

Oracle Communications Policy Management

Network Function Virtualization Update (R12.5)

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Glossary

This section lists terms and acronyms specific to this document.

Acronym/Term	Definition
CMP	Configuration Management Platform
Guest	The VM running on the Host server.
HA	High Availability
HDD	Hard Disk Drive
Host	The server on which the VM (Guest) is running.
KPI	Key Performance Indicator
MP	Message Processor
MPE	Multimedia Policy Engine
NFA	Network Function Agent
NFV	Network Function Virtualization
NOAM	Network Operations, Administration, and Maintenance
OAM	Operations, Administration and Management
OSM	Open Source Management and Orchestration
PCRF	Policy and Charging Rules Function
PDP	Packet Data Protocol
PFE	Policy Front End
RAM	Random Access Memory
SOAM	System Operations, Administration and Maintenance
UOA	UDR Orchestration Adaptor
UOI	UDR Orchestration Interface
vCPU	Virtual CPU
VM	Virtual Machine
VNF	Virtual Network Function
VNFC	Virtual Network Function Component (MPE, PFE, VMs)



Introduction

Oracle Communications Policy Management is a highly scalable and robust 3GPP PCRF system that supports 3G, 4G, IMS, VoLTE, VoWiFi, and Fixed Mobile Convergence. Oracle Communications Policy Management is the leading independent policy vendor and interoperates with commonly deployed GGSNs, PGWs, DPIs, TDFs, P-CSCFs, SDPs, Application Servers, OTT Gateways, OCSs and HSSs.

When deployed on bare metal servers, Oracle Communications Policy Management components (MPE, PFE and CMP) are available on a well-defined set of servers. In addition, each component can be deployed as a Virtual Network Function Component (VNFC). This enables Oracle Communications Policy Management to run on a broad range of hardware configurations.

While adding flexibility, virtualized deployment increase complexity and associated costs. To minimize the impact, Oracle has introduced the Network Function Agent (NFA). The new function adds automation to simplify the process of deploying, modifying and terminating PFE and MPE clusters.

This paper outlines the Oracle Communications Policy Management virtualized deployment information including supported hypervisors, NFV performance testing, and current deployment options. It also provides an introduction to NFA, Orchestration capabilities and summarizes Oracle's direction.

Oracle Communications Policy Management as a Virtualized Network Function

An Oracle Communications Policy Management system consists of three components that can operate independently with different lifecycles (instantiate and deploy, scale, turn down). The Policy Front End (PFE), also called as Multi-Protocol Routing Agent (MRA), enables communication with Policy Control and Enforcement Functions (PCEF), Traffic Detection Functions (TDF) and Application Functions (AF). The Multimedia Policy Engine (MPE) performs policy decisions based on these communications and interacts with User Data Repository (UDR)/Subscriber Profile Repository (SPR) and Online Charging System (OCS). The Configuration Management Platform (CMP) performs the role of an Element Management System (EMS). Each component can run directly on specified hardware or as a guest under the supported hypervisors.

Oracle Communications Policy Management operates in two modes: high availability or geo-redundant configuration. In the high availability mode, each cluster consists of an active and standby server. In geo-redundant systems, each PFE and MPE cluster includes three servers, with active and standby servers at a single site, and a third server located at geo-redundant site.

Oracle Communications Policy Management can run as a guest on the following hypervisors with the associated Virtual Infrastructure Managers, using the following minimum release levels:

- KVM qemu-kvm-1.5.3-126.el7/Oracle Open Stack (Oracle Linux7.3)

- KVM qemu-kvm (2.9.0)/ Open Stack (Pike)
- VMware ESXi version 6.5/VMware vSphere

To provide scaling guidelines, Oracle validates Oracle Communications Policy Management operation on Oracle X5-2 and HP Gen9 servers using a NFV reference profile which specifies the Virtual CPU (vCPU), memory (RAM), Hard Disk Drive (HDD) sizing and virtual NICs which are available to the VM. The profile definition is independent of which hypervisor and VIM is used. The Oracle Communications Policy Management VNFC reference profile definition is listed in Table 1.

Deployment Option	CMP Profile	PFE/MPE Profile
Standard Production	12 vCPUs, 60GB RAM and 108GB HDD	12 vCPUs, 60GB RAM and 108GB HDD
Oracle Communications Policy Management-Low Profile	4 vCPUs, 10GB RAM and 108GB HDD	10 vCPUs, 32GB RAM and 108GB HDD

Table 1: Oracle Communications Policy Management VM Reference Profile options for Production

Oracle Communications Policy Management Automation using Network Function Agent (NFA)

While virtualization reduces hardware costs by allowing multiple applications to reside on the same physical server, introducing virtualization increases complexity and the associated operational costs. *Automation* reduces the number of manual steps required to deploy new instances of Oracle Communications Policy Management components, allowing new clusters to be brought up more quickly and with less chance of error.

Oracle Communications Policy Management automation is provided by the Network Function Agent (NFA). This Oracle Communications Policy Management component operates in conjunction with CMP to reduce the complexity of deploying new (or removing) PFE or MPE clusters running as VM guests. Oracle Communications Policy Management NFA conforms to ETSI's Management and Network Orchestration (MANO) framework, which is the evolving standard for NFV automation and orchestration depicted in Figure 1. NFA performs the role of the VNF Manager defined by this architecture, while CMP is enhanced to automate the Element Management (EM) functions required to deploy new virtual clusters.

