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Cloud Native Core, Converged Policy Benchmarking Guide

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Acronyms

The following table provides information about the acronyms and the terminology used in the document.

Table Acronyms and Terminologies

Acronym	Description
ASM	Aspen Service Mesh
AMF	Access and Mobility Management Function
AAR	Authorization Authentication Request
BSF	Oracle Communications Cloud Native Core, Binding Support Function
CPS	Call Per Second
CHF	Charging Function
CNE	Oracle Communications Cloud Native Core, Cloud Native Environment
CPU	Central Processing Unit
DNN	Data Network Name
HTTP	Hypertext Transfer Protocol
LDAP	Lightweight Directory Access Protocol
MPS	Messages Per Second
NF	Network Function
NRF	Oracle Communications Cloud Native Core, Network Repository Function
OCS	Online Charging System
PER	Policy Event Record
PCF	Oracle Communications Cloud Native Core, Policy Control Function
PCRF	Policy and Charging Rules Function
PV	Persistent Volume
RAM	Random Access Memory
RAR	Re-Authorization Request
SAL	Subscriber Activity Log
SSV	Subscriber State Variable
STR	Session Termination Request
SM	Session Management
Sy	Diameter Sy reference point
TPS	Transactions Per Second
UDR	Oracle Communications Cloud Native Core, Unified Data Repository
vCNE	Virtual Cloud Native Environment

What’s New in this Guide

This section introduces the documentation updates for Release 25.1.2xx in *Oracle Communications Cloud Native Core, Converged Policy Benchmarking Guide*.

Release 25.1.200 - G39805-01, July 2025

Updated the deployment details used for benchmarking Converged Policy 25.1.200 performance and capacity of Policy data Deployed Components section.

Added the following and test scenarios:

- 54K TPS from 1 Site-1 Without Profile
- 41K TPS on Site-1 with NRF Caching and UDR group-id-list Based Discovery Enabled
- 46.5K TPS Single Site with Replication Enabled with UDR Interworking
- PCF 15K TPS on two Non ASM Sites

1 Introduction

Oracle Communications Cloud Native Core, Converged Policy (Policy) is a key component of the 5G Service Based Architecture (SBA). It is a cloud native solution consisting of both, a 4G Policy and Charging Rules Function (PCRF) and a 5G Policy Control Function (PCF) as a unified framework. It provides a flexible, secure, and scalable policy designing solution.

Policy interacts with other Network Functions (NF) through Network Repository Function (NRF) to provide a unified communication platform for the NFs to interact with each other. It helps operators to design, test, and deploy different network policies supporting 5G deployments. Policy solution supports deployments into cloud native environment, including containers on bare metal managed by Kubernetes or VMs managed by OpenStack.

> **Note**
>
> The performance and capacity of the Policy system may vary based on the Call model, Feature/Interface configurations, underlying CNE and hardware environment, including but not limited to the complexity of deployed policies, policy table size, object expression, and custom json usage in policy design.

For more information about Policy architecture, see *Oracle Communications Cloud Native Core, Converged Policy User Guide*.

1.1 Purpose and Scope

This document is designed to help operators in measuring the performance and capacity of Policy, Policy microservices, and deployment environment setup software such as Cloud Native Environment (CNE) and cnDBTier.

It is recommended that Policy is run through a benchmark on the target cloud native infrastructure to determine the capacity and performance in the target infrastructure. This information can be used to adjust the initial deployment resources for Policy. These recommendations are just guidelines, since the actual performance of the Policy can vary significantly based on the details of the infrastructure.

1.2 References

- *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Converged Policy User Guide*
- *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, cnDBTier Installation, Upgrade, and Fault Recovery Guide*

2 Deployment Environment

This section provides information about the cloud native platform infrastructure details for deploying Oracle Communications Cloud Native Core, Converged Policy.

> **Note**
>
> The performance and capacity of the Policy system may vary based on the Call model, Feature/Interface configurations, underlying CNE and hardware environment, including but not limited to the complexity of deployed policies, policy table size, object expression, and custom json usage in policy design.

2.1 Deployed Components

This section provides details about the deployed components.

Deployment Platform

Oracle Communications Cloud Native Core, Cloud Native Environment (CNE) 23.3.x or 24.2.x and BareMetal are used for performing benchmark tests.

Table 2-1 Observability Services

Service Name	Version
OpenSearch	2.15.0
Fluentd	1.17.1
Prometheus	3.2.0
Grafana	9.5.3
Jaeger	1.65.0

Cloud Native Orchestrator

Kubernetes 1.29.x is used to manage application pods across the cluster.

cnDBTier

cnDBTier 25.1.200 is used for performing benchmark tests.

Policy Infrastructure Details

Infrastructure used for benchmarking Policy performance run is described in this section.

Table 2-2 Hardware Details

Hardware	Details
Environment	BareMetal
Server	Oracle Server X9-2

Table 2-2 (Cont.) Hardware Details

Hardware	Details
Model	Intel(R) Xeon(R) Platinum 8358
Clock Speed	2.600 GHz
Total Cores	128
Memory Size	768 GB
Type	DDR4 SDRAM
Installed DIMMs	18
Maximum DIMMs	24
Installed Memory	768 GB

Table 2-3 Software Details

Aplications	Version
Policy	24.3.0
cnDBTier	24.3.0
OSO	NA
CNE	24.2.0

For more information about Policy Installation, see *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*.

2.2 Deployment Diagram

Figure 2-1 Policy Deployment in Single Site with ASM Disabled

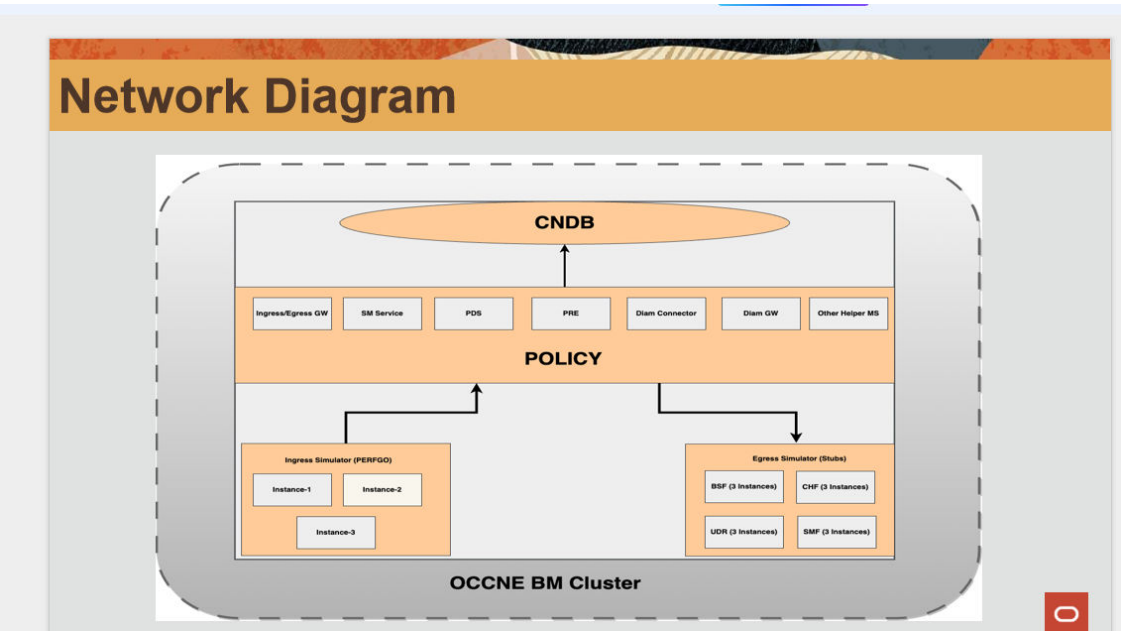


Figure 2-2 Policy Deployment in Two-Site GR Setup

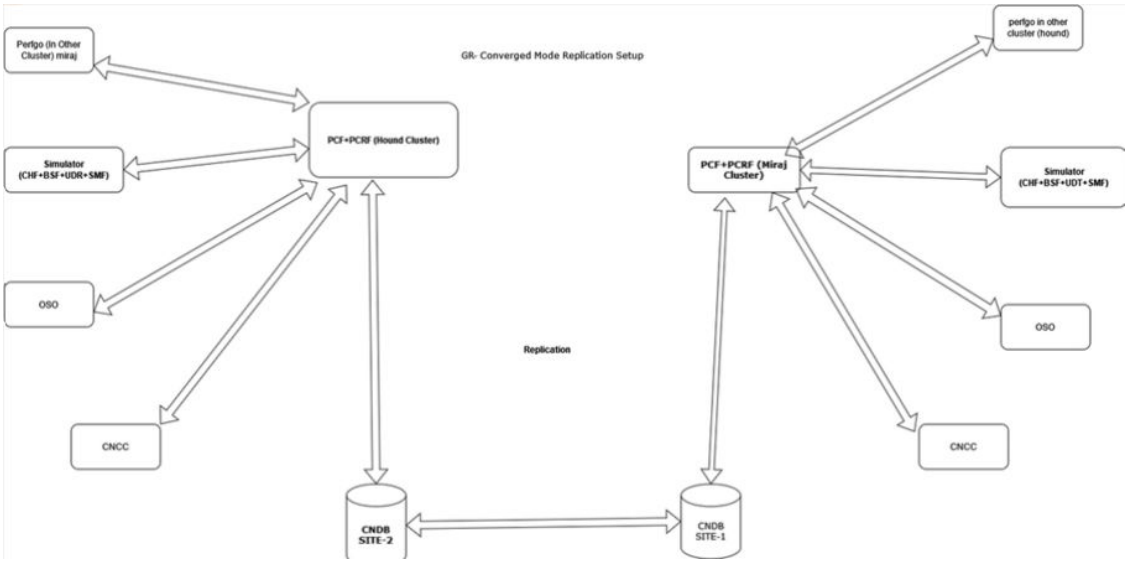
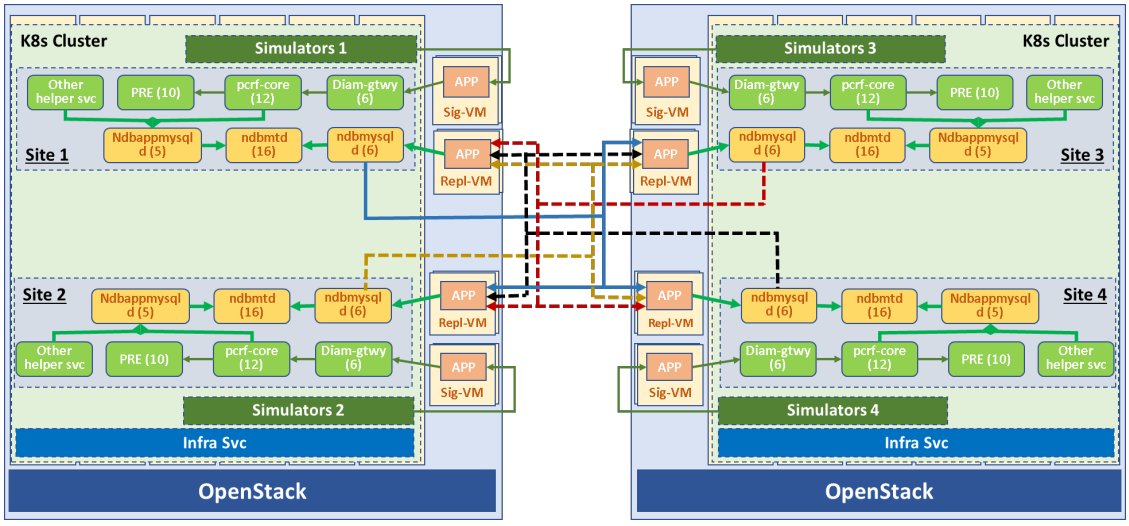


Figure 2-3 Policy Deployment in Four-Site GR Setup



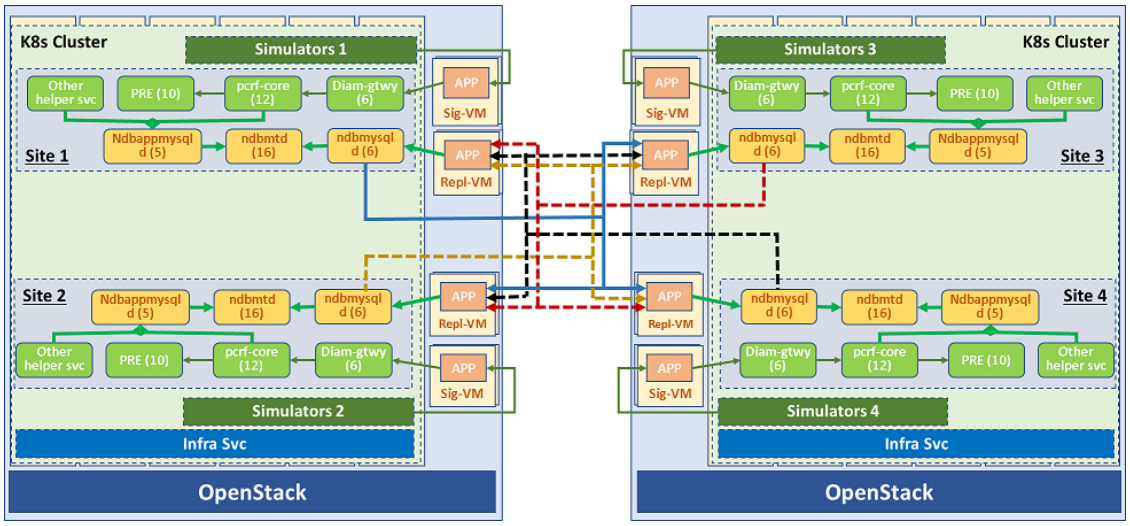
3
Benchmarking Policy Call Models

This section describes different Policy call models and the performance test scenarios which were run using these call model.

3.1 PCRF Call Model 1

The following diagram describes the architecture for a multisite PCRF deployment.

Figure 3-1 PCRF 4 Site GR Deployment Architecture



To test this PCRF call model, the Policy application is deployed in converged mode on a four-site georedundant site. The cnDBTier database and PCRF application are replicated on all the four-sites. The database replication is used to perform data synchronization between databases over the replication channels.

3.1.1 Test Scenario 1: PCRF Data Call Model on Four-Site GeoRedundant setup, with 7.5K Transaction Per Second (TPS) on each site and ASM disabled

This test run benchmarks the performance and capacity of PCRF data call model that is deployed in converged mode on a four-site georedundant setup. Each site in the setup handles an incoming traffic of 7.5K TPS. Aspen Service Mesh (ASM) is disabled.

3.1.1.1 Test Case and Setup Details

Table 3-1 Test Case Parmeters

Parameters	Values
Call Rate	30K TPS (7.5K TPS on each site)
Execution Time	12 Hours
ASM	Disable

Table 3-2 Call Model Data

Messages	Total CPS Instance-1	sy Traffic	Ldap Traffic	Total TPS
CCR-I	320	320	320	960
CCR-U	320	0	0	320
CCR-T	320	320	0	640
Total Messages	960	640	320	1920

Table 3-3 PCRF Configurations

Service Name	Status
Binding Service	Disable
Policy Event Record (PER)	Disable
Subscriber Activity Log (SAL)	Enable
LDAP	Enable
Online Charging System (OCS)	Enable

Table 3-4 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Disable
N36 UDR subscription (N7/N15-Nudr)	Disable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Disable
BSF (N7-Nbsf)	Disable
AMF on demand nrf discovery	Disable
LDAP (Gx-LDAP)	Enable
Sy (PCF N7-Sy)	Enable

Table 3-5 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	Enable
Sd (Gx-Sd)	Disable
Gx UDR query (Gx-Nudr)	Disable

Table 3-5 (Cont.) PCRF Interfaces

Feature Name	Status
Gx UDR subscription (Gx-Nudr	Disable
CHF enabled (AM)	Disable
Usage Monitoring (Gx)	Disable
Subscriber HTTP Notifier (Gx)	Disable

Table 3-6 Configuring cnDBTier Helm Parameters

Helm Parameter	New Value
ndb_batch_size	2G
TimeBetweenEpochs	100
NoOfFragmentLogFiles	50
FragmentLogFileSize	256M
RedoBuffer	1024M
ndbappmysqld Pods Memory	19/20 Gi
ndbmtd pods CPU	8/8
ndb_report_thresh_binlog_epoch_slip	50
ndb_eventbuffer_max_alloc	19G
ndb_log_update_minimal	1
ndbmysqld Pods Memory	25/25 Gi
replicationskiperrors	enable: true
replica_skip_errors	'1007,1008,1050,1051,1022'
numOfEmptyApiSlots	4

Table 3-7 Policy Microservices Resource

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ocpcf-appinfo	1	1	0.5	1	1
ocpcf-oc-binding	5	6	1	8	15
ocpcf-oc-diam-connector	3	4	1	2	8
ocpcf-oc-diam-gateway	3	4	1	2	7
ocpcf-occnp-config-server	2	4	0.5	2	1
ocpcf-occnp-egress-gateway	3	4	4	6	2
ocpcf-ocpm-ldap-gateway	3	4	1	2	10
ocpcf-occnp-ingress-gateway	3	4	4	6	2

Table 3-7 (Cont.) Policy Microservices Resource

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ocpcf-occnp-nrf-client-nfdiscovery	3	4	0.5	2	2
ocpcf-occnp-nrf-client-nfmanagement	1	1	1	1	2
ocpcf-ocpm-audit-service	1	2	1	1	1
ocpcf-ocpm-cm-service	2	4	0.5	2	1
ocpcf-ocpm-policyds	5	6	1	4	25
ocpcf-ocpm-pre	5	5	0.5	4	25
ocpcf-ocpm-queryservice	1	2	1	1	1
ocpcf-pcf-smservice	7	8	1	4	2
ocpcf-pcrf-core	7	8	8	8	30
ocpcf-performance	1	1	0.5	1	2

> **Note**
>
> Min Replica = Max Replica

Table 3-8 cnDBTier Services Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ndbappmysqld	8	8	19	20	5
ndbmgmd	2	2	9	11	2
ndbmtd	8	8	73	83	8
ndbmysqld	4	4	19	20	12

> **Note**
>
> Min Replica = Max Replica

3.1.1.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the Pod).

Table 3-9 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y)- Site 2	CPU(X/Y) - Site 3	CPU(X/Y) - Site 4
ocpcf-alternate-route	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-appinfo	1%/80%	2%/80%	2%/80%	3%/80%
ocpcf-occnp-config-server	10%/80%	11%/80%	12%/80%	12%/80%
ocpcf-oc-diam-connector	10%/40%	11%/40%	10%/40%	10%/40%
ocpcf-occnp-egress-gateway	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-occnp-ingress-gateway	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-ocpm-ldap-gateway	4%/60%	4%/60%	5%/60%	4%/60%
ocpcf-occnp-nrf-client-nfdiscovery	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-occnp-nrf-client-nfmanagement	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-oc-binding	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-occnp-chf-connector	0%/50%	0%/50%	0%/50%	0%/50%
ocpcf-occnp-udr-connector	0%/50%	0%/50%	0%/50%	0%/50%
ocpcf-ocpm-audit-service	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-ocpm-policyds	11%/60%	11%/60%	11%/60%	11%/60%
ocpcf-ocpm-soapconnector	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-ocpm-pre	13%/80%	13%/80%	13%/80%	13%/80%
ocpcf-pcf-smservice	0%/50%	0%/50%	0%/50%	0%/50%
ocpcf-pcrf-core	7%/40%	7%/40%	7%/40%	7%/40%
ocpcf-ocpm-queryservice	0%/80%	0%/80%	0%/80%	0%/80%

Table 3-10 cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2	CPU (X/Y) - Site 3	CPU (X/Y) - Site 4
ndbappmysqld	35%/80%	36%/80%	35%/80%	35%/80%
ndbmgmd	1%/80%	1%/80%	0%/80%	0%/80%

Table 3-10 (Cont.) cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2	CPU (X/Y) - Site 3	CPU (X/Y) - Site 4
ndbmtd	15%/80%	15%/80%	18%/80%	17%/80%
ndbmysqld	5%/80%	5%/80%	5%/80%	5%/80%

3.1.1.3 Results

The following table provides observation data for the performance test that can be used for benchmark testing:

Table 3-11 Result and Observations

Parameter	Values
Test Duration	12 Hours
TPS Achieved	30K TPS (7.5KTPS on each site)

It was observed that on a four-site GR setup, handling an incoming traffic of 7.5K TPS on each site, the call model was working successfully without any replication delay and traffic drop.

3.1.2 Test Scenario 2: PCRF Voice Call Model on Two-Sites of Four-Site GeoRedundant setup, with 15K Transaction Per Second (TPS) on each site and ASM disabled

This test run benchmarks the performance and capacity of PCRF voice call model that is deployed in converged mode on a two-site of a four-site georedundant setup. Each site in the setup handles an incoming traffic of 15K TPS, and with Aspen Service Mesh (ASM) disabled.

3.1.2.1 Test Case and Setup Details

Table 3-12 Test Case Parmeters

Parameters	Values
Call Rate	30K TPS (15K TPS on each site)
Execution Time	10 Hours
ASM	Disable

Table 3-13 Call Model Data

Command	Messages per call
CCRI (Single APN)	9.08%
CCRU (Single APN)	18.18%
CCRT (Single APN)	9.09 %
Gx RAR	18.18%
AARI	9.09 %
AARU	9.09 %

Table 3-13 (Cont.) Call Model Data

Command	Messages per call
Rx RAR	18.18%
STR	9.09%

Table 3-14 PCRF Configurations

Service Name	Status
Binding Service	Enable
Policy Event Record (PER)	Disable
Subscriber Activity Logging (SAL)	Enable
LDAP	Disable
Online Charging System (OCS)	Disable

Table 3-15 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Disable
N36 UDR subscription (N7/N15-Nudr)	Disable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Disable
BSF (N7-Nbsf)	Disable
AMF on demand nrf discovery	Disable
LDAP (Gx-LDAP)	Disable
Sy (PCF N7-Sy)	Disable

Table 3-16 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	Disable
Sd (Gx-Sd)	Disable
Gx UDR query (Gx-Nudr)	Disable
Gx UDR subscription (Gx-Nudr	Disable
CHF enabled (AM)	Disable
Usage Monitoring (Gx)	Disable
Subscriber HTTP Notifier (Gx)	Disable

Table 3-17 Configuring cnDBTier Helm Parameters

Helm Parameter	Value
ndb_batch_size	2G
TimeBetweenEpochs	100
NoOfFragmentLogFiles	50
FragmentLogFileSize	256M

Table 3-17 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value
RedoBuffer	1024M
ndbappmysqld Pods Memory	19/20 Gi
ndbmtd pods CPU	8/8
ndb_report_thresh_binlog_epoch_slip	50
ndb_eventbuffer_max_alloc	19G
ndb_log_update_minimal	1
ndbmysqld Pods Memory	25/25 Gi
replicationskiperrors	enable: true
replica_skip_errors	'1007,1008,1050,1051,1022'
numOfEmptyApiSlots	4

Table 3-18 Policy Microservices Resource

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ocpcf-appinfo	1	1	0.5	1	1
ocpcf-oc-binding	5	6	1	8	18
ocpcf-oc-diam-connector	3	4	1	2	8
ocpcf-oc-diam-gateway	3	4	1	2	9
ocpcf-occnp-config-server	2	4	0.5	2	2
ocpcf-occnp-egress-gateway	3	4	4	6	1
ocpcf-ocpm-ldap-gateway	3	4	1	2	0
ocpcf-occnp-ingress-gateway	3	4	4	6	2
ocpcf-occnp-nrf-client-nfdiscovery	3	4	0.5.	2	1
ocpcf-occnp-nrf-client-nfmanagement	1	1	1	1	1
ocpcf-ocpm-audit-service	1	2	1	1	1
ocpcf-ocpm-cm-service	2	4	0.5	2	1
ocpcf-ocpm-policyds	5	6	1	4	2
ocpcf-ocpm-pre	5	5	0.5	4	15
ocpcf-ocpm-queryservice	1	2	1	1	1

Table 3-18 (Cont.) Policy Microservices Resource

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ocpcf-pcf-smservice	7	8	1	4	2
ocpcf-pcrf-core	7	8	8	8	24
ocpcf-performance	1	1	0.5	1	2

> **Note**
>
> Min Replica = Max Replica

Table 3-19 cnDBTier Microservices Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ndbappmysqld	8	8	19	20	5
ndbmgmd	2	2	9	11	3
ndbmtd	8	8	73	83	8
ndbmysqld	4	4	19	20	6

> **Note**
>
> Min Replica = Max Replica

3.1.2.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Table 3-20 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
ocpcf-appinfo	2%/80%	1%/80%
ocpcf-occnp-config-server	8%/80%	8%/80%
ocpcf-oc-diam-connector	0%/40%	0%/40%
ocpcf-occnp-egress-gateway	0%/80%	0%/80%
ocpcf-occnp-ingress-gateway	0%/80%	1%/80%
ocpcf-occnp-nrf-client-nfdiscovery	0%/80%	0%/80%
ocpcf-occnp-nrf-client-nfmanagement	0%/80%	0%/80%
ocpcf-oc-binding	12%/60%	0%/60%

Table 3-20 (Cont.) Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
ocpcf-ocpm-audit-service	0%/60%	0%/60%
ocpcf-ocpm-policyds	0%/60%	0%/60%
ocpcf-ocpm-pre	13%/80%	0%/80%
ocpcf-pcf-smservice	0%/50%	0%/50%
ocpcf-pcrf-core	25%/40%	0%/40%
ocpcf-ocpm-queryservice	0%/80%	0%/80%

Table 3-21 cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
ndbappmysqld	75%/80%	76%/80%
ndbmgmd	0%/80%	0%/80%
ndbmtd	19%/80%	6%/80%
ndbmysqld	8%/80%	3%/80%

3.1.2.3 Results

In this four site geo-redundant setup, it was observed that,

- each of the two sites handles traffic of 15k TPS successfully, and
- in the event of two site failure, the system failover to the two redundant sites quickly.

