Oracle Communications Policy Management

Feature Guide for Wireless & Fixed Networks (Release 11.5)

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List of Terms

Acronym	Meaning
3GPP	3rd Generation Partnership Project
AAR	Authorization Authentication Request (Diameter message)
CCR	Credit Control Request (Diameter message)
CMP	Configuration Management Platform
COMCOL	Oracle database application used by OCPM
GGSN	Gateway GPRS Support Node (system)
Gx	3GPP reference point between PCEF and PCRF
Gy	3GPP reference point between PCEF and OCS
HSS	Home Subscriber Service (system)
IP-CAN	Internet Protocol Connectivity Access Network
MCC	Mobile Country Code
MNC	Mobile Network Code
MPE	Multimedia Policy Engine
MRA	Multiprotocol Routing Agent (also referred to as the Policy Front End (PFE)
OCPM	Oracle Communications Policy Management (product, provides PCRF function)

Acronym	Meaning
OCS	Online Charging System (system)
OCDM	Oracle Communications Data Model (product)
OCSG	Oracle Communications Services Gateway (product)
OSSI	Operations Support Systems Interface
PCEF	Policy and Charging Enforcement Point (system)
RAR	Re-Auth Request (Diameter message)
RAT	Radio Access Type
Rx	3GPP reference point between the PCRF and Application Function (AF) such as a P-CSCF
Sh	3GPP reference point used between the PCRF and Subscriber Profile Repository (SPR) or Home Subscriber Server (HSS)
Sd	3GPP reference point between the PCRF and Traffic Detection Function (TDF)
SPR	Subscriber Profile Repository (system)
Sy	3GPP reference point between the PCRF and On-Line Charging System (OCS)
UDR	User Data Repository (system)
XML	Extensible Markup Language

Oracle Communications Policy Management

Release 11.5 Feature Guide (Wireless & Fixed Networks)

Introduction

As broadband services become ubiquitous, across both fixed and mobile networks, it becomes increasingly important for the operator to be able to control the services and subscribers in real time. The capability in the network that is required to deliver on the vision of real time control of services, applications and subscribers is called *policy management*. For wireless networks, this function is provided by a Policy Charging and Rules Function (PCRF) device, as defined by the 3GPP organization. For cable networks, this function is provided by Packet Cable Multimedia (PCMM), defined by CableLabs. Oracle Communications Policy Management (OCPM) provides both of these functions. This document focuses on the OCPM support for wireless networks. In addition to supporting 3GPP signaling using Diameter messaging, OCPM also supports RADIUS CoA messaging which is commonly used in fixed line broadband networks.

Policy management is the key to monetizing the network and recapturing control of subscriber experience. As the centralized policy decision-making point for a wireless network, OCPM enables you to control network usage and enable new revenue opportunities. Some of the use cases enabled by OCPM, typically for either individual subscribers or established pools of users, include:

- Limit download speeds during peak times in order to avoid network congestion, while allowing higher data rates during off-peak times
- Control network access and charging for access to specific services
- Offer tiered service levels which provide different performance parameters (e.g., gold level service has higher throughput and provides higher monthly data allowance)
- Establish guaranteed bandwidth paths to ensure good quality service for high revenue applications (e.g., gaming)
- Set aggregate usage thresholds to notify subscribers (e.g., when they exceed 80% of quota) or enforce limits (e.g., throttle when they reach 110% of quota or redirect to a self-service portal)
- Limit the number of simultaneous application sessions (per subscriber or per application)
- Pre-paid access, either for a specified period of time (e.g., per day) or usage (e.g., per GB)
- Immediate on-demand bandwidth increase to support heavy volume (turbo button)
- Loyalty programs which provide free or reduced-cost access to services
- Subscriber / parental controls to block/allow access to specific sites at specified times
- Access specific other subscribers (“family and friends calling circle”), to specific websites (“free music streaming”), or during off-peak hours (e.g., “free nights and weekends”) without reducing monthly allowances
- Prioritize specific traffic types including emergency calls, medical devices or VPN services

OCPM is a powerful, flexible scalable PCRF which is in production in over 55 deployments in 39 countries in support of a broad range of use cases including LTE services and VoLTE. In addition to providing you with feature-rich ability to control your network, it allows you to implement marketing strategies by allowing rapid deployment of new use cases. The highly scalable and resilient architecture provides the telco-grade reliability required to support the current explosive growth in subscribers and services.

OCPM's wide range of capabilities enables you to rapidly roll out converged services across multiple access networks including wireless 2G/3G/4G networks with or without VoLTE, fixed line networks (using RADIUS CoA as well as Diameter) and wireless LANs.

Wireless Interworking

OCPM communicates with other wireless network elements, as shown in Figure 1.

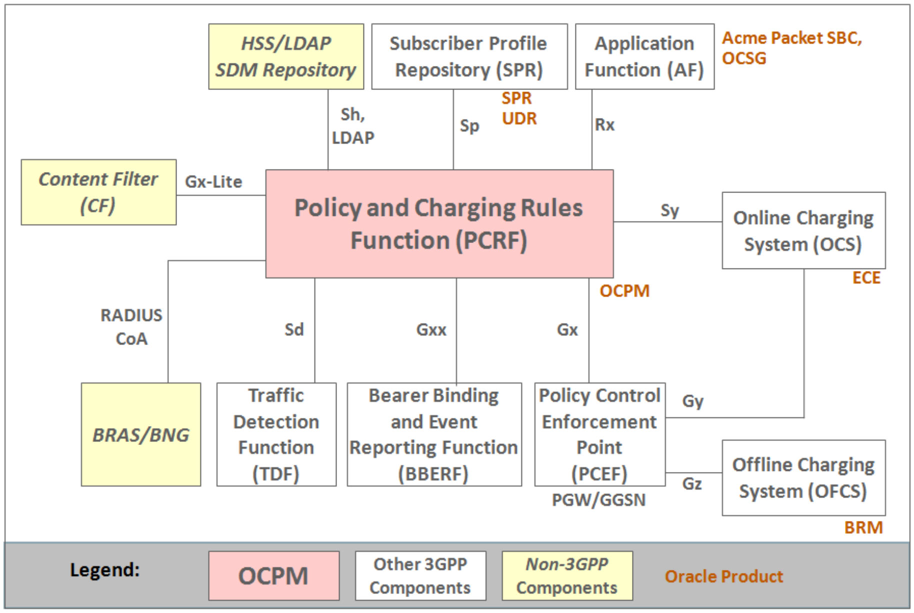

HSS/LDAP SDM Repository
Subscriber Profile Repository (SPR)
Application Function (AF)
Acme Packet SBC, OCSG
Sh, LDAP
Sp
SPR UDR
Rx
Content Filter (CF)
Gx-Lite
Policy and Charging Rules Function (PCRF)
Sy
Online Charging System (OCS)
ECE
OCPM
RADIUS CoA
Sd
Gxx
Gx
BRAS/BNG
Traffic Detection Function (TDF)
Bearer Binding and Event Reporting Function (BBERF)
Policy Control Enforcement Point (PCEF)
PGW/GGSN
Gy
Gz
Offline Charging System (OFCS)
BRM
Legend:
OCPM
Other 3GPP Components
Non-3GPP Components
Oracle Product

Figure 1: Oracle Converged Architecture using OCPM

Oracle's support for wireless 3GPP signaling includes the following product families:

- **Oracle Communications Policy Management (OCPM):** OCPM provides PCRF functionality as defined by the 3GPP standards organization. This centralized signaling control point applies operator-defined rules that enforce business needs, such as whether a subscriber is authorized to access a service, whether it can be accessed from the current location and the bandwidth which should be allocated.

  OCPM is compliant with 3GPP standards specifications including TS 23.203, TS 29.212, TS 29.213, TS29.214, TS29.219, and TS 29.239 as defined in Oracle's 3GPP Statement of Compliance Documents. OCPM supports all PCRF capabilities for session binding, QoS authorization, and dynamic charging for each application session established via the IMS framework. In addition to supporting 3GPP standards, OCPM has been tested with IMS and Mobile Gateway infrastructures from leading vendors.

- **Oracle Communication Subscriber Profile Repository (SPR)/Oracle Communications User Data Repository (UDR):** SPR, and its successor UDR, provide 3GPP SPR functionality. OCPM and SPR/UDR also have been extended to provide quota management, eliminating the need for a separate OCS in some networks.

- **Business and Revenue Management (BRM):** BRM serves as the 3GPP offline charging system (OFCS) as well as providing the ability to define new subscribers and what they are allowed to do.

- **Elastic Charging Engine (ECE):** ECE, which is part of the BRM product suite, serves as the 3GPP online charging system (OCS).
- **Oracle Session Border Controller (SBC):** OCPM is interoperable with Oracle (formerly Acme Packet) Session Border Controllers. These function as a P-CSCF, which is a type of Application Function (AF) in the 3GPP reference architecture.
- **Diameter Signaling Router (DSR):** These and other network elements are interconnected using Diameter Routing Agents (DRAs) such as Oracle's DSR. There may be multiple Diameter networks connecting various types of equipment, as shown in Figure 2.

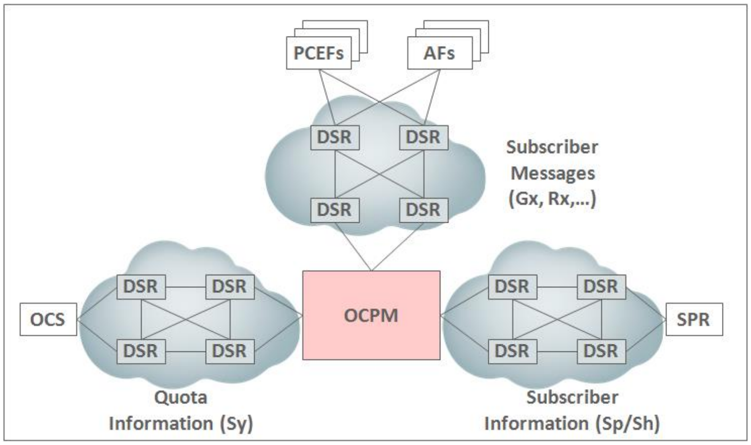


Figure 2: Diameter Physical Connectivity

Oracle Solutions

The capabilities provided by OCPM can be expanded when used in conjunction with other Oracle products including:

- **Network Policy as a Service (NPaaS):** Oracle's NPaaS solution securely exposes and aggregates network policy assets to accelerate innovation and external partner collaboration, enabling the operator to provide compelling new services to grow revenue. Oracle Communications Services Gateway (OCSG) exchanges information with OCPM using the CableLabs PCMM (for cable networks) or 3GPP Rx (for wireless networks) interfaces.
- **Oracle Communications Policy Analytics:** OCPM has been integrated with Oracle Communications Data Model (OCDM) into a pre-built analytics solution designed for quick implementation. Policy Analytics provides insight into OCPM value and effectiveness. Analytics systems provide detailed reports on policy usage, quota usage, subscriber behavior, and policy system performance, among other items. OCPM can generate an Analytics Data Stream (ADS) to send information about what is occurring to an external server for analysis.

OCPM Servers and Topologies Overview

OCPM consists of the following components:

- MPE: The Multimedia Policy Engine (MPE) implements the majority of the PCRF functionality provided by OCPM. When a request is received, the MPE contacts external data sources to find additional data related to the request and execute policies based on all known information and then processes the operator-defined policies.
- MRA: The Multi-Protocol Routing Agent (MRA) is a stateful load balancer that selects which MPE will support each initial subscriber requests, based on how loaded each MPE is. Subsequent requests for the same subscriber are then forwarded to the MPE assigned for that subscriber. The MRA also correlates traffic between different sessions. The MRA is also referred to as the Policy Front End (PFE) to highlight that this is not a general-purpose Diameter router.
- CMP: The Configuration Management Platform (CMP) provides system configuration and provisioning policies. It also provides a consolidated view of system alarms and logs for managing/monitoring MPEs and MRAs. CMP also provides an OSSI XML API for exporting/importing information to/from external systems.

An OCPM *PCRF node* is defined as one MRA cluster and the MPE clusters for which it provides load balancing and correlation. PCRF node scaling is achieved by adding MPEs. Once MRA capacity is reached, additional MRA clusters may be added with additional MPEs. Collectively, a single CMP instance (one or two HA clusters) and the PCRF nodes which it controls are referred to as an OCPM *PCRF system*.

Each OCPM server can run on supported configurations of the following hardware families:

Table 1: Supported Hardware Families

Server	Supported Server Hardware
CMP	HP BL460C G6/G8 Blade Server (in c7000 enclosure) HP DL380 G6/G8 Rack Mount Server Sun Netra x3-2
MPE, MRA/PFE	HP BL460C G6/G7/G8+ Blade Server (in c7000 enclosure) HP DL380 G6/G7/G8+ Rack Mount Server Sun Netra x3-2
SPR/UDR	HP BL460C G6/G7/G8+ Blade Server
Management Server (required when using c7000 enclosure)	HP DL380 G6/G7/G8+ Rack Mount Server (DC) HP DL360 G6 Rack Mount Server (AC)

Figure 3 provides an illustrative flow through an OCPM node, such as when an initial subscriber session request is received:

1. A subscriber request is received by the MRA, which determines which MPE should process this message and forwards the packet to that server. Load conditions are shared between MRA and the MPEs using Oracle's Distributed Routing Management Application (DRMA) protocol. In this example, the MRA has selected MPE cluster 2 to support this new subscriber request, and has forwarded the message to the active server in that cluster.

2. The MPE queries external data sources such as subscriber repositories (SPR/UDR/HSS) and/or online charging servers (OCS) to gather information about the subscriber.
3. Once all information is received, the MPE processes the policies to determine the appropriate actions, and forwards the response to the MRA.
4. The MRA performs any required processing and forwards the response to the requester.

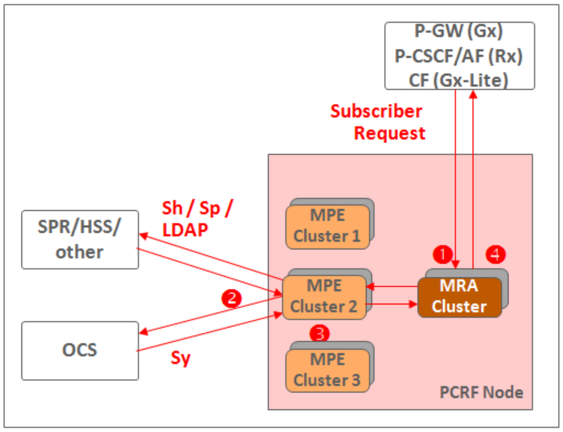


Figure 3: Sample Packet Flow through OCPM

OCPM interworks with a wide range of 3GPP-compliant and other equipment including:

- Policy and Charging Enforcement Functions (PCEF): PDN Gateways (PGW) and Gateway GPRS Support Nodes (GGSN)
- Serving Gateways (SGW) and Serving GPRS support node (SGSN)
- Application Functions (AF) such as P-CSCF
- Traffic Detection Functions (TDF)
- Online Charging Systems (OCS)
- Lawful Intercept Mediation Function (LIMF)

Server Redundancy

Redundancy is implemented for each component as described below.