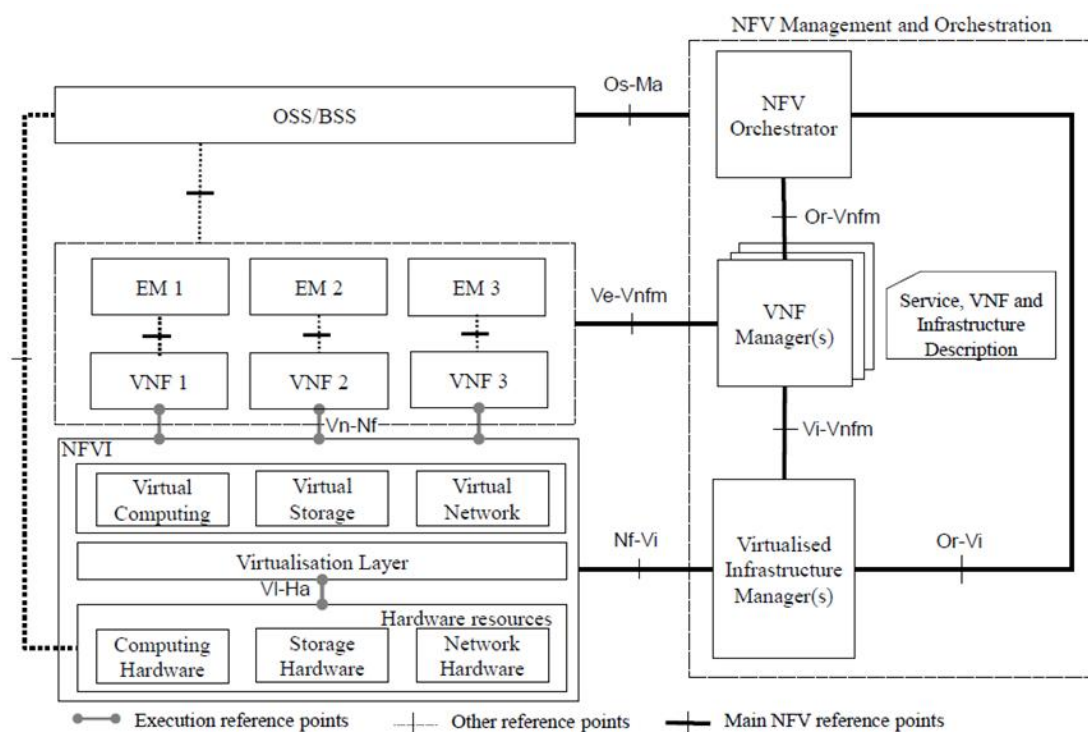


Figure 1: MANO Framework

As shown in Figure 4, NFA works with CMP and the VIM to speed up deployment of new PFE or MPE clusters. Under operator control, OpenStack allocates resources for new PFE or MPE instances, places them onto appropriate hosts, configures these components based on Openstack catalog information and adds them into the Oracle Communications Policy Management system topology. Using NFA, you can streamline the steps required to perform tasks such as:

- Create an individual server instance, high-availability cluster or geo-redundant cluster
- Add an additional server to migrate from a high-availability to a geo-redundant deployment
- Terminate a server or cluster
- Upgrade to a new release by sequentially deleting each server instance in a cluster and creating a new instance which runs the upgraded software

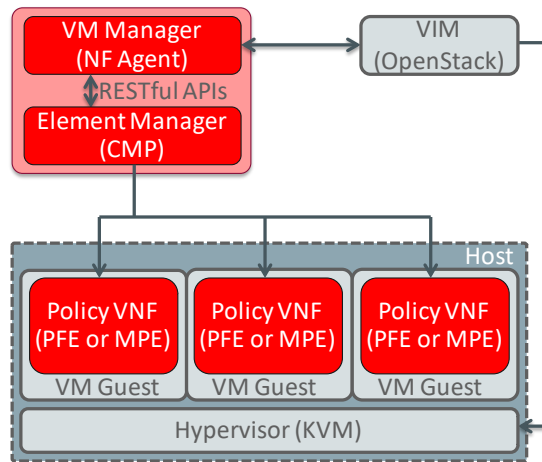


Figure 2: NFV Automation Overview Using NFA

NFA works in conjunction with CMP and the VIM to create new PFE and MPE guests as follows:

- Oracle Communications Policy Management systems profiles and images are populated in the OpenStack catalog using the following steps:
 - The PFE and MPE software images are loaded into the VIM
 - The VNF profiles are defined to within the VIM.
 - The Openstack resources which can be used by Oracle Communications Policy Management are grouped into Availability Zones and Security Groups
- Using standard OpenStack Compute API or HEAT Template interfaces, you create a new (or modify an existing) cluster by:
 - Choosing the desired cluster type (high availability, geo-redundant or individual server)
 - Selecting the software image, resource profile and affinity/security zones from the OpenStack catalog options
 - Providing initial required server configuration such as the instance name, DNS server and NTP server.
- After the VIM creates the instances, NFA instructs CMP to add the new servers into its Topology database. The operator then uses CMP to provide additional information such as associating a newly created MPE with an existing PFE, and assigning virtual IP addresses such as signaling (SIG-A).

While NFA runs as a separate process, the user interface is integrated into CMP. This approach provides a single GUI interface for all management, while enabling other authorized tools such as network service orchestrators (NSOs) to interface with the NFA using open RESTful APIs in the future. NFA has been verified with Oracle OpenStack v2 (Kilo) as well as the OpenStack Liberty release.

In addition to the automation support with the Openstack environment, NFA is enhanced to interact with the vCloudDirector using the vCloud API for Oracle Communications Policy Management VM instantiation pertaining to VMWare environment as depicted in Figure 3

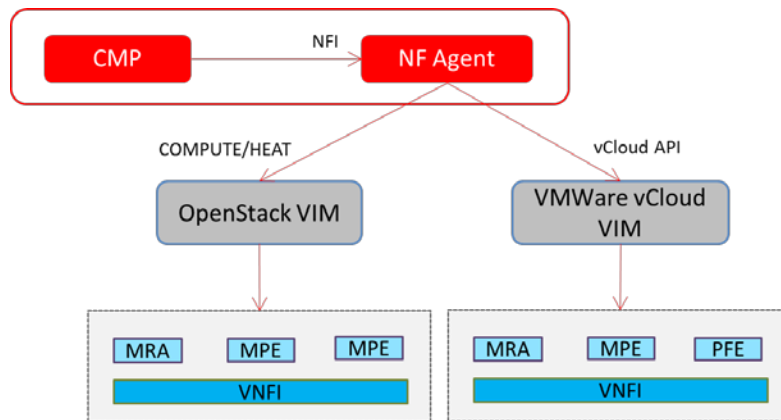


Figure 3: NFA—vCloud API support

Oracle NFA is enhanced to support VMWare vCloud API for managing VM lifecycle. The vCloud API is a REST based API. This VNFC management is supported by the CMP node where the VNFs are instantiated by the EM and resources are allocated by the NFA. This flow is similar to section B.3.2.1 VNF instantiation from EM in the *ETSI GS NFV-MANO* specification. This Oracle Communications Policy Management release support for automated VM deployment with the vCloudDirector can be used for demo/customer trial purposes only

Following steps for creating Oracle Communications Policy Management VNFC (MRA/MPE) cluster is listed below

- CMP (NFA) shall be functional with the VIM connection established with VMWare vCloud VIM
- VMWare vCloud environment should be preconfigured for organization, VDC, VDC network, user, catalog and vApp Template information.
- The on-boarding of CMP/MRA/MPE images are to be processed manually from the VMWare vCloud Director GUI
- NFA allows for VIM type to include VMware vCloud as part of VIM connection. GUI also allows querying for vApp template for VM selection
- Perform Topology settings using the NFA GUI by providing information pertaining to VDC, VM, vApp template, vApp name and so on. for Oracle Communications Policy Management VNF instantiation
- In addition to this instantiation, Oracle Communications Policy Management VNF clusters can be updated using the NFA GUI

NFA can interwork with vCloud API 5.5 and this Oracle Communications Policy Management release will be suitable for performing customer PoC and lab trial purposes only.