3.1.3 Test Scenario: PCRF Data Call Model on Two-Site GeoRedundant setup, with each site handling 11.5K TPS and ASM disabled

This test run benchmarks the performance and capacity of PCRF data call model that is deployed in converged mode on a two-site georedundant setup. Each site in the setup handles an incoming traffic of 11.5K Transaction Per Second (TPS). Aspen Service Mesh (ASM) is disabled.

The cnDBTier database and PCRF application is replicated on both the sites using Multi-channel replication. The database replication is used to perform data synchronization between databases over the replication channels.

3.1.3.1 Test Case and Setup Details

Table 3-22 Test Case Parmeters

Parameters	Values
Call Rate	23K TPS (11.5K TPS on each site)
Execution Time	60 Hours
ASM	Disable

Table 3-23 Call Model Data

Messages	Total TPS
CCR-I	2320
CCR-U	1220
CCR-T	2320
SNR	450
RAR	450
Sy	2440
LDAP	2320
Total Messages	11520

Table 3-24 PCRF Configurations

Service Name	Status
Binding Service	Enable
Policy Event Record (PER)	Disable
Subscriber Activity Log (SAL)	Enable
LDAP	Enable
Online Charging System (OCS)	Enable
PDS and Binding Compression	Enable
Audit Service	Enable
Replication	Enable
Bulwark Service	Disable
Alternate Route Service	Disable

Table 3-25 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Disable
N36 UDR subscription (N7/N15-Nudr)	Disable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Disable
BSF (N7-Nbsf)	Disable
AMF on demand nrf discovery	Disable
LDAP (Gx-LDAP)	Enable
Sy (PCF N7-Sy)	Enable

Table 3-26 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	Enable
Sd (Gx-Sd)	Disable
Gx UDR query (Gx-Nudr)	Disable
Gx UDR subscription (Gx-Nudr	Disable

Table 3-26 (Cont.) PCRF Interfaces

Feature Name	Status
CHF enabled (AM)	Disable
Usage Monitoring (Gx)	Disable
Subscriber HTTP Notifier (Gx)	Disable

Table 3-27 Configuring cnDBTier Helm Parameters

Helm Parameter	New Value
ndb_batch_size	2G
TimeBetweenEpochs	100
NoOfFragmentLogFiles	50
FragmentLogFileSize	256M
RedoBuffer	1024M
ndbappmysqld Pods Memory	19/20 Gi
ndbmtd pods CPU	8/8
ndb_report_thresh_binlog_epoch_slip	50
ndb_eventbuffer_max_alloc	19G
ndb_log_update_minimal	1
ndbmysqld Pods Memory	25/25 Gi
replicationskiperrors	enable: true
replica_skip_errors	'1007,1008,1050,1051,1022'
numOfEmptyApiSlots	4

Table 3-28 Policy Microservices Resource

Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
Appinfo Service	1	1	0.5	1	1
Binding Service	5	6	1	8	15
Diameter Connector Service	3	4	1	2	8
Diameter Gateway Service	3	4	2	2	7
Config Server	2	4	0.5	2	2
Egress Gateway Service	3	4	4	6	1
LDAP Gateway Service	3	4	1	2	10
Ingress Gateway	3	4	4	6	1

Table 3-28 (Cont.) Policy Microservices Resource

Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
Nrf-client-Nfdiscovery Service	3	4	0.5	2	1
Nrf-client-Nfmanagement Service	1	1	1	1	1
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	2
PolicyDS Service	5	6	1	2	25
PRE Service	5	5	2	4	25
Query Service	1	2	1	1	1
PCRF Core Service	7	8	8	8	30
Performance	1	1	0.5	1	2

> **Note**
>
> Min Replica = Max Replica

Table 3-29 cnDBTier Services Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ndbappmysqld	8	8	19	20	5
ndbmgmd	2	2	9	11	2
ndbmtd	10	10	73	83	8
ndbmysqld	8	8	25	25	4

> **Note**
>
> Min Replica = Max Replica

3.1.3.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the Pod).

Table 3-30 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site1	CPU (X/Y)- Site2
ocpcf-appinfo	3%/80%	3%/80%
ocpcf-occnp-config-server	10%/80%	15%/80%
ocpcf-oc-diam-connector	23%/40%	17%/40%
ocpcf-occnp-egress-gateway	0%/80%	0%/80%
ocpcf-occnp-ingress-gateway	1%/80%	1%/80%
ocpcf-ocpm-ldap-gateway	10%/60%	8%/60%
ocpcf-occnp-nrf-client-nfdiscovery	0%/80%	0%/80%
ocpcf-occnp-nrf-client-nfmanagement	0%/80%	0%/80%
ocpcf-oc-binding	16%/60%	13%/60%
ocpcf-ocpm-audit-service	0%/60%	0%/60%
ocpcf-ocpm-policyds	25%/60%	25%/60%
ocpcf-ocpm-pre	15%/80%	15%/80%
ocpcf-pcrf-core	19%/40%	18%/40%
ocpcf-ocpm-queryservice	0%/80%	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-31 cnDBTier Microservices Resource Utilization

Service	CPU (X/Y)- Site1	CPU (X/Y)- Site2
ndbappmysqld	51%/80%	51%/80%
ndbmgmd	0%/80%	0%/80%
ndbmtd	23%/80%	23%/80%
ndbmysqld	5%/80%	4%/80%

3.1.3.3 Results

Table 3-32 Average PCRF Core JDBC Latency Observations

Site1	Site2
6.10ms	5.73ms

3.1.4 Test Scenario: PCRF Voice Call Model on Two-Site GeoRedundant setup, with 15K TPS on each site and ASM disabled

This test run benchmarks the performance and capacity of PCRF voice call model that is deployed in converged mode on a two-site georedundant setup. Each site in the setup handles an incoming traffic of 15K TPS. Aspen Service Mesh (ASM) is disabled.

The cnDBTier database and PCRF application is replicated on both the sites using Single-channel replication. The database replication is used to perform data synchronization between databases over the replication channels.

3.1.4.1 Test Case and Setup Details

Table 3-33 Test Case Parmeters

Parameters	Values
Call Rate	30K TPS (15K TPS on each site)
Execution Time	110 Hours
Traffic Ratio	CCRI-I, AARI –1, CCRU-2, AARU - 1, RAR-Gx-1, RAR-Rx-1, STR –1, CCRT-1
ASM	Disable

Table 3-34 PCRF Configurations

Service Name	Status
Binding Service	Enable
Policy Event Record (PER)	Enable
Subscriber Activity Log (SAL)	Enable
LDAP	Disable
Online Charging System (OCS)	Disable
Audit Service	Enable
Replication	Enable
Bulwark Service	Disable
Alternate Route Service	Disable

Table 3-35 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Disable
N36 UDR subscription (N7/N15-Nudr)	Disable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Disable
BSF (N7-Nbsf)	Disable
AMF on demand nrf discovery	Disable
LDAP (Gx-LDAP)	Disable
Sy (PCF N7-Sy)	Enable

Table 3-36 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	Enable
Sd (Gx-Sd)	Disable
Gx UDR query (Gx-Nudr)	Disable
Gx UDR subscription (Gx-Nudr	Disable
CHF enabled (AM)	Disable
Usage Monitoring (Gx)	Disable

Table 3-36 (Cont.) PCRF Interfaces

Feature Name	Status
Subscriber HTTP Notifier (Gx)	Disable

Table 3-37 Configuring cnDBTier Helm Parameters

Helm Parameter	New Value
ndb_batch_size	2G
TimeBetweenEpochs	100
NoOfFragmentLogFiles	50
FragmentLogFileSize	256M
RedoBuffer	1024M
ndbappmysqld Pods Memory	19/20 Gi
ndbmtd pods CPU	8/8
ndb_report_thresh_binlog_epoch_slip	50
ndb_eventbuffer_max_alloc	19G
ndb_log_update_minimal	1
ndbmysqld Pods Memory	25/25 Gi
replicationskiperrors	enable: true
replica_skip_errors	'1007,1008,1050,1051,1022'
numOfEmptyApiSlots	4

Table 3-38 Policy Microservices Resource

Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
Appinfo Service	1	1	0.5	1	1
Binding Service	5	6	1	8	18
Diameter Connector Service	3	4	1	2	5
Diameter Gateway Service	3	4	1	2	9
Config Server	2	4	0.5	2	2
Egress Gateway Service	3	4	4	6	1
Ingress Gateway Service	3	4	4	6	1
Nrf-client-Nfdiscovery Service	3	4	0.5	2	1
Nrf-client-Nfmanagement Service	1	1	1	1	1

Table 3-38 (Cont.) Policy Microservices Resource

Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	2
PolicyDS Service	5	6	1	4	5
PRE Service	3	8	0.5	4	15
Query Service	1	2	1	1	1
PCRF Core Service	7	8	8	8	24
Performance	1	1	0.5	1	2

> **Note**
>
> Min Replica = Max Replica

Table 3-39 cnDBTier Services Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ndbappmysqld	8	8	19	20	5
ndbmgmd	4	4	9	11	2
ndbmtd	10	10	73	83	8
ndbmysqld	10	10	25	25	2

> **Note**
>
> Min Replica = Max Replica

3.1.4.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the Pod).

Table 3-40 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y)- Site 2
ocpcf-appinfo	2%/80%	1%/80%
ocpcf-occnp-config-server	7%/80%	6%/80%
ocpcf-oc-diam-connector	0%/40%	0%/40%
ocpcf-occnp-egress-gateway	0%/80%	0%/80%

Table 3-40 (Cont.) Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y)- Site 2
ocpcf-occnp-ingress-gateway	0%/80%	0%/80%
ocpcf-occnp-nrf-client-nfdiscovery	0%/80%	0%/80%
ocpcf-occnp-nrf-client-nfmanagement	0%/80%	0%/80%
ocpcf-oc-binding	0%/60%	0%/60%
ocpcf-ocpm-audit-service	0%/60%	0%/60%
ocpcf-ocpm-policyds	0%/60%	0%/60%
ocpcf-ocpm-pre	0%/80%	0%/80%
ocpcf-pcrf-core	0%/40%	0%/40%
ocpcf-ocpm-queryservice	0%/80%	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-41 cnDBTier Microservices Resource Utilization

Service	CPU (X/Y)- Site1	CPU (X/Y)- Site2
ndbappmysqld	78%/80%	78%/80%
ndbmgmd	0%/80%	0%/80%
ndbmtd	1%/80%	1%/80%
ndbmysqld	0%/80%	0%/80%

3.1.4.3 Results

Table 3-42 Average PCRF Core JDBC Latency Observations

Site1	Site2
2.41ms	2.23ms

3.1.5 46.5K TPS Single Site with Replication Enabled with UDR Interworking

This test run benchmarks the performance and capacity of Policy data call model that is deployed in PCF mode. The PCF application's total traffic (Ingress + Egress) of 46.5K TPS on single site Non-ASM PCF Setup with UDR interworking.

3.1.5.1 Test Case and Setup Details

Policy Infrastructure Details

Infrastructure used for benchmarking Policy performance run is described in this section.

Table 3-43 Hardware Details

Hardware	Details
Environment	BareMetal
Server	ORACLE SERVER X9-2
Model	Intel(R) Xeon(R) Platinum 8358 CPU
Clock Speed	2.600 GHz
Total Cores	128
Memory Size	1024 GB
Type	DDR4 SDRAM
Installed DIMMs	16
Maximum DIMMs	32
Installed Memory	1024 GB

Table 3-44 Software Details

Aplications	Version
Policy	25.1.200
cnDBTier	25.1.200
OSO	NA
CNE	23.3.5

For more information about Policy Installation, see *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*.

The following table describes the testcase parameters and their values:

Table 3-45 Testcase Parameters

Parameter	Value
Call Rate (Ingress + Egress)	46.5K TPS on a single site Non-ASM PCF Setup with UDR interworking
ASM	Disable
Traffic Ratio	46.5K TPS on a single site
Active User Count	NA

Policy Project Details:

This test case shall pump traffic Call Rate: 46.5K TPS on a single site Non-ASM PCF Setup with UDR interworking.

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low– No Usage of Loops in Blockly logic, No JSON operations, No complex Java Script code in Object Expression /Statement Expression.

- Medium - Usage of Loops in Blockly logic, Policy Table Wildcard match <= 3 fields, MatchList < 3, 3 < RegEx match < 6
- High - JSON Operations – Custom, complex Java Script code in Object Expression / Statement Expression, Policy Table Wildcard match > 3 fields, MatchLists >= 3, RegEx mat >= 6

Call Model Data:

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-46 Policy Configurations

Feature Name	Configuration
SAL	Enabled
Binding Service	Disabled
Congestion and Overload	Disabled
PDS Single UEID	Enabled (GPSI)
PRIMARYKEY_LOOKUP_ENABLED	Enabled (true)
PER	Disabled
OCS	Enabled
Audit	Enabled
PDS Compression scheme	Disabled

Table 3-47 Call Model Data

Service Name	Traffic at Site1	Traffic at Site2
Pcrf-Total-Tps (	46500	-

Resource Footprint (per site):

Policy microservices Resource allocation at Site1:

Table 3-48 PCRF

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
NRFsim	2	NA	NA	NA	NA
Appinfo	1	2	1	2Gi	1Gi
Bulwark Service	2	8	8	6Gi	6Gi
Binding Service	1	6	6	8Gi	8Gi
Diameter Connector	4	4	4	2Gi	1Gi
CHF Connector User Service	2	6	6	4Gi	4Gi
Config-server	2	4	4	2Gi	512Mi
Egress Gateway	6	4	4	6Gi	6Gi
Ingress Gateway	2	5	5	6Gi	6Gi

Table 3-48 (Cont.) PCRF

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
NRF Client NF Discovery	2	4	4	4Gi	4Gi
NRF Client Management	2	1	1	1Gi	1Gi
UDR connector User Service	11	6	6	4Gi	4Gi
Audit Service	2	2	2	4Gi	4Gi
CM service	2	4	2	2Gi	512Mi
PolicyDS	28	7	7	8Gi	8Gi
PRE Service	20	4	4	4Gi	4Gi
Query Service	1	2	1	1Gi	1Gi
AM Service	2	8	8	8Gi	8Gi
SM Service	2	2	2	2Gi	2Gi
UE Policy Service	2	8	8	6Gi	6Gi
PCRF Core	32	8	8	8Gi	8Gi
Perf-info	2	2	1	2Gi	1Gi
UDMsim	2	NA	NA	NA	NA
Diameter Gateway	2	4	4	2Gi	1Gi

Table 3-49 UDR

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
UDR-Site1-ocudr-alternate-route/istio-proxy	2	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-alternate-route/alternate-route	2	2	2	2Gi	2Gi
UDR-Site1-ocudr-appinfo/istio-proxy	2	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-appinfo/appinfo	2	1	1	1Gi	1Gi
UDR-Site1-ocudr-egressgateway/istio-proxy	2	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-egressgateway/egressgateway	2	6	6	4Gi	4Gi

Table 3-49 (Cont.) UDR

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
UDR-Site1-ocudr-ingressgateway-prov/istio-proxy	2	2000m	2000m	1Gi	1Gi
UDR-Site1-ocudr-ingressgateway-prov/ingressgateway-prov	2	4	4	4Gi	4Gi
UDR-Site1-ocudr-ingressgateway-sig/istio-proxy	9	4000m	4000m	1Gi	1Gi
UDR-Site1-ocudr-ingressgateway-sig/ingressgateway-sig	9	6	6	4Gi	4Gi
UDR-Site1-ocudr-nudr-config/istio-proxy	2	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-nudr-config/nudr-config	2	2	2	2Gi	2Gi
UDR-Site1-ocudr-nudr-config-server/istio-proxy	2	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-nudr-config-server/config-server	2	2	2	2Gi	512Mi
UDR-Site1-ocudr-nudr-dbcr-auditor-service/istio-proxy	1	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-nudr-dbcr-auditor-service/nudr-dbcr-auditor-service	1	2	2	2Gi	2Gi

Table 3-49 (Cont.) UDR

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
UDR-Site1-ocudr-nudr-diameterproxy/nudr-diameterproxy	2	6	6	4Gi	4Gi
UDR-Site1-ocudr-nudr-dr-provservice/istio-proxy	2	2000m	2000m	1Gi	1Gi
UDR-Site1-ocudr-nudr-dr-provservice/nudr-dr-provservice	2	4	4	4Gi	4Gi
UDR-Site1-ocudr-nudr-drservice/istio-proxy	12	3000m	3000m	1Gi	1Gi
UDR-Site1-ocudr-nudr-drservice/nudr-drservice	12	6	6	4Gi	4Gi
UDR-Site1-ocudr-nudr-notify-service/nudr-notify-service	3	6	6	5Gi	5Gi
UDR-Site1-ocudr-nudr-nrf-client-nfmanagement/istio-proxy	2	1000m	1000m	1Gi	1Gi
UDR-Site1-ocudr-nudr-nrf-client-nfmanagement/nrf-client-nfmanagement	2	1	1	1Gi	1Gi
UDR-Site1-ocudr-nudr-ondemand-migration/nudr-ondemand-migration	2	2	2	2Gi	2Gi
UDR-Site1-ocudr-performance/istio-proxy	2	1000m	1000m	1Gi	1Gi

Table 3-49 (Cont.) UDR

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
UDR-Site1-ocudr-performance/perf-info	2	1	1	1Gi	1Gi
UDR-Site1-ocudr-nudr-diam-gateway/nudr-diam-gateway	2	6	6	5Gi	5Gi

Table 3-50 cnDBTier (for Policy) resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-mysql-cluster-chio-inde-replication-svc/chio-inde-replication-svc	1	3	2	12Gi	12Gi
Site1-mysql-cluster-chio-inde-replication-svc/db-infra-monitor-svc	1	100m	100m	256Mi	256Mi
Site1-mysql-cluster-chio-inde-replication-svc-2/chio-inde-replication-svc-2	1	2	2	12Gi	12Gi
Site1-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site1-mysql-cluster-db-monitor-svc/db-monitor-svc	1	5	4	4Gi	4Gi
Site1-ndbappmysqld/mysqlndbcluster	10	9	9	20Gi	20Gi
Site1-ndbappmysqld/db-infra-monitor-svc	10	100m	100m	256Mi	256Mi

Table 3-50 (Cont.) cnDBTier (for Policy) resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-ndbappmysqld/init-sidecar	10	300m	300m	512Mi	512Mi
Site1-ndbmgmd/mysqlndbcluster	2	5	4	10Gi	8Gi
Site1-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site1-ndbmtd/mysqlndbcluster	6	12	12	125Gi	125Gi
Site1-ndbmtd/db-backup-executor-svc	6	1200m	1200m	2560Mi	2560Mi
Site1-ndbmtd/db-infra-monitor-svc	6	100m	100m	256Mi	256Mi
Site1-ndbmysqld/mysqlndbcluster	4	5	4	21Gi	21Gi
Site1-ndbmysqld/init-sidecar	4	300m	300m	512Mi	512Mi
Site1-ndbmysqld/db-infra-monitor-svc	4	100m	100m	256Mi	256Mi

Table 3-51 cnDBTier (for Policy) resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site2-mysql-cluster-db-monitor-svc/db-monitor-svc	1	5	4	4Gi	4Gi

Table 3-51 (Cont.) cnDBTier (for Policy) resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-mysql-cluster-inde-chio-replication-svc/inde-chio-replication-svc	1	3	2	12Gi	12Gi
Site2-mysql-cluster-inde-chio-replication-svc/db-infra-monitor-svc	1	100m	100m	256Mi	256Mi
Site2-mysql-cluster-inde-chio-replication-svc-2/inde-chio-replication-svc-2	1	2	2	12Gi	12Gi
Site2-ndbappmysqld/mysqlndbcluster	10	9	9	20Gi	20Gi
Site2-ndbappmysqld/db-infra-monitor-svc	10	100m	100m	256Mi	256Mi
Site2-ndbappmysqld/init-sidecar	10	300m	300m	512Mi	512Mi
Site2-ndbmgmd/mysqlndbcluster	2	5	4	10Gi	8Gi
Site2-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site2-ndbmtd/mysqlndbcluster	6	12	12	125Gi	125Gi
Site2-ndbmtd/db-backup-executor-svc	6	1200m	1200m	2560Mi	2560Mi
Site2-ndbmtd/db-infra-monitor-svc	6	100m	100m	256Mi	256Mi
Site2-ndbmysqld/mysqlndbcluster	4	5	4	21Gi	21Gi

Table 3-51 (Cont.) cnDBTier (for Policy) resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-ndbmysqld/init-sidecar	4	300m	300m	512Mi	512Mi
Site2-ndbmysqld/db-infra-monitor-svc	4	100m	100m	256Mi	256Mi

Table 3-52 cnDBTier (for UDR) resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-mysql-cluster-chio-inde-replication-svc/chio-inde-replication-svc	1	2	2	12Gi	12Gi
Site1-mysql-cluster-chio-inde-replication-svc/db-infra-monitor-svc	1	100m	100m	256Mi	256Mi
Site1-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site1-mysql-cluster-db-monitor-svc/db-monitor-svc	1	4	4	4Gi	4Gi
Site1-ndbappmysqld/mysqlndbcluster	10	6	6	4Gi	4Gi
Site1-ndbappmysqld/db-infra-monitor-svc	10	100m	100m	256Mi	256Mi
Site1-ndbappmysqld/init-sidecar	10	100m	100m	256Mi	256Mi
Site1-ndbmgmd/mysqlndbcluster	2	3	3	10Gi	10Gi

Table 3-52 (Cont.) cnDBTier (for UDR) resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site1-ndbmtd/mysqlndbcluster	4	4	4	120Gi	120Gi
Site1-ndbmtd/db-backup-executor-svc	4	100m	100m	256Mi	256Mi
Site1-ndbmtd/db-infra-monitor-svc	4	100m	100m	256Mi	256Mi
Site1-ndbmysqld/mysqlndbcluster	2	4	4	10Gi	10Gi
Site1-ndbmysqld/init-sidecar	2	100m	100m	256Mi	256Mi
Site1-ndbmysqld/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi

Table 3-53 cnDBTier (for UDR) resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-mysql-cluster-chio-inde-replication-svc/chio-inde-replication-svc	1	2	2	12Gi	12Gi
Site2-mysql-cluster-chio-inde-replication-svc/db-infra-monitor-svc	1	100m	100m	256Mi	256Mi
Site2-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi

Table 3-53 (Cont.) cnDBTier (for UDR) resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-mysql-cluster-db-monitor-svc/db-monitor-svc	1	4	4	4Gi	4Gi
Site2-ndbappmysqld/mysqlndbcluster	10	6	6	4Gi	4Gi
Site2-ndbappmysqld/db-infra-monitor-svc	10	100m	100m	256Mi	256Mi
Site2-ndbappmysqld/init-sidecar	10	100m	100m	256Mi	256Mi
Site2-ndbmgmd/mysqlndbcluster	2	3	3	10Gi	10Gi
Site2-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site2-ndbmtd/mysqlndbcluster	4	4	4	120Gi	120Gi
Site2-ndbmtd/db-backup-executor-svc	4	100m	100m	256Mi	256Mi
Site2-ndbmtd/db-infra-monitor-svc	4	100m	100m	256Mi	256Mi
Site2-ndbmysqld/mysqlndbcluster	2	4	4	10Gi	10Gi
Site2-ndbmysqld/init-sidecar	2	100m	100m	256Mi	256Mi
Site2-ndbmysqld/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi

3.1.5.2 CPU Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-54 Policy Microservices and their Resource Utilization

Service Name	CPU at Site1	Memory at Site1	CPU at Site2	Memory at Site2
NRFsim	['NA']	['NA']	None	None
Appinfo	2.05%	12.99%	None	None
Bulwark service	0.04%	10.09%	None	None
Binding service	0.03%	7.71%	None	None
Diameter Connector	23.41%	49.26%	None	None
CHF Connector	0.05%	14.72%	None	None
Config Service	5.22%	47.71%	None	None
Egress Gateway	35.83%	34.24%	None	None
Ingress Gateway	0.19%	15.71%	None	None
NRF Client NF Discovery	0.09%	24.73%	None	None
NRF Client NF Management	0.35%	49.02%	None	None
UDR Connector	14.02%	41.10%	None	None
Audit Service	1.12%	29.38%	None	None
CM Service	0.24%	35.28%	None	None
PDS	34.78%	51.91%	None	None
PRE	28.38%	60.54%	None	None
Query Service	0.05%	31.54%	None	None
AM Service	0.04%	8.26%	None	None
SM Service	0.10%	38.28%	None	None
UE Service	0.04%	10.66%	None	None
PCRF Core	34.23%	52.03%	None	None
PerfInfo	0.10%	6.45%	None	None
UDMsim	['NA']	['NA']	None	None
Diameter Gateway	76.15%	48.80%	None	None

The following table provides information about observed values of cnDBTier services.