High Availability Cluster (MPE, MRA, CMP)

The basic unit of resiliency within the OCPM is the high availability (HA) cluster, which is a pair of co-located servers which are continually synchronized. These servers may be identified in any of several ways:

- The physical servers are referred to as server A and server B. They are also referred to as *primary* and *standby* servers.
- At any given time, either server may be in the active state, while the other server is in a backup state. The active server processes packets and continually updates the backup server about known sessions so that it can take over if needed.

MRA, MPE and CMP can all be implemented as HA clusters.

Note that each cluster independently determines which server is active. For example, the primary server (server A) may be active for one MPE cluster, while the standby server (server B) is active for another MPE cluster.

Geographic Redundant Cluster (MPE, MRA)

MRA and MPE clusters may be extended by adding a third server, also called server C or the spare server. This server resides at a different site, but is continually synchronized with the active server. The spare server becomes active if neither server at the primary site is reachable, which may happen if connectivity is lost to that site.   When MRA/MPE geo-redundancy is employed, a spare server is typically deployed for every cluster.

Again, each cluster independently determines which server is active. For example, server A may be active for one cluster, server B can be active for a different cluster, and server C can be active for a third cluster. The active server in each cluster continually updates both backup servers.

Disaster Recovery Cluster (CMP)

Since there can only be one active CMP in the network, an additional level of redundancy is available for this component. You can manually switch to using a separate disaster recovery CMP (DR-CMP) cluster if a power failure occurs at the primary site or a network outage prevents reaching the primary CMP cluster. The DR-CMP is typically located at a backup site.

Figure 4 illustrates the various resiliency schemes. Under normal operation, the primary server at the primary site (site 1) would be the active server, which is shown using a different color.

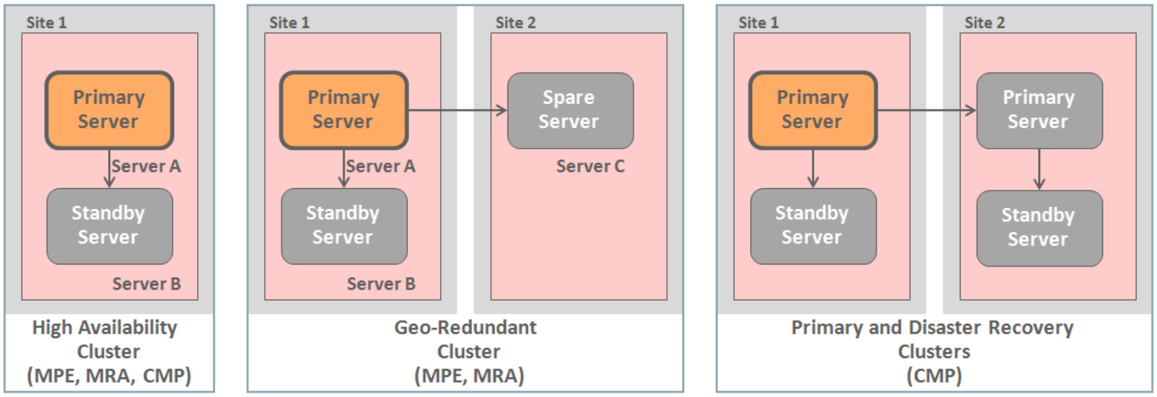


Figure 4: OCPM Cluster Resiliency

Network Topologies

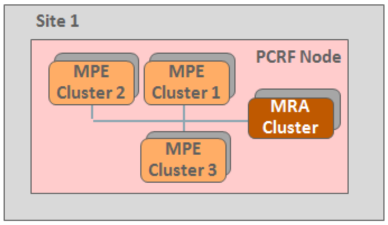
This chapter describes three topologies supported by OCPM. They range from a simple solution with only cluster redundancy to a highly available solution with extreme scalability and multiple redundancy levels. The topologies are:

- Standalone PCRF Node
- PCRF Segments (Geo-Diverse)
- Geo-Redundant Design

Standalone PCRF Node

The simplest policy system is a single PCRF node, which consists of one high-availability (two server) MRA cluster and one/more associated MPE clusters. All of these elements are managed by one CMP cluster. This topology is illustrated in Figure 5. In each cluster, the colored servers are active and the gray servers are in standby mode.

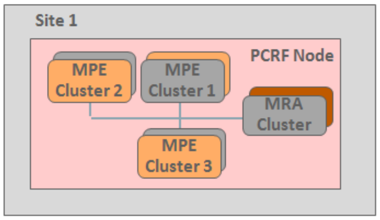
This example includes three MPE HA clusters. The entire PCRF node must be located at the same site, while the CMP may reside at a different location.



- Server A on top, Server B is in back
- Active servers are colored, standby servers are shown in gray

Figure 5: Standalone PCRF Node Topology (Server A is active for all clusters)

Note that each cluster independently determines which server is active. For example, Server A may be active for the MRA cluster, while server B is active for MPE cluster 1. This is depicted in Figure 6.



- Server A on top, Server B is in back
- Active servers are colored, standby servers are shown in gray

Figure 6: Standalone PCRF Node Topology (Server B is active for some clusters)

An operator can deploy multiple independent PCRF nodes which do not communicate with each other. A single CMP cluster can support multiple PCRF nodes.

Associated PCRF Nodes (Geo-Diverse)

This topology interconnects multiple PCRF nodes into a single *policy segment*, which is a collection of PCRF nodes which share session/subscriber binding information. All PCRF nodes within a policy segment are managed by a single CMP cluster.

When an MRA receives a message for a subscriber it does not know about, it first checks whether this is for a subscriber that is known to another PCRF node. If so, the request is handed off to the appropriate PCRF node; otherwise, the original MRA takes ownership of this subscriber and assigns an MPE. The active MRAs share information using the Distributed Routing and Management Application (DRMA).

Multiple standalone PCRF nodes can be located at the same site to increase overall scaling, or they can be spread across two or more different locations to improve resiliency. For example, a P-GW may be provisioned to send a request to a preferred MRA, and if a response is not received within a specified time then the request is sent to a different MRA. When the policy segment includes PCRF nodes at multiple sites, it is called a geo-diverse deployment. Figure 7 depicts this topology with four PCRF nodes across two sites.

OCPM sites are often deployed in pairs to simplify scaling of the Diameter network. Each Diameter peer provides a primary and secondary Diameter connection to reliably reach the OCPM. If the MPE supporting a subscriber is not local to the MRA which received the message, it routes the message to the appropriate MRA. This approach simplifies the mesh of connections between the MRA and the MPEs.

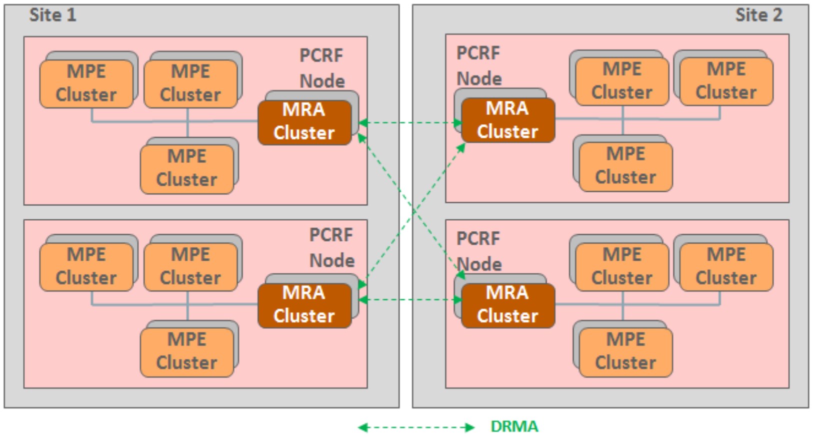


Figure 7: Interconnected PCRF Nodes (Geo-Diverse) Topology

While the MRAs share information about which subscribers are supported by each, specific binding information is not replicated between MRAs. Therefore, losing all connectivity paths to a PCRF node causes existing sessions established on that PCRF node to fail.

Geo-Redundant Design

This topology provides an additional level of resiliency by adding a third server to each cluster. Each geo-redundant cluster has two servers (A and B) at one site and a single server (C) at the other site. Since information about each subscriber is shared between all servers within a cluster, session information is maintained at server C even if both servers at the primary site (servers A & B) fail. Figure 8 illustrates this scenario with two PCRF nodes. For PCRF1, the primary server (server A) is active for all clusters. For PCRF Node 2, the server B has become active for MPE cluster 3, and the server C is active for cluster 5.

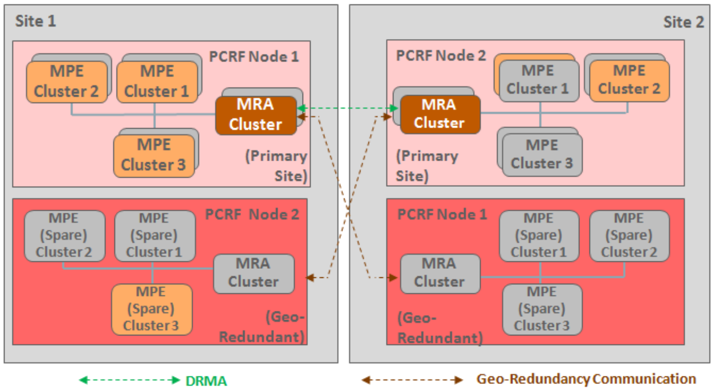


Figure 8: Geo-Redundant Design Topology

If the primary (dual-server) cluster fails, then sessions are routed through an active primary MRA to the geo-redundant server for that cluster. Figure 9 shows the connections when site 1 fails. In this case, the geo-redundant server for PCRF Node 1 takes over the load, with communications destined for PCRF Node 1 passing through the active MRA for PCRF Node 2.

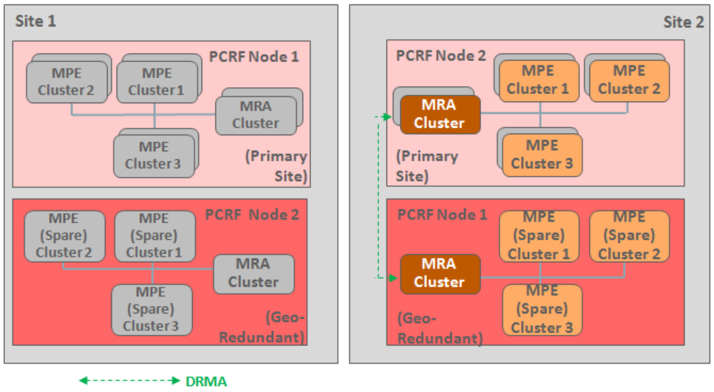


Figure 9: Geo-Redundant Design with Site Failure

While each geo-redundant PCRF node spans exactly two sites, the overall deployment may encompass additional locations. For example, Figure 10 shows a simplified view of a geo-redundant design spanning three sites. Each PCRF node can have a DRMA connection to every other PCRF node.

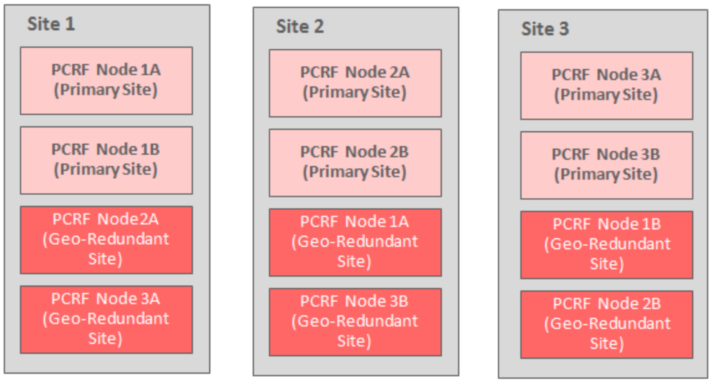

Site 1
PCRF Node 1A (Primary Site)
PCRF Node 1B (Primary Site)
PCRF Node2A (Geo-Redundant Site)
PCRF Node 3A (Geo-Redundant Site)
Site 2
PCRF Node 2A (Primary Site)
PCRF Node 2B (Primary Site)
PCRF Node 1A (Geo-Redundant Site)
PCRF Node 3B (Geo-Redundant Site)
Site 3
PCRF Node 3A (Primary Site)
PCRF Node 3B (Primary Site)
PCRF Node 1B (Geo-Redundant Site)
PCRF Node 2B (Geo-Redundant Site)

Figure 10: Three-Site Geo-Redundant Design (Simplified View)

Understanding Policy Management

OCPM takes predetermined actions based on received packets and also executes operator-defined *policy rules*. A policy rule is a statement which defines actions which are taken when one or more conditions are met. There are three key components:

- Policy Trigger: An event which causes policies to be *evaluated*
- Policy Condition: The criteria which are evaluated.
- Policy Action: Actions which occur if the condition is met.

Policy Triggers

OCPM executes operator-defined policies which perform appropriate action(s) based on specified conditions. Policy evaluation is most commonly triggered when a message is received from another device, including PCEF (via Gx interface), AF (via Rx interface), DPI/TDF (via Sd interface), SPR/UDR/HSS (via Sh/Sp/LDAP interfaces), and OCS (via the Sy interface). Policy evaluation can also be triggered based on internally-generated time and day information. This allows you to define time periods and associated actions to be performed when time transitions from one period to another.

Some triggers cause OCPM to contact other data sources to gather additional information. For example, when receiving an initial session request (Gx:CCR-I message), OCPM typically retrieves the subscriber's provisioned information/entitlements and quota related information (from an Oracle SPR/UDR or third party repository) and stores these data elements in its local database. Once the relevant information is in place, OCPM can use the information in the message, information about the subscriber from other systems/components, as well as state information (that is, information previously learned) stored in OCPM to evaluate the policy conditions.