Oracle Communications Policy Management Orchestration using Network Function Agent (NFA)

While virtualization insulates the network functions from those resources through a virtualization layer. This decoupling of infrastructure layer and the network functions has created scope for a methodology to manage the infrastructure and orchestrate the allocation of resource based on the requirement of network function and services. Network Function Virtualization-Management and Network Orchestration (NFV-MANO) architecture is the framework created for performing the necessary management and orchestration. NFA provides the function equivalent of a VNF Manager and CMP acts as an EM to the policy VNF.

Policy orchestration use cases are supported by implementing two layers at the NFA, an adaptation layer and a service layer as depicted in Figure 4. Functionality of these layers:

- The NF Agent Orchestration Adaptor layer act as a front end within NF agent for interacting with northbound external orchestrators. This layer is also responsible for translating orchestrator provided messages into internal messages towards orchestration service layer. This layer ensures that any external orchestration interface change is transparent to NF Agent internal logic.
- The NF Agent Orchestration Service layer targets to fulfill internal orchestration related functions. For example, applying service configuration on the VNF by calling the CMP PPI.

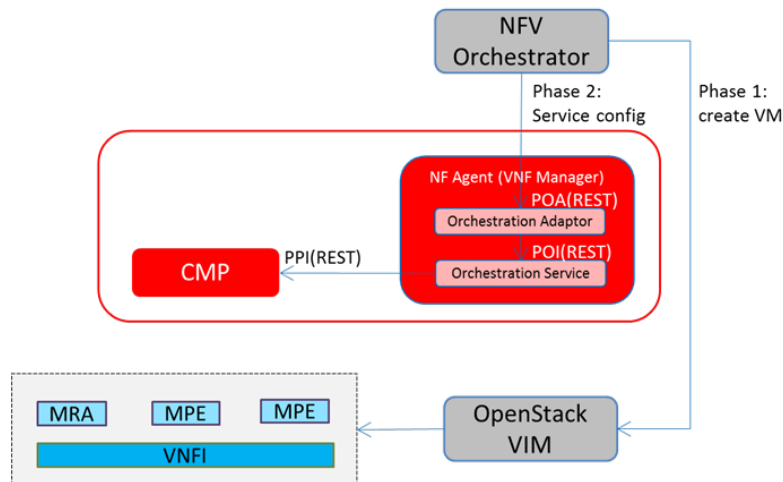


Figure 4: NF Agent Layer for Policy Orchestration

NFA implementation includes support for VNF deployment and scaling call flows wherein resource allocation is performed by an orchestrator (also known as Two Phase orchestration) similar to sections B.3.1.2 and B.4.3 as specified in ETSI NFV MANO specification. Depiction for the two phase orchestration is provided in Figure 5.

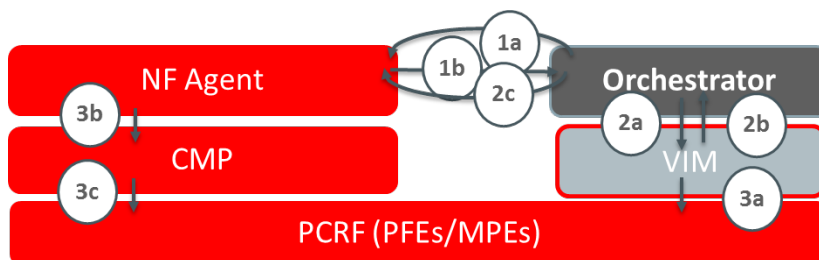


Figure 5: VNF Deployment/Scaling with Resource Allocation done by an Orchestrator

Following steps describes the resource allocation performed by an orchestrator

- Steps 1 includes NSO requesting resources for create/update of Oracle Communications Policy Management VNF (Step 1a) which is followed by NFA providing the same towards NSO (Step 1b). Please note that in this Oracle Communications Policy Management release, NFA does not perform dynamic resource determination but utilize pre-defined HEAT and service configuration templates
- Step 2 involves the resource allocation performed by the NSO by communicating with an Openstack VIM (step 2a) subsequently retrieving the VM related information from the VIM (2b). This information is provided back to the NFA by the NSO (2c)

- Step 3 involves VIM creating a new instances (or) updates resources. Step 2c allows NFA to notify the CMP to push appropriate configuration parameters (3b) which is followed by CMP performing the actions as specified by NFA in Step 3c.

CMP/NFA deployment includes procedure includes creating CMP VMs/clusters, configure CMPs and NF Agent to make them ready for service as depicted in Figure 6.