Table 3-55 Observed CPU utilization values of cnDBTier services

Service Name	CPU at Site1	Memory at Site1	CPU at Site2	Memory at Site2
mysql-cluster-chio-inde-replication-svc/chio-inde-replication-svc	0.20%	2.38%	None	None
mysql-cluster-chio-inde-replication-svc/db-infra-monitor-svc	2.00%	19.92%	None	None

Table 3-55 (Cont.) Observed CPU utilization values of cnDBTier services

Service Name	CPU at Site1	Memory at Site1	CPU at Site2	Memory at Site2
mysql-cluster-chio-inde-replication-svc-2/chio-inde-replication-svc-2	0.30%	2.24%	None	None
mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	4.00%	69.53%	None	None
mysql-cluster-db-monitor-svc/db-monitor-svc	0.10%	12.92%	None	None
ndbappmysqld/ mysqlndbcluster	57.55%	28.25%	None	None
ndbappmysqld/db-infra-monitor-svc	1.90%	21.68%	None	None
ndbappmysqld/init-sidecar	0.67%	0.20%	None	None
ndbmgmd/ mysqlndbcluster	0.12%	20.21%	None	None
ndbmgmd/db-infra-monitor-svc	1.00%	20.70%	None	None
ndbmtd/ mysqlndbcluster	37.85%	90.47%	None	None
ndbmtd/db-backup-executor-svc	0.08%	2.17%	None	None
ndbmtd/db-infra-monitor-svc	3.00%	21.22%	None	None
ndbmysqld/ mysqlndbcluster	10.77%	21.37%	None	None
ndbmysqld/init-sidecar	0.67%	0.20%	None	None
ndbmysqld/db-infra-monitor-svc	3.00%	23.05%	None	None

3.1.5.3 Results

Table 3-56 Average Latency Observations for PCRF In Milliseconds:

Service Name	Latency at Site1	Latency at Site2
PCRF_Policyds	12.7	-
PCRF_Binding	0.00	-
PCRF_Diam_connector	1.17	-
PCRF_Core_JDBC_Latency	1.00	-

Table 3-57 Average Latency Observations for UDR In Milliseconds:

Service Name	Latency at Site1	Latency at Site2
UDR_DB_Latency	0.02	-
UDR_Req_Latency	1.51	-
Diam_Db_Latency	0.00	-
Diam_Backend_Latency	0.00	-

Table 3-58 Average Latency Observations for PCRF for current percentile In Milliseconds:

Methods	50th Percentile at Site1	99th Percentile at Site1	50th Percentile at Site2	99th Percentile at Site2
DIAM	0.00	0.02	-	-

Table 3-59 Average Latency Observations for UDR for current percentile In MilliSeconds:

Methods	50th Percentile at Site1	99th Percentile at Site1	50th Percentile at Site2	99th Percentile at Site2
IGW_GET	0.00	0.01	-	-
IGW_DELETE	0.00	0.01	-	-
IGW_PUT	0.00	0.00	-	-
EGW_GET	0.00	0.00	-	-
EGW_DELETE	0.00	0.00	-	-
EGW_PUT	0.00	0.01	-	-

Table 3-60 Latency obervations for cnDBTier services

Site-Slave Node	cnDBTier Replication Slave Delay (seconds)
Site1-ndbmysqld	0-1
Site2-ndbmysqld	0-1

3.2 PCF Call Model 2

Following are the cnDBTier Helm Parameters that needs to be configured for all the test scenarios for AM/UE (15K, 25K, 30K, 60K, and 75K).

Table 3-61 Configuring cnDBTier Helm Parameters

Helm Parameter	Value
db-monitor-svc.restartSQLNodesIfBinlogThreadStalled	true
global.additionalndbconfigurations.mysqld.binlog_cache_size	10485760
global.additionalndbconfigurations.ndb.NoOfFragmentLogFiles	64

Table 3-61 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value
global.additionalndbconfigurations.mysqld.ndb_allow_copying_alter_table	1
global.additionalndbconfigurations.ndb.ConnectCheckIntervalDelay	500
global.additionalndbconfigurations.ndb.NoOfFragmentLogParts	6
global.additionalndbconfigurations.ndb.MaxNoOfExecutionThreads	10
global.additionalndbconfigurations.ndb.FragmentLogFileSize	32M
db-monitor-svc.binlogthreadstore.capacity	5
global.additionalndbconfigurations.mysqld.ndb_allow_copying_alter_table	ON
global.additionalndbconfigurations.ndb.MaxNoOfOrderedIndexes	4096
global.additionalndbconfigurations.ndb.binlog_expire_logs_seconds	259200
global.additionalndbconfigurations.ndb.MaxBufferedEpochBytes	536870912
global.additionalndbconfigurations.ndb.MaxBufferedEpochs	1000
global.additionalndbconfigurations.ndb.MaxNoOfUniqueHashIndexes	4096
global.additionalndbconfigurations.ndb.HeartbeatIntervalDbDb	500
global.additionalndbconfigurations.ndb.SchedulerExecutionTimer	100
global.additionalndbconfigurations.ndb.RedoBuffer	32M
global.additionalndbconfigurations.ndb.TotalSendBufferMemory	3072M

3.2.1 Test Scenario: PCF Call Model on Two-Site GeoRedundant setup, with 15K TPS each for AM/UE and ASM enabled.

This test run benchmarks the performance and capacity of Policy data call model that is deployed in PCF mode. The PCF application handles an incoming traffic of 30K TPS, with 15K TPS each for AM and UE services. For this setup Aspen Service Mesh (ASM) was enabled.

3.2.1.1 Test Case and Setup Details

Table 3-62 Test Case Parmeters

Parameters	Values
Call Rate	30K TPS on Single site
Execution Time	17 Hours
ASM	Enable

Table 3-62 (Cont.) Test Case Parmeters

Parameters	Values
Traffic Ratio	1:0:1 (AM/UE Create: AM/UE Update: AM/UE delete)
Active Subscribers	~10000000

Table 3-63 Call Model

Service Name	AM Service			UE Service			Total MPS	Total TPS
	Ingress	Egress	Total MPS	Ingress	Egress	Total MPS		
Ingress	3600	3600	7200	3600	3600	7200	14400	7200
PRE	3600	0	3600	3600	0	3600	7200	3600
PDS	9000	9000	18000	8100	6300	14400	34200	17100
Egress	9900	9900	19800	13500	13500	27000	46800	23,400
Nrf Discovery	1800	1800	3600	1800	1800	3600	7200	3600
UDR Connector	6300	8100	14400	6300	6300	12600	27000	13500
CHF Connector	3600	3600	7200	0	0	0	7200	3600
AM	3600	18900	22500	0	0	0	22500	11250
UE	0	0	0	3600	20700	24300	24300	12150
Bulwark	7200	0	7200	7200	0	7200	14400	7200

Table 3-64 PCF Configuration

Service Name	Status
Bulwark Service	Enable
Binding Service	Disable
Subscriber State Variable (SSV)	Enable
Validate_user	Disable
Alternate Route Service	Disable
Audit Service	Enable
Binlog	Enable

Table 3-65 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enable
N36 UDR subscription (N7/N15-Nudr)	Enable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Disable
BSF (N7-Nbsf)	Disable

Table 3-65 (Cont.) PCF Interfaces

Feature Name	Status
AMF on demand nrf discovery	Disable
LDAP (Gx-LDAP)	Disable
Sy (PCF N7-Sy)	Enable

Table 3-66 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	Disable
Sd (Gx-Sd)	Disable
Gx UDR query (Gx-Nudr)	Disable
Gx UDR subscription (Gx-Nudr	Disable
CHF enabled (AM)	Disable
Usage Monitoring (Gx)	Disable
Subscriber HTTP Notifier (Gx)	Disable

Table 3-67 Configuring cnDBTier Helm Parameters

Helm Parameter	Value
restartSQLNodesIfBinlogThreadStalled	true
binlog_cache_size	65536
ndbsqld node memory	54Gi
NoOfFragmentLogFiles	96
ndb_allow_copying_alter_table	1

Table 3-68 Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
Appinfo	1	1	0.5	1	2
Audit Service	1	2	1	1	2
CM Service	2	4	0.5	2	2
Config Service	2	4	0.5	2	2
Egress Gateway	4	4	4	6	13
Ingress Gateway	4	4	4	6	4
Nrf Client Management	1	1	1	1	2
Diameter Gateway	4	4	1	2	0
Diameter Connector	4	4	1	2	0
AM Service	8	8	1	4	9

Table 3-68 (Cont.) Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
UE Service	8	8	1	4	11
Nrf Client Discovery	4	4	0.5	2	4
Query Service	1	2	1	1	2
PCRF Core Service	8	8	8	8	0
Performance	1	1	0.5	1	2
PRE Service	4	4	0.5	2	6
SM Service	8	8	1	4	0
PDS	6	6	1	4	17
UDR Connector	6	6	1	4	7
CHF Connector	6	6	1	4	2
LDAP Gateway Service	3	4	1	2	0
Binding Service	5	6	1	8	0
SOAP Connector	2	4	4	4	0
Alternate Route Service	2	2	2	4	4
Bulwark Service	8	8	1	4	3

Note

Min Replica = Max Replica

Table 3-69 cnDBTier Microservices Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replica
ndbappmysqld	15	15	18	18	6
ndbmgmd	3	3	10	10	2
ndbmtd	12	12	96	96	12
ndbmysqld	4	4	54	54	2

Note

Min Replica = Max Replica

3.2.1.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Table 3-70 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site1
ocpcf-alternate-route	0%/80%
ocpcf-appinfo	0%/80%
ocpcf-bulwark	0%/60%
ocpcf-occnp-config-server	9%/80%
ocpcf-occnp-egress-gateway	46%/80%
ocpcf-occnp-ingress-gateway	38%/80%
ocpcf-occnp-nrf-client-nfdiscovery	38%/80%
ocpcf-occnp-nrf-client-nfmanagement	15%/80%
ocpcf-oc-binding	0%/60%
ocpcf-occnp-chf-connector	0%/50%
ocpcf-occnp-udr-connector	46%/50%
ocpcf-ocpm-audit-service	0%/60%
ocpcf-ocpm-policyds	32%/60%
ocpcf-ocpm-pre	18%/80%
ocpcf-pcf-amservice	21%/30%
ocpcf-pcf-ueservice	33%30%
ocpcf-ocpm-queryservice	0%80%

The following table provides

Table 3-71 cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1
ndbappmysqld	31%/80%
ndbmgmd	0%/80%
ndbmtd	43%/80%
ndbmysqld	9%/80%

3.2.1.3 Results

Table 3-72 Latency Observations

NF	Procedure	NF Processing Time - (Average/50%) ms	NF Processing Time - (99%) ms
AM-PCF	AM-Create (simulator)	56.2	47.6
	AM-Delete (simulator)	50.2	44.6
UE-PCF	AM-Create (simulator)	78.6	63.3
	AM-Delete (simulator)	7.6	6.3

Latency Observations for Policy Services:

Table 3-73 Latency Observations for Policy Services:

Services	Average Latency (ms)
Ingress	45.6
PDS	26.9
UDR	7.60
NrfClient Discovery - OnDemand	6.39
Egress	0.914

- Able to achieve 30K TPS with AM (15K) and UE (15K) with constant approximate run of 17 Hours.
- Latency was constant through out the call model run, with
  - approximate of 46ms for Ingress, and
  - approximate of <=20ms for rest of the PCF services

3.2.2 Test Scenario: PCF AM/UE Call Model on Two-Site GeoRedundant setup, with each site handling 25K TPS traffic and ASM enabled

This test run benchmarks the performance and capacity of Policy AM/UE data call model that is deployed in PCF mode. The PCF application handles a total (Ingress + Egress) traffic of 50K TPS, with each site handling a traffic of 25K TPS. For this setup Aspen Service Mesh (ASM) was enabled.

In this test setup, the Georedundant (GR) mode was enabled in cnDBTier and it was configured for 3 channel replication.

3.2.2.1 Test Case and Setup Details

Table 3-74 Test Case Parmeters

Parameters	Values
Call Rate (Ingress + Egress)	50K TPS on Single site
Execution Time	94 Hours
ASM	Enable
Traffic Ratio	1:0:1 (AM/UE Create: AM/UE Update: AM/UE delete)
Active Subscribers	12591141

Table 3-75 TPS Distribution

TPS Distribution	Site1	Site2
AM Ingress	6.12K	0
AM Egress	18.88K	0
UE Ingress	6.12K	0
UE Egress	18.88K	0
Total TPS	50K	0

Table 3-76 Call Model

Service Name	AM Service			UE Service			Total MPS	Total TPS
	Ingress	Egress	Total MPS	Ingress	Egress	Total MPS		
Ingress	6250	6250	12500	6250	6250	12500	25000	12500
PRE	6250	0	6250	6250	0	6250	12500	6250
PDS	9375	9375	18750	9375	9375	18750	37500	18750
Egress	12500	12500	25000	25000	25000	50000	75000	37500
Nrf Discovery	3125	3125	6250	6250	6250	12500	18750	9375
UDR Connector	9375	12500	21875	9375	12500	21875	43750	21875
CHF Connector	0	0	0	0	0	0	0	0
AM	6250	15625	21875	0	0	0	21875	10937.5
UE	0	0	0	6250	28125	34375	34375	17187.5
Bulwark	0	0	0	0	0	0	0	0

Table 3-77 PCF Configuration

Service Name	Status
Bulwark Service	Disable
Binding Service	NA
Subscriber State Variable (SSV)	Enable
Validate_user	Disable
Alternate Route Service	Disable
Audit Service	Enable
Binlog	Enable

Table 3-78 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enable
N36 UDR subscription (N7/N15-Nudr)	Enable
UDR on-demand nrf discovery	Enable
CHF (SM-Nchf)	Disable
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	Enable
LDAP (Gx-LDAP)	Disable
Sy (PCF N7-Sy)	Disable

Table 3-79 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	Enable
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Table 3-80 Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
restartSQLNodesIfBinlogThreadStalled	true	`db-monitor-svc:` `restartSQLNodesIfBinlogThreadStalled: true`

binlog_cache_size	10485760	`additionalndbconfigurations:`
		`  mysqld:`
		`binlog_cache_size: '10485760'`

ConnectCheckIntervalDelay	500	`additionalndbconfigurations:`
		`    ndb:`
		`ConnectCheckIntervalDelay: 500`

Table 3-80 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
NoOfFragmentLogFiles	32	# values for configuration files, cnf ndbconfigurations: ndb: NoOfFragmentLogFiles: 32
NoOfFragmentLogParts	6	ndbconfigurations: ndb: NoOfFragmentLogParts: 6
MaxNoOfExecutionThreads	14	ndbconfigurations: ndb: MaxNoOfExecutionThreads: 14
FragmentLogFileSize	128M	additionalndbconfigurations: ndb: FragmentLogFileSize: 128M
binlogthreadstore.capacity	5	db-monitor-svc: binlogthreadstore: capacity: 5

Table 3-80 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration

ndb_allow_copying_alter_table	ON	additionalndbconfigurations:
		  mysqld:
		  # use replica_skip_errors as slave-skip-errors/ slave_skip_errors is deprecated
		
		ndb_allow_copying_alter_table: 'ON'

> **Note**
>
> The cnDBTier customized parameters values remains same for both site1 and site2.

Table 3-81 Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Min Replicas	Max Replicas	Request/ Limit Isito CPU	Request/ Limit Isito Memory
Appinfo	1	1	0.5	1	2	2	2	2
Audit Service	2	2	4	4	2	2	2	2
CM Service	2	4	0.5	2	2	2	2	2
Config Service	4	4	0.5	2	2	2	2	2
Egress Gateway	4	4	6	6	2	27	2	2
Ingress Gateway	5	5	6	6	2	8	2.5	2
Nrf Client Management	1	1	1	1	2	2	2	2
Diameter Gateway	4	4	1	2	0	0	2	2
Diameter Connector	4	4	1	2	0	0	2	2
AM Service	8	8	1	4	2	6	2	2

Table 3-81 (Cont.) Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Min Replicas	Max Replicas	Request/ Limit Isito CPU	Request/ Limit Isito Memory
UE Service	8	8	1	4	2	16	2	2
Nrf Client Discovery	4	4	0.5	2	2	7	2	2
Query Service	1	2	1	1	2	2	2	2
PCRF Core Service	8	8	8	8	0	0	2	2
Performance	1	1	0.5	1	2	2	2	2
PRE Service	4	4	4	4	2	4	1.5	2
SM Service	7	7	10	10	0	0	2.5	2
PDS	7	7	8	8	2	22	2.5	4
UDR Connector	6	6	4	4	2	14	2	2
CHF Connector	6	6	4	4	0	0	2	2
LDAP Gateway Service	3	4	1	2	0	0	2	2
Binding Service	6	6	8	8	2	0	2.5	2
SOAP Connector	2	4	4	4	0	0	2	2
Alternate Route Service	2	2	2	4	2	5	2	2
Bulwark Service	8	8	6	6	0	0	2.5	2

Table 3-82 cnDBTier Microservices Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Request/ Limit Istio CPU	Request/ Limit Istio Memory
ndbappmysqld		12		20	12	5	5
ndbmgmd		3		10	2	2	2
ndbmtd		12		129	10	6	6

Table 3-82 (Cont.) cnDBTier Microservices Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Request/ Limit Istio CPU	Request/ Limit Istio Memory
ndbmysqld		4		54	6	4	4

3.2.2.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The average CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Table 3-83 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site1
ocpcf-alternate-route	0%/80%
ocpcf-appinfo	0%/80%
ocpcf-bulwark	0%/60%
ocpcf-occnp-config-server	16%/80%
ocpcf-occnp-egress-gateway	60%/80%
ocpcf-occnp-ingress-gateway	55%/80%
ocpcf-occnp-nrf-client-nfdiscovery	43%/80%
ocpcf-occnp-nrf-client-nfmanagement	0%/80%
ocpcf-oc-binding	0%/60%
ocpcf-occnp-chf-connector	0%/50%
ocpcf-occnp-udr-connector	48%/50%
ocpcf-ocpm-audit-service	0%/60%
ocpcf-ocpm-policyds	49%/60%
ocpcf-ocpm-pre	25%/80%
ocpcf-pcf-amservice	32%/30%
ocpcf-pcf-ueservice	54%30%
ocpcf-ocpm-queryservice	0%80%

Table 3-84 cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ndbappmysqld	26%/80%	20%/80%
ndbmgmd	0%/80%	0%/80%
ndbmtd	63%/80%	60%/80%
ndbmysqld	6%/80%	1%/80%

3.2.2.3 Results

Table 3-85 Latency Observations

AM/UE Flow	50th Percentile (mean)	95th Percentile (mean)
AM Create	48ms	96ms
AM Delete	50ms	93ms
UE Create	72ms	125ms
UE Delete	7ms	11ms

3.2.3 Test Scenario: PCF SM Call Model on Two-Site GeoRedundant setup, with each site handling 43K TPS traffic and ASM Enabled

This test run benchmarks the performance and capacity of Policy SM data call model that is deployed in PCF mode on a two-site georedundant setup. The PCF application handles a total (Ingress + Egress) traffic of 60K TPS, with each site handling a traffic of 21.5K TPS. For this setup Aspen Service Mesh (ASM) was enabled.

In this test setup, the Georedundant (GR) mode was enabled in cnDBTier and it was configured for 3 channel replication.

3.2.3.1 Test Case and Setup Details

Table 3-86 Test Case Parmeters

Parameters	Values
Call Rate (Ingress + Egress)	21.5K TPS on Site1, 21.5K TPS on Site2
ASM	Enable
Traffic Ratio	Internet:- 1 SM Create : 74 SM Updates : 1 SM DeleteIMS:- 1 SM Create : 8 SM Updates : 1 SM DeleteAPP:- 1 SM Create : 0 SM Updates : 1 SM DeleteADMIN:- 1 SM Create : 0 SM Updates : 1 SM DeleteIMS Rx:- 1 Create : 1 STR
Active Subscribers	10000000 subscribers and 20000000 sessions

Policy Project Details:

The Policy design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was High.

Policy Project's Complexity Level Definition:

- Low– No Usage of Loops in Blockly logic, No JSON operations, No complex Java Script code in Object Expression /Statement Expression.
- Medium - Usage of Loops in Blockly logic, Policy Table Wildcard match <= 3 fields, MatchList < 3, 3 < RegEx match < 6
- High - JSON Operations – Custom, complex Java Script code in Object Expression / Statement Expression, Policy Table Wildcard match > 3 fields, MatchLists >= 3, RegEx mat >= 6

Table 3-87 PCF Configuration

Name	Status
Bulwark Service	Enable
Binding Service	Enable
Subscriber State Variable (SSV)	Enable
Validate_user	Disable
Alternate Route	Disable
Audit Service	Enable
Enable Custom JSON	Enable

Table 3-88 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enable
N36 UDR subscription (N7/N15-Nudr)	Enable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Enable
BSF (N7-Nbsf)	Enable
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Sy (PCF N7-Sy)	NA

Table 3-89 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Table 3-90 Configuring Policy Helm Parameters

Service Name	Policy Helm Configuration

Ingress Gateway	`ingress-gateway:`
	`  applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

Table 3-90 (Cont.) Configuring Policy Helm Parameters

Service Name	Policy Helm Configuration
Egress Gateway	ingress-gateway: applicationThreadPoolConfig: corePoolSize: 20 maxPoolSize: 20 queueCapacity: 7500

> **Note**
>
> The Policy customized parameters values remains same for both site1 and site2.