OCPM can limit the number of total (Gx, Gx-Lite and Rx) sessions that a subscriber can have. OCPM correlates the various sessions for each subscriber, or pool of subscribers such as a family plan, if supported by the subscriber repository using either a user identifier such as IMSI or MS-ISDN, or using network session information such as IP address and APN. Policy conditions and actions can utilize all the available information regarding a subscriber when decisions are evaluated. For example:

- Receiving a VoLTE session request across the Rx interface typically results in OCPM sending an updated PCC rule to the PCEF.
- OCPM can determine roaming status via the PCEF Gx information and then push down roaming rules to a DPI device.
- OCPM can use quota-related information gathered over Gx+ with a DPI device to enable different rules on Gx with the PCEF.

OCPM can maintain sessions on multiple Gx interfaces with different PCEFs for a given subscriber session. A single trigger event can cause OCPM to install new policy rules to multiple PCEFs .

Policy Conditions

The overall policy condition includes one or more conditions which are checked, connected by logical AND, OR, and NOT operators. Many (but not all) conditions check for specific values using the format "if parameter operator value", e.g., "where RAT-Type is equal to WLAN". Policy conditions can also check for the presence of specific information (e.g., if the time zone AVP exists"), ranges ("if the bandwidth is between 100 Mbps and 200 Mbps") and many other conditions. You can also define (via GUI or importing) match lists of items to be checked in policy conditions. For example, you can check whether the SGSN/SGW address that is included in the Gx:CCR-I trigger message is (or is not) included in an imported SGSN/SGW file.   In addition, OCPM can operate using either the subscriber local time zone or the system local time zone.

OCPM policy conditions are grouped into the following categories:

- Request: Conditions related to the application associated with the request.
- Network Identity: Conditions related to the specific network device for which the policy rule is being evaluated. This includes conditions based on the network device type, as well as those that refer to specific unique identifiers for network devices.
- Device Usage: Conditions related to the calculated usage for the network device for which the policy rule is being evaluated. This usage includes device-level tracking of both bandwidth and flow/session counts.
- Mobility: Conditions that are based on information associated with networks that include mobile subscribers (such as a wireless network).
- User: Conditions related to the subscriber, or subscriber account, that is associated with the protocol message that triggered the policy rule execution. This includes subscriber-level and account-level tracking of usage.
- User State: Conditions related to subscriber properties.
- Policy Context Properties: Conditions related to the context in which a policy is evaluated.
- Time of Day: Conditions related to the time at which the policy rules are being executed.
- Policy Counters: Conditions related to policy counters stored in online charging servers (OCSs).

A policy does not need to have any policy conditions defined. In this case, the policy actions are always applied.

To simplify policy creation, Policy Wizard uses the following terminology for sessions:

- Enforcement Session: Gx, Gxx or Gx-Lite Session
- IP-CAN Session: Gx session
- GW Control Session: Gxx session
- DPI Enforcement Session: Gx-Lite session
- Application Session: Rx Session (policy tests for AAR-I and AAR-U)

Policy Actions

OCPM supports a wide range of policy actions. The first policy action related to any subscriber is typically to instruct the PCEF how to treat this subscriber. This occurs by pushing a new PCC rule, modifying an existing rule, or telling the PCEF to use a pre-defined rule. Of course, rules are removed when a session terminates. Many actions are also available to modify the available quota. OCPM can also instruct the PCEF to redirect traffic to a different port. OCPM also supports sending SMS notifications to one or multiple subscribers, and can also send email messages. Alarm/Trap/Syslog notifications can also be sent to network operations center.

Policy Example

A pseudo-code example of a policy is:

IF (Policy Conditions)

1. This subscriber is entitled to video AND
2. is connected to a UMTS network AND
3. is in their home network (is not roaming) AND
4. cumulative usage for this billing cycle is less than quota threshold AND
5. the number of sessions currently admitted behind this SGSN/SGW is less than the maximum allowed AND
6. video is allowed during this time period

THEN (Policy Actions)

7. Admit session
8. Set the minimum guaranteed downstream bandwidth to 1 Mbps
9. Set the maximum allowed downstream bandwidth to 2 Mbps
10. Enable video service (only)

The first line of the policy rule checks against subscriber entitlements which is information retrieved via the UDR. Lines 2 and 3 of the statement checks specific data retrieved from the PCEF via the CCR message. Line 4 involves checks based on usage information, and Line 5 is a resource threshold check based on OCPM keeping track of resources associated with nodes in the network. Line 6 verifies that the subscriber is entitled to the services during the time of day.

The actions which are executed if these conditions are met appear on the last few lines. In this case the session is allowed for video service only, and the allowable bandwidth is set.

The actual policies are written via a graphical rules creation wizard called Policy Wizard. Available policy conditions and actions are described in the *CMP Wireless User's Guide*.

MRA Overview

The MRA is the front-end component of OCPM which directs traffic to the appropriate MPE. It provides the following capabilities:

- MPE load balancing: For initial session requests, the MRA selects which MPE supports the session. Each MPE passes load status information to its MRA, allowing the MRA to intelligently make this decision.
- Session binding: For established sessions, the MRA forwards subsequent messages for this session to the assigned MPE. In addition, the MRA provides session correlation, forwarding requests for the same subscriber to the same MPE.
- Topology hiding: The MRA also supports topology hiding for Gx and Rx applications. Upstream nodes do not see any information about individual MPEs.
- Simplified scaling: Using an MRA allows MPEs to be added (and the Diameter traffic load rebalanced) without affecting PCEF configuration. Implementing an MRA also reduces the mesh of Diameter connections, allowing the PGW to forward traffic to a small number of MRAs rather than a larger number of MPEs.
- MRA multi-homing: Multiple MRAs can be logically interconnected ("associated") to further increase scalability. These MRAs share information to ensure that messages are serviced by the appropriate MPE, regardless of which MRA receives the message.
- Improved reliability: Multi-homing also improves reliability by enabling the overall wireless signaling network to routing around individual connection failures.
- Congestion management: When congestion occurs on an MPE, the MRA can be configured to pass only selected types of messages to that MPE. The behavior can be customized, although default operation is pre-defined.

MPE Overview

The MPE is the OCPM component which provides the PCRF functionality. This section provides a brief overview of major capabilities provided by Oracle's PCRF implementation. Provisioning of these functions is performed using CMP.

Powerful Policy Support

OCPM supports over 250 policy conditions and 150 policy actions. CMP's Policy Wizard walks you through the process of creating policies. Policies can be created from scratch, or an existing policy can be used as the basis for a new policy. You select the desired condition (e.g., "where RAT_Type is equal to <value>") or action (e.g., "set QCI to <value>") from a list, and then click on the appropriate fields to specify the desired values. Complex policy conditions can be created using AND, OR and NOT modifiers. Policy Wizard is described later in this document.

Flexible AVPs

OCPM allows you to easily define new AVPs using standard or experimental formats. This allows you to easily support new capabilities without updating your OCPM software. In addition, any known AVP can be inserted into messages, including Diameter applications that they are not originally specified for.

Policy Tables

Policy Tables can reduce the number of policies required when only a few variables change between different policies. Each row in the Policy Table represents a set of policy conditions and actions. Some columns (referred to as key fields and shown in red in Table 2) identify the policy conditions, while other columns define the required policy action. When all key columns are matched within a single row, then the corresponding actions identified in the remaining columns are executed. For example, the following table allows using a single policy to install and remove PCC rules on APNs, instead of requiring four separate policies:

TABLE 2: SAMPLE POLICY TABLE

APN	Install PCC Rules	Remove PCC Rules
telco.g1t1	telco rulebase qos t1	modem stop qos
telco.g1t2	telco rulebase qos t2	modem stop qos
telco.g2t1	modem stop qos	telco rulebase qos t1

Policy Export/Import

Existing policies, policy groups, templates, and traffic profiles, traffic profile groups, as well as other information, can be exported via the CMP GUI and later imported via the GUI if the operator wishes to "rollback" to a previous set of policies and/or traffic profiles/groups. The exported file includes a version number and the CMP software version under which the export was performed. This allows manual selection of the correct export file that the operator wishes to import.

The import/export solution also provides several import options to indicate how existing data is to be treated compared to the data being imported should data collisions/conflicts occur, and which determine whether/how policies are re-deployed to the MPEs upon import. The import options are:

- Delete all before importing: All policies, policy groups, and templates currently on the CMP and all MPEs are deleted. Imported policies are restored to the CMP, but are not automatically deployed to the MPEs. The user must manually deploy the policies after the import is complete.
- Overwrite with imported version: All items are imported. If the CMP currently contains any policies, policy groups, or templates using the same names as the ones being imported, they are overwritten with the imported versions. Any existing policies that are changed as a result of the import, and that are already deployed to an MPE(s), are automatically re-deployed after the import. Any existing policies that are changed, and that are not already deployed to an MPE(s), are not automatically deployed after the import – the user must manually deploy these policies after import,
- Reject any that already exist: All items are imported except for imported versions with the same name as any policy, policy group, or template currently on the CMP. Matching items are not imported. New (non-matching) items are imported, but are not automatically deployed to the MPEs. The user must manually deploy the policies after the import is complete.
- Any collisions prevent all importing: No items are imported if any of the imported versions has the same name as any policy, policy group, or template currently on the CMP. This is the default.

Policy Rollback

CMP provides the ability to take a snapshot (“checkpoint”) of the deployed policies. If modifications result in unexpected behavior, you can re-apply this previously saved configuration. The data saved within this snapshot consists of all the data currently contained within the export file that is currently available from the CMP navigation pane, which includes all policies, policy groups, templates, traffic profiles, and traffic profile groups.

You can also delete a specific checkpoint from the saved list. This provides flexibility in pruning the number of saved checkpoints rather than simply deleting the oldest saved version.

SDP and Codec Support

You can create policies which set traffic parameters based upon specific codec-data SDP information. In addition, OCPM supports default bandwidth setting numerous codecs including AMR, AMR-WB and T.38 (fax).

Stale Session Cleanup

If a subscriber session has existed for longer than its configured maximum validity time without any explicit updates from the corresponding gateway, or if a more recent session exists for the same subscriber and protocol, the session is considered "stale." CMP can remove stale subscriber sessions. This cleanup behavior is configurable.

Congestion Management (Load Shedding)

The MPE can detect and respond to overload conditions. During times of congestion, each node can reject selected packets by notifying upstream devices that the packets cannot be processed. Each node ranks its congestion level, and messages are selectively rejected based on this. For example, at the lowest congestion level, new session requests (CCR-I) are rejected so that the sender can resend them to a different MPE. More severe congestion levels result in additional packets being rejected. Default actions are provided but can be modified by the operator. The load shedding infrastructure takes into account all Diameter applications and the request types when performing admission control on the corresponding requests.

Sponsored Data Connectivity

OCPM supports the 3GPP standard method for Sponsored Data Connectivity, which allows the subscriber's application traffic to be sponsored by an application service provider. The sponsor establishes a business agreement with the service provider and reimburses for a user's specific application usage associated with the application service provider.

OCPM allocates monitoring keys, grants quota and delivers usage reports received by OCPM to the AF when the threshold is reached or the session is terminated. OCPM accomplishes this by installing PCC Rules on the PGW.

RADIUS CoA Support

OCPM can interface with BRAS using the RADIUS CoA support, allowing the same policy solution to support converged wireless and fixed line deployments. OCPM has a flexible mechanism to support TLV and VSA definitions for CoA messages. The charging and subscriber quota information is sent from the OCS to OCPM using the Sy interface for policy re-evaluation to determine if new CoA rules should be sent to the BRAS to change the subscriber's current service. RADIUS session and Sd session correlation is also supported when there is both a BRAS and TDF in the subscriber service or call flow.

Advanced Quota Management

OCPM's quota management features allow you to implement policy control based on subscriber usage, without requiring an OCS. When a subscriber first attaches, OCPM retrieves information about the subscriber's quota/balance from the charging system. When a subscriber detaches, the updated balance information can be pushed back to the charging system. OCPM can also subscribe to be notified of quota changes.

OCPM supports quota management in conjunction with several charging systems, including Oracle's SPR/UDR. OCPM and SPR/UDR exchange quota information using the Sp interface. Oracle pioneered the use of quota management across the Gx interface, and these enhancements have now been adopted by 3GPP.

Based on information about subscriber usage, policy decisions can be made and policy rules can be pushed to the PCEF or TDF to change enforcement. This OCPM can use quota information in policy conditions to take actions such as:

- Set or modify the quota available to this subscriber.
- Grant the user a quota (e.g., volume/time) and set a volume/time threshold for when the PCEF needs to re-authorize with OCPM (acting as Quota Manager) for additional units.
- Query the PCEF to determine the amount of usage (at any point in time mid-session) and potentially grant more.
- Redirect the user session to a top-up portal where they can recharge units, Advice of Charge portal to notify and/or for the user to explicitly accept charges, or a to a Customer Care portal.
- Terminate the credit control session (normally in the case where the user runs out of granted units) or particular service.
- Install dynamic subscriber rules, such as throttling the user once a quota threshold is exceeded.

Specific controls and capabilities vary depending on the signaling interface and parameters provided. Subscriber pools (e.g., family plan) as well as individual subscribers are supported.

OCPM can also receive quota information from the PCEF when the quota has been deleted (quota breach) or updated (quota reallocation) and use this information in policies. The billing day can be changed within the current billing cycle if the user has no usage recorded, the next billing cycle, or when starting a new session.

Using CMP to Operate Your System

OCPM system configuration, policy provisioning and monitoring are performed via CMP. The primary operator interface is the graphical user interface, which is illustrated in Figure 11. Using the GUI, the operator can define servers and clusters, provision policies, monitor the system, upgrade software and perform administrative functions. This section focuses on the tasks required to get the system operational. Within the GUI, functions are selected from the menu in the left-hand frame, and parameters are configured and viewed in the main work area.