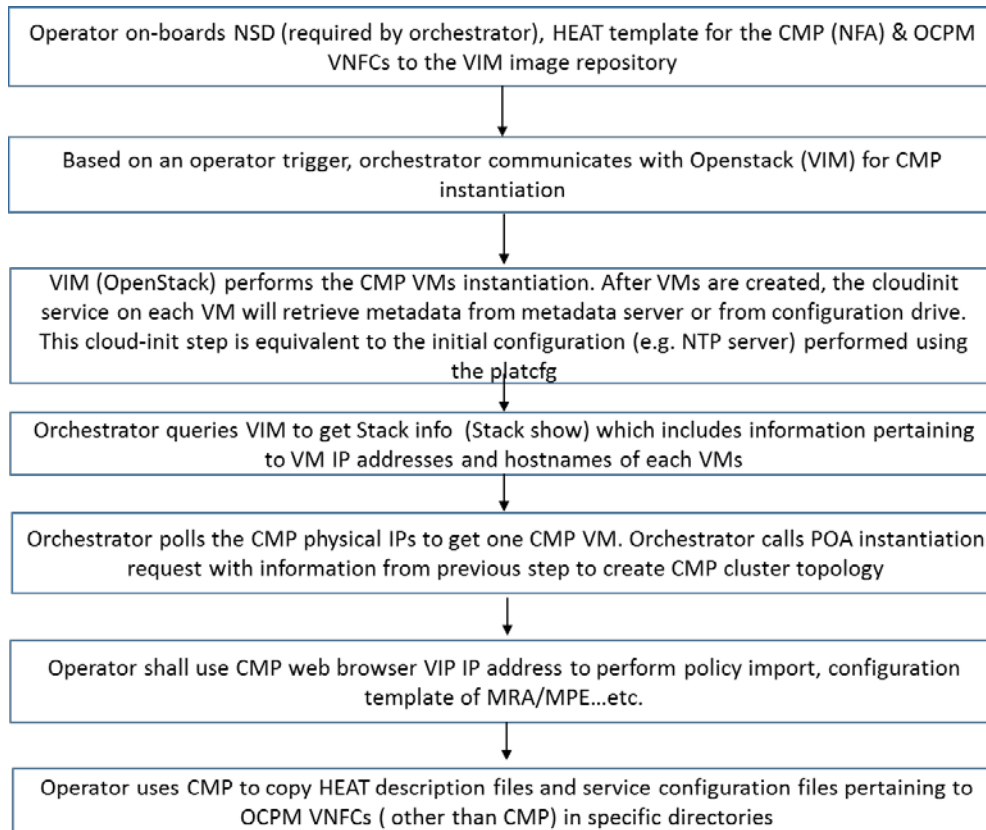


Figure 6: CMP/NF agent instantiation steps through an orchestrator

Based on the depiction in Figure4, CMP and NF agent are now ready for MRA/MPE instantiation and as well allow scaling procedures when requests are triggered through an orchestrator. Please note that scaling level information is used for instantiation of MRA and MPE VNFCs. During the design phase, scaling levels and corresponding actions expected with the addition/deletion of VNFCs can be determined. Basic steps for performing basic addition of MRA and MPE, assumed to be at scaling level 1 is provided below as an example in Figure 7

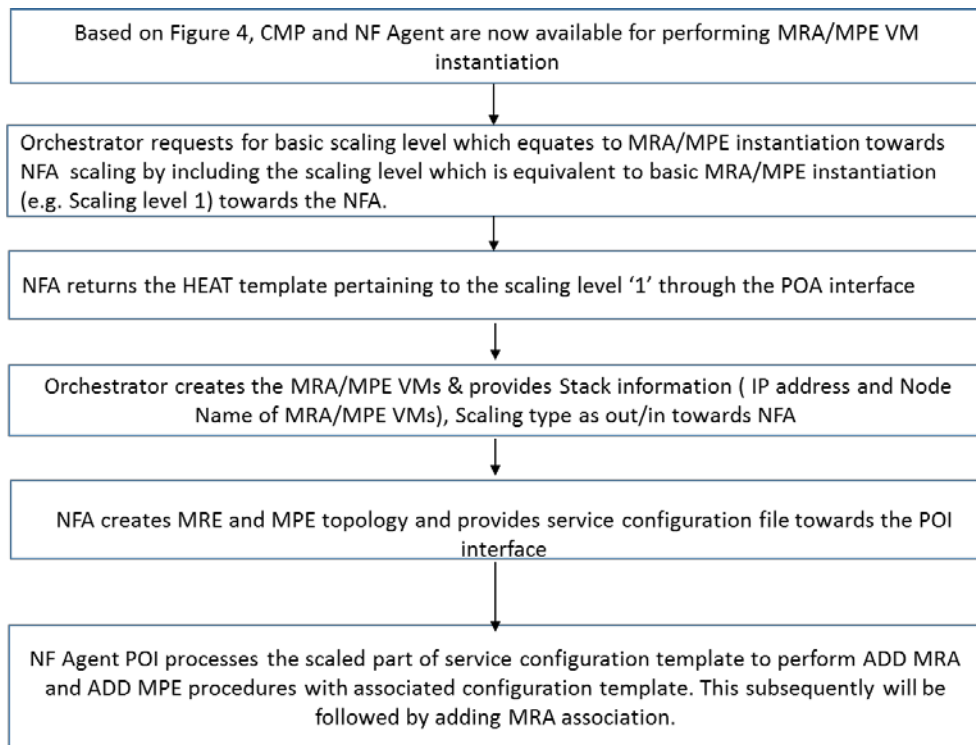


Figure 7: An example MRA/MPE Instantiation steps through an orchestrator

NFV solution allows operators to scale out VNFCs dynamically when additional resources are required and similarly scale-in can be performed when resources may no longer be required. Oracle Communications Policy Management supports scaling procedures when triggered through an orchestrator. Scaling implementation includes Oracle Communications Policy Management providing the level of scale during the scaling request. Scaling in procedures in this Oracle Communications Policy Management release may affect active subscriber session if the component that is scaled in has active sessions on it. Basic steps for scaling can be as follows

- Orchestrator requests for scaling by including the scaling level (m) towards the NFA. NFA returns the HEAT template pertaining to the scaling level m through the POA interface
- Orchestrator communicates with Openstack for the creation of VMs for MRA and MPE and also retrieves the stack information (IP and Host Names of VMs) from the VIM
- Orchestrator provides NFA POA with scaling type (out is for scaling out and in is for scaling in), scaling level and parameters (HEAT stack output) based on the requirement
- NFA POA interface creates MRA/MPE topology and verifies the status by polling
- NFA POA communicates with the NFA POI for this scaling request with information on the scaling level
- NFA POI checks the service configuration file pertaining to this level (m) and processes scaled part of the service configuration file
- NFA POI requests using the PPI interface towards the CMP for creating MRA servers, applying configuration templates, associating MPE to MPE pool of an MRA. Addition of MRA and MPE may be performed with multiple requests and they are based on the scale requirements.

- In addition to above steps, NFA POI using the PPI interface towards the CMP for performing MRA association and pushing configuration to MRA configuration clusters

Scaling flows through an orchestrator can be described using the Figure 8. The OCPM_0, OCPM_1, OCPM_2, OCPM_3 are 4 sample levels of Oracle Communications Policy Management used for describing this flow.

OCPM_0 is a special level where only CMP component and NF Agent service are deployed

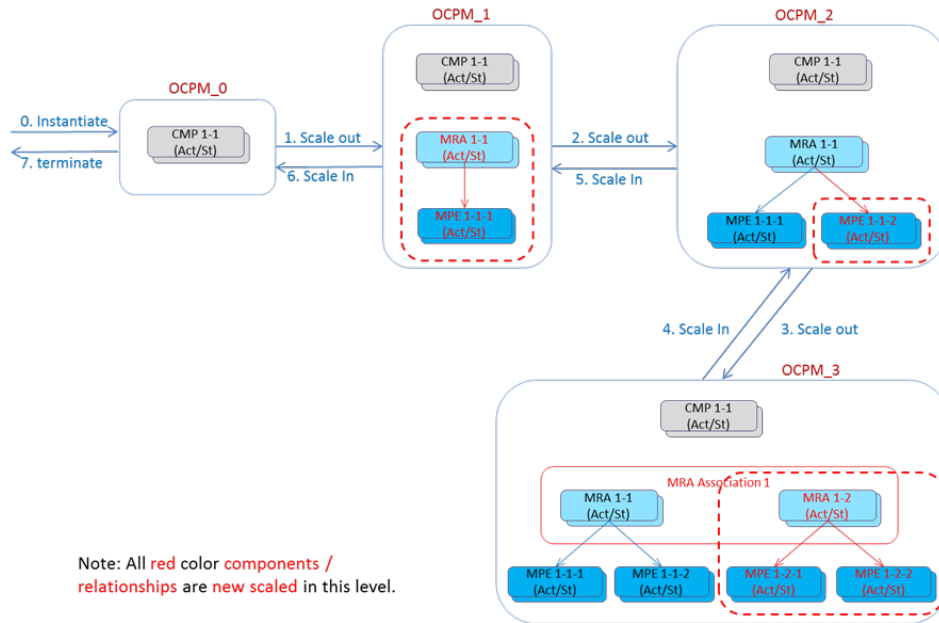


Figure 8: Sample Oracle Communications Policy Management Instantiation and Scaling flow