Table 3-91 Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
binlog_cache_size	10485760	additionalndbconfigurations: mysqld: binlog_cache_size: '10485760'
ConnectCheckIntervalDelay	500	additionalndbconfigurations: ndb: ConnectCheckIntervalDelay: 500
NoOfFragmentLogFiles	32	# values for configuration files, cnf ndbconfigurations: ndb: NoOfFragmentLogFiles: 32

Table 3-91 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
NoOfFragmentLogParts	4	ndbconfigurations: ndb: NoOfFragmentLogParts: 4
MaxNoOfExecutionThreads	11	ndbconfigurations: ndb: MaxNoOfExecutionThreads: 11
FragmentLogFileSize	128M	additionalndbconfigurations: ndb: FragmentLogFileSize: 128M
binlogthreadstore.capacity	5	db-monitor-svc: binlogthreadstore: capacity: 5
ndb_allow_copying_alter_table	ON	additionalndbconfigurations: mysqld: # use replica_skip_errors as slave-skip-errors/ slave_skip_errors is deprecated ndb_allow_copying_alter_table: 'ON'

> **Note**
>
> The cnDBTier customized parameters values remains same for both site1 and site2.

Table 3-92 Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Min Replicas	Max Replicas	Request/ Limit Isito CPU	Request/ Limit Isito Memory
Appinfo	1	1	0.5	1	2	2	2	2
Audit Service	2	2	4	4	2	2	2	2
CM Service	2	4	0.5	2	2	2	2	2
Config Service	4	4	0.5	2	2	2	2	2
Egress Gateway	4	4	6	6	2	6	2	2
Ingress Gateway	5	5	6	6	2	27	2.5	2
NRF Client Management	1	1	1	1	2	2	2	2
Diameter Gateway	4	4	1	2	2	2	2	2
Diameter Connector	4	4	1	2	2	2	2	2
AM Service	8	8	1	4	0	0	2	2
UE Service	8	8	1	4	0	0	2	2
NRF Client Discovery	4	4	2	2	2	2	2	2
Query Service	1	2	1	1	2	2	2	2
PCRF Core Service	8	8	8	8	0	0	2	2
Performance	1	1	0.5	1	2	2	2	2
PRE Service	4	4	4	4	2	55	1.5	2
SM Service	7	7	10	10	2	76	2	2
PDS Service	7	7	8	8	2	21	2.5	4
UDR Connector	6	6	4	2	2	2	2	2

Table 3-92 (Cont.) Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Min Replicas	Max Replicas	Request/ Limit Isito CPU	Request/ Limit Isito Memory
CHF Connecto r	6	6	4	4	2	2	2	2
LDAP Gateway Service	3	4	1	2	0	0	2	2
Binding Service	6	6	8	8	2	3	2.5	2
SOAP Connecto r	2	4	4	4	0	0	2	2
Alternate Route Service	2	2	2	4	2	2	2	2
Bulwark Service	8	8	6	6	2	19	2.5	2

Table 3-93 cnDBTier Microservices Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
ndbappmysqld	12	12	18	18	18
ndbmgmd	3	3	8	8	2
ndbmtd	10	10	132	132	10
ndbmysqld	4	4	54	54	12

> **Note**
>
> Min Replica = Max Replica

3.2.3.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The average CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Table 3-94 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
ocpcf-occnp-alternate route	0.10%%/9.56%	0.10%%/9.97%
ocpcf-appinfo	4.40%/25.78%	4.50%/25.34%
ocpcf-bulwark	17.55%/17.13%	0.04%/14.53%

Table 3-94 (Cont.) Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
ocpcf-occnp-config-server	6.17%/42.65%	3.70%/40.19%
ocpcf-occnp-egress-gateway	19.48%/21.97%	0.04%/20.34%
ocpcf-occnp-ingress-gateway	16.50%/32.03%	0.54%/25.63%
ocpcf-occnp-nrf-client-nfdiscovery	7.94%/51.84%	0.07%/38.38%
ocpcf-occnp-nrf-client-nfmanagement	1.75%/50.29%	0.35%/48.73%
ocpcf-oc-binding	12.36%/17.44%	0.05%/12.41%
ocpcf-occnp-chf-connector	11.87%/22.10%	0.05%/18.97%
ocpcf-occnp-udr-connector	14.83%/23.34%	0.06%/17.67%
ocpcf-ocpm-audit-service	0.22%/16.35%	0.10%/12.41%
ocpcf-ocpm-policyds	21.13%/22.16%	0.03%/18.47%
ocpcf-ocpm-pre	21.64%/47.43%	0.21%/12.82%
ocpcf-pcf-smservice	22.38%/25.81%	0.04%/18.15%
ocpcf-ocpm-queryservice	0.05%/23.54%	0.05%/24.12%

Table 3-95 cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ndbappmysqld	28.57%/41.04%	0.31%/32.17%
ndbmgmd	0.22%/25.38%	0.22%/25.41%
ndbmtd	55.88%/46.89%	9.32%/46.90%

3.2.3.3 Results

Table 3-96 Latency Observations

Services	Average Latency (ms)
Ingress	34.8
SM	30.7
PDS	13.8
UDR	3.97
NRFClient Discovery	2.60
CHF	2.80
Binding	16.0
Diam-connector	1.36
Egress	8.39

3.2.4 Test Scenario: PCF SM Call Model on Two-Site GeoRedundant setup, with each site handling 30K TPS traffic and ASM Enabled

This test run benchmarks the performance and capacity of Policy SM data call model that is deployed in PCF mode on a two-site georedundant setup. The PCF application handles a total

(Ingress + Egress) traffic of 60K TPS, with each site handling a traffic of 30K TPS. For this setup Aspen Service Mesh (ASM) was enabled.

In this test setup, the Georedundant (GR) mode was enabled in cnDBTier and it was configured for 3 channel replication.

3.2.4.1 Test Case and Setup Details

Table 3-97 Test Case Parmeters

Parameters	Values
Call Rate (Ingress + Egress)	30K TPS on Site1, 30K TPS on Site2
ASM	Enable
Traffic Ratio	Internet:- 1 SM Create : 74 SM Updates : 1 SM Delete IMS Rx:- 1 Create : 1 Update : 1 STR
Active Subscribers	393590 (Site1) + 393589 (Site2) = 787179

Policy Project Details:

The Policy design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was High.

Policy Project's Complexity Level Definition:

- Low– No Usage of Loops in Blockly logic, No JSON operations, No complex Java Script code in Object Expression /Statement Expression.
- Medium - Usage of Loops in Blockly logic, Policy Table Wildcard match <= 3 fields, MatchList < 3, 3 < RegEx match < 6
- High - JSON Operations – Custom, complex Java Script code in Object Expression / Statement Expression, Policy Table Wildcard match > 3 fields, MatchLists >= 3, RegEx mat >= 6

Table 3-98 Call Model

Service Name	DNN1 SM Service (MPS)		DNN2 SM Service and Rx Interface (MPS)				Total MPS
	Inbound Message	Outbound Message	Inbound Message	Outbound Message	Inbound Message	Outbound Message	
Ingress Gateway	49000	49000	1520	1520	0	0	101040
SM Service	49654	209036	1526	10739	2533	7094	280590
PRE Service	49000	0	1520	0	1520	0	52040
PDS Service	58114	3924	3623	525	3040	0	69230
Egress Gateway	4578	4578	1545	1545	1520	1520	15290
NRF Discovery	654	654	6	6	0	0	1320

Table 3-98 (Cont.) Call Model

Service Name	DNN1 SM Service (MPS)		DNN2 SM Service and Rx Interface (MPS)				Total MPS
	Inbound Message	Outbound Message	Inbound Message	Outbound Message	Inbound Message	Outbound Message	
UDR Connector	1962	2616	513	519	0	0	5610
CHF Connector	1308	1308	6	6	0	0	2630
Binding Service	1307	0	2027	1014	0	0	4350
Diameter Connector	0	0	507	507	1520	2533	5070
Diameter Gateway	0	0	507	507	1520	1520	4060
Bulwark Service	99308	0	3052	0	1013	0	103380

Table 3-99 PCF Configuration

Name	Status
Bulwark Service	Enable
Binding Service	Enable
Subscriber State Variable (SSV)	Enable
Validate_user	Disable
Alternate Route	Disable
Audit Service	Enable
Enable Custom JSON	Enable

Table 3-100 PCF Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enable
N36 UDR subscription (N7/N15-Nudr)	Enable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Enable
BSF (N7-Nbsf)	Enable
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Sy (PCF N7-Sy)	NA

Table 3-101 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA

Table 3-101 (Cont.) PCRF Interfaces

Feature Name	Status
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Table 3-102 Configuring Policy Helm Parameters

Service Name	Policy Helm Configuration

Ingress Gateway	`ingress-gateway:`
	`  applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

Egress Gateway	`ingress-gateway:`
	`  applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

> **Note**
>
> The Policy customized parameters values remains same for both site1 and site2.

Table 3-103 Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration

binlog_cache_size	10485760	`additionalndbconfigurations:`
		`  mysqld:`
		`binlog_cache_size: '10485760'`

Table 3-103 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
ConnectCheckIntervalDelay	500	additionalndbconfigurations: ndb: ConnectCheckIntervalDelay: 500
NoOfFragmentLogFiles	32	# values for configuration files, cnf ndbconfigurations: ndb: NoOfFragmentLogFiles: 32
NoOfFragmentLogParts	4	ndbconfigurations: ndb: NoOfFragmentLogParts: 4
MaxNoOfExecutionThreads	11	ndbconfigurations: ndb: MaxNoOfExecutionThreads: 11
FragmentLogFileSize	128M	additionalndbconfigurations: ndb: FragmentLogFileSize: 128M

Table 3-103 (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration

binlogthreadstore.capacity	5	db-monitor-svc:
		  binlogthreadstore:
		  capacity: 5

ndb_allow_copying_alter_table	ON	additionalndbconfigurations:
		  mysqld:
		  # use replica_skip_errors as slave-skip-errors/ slave_skip_errors is deprecated
		
		ndb_allow_copying_alter_table: 'ON'

> **Note**
>
> The cnDBTier customized parameters values remains same for both site1 and site2.

Table 3-104 Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Min Replicas	Max Replicas	Request/ Limit Isito CPU	Request/ Limit Isito Memory
Appinfo	1	1	0.5	1	2	2	2	2
Audit Service	2	2	4	4	2	2	2	2
CM Service	2	4	0.5	2	2	2	2	2
Config Service	4	4	0.5	2	2	2	2	2
Egress Gateway	4	4	6	6	2	6	2	2
Ingress Gateway	5	5	6	6	2	27	2.5	2
NRF Client Management	1	1	1	1	2	2	2	2

Table 3-104 (Cont.) Policy Microservices Resources

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Min Replicas	Max Replicas	Request/ Limit Isito CPU	Request/ Limit Isito Memory
Diameter Gateway	4	4	1	2	2	2	2	2
Diameter Connector	4	4	1	2	2	2	2	2
AM Service	8	8	1	4	0	0	2	2
UE Service	8	8	1	4	0	0	2	2
NRF Client Discovery	4	4	2	2	2	2	2	2
Query Service	1	2	1	1	2	2	2	2
PCRF Core Service	8	8	8	8	0	0	2	2
Performance	1	1	0.5	1	2	2	2	2
PRE Service	4	4	4	4	2	55	1.5	2
SM Service	7	7	10	10	2	76	2.5	2
PDS Service	7	7	8	8	2	21	2.5	4
UDR Connector	6	6	4	2	2	2	2	2
CHF Connector	6	6	4	4	2	2	2	2
LDAP Gateway Service	3	4	1	2	0	0	2	2
Binding Service	6	6	8	8	2	3	2.5	2
SOAP Connector	2	4	4	4	0	0	2	2
Alternate Route Service	2	2	2	4	2	2	2	2
Bulwark Service	8	8	6	6	2	19	2.5	2

Table 3-105 cnDBTier Microservices Resources:

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
ndbappmysqld	12	12	18	18	18
ndbmgmd	3	3	8	8	2
ndbmtd	10	10	132	132	10
ndbmysqld	4	4	54	54	12

> **Note**
>
> Min Replica = Max Replica

3.2.4.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The average CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Table 3-106 Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ocpcf-alternate-route	0%/80%	0%/80%
ocpcf-appinfo	1%/80%	1%/80%
ocpcf-bulwark	22%/60%	23%/60%
ocpcf-occnp-config-server	9%/80%	10%/80%
ocpcf-oc-diam-connector	8%/40%	8%/40%
ocpcf-occnp-egress-gateway	11%/80%	10%/80%
ocpcf-occnp-ingress-gateway	19%/80%	24%/80%
ocpcf-occnp-nrf-client-nfdiscovery	5%/80%	5%/80%
ocpcf-occnp-nrf-client-nfmanagement	0%/80%	0%/80%
ocpcf-oc-binding	17%/60%	17%/60%
ocpcf-occnp-chf-connector	7%/50%	7%/50%
ocpcf-occnp-udr-connector	15%/50%	14%/50%
ocpcf-ocpm-audit-service	0%/50%	0%/50%
ocpcf-ocpm-policyds	19%/60%	19%/60%
ocpcf-ocpm-pre	26%/80%	27%/80%
ocpcf-pcf-amservice	0%/30%	0%/30%
ocpcf-pcf-ueservice	0%/30%	0%/30%
ocpcf-pcf-smservice	25%/50%	25%/50%
ocpcf-ocpm-queryservice	0%80%	0%80%

Table 3-107 cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ndbappmysqld	42%/80%	37%/80%
ndbmgmd	0%/80%	0%/80%
ndbmtd	32%/80%	31%/80%
ndbmysqld	4%/80%	4%/80%

3.2.4.3 Results

Table 3-108 Latency Observations

SM Call Flow	50th Percentile (mean)	95th Percentile (mean)
SM Create	37ms	57ms
SM Update	14ms	30ms
SM Delete	14ms	23ms

3.2.5 Test Scenario: PCF AM/UE Call Model on Two-Site Georedundant Setup, with Each Site Handling 30K TPS Traffic and ASM Enabled

This test run benchmarks the performance and capacity of Policy AM/UE data call model that is deployed in PCF mode. The PCF application handles a total (Ingress + Egress) traffic of 60K TPS, with each site handling a traffic of 30K TPS. For this setup, Aspen Service Mesh (ASM) was enabled between Policy services and it was disabled between Policy services and cnDBTier data services. Application data compression was enabled at AM, UE, and PDS services. The Multithreaded Applier (MTA) feature that helps in peak replication throughput was enabled at cnDBTier.

3.2.5.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Ingress + Egress)	60K TPS (30K on site-1 and 30K on SITE-2)
ASM	Enable
Traffic Ratio	AM 1-Create 0-update 1-delete UE 1-Create 0-update 1-delete
Active User Count	12000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Table 3-109 Traffic distribution

	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic
UE service	Site 1			Site 2		
	3157	10953	14109	3036	10579	13615
AM service	3158	10953	14111	3078	10579	13657
Total			28220			27271

Policy Configurations

Following Policy configurations were either enabled or disabled for running this call flow:

Table 3-110 Policy microservices configuration

Name	Status
Bulwark	Enabled
Binding	Disabled
Subscriber State Variable (SSV)	Enabled
Validate_user	Disabled
Alternate Route	Disabled
Audit	Enabled
Compression (Binding & SM Service)	Enabled
SYSTEM.COLLISION.DETECTION	Enabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-111 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enabled
N36 UDR subscription (N7/N15-Nudr)	Enabled
UDR on-demand nrf discovery	Disabled
CHF (Nchf)	Enabled
BSF (N7-Nbsf)	Enabled
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA

Table 3-111 (Cont.) Policy interfaces

Feature Name	Status
Subscriber HTTP Notifier (Gx)	NA

Table 3-112 PCRF interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring Policy Helm Parameters

The following Policy optimization parameters were configured for this run:

Table 3-113 Optimization parameters for Policy services

Service	Policy Helm Configurations

policyds	`- name: DATASOURCE_HIKARI_MIN_IDLE`
	`  value: "90"`
	`- name: DATASOURCE_HIKARI_MAX_POOL_SIZE`
	`  value: "90"`
	`- name: DEFAULT_BOUNDED_ELASTIC_QUEUE_SIZE`
	`  value: "80"`

UE	`DB_MAX_POOL_SIZE=60`

INGRESS	`applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

Table 3-113 (Cont.) Optimization parameters for Policy services

Service	Policy Helm Configurations

EGRESS	`applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

Configuring cnDbTier Helm Parameters

The following cnDBTier optimization parameters were configured for this run:

Table 3-114 Optimization paramters for CnDBTier services

Helm Parameter	Value	CnDBTier Helm Configuration

ConnectCheckIntervalDelay	500	`additionalndbconfigurations:`
		`  ndb:`
		`ConnectCheckIntervalDelay: 500`

NoOfFragmentLogParts	4	`ndbconfigurations:`
		`  ndb:`
		`NoOfFragmentLogParts: 4`

MaxNoOfExecutionThreads	11	`ndbconfigurations:`
		`  ndb:`
		`MaxNoOfExecutionThreads: 11`

FragmentLogFileSize	128M	`additionalndbconfigurations:`
		`  ndb:`
		`FragmentLogFileSize: 128M`

Table 3-114 (Cont.) Optimization paramters for CnDBTier services

Helm Parameter	Value	CnDBTier Helm Configuration

NoOfFragmentLogFiles	32	`ndbconfigurations:`
		`  ndb:`
		
		`NoOfFragmentLogFiles: 32`

binlogthreadstore.capacity	5	`db-monitor-svc:`
		`  binlogthreadstore:`
		`  capacity: 5`

ndb_allow_copying_alter_table	ON	`additionalndbconfigurations:`
		`  mysqld:`
		`  # use replica_skip_errors as slave-skip-errors/ slave_skip_errors is deprecated`
		
		`ndb_allow_copying_alter_table: 'ON'`

binlog_cache_size	10485760	`additionalndbconfigurations:`
		`  mysqld:`
		`  binlog_cache_size: '10485760'`

Policy Microservices Resources

Table 3-115 Policy microservices Resource allocation for Site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Appinfo	1	1	1 Gi	512Mi	2	2	2 Gi
Audit Service	2	2	4 Gi	4 Gi	2	2	2 Gi
CM Service	4	4	2 Gi	2 Gi	2	2	2 Gi

Table 3-115 (Cont.) Policy microservices Resource allocation for Site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Config Service	4	2	2Gi	2Gi	2	2	2 Gi
Egress Gateway	2	2	6Gi	6Gi	27	4	2 Gi
Ingress Gateway	5	5	6Gi	6Gi	8	2500m	2Gi
NRF Client NF Discovry	6	6	10Gi	10Gi	9	2	2Gi
NRF Client Management	1	1	1Gi	1Gi	1	2	2Gi
AM Service	6	6		10Gi	12	3	2Gi
UE Service	8	8	2Gi	2Gi	20	3	1Gi
Query Service	2	1	1Gi	1Gi	2		
Performanc e	1	1	1Gi	512Mi	2		
PRE	4	4	4Gi	4Gi	7	1500m	2Gi
SM Service	1	1	1Gi	1Gi	1	3	2Gi
PDS	7	7	8Gi	8Gi	24	3	4 Gi
UDR Connector	4	4	4Gi	4Gi	20	2	2Gi
CHF Connector/ User Service	6	6	4Gi	4Gi	8	2	2Gi
Alternate Route Service	2	2	4Gi	2Gi	1	2	2Gi
Bulwark Service	8	8	4Gi	4Gi	7	3	4Gi

Table 3-116 Policy microservices Resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Appinfo	1	1	1 Gi	512Mi	2	2	2 Gi
Audit Service	2	2	4 Gi	4 Gi	2	2	2 Gi
CM Service	4	4	2 Gi	2 Gi	2	2	2 Gi

Table 3-116 (Cont.) Policy microservices Resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Config Service	4	2	2Gi	500m	2	2	2 Gi
Egress Gateway	4	4	6Gi	6Gi	20	2	2 Gi
Ingress Gateway	5	5	6Gi	6Gi	8	2.5	2Gi
NRF Client NF Discovery	6	6	10Gi	10Gi	9	2	2Gi
NRF Client Management	1	1	1Gi	1Gi	1	2	2Gi
AM Service	6	6	10Gi	10Gi	9	3	2Gi
UE Service	8	8	4Gi	4Gi	18	2	2Gi
Query Service	2	1	1Gi	1Gi	2		
Performance	1	1	1Gi	512Mi	2		
PRE	4	4	4Gi	4Gi	7	1.5	2Gi
SM Service	1	1	1Gi	1Gi	1	0.5	2Gi
PDS	7	7	8Gi	8Gi	22	2.5	4Gi
UDR Connector	4	4	4Gi	4Gi	20	2	2Gi
CHF Connector/ User Service	6	6	4Gi	4Gi	3	2	2Gi
Alternate Route Service	0.5	0.5	4Gi	2Gi	1	0.5	2Gi
Bulwark Service	8	8	4Gi	4Gi	5	2	4Gi

Table 3-117 CnDBTier Resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
ndbappmysqld	12	12	20Gi	20Gi	12	5	5Gi
ndbmgmd	3	3	8Gi	8Gi	2	3	1Gi
ndbmtd	12	12	129Gi	129Gi	10	6	6Gi
ndbmysqld	4	4	16Gi	16Gi	6	5	5Gi

Table 3-118 CnDBTier resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
ndbappmysqld	12	12	20Gi	20Gi	12	5	5Gi
ndbmgmd	3	3	8Gi	8Gi	2	3	1Gi
ndbmtd	12	12	129Gi	129Gi	10	6	6Gi
ndbmysqld	4	4	16Gi	16Gi	6	5	5Gi

3.2.5.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-119 CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
ocpcf-occnp-alternate route/istio	0.10%	4.88%	0.60%	4.44%
ocpcf-occnp-alternate route	0.15%	9.38%	0.60%	6.76%
ocpcf-appinfo/istio	'0.18%	5.35%	0.20%	5.18%
ocpcf-appinfo	2.65%	23.78%	'4.40%	23.58%
ocpcf-bulwark/istio	25.27%	2.30%	59.09%	2.88%
ocpcf-bulwark	17.78%'	17.36%	29.15%	20.51%
ocpcf-occnp-config-server/istio	11.30%	5.42%'	14.03%	6.42%
ocpcf-occnp-config-server	7.51%	29.98%	9.46%	30.44%
ocpcf-occnp-egress-gateway/istio	5.90%	5.18%	13.11%	5.89%
ocpcf-occnp-egress-gateway	23.25%	19.32%	38.80%	20.48%
ocpcf-occnp-ingress-gateway/istio	21.98%	6.99%	18.80%	7.64%

Table 3-119 (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
ocpcf-occnp-ingress-gateway	19.87%	24.11%	23.62%	23.45%
ocpcf-occnp-nrf-client-nfdiscovery/istio	17.95%	5.21%	27.92%	5.83%
ocpcf-occnp-nrf-client-nfdiscovery	9.81%	9.91%	13.84%	9.48%
ocpcf-occnp-nrf-client-nfmanagement/istio	0.15%	4.79%	0.20%	5.22%
ocpcf-occnp-nrf-client-nfmanagement	0.40%	44.92%	0.40%	47.17%
ocpcf-performance/perf-info	1.90%	11.82%	1.00%	12.40%
ocpcf-occnp-chf-connector/istio	14.88%	5.22%	47.70%	6.23%
ocpcf-occnp-chf-connector	7.78%	14.96%	24.25%	14.87%
ocpcf-occnp-udr-connector/istio	20.30%	5.52%	29.43%	6.24%
ocpcf-occnp-udr-connector	18.32%	15.26%	23.51%	15.08%
ocpcf-ocpm-audit-service/istio	0.18%	4.61%	0.25%	5.10%
ocpcf-ocpm-audit-service	0.22%	13.00%	0.83%	12.59%
ocpcf-ocpm-cm-service/istio	0.80%	4.96%	0.92%	5.20%
ocpcf-ocpm-cm-service/cm-service	0.76%	28.34%	0.83%	30.76%
ocpcf-ocpm-policyds/istio	21.30%	2.84%	35.80%	3.03%
ocpcf-ocpm-policyds	24.84%	30.74%	33.41%	31.08%
ocpcf-occnp-amservice/istio	24.62%	5.72%	43.19%	6.43%
ocpcf-occnp-amservice	26.90%	9.40%	44.37%	10.71%
ocpcf-ocpm-pre/istio	24.99%	5.81%	45.51%	5.82%
ocpcf-ocpm-pre	'18.59%	32.53%	30.70%	30.35%
ocpcf-pcf-smservice/istio	0.17%	4.83%	.60%	6.01%
ocpcf-pcf-smservice	0.40%	37.11%	0.40%	37.40%
ocpcf-pcf-ueservice/istio	15.49%	5.64%	35.09%	6.01%

Table 3-119 (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
ocpcf-pcf-ueservice	22.16%	34.16%	29.61%	38.23%
ocpcf-ocpm-queryservice	0.05%	23.39%	0.50%	23.68%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-120 CPU/Memory Utilization by CnDBTier services

Service	CPU (Site 1)	Memory CPU (Site 1)	CPU (Site 2)	Memory (Site 2)
ndbappmysqld/istio	23.14%	2.48%	22.78%	2.50%
ndbappmysqld/mysqlndbcluster	21.31%	50.17%	26.48%	35.47%
ndbappmysqld/init-sidecar	2.25%	0.39%	3.00%	0.39%
ndbmgmd/istio-proxy	0.33%	10.74%	0.43%	11.38%
ndbmgmd/mysqlndbcluster	0.25%	25.21%	0.35%	25.16%
ndbmtd/istio-proxy	47.02%	2.06%	31.61%	1.96%
ndbmtd/mysqlndbcluster	44.95%	81.17%	42.45%	79.71%
ndbmysqld/istio-proxy	0.00%	0.00%	0.00%	0.00%
ndbmysqld/mysqlndbcluster	4.23%	30.30%	7.72%	28.85%
ndbmysqld/init-sidecar	2.00%	0.39%	2.83%	0.59%

3.2.5.3 Results

Average Latency Observations for the AM and UE call flow:

Call Flow	50th Percentile (ms)	95th Percentile (ms)
AM CREATE	40.8	110
AM DELETE	35.7	60.2
UE CREATE	56.8	102
UE DELETE	6.37	8.94

3.2.6 Test Scenario: PCF AM/UE Call Model on Two-Site Georedundant Setup, with Single-Site Handling 60K TPS Traffic and ASM Enabled

This test run benchmarks the performance and capacity of Policy AM/UE data call model that is deployed in PCF mode.. The PCF application handles a total traffic (Ingress + Egress) of 60K TPS on one site and there is no traffic on the other site. APP Compression was enabled. The test was run for 1.0 hour duration. For this setup, Aspen Service Mesh (ASM) was enabled between Policy services and it was disabled between Policy service pods and DB data pods.