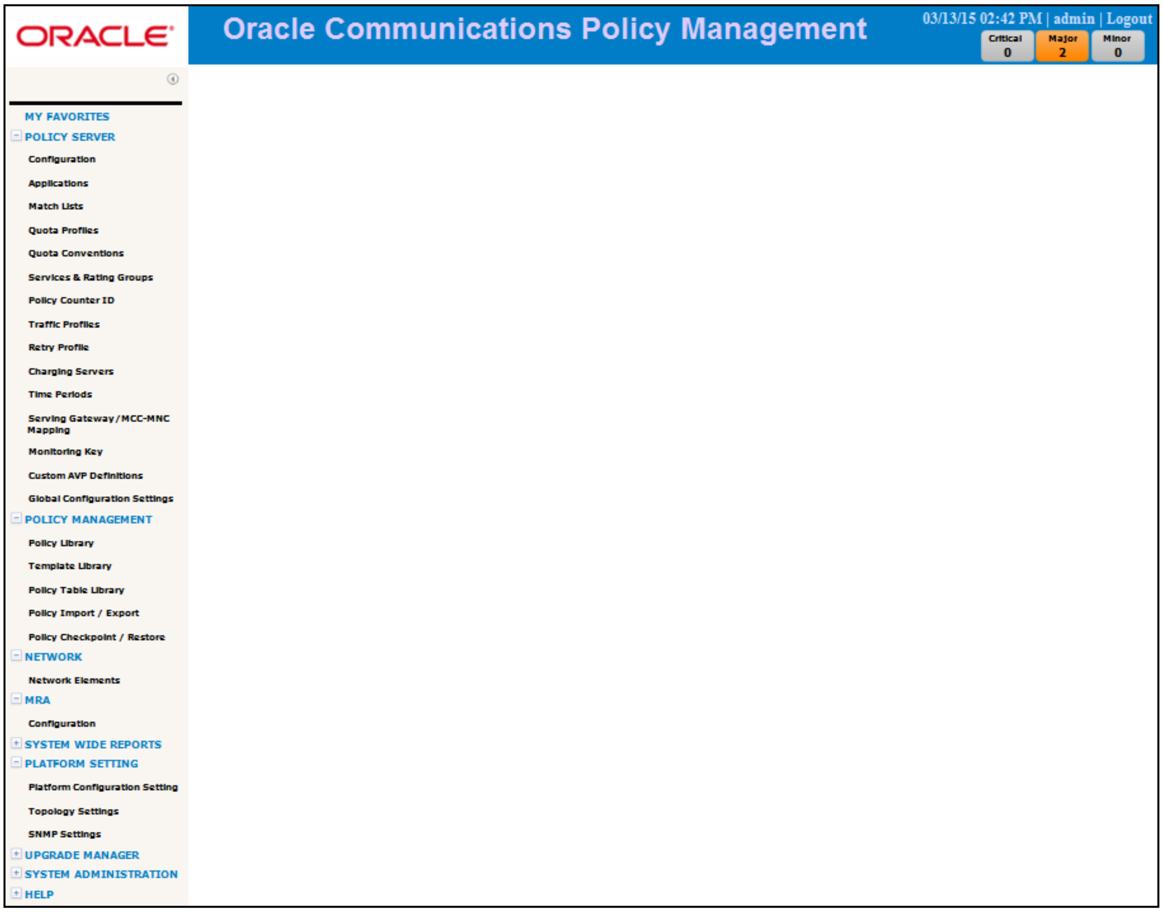


Figure 11: CMP Navigation Bar

Additionally, CMP supports an OSSI interface which allows bulk configuration data to be provisioned into, and queried from, the system. This interface uses XML documents snippets posted or retrieved over HTTP(s).

The user interface exposes a subset of the information available in use for evaluating policy conditions. The information that the operator sees can be customized by modifying an XML file.

The major steps to implement OCPM are:

- Initial system setup
- Policy creation and deployment
- Monitoring and management

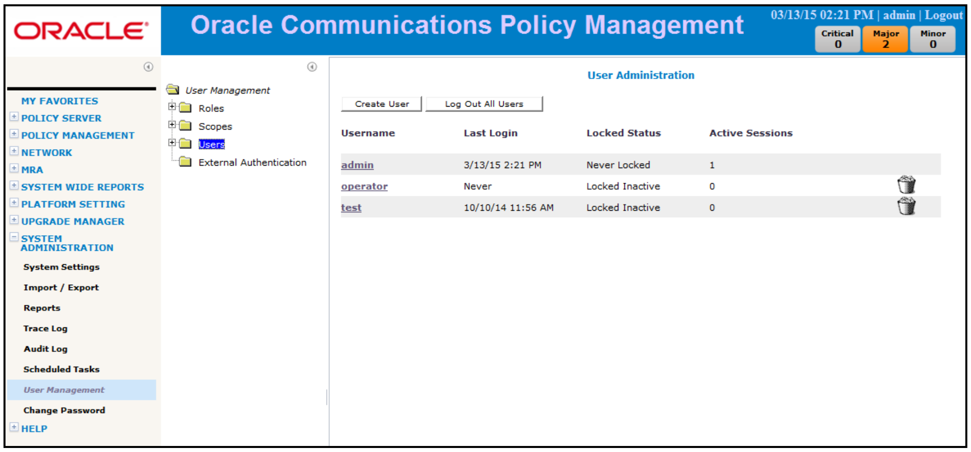
Initial System Setup

Initial system setup includes the following:

1. System Administration: Create an account for each authorized operator
2. Topology Definition: Define how servers are interconnected into clusters
3. Network Definition: Define the other devices (Network Elements, Data Sources, Online Charging Servers) which communicate with OCPM. At this point you can also include any one-time definitions, such as any custom AVPs which are used on your network.

System Administration

The first step is to authorize operators to perform the various tasks. There are three default *roles*: Administrator, Operator and Viewer. The Administrator has all permissions, an Operator cannot access the User Management functions, and the Viewer can look but not change settings. New roles can be created, and the permissions of each role can be modified. Individual *user* accounts can point to the desired role. In addition, the *scope* of resources which can be modified by each user can also be defined. These functions are performed using the User Management screen under System Administration, which is shown in Figure 12.



User Administration

Username	Last Login	Locked Status	Active Sessions
admin	3/13/15 2:21 PM	Never Locked	1
operator	Never	Locked Inactive	0
test	10/10/14 11:56 AM	Locked Inactive	0

Figure 12: User Administration Screen

Topology Definition

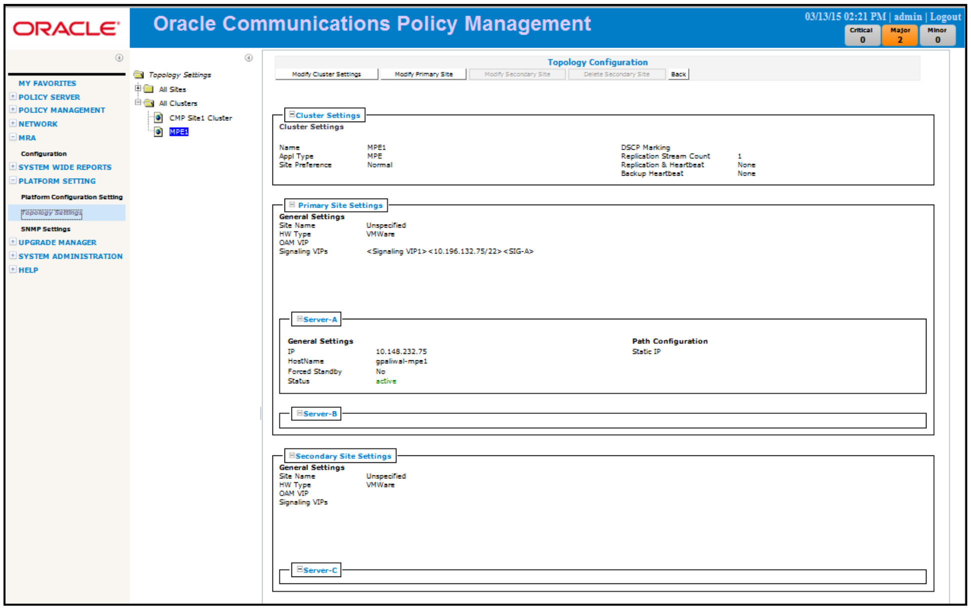
After installing the hardware, servers are assigned to clusters. Key decisions to be made in conjunction with Oracle include:

- Number of MPEs and MRAs required per site. This is based on the volume of traffic expected.
- Whether geo-redundancy is used, including locations of geo-redundant servers.

After the hardware is installed and configured, the following steps are required:

- Define each cluster. Individual servers are grouped into clusters using CMP.
- Assign MPE clusters to MRA clusters.

Figure 13 shows the Topology Settings screen which is used to define clusters.



Cluster Settings

Cluster Settings

Name	MPE1	DSCP Marking	
Appl Type	MPE	Replication Stream Count	1
Site Preference	Normal	Replication & Heartbeat	None
		Backup Heartbeat	None

Primary Site Settings

General Settings

Site Name	Unspecified
HW Type	VMWare
OAM VIP	
Signaling VIPs	<Signaling VIP1><10.196.132.75/22><SIG-A>

Server-A

General Settings		Path Configuration
IP	10.148.232.75	Static IP
HostName	gpaliwal-mpe1	
Forced Standby	No	
Status	active	

Server-B

Secondary Site Settings

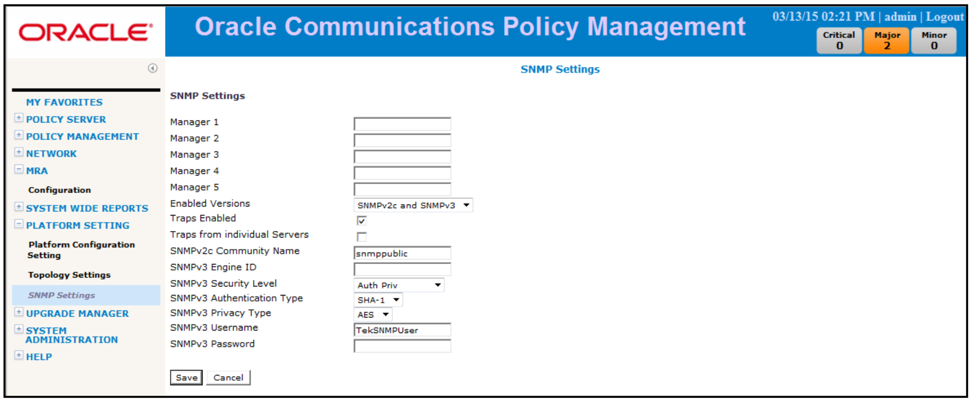
General Settings

Site Name	Unspecified
HW Type	VMWare
OAM VIP	
Signaling VIPs	

Server-C

Figure 13: Topology Settings Screen

CMP is also used to define SNMP settings, as shown in Figure 14. OCPM can be configured so that CMP is the source of all traps. Alternatively, each server can generate its own traps. SNMP traps are listed in the *SNMP User's Guide*.



SNMP Settings

SNMP Settings

Manager 1	
Manager 2	
Manager 3	
Manager 4	
Manager 5	
Enabled Versions	SNMPv2c and SNMPv3
Traps Enabled	☑
Traps from individual Servers	□
SNMPv2c Community Name	snmppublic
SNMPv3 Engine ID	
SNMPv3 Security Level	Auth Priv
SNMPv3 Authentication Type	SHA-1
SNMPv3 Privacy Type	AES
SNMPv3 Username	TekSNMPUser
SNMPv3 Password	

Figure 14: SNMP Settings Screen

When the time comes to upgrade to a later version of OCPM software, *Upgrade Manager* provides step by step guidance through the software upgrade. Multiple MRA/MPE servers can be upgraded simultaneously. If any issues arise, Upgrade Manager guides the operator through the backout procedure.

Network Definition

Using CMP, you define the other devices with which OCPM communicates. By selecting from the navigation bar, you can configure:

- Network Elements, which are devices that can initiate connections (required). These include PGWs, GGSNs and TDFs.

- Serving Gateways (if needed). An SGSN/SGW may not provide a GGSN/PGW with mobile country code (MCC)/mobile network code (MNC) information, reducing OCPM's ability to detect specific roaming scenarios. This mapping table converts an SGSN IP address to the proper MCC/MNC value. Once the MCC/MNC values are determined, they can be used in policies to differentiate subscriber treatment based on the specific roaming scenario.

- Third Party AVPs (if needed): Most information is transmitted using Attribute Value Pairs (AVPs). Some network elements may support non-standard AVPs, or AVPs which were standardized after OCPM was installed in your network. In addition to the built-in support for standard AVPs, you can define additional AVPs which can then be used in policies. A policy condition can evaluate an AVP in Diameter messages, set an AVP using a user value in the UDR system or set a user value in the UDR using an AVP. A policy action can set or remove the AVP.

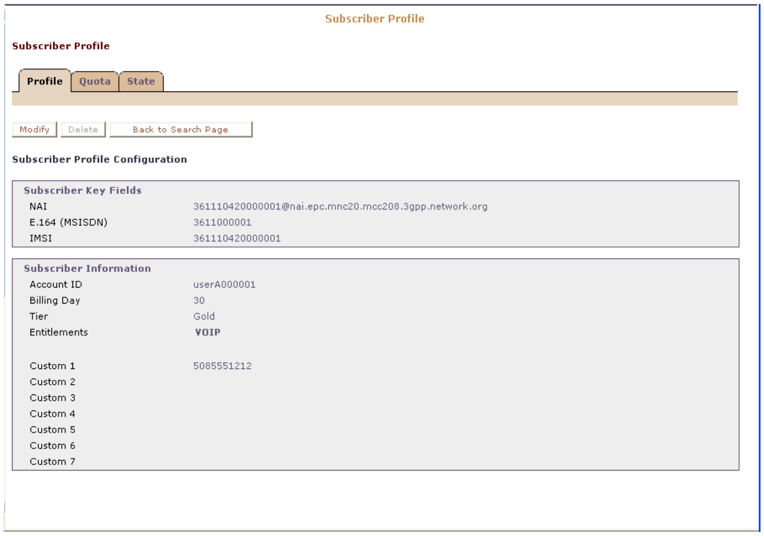
When using an OCS, the following parameters should be defined using CMP:

- Online Charging Servers: When an OCS is defined, OCPM requests quota information when establishing or updating subscriber sessions.

- Policy Counter Identifiers (if desired): OCPM communicates with OCS using 3GPP-defined policy counters. You can provision a name for each policy counter, which can then be used in policies. This optional ease-of-use capability is *not* required to communicate with an OCS.

To support quota management using an SPR/UDR, the following can also be defined using CMP:

- Subscriber Profile Repositories: CMP allows you to define subscriber profile repositories; find/create/modify/delete subscriber records using a variety of APIs; add subscribers to pools; and create/ modify/ delete quota profiles for subscribers/pools. These functions are supported using an Oracle RESTful API interface or a Diameter Sh interface.