All the steps are triggered through an Orchestrator

- Step 0 is Deployment of CMP and NF Agent. The OCPM_0 is the initially deployed CMP clusters where NF Agent resides on. This indicates that
 - OCPM_0 has been deployed, CMP/NF Agent is deployed and running
 - CMP/NF Agent have any deployment specific configuration completed.
 - Service configuration files, Heat Templates, configuration templates, policies, and so on must be created/loaded on the CMP/NF Agent.
- Step 1 is Scale out MRA and MPE, in this sample, a MRA cluster and a MPE cluster has been scaled. The Oracle Communications Policy Management system is in scale level 1.
- Step 2 is Scale out MPEs, a new MPE cluster is scaled out and associated with existing MRA and the Oracle Communications Policy Management is moved to Scale level 2
- Step 3 is Scale out MRA and MPEs, new MRA cluster with 2 associated MPE clusters are scaled out. The Oracle Communications Policy Management system becomes scale level 3.
- Step 4, 5, 6 are Scale in, these scale in the system back to level 2 and level 1, and at last level 0.
- Step 7 is Termination, in this sample, after 3 scale in steps, there is only 1 CMP cluster in the Oracle Communications Policy Management system level 0, the termination will only terminate the CMP VMs.

NFA has been verified with Oracle Network Service Orchestrator versions 7.3.5 and 7.3.5.1

Oracle Communications UDR Orchestration using Network Function Agent (NFA)

Introduction of Oracle Communications Policy Management orchestration support in Oracle Communications Policy Management 12.4 provides a conducive environment suitable for performing Oracle Communications UDR orchestration. Oracle Communications UDR as a network entity usually gets deployed with Oracle Communications Policy Management hence re-using NFA for performing Oracle Communications UDR orchestration is inevitable. Oracle Communications UDR orchestration use cases are supported by implementing two additional layers at the NFA, an UDR adaption layer and a service layer as depicted in Figure 9

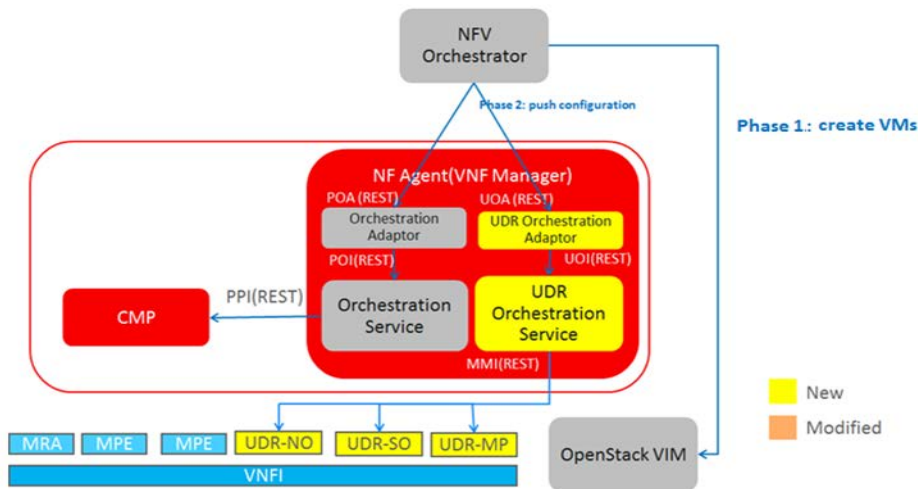


Figure 9: Oracle Communications UDR Orchestration layers

Oracle Communications UDR orchestration is notably different from Oracle Communications Policy Management orchestration because Oracle Communications UDR service configuration will be accomplished using MMI commands instead of CMP PPI interface. It should be clarified that CMP/NFA is a minimum requirement for performing Oracle Communications UDR NFV use cases, wherein resource allocation is performed by an orchestrator. Oracle Communications UDR orchestration use case attempted in this release would be Oracle Communications UDR instantiation, termination and scaling use cases.

CMP and NF agent instantiation is captured already in this document (refer Figure 6). Availability of the CMP/NF agent for performing Oracle Communications UDR orchestration can be considered as level 0. From level 0, instantiation of SOAM, NOAM and MP VNFCs can be performed. During the design phase, scaling levels and corresponding actions expected with the addition/deletion of VNFCs can be determined. Basic steps for performing basic addition of Oracle Communications UDR VNFCs, assumed to be at scaling level 1 is provided below as an example in Figure 10.