In this test setup, the Georedundant (GR) mode was enabled in cnDBTier. It was configured for 2 channel replication and the Application Data compression was enabled at AM, UE, and PDS services on Site 2.

3.2.6.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Ingress + Egress)	60k on site-1 and no traffic on site-2
ASM	Enable
Traffic Ratio	AM 1-Create 0-update 1-delete UE 1-Create 0-update 1-delete
Active User Count	12000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Table 3-121 Traffic distribution

	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic
UE service	Site 1			Site 2		

Table 3-121 (Cont.) Traffic distribution

	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic
	6672	30024	36696	-	-	-
AM service	6672	16680	23352	-	-	-
Total			60048	-	-	-

Policy Configurations

Following Policy microservices were either enabled or disabled for running this call flow:

Table 3-122 Policy microservices configuration

Name	Status
Bulwark	Enabled
Binding	Disabled
Subscriber State Variable (SSV)	Dnabled
Validate_user	Disabled
Alternate Route	Disabled
Audit	Enabled
Compression (Binding & SM Service)	Enabled
SYSTEM.COLLISION.DETECTION	Enabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-123 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enable
N36 UDR subscription (N7/N15-Nudr)	Enable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Enable
BSF (N7-Nbsf)	Enable
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Subscriber HTTP Notifier (Gx)	NA

The following PCRF interfaces that were either enabled or disabled to run this call flow:

Table 3-124 PCRF interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA

Table 3-124 (Cont.) PCRF interfaces

Feature Name	Status
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring Policy Helm Parameters

The following Policy optimization parameters were configured for this run:

Table 3-125 Optimization parameters for Policy services

Service	Policy Helm Configurations

policyds	`- name: DATASOURCE_HIKARI_MIN_IDLE`
	`  value: "90"`
	`- name: DATASOURCE_HIKARI_MAX_POOL_SIZE`
	`  value: "90"`
	`- name: DEFAULT_BOUNDED_ELASTIC_QUEUE_SIZE`
	`  value: "80"`

UE	`DB_MAX_POOL_SIZE=60`

INGRESS	`applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

EGRESS	`applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

Configuring cnDbTier Helm Parameters

The following cnDBTier optimization parameters were configured for this run:

Table 3-126 Optimization paramters for CnDBTier services

Helm Parameter	Value	CnDBTier Helm Configuration
ConnectCheckIntervalDelay	500	additionalndbconfigurations: ndb: ConnectCheckIntervalDelay: 500
NoOfFragmentLogParts	4	ndbconfigurations: ndb: NoOfFragmentLogParts: 4
MaxNoOfExecutionThreads	11	ndbconfigurations: ndb: MaxNoOfExecutionThreads: 11
FragmentLogFileSize	128M	additionalndbconfigurations: ndb: FragmentLogFileSize: 128M
NoOfFragmentLogFiles	32	ndbconfigurations: ndb: NoOfFragmentLogFiles: 32
binlogthreadstore.capacity	5	db-monitor-svc: binlogthreadstore: capacity: 5

Table 3-126 (Cont.) Optimization paramters for CnDBTier services

Helm Parameter	Value	CnDBTier Helm Configuration

ndb_allow_copying_alter_table	ON	additionalndbconfigurations:
		  mysqld:
		  # use replica_skip_errors as slave-skip-errors/ slave_skip_errors is deprecated
		
		ndb_allow_copying_alter_table: 'ON'

binlog_cache_size	10485760	additionalndbconfigurations:
		  mysqld:
		  binlog_cache_size: '10485760'

Policy Microservices Resources

Table 3-127 Policy microservices resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Appinfo	1	1	1 Gi	512Mi	2	2	2 Gi
Audit Service	2	2	4 Gi	4 Gi	2	2	2 Gi
CM Service	4	4	2 Gi	2 Gi	2	2	2 Gi
Config Service	4	2	2Gi	2Gi	2	2	2 Gi
Egress Gateway	2	2	6Gi	6Gi	27	4	2 Gi
Ingress Gateway	5	5	6Gi	6Gi	8	2.5	2 Gi
NRF Client NF Discovry	6	6	10Gi	10Gi	9	2	2 Gi
NRF Client Management	1	1	1Gi	1Gi	1	2	2 Gi
AM Service	6	6	10Gi	10Gi	12	3	2 Gi

Table 3-127 (Cont.) Policy microservices resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
UE Service	8	8	2Gi	2Gi	20	2	1 Gi
Query Service	2	1	1Gi	1Gi	2		
Performance	1	1	1Gi	512Mi	2	2	1 Gi
PRE	4	4	4Gi	4Gi	7	1.5	2 Gi
SM Service	1	1	1Gi	1Gi	1	3	2 Gi
PDS	7	7	8Gi	8Gi	24	3	4 Gi
UDR Connector	4	4	4Gi	4Gi	20	2	2 Gi
CHF Connector/ User Service	6	6	4Gi	4Gi	8	2	2 Gi
Alternate Route Service	2	2	4Gi	2Gi	1	2	2 Gi
Bulwark Service	8	8	4Gi	4Gi	7	3	4 Gi

Table 3-128 Policy microservices resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory
Appinfo	1	1	1 Gi	512Mi	2	2	2 Gi
Audit Service	2	2	4 Gi	4 Gi	2	2	2 Gi
CM Service	4	4	2 Gi	2 Gi	2	2	2 Gi
Config Service	4	2	2Gi	500m	2	2	2 Gi
Egress Gateway	4	4	6Gi	6Gi	20	2	2 Gi
Ingress Gateway	5	5	6Gi	6Gi	8	2.5	2Gi
NRF Client NF Discovery	6	6	10Gi	10Gi	9	2	2 Gi
NRF Client Management	1	1	1Gi	1Gi	1	2	2 Gi
AM Service	6	6	10Gi	10Gi	9	3	2 Gi

Table 3-128 (Cont.) Policy microservices resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory
UE Service	8	8	4Gi	4Gi	18	2	2 Gi
Query Service	2	1	1Gi	1Gi	2		
Performance	1	1	1Gi	512Mi	2		
PRE	4	4	4Gi	4Gi	7	1.5	2 Gi
SM Service	1	1	1Gi	1Gi	1	0.5	2 Gi
PDS	7	7	8Gi	8Gi	22	2.5	4 Gi
UDR Connector	4	4	4Gi	4Gi	20	2	2 Gi
CHF Connector/ User Service	6	6	4Gi	4Gi	3	2	2 Gi
Alternate Route Service	0.5	0.5	4Gi	2Gi	1	0.5	2 Gi
Bulwark Service	8	8	4Gi	4Gi	5	2	4 Gi

Table 3-129 CnDBTier resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory
ndbappmysqld/ mysqlndbcluster	12	12	20Gi	20Gi	12	5	5Gi
ndbappmysqld/init-sidecar	0.1	0.1	256Mi	256Mi	12		
ndbmgmd/ mysqlndbcluster	3	3	8Gi	8Gi	2	3	1Gi
ndbmtd/ mysqlndbcluster	12	12	129Gi	129Gi	10	6	6Gi
ndbmysqld/ mysqlndbcluster	4	4	16Gi	16Gi	6	5	5Gi
ndbmysqld/ init-sidecar	0.1	0.1	256Mi	256Mi	6		

Table 3-130 CnDBTier resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory
ndbappmysqld/ mysqlndbcluster	12	12	20Gi	20Gi	12	5	5Gi
ndbappmysqld/init-sidecar	0.1	0.1	256Mi	256Mi	12		
ndbmgmd/ mysqlndbcluster	3	3	8Gi	8Gi	2	3	1Gi
ndbmtd/ mysqlndbcluster	12	12	129Gi	129Gi	10	6	6Gi
ndbmysqld/ mysqlndbcluster	4	4	16Gi	16Gi	6	5	5Gi
ndbmysqld/ init-sidecar	0.1	0.1	256Mi	256Mi	6		

3.2.6.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-131 CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
ocpcf-appinfo/istio	0.25%	7.18%	0.22%	5.59%
ocpcf-appinfo	4.20	32.97%	2.50%	23.24%
ocpcf-bulwark/istio	0.10%	2.91%	0.15%	2.78%
ocpcf-bulwark	0.04%	37.21%	0.05%	12.23%
ocpcf-oc-binding/ istio	0.20%	5.57%	0.30%	6.01%
ocpcf-oc-binding/ binding	0.03%	7.73%	0.03%	7.46%

Table 3-131 (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
ocpcf-occnp-alternate route/istio	0.15%	5.27%	0.25%	5.42%
ocpcf-occnp-alternate route/istio	0.10%	9.59%	0.10%	9.35%
ocpcf-occnp-chf-connector/istio	11.60%	5.03%	0.50%	5.76%
ocpcf-occnp-chf-connector	12.10%	10.72%	0.08%	10.94%
ocpcf-occnp-config-server/istio	13.85%	6.13%	5.80%	6.23%
ocpcf-occnp-config-server	9.50%	43.14%	3.50%	36.67%
ocpcf-occnp-egress-gateway/istio	10.13%	5.40%	0.19%	5.92%
ocpcf-occnp-egress-gateway	49.76%	19.64%	0.07%	9.69%
ocpcf-occnp-ingress-gateway/istio	36.23%	10.00%	0.20%	5.85%
ocpcf-occnp-ingress-gateway	45.73%	32.97%	0.24%	19.07%
ocpcf-occnp-nrf-client-nfdiscovery/istio	59.12%	8.17%	0.26%	5.82%
ocpcf-occnp-nrf-client-nfdiscovery	51.44%	59.33%	0.08%	33.86%
ocpcf-occnp-nrf-client-nfmanagement/istio	0.70%	5.42%	0.20%	5.57%
ocpcf-occnp-nrf-client-nfmanagement	0.40%	44.82%	0.40%	46.39%
ocpcf-occnp-udr-connector/istio	69.88%	8.00%	0.47%	5.69%
ocpcf-occnp-udr-connector	35.60%	32.06%	0.08%	11.15%
ocpcf-ocpm-audit-service/istio	0.25%	5.59%	0.25%	5.47%
ocpcf-ocpm-audit-service	0.57%	23.69%	0.38%	13.01%
ocpcf-ocpm-cm-service/istio	0.85%	5.27%	0.55%	6.05%
ocpcf-ocpm-cm-service/cm-service	0.71%	37.21%	0.33%	33.81%
ocpcf-ocpm-policyds/istio	49.69%	3.91%	0.17%	2.86%
ocpcf-ocpm-policyds	40.46%	32.78%	0.03%	14.43%

Table 3-131 (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
ocpcf-ocpm-pre/istio	33.67%	7.14%	0.35%	6.24%
ocpcf-ocpm-pre	37.21%	49.02%	0.31%	8.65%
ocpcf-ocpm-queryservice	0.05%	28.22%	0.08%	24.41%
ocpcf-occnp-amservice/istio	32.87%	8.59%	0.39%	5.86%
ocpcf-occnp-amservice	29.83%	23.16%	0.04%	12.90%
ocpcf-pcf-ueservice/istio	56.27%	9.83%	0.35%	5.65%
ocpcf-pcf-ueservice	44.94%	45.22%	0.05%	14.07%
ocpcf-performance/perf-info	3.10%	10.84%	1.40%	11.04%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-132 CPU/Memory Utilization by CnDBTier services

App/Container	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
ndbappmysqld/istio-proxy	0.40%	2.00%	0.33%	2.22%
ndbappmysqld/mysqlndbcluster	0.19%	20.91%	0.20%	20.88%
ndbappmysqld/init-sidecar	2.08%	0.39%	2.17%	0.39%
ndbmgmd/istio-proxy	0.55%	9.96%	0.68%	10.79%
ndbmgmd/mysqlndbcluster	0.37%	25.12%	0.40%	25.12%
ndbmtd/istio-proxy	0.66%	1.75%	0.53%	1.39%
ndbmtd/mysqlndbcluster	0.69%	81.13%	5110.41%	71.33%
ndbmysqld/istio-proxy	0.00%	0.00%	0.00%	0.00%
ndbmysqld/mysqlndbcluster	0.52%	26.07%	0.57%	26.07%
ndbmysqld/init-sidecar	2.33%	0.39%	2.17%	0.39%

3.2.6.3 Results

Average Latency Observations for the AM and UE call flow:

Call Flow	50th Percentile (ms)	95th Percentile (ms)
AM CREATE	88.8	176
AM DELETE	84.2	152
UE CREATE	106	204
UE DELETE	5.74	10.4

3.2.7 Test Scenario: PCF AM/UE Call Model on Two-Site Georedundant Setup, with Single-Site Handling 75K TPS Traffic and ASM Enabled

This test run benchmarks the performance and capacity of Policy AM/UE data call model that is deployed in PCF mode. The PCF application handles a total traffic (Ingress + Egress) of 75K TPS on one site and there is no traffic on the other site. Application compression was enabled. For this setup, Aspen Service Mesh (ASM) was enabled between Policy services and it was disabled between Policy service pods and Database data pods.

In this test setup, the Georedundant (GR) mode was enabled in cnDBTier. It was configured for 3 channel replication and the Application Data compression was enabled at AM, UE, and PDS services on Site 2.

3.2.7.1 Test Case and Setup Details

Table 3-133 Testcase Parameters

Parameters	Values
Call Rate (Ingress + Egress)	75k on site-1 and no traffic on site-2
ASM	Enable
Traffic Ratio	AM 1-Create 0-update 1-delete UE 1-Create 0-update 1-delete
Active User Count	12000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Table 3-134 Traffic distribution on Site1

Services	Ingress Gateway	Egress Gateway	Total Ingress/Egress Traffic
UE service	8340	37530	45870
AM service	8340	20850	29190
Total			75060

Policy Configurations

Following Policy microservices or features were either enabled or disabled for running this call flow:

Table 3-135 Policy microservices or features configuration

Name	Status
Bulwark	Enabled
Binding	Disabled
Local Subscriber State Variable (SSV)	Enabled
Validate_user	Disabled
Alternate Route	Disabled
Audit	Enabled
Compression (AM, SM, and PDS Service)	Enabled
SYSTEM.COLLISION.DETECTION	Enabled
CHF Async	Enabled
Session Limiting	Enabled
Collision Detection	Enabled
Pending Transaction for Bulwark	Enabled
Preferntial Search	SUPI

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-136 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enabled
N36 UDR subscription (N7/N15-Nudr)	Enabled
UDR on-demand nrf discovery	Enabled
CHF (SM-Nchf)	Enabled
BSF (N7-Nbsf)	Disabled
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Subscriber HTTP Notifier (Gx)	NA

The following PCRF interfaces that were either enabled or disabled to run this call flow:

Table 3-137 PCRF interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring Policy Helm Parameters

The following Policy optimization parameters were configured for this run:

Table 3-138 Optimization parameters for Policy services

Service	Policy Helm Configurations

policyds	`- name: DATASOURCE_HIKARI_MIN_IDLE`
	`  value: "90"`
	`- name: DATASOURCE_HIKARI_MAX_POOL_SIZE`
	`  value: "90"`
	`- name: DEFAULT_BOUNDED_ELASTIC_QUEUE_SIZE`
	`  value: "80"`

UE	`DB_MAX_POOL_SIZE=60`

INGRESS	`applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

EGRESS	`applicationThreadPoolConfig:`
	`  corePoolSize: 20`
	`  maxPoolSize: 20`
	`  queueCapacity: 7500`

Configuring cnDbTier Helm Parameters

The following cnDBTier optimization parameters were configured for this run:

Table 3-139 Optimization paramters for CnDBTier services

Helm Parameter	Value	CnDBTier Helm Configuration
ConnectCheckIntervalDelay	0	additionalndbconfigurations: ndb: ConnectCheckIntervalDelay: 0
NoOfFragmentLogParts	6	ndbconfigurations: ndb: NoOfFragmentLogParts: 6
MaxNoOfExecutionThreads	14	ndbconfigurations: ndb: MaxNoOfExecutionThreads: 14
FragmentLogFileSize	128M	additionalndbconfigurations: ndb: FragmentLogFileSize: 128M
NoOfFragmentLogFiles	96	ndbconfigurations: ndb: NoOfFragmentLogFiles: 96
binlogthreadstore.capacity	5	db-monitor-svc: binlogthreadstore: capacity: 5

Table 3-139 (Cont.) Optimization paramters for CnDBTier services

Helm Parameter	Value	CnDBTier Helm Configuration

ndb_allow_copying_alter_table	1	additionalndbconfigurations:
		  mysqld:
		  # use replica_skip_errors as slave-skip-errors/ slave_skip_errors is deprecated
		
		ndb_allow_copying_alter_table: 1

binlog_cache_size	10485760	additionalndbconfigurations:
		  mysqld:
		  binlog_cache_size: '10485760'

maxnumberofconcurrentscans	495	maxnumberofconcurrentscans: 495
db_eventbuffer_max_alloc	12G	ndbmysqld db_eventbuffer_max_alloc: 12G
HeartbeatIntervalDbDb	1250	ndbmtd HeartbeatIntervalDbDb: 1250

Policy Microservices Resources

> **Note**
>
> Changes in the resource requirements are highlighted in bold.

Table 3-140 Policy microservices resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Appinfo	1	1	1 Gi	512Mi	2	2	2 Gi
Audit Service	2	2	4 Gi	4 Gi	2	2	2 Gi
CM Service	4	4	2 Gi	2 Gi	2	2	2 Gi
Config Service	**2**	2	2Gi	2Gi	2	2	2 Gi
Egress Gateway	**27**	**27**	6Gi	6Gi	27	4	2 Gi
Ingress Gateway	**8**	**8**	6Gi	6Gi	8	2.5	2 Gi
NRF Client NF Discovry	**9**	**9**	10Gi	10Gi	9	2	2 Gi
NRF Client Management	**2**	**2**	1Gi	1Gi	**2**	2	2 Gi
AM Service	**12**	**12**	8Gi	8Gi	12	3	2 Gi
UE Service	**20**	**20**	6Gi	6Gi	20	2	1 Gi
Query Service	2	**2**	1Gi	1Gi	2		
Performance	1	1	1Gi	512Mi	2	2	1 Gi
PRE	**7**	**7**	4Gi	4Gi	7	1.5	2 Gi
SM Service	1	1	1Gi	1Gi	1	3	2 Gi
PDS	**24**	**24**	8Gi	8Gi	24	3	4 Gi
UDR Connector	**20**	**20**	4Gi	4Gi	20	2	2 Gi
CHF Connector/ User Service	**8**	**8**	4Gi	4Gi	8	2	2 Gi
Alternate Route Service	**1**	**1**	4Gi	2Gi	1	2	2 Gi
Bulwark Service	8	8	4Gi	4Gi	**7**	3	4 Gi

Table 3-141 CnDBTier resource allocation on Site-2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory
ndbappmysqld	12	12	20Gi	20Gi	12	5	5Gi
ndbmgmd	**2**	**2**	8Gi	8Gi	2	3	1Gi
ndbmtd	**10**	**10**	129Gi	129Gi	10	6	6Gi
ndbmysqld	**6**	**6**	16Gi	16Gi	6	5	5Gi

3.2.7.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-142 Utilization by Policy Microservices

Service	CPU (X/Y) - Site1
ocpcf-occnp-alternate route	0%/80%
ocpcf-appinfo	1%/80%
ocpcf-bulwark	46%/60%
ocpcf-config-server	12%/80%
ocpcf-ingress-gateway	48%/80%
ocpcf-egress-gateway	45%/80%
ocpcf-nrf-client-nfdiscovery	31%/80%
ocpcf-nrf-client-nfmanagament	0%/80%
ocpcf-occnp-chf-connector	17%/50%
ocpcf-occnp-udr-connector	35%/50%
ocpcf-occpm-audit-service	0%/60%
ocpcf-occpm-policyds	43%/60%
ocpcf-amservice	26%/30%
ocpcf-pcf-pre	26%/80%
ocpcf-pcf-smservice	0%/50%
ocpcf-pcf-ueservice	58%/30%
ocpcf-ocpm-queryservice	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-143 Utilization by CnDBTier services

App/Container	CPU (X/Y) - Site2
ndbappmysqld	31%/80%
ndbmgmd	0%/80%
ndbmtd	58%/80%
mdbmysqld	5%/80%

3.2.7.3 Results

Average Latency Observations for the AM and UE call flow:

Table 3-144 Latency Observations

Call Flow	50th Percentile (ms)	95th Percentile (ms)
AM CREATE	44.1	43.3
AM DELETE	41.3	38.8
UE CREATE	67.5	65.0
UE DELETE	11.7	10.3

3.2.8 Test Scenario: PCF SM Call Model on Two-Site GeoRedundant setup, with Single-Site Handling 43K TPS traffic and ASM Enabled

This test run benchmarks the performance and capacity of Policy PCF SM call model that is deployed in PCF mode on a two-site georedundant setup. The PCF application handles a total traffic (Ingress + Egress) of 43K TPS on one site and there is no traffic on the other site

In this test setup, the Georedundant (GR) mode was enabled in cnDBTier. It was configured for multi channel replication.