Subscriber Profile Configuration

Subscriber Key Fields

NAI	361110420000001@nai.epc.mnc20.mcc208.3gpp.network.org
E.164 (MSISDN)	3611000001
IMSI	361110420000001

Subscriber Information

Account ID	userA000001
Billing Day	30
Tier	Gold
Entitlements	VOIP
Custom 1	5085551212
Custom 2	
Custom 3	
Custom 4	
Custom 5	
Custom 6	
Custom 7	

Figure 15: Subscriber Profile Page

- Services and Rating Groups: A service identifies a class of traffic such as voice, peer-to-peer, or multimedia. For organizational purposes, you can associate services into rating groups.

- Quotas: This limits the amount of data, active session time, or service-specific events that a subscriber can consume. Quotas can be applied to individual services or to rating groups, and can be associated with a time period. A quota profile specifies default values for quotas and defines how quotas are implemented. There are two types of quota profiles: A plan describes a subscriber's basic, recurring service and may include time and volume limits which are computed automatically or through policy rules. A pass is a one-time override that temporarily replaces or augments a subscriber's default plan or service. Passes are common options for pre-paid subscribers, who frequently have limited or no data access via their basic plan, and may purchase passes to gain access to such services. While a pass is in effect, it may modify the Quality of Service (QoS) controls, charging parameters, or other configurable rules associated with a subscriber service. They can also be used to allow casual use and/or promotional plans for pre- or post-paid subscribers to purchase services on an occasional basis, for which they would not otherwise subscribe on an ongoing basis. A pass may be valid for a restricted interval or continuously available.

- Quota Conventions: These control rollovers and top-ups, which can override the basic quota. A *rollover* allows a subscriber to carry forward unused units from one billing cycle to another.   A *top-up* allows a subscriber to obtain additional units for an existing plan.
- Monitoring Keys: This unique operator-defined string identifies the quota profile to be used by a policy and charging control (PCC) rule and application detection control (ADC) rule for usage tracking. The monitoring key is associated with the quota profile by selecting a policy action that grants usage to a selected number of quota profiles. Monitoring keys are a simplified way of communicating quota information between OCPM and other network elements to perform quota tracking.

Policy Creation and Deployment

After the system has been created, you are ready to create policies. This includes the following steps:

- Create supporting objects which are referenced in policies
- Create the policies which are evaluated. Policies can also be collected into groups, which is simply a list of policies which are typically executed together. You can also create groups of groups.
- Deploy the policies to the MPEs. Different policies can be deployed to different MPEs, allowing you to test a set of policies on a test or FOA system before being deployed into the production network.

Create Supporting Objects

To simplify policy creation, common information can be stored in separate supporting objects which are referenced by policies. There are several types of supporting objects:

- Match Lists, which are a list of possible values of a specified type (e.g., IPv4 addresses, or simple csv). For example, you can create a list of MCC/MNC values which represent operators with whom you have reciprocal roaming agreements.
- Applications, which are a list of IP addresses or Diameter identities which should be treated similarly, e.g., multiple servers performing the same function.
- Traffic Profiles, which is a set of pre-defined traffic parameters which are assigned to a subscriber. For example, one traffic profile can define the bandwidth and priority parameters for gold tier customers on an LTE network. Additional traffic profiles would be created for other customer tiers and network types. The appropriate traffic profile is applied via policy when a customer initially connects or moves to another type of network.
- Retry Profiles, which specify the circumstances under which installation of a policy and charging control (PCC) rule is retried if the rule is reported to have failed.

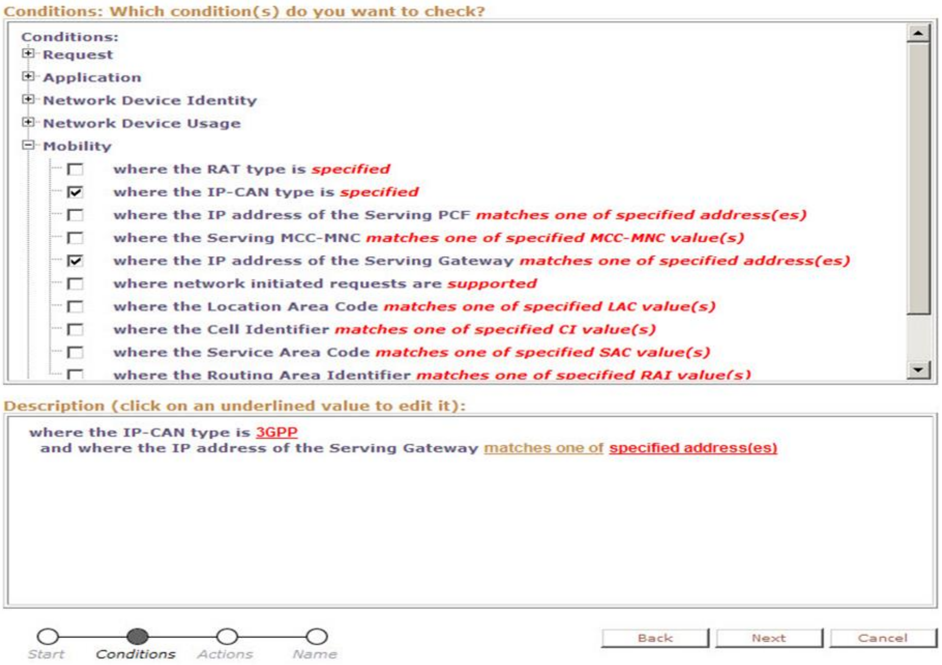
- Time of Day profiles, which define time periods which can be used when evaluating policies.

Policy Provisioning

Policies are typically initially created using the Policy Wizard function within CMP, which walks the user through policy creation as follows:

1. Create a new policy from scratch, create a copy of an existing policy, or modify an existing policy.
2. Select the policy tables which are used as part of this policy
3. Select the desired policy condition(s), and fill in the appropriate values. Policy Wizard provides the valid choices, or performs validity checking on inputted data (e.g., ensure that the entered text is a valid IP address). Policy conditions can include any of the following:
    - The type of message which triggered policy evaluation (e.g., Gx:CCR-I)
    - Information included in that message (e.g., RAT-Type=WLAN)
    - Information included in messages in response to queries by OCPM (e.g., entitlement information included in the subscriber profile, received from the SPR)
    - Information previously stored by OCPM. OCPM keeps track of all session states, enabling it to perform the appropriate binding (and removal) of resources to subscribers and applications.

    By default, all policy conditions need to be met for the policy actions to be applied. However, policies can also include logical OR and NOT operators to create complex policy conditions. Policies can be created which do not include policies conditions. Figure 16 shows a typical Policy Wizard screen for selecting policy conditions.



Conditions: Which condition(s) do you want to check?

Conditions:
⊞ Request
⊞ Application
⊞ Network Device Identity
⊞ Network Device Usage
⊟ Mobility
☐ where the RAT type is *specified*
☑ where the IP-CAN type is *specified*
☐ where the IP address of the Serving PCF *matches one of specified address(es)*
☐ where the Serving MCC-MNC *matches one of specified MCC-MNC value(s)*
☑ where the IP address of the Serving Gateway *matches one of specified address(es)*
☐ where network initiated requests are *supported*
☐ where the Location Area Code *matches one of specified LAC value(s)*
☐ where the Cell Identifier *matches one of specified CI value(s)*
☐ where the Service Area Code *matches one of specified SAC value(s)*
☐ where the Routing Area Identifier *matches one of specified RAI value(s)*

Description (click on an underlined value to edit it):

where the IP-CAN type is 3GPP
and where the IP address of the Serving Gateway matches one of specified address(es)

Figure 16: Selecting Policy Conditions

4. Select the appropriate policy action(s), again specifying values if needed. Policies can include a policy action which evaluates another policy (or Policy Group).

   All policies must contain exactly one mandatory action from the following list:

   - Accept message: After executing the current policy rule, OCPM continues with the normal processing of the protocol message but no further policy rules are evaluated.
   - Break from policy level: Stop evaluating the current policy and continue policy evaluation with the next policy at the parent's level. This is applicable only when using *policy nesting*.
   - Continue processing message: After executing the current policy rule, OCPM continues with the next policy rule.
   - Reject message: After executing the current policy rule, OCPM terminates all policy-rule processing and rejects the current protocol message. For most application-level requests this translates into some type of error being sent back to the application.
   - Skip to next device: Stop evaluating policies for the current device and continue policy evaluation with the next device. If there is no next device, policy execution ends.
   - Skip to next flow: Stop evaluating policies for the current flow and continue policy evaluation with the next flow. If there is no next flow, evaluation continues with the next device; if there is no next device, policy execution ends.

5. Specify the name of the policy.

An example of a fully defined policy is shown in Figure 17:

Name: Apply_QoS_on_Handoff

Conditions:

where the flow is an application flow
  and where the request is modifying an existing session
  and where the APN matches one of ims*
  and where the RAT type is WLAN
  and where the flow media type is one of Video
  and where the event trigger is one of RAT_CHANGE
  and where the AF-Application-ID matches one of voip1

Actions:

evaluate policy Apply_QoS_Parameters_On_Handoff
evaluate policy WLAN_IMS_Audio
accept message

Figure 17: Sample Policy

Policies can also be exported and imported using the OSSI/XML interface. This allows policies and supporting objects created on one system to be ported to other OCPM systems.

Deploying Policies

After policies are defined, they are deployed to one or more MPEs. Different MPEs can execute different policies. Several tools are available to control how policies are executed:

- Policy Groups allow you to create a list of policies which are executed sequentially. These are useful when a set of policies are always executed together, and are also used with policy nesting. A policy group can also be a “group of groups” which contains other policy groups.
- Policy Nesting provides additional control over whether policies are evaluated, which also reduces processing requirements. For example, given the following policies and policy groups:

  1. Policy1: Action=evaluate GroupA (which includes Policy2, Policy3)
  2. Policy4

  If any policy in GroupA evaluates to true *and* includes the “break from policy level” mandatory action, then subsequent policies in the same Policy Group are skipped. In this example, if Policy1 and Policy2 are true and Policy2 includes this action, then the order of policy evaluation is Policy1 > Policy2 > Policy4.
- Policy Ordering: In complex scenarios, the outcome of the policy execution depends on the order in which the policies are executed. OCPM allows you to specify the order in which policies are executed.
- MPE Groups: MPEs can be grouped together, simplifying the process of deploying the same policies to multiple MPEs. For instance, new policies can be tested on a single MPE, and then deployed to the MPE group which includes the remaining MPEs.

Monitoring and Management

CMP provides detailed system management functions allowing the display of events or alarms received by the system and user management. Additionally the system audits all operations performed via the GUI as well as the OSSI interface allowing configuration changes to be tracked by time and operator.

Monitoring functions include the following:

- KPI dashboard
- Alarms
- System-wide trending (graphical) reports
- System-wide tabular reports
- Server (MRA/MPE) reports

Most information is collected by individual servers and forwarded to CMP. Server (MRA/MPE) reports are found under the “Reports” tab in the “*Policy Server (MPE)➔Configuration”* or “*MRA➔Configuration”* sections. All other functions are available via system-wide reports, as shown in Figure 18. All system-wide reports refresh every 10 seconds unless disabled. Many system-wide reports are customizable to view individual servers, all MPE, all MRAs, or all servers. They can also be printed or exported using csv.

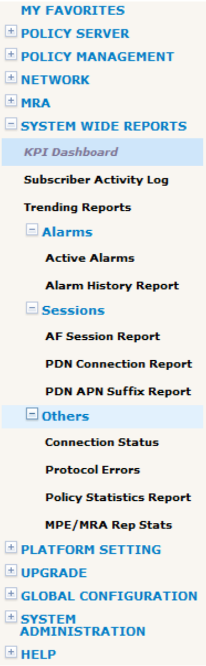
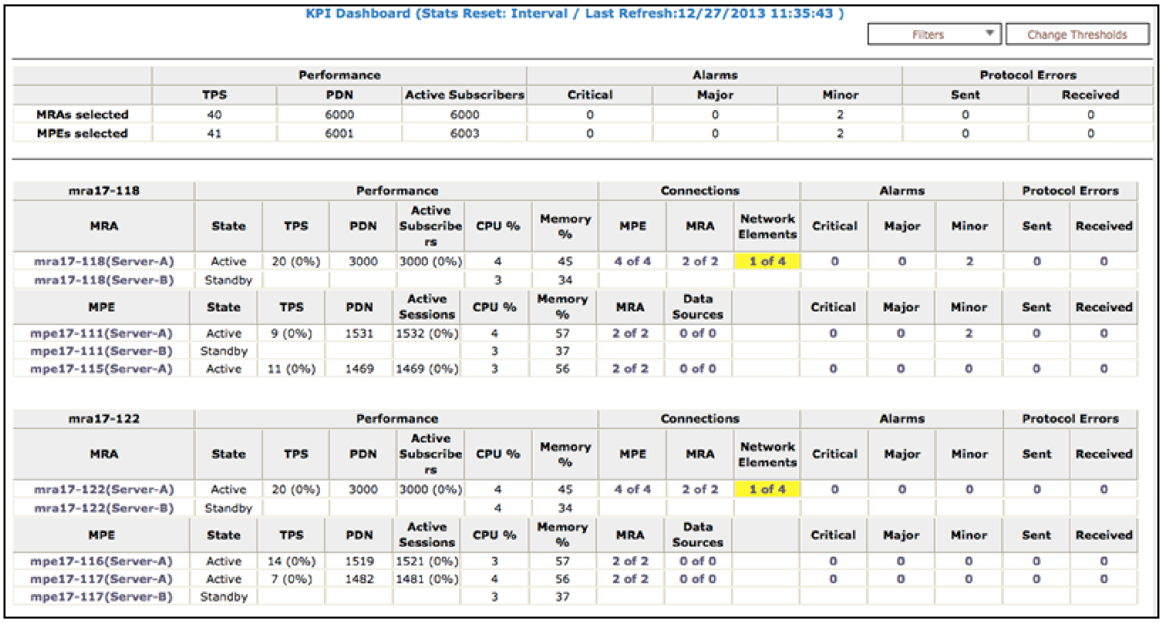


Figure 18: System-Wide

KPI Dashboard

The Key Performance Indicator (KPI) dashboard is the overall system monitoring screen which provides real-time monitoring of the aggregated error and alarm counters. The KPI dashboard tracks alarms and protocol errors as they are happening, which allows better monitoring to prevent events such as system overloads and outages.

The KPI dashboard displays each severity as a column. Each severity column contains the alarm counters of unacknowledged alarms. Alarm signaling is supported by the existing Oracle COMCOL alarm functionality. **Error! Reference source not found.** shows a sample KPI dashboard.



