group instances using fault domain: Distribute clustered applications over fault domains to ensure the application can continue to run even if a fault domain has an outage. Group instances in a non-clustered application into a fault domain to reduce the number of fault domains that can cause an application outage. For example, if you have an application consisting of web server, app server and database server instances, place all of them in the same fault domain to reduce their exposure.

PCA also aligns with OCI's logical partitioning: PCA contains a *Compute Enclave*, which comprises the resources where cloud workload instances run, in particular the compute nodes assigned to the Fault Domains. This is logically isolated from the *Service Enclav*e, where the appliance infrastructure is controlled. This provides isolation between services provided by PCA and the workload executing on it.

The Service Enclave uses three management nodes arranged in a cluster to provide automatic resiliency for services if a hardware failure occurs. The Compute Enclave consists of multiple compute nodes, distributed across the three fault Domains. The Compute Enclave contains one or more *tenancies*, which are securely isolated from each other by means of tunneling and encapsulation in the appliance network. Tenancies are hosted on the same physical hardware, but users and resources that belong to a given tenancy cannot interact with other tenancies.

PLANNING FOR AVAILABILITY

Availability planning consists of two contexts: availability for the PCA system itself, and availability for applications running on it.

PCA avoids single points of failure and automates recovery from component failure at the system level, so the primary planning activities for overall system availability are to

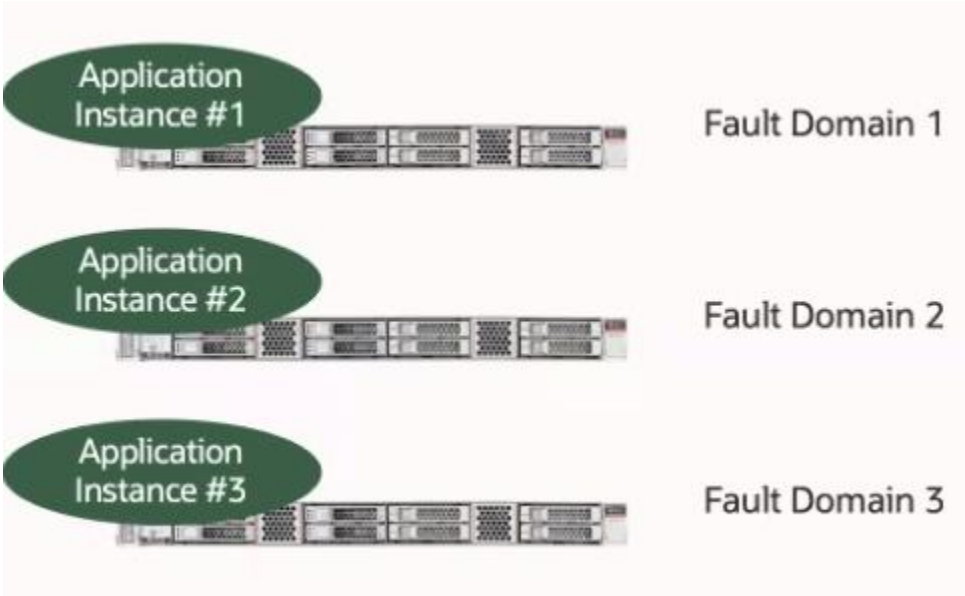
- Install the PCA according to the Oracle PCA Installation Guide for Release 3.0.1 https://docs.oracle.com/en/engineered-systems/private-cloud-appliance/3.0/install-3.0.1/index.html providing reliable and adequate power. Ensure that requirements for temperature, humidity, ventilation and cooling are met, and that there is network redundancy external to the PCA system.
- Implement monitoring and reporting of hardware and software faults according to the Oracle PCA Administrator Guide for Release 3.0.1 https://docs.oracle.com/en/engineered-systems/private-cloud-appliance/3.0/admin-3.0.1/index.html using Oracle Automatic Service Request (ASR) to report faults or failing components.
- Perform periodic maintenance is applied to system and hardware components to prevent outages. This includes patching software and firmware across the platform, and replacing physical components before they fail.

PCA permits zero-downtime maintenance and upgrade so the system environment can be serviced without application outage. The Service Enclave and ZFS appliance are clustered to permit an individual server or storage head to be rebooted without losing service. Similarly, network components are provisioned with redundant switches and paths so an individual component can be offline without service disruption. The Administration Guide describes how to update each component.

Highly available applications with clustering

True high availability requires clustered applications that are composed of multiple instances that can continue operation if any instance fails or is stopped for maintenance. This is available with applications like Oracle WebLogic and Oracle Real Application Clusters (RAC) which consist of multiple nodes to provide high availability. Consider a highly available application based on two web servers and a clustered database. In this scenario, you should group one web server and one database node in one fault domain and the other half of each pair in another fault domain. This placement ensures that a

failure of any one fault domain does not result in an outage for your application.