3.2.8.1 Test Case and Setup Details

The following table describes the testcase parameters and their values:

Table 3-145 Testcase Parameters

Parameters	Values
Call Rate (Ingress + Egress)	43k on site-1 and no traffic on site-2
ASM	Enable
Traffic Ratio	Internet : SM 1-Create 15-update 1-delete IMS: SM 1-Create 8-update 1-delete Application: SM 1-Create 0-update 1-delete Administrator: SM 1-Create 0-update 1-delete
Active User Count	10000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Table 3-146 Call Model

TPS	Site 1	Site2
SM-IGW	20722.23	0
SM-EGW	16676.15	0
SM-DIAM-IGW	3315.61	0
SM-DIAM-EGW	2492.63	0
Total SM	43206	0

Table 3-147 Policy microservices configuration

Name	Status
Bulwark	Enabled
Binding	Disabled
Subscriber State Variable (SSV)	Dnabled
Validate_user	Disabled
Alternate Route	Disabled
Audit	Enabled
Compression (Binding & SM Service)	Enabled
SYSTEM.COLLISION.DETECTION	Enabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-148 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	Enable
N36 UDR subscription (N7/N15-Nudr)	Enable
UDR on-demand nrf discovery	Disable
CHF (SM-Nchf)	Enable
BSF (N7-Nbsf)	Enable
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA

Table 3-148 (Cont.) Policy interfaces

Feature Name	Status
Subscriber HTTP Notifier (Gx)	NA

The following PCRF interfaces that were either enabled or disabled to run this call flow:

Table 3-149 PCRF interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Policy Microservices Resources

Table 3-150 Policy microservices resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
Appinfo	2	2	1 Gi	512Mi	2	2	2Gi
Bulwark	8	8	6Gi	2Gi	15	2500m	2500m
Binding	6	6	8Gi	8Gi	11	2500m	2500m
Diameter Connector	4	4	2Gi	1Gi	6	2	2Gi
Alternate Route	2	2	4Gi	2Gi	2	2	2Gi
CHF Connector	6	6	4Gi	4Gi	4	2	2Gi
Config Server	4	4	2Gi	512Mi	2	2	2Gi
Egress Gateway	8	8	6Gi	6Gi	9	4	2Gi
Ingress Gateway	5	5	6Gi	6Gi	29	2500m	2Gi
Diameter Gateway	4	4	2Gi	1Gi	4	2	2Gi
NRF Client NF Discovery	4	4	2Gi	2Gi	4	2	2Gi
NRF Client Management	1	1	1Gi	1Gi	2	2	2Gi

Table 3-150 (Cont.) Policy microservices resource allocation for site1

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory (Gi)
UDR Connector	6	6	4Gi	4Gi	8	2	2Gi
Audit	2	2	4Gi	4Gi	2	2	2Gi
CM Service	4	2	2Gi	512Mi	2	2	2Gi
PolicyDS	7	7	8Gi	8Gi	30	2500m	4Gi
PRE Service	4	4	4Gi	4Gi	39	1500m	2Gi
Query Service	2	1	1Gi	1Gi	2	2	2Gi
SM Service	7	7	10Gi	10Gi	64	2500m	2Gi
Performance	2	1	1Gi	512Mi	NA	NA	NA

Table 3-151 CnDBTier resource allocation for site2

Service Name	CPU Resource per Container (Limit)	CPU Resource per Container (Request)	Memory Resource per Container (Limit)	Memory Resource per Container (Request)	Replica Count	Request/ Limit Istio CPU	Request/ Limit Istio Memory
ndbappmysqld	12	12	18Gi	18Gi	18	5000m	4Gi
ndbmgmd	3	3	8Gi	8Gi	2	3000m	1Gi
ndbmtd	10	10	132Gi	132Gi	10	5000m	4Gi
ndbmysqld	4	4		154Gi	12	5000m	4Gi

3.2.8.2 CPU and Memory Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices.

Table 3-152 Policy Microservices Resource Utilization

Services	CPU - Site1	Memory - Site1
appinfo	['0.100 (2.50%)']	['0.520 (25.98%)']
bulwark	['20.899 (17.42%)']	['19.323 (21.47%)']
binding	['7.875 (11.93%)']	['34.009 (38.65%)']
diam-connector	['3.362 (14.01%)']	['4.147 (34.56%)']
occnp-alternate-route	['0.004 (0.10%)']	['0.719 (8.98%)']
user-service	['2.902 (12.09%)']	['3.445 (21.53%)']
config-server	['0.582 (7.27%)']	['1.800 (45.00%)']
occnp-egress-gateway	['13.399 (18.61%)']	['12.664 (23.45%)']

Table 3-152 (Cont.) Policy Microservices Resource Utilization

Services	CPU - Site1	Memory - Site1
occnp-ingress-gateway	['23.737 (16.37%)']	['60.212 (34.60%)']
nrf-client-nfdiscovery	['1.493 (9.33%)']	['5.118 (63.98%)']
nrf-client-nfmanagement	['0.008 (0.40%)']	['0.994 (49.71%)']
user-service	['6.971 (14.52%)']	['9.528 (29.78%)']
audit-service	['0.010 (0.25%)']	['0.996 (12.45%)']
cm-service	['0.061 (0.76%)']	['1.662 (41.55%)']
policyds	['44.964 (21.41%)']	['100.335 (41.81%)']
pre-service	['34.096 (21.86%)']	['75.009 (48.08%)']
queryservice	['0.002 (0.05%)']	['0.486 (24.32%)']
sm-service	['96.699 (21.58%)']	['309.705 (48.39%)']
perf-info	['0.481 (24.05%)']	['0.279 (13.96%)']
diam-gateway	['1.579 (9.87%)']	['3.539 (44.24%)']

Table 3-153 cnDBTier Services Resource Utilization

Services	CPU - Site1	Memory - Site1
ndbappmysqld	['52.806 (24.45%)']	['154.933 (47.82%)']
ndbmgmd	['0.013 (0.22%)']	['4.058 (25.36%)']
ndbmtd	['53.643 (53.64%)']	['767.512 (58.14%)']
ndbmysqld	['2.729 (5.69%)']	['101.743 (5.51%)']

3.2.8.3 Results

Table 3-154 Latency Observations

SM Call Flow	50th Percentile (mean)	95th Percentile (mean)
SM Create	172ms	496ms
SM Update	27.4ms	141ms
SM Delete	20.6ms	98.5ms

3.2.9 54K TPS from 1 Site-1 Without Profile

This test run benchmarks the performance and capacity of Policy data with 54K from site-1 without profile. Replication is on single-channel and Binding service and PRE are enabled.

3.2.9.1 Test Case and Setup Details

Policy Infrastructure Details

Infrastructure used for benchmarking Policy performance run is described in this section.

Table 3-155 Hardware Details

Hardware	Details
Environment	BareMetal
Server	ORACLE SERVER X9-2
Model	Intel(R) Xeon(R) Platinum 8358 CPU
Clock Speed	2.600 GHz
Total Cores	128
Memory Size	768 GB
Type	DDR4 SDRAM
Installed DIMMs	24
Maximum DIMMs	32
Installed Memory	768 GB

Table 3-156 Software Details

Aplications	Version
Policy	25.1.200
cnDBTier	25.1.200
ASM	1.14.6
OSO	NA
CNE	23.3.3

For more information about Policy Installation, see *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*.

Testcase Parameters

The following table describes the testcase parameters and their values:

Table 3-157 Testcase Parameters

Parameter	Value
Call Rate (Ingress + Egress)	54K from site-1 without profile
ASM	Enable
Traffic Ratio	AM- Create-1 , AM Delete-1 , UE Create-1 , UE Delete-1 , N1N2transfer-1, N1subscribe-1, N1Unsubscribe-1
Active Subscribers	8M

Policy Project Details:

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low– No Usage of Loops in Blockly logic, No JSON operations, No complex Java Script code in Object Expression /Statement Expression.

- Medium - Usage of Loops in Blockly logic, Policy Table Wildcard match <= 3 fields, MatchList < 3, 3 < RegEx match < 6
- High - JSON Operations – Custom, complex Java Script code in Object Expression / Statement Expression, Policy Table Wildcard match > 3 fields, MatchLists >= 3, RegEx mat >= 6

Table 3-158 Call Model Data:

Call Flow	Traffic at Site1 (TPS)	Traffic at Site2 (TPS)
Ingress Service	21204.32	0.00
Egress Service	32539.66	0.23
Diameter Gateway In	0.00	0.00
Diameter Gateway Out	0.00	0.00
Total	53743	0.00

Policy Configurations:

Following PCF features were either enabled or disabled for running this call flow:

Table 3-159 Policy Configurations:

Feature Name	Status
RAB	Enabled
SAC	Enabled
Single UE ID	Enabled
Location Information Header	Enabled
Overload Control	Enabled
Congestion Control	Enabled
PRIMARYKEY_LOOKUP_ENABLED	Enabled

Configuring Policy Helm Parameters

There are no optimization parameters configured for this run:

Configuring cnDbTier Helm Parameters

There are no optimization parameters configured for this run:

Resource Footprint:

Table 3-160 Policy microservices Resource allocation for Site1:

Service Name	CPU Request per Container (#)	CPU Limit per Container (#)	Memory Request per Container	Memory Limit per Container	Replicas
Appinfo	1	1	1	512 Mi	2
Appinfo Istio	2	2	2	2	2
Bulwark service	8	8	6	6	9
Bulwark service Istio	3	3	4	4	9
Alternate Route Service	2	2	4	2	7

Table 3-160 (Cont.) Policy microservices Resource allocation for Site1:

Service Name	CPU Request per Container (#)	CPU Limit per Container (#)	Memory Request per Container	Memory Limit per Container	Replicas
Alternate Route Service Istio	2	2	2	2	7
CHF Connector	6	6	4	4	1
CHF Connector Istio	2	2	2	2	1
Config Service	4	2	2	512 Mi	2
Config Service Istio	2	2	2	2	2
Egress Gateway	4	4	6	6	48
Egress Gateway Istio	2	2	2	2	48
Ingress Gateway	5	5	6	6	15
Ingress Gateway Istio	2500m	2500m	2	2	15
NRF Client NF Management	1	1	1	1	2
NRF Client NF Management Istio	2	2	2	2	2
NRF Client NF Discovery	4	4	4	4	10
NRF Client NF Discovery Istio	2	2	2	2	10
UDR Connector User Service	6	6	4	4	25
UDR Connector Istio	2	2	2	2	25
Audit Service	2	2	4	4	2
Audit Service Istio	2	2	2	2	2
CM Service	4	4	2	2	2
CM Service Istio	2	2	2	2	2
PDS	7	7	8	8	25
PDS Istio	2.5	2.5	4	4	25
PRE	4	4	4	4	16
PRE Istio	1500m	1500m	2	2	16
Query Service	2	1	1	1	2
Query Service Istio	2	2	2	2	2
AM Service	8	8	8	8	20
AM Service Istio	3	3	2	2	20

Table 3-160 (Cont.) Policy microservices Resource allocation for Site1:

Service Name	CPU Request per Container (#)	CPU Limit per Container (#)	Memory Request per Container	Memory Limit per Container	Replicas
UE Policy Service	8	8	6	6	25
UE Policy Service Istio	2	2	2	2	25
PerfInfo	1	1	1	512Mi	2

Table 3-161 Policy microservices Resource allocation for Site2:

Service Name	CPU Request per Container (#)	CPU Limit per Container (#)	Memory Request per Container	Memory Limit per Container	Replicas
Appinfo	1	1	1	512 Mi	2
Appinfo Istio	2	2	2	2	2
Bulwark service	8	8	6	6	1
Bulwark service Istio	3	3	4	4	1
Alternate Route Service	2	2	4	2	1
Alternate Route Service Istio	2	2	2	2	1
CHF Connector	6	6	4	4	1
CHF Connector Istio	2	2	2	2	1
Config Service	4	2	2	512 Mi	2
Config Service Istio	2	2	2	2	2
Egress Gateway	4	4	6	6	1
Egress Gateway Istio	2	2	2	2	1
Ingress Gateway	5	5	6	6	1
Ingress Gateway Istio	2500m	2500m	2	2	1
NRF Client NF Management	1	1	1	1	2
NRF Client NF Management Istio	2	2	2	2	2
NRF Client NF Discovery	4	4	4	4	1
NRF Client NF Discovery Istio	2	2	2	2	1
UDR Connector User Service	6	6	4	4	1

Table 3-161 (Cont.) Policy microservices Resource allocation for Site2:

Service Name	CPU Request per Container (#)	CPU Limit per Container (#)	Memory Request per Container	Memory Limit per Container	Replicas
UDR Connector Istio	2	2	2	2	1
Audit Service	2	2	2	4	4
Audit Service Istio	2	2	2	2	2
CM Service	4	4	2	2	2
CM Service Istio	2	2	2	2	2
PDS	7	7	8	8	1
PDS Istio	2.5	2.5	4	4	1
PRE	4	4	4	4	1
PRE Istio	1500m	1500m	2	2	1
Query Service	2	1	1	1	2
Query Service Istio	2	2	2	2	2
AM Service	8	8	8	8	2
AM Service Istio	3	3	2	2	1
UE Policy Service	8	8	6	6	1
UE Policy Service Istio	2	2	2	2	1
PerfInfo	1	1	1	512 Mi	2

Table 3-162 cnDBTier services resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-mysql-cluster-db-backup-manager-svc/ istio-proxy	1	1	1	2Gi	2Gi
Site1-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site1-mysql-cluster-db-monitor-svc/ istio-proxy	1	1	1	2Gi	2Gi

Table 3-162 (Cont.) cnDBTier services resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-mysql-cluster-db-monitor-svc/db-monitor-svc	1	1	1	512Mi	512Mi
Site1-ndbappmysqld/istio-proxy	16	4	4	2Gi	2Gi
Site1-ndbappmysqld/mysqlndbcluster	16	12	12	20Gi	20Gi
Site1-ndbappmysqld/db-infra-monitor-svc	16	NA	NA	NA	20Gi
Site1-ndbappmysqld/init-sidecar	16	300m	300m	512Mi	512Mi
Site1-ndbmgmd/istio-proxy	2	1	1	2Gi	2Gi
Site1-ndbmgmd/mysqlndbcluster	2	4	4	10Gi	8Gi
Site1-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site1-ndbmtd/istio-proxy	10	5	5	2Gi	2Gi
Site1-ndbmtd/mysqlndbcluster	10	12	12	75Gi	75Gi
Site1-ndbmtd/db-backup-executor-svc	10	1	1	2Gi	2Gi
Site1-ndbmtd/db-infra-monitor-svc	10	200m	200m	256Mi	256Mi
Site1-ndbmysqld/istio-proxy	6	1	1	2Gi	2Gi
Site1-ndbmysqld/mysqlndbcluster	6	4	4	16Gi	16Gi

Table 3-162 (Cont.) cnDBTier services resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-ndbmysqld/init-sidecar	6	300m	300m	512Mi	512Mi
Site1-ndbmysqld/db-infra-monitor-svc	6	100m	100m	256Mi	256Mi

Table 3-163 cnDBTier services resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-mysql-cluster-db-backup-manager-svc/istio-proxy	1	1	1	2Gi	2Gi
Site2-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site2-mysql-cluster-db-monitor-svc/istio-proxy	1	1	1	2Gi	2Gi
Site2-mysql-cluster-db-monitor-svc/db-monitor-svc	1	1	1	512Mi	512Mi
Site2-ndbappmysqld/istio-proxy	16	4	4	2Gi	2Gi
Site2-ndbappmysqld/mysqlndbcluster	16	12	12	20Gi	20Gi
Site2-ndbmgmd/istio-proxy	2	1	1	2Gi	2Gi
Site2-ndbmgmd/mysqlndbcluster	2	4	4	10Gi	8Gi
Site2-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi

Table 3-163 (Cont.) cnDBTier services resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-ndbmtd/istio-proxy	10	5	5	2Gi	2Gi
Site2-ndbmtd/mysqlndbcluster	10	12	12	75Gi	75Gi
Site2-ndbmtd/db-backup-executor-svc	10	1	1	2Gi	2Gi
Site2-ndbmtd/db-infra-monitor-svc	10	200m	200m	256Mi	256Mi
Site2-ndbmysqld/istio-proxy	6	1	1	2Gi	2Gi
ndbmysqld	6	4	4	16Gi	16Gi
Site2-ndbmysqld/init-sidecar	6	300m	300m	512Mi	512Mi
Site2-ndbmysqld/db-infra-monitor-svc	6	100m	100m	256Mi	256Mi

Note

Min Replica = Max Replica

3.2.9.2 CPU Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-164 Policy Microservices and their Resource Utilization

Service Name	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
AppInfo Istio	0.27%	13.99%	0.27%	19.85%
AppInfo	4.70%	26.71%	3.35%	26.07%
Bulwark service Istio	37.78%	8.08%	0.10%	.28%
Bulwark service	34.28%	24.34%	0.05%	17.19%

Table 3-164 (Cont.) Policy Microservices and their Resource Utilization

Service Name	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
Alternate Route service Istio	25.84%	42.63%	0.20%	18.85%
Alternate Route service	30.58%	16.01%	0.15%	9.81%
CHF Connector Istio	0.40%	13.43%	0.40%	18.36%
CHF Connector	0.07%	16.09%	0.05%	12.55%
Config-server Istio	13.48%	15.80%	1.27%	13.60%
Config-server	8.62%	42.09%	0.80%	40.28%
Egress Gateway Istio	19.84%	14.93%	0.20%	19.04%
Egress Gateway	16.28%	18.85%	0.10%	16.16%
Ingress Gateway Istio	29.75%	24.96%	0.72%	20.07%
Ingress Gateway	30.97%	55.49%	0.58%	26.20%
NRF Client NF Discovery Istio	17.26%	16.57%	0.15%	18.75%
NRF Client NF Discovery	18.54%	63.53%	0.05%	19.34%
NRF Client NF Management Istio	0.20%	14.60%	0.20%	18.85%
NRF Client NF Management	0.35%	53.66%	0.35%	49.80%
UDR Connector Istio	51.14%	21.62%	0.40%	18.55%
UDR Connector	31.42%	52.54%	0.08%	22.14%
Audit Service Istio	0.20%	12.99%	0.18%	17.68%
Audit Service	0.12%	33.57%	0.10%	41.38%
CM Service Istio	0.85%	13.99%	0.22%	18.19%
CM Service	0.84%	44.97%	0.16%	48.51%

The following table provides information about observed values of cnDBTier services.

Table 3-165 Observed CPU utilization values of cnDBTier services

Service Name	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
mysql-cluster-db-backup-manager-svc/istio-proxy	0.30%	17.38%	0.40%	17.29%
mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	5.00%	88.28%	16.00%	75.00%
mysql-cluster-db-monitor-svc/istio-proxy	0.50%	17.58%	0.60%	17.53%

Table 3-165 (Cont.) Observed CPU utilization values of cnDBTier services

Service Name	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
mysql-cluster-db-monitor-svc/db-monitor-svc	1.50%	66.99%	1.50%	66.80%

3.2.9.3 Results

Table 3-166 Average Latency Observations (in MilliSeconds) for the Call flow:

Call Flow	Average Latency Site1	Average Latency at Site2
PCF_IGW_Latency	20.85	0.00
PCF_SM_Svc_Overall	0.00	0.00
PCF_POLICYPDS_Overall	13.78	0.00
PCF_UDRCONNECTOR_Overall	10.15	0.00
PCF_CHFCONNECTOR_Overall	0.00	0.00
PCF_NRFCLIENT_On_Demand	0.26	0.00
PCF_UsrSvc_Overall	0.00	0.00
PCF_EGRESS_Latency	0.77	0.80
PCF_Binding_Svc_Latency	0.00	0.00
PCF_Diam_Connector_Latency	0.00	0.00
PCF_Diam_Gw_Latency	0.00	0.00
PCF_Usage_Mon	0.00	0.00
Pcrf_Core_Overall	0.00	0.00

Table 3-167 Average Current Percentile Latency Observations

Methods	50th Percentile (Site1)	99th Percentile (Site1)	50th Percentile (Site2)	99th Percentile (Site2)
UE POST	39.09	74.65	0.00	0.00
UE DELETE	0.00	0.00	0.00	0.00
AM POST	26.39	63.41	0.00	0.00
AM DELETE	0.00	0.00	0.00	0.00
SM POST	0.00	0.00	0.00	0.00
SM DELETE	0.00	0.00	0.00	0.00

Table 3-168 Latency obervations for cnDBTier services

Site-Slave Node(In Seconds)	cnDBtier Replication Delay
Site-1-ndbmysqld-0	0
Site-1-ndbmysqld-2	0
Site-1-ndbmysqld-4	0
Site-2-ndbmysqld-0	0
Site-2-ndbmysqld-2	0
Site-2-ndbmysqld-4	0

3.2.10 41K TPS on Site-1 with NRF Caching and UDR group-id-list Based Discovery Enabled

This test run benchmarks the performance and capacity of Policy data call model that is deployed in PCF mode on a 2 sites setup. The test was run for 41K TPS on 2 sites with ASM disabled. The Policy application handles a total (Ingress + Egress) traffic of 41K TPS on two sites.

3.2.10.1 Test Case and Setup Details

Policy Infrastructure Details

Infrastructure used for benchmarking Policy performance run is described in this section.

Table 3-169 Hardware Details

Hardware	Details
Environment	BareMetal
Server	ORACLE SERVER X9-2
Model	Intel(R) Xeon(R) Platinum 8358 CPU
Clock Speed	2.600 GHz
Total Cores	128
Memory Size	768 GB
Type	DDR4 SDRAM
Installed DIMMs	24
Maximum DIMMs	32
Installed Memory	768 GB

Table 3-170 Software Details

Aplications	Version
Policy	25.1.200
cnDBTier	25.1.200
ASM	1.14.6-am1
OSO	NA
CNE	23.3.3

For more information about Policy Installation, see *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*.

The following table describes the testcase parameters and their values:

Table 3-171 Testcase Parameters

Parameters	Values
Call Rate (Ingress + Egress)	41K TPS on Site-1 (With NRF caching and UDR group-id-list based discovery Enabled)
ASM	Enabled

Table 3-171 (Cont.) Testcase Parameters

Parameters	Values
Traffic Ratio	Internet : SM 1-Create 15-update 1-delete IMS: SM 1-Create 8-update 1-delete Application: SM 1-Create 0-update 1-delete Administrator: SM 1-Create 0-update 1-delete
Active Subscribers	10M

Policy Project Details:

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was High.