KPI Dashboard (Stats Reset: Interval / Last Refresh:12/27/2013 11:35:43)

	Performance			Alarms			Protocol Errors	
	TPS	PDN	Active Subscribers	Critical	Major	Minor	Sent	Received
MRAs selected	40	6000	6000	0	0	2	0	0
MPEs selected	41	6001	6003	0	0	2	0	0

mra17-118	Performance						Connections			Alarms			Protocol Errors	
MRA	State	TPS	PDN	Active Subscribers	CPU %	Memory %	MPE	MRA	Network Elements	Critical	Major	Minor	Sent	Received
mra17-118(Server-A)	Active	20 (0%)	3000	3000 (0%)	4	45	4 of 4	2 of 2	1 of 4	0	0	2	0	0
mra17-118(Server-B)	Standby				3	34								
MPE	State	TPS	PDN	Active Sessions	CPU %	Memory %	MRA	Data Sources		Critical	Major	Minor	Sent	Received
mpe17-111(Server-A)	Active	9 (0%)	1531	1532 (0%)	4	57	2 of 2	0 of 0		0	0	2	0	0
mpe17-111(Server-B)	Standby				3	37								
mpe17-115(Server-A)	Active	11 (0%)	1469	1469 (0%)	3	56	2 of 2	0 of 0		0	0	0	0	0

mra17-122	Performance						Connections			Alarms			Protocol Errors	
MRA	State	TPS	PDN	Active Subscribers	CPU %	Memory %	MPE	MRA	Network Elements	Critical	Major	Minor	Sent	Received
mra17-122(Server-A)	Active	20 (0%)	3000	3000 (0%)	4	45	4 of 4	2 of 2	1 of 4	0	0	0	0	0
mra17-122(Server-B)	Standby				4	34								
MPE	State	TPS	PDN	Active Sessions	CPU %	Memory %	MRA	Data Sources		Critical	Major	Minor	Sent	Received
mpe17-116(Server-A)	Active	14 (0%)	1519	1521 (0%)	3	57	2 of 2	0 of 0		0	0	0	0	0
mpe17-117(Server-A)	Active	7 (0%)	1482	1481 (0%)	4	56	2 of 2	0 of 0		0	0	0	0	0
mpe17-117(Server-B)	Standby				3	37								

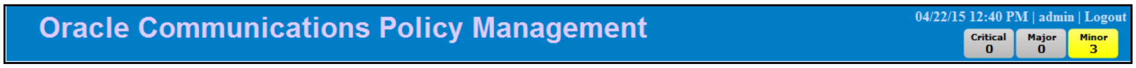
Figure 19: KPI Dashboard

The KPI dashboard displays system wide alarms and errors reports with hyperlinks to device-specific reports. On the KPI dashboard, each name of a MPE or MRA is a hyperlink to its associated Reports tab. Each value in the Connections column is a hyperlink to the connection type sub-screen under the Reports tab. Each alarm or error count value is a link to its respective device-specific report screen.

Alarm Reports

Every CMP screen displays an alarm summary in the upper right-hand corner of the screen, as shown in Figure 20. OCPM alarms have three severity levels:

- Critical: Service is being interrupted
- Major: Service may be interrupted if the issue is not corrected
- Minor: Alarm is not a service-affecting fault



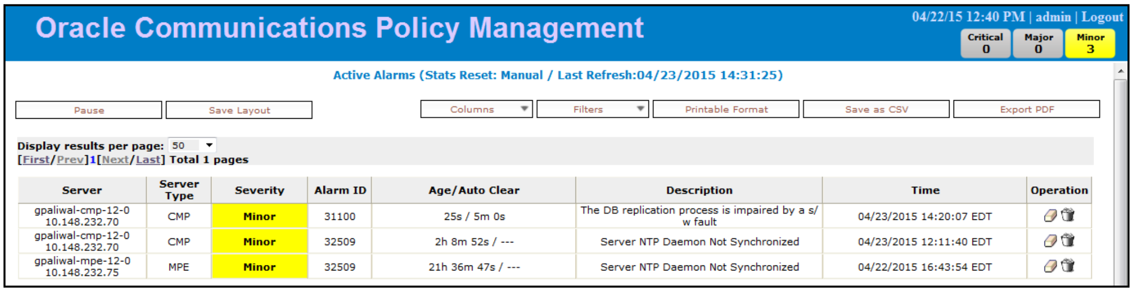
Oracle Communications Policy Management

04/22/15 12:40 PM | admin | Logout

Critical	Major	Minor
0	0	3

Figure 20: Alarm Summary in Top Banner

There are two alarm reports: the Active Alarm Report and the Alarm History Report. The *Active Alarm Report*, shown in Figure 20, provides the list of active alarms for CMP, MPE, and MRA servers. The columns in the report include Server identity, Server type (CMP, MPE, or MRA), Severity, Alarm ID, Age, Description, Time, and Operation.



Oracle Communications Policy Management

04/22/15 12:40 PM | admin | Logout

Critical	Major	Minor
0	0	3

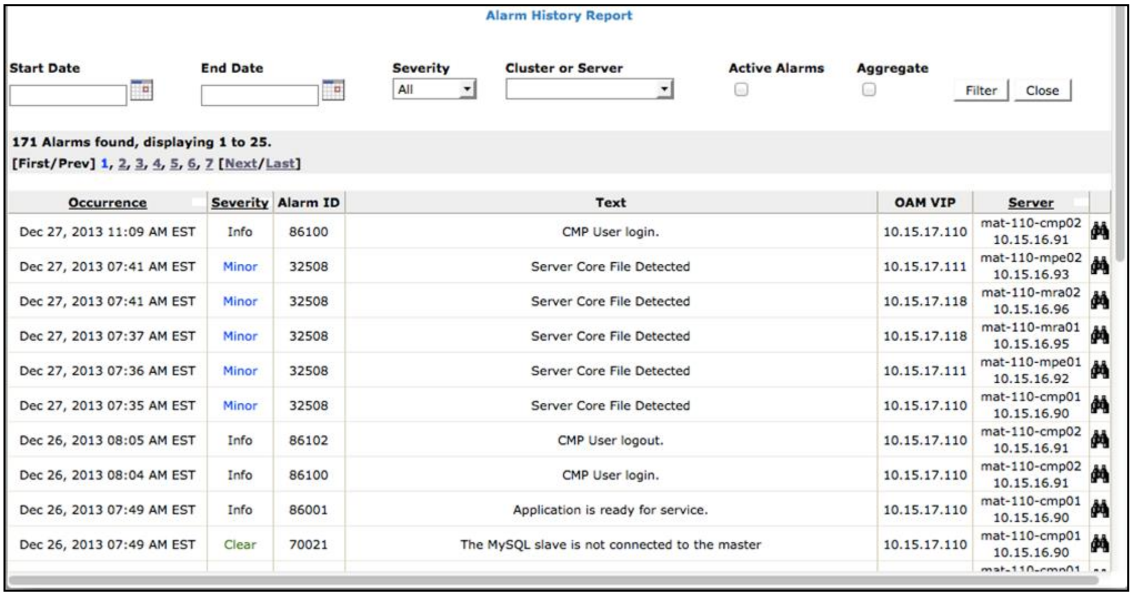
Active Alarms (Stats Reset: Manual / Last Refresh:04/23/2015 14:31:25)

Display results per page: 50
[First/Prev]1[Next/Last] Total 1 pages

Server	Server Type	Severity	Alarm ID	Age/Auto Clear	Description	Time	Operation
gpaliwal-cmp-12-0 10.148.232.70	CMP	Minor	31100	25s / 5m 0s	The DB replication process is impaired by a s/w fault	04/23/2015 14:20:07 EDT	
gpaliwal-cmp-12-0 10.148.232.70	CMP	Minor	32509	2h 8m 52s / ---	Server NTP Daemon Not Synchronized	04/23/2015 12:11:40 EDT	
gpaliwal-mpe-12-0 10.148.232.75	MPE	Minor	32509	21h 36m 47s / ---	Server NTP Daemon Not Synchronized	04/22/2015 16:43:54 EDT	

Figure 20: Active Alarm Report

The *Alarm History Report*, shown in Figure 21, provides the alarm history for each CMP, MPE, and MRA server.



Alarm History Report

Start Date:
End Date:
Severity: All
Cluster or Server:
Active Alarms: □
Aggregate: □

171 Alarms found, displaying 1 to 25.
[First/Prev] 1, 2, 3, 4, 5, 6, 7 [Next/Last]

Occurrence	Severity	Alarm ID	Text	OAM VIP	Server
Dec 27, 2013 11:09 AM EST	Info	86100	CMP User login.	10.15.17.110	mat-110-cmp02 10.15.16.91
Dec 27, 2013 07:41 AM EST	Minor	32508	Server Core File Detected	10.15.17.111	mat-110-mpe02 10.15.16.93
Dec 27, 2013 07:41 AM EST	Minor	32508	Server Core File Detected	10.15.17.118	mat-110-mra02 10.15.16.96
Dec 27, 2013 07:37 AM EST	Minor	32508	Server Core File Detected	10.15.17.118	mat-110-mra01 10.15.16.95
Dec 27, 2013 07:36 AM EST	Minor	32508	Server Core File Detected	10.15.17.111	mat-110-mpe01 10.15.16.92
Dec 27, 2013 07:35 AM EST	Minor	32508	Server Core File Detected	10.15.17.110	mat-110-cmp01 10.15.16.90
Dec 26, 2013 08:05 AM EST	Info	86102	CMP User logout.	10.15.17.110	mat-110-cmp02 10.15.16.91
Dec 26, 2013 08:04 AM EST	Info	86100	CMP User login.	10.15.17.110	mat-110-cmp02 10.15.16.91
Dec 26, 2013 07:49 AM EST	Info	86001	Application is ready for service.	10.15.17.110	mat-110-cmp01 10.15.16.90
Dec 26, 2013 07:49 AM EST	Clear	70021	The MySQL slave is not connected to the master	10.15.17.110	mat-110-cmp01 10.15.16.90

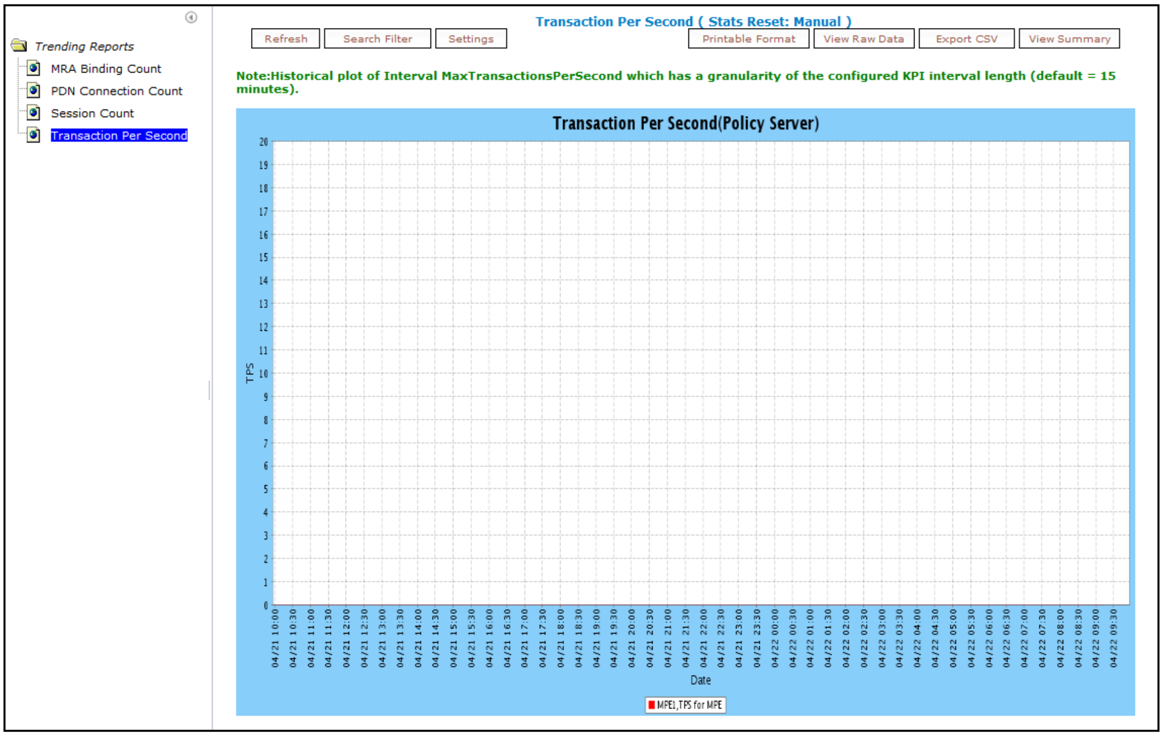
Figure 21: Alarm History Report

System-Wide Trending Reports

CMP provides a graphical display of MRA and MPE key statistics. The statistics that can be graphed include:

- MRA Binding Count
- PDN Connection Count
- Session Count
- Transactions Per Second

As shown in Figure 22, you can also use the search filter to select which devices to graph, or display an aggregated view. The default interval time of 15 minutes can be changed via the Settings button. The information can also be displayed in tabular format using the “View Summary” button.



Note:Historical plot of Interval MaxTransactionsPerSecond which has a granularity of the configured KPI interval length (default = 15 minutes).