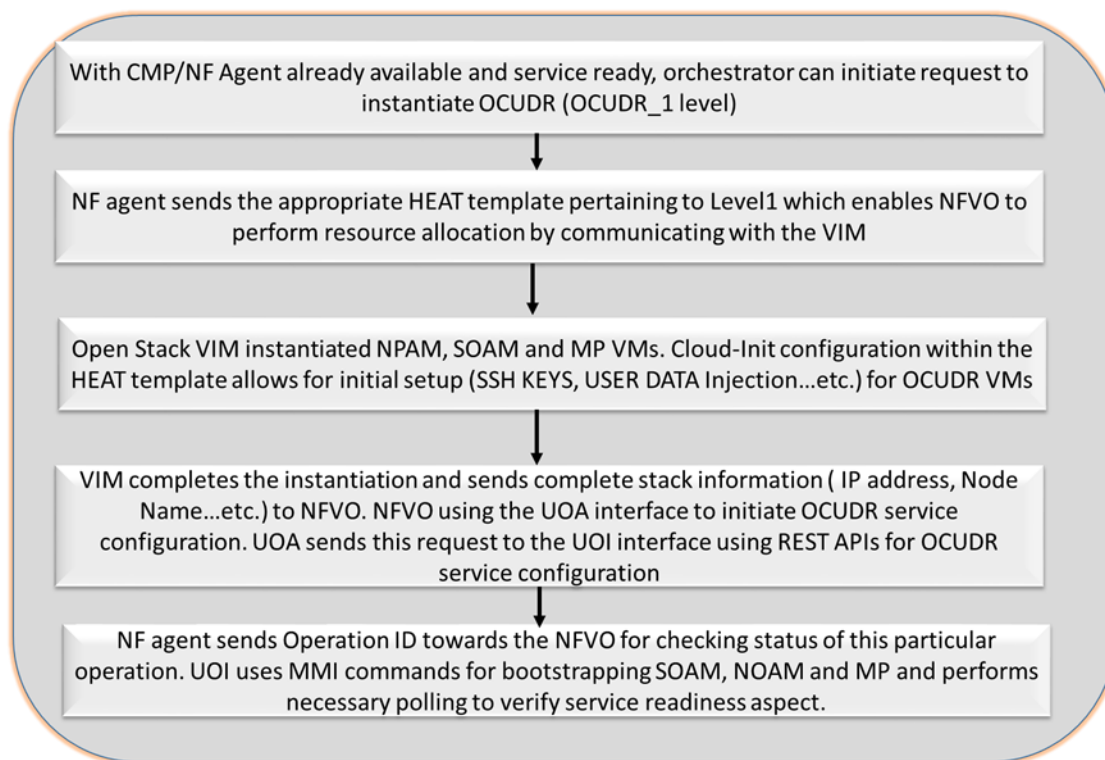


Figure 10: An example Oracle Communications UDR Instantiation Flow

In this Oracle Communications UDR release, instantiated Oracle Communications UDR VNFs requires to be manually triggered to make it operational. This is due to the limitation in the MMI options available in this release.

Scaling flows through an orchestrator can be described using the Figure. The OCPM_0, OCUDR_1, and OCUDR_2 sample levels of Oracle Communications UDR are used for describing this flow

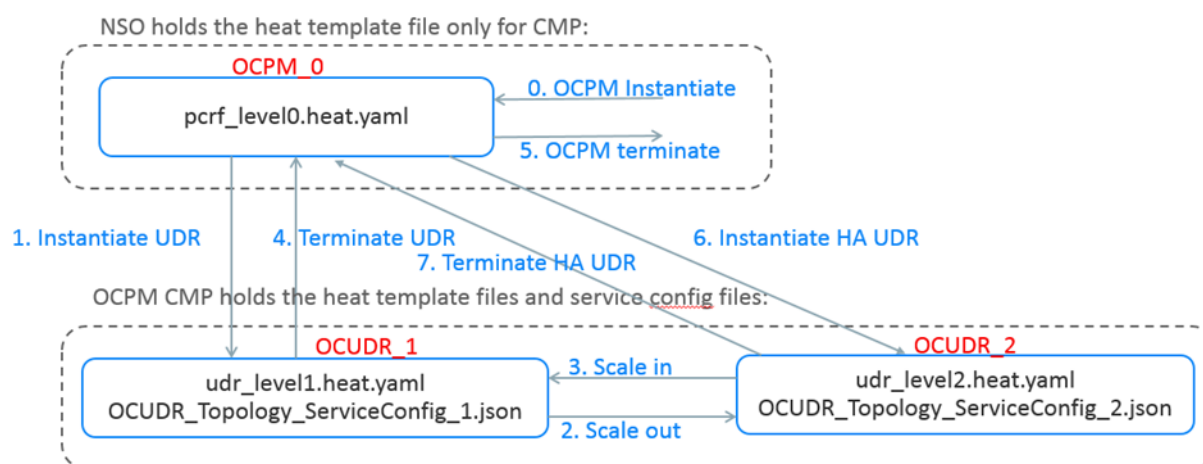


Figure 11: Sample Oracle Communications UDR instantiation and scaling flow

OCPM_0—CMP and NF Agent

NFVO triggers creation of CMP clusters when it receives a trigger from OSS/BSS or by a manual trigger. NFVO holds the Heat Template needed to create CMP clusters. The OCPM_0 is the initial state where CMP clusters are deployed on which NF Agent resides. Both CMP and NF Agent are running and their deployment specific configurations are complete. Once CMP service configurations are done, NF Agent can return HEAT Templates needed for Oracle Communications UDR Orchestration.

OCUDR_1—Standalone Oracle Communications UDR

CMP clusters and NF Agent have been successfully deployed as explained in OCPM_0 is a prerequisite for this state. NFVO triggers creation of Oracle Communications UDR when it receives a trigger from OSS/BSS or by a manual trigger. NFVO will send a get template for level 1 to NF Agent. Once NF Agent responds with correct template, NFVO will instantiate VMs needed for OCUDR_1 level and triggers Instantiate Oracle Communications UDR request to NF Agent with level 1. NF Agent will initiate a service configuration of Oracle Communications UDR for level 1 and returns the operation ID to NFVO which can be queried to see if the service configurations are complete.

OCUDR_2—HA Oracle Communications UDR

The OCUDR_2 state can be reached by two ways as shown by Figure. Oracle Communications UDR Orchestration States.

First way of reaching OCUDR_2 state is, by Scaling out OCUDR_1 to OCUDR_2. This approach assumes that CMP clusters and NF Agent have been successfully deployed as explained in OCPM_0 and also Oracle Communications UDR is running in standalone configuration as explained in OCUDR_1 state are a prerequisite for this state. The instantiation procedure for OCUDR_1 is explained above. Once NFVO receives a manual trigger to scale out Oracle Communications UDR application, NFVO will send a get template request for OCUDR_2 level to NF Agent. Once NF Agent responds with correct template, NFVO will instantiate VMs needed for OCUDR_2 level and triggers scale out Oracle Communications UDR request to NF Agent with level 2. NF Agent will initiate a service configuration of Oracle Communications UDR for level 2 and returns the operation ID to NFVO which can be queried to see if the service configurations are complete.

The Second way off reaching OCUDR_2 state is by executing Instantiate HA Oracle Communications UDR. This approach assumes that CMP clusters and NF Agent have been successfully deployed as explained in OCPM_0 only. Once NFVO receives a manual trigger to deploy HA Oracle Communications UDR application, NFVO will send get template request for OCUDR_2 level to NF Agent. Once NF Agent responds with correct template, NFVO will instantiate VMs needed for OCUDR_2 level and triggers instantiate Oracle Communications UDR request to NF Agent with level 2. NF Agent will initiate a service configuration of Oracle Communications UDR for OCUDR_2 level and returns the operation ID to NFVO which can be queried to see if the service configurations are complete.