Complexity Level Definition:

- Low– No Usage of Loops in Blockly logic, No JSON operations, No complex Java Script code in Object Expression /Statement Expression.
- Medium - Usage of Loops in Blockly logic, Policy Table Wildcard match <= 3 fields, MatchList < 3, 3 < RegEx match < 6
- High - JSON Operations – Custom, complex Java Script code in Object Expression / Statement Expression, Policy Table Wildcard match > 3 fields, MatchLists >= 3, RegEx mat >= 6

Call Model Data

Table 3-172 Traffic distribution per call flow

Call Flow	Traffic at Site1	Traffic at Site2
TOTAL-IGW	21844.57	0.00
TOTAL-EGW	13308.29	0.00
DIAM-GW-IN-TOTAL	3427.82	0.00
DIAM-GW-OUT-TOTAL	2700.02	0.00
TOTAL-TPS	41280	0.00

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-173 Policy Configurations

Feature Name	Configuration
PDS- Application Compression	Enabled
NRF cacheing and UDR group-id-list based discovery	Enabled
PDS Single UE ID Configuration • Type Of Search: SINGLE_UE_ID_PREFERENTIAL_SEARCH • Primary Key Combination: SUPI • Subscriber Source Types: SmPolicyData,SpendingLimitData,SubscriberStateVariable	Enabled

Table 3-173 (Cont.) Policy Configurations

Feature Name	Configuration
PDS Location Information Header support • PRIMARYKEY_LOOKUP_ENABLED - TRUE	Enabled
Congestion Control with Default Values: • UDR Connector • SM service • Binding service • PDS • CHF Connector • Bulwark service	Enabled

Configuring Policy Helm Parameters

There were no optimized parameters configured for this run:

Configuring cnDbTier Helm Parameters

There were no optimized parameters configured for this run:

Resource Footprint:

Table 3-174 Policy microservices resource allocation

Service Name	Replicas	CPU Limit per Container (#)	CPU Limit per Container (#)	Memory Limit per Container	Memory Request per Container
Appinfo Istio	2	2	2	2Gi	2Gi
Appinfo	2	2	2	1Gi	512Mi
Bulwark service Istio	15	2500m	2500m	2Gi	2Gi
Bulwark service	15	8	8	6Gi	6Gi
Binding service Istio	11	2500m	2500m	2Gi	2Gi
Binding service	11	6	6	8Gi	8Gi
Diameter Connector Istio	6	2	2	2Gi	2Gi
Diameter Connector	6	4	4	2Gi	1Gi
Alternate Route Service Istio	2	2	2	2Gi	2Gi
Alternate Route Service	2	2	2	4Gi	2Gi
CHF Connector Istio	4	2	2	2Gi	2Gi
CHF Connector	4	6	6	4Gi	4Gi
Config Service Istio	2	2	2	2Gi	2Gi
Config Service	2	4	4	2Gi	512Mi
Egress Gateway Istio	9	4	4	2Gi	2Gi

Table 3-174 (Cont.) Policy microservices resource allocation

Service Name	Replicas	CPU Limit per Container (#)	CPU Limit per Container (#)	Memory Limit per Container	Memory Request per Container
Egress Gateway	9	8	8	6Gi	6Gi
Ingress Gateway Istio	29	2500m	2500m	2Gi	2Gi
Ingress Gateway	29	5	5	6Gi	6Gi
NRF Client NF Discovery Istio	4	2	2	2Gi	2Gi
NRF Client NF Discovery	4	4	4	2Gi	2Gi
NRF Client NF Management Istio	2	2	2	2Gi	2Gi
NRF Client NF Management	2	1	1	1Gi	1Gi
UDR Connector Istio	8	2	2	2Gi	2Gi
UDR Connector	8	6	6	4Gi	4Gi
Audit Service Istio	2	2	2	2Gi	2Gi
Audit Service	2	2	2	4Gi	4Gi
CM Service Istio	2	2	2	2Gi	2Gi
CM Service	2	4	2	2Gi	512Mi
PDS Istio	30	2500m	2500m	4Gi	4Gi
PDs	30	7	7	8Gi	8Gi
PRE Istio	39	1500m	1500m	2Gi	2Gi
PRE	39	4	4	4Gi	4Gi
Query Service Istio	2	2	2	2Gi	2Gi
Query Service	2	2	1	1Gi	1Gi
SM Service Istio	64	2500m	2500m	2Gi	2Gi
SM Service	64	7	7	10Gi	10Gi
PerfInfo	2	1	1	1Gi	512Mi
Diameter Gateway Istio	4	2	2	2Gi	2Gi
Diameter Gateway	4	4	4	2Gi	1Gi

Table 3-175 cnDBTier services resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Limit per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site1-mysql-cluster-db-monitor-svc/db-monitor-svc	1	4	4	4Gi	4Gi
Site1-ndbappmysqld/istio-proxy	18	3000m	3000m	2Gi	2Gi
Site1-ndbappmysqld/mysqlndbcluster	18	12	12	18Gi	18Gi
Site1-ndbappmysqld/init-sidecar	18	100m	100m	256Mi	256Mi
Site1-ndbmgmd/istio-proxy	2	1000m	1000m	2Gi	2Gi
Site1-ndbmgmd/mysqlndbcluster	2	3	3	8Gi	8Gi
Site1-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site1-ndbmtd/istio-proxy	10	4000m	4000m	2Gi	2Gi
Site1-ndbmtd/mysqlndbcluster	10	10	10	132Gi	132Gi
Site1-ndbmtd/db-backup-executor-svc	10	1	1	2Gi	2Gi
Site1-ndbmtd/db-infra-monitor-svc	10	100m	100m	256Mi	256Mi
Site1-ndbmysqld/istio-proxy	12	5000m	5000m	4Gi	4Gi

Table 3-175 (Cont.) cnDBTier services resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Limit per Container (#)	Memory Limit per Container	Memory Request per Container
Site1-ndbmysqld/mysqlndbcluster	12	4	4	24Gi	24Gi
Site1-ndbmysqld/init-sidecar	12	100m	100m	256Mi	256Mi
Site1-ndbmysqld/db-infra-monitor-svc	12	100m	100m	256Mi	256Mi

Table 3-176 cnDBTier services resource allocation at Site2

Service Name	Replicas	CPU Limit per Container (#)	CPU Limit per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	100m	100m	128Mi	128Mi
Site2-mysql-cluster-db-monitor-svc/db-monitor-svc	1	4	4	4Gi	4Gi
Site2-ndbappmysqld/istio-proxy	18	3000m	3000m	2Gi	2Gi
Site2-ndbappmysqld/mysqlndbcluster	18	12	12	18Gi	18Gi
Site2-ndbappmysqld/init-sidecar	18	100m	100m	256Mi	256Mi
Site2-ndbmgmd/istio-proxy	2	1000m	1000m	2Gi	2Gi
Site2-ndbmgmd/mysqlndbcluster	2	3	3	8Gi	8Gi
Site2-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi

Table 3-176 (Cont.) cnDBTier services resource allocation at Site2

Service Name	Replicas	CPU Limit per Container (#)	CPU Limit per Container (#)	Memory Limit per Container	Memory Request per Container
Site2-ndbmtd/istio-proxy	10	4000m	4000m	2Gi	2Gi
Site2-ndbmtd/mysqlndbcluster	10	10	10	132Gi	132Gi
Site2-ndbmtd/db-backup-executor-svc	10	1	1	2Gi	2Gi
Site2-ndbmtd/db-infra-monitor-svc	10	100m	100m	256Mi	256Mi
Site2-ndbmysqld/istio-proxy	12	5000m	5000m	4Gi	4Gi
Site2-ndbmysqld/mysqlndbcluster	12	4	4	24Gi	24Gi
Site2-ndbmysqld/init-sidecar	12	100m	100m	256Mi	256Mi
Site2-ndbmysqld/db-infra-monitor-svc	12	100m	100m	256Mi	256Mi

Note: Min Replica = Max Replica

3.2.10.2 CPU Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-177 Policy Microservices and their Resource Utilization

Service Name	CPU per Container (Site1)	Memory per Container (Site1)	CPU per Container (Site 2)	Memory per container (Site2)
Appinfo Istio	0.25%	16.72%	None	None
Appinfo	2.75%	27.34%	None	None
Bulwark service Istio	31.96%	17.96%	None	None
Bulwark service	26.22%	21.74%	None	None

Table 3-177 (Cont.) Policy Microservices and their Resource Utilization

Service Name	CPU per Container (Site1)	Memory per Container (Site1)	CPU per Container (Site 2)	Memory per container (Site2)
Binding service Istio	16.87%	19.28%	None	None
Binding service	14.28%	36.59%	None	None
Diameter Connector Istio	18.69%	18.43%	None	None
Diameter Connector	14.09%	35.38%	None	None
Alternate Route Service Istio	30.50%	45.61%	None	None
Alternate Route Service	33.02%	12.81%	None	None
CHF Connector Istio	25.60%	24.24%	None	None
CHF Connector	12.83%	28.59%	None	None
Config Service Istio	10.72%	19.04%	None	None
Config Service	7.17%	40.94%	None	None
Egress Gateway Istio	14.51%	20.76%	None	None
Egress Gateway	16.34%	23.40%	None	None
Ingress Gateway Istio	17.10%	25.30%	None	None
Ingress Gateway	19.58%	40.88%	None	None
NRF Client NF Discovery Istio	1.01%	16.32%	None	None
NRF Client NF Discovery	4.61%	61.45%	None	None
NRF Client NF Management	0.18%	16.48%	None	None
NRF Client NF Management Istio	0.40%	47.51%	None	None
UDR Connector Istio	28.58%	30.82%	None	None
UDR Connector	14.65%	26.41%	None	None
Audit Service Istio	2.15%	15.80%	None	None
Audit Service	2.55%	38.61%	None	None
CM Service Istio	0.88%	16.02%	None	None
CM Service	0.68%	43.02%	None	None
PDS Istio	22.74%	10.60%	None	None
PDS	23.33%	49.58%	None	None
PRE Istio	13.22%	17.43%	None	None
PRE	25.83%	54.53%	None	None
Query Service Istio	1.88%	16.11%	None	None
Query Service	8.48%	37.26%	None	None
SM Service Istio	29.58%	20.73%	None	None
SM Service	29.44%	55.17%	None	None

Table 3-177 (Cont.) Policy Microservices and their Resource Utilization

Service Name	CPU per Container (Site1)	Memory per Container (Site1)	CPU per Container (Site 2)	Memory per container (Site2)
PerfInfo	19.35%	14.99%	None	None
Diameter Gateway Istio	6.10%	16.94%	None	None
Diameter Gateway	11.38%	37.26%	None	None

The following table provides information about observed values of cnDBTier services.

Table 3-178 Observed CPU utilization Values of cnDBTier Services

Service Name	CPU per Container (Site1)	Memory per Container (Site1)	CPU per Container (Site 2)	Memory per container (Site2)
mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	5.00%	64.84%	1.00%	67.97%
mysql-cluster-db-monitor-svc/db-monitor-svc	2.00%	23.97%	0.12%	21.66%
ndbappmysqld/ istio-proxy	44.07%	19.01%	0.44%	18.07%
ndbappmysqld/ mysqlndbcluster	30.41%	27.76%	0.11%	24.20%
ndbappmysqld/init-sidecar	2.00%	0.39%	2.00%	0.39%
ndbmgmd/istio-proxy	0.80%	17.72%	0.70%	17.70%
ndbmgmd/ mysqlndbcluster	0.18%	25.40%	0.20%	25.40%
ndbmgmd/db-infra-monitor-svc	1.00%	11.52%	1.00%	11.13%
ndbmtd/istio-proxy	57.58%	18.24%	6.10%	18.46%
ndbmtd/ mysqlndbcluster	45.76%	66.75%	8.10%	66.78%
ndbmtd/db-backup-executor-svc	0.10%	2.76%	0.10%	2.76%
ndbmtd/db-infra-monitor-svc	1.30%	11.29%	1.40%	11.33%
ndbmysqld/istio-proxy	3.72%	9.10%	0.59%	9.06%
ndbmysqld/ mysqlndbcluster	6.49%	21.62%	2.71%	18.27%
ndbmysqld/init-sidecar	2.00%	0.39%	2.00%	0.39%
ndbmysqld/db-infra-monitor-svc	1.00%	11.39%	1.00%	11.13%

3.2.10.3 Results

Table 3-179 Average Latency Observations (In Milli Seconds) for the call flows:

Service Name	Observed Latency at Site1	Observed Latency at Site2
PCF_IGW_Latency	37.32	0.00
PCF_SM_Svc_Overall	33.88	0.00
PCF_POLICYPDS_Overall	11.04	0.00
PCF_UDRCONNECTOR_Overall	3.51	0.00
PCF_CHFCONNECTOR_Overall	3.08	0.00
PCF_NRFCLIENT_On_Demand	0.16	0.00
PCF_UsrSvc_Overall	3.08	0.00
PCF_EGRESS_Latency	0.52	0.00
PCF_Binding_Svc_Latency	19.86	0.00
PCF_Diam_Connector_Latency	1.53	0.00
PCF_Diam_Gw_Latency	21.37	0.00
PCF_Usage_Mon	0.00	0.00
Pcrf_Core_Overall	0.00	0.00

Table 3-180 Average Current Percentile Latency Observations

METHODS	50th Percentile (Site1)	99th Percentile (Site1)	50th Percentile (Site2)	99th Percentile (Site2)
UE POST	0.00	0.00	0.00	0.00
UE DELETE	0.00	0.00	0.00	0.00
AM POST	0.00	0.00	0.00	0.00
AM DELETE	0.00	0.00	0.00	0.00
SM POST	63.21	110.72	0.00	0.00
SM DELETE	0.00	0.00	0.00	0.00

Table 3-181 Latency obervations for cnDBTier services

Site-Slave Node(In Seconds)	cnDBtier Replication Delay
Site-1-ndbmysqld-0	0
Site-1-ndbmysqld-2	0
Site-1-ndbmysqld-4	0
Site-1-ndbmysqld-6	0
Site-1-ndbmysqld-8	0
Site-1-ndbmysqld-10	0
Site-2-ndbmysqld-0	0
Site-2-ndbmysqld-2	0
Site-2-ndbmysqld-4	0
Site-2-ndbmysqld-6	0
Site-2-ndbmysqld-8	0
Site-2-ndbmysqld-10	0

3.3 Policy Call Model 3

3.3.1 Test Scenario: Policy Voice Call Model on Four-Site Georedundant Setup, with 7.5K TPS Traffic on Each Site and ASM Disabled

This test run benchmarks the performance and capacity of Policy voice call model that is deployed in converged mode on a four-site georedundant setup. Each of the sites handles a traffic of 7.5K TPS at Diameter Gateway. For this setup, Policy Event Record (PER) and Binding feature were enabled and Aspen Service Mesh (ASM) was disabled. This setup has single-channel replication.

3.3.1.1 Test Case and Setup Details

Test Case Parmeters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Diameter Gateway)	**30**K TPS (7.5KTPS on four site)
ASM	Disable
Traffic Ratio	CCRI-I, AARI –1, CCRU-2, AARU - 1, RAR-Gx-1, RAR-Rx-1, STR –1, CCRT-1.
Active Subscribers	10000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Service Name	TPS
Ingress Service	NA
Egress Service	NA
Diameter Gateway	7.5K TPS
Diameter Connector	NA
SM service	NA

Service Name	TPS
PDS Service	NA
PRE Service	NA
NRF Discovery	NA
UDR Connector	NA
CHF Connector	NA
Binding Service	NA
Bulwark Service	NA

Policy Configurations

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-182 Policy Configurations

Service Name	Status
Binding	Enabled
PRE	Enabled
SAL	Enabled
LDAP	Disabled
OCS	Disabled
Audit	Enabled
Replication	Enabled
Bulwark	Disabled
Alternate routing	Disabled

Following Policy Interfaces were either enabled or disabled for running this call flow:

Table 3-183 Policy Interfaces

Feature Name	Status
AMF on demand nrf discovery	NA
BSF (N7-Nbsf)	NA
CHF (SM-Nchf)	NA
LDAP (Gx-LDAP)	NA
N36 UDR query (N7/N15-Nudr)	NA
N36 UDR subscription (N7/N15-Nudr)	NA
Sy (PCF N7-Sy)	NA
UDR on-demand nrf discovery	NA

Following PCRF interfaces were either enabled or disabled for running this call flow:

Table 3-184 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA

Table 3-184 (Cont.) PCRF Interfaces

Feature Name	Status
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr)	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring Policy Helm Parameters

There are no optimization parameters configured for this run.

Configuring cnDbTier Helm Parameters

There are no optimization parameters configured for this run.

Policy Microservices Resources

Table 3-185 Policy microservices Resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
Appinfo	1	2	1	2	1
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	1
Config Service	2	4	0.5	2	1
Egress Gateway	5	5	6	6	2
Ingress Gateway	3	4	4	6	2
Nrf Client Management	1	1	1	1	2
Diameter Gateway	3	4	1	2	9
Diameter Connector	3	4	1	2	5
Nrf Client Discovery	3	4	0.5	2	2
Query Service	1	2	1	1	1
PCRF Core Service	7	8	8	8	24
Performance	1	1	0.5	1	2
PRE Service	4	4	0.5	4	15
SM Service	7	7	10	10	2
PDS	7	7	8	8	5
Binding Service	5	6	1	8	18

Table 3-186 cnDBTier services resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Storage
ndbappmysqld	8	8	19	20	5	32Gi
ndbmgmd	2	2	9	11	2	16Gi
ndbmtd	8	8	73	83	8	76Gi
ndbmysqld	4	4	25	25	6	131Gi

Note: Min Replica = Max Replica

3.3.1.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-187 CPU/Memory Utilization by Policy Microservices

Service Name	Site 1 CPU (X/Y)	Site 2 CPU (X/Y)	Site 3 CPU (X/Y)	Site 4 CPU (X/Y)
ocpcf-appinfo-hpa-v2	3%/80%	3%/80%	3%/80%	3%/80%
ocpcf-config-server-hpa-v2	8%/80%	9%/80%	7%/80%	7%/80%
ocpcf-diam-connector-hpa	0%/40%	0%/40%	0%/40%	0%/40%
ocpcf-egress-gateway-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-ingress-gateway-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-nrf-client-nfdiscovery-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-nrf-client-nfmanagement-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-oc-binding-hpa	6%/60%	6%/60%	6%/60%	6%/60%
ocpcf-ocpm-audit-service-hpa-v2	4%/60%	1%/60%	1%/60%	1%/60%
ocpcf-ocpm-policyds-hpa	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-pcf-pre-hpa	17%/80%	18%/80%	17%/80%	17%/80%

Table 3-187 (Cont.) CPU/Memory Utilization by Policy Microservices

Service Name	Site 1 CPU (X/Y)	Site 2 CPU (X/Y)	Site 3 CPU (X/Y)	Site 4 CPU (X/Y)
ocpcf-pcrf-core-hpa	12%/40%	12%/40%	12%/40%	12%/40%
ocpcf-query-service-hpa	0%/80%	0%/80%	0%/80%	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-188 CPU/Memory Utilization by CnDBTier services

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ndbappmysqld	88%/80%	87%/80%	89%/80%	88%/80%
ndbmgmd	0%/80%	0%/80%	0%/80%	0%/80%
ndbmtd	16%/80%	17%/80%	17%/80%	18%/80%
ndbmysqld	8%/80%	9%/80%	10%/80%	8%/80%

3.3.1.3 Results

Table 3-189 Average PCRF Core JDBC Latency Observations

Site 1	Site 2	Site 3	Site 4
2.19 ms	2.32 ms	2.66 ms	2.56 ms

3.3.2 Test Scenario: Policy Voice Call Model on Four-Site Georedundant Setup, with 15K TPS Traffic on Two Sites and No Traffic on Other Two Sites

This test run benchmarks the performance and capacity of Policy voice call model that is deployed in converged mode on a four-site georedundant setup. Two of the sites (site1 and site3) handle a traffic of 15K TPS at Diameter Gateway and there is no traffic on the other two sites (site2 and site4). For this setup, Binding and Policy Event Record (PER) features were enabled and Aspen Service Mesh (ASM) was disabled. This setup has single-channel replication.

3.3.2.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Diameter Gateway)	**30**KTPS (15KTPS on two sites)
ASM	Disable
Traffic Ratio	CCRI-I, AARI –1, CCRU-2, AARU - 1, RAR-Gx-1, RAR-Rx-1, STR –1, CCRT-1.
Active Subscribers	10000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Services	TPS
Ingress Service	NA
Egress Service	NA
Diameter Gateway	15K TPS
Diameter Connector	NA
SM service	NA
PDS Service	NA
PRE Service	NA
NRF Discovery	NA
UDR Connector	NA
CHF Connector	NA
Binding Service	NA
Bulwark Service	NA

Policy Configurations

Following Policy configurations were either enabled or disabled for running this call flow:

Table 3-190 Policy Microservices Configuration

Service Name	Status
Binding	Enabled
PER	Enabled
SAL	Enabled
LDAP	Disabled
OCS	Disabled
Audit	Enabled
Replication	Enabled
Bulkwark	Disabled
Alternate routing	Disabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-191 Policy Interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	NA
N36 UDR subscription (N7/N15-Nudr)	NA
UDR on-demand nrf discovery	NA
CHF (SM-Nchf)	NA
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Sy (PCF N7-Sy)	NA

Following PCRF interfaces were either enabled or disabled for running this call flow:

Table 3-192 PCRF Interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr)	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring Policy Helm Parameters

There were no optimized parameters configured for this run.

Configuring cnDbTier Helm Parameters

There were no optimized parameters configured for this run.

Policy Microservices Resources

Table 3-193 Policy microservices resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
Appinfo	1	1	0.5	1	1
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	1
Config Service	2	4	0.5	2	1
Egress Gateway	3	4	4	6	2
Ingress Gateway	3	4	4	6	2
Nrf Client Management	1	1	1	1	2

Table 3-193 (Cont.) Policy microservices resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
Diameter Gateway	3	4	1	2	9
Diameter Connector	3	4	1	2	5
Nrf Client Discovery	3	4	0.5	2	2
Query Service	1	2	1	1	1
PCRF Core Service	7	8	8	8	24
Performance	1	1	0.5	1	2
PRE Service	5	5	0.5	4	15
SM Service	7	8	1	4	2
PDS	5	6	1	4	5
Binding Service	5	6	1	8	18

Table 3-194 cnDBTier services resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Storage
ndbappmysqld	8	8	19	20	5	32Gi
ndbmgmd	2	2	9	11	2	16Gi
ndbmtd	8	8	73	83	8	76Gi
ndbmysqld	4	4	25	25	6	131Gi

Min Replica = Max Replica

3.3.2.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-195 CPU/Memory Utilization by Policy Microservices

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ocpcf-appinfo-hpa-v2beta1	2%/80%	2%/80%	3%/80%	2%/80%
ocpcf-config-server-hpa-v2beta1	7%/80%	9%/80%	9%/80%	8%/80%
ocpcf-diam-connector-hpa-v2beta1	0%/40%	0%/40%	0%/40%	0%/40%
ocpcf-egress-gateway-v2beta1	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-ingress-gateway-v2beta1	1%/80%	0%/80%	1%/80%	0%/80%
ocpcf-nrf-client-nfdiscovery-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-nrf-client-nfmanagement-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-oc-binding-hpa	11%/60%	0%/60%	11%/60%	0%/60%
ocpcf-ocpm-audit-service-hpa-v2beta1	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-ocpm-policyds-hpa	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-pcf-pre-hpa	10%/80%	0%/80%	10%/80%	0%/80%
ocpcf-pcf-smservice-hpa	0%/50%	0%/50%	0%/50%	0%/50%
ocpcf-pcrf-core-hpa	25%/40%	0%/80%	24%/40%	0%/40%
ocpcf-query-service-hpa	0%/80%	0%/40%	0%/80%	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-196 CPU/Memory Utilization by CnDBTier services

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ndbappmysqld	73%/80%	23%/80%	89%/80%	23%/80%
ndbmgmd	0%/80%	0%/80%	0%/80%	0%/80%
ndbmtd	22530%/80%	7280%/80%	16%/80%	7%/80%
ndbmysqld	8%/80%	4%/80%	8%/80%	4%/80%

3.3.2.3 Results

Table 3-197 Average PCRF Core JDBC Latency Observations

Site 1	Site 2	Site 3	Site 4
2.62 ms	-	4.28 ms	-

3.4 Policy Call Model 4

3.4.1 Test Scenario: Policy Call Model on Four-Site Georedundant Setup, with 7.5K TPS Traffic on Each Site and ASM Disabled

This test run benchmarks the performance and capacity of Policy data call model that is deployed in converged mode on a four-site georedundant setup. Each of the sites handles a traffic of 7.5K TPS at Diameter Gateway. For this setup, Binding feature was enabled and Aspen Service Mesh (ASM) was disabled. This setup has single-channel replication.