Figure 22: Trending Report Example

System-Wide Tabular Reports

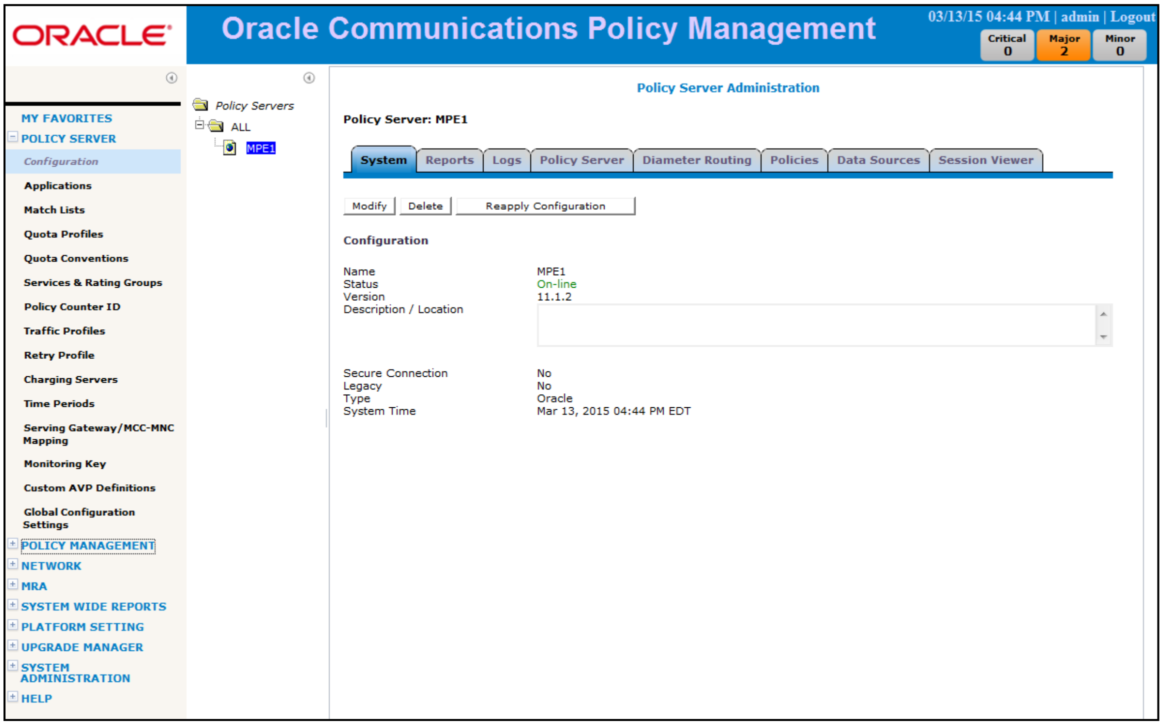
CMP provides a variety of other reports which summarize activity across multiple servers:

- AF Session Report: This report contains current and maximum AF session count (i.e., Rx session) for each MPE and associated MRA on per RAT-Type. The operator can choose (customize) the RAT-Types (all RAT-Types defined by 3GPP are supported) to be included in the report. The AF session count for MRA is the aggregate of session counts for all MPEs in the MRA’s pool.
- PDN Connection Report: This report contains current and maximum PDN connection counts (i.e., Gx session) for each MPE and associated MRA per RAT-Type. The operator can choose (customize) the RAT-Types (all RAT-Types defined by 3GPP are supported) to be included in the report. The PDN connection count for MRA is the aggregate of session counts for all MPEs in the MRA’s pool.

- PDN APN Suffix Report: This report contains current and maximum PDN connection count (i.e., Gx session) per APN. The operator can choose all or set of specific APNs (filter) to be included in the report.
- Connection Status Report: This report contains all Home Subscriber Server (HSS) and gateway connections. The report provides filters (by server, status, site, and error) and report-management actions such as print, save, and export. The data in the connection report is derived from the statistics or counters, which are also used as the basis for the Reports tab for the MPE or MRA.
- Protocol Errors Report: This report contains all protocol error statistics retrieved from the system, allows filtering of data, and has print, save, and export functions.
- Policy Statistics Report: CMP can display statistics on policy execution for each policy on each MPE.
- Replication Statistics Report: This report shows the number of sent and received packets (total, peak and average) for each MPE/MRA along with the link type (LAN for local server and WAN for remote spare server).

Server Reports

CMP also provides monitoring of individual MRA and MPE servers, as shown in Figure 23. The numerous tabs allow you to see basic system information, create reports for individual clusters, view logs and routing information, see what policies are deployed to this MPE cluster, see which data sources (SPR/UDR and OCS) this MPE communicates with, and view detailed information about specific sessions.



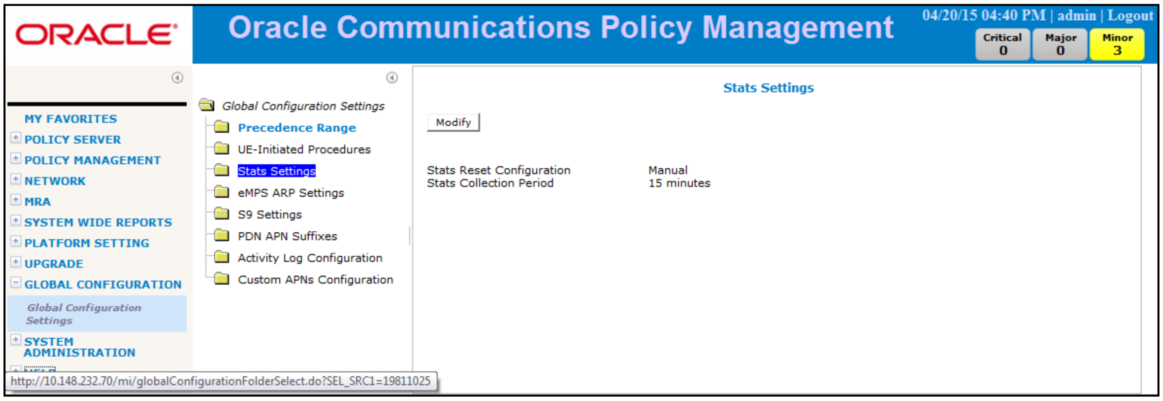
Policy Server: MPE1

Configuration

Name	MPE1
Status	On-line
Version	11.1.2
Description / Location	
Secure Connection	No
Legacy	No
Type	Oracle
System Time	Mar 13, 2015 04:44 PM EDT

Figure 23: Policy Server (MPE) Administration Screen

In addition to the system wide reports, information about each MPE and MRA can be displayed using the “Reports” tab.   As shown in Figure 24, these statistics are collected periodically at user-defined intervals, and can be reset automatically at specific intervals or manually.



Stats Settings

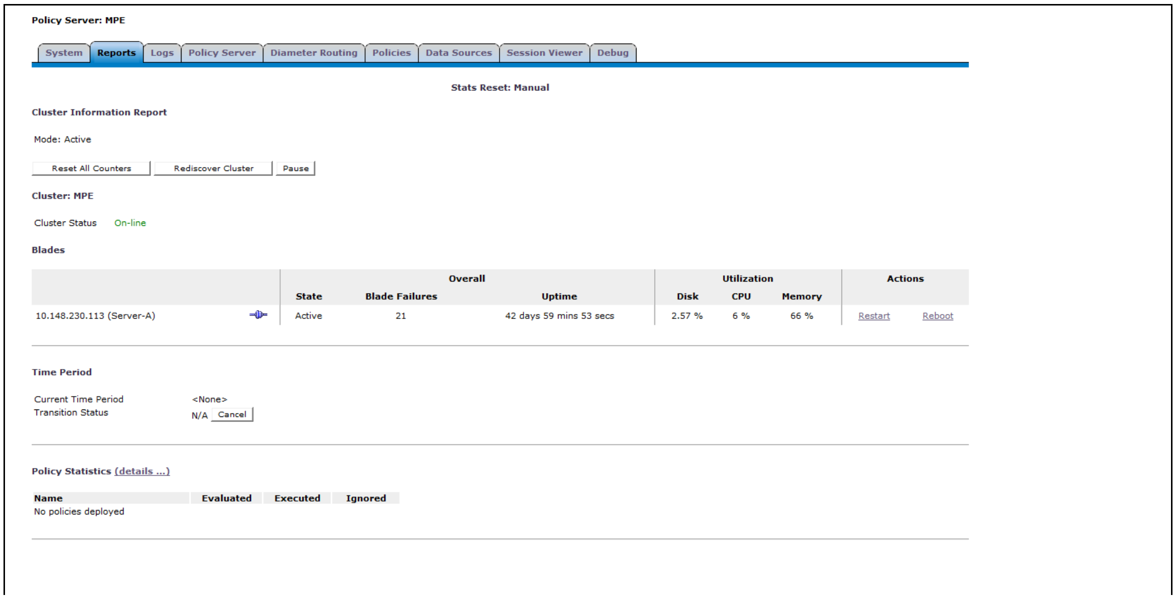
Stats Reset Configuration	Manual
Stats Collection Period	15 minutes

Figure 24: Statistics Settings

A statistics file generator scheduled task periodically queries the OSSI interface for statistics and stores the results in a local repository. Statistics can also be:

- Pushed to up to four remote repositories in csv format, using rsynch over SSH.
- Pulled by an external interface using OSSI. Using the OSSI interface, reporting systems can query all or portions of the performance data filtering by time, network element and resource. XML schema documents are provided allowing easy parsing and integration of the data.

Error! Reference source not found. shows the full statistics screen for an MPE server. The appropriate corresponding information is also available for MRAs. You can select the provided hyperlinks to see additional information about most categories.



Policy Server: MPE

Stats Reset: Manual

Cluster Information Report

Mode: Active

Cluster: MPE

Cluster Status On-line

Blades

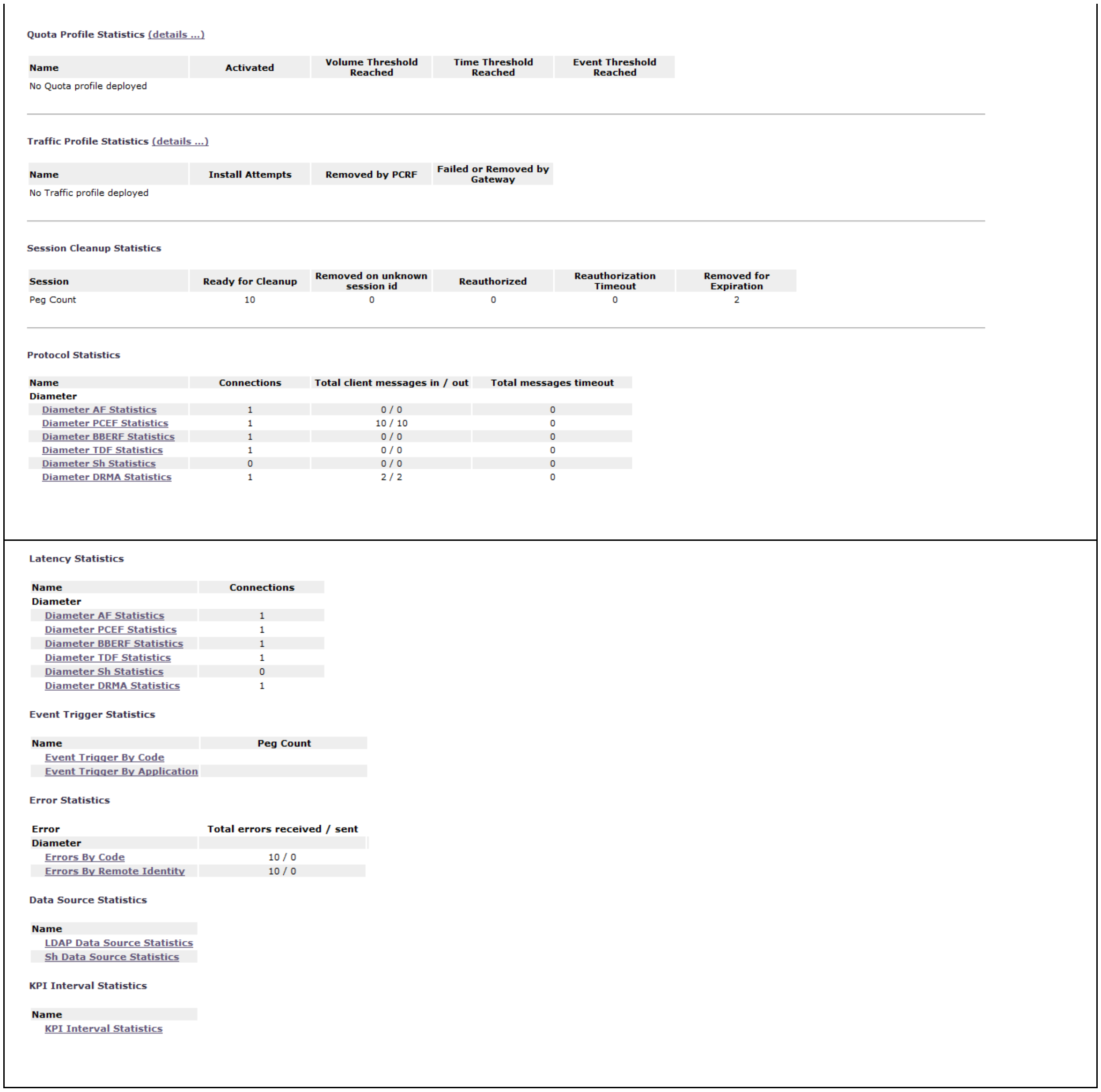
	Overall			Utilization			Actions	
	State	Blade Failures	Uptime	Disk	CPU	Memory		
10.148.230.113 (Server-A)	Active	21	42 days 59 mins 53 secs	2.57 %	6 %	66 %	Restart	Reboot

Time Period

Current Time Period	<None>
Transition Status	N/A

Policy Statistics (details ...)

Name	Evaluated	Executed	Ignored
No policies deployed			



Quota Profile Statistics (details ...)

Name	Activated	Volume Threshold Reached	Time Threshold Reached	Event Threshold Reached
No Quota profile deployed				

Traffic Profile Statistics (details ...)

Name	Install Attempts	Removed by PCRF	Failed or Removed by Gateway
No Traffic profile deployed			

Session Cleanup Statistics

Session	Ready for Cleanup	Removed on unknown session id	Reauthorized	Reauthorization Timeout	Removed for Expiration
Peg Count	10	0	0	0	2

Protocol Statistics

Name	Connections	Total client messages in / out	Total messages timeout
Diameter			
Diameter AF Statistics	1	0 / 0	0
Diameter PCEF Statistics	1	10 / 10	0
Diameter BBERF Statistics	1	0 / 0	0
Diameter TDF Statistics	1	0 / 0	0
Diameter Sh Statistics	0	0 / 0	0
Diameter DRMA Statistics	1	2 / 2	0

Latency Statistics

Name	Connections
Diameter	
Diameter AF Statistics	1
Diameter PCEF Statistics	1
Diameter BBERF Statistics	1
Diameter TDF Statistics	1
Diameter Sh Statistics	0
Diameter DRMA Statistics	1

Event Trigger Statistics

Name	Peg Count
Event Trigger By Code	
Event Trigger By Application	

Error Statistics

Error	Total errors received / sent
Diameter	
Errors By Code	10 / 0
Errors By Remote Identity	10 / 0

Data Source Statistics

Name
LDAP Data Source Statistics
Sh Data Source Statistics

KPI Interval Statistics

Name
KPI Interval Statistics

Figure 25: MPE Reports

The available information includes:

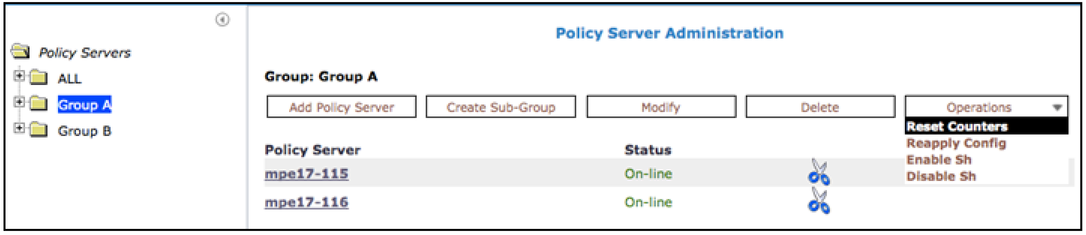
- Hardware status.
- Policy statistics: Number evaluated, executed (policy conditions evaluate to TRUE so the policy actions are executed) and ignored (policy conditions evaluate to FALSE).
- Quota and traffic profile statistics.
- Session cleanup statistics: If a subscriber session has existed for longer than its configured maximum validity time without any explicit updates from the corresponding gateway, or if a more recent session exists for the same subscriber and protocol, the session is considered "stale" and can be removed via the configurable *stale session cleanup* procedure.