Clustered applications are deployed using *instance pools* and *instance configurations*, which are described in the Oracle PCA Concepts Guide for Release 3.0.1 https://docs.oracle.com/en/engineered-systems/private-cloud-appliance/3.0/concept-3.0.1/index.html and the Oracle PCA User Guide for Release 3.0.1 https://docs.oracle.com/en/engineered-systems/private-cloud-appliance/3.0/user-3.0.1/index.html and defined using the PCA command line interface or graphical user interface.

An instance configuration is a template that defines the settings to use when creating compute instances. An instance pool is a set of instances that is managed as a group, and is intended to be assigned to resources in different Fault Domains to ensure resiliency. Instance configurations are defined using the OCI CLI compute management as described at https://docs.oracle.com/en-us/iaas/tools/oci-cli/2.7.0/oci_cli_docs/cmdref/compute-management.html

Here's an example of a command to create an instance configuration with a specified JSON file:

```
{

  "instanceType": "compute",
  "launchDetails" : {
   "availabilityDomain":"pca",
    "compartmentId":"ocid1.tenancy.oc1.pca.ehonlbo0zryxz8qrzkqu2aj2nl65oukbgz7747zgl6i8af9osd
ak00090146",
    "displayName":"instanceTest",
   "fault-domain": "FAULT-DOMAIN-1",
   "shape":"VM.PCAStandard1.1",
   "sourceDetails": {
      "sourceType": "image",
      "imageId":
"ocid1.image.oc1.pca.ozahv9rnjdeocdtllxoo1kmz0qhz2ydik02rsv3iu9hk7ur0lsq2w7hplzqs"
    },
   "createVnicDetails" : {
    "subnetId":"ocid1.subnet.oc1.pca.tjboysuskqxaf0o3fgp2324w8c7ztkpxd7v4if89tq54a83pf2y6veey
4m4h"
   }
  }
}
# oci compute-management instance-configuration create file:///root/instanceDetails.json --
compartment-id $OCI_CLI_TENANCY
```

Instance pools let you create and manage multiple compute instances as a group. They also enable integration with other services, such as the Load Balancing service. Compute instance members of an instance pool are distributed across Fault Domains, which prevents single point of failure - different cluster nodes will operate on different hardware. After you have created an instance pool, you can update the size of the pool, add and remove existing instances from the pool, and attach or detach load balancers.

Here is syntax for creating an instance pool shown with the related JSON file:

```
$ oci compute-management instance-pool create --size 3 --placement-configurations
file:///root/placementConfigurations.json --instance-configuration-id \

ocid1.instanceConfiguration.oc1.pca.e2hu9wwmsgwg3hozgzqr2y13prd0wtzpfbkgll6wdki0w5c6m9vrvour7
zc0 --compartment-id $OCI_CLI_TENANCY

[
{
"availabilityDomain": "ad1",
"faultDomains": [
"FAULT-DOMAIN-1",
"FAULT-DOMAIN-2",
"FAULT-DOMAIN-3"
],
"primarySubnetId":
"ocid1.subnet.oc1.pca.waxtbut2dzij87fkylapaocin363nq5ckz8rn71c3e4oq7k57zkjismkhwrc"
}
]
```

To start an instance pool, issue the following command, substituting in the actual ID:

```
oci compute-management instance-pool start --instance-pool-id \
ocid1.instancePool.oc1.pca.27rudn0sjft7ucwrqa4t4mxjczgs4e5xhxzv7r7mitji1pxb6kj3ygeriytp
```

You can automatically adjust the number of instances in an instance pool based on performance metrics or a schedule. You can also stop and start instances in an instance pool based on a schedule. To do this, you enable autoscaling for the instance pool.

Single-instance applications

While clustered applications are necessary for continuous availability, it is also common to use single-instance applications such as Oracle Database SE and many home-grown applications when requirements are less strict, and it is acceptable to take an application outage due to a fault.

In this scenario, your application architecture is not highly available, and a server outage would cause an application outage until the VM instances are restarted.

The risk can be reduced by using fault domains. For example, if a single-instance application contains a non-clustered database, app server and webserver in three different virtual machines, host them in the same Fault Domain. This ensures that the application is only impacted by the failure of a single fault domain, providing greater application availability overall.

ADMINISTRATION FOR MAINTENANCE AND PLANNED OUTAGE

A rolling upgrade plan is used for planned maintenance on compute nodes. The compute node is first placed in maintenance mode by the administrator, and running compute instances are live-migrated to another compute node. Maintenance mode is activated when there are no more running instances on the compute node, and then the administrator can execute steps to update software, firmware, and reboot as needed. After maintenance is complete, the compute node is

made active again, and the administrator moves to the next compute node till all are serviced. Customers must ensure that there is sufficient capacity to run their workload during periods of reduced capacity while servers are being updated.

SUMMARY

The Oracle Private Cloud Appliance (PCA) is a robust platform designed to permit highly available cloud applications. This technical brief describes PCA features that enhance availability, and describes techniques available to administrators and cloud application developers to enhance availability.

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