Oracle Communications Policy Management Support for Open Source Management and Orchestration (OSM)

ETSI OSM is an operator led ETSI community that is delivering a production quality Open Source Management and Orchestration (MANO) stack aligned with ETSI NFV Information Models and that meets the requirements of production NFV networks. Figure 12 shows the approximate mapping of scope between the OSM components and the ETSI NFV MANO logical view

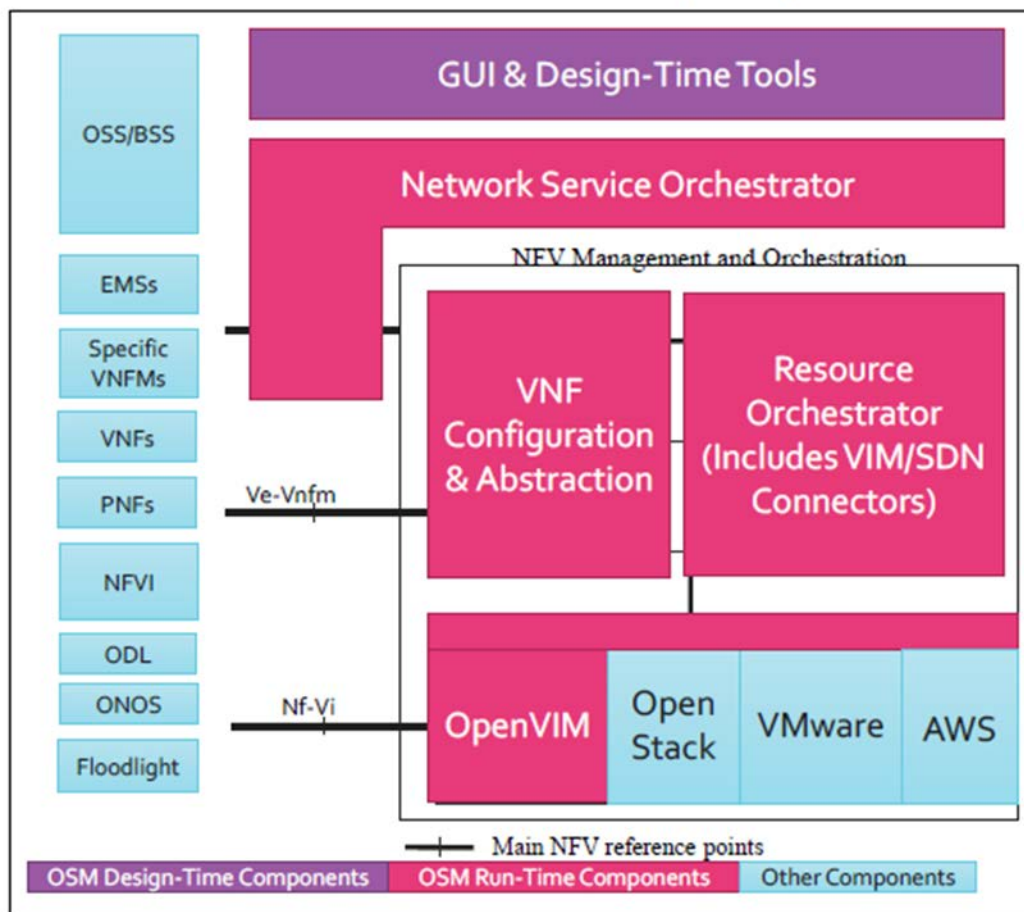


Figure 12: OSM Mapping with ETSI Mapping

The OSM community has defined an expansive scope for the project covering both design time and run time aspects related to service delivery for telecommunications service provider environments

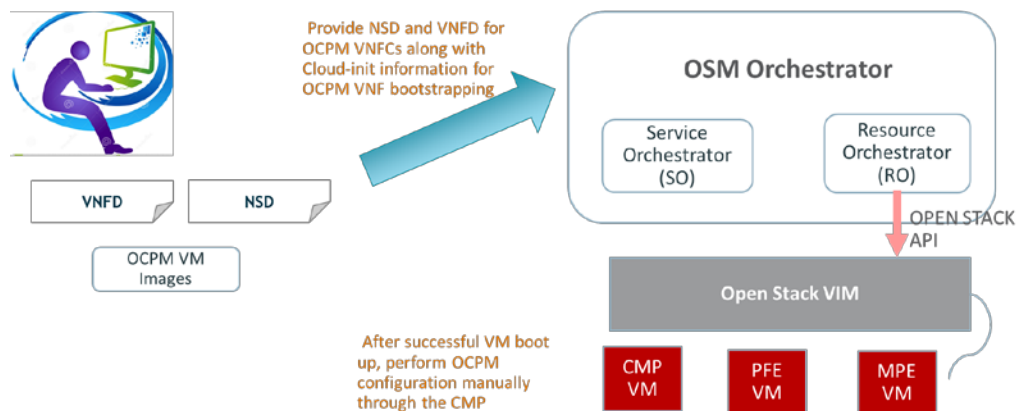




Figure 13: Oracle Communications Policy Management Support in an OSM environment

As part of this Oracle Communications Policy Management release 12.5, VNF Descriptors (VNFD) and Network Service Descriptors (NSD) pertaining to Oracle Communications Policy Management VNFCs are provided to the Resource Orchestrator component of the OSM architecture for bringing up these VMs. These artifacts also include cloud-init procedure for performing, initial configuration (for example, platcfg configuration such as hostname, OAM IP address, Gateway, NTP IP address, DNS and so on) pertaining to Oracle Communications Policy Management VMs. These Oracle Communications Policy Management artifacts depicted as in Figure 13 have been tested with OSM version 1, 2 and 3 and these are available for demo and PoC purposes only.

Plan in the near future is to implement Juju for performing some of the automated configuration provided OSM community addresses stability issues with OSM and Juju.

Direction

Introducing the NFA to simplify instantiating new Oracle Communications Policy Management components in a KVM/OpenStack environment is an important step towards integrating Oracle Communications Policy Management into orchestrated NFV deployments. Oracle is evaluating other NFV enhancements as potential future feature candidates such as:

- Adding support for VNF Management for Management and orchestration frameworks (for example, OSM and ONAP)
- Support for Juju Charms for performing service configuration automatically in OSM 5 environment
- Support for ONAPs on-going projects such as VF-C for necessary communication with VNFM/CMP
- Support for ETSI MANO specification such as SOL 002 and SOL 003 for VNFM communication with an external orchestrator and EMS for NFV use cases.
- Orchestration support enhancement for a VNF Management type other than already supported OpenStack/HEAT
- Adding support for external orchestrators to instantiate, scale, modify or terminate MPE and PFE

Summary

Oracle Communications Policy Management can be deployed in virtualized environments using KVM, VMware, and OVM hypervisors as well as on specific bare metal servers. Oracle tests and validates the performance of the defined Oracle Communications Policy Management VNFC profiles on combinations of hypervisors running on selected hardware. Oracle considers Oracle Communications Policy Management Low profile to be a minimum requirement for supporting Oracle Communications Policy Management deployments. In addition to this, operators can run Oracle Communications Policy Management on other hardware platforms or using profiles (resources not lesser than the Oracle Communications Policy Management low profile) using the specified hypervisors. In this case the service provider should validate the performance of the virtualized system in their labs and production environments or can optionally use the Oracle Consulting Services team.