- Protocol statistics: Summarizes the connections to various other network elements.
- Latency statistics: This information is given per network element, per MPE, and per MRA.
- Event trigger statistics: These counters are tracked per network element and per MPE.
- Error statistics: Displays error sent/received by error code and by device.
- Data source statistics: Statistics are shown for LDAP and Sh data sources.
- KPI interval statistics: Shows information about the configured collection interval.

Additional Monitoring/Management Functions

CMP provides other tools to assist in operating your network, including:

- Management, Audit and Trace Logs: These track the various system activities. They are available under “System Administration”.
- Subscriber Activity Log: MPEs can provide a detailed trace for up to 20 subscribers. This debugging tool simplifies problem determination, including for testing new functionality. This is available under “System Wide Reports”.
- Hardware Management Report: This report summarizes the available servers, displays disk/CPU/memory utilization, tracks the number of server failures, and allows the user to restart a server. This is available under “System Administration”.
- Session Viewer: This displays current session and binding data for a subscriber. It is available for each server via the “Session Viewer tab in the “Policy Server➔Configuration” section. The user provides a subscriber identifier such as IMSI, MS-ISDN, IP, and NAI. CMP then displays the current session and binding data for that subscriber from the MRA or MPE that manages the session. If users get the binding data from the MRA, the operator can click the binding MPE hyperlink to go directly to the MPE Session Viewer tab and look up the subscriber data.
- CMP Bulk Operations: You can execute a specific subset of an operation on a group of servers. The user selects a server group instance instead of an individual server, and any operations performed are applied to all servers within the group. The supported MPE operations are shown in Figure 26. For MRAs, the Reset Counters and Reapply Configuration commands may be applied to groups.



Group: Group A

Policy Server	Status
mpe17-115	On-line
mpe17-116	On-line

Figure 26: CMP Bulk Operations

- CMP Online Help: OCPM includes online help to look up descriptions of alarms or trace log items. While displaying the Active Alarm page, the Alarm History Report, or the Trace Log Viewer you can click on an alarm or trace log item to open the help and display reference documentation for that alarm or trace log item. CMP also includes online help for Policy Wizard conditions and actions while defining policies. For each policy condition or action, the help section contains a general description, a list of applicable parameters, and an example if available.

Appendix A: Networking and Security Overview

All OCPM servers are built on a common platform which provides the common networking and security functionality.

Security

As a global provider of signaling and broadband data management solutions, Oracle is committed to delivering secure solutions. MPE, MRA CMP and UDR are built upon a common telecommunications grade Oracle Linux implementation. As the OS represents the largest portion of the total attack surface in an application, special attention is given by Oracle to ensure continuous efforts are made in hardening of the OS and reduction of its overall attack surface. This includes, in part, regular security updates, custom security patching from upstream providers, kernel hardening, restrictive user access and permissions, log management and removal of unnecessary services, ports and software. By utilizing this common infrastructure all components take advantage of the common carrier grade platform that supports a broad range of security features.

Each component provides several levels of security to prevent unauthorized access to the system. A username and a password must be provided to access the system through the CLI, web interface, and any remote provisioning interface. Remote computer connections are allowed only using a secure shell (ssh) or secure HTTP connection. All user initiated logins are captured in the audit logs. The logs provide information about the access and duration of the sessions on the system.   In addition, terminal activity timeout and password restrictions (minimum length, minimum lifetime, maximum lifetime and warning age) are provided. The system can restrict the number of login warnings before the password is disabled.

All daemons that are not required have been disabled. The “r” commands (rsh, rcp, rexec) are not used, and incoming telnet and ftp connections are not permitted. No passwords are sent across the network in clear text. Public-key encryption is the only supported method for incoming network access. ssh is used for secure network logins, while scp and sftp are used for secure file transfers.

Additional security design choices include:

- Configuration file revision history: Files that provide OS level configuration are revision controlled using RCS.
- Minimal software package content: In order to eliminate unnecessary vulnerabilities, only required software packages are included as part of the distribution package.
- Minimal user accounts: User accounts are kept to an absolute minimum to reduce the risk of unauthorized access to any server.
- Minimal system services: All non-essential system services are disabled.
- Restricted file permissions: All file permissions are restricted utilizing the least access rule, (allow write access only where needed). Restrict elevated authority by finding Set UID root programs and removing the SUID bit if possible, and by removing all access to directories, files, and programs that are not required.
- No DNS or NIS name services: The system can be configured to use only local file lookup by changing the file /etc/nsswitch.conf.

Networking

To simplify operations, each OCPM server can use multiple logical networks (that is, multiple IP addresses and VLAN identifiers) to support various functions. The following networks are required:

- Operations, Administration and Management (OAM): All PCRF functionality can be performed using the OAM network. However, in most cases incremental functionality is deployed using the optional logical interfaces discussed below, and this network is used for operational control.

The following network is required when using specific hardware:

- Platform Management (PlatMgt): This logical network supports hardware management, including support for HP's iLO (Integrated Lights Out) operation.

The following optional networks can also be configured:

- Signaling (SIG-A, SIG-B): In almost all networks, signaling between network elements occurs on a separate logical interface (SIG-A). Some operators split the signaling across the two available signaling interfaces.
- Replication (REP): Geo-redundant replication can be done using a separate logical set of replication (REP) addresses. This function can alternatively be performed using the OAM or SIG interfaces.
- Backup (BKUP): A separate set of addresses for backup using Symantec Netbackup.

OCPM also supports the following:

- Separate DSCP markings can be set for signaling traffic and geo-redundant replication so that switching/routing components can effectively prioritize traffic.
- Different IP versions can be used to each Diameter peer. OCPM's IPv6 implementation complies with the DoD standard for an IPv6 capable (1) Host and Workstations and (2) Advanced Server, as outlined in DoD's IPv6 Standard Profiles for IPv6 Capable Products Version 2.0.
- Connections to Diameter peers use either Transmission Control Protocol (TCP) or Stream Control Transmission Protocol (SCTP), including SCTP multi-homing.

Appendix B: What's New in Release 11.5

3GPP Enhancements

- Sy Enhancements. OCPM now supports primary, secondary and tertiary systems. 3GPP Pending Policy Counter support allows the OCS to send (in SNR) a specific time that the OCS would like that counter to become active for policy re-evaluation. In addition, Sy lookups can be triggered using policy actions.
- 3GPP NetLoc Procedures: This 3GPP standardized procedures allows the P-CSCF or AF to request the subscriber's User Location Information (ULI) from the PGW or PCEF. This is important for VoLTE calling for emergency calling services.
- 3GPP Charging Correlation: This mechanism allows an AF to get updated charging information, by requesting that the PCRF requests this charging information from the PCEF and forward it to the requester.
- 3GPP PS-to-CS (Packet Switched to Circuit Switched) Handover: OCPM can notify the P-CSCF or AF that there has been a handover and the P-CSCF is no longer needed for that flow.
- 3GPP Sponsored Data Connectivity: This procedure allows specific user traffic to be sponsored by an OTT provider with special charging rules. For example it could be that ESPN wants to allow their subscribers to view their application without taking any quota away from that subscriber or may want a specific charging rule assigned. Maximum data levels can be specified and the sponsor can be sent a report on consumed data.
- 3GPP protocol updates (Gx, Rx, Sh): OCPM now supports additional capabilities to support 3GPP Release 11. Support has been added for Rx:AAR (-I and -U) messages. Min-Requested-Bandwidth-UL and Min-Requested-Bandwidth-DL AVPs are now supported in the Media-Component-Description AVP. Min-Requested-Bandwidth-UL/DL can be used in policy conditions.
- IN/OUT Enhancement for Flow-Description AVP: OCPM has been updated to optionally support an updated implementation of this AVP. Since deployed third party equipment may not support this change, this functionality must be enabled on OCPM.
- Duplicate Gx Request Handling: OCPM has improved its handling of duplicate Gx requests.

Quota Management

- Pooled Quota Enhancements: Subscriber quota pools can now have one or more pool quota passes, allowing subscribers to roll over and top up their monthly pooled quota plans.   These capabilities had previously been available only for individual subscribers. In addition, subscriber pools can support up to 25 members when using SPR R9.3 or up to 10 members when using OCUDR R10.0.
  Pro-rating per Quota Profile has also been added.
- Trigger RAR on quota change by provisioning interface: OCPM now performs policy evaluation when PNR is received due to a quota or state data update (PNR). A new policy condition checks the type of the notification that triggered PNR. An RAR can be triggered via an existing policy action.
- Table Driven Policy for Multiple Entitlements: OCPM now supports handle scenarios where multiple entitlements are defined for a subscriber.

Additional Functions

- RADIUS Change of Authorization (CoA): OCPM now supports Radius COA and provides a converged wireless/wireline solution. It includes the ability to add custom RADIUS Vendor Specific Attributes (VSAs). System Enhancements.
- RADIUS/Diameter Correlation: RADIUS sessions can be correlated with Gx/Gx-Lite sessions, with the RADIUS considered as a primary session. In addition, RADIUS sessions can trigger Sy and Sd communications.
- MRA RADIUS Routing: MRA can now route RADIUS messages.
- Codec SDP support: OCPM now allows creating policy conditions using any media type (e.g. m=random). In addition, default bandwidth calculations are provided for H.264 (MPEG4) video codec. All transport types are supported for T.38 Fax.
- Diameter Overload Handling Enhancements: The algorithm used to determine which MPE is selected by the MRA/PFE now includes additional load factors. Three levels of overload congestion are provided, and you can configure how OCPM reacts to each message type at each level. Default behaviors are provided.

Monitoring and Management

- Additional management reports: *Display MRA/PFE Aggregated Counts* and *Display AF Session Count by RAT type* reports are now available.
- Subscriber Activity Log: This troubleshooting tool allows operators to trace all of Gx, Rx, Sh, Sd and Sy messages and flows for specified subscribers.
- Policy Checkpoint Enhancements: The checkpoint function now supports Match Lists, Retry Profiles, Policy Tables, Application Profiles and Policy Counter IDs. Up to 10 policy checkpoints are supported.
- User Defined Query of the MPE Session State Database: This feature allows an operator to create a subset of the session state database. The output is a compressed XML file that is saved on a disk. The query mechanism is executed through command line shell interface and can be used in conjunction with OS tools. The report allows a user to filter sessions by: last activity timestamp, called station ID (APN name), session create time (PDN connect time), origin host ID (originating Diameter identity), Diameter application ID or Subscription ID.
- CMP Bulk Operations: This feature allows you to apply certain actions to multiple MRAs/MPEs using a single command. The following commands are supported: Reapply Configuration, Reset Counters, and Enable/Disable Sh (MPE only).
- Allow any AVP in the dictionary to be inserted in a message: This allows any known AVP to be inserted in messages. This includes Diameter applications that they are not originally specified for.

Reliability and Scalability

- Dual Path HA Heartbeat Enhancements: To help differentiate between a remote server failure and a network failure, OCPM can send “heartbeat” packets to the remote service using two different logical networks. This feature improves the failure detection algorithm used to determine whether the remote server is down.

- Split-Brain Resolution Enhancements: When connectivity is lost between two OCPM sites supporting a single cluster, it is possible for OCPM nodes a both sites to become an *active* server. This enhancement improves the ability to select which server should remain active after the network recovers.
- Multi-site MRA Optimizations and Enhancements: OCPM can now support up to 10 nodes (MRAs) per policy segment. Previously, a segment could include up to 4 nodes.

Database, Networking and Security

- Multi-Stream Replication over WAN: This enhancement improves replication performance by allowing multiple TCP or SCTP connections to be used between a pair of servers.
- Replication Interface: This enhancement allow the operator to optionally separate the replication traffic onto its own interface (separate IP address and VLAN) and allows replication traffic to be marked with DSCP.
- Oracle Communications UDR: OCUDR 10.0 is now supported in addition to SPR R9.3. OCUDR and SPR contain subscriber profiles and quota information.
- Sun Netra X3-2: OCPM R11.5 runs on selected configurations of Sun Netra X3-2 rack-mount servers.
- Security enhancements: Root login is now restricted to the local console. Passwords now require three out of four character types (upper alpha, lower alpha, numeric, and special). New and reset passwords expire upon the first login to the user account. Default file permissions now have consistent, secure values.

Appendix C: Reference Documents

This section lists out any other documents that a user may want to reference for more information.

TABLE 3: REFERENCE DOCUMENTATION

Document Number	Document Name
http://docs.oracle.com/cd/E55076_01/index.htm	Oracle Communication Policy Management documentation set (Release 11.5)
http://www.oracle.com/us/products/applications/communications/subscriber-data-management/index.html .	Oracle Communications SPR/UDR overview
http://docs.oracle.com/cd/E48805_01/index.htm	Oracle Communications SPR documentation set (Release 9.3)
http://docs.oracle.com/cd/E58598_01/index.htm	Oracle Communications UDR documentation set (Release 10)
http://www.oracle.com/us/products/applications/communications/industry-analytics/data-model/overview/index.html	Oracle Communications Data Model (OCDM) overview
http://www.oracle.com/us/products/applications/communications/connected-digital-lifestyle/services-gatekeeper/overview/index.html	Oracle Communications Services Gateway (OCSG) overview

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