For KVM/OpenStack environments, Oracle Communications Policy Management's Network Function Agent (NFA) simplifies the process of adding, modifying and removing virtual servers and clusters. NFA can communicate with multiple KVM/OpenStack VIMs and integrates with CMP, allowing customers to easily take advantage of this important capability. NFA works in a role similar to that of an ETSI VNFM providing capabilities for performing Oracle Communications Policy Management and Oracle Communications UDR orchestration use cases.

Appendix A: Entry Level and Lab Systems

Entry Level System

Oracle Communications Policy Management provides an Entry Level Oracle Communications Policy Management System for small operators and lab testing. This system is deployed in Virtual Machines on a pair of Oracle X5-2 RMS systems executing Oracle Enterprise Linux with the KVM hypervisor, as a fully functional, highly available, minimal footprint solution. Each server includes one CMP, one PFE and two MPEs. The high availability (two servers per cluster) mode is shown in Figure 14. A third server can be added to support geo-redundancy. Each component uses the Oracle Communications Policy Management VNF reference profile.

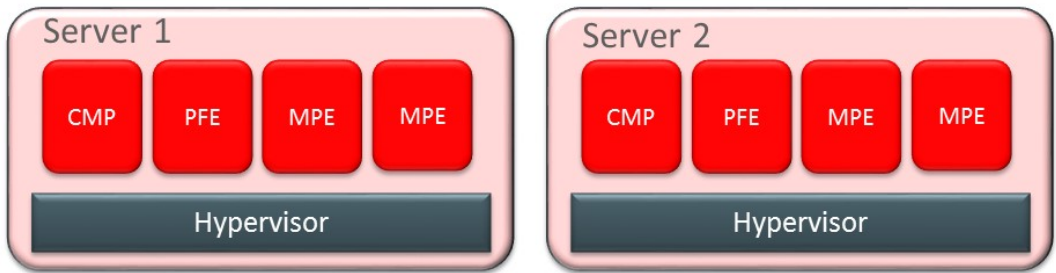


Figure 14: Entry Level Oracle Communications Policy Management Configuration

Lab System

For customers looking to run Oracle Communications Policy Management in a lab on a system with a smaller CPU and memory footprint, Oracle supports a simpler configuration for which can be used for functional testing, as shown in Figure 15:

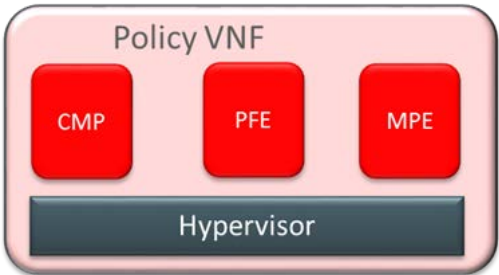



Figure 15: Lab System Configuration

All servers within a cluster must be configured with the same virtual profile. The cluster also cannot be a mixture of bare metal and VM-based servers. The profile for lab configuration is shown in Table 2.

Component	vCPU	RAM	HDD	vNIC
MPE, PFE or CMP	4	8GB	75G	4

Table 2: Virtualization Profile for Lab System



This configuration has been tested on Oracle X3-2, Oracle X4-2, Oracle X5-2, HP Gen8, and HP Gen 9 with KVM, OVM and VMware hypervisors. (Not all hypervisors are supported on all hardware.) It is recommended that feature testing using this lab configuration be performed using the high availability (dual server) mode.



Appendix B: Hardware Validation

Oracle Communications Policy Management operates on bare metal or as a VM guest. VNF performance shown in this paper reflects testing performed using the VNF reference profile on the following servers:

- Oracle Server X6-2 rack-mounted server
 - CPU: Intel® Xeon® CPU @ 2.200GHz
 - Number of hyperthreaded vCPU: 88
 - RAM: 256 GB
 - HDD: 2x HGST (1.2 TB each)
 - NICs: 10GbE SFP+ NIC with minimum of 2 ports, or 10GbE RJ45 NIC with minimum of 2 ports
- Oracle Server X7-2 rack-mounted server
 - CPU: Intel® Xeon® CPU @ 2.100GHz
 - Number of hyperthreaded vCPUs: 96
 - RAM: 256 GB
 - HDD: 2x HGST (1.2 TB each)
 - NICs: 10GbE SFP+ NIC with minimum of 2 ports, or 10GbE RJ45 NIC with minimum of 2 ports:

Appendix C: Oracle Communications Policy Management Capacity Benchmark

Oracle validates the performance and capacity on each server. *Capacity* is determined by the available memory. MPE capacity is measured by the number of concurrent sessions supported, while PFE capacity is measured by the number of bindings.

Reference Profiles	PFE	MPE
Standard Production *	20 million bindings	5 million sessions
Low Profile production *	12 million bindings	3 million sessions
Note: *Bindings and session supported were tested at Oracle labs using the hardware and hypervisor combination provided in Table 4		

Table 3: PFE/MPE Capacity

Performance is measured in Transactions per Second (TPS) for both MPE and PFE. The performance can vary based on both the selected hypervisor and the underlying hardware. These results utilize a representative call model derived from customer experience using the reference profile. The call model that was used in virtualized Oracle Communications Policy Management benchmarking includes a distribution of transactions on Gx, Rx, Sd, Sy, and Sh 3GPP interfaces. Performance testing results are summarized in Table 4.

Server Hardware	Hypervisor	PFE Performance per Guest	MPE Performance per Guest	Number of VM Guests per Server
Standard Production Profile				
Oracle X7-2	VMware	38,000 TPS	4,500 TPS	4
Oracle X7-2	KVM ^{2,3}	24,000 TPS	4,000 TPS	4
Oracle X7-2	Openstack (pike)	24,000 TPS	4,000 TPS	4
Notes:				
1. The servers with two disks worked as RAID0 mode				
2. CPU pinning was utilized for testing with the KVM hypervisor.				
3. Disk cache mode write back and disk IO mode threads were used for testing with KVM hypervisor.				
Low Profile Production				
Oracle X6-2	KVM ^{2,3}	18,000 TPS	3,000 TPS	7 (1 MRA, 1 CMP and 5 MPEs)
Oracle X7-2	Openstack	18,000 TPS	3,000 TPS	7 (1 MRA, 1 CMP and 5 MPEs)
Notes:				
1. The servers with two disks worked as RAID0 mode.				
2. CPU pinning was utilized for testing with the KVM hypervisor.				
3. Disk cache mode write back and disk IO mode threads were used for testing with KVM hypervisor.				

Table 4: Performance using Reference Profile



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