3.4.1.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Diameter Gateway)	30KTPS (7.5KTPS on each site)
ASM	Disable
Traffic Ratio	CCRI (Single APN), CCRU (Single APN), CCRT (Single APN), AARU, RAR -rx, RAR-gx, STR.
Active Subscribers	10000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Table 3-198 Traffic distribution

Service Name	TPS
Ingress Service	NA
Egress Service	NA
Diameter Gateway	7.5K TPS
Diameter Connector	NA
SM service	NA

Table 3-198 (Cont.) Traffic distribution

Service Name	TPS
PDS Service	NA
PRE Service	NA
NRF Discovery	NA
UDR Connector	NA
CHF Connector	NA
Binding Service	NA
Bulwark Service	NA

Policy Configurations

Following Policy services were either enabled or disabled for running this call flow:

Table 3-199 Policy services configuration

Service Name	Status
Binding	Enabled
PER	Disabled
SAL	Enabled
LDAP	Disabled
OCS	Disabled
Audit	Enabled
Replication	Enabled
Bulkwark	Disabled
Alternate routing	Disabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-200 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	NA
N36 UDR subscription (N7/N15-Nudr)	NA
UDR on-demand nrf discovery	NA
CHF (SM-Nchf)	NA
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Sy (PCF N7-Sy)	NA
Diameter GW (PGW to PCRF)	Active

Following PCRF interfaces were either enabled or disabled for running this call flow:

Table 3-201 PCRF intefaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr)	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring PCF Helm Parameters

There were no optimization parameters configured for this run.

Configuring cnDbTier Helm Parameters

There were no optimization parameters configured for this run.

Policy Microservices Resources

Table 3-202 Policy microservices resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
Appinfo	1	1	0.5	1	1
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	1
Config Service	2	4	0.5	2	1
Egress Gateway	3	4	4	6	2
Ingress Gateway	3	4	4	6	2
Nrf Client Management	1	1	1	1	2
Diameter Gateway	3	4	1	2	9
Diameter Connector	3	4	1	2	5
Nrf Client Discovery	3	4	0.5	2	2
Query Service	1	2	1	1	1
PCRF Core Service	7	8	8	8	24
Performance	1	1	0.5	1	2
PRE Service	5	5	0.5	4	15
SM Service	7	8	1	4	2
PDS	5	6	1	4	5
Binding Service	5	6	1	8	18

Table 3-203 cnDBTier services resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Storage
ndbappmysqld	8	8	19	20	5	32Gi
ndbmgmd	2	2	9	11	2	16Gi
ndbmtd	8	8	73	83	8	76Gi
ndbmysqld	4	4	25	25	6	131Gi

Min Replica = Max Replica

3.4.1.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-204 CPU/Memory Utilization by Policy Microservices

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ocpcf-appinfo-hpa-v2beta1	1%/80%	2%/80%	2%/80%	1%/80%
ocpcf-config-server-hpa-v2beta1	8%/80%	9%/80%	8%/80%	7%/80%
ocpcf-diam-connector-hpa-v2beta1	0%/40%	0%/40%	0%/40%	0%/40%
ocpcf-egress-gateway-v2beta1	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-ingress-gateway-v2beta1	1%/80%	1%/80%	1%/80%	1%/80%
ocpcf-nrf-client-nfdiscovery-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-nrf-client-nfmanagement-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-oc-binding-hpa	6%/60%	6%/60%	6%/60%	6%/60%
ocpcf-ocpm-audit-service-hpa-v2beta1	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-ocpm-policyds-hpa	0%/60%	0%/60%	0%/60%	0%/60%

Table 3-204 (Cont.) CPU/Memory Utilization by Policy Microservices

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ocpcf-pcf-pre-hpa	6%/80%	6%/80%	6%/80%	6%/80%
ocpcf-pcf-smservice-hpa	0%/50%	0%/50%	0%/50%	0%/50%
ocpcf-pcrf-core-hpa	13%/40%	0%/80%	14%/40%	14%/40%
ocpcf-query-service-hpa	0%/80%	13%/40%	0%/80%	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-205 CPU/Memory Utilization by CnDBTier services

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ndbappmysqld	71%/80%	84%/80%	84%/80%	85%/80%
ndbmgmd	0%/80%	0%/80%	0%/80%	1%/80%
ndbmtd	14%/80%	11%/80%	16%/80%	15%/80%
ndbmysqld	12%/80%	12%/80%	13%/80%	12%/80%

3.4.1.3 Results

Table 3-206 Average PCRF Core JDBC Latency Observations

Site 1	Site 2	Site 3	Site 4
2.30 ms	2.20 ms	2.66 ms	2.85 ms

3.4.2 Test Scenario: Policy Call Model on Four-Site Georedundant Setup, with 15K TPS Traffic on Two Sites and No Traffic on Other Two Sites

This test run benchmarks the performance and capacity of Policy data call model that is deployed in converged mode on a four-site georedundant setup. Two of the sites (site1 and site3) handle a traffic of 15K TPS at Diameter Gateway and there is no traffic on the other two sites (site2 and site4). For this setup, Binding feature was enabled and Aspen Service Mesh (ASM) was disabled. This setup has single-channel replication.

3.4.2.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Diameter Gateway)	30KTPS (15 KTPS on two site)
ASM	Disable

Parameters	Values
Traffic Ratio	CCRI (Single APN), CCRU (Single APN), CCRT (Single APN), AARU, RAR -rx, RAR-gx, STR.
Active Subscribers	10000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Table 3-207 Traffic distribution

Service Name	TPS
Ingress Service	NA
Egress Service	NA
Diameter Gateway	15K TPS
Diameter Connector	NA
SM service	NA
PDS Service	NA
PRE Service	NA
NRF Discovery	NA
UDR Connector	NA
CHF Connector	NA
Binding Service	NA
Bulwark Service	NA

Policy Configurations

Following Policy services were either enabled or disabled for running this call flow:

Table 3-208 Policy microservices configuration

Service Name	Status
Binding	Enabled
PER	Disabled
SAL	Enabled

Table 3-208 (Cont.) Policy microservices configuration

Service Name	Status
LDAP	Disabled
OCS	Disabled
Audit	Enabled
Replication	Enabled
Bulkwark	Disabled
Alternate routing	Disabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-209 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	NA
N36 UDR subscription (N7/N15-Nudr)	NA
UDR on-demand nrf discovery	NA
CHF (SM-Nchf)	NA
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Sy (PCF N7-Sy)	NA
Diameter (PGW to PCRF)	Active

Following PCRF interfaces were either enabled or disabled for running this call flow:

Table 3-210 PCRF interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr)	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA
Diameter (PGW to PCRF)	Active

Configuring cnDbTier Helm Parameters

There were no optimization parameters configured for this run.

Configuring cnDbTier Helm Parameters

There were no optimization parameters configured for this run.

Policy Microservices Resources

Table 3-211 Policy microservices resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
Appinfo	1	1	0.5	1	1
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	1
Config Service	2	4	0.5	2	1
Egress Gateway	3	4	4	6	2
Ingress Gateway	3	4	4	6	2
Nrf Client Management	1	1	1	1	2
Diameter Gateway	3	4	1	2	9
Diameter Connector	3	4	1	2	5
Nrf Client Discovery	3	4	0.5	2	2
Query Service	1	2	1	1	1
PCRF Core Service	7	8	8	8	24
Performance	1	1	0.5	1	2
PRE Service	5	5	0.5	4	15
SM Service	7	8	1	4	2
PDS	5	6	1	4	5
Binding Service	5	6	1	8	18

Table 3-212 cnDBTier services resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Storage
ndbappmysqld	8	8	19	20	5	32Gi
ndbmgmd	2	2	9	11	2	16Gi
ndbmtd	8	8	73	83	8	76Gi
ndbmysqld	4	4	25	25	6	131Gi

Min Replica = Max Replica

3.4.2.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-213 CPU/Memory Utilization by Policy Microservices

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ocpcf-appinfo-hpa-v2	3%/80%	3%/80%	4%/80%	3%/80%
ocpcf-config-server-hpa-v2	8%/80%	8%/80%	7%/80%	7%/80%
ocpcf-diam-connector-hpa	0%/40%	0%/40%	0%/40%	0%/40%
ocpcf-egress-gateway-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-ingress-gateway-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-nrf-client-nfdiscovery-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-nrf-client-nfmanagement-v2	0%/80%	0%/80%	0%/80%	0%/80%
ocpcf-oc-binding-hpa	11%/60%	0%/60%	12%/60%	0%/60%
ocpcf-ocpm-audit-service-hpa-v2	4%/60%	4%/60%	3%/60%	4%/60%
ocpcf-ocpm-policyds-hpa	0%/60%	0%/60%	0%/60%	0%/60%
ocpcf-pcf-pre-hpa	37%/80%	0%/80%	37%/80%	0%/80%
ocpcf-pcrf-core-hpa	24%/40%	0%/40%	24%/40%	0%/40%
ocpcf-query-service-hpa	0%/80%	0%/80%	0%/80%	0%/80%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-214 CPU/Memory Utilization by CnDBTier services

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)	Site3 - CPU (X/Y)	Site4 - CPU (X/Y)
ndbappmysqld	91%/80%	87%/80%	92%/80%	88%/80%
ndbmgmd	0%/80%	0%/80%	0%/80%	0%/80%
ndbmtd	23%/80%	8%/80%	20%/80%	11%/80%
ndbmysqld	12%/80%	6%/80%	12%/80%	6%/80%

3.4.2.3 Results

Table 3-215 Average PCRF Core JDBC Latency Observations

Site 1	Site 2	Site 3	Site 4
2.66 ms	1.26 ms	4.14 ms	1.74 ms

3.4.3 Test Scenario: Policy Call Model on Two-Site Georedundant Setup, with 15K TPS Traffic on Two Sites

This test run benchmarks the performance and capacity of Policy data call model that is deployed in PCF mode on a two-site of a two-site non-ASM GR Setup. Replication is on single-channel and Binding and PRE Enabled. The Policy application handles a total Ingress and Egress traffic of 15K TPS on two sites.

3.4.3.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Diameter Gateway)	30KTPS (15K TPS on two site)
ASM	Disable
Traffic Ratio	CCRI-I, AARI –1, CCRU-2, AARU - 1, RAR-Gx-1, RAR-Rx-1, STR –1, CCRT-1
Active Subscribers	10000000

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model Data

Table 3-216 Traffic distribution

Service Name	TPS
Ingress Service	NA
Egress Service	NA
Diameter Gateway Ingress	8.33K TPS
Diameter Gateway Egress	6.31K TPS
Diameter Connector	NA
SM service	NA
PDS Service	NA
PRE Service	NA
NRF Discovery	NA
UDR Connector	NA
CHF Connector	NA
Binding Service	NA
Bulwark Service	NA

Policy Configurations

Following Policy services were either enabled or disabled for running this call flow:

Table 3-217 Policy microservices configuration

Service Name	Status
Binding	Enabled
PER	Enabled
SAL	Enabled
LDAP	Disabled
OCS	Disabled
Audit	Enabled
Replication	Enabled
Bulwark	Disabled
Alternate routing	Disabled

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-218 Policy interfaces

Feature Name	Status
N36 UDR query (N7/N15-Nudr)	NA
N36 UDR subscription (N7/N15-Nudr)	NA
UDR on-demand nrf discovery	NA
CHF (SM-Nchf)	NA
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	NA

Table 3-218 (Cont.) Policy interfaces

Feature Name	Status
LDAP (Gx-LDAP)	NA
Sy (PCF N7-Sy)	NA

Following PCRF interfaces were either enabled or disabled for running this call flow:

Table 3-219 PCRF interfaces

Feature Name	Status
Sy (PCRF Gx-Sy)	NA
Sd (Gx-Sd)	NA
Gx UDR query (Gx-Nudr)	NA
Gx UDR subscription (Gx-Nudr)	NA
CHF enabled (AM)	NA
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Configuring cnDbTier Helm Parameters

There were no optimization parameters configured for this run.

Configuring cnDbTier Helm Parameters

There were no optimization parameters configured for this run.

Policy Microservices Resources

Table 3-220 Policy microservices resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
Appinfo	1	1	0.5	1	1
Audit Service	1	2	1	1	1
CM Service	2	4	0.5	2	1
Config Service	2	4	0.5	2	1
Egress Gateway	3	4	4	6	2
Ingress Gateway	3	4	4	6	2
Nrf Client Management	1	1	1	1	2
Diameter Gateway	3	4	1	2	9
Diameter Connector	3	4	1	2	5
Nrf Client Discovery	3	4	0.5	2	2
Query Service	1	2	1	1	1

Table 3-220 (Cont.) Policy microservices resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas
PCRF Core Service	7	8	8	8	24
Performance	1	1	0.5	1	2
PRE Service	5	5	0.5	4	15
SM Service	7	8	1	4	2
PDS	5	6	1	4	5
Binding Service	5	6	1	8	18

Table 3-221 cnDBTier services resource allocation

Service Name	CPU Request Per Pod	CPU Limit Per Pod	Memory Request Per Pod (Gi)	Memory Limit Per Pod (Gi)	Replicas	Storage
ndbappmysqld	8	8	19	20	5	32Gi
ndbmgmd	2	2	9	11	2	16Gi
ndbmtd	8	8	73	83	8	76Gi
ndbmysqld	4	4	25	25	6	131Gi

Min Replica = Max Replica

3.4.3.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-222 CPU/Memory Utilization by Policy Microservices

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)
ocpcf-appinfo-hpa-v2	4%/80%	5%/80%
ocpcf-config-server-hpa-v2	8%/80%	8%/80%
ocpcf-diam-connector-hpa	0%/40%	0%/40%
ocpcf-egress-gateway-v2	0%/80%	0%/80%
ocpcf-ingress-gateway-v2	0%/80%	0%/80%
ocpcf-nrf-client-nfdiscovery-v2	0%/80%	0%/80%

Table 3-222 (Cont.) CPU/Memory Utilization by Policy Microservices

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)
ocpcf-nrf-client-nfmanagement-v2	0%/80%	0%/80%
ocpcf-oc-binding-hpa	8%/60%	8%/60%
Diam-Gw (from dashboard)	2.5%/80%	2.5%/80%
ocpcf-ocpm-audit-service-hpa-v2	4%/60%	4%/60%
ocpcf-ocpm-policyds-hpa	0%/60%	0%/60%
ocpcf-pcf-pre-hpa	40%/80%	42%/80%
ocpcf-pcrf-core-hpa	25%/40%	24%/40%
ocpcf-query-service-hpa	0%/80%	0%/40%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-223 CPU/Memory Utilization by CnDBTier services

Service Name	Site1 - CPU (X/Y)	Site2 - CPU (X/Y)
ndbappmysqld	85%/80%	92%/80%
ndbmgmd	0%/80%	0%/80%
ndbmtd	15%/80%	15%/80%
ndbmysqld	6%/80%	6%/80%

3.4.3.3 Results

Table 3-224 Average PCRF Core JDBC Latency Observations

Site 1	Site 2
2.07 ms	2.03 ms

3.4.4 PCF 15K TPS on two Non ASM Sites

3.4.4.1 Test Case and Setup Details

Policy Infrastructure Details

Infrastructure used for benchmarking Policy performance run is described in this section.

Table 3-225 Hardware Details

Hardware	Details
Environment	Hypervisor
Server	ORACLE SERVER X8-2
Model	Intel(R) Xeon(R) Platinum 8260 CPU
Clock Speed	2.400 GHz

Table 3-225 (Cont.) Hardware Details

Hardware	Details
Total Cores	96
Memory Size	576 GB
Type	DDR4 SDRAM
Installed DIMMs	18
Maximum DIMMs	24
Installed Memory	576 GB

Table 3-226 Software Details

Aplications	Version
Policy	25.1.200
cnDBTier	25.1.200
OSO	NA
CNE	24.2.0

For more information about Policy Installation, see *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*.

Testcase Parameters

The following table describes the testcase parameters and their values:

Table 3-227 Testcase Parameters

Parameters	Values
Call Rate (Ingress + Egress)	(15 ktps each sites) with 2 non ASM sites
ASM	Disabled
Traffic Ratio	15ktps on two sites
Deployment Model	Site1/2 PCRF deployed in same cluster thrust1

Policy Project Details:

This test case shall pump traffic Call Rate: 15K TPS on two sites Non ASM PCF with duration=128.0 hours.

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low– No Usage of Loops in Blockly logic, No JSON operations, No complex Java Script code in Object Expression /Statement Expression.
- Medium - Usage of Loops in Blockly logic, Policy Table Wildcard match <= 3 fields, MatchList < 3, 3 < RegEx match < 6
- High - JSON Operations – Custom, complex Java Script code in Object Expression / Statement Expression, Policy Table Wildcard match > 3 fields, MatchLists >= 3, RegEx mat >= 6

Table 3-228 Model Data

Traffic (TPS)	Site1	Site2
Pcrf-Total-Tps	15107.29	15119.52

Policy Configurations:

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-229 Policy Configurations

Service Name	Status
Bulwark service	Disabled
Binding service	Enabled
Alternate Route service	Disabled
Audit service	Enabled
PER	Enabled
SAL	Disabled
LDAP	Disabled
OCS	Disabled
Replication	Enabled

Configuring Policy Helm Parameters

There are no optimization parameters configured for this run:

Configuring cnDbTier Helm Parameters

There are no optimization parameters configured for this run:

Resource Footprint (per site):

Table 3-230 Policy microservices resource allocation Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
Appinfo	1	1	1	1Gi	512Mi
Binding Service	18	6	5	8Gi	1Gi
Diameter Connector	1	4	3	2Gi	1Gi
Config-server	2	4	2	2Gi	512Mi
Egress Gateway	1	4	3	6Gi	4Gi
Ingress Gateway	1	4	3	6Gi	4Gi
NRF Client NF Discovery	1	4	3	2Gi	512Mi
NRF Client Management	1	1	1	1Gi	1Gi
Audit Service	1	2	1	1Gi	1Gi

Table 3-230 (Cont.) Policy microservices resource allocation Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
CM Service	2	4	2	2Gi	512Mi
PRE Service	24	8	8	4Gi	4Gi
Query Service	1	2	1	1Gi	1Gi
PCRF Core	24	8	7	8Gi	8Gi
Perfinfo	2	1	1	1Gi	512Mi
Diameter Gateway	9	4	3	2Gi	1Gi

Table 3-231 Policy microservices resource allocation Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
Appinfo	1	1	1	1Gi	512Mi
Binding Service	18	6	5	8Gi	1Gi
Diameter Connector	1	4	3	2Gi	1Gi
Config-server	2	4	2	2Gi	512Mi
Egress Gateway	1	4	3	6Gi	4Gi
Ingress Gateway	1	4	3	6Gi	4Gi
NRF Client NF Discovery	1	4	3	2Gi	512Mi
NRF Client Management	1	1	1	1Gi	1Gi
Audit Service	1	2	1	1Gi	1Gi
CM Service	2	4	2	2Gi	512Mi
PRE Service	24	3	3	4Gi	4Gi
Query Service	1	2	1	1Gi	1Gi
PCRF Core	24	8	7	8Gi	8Gi
Perf-info	2	1	1	1Gi	512Mi
Diameter Gateway	9	4	3	2Gi	1Gi

Table 3-232 CnDBTier Resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
Site1-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	1	1	1Gi	1Gi
Site1-mysql-cluster-db-monitor-svc/db-monitor-svc	1	4	4	4Gi	4Gi
Site1-mysql-cluster-site1-site2-replication-svc/site1-site2-replication-svc	1	2	2	12Gi	12Gi
Site1-mysql-cluster-site1-site2-replication-svc/db-infra-monitor-svc	1	100m	100m	256Mi	256Mi
Site1-ndbappmysqld/mysqlndbcluster	5	8	8	20Gi	19Gi
Site1-ndbappmysqld/db-infra-monitor-svc	5	NA	NA	NA	19Gi
Site1-ndbappmysqld/init-sidecar	5	100m	100m	256Mi	256Mi
Site1-ndbmgmd/mysqlndbcluster	2	4	4	11520Mi	9Gi
Site1-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site1-ndbmtd/mysqlndbcluster	8	10	10	83Gi	73Gi
Site1-ndbmtd/db-backup-executor-svc	8	1	1	2Gi	2Gi

Table 3-232 (Cont.) CnDBTier Resource allocation at Site1:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
Site1-ndbmtd/db-infra-monitor-svc	8	100m	100m	256Mi	256Mi
Site1-ndbmysqld/mysqlndbcluster	2	10	10	25Gi	25Gi
Site1-ndbmysqld/init-sidecar	2	100m	100m	256Mi	256Mi
Site1-ndbmysqld/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi

Table 3-233 CnDBTier Resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
Site2-mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	1	1	1	1Gi	1Gi
Site2-mysql-cluster-db-monitor-svc/db-monitor-svc	1	4	4	4Gi	4Gi
Site2-mysql-cluster-site2-site1-replication-svc/site2-site1-replication-svc	1	2	2	12Gi	12Gi
Site2-mysql-cluster-site2-site1-replication-svc/db-infra-monitor-svc	1	100m	100m	256Mi	256Mi
Site2-ndbappmysqld/mysqlndbcluster	5	8	8	20Gi	19Gi

Table 3-233 (Cont.) CnDBTier Resource allocation at Site2:

Service Name	Replicas	CPU Limit per Container (#)	CPU Request per Container (#)	Memory Limit per Container	Memory Resources per Container
Site2-ndbappmysqld/db-infra-monitor-svc	5	NA	NA	NA	19Gi
Site2-ndbappmysqld/init-sidecar	5	100m	100m	256Mi	256Mi
Site2-ndbmgmd/mysqlndbcluster	2	4	4	11520Mi	9Gi
Site2-ndbmgmd/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi
Site2-ndbmtd/mysqlndbcluster	8	10	10	83Gi	73Gi
Site2-ndbmtd/db-backup-executor-svc	8	1	1	2Gi	2Gi
Site2-ndbmtd/db-infra-monitor-svc	8	100m	100m	256Mi	256Mi
Site2-ndbmysqld/mysqlndbcluster	2	10	10	25Gi	25Gi
Site2-ndbmysqld/init-sidecar	2	100m	100m	256Mi	256Mi
Site2-ndbmysqld/db-infra-monitor-svc	2	100m	100m	256Mi	256Mi

3.4.4.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the Pod).

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-234 Policy microservices and their Resource Utilization

Application/ Contrainer	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
Appinfo	2.90%	25.49%	2.80%	25.98%
Binding Service	7.78%	35.65%	7.54%	35.46%
Diameter Connector	0.12%	20.80%	0.10%	22.07%
Config-server	4.04%	46.58%	5.17%	48.58%
Egress Gateway	0.10%	13.20%	0.10%	11.10%
Ingress Gateway	0.47%	16.46%	0.53%	16.28%
NRF Client NF Discovery	0.10%	47.90%	0.10%	33.98%
NRF Client Management	0.30%	47.85%	0.30%	43.75%
Audit Service	0.20%	39.94%	0.15%	40.14%
Cm-service	0.29%	38.55%	0.34%	34.38%
PRE Service	10.89%	56.65%	34.16%	60.69%
Query Service	0.05%	30.57%	0.05%	30.57%
PCRF Core	30.45%	50.98%	29.86%	50.79%
Perf-info	6.95%	13.48%	6.05%	13.72%
Diameter Gateway	18.46%	49.63%	17.61%	48.55%

The following table provides information about observed values of cnDBTier services.

Table 3-235 Observed CPU utilization values of cnDBTier services

Application/ Contrainer	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
mysql-cluster-db-backup-manager-svc/db-backup-manager-svc	0.60%	9.38%	2.00%	9.38%
mysql-cluster-db-monitor-svc/db-monitor-svc	0.18%	12.89%	0.73%	12.48%
mysql-cluster-site1-site2-replication-svc/site1-site2-replication-svc	0.40%	2.22%	None	None
mysql-cluster-site1-site2-replication-svc/db-infra-monitor-svc	2.00%	20.31%	None	None
ndbappmysqld/ mysqlndbcluster	50.11%	30.29%	52.91%	28.18%
ndbappmysqld/db-infra-monitor-svc	['NA']	['NA']	['NA']	['NA']

Table 3-235 (Cont.) Observed CPU utilization values of cnDBTier services

Application/ Contrainer	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
ndbappmysqld/init-sidecar	3.00%	0.39%	3.20%	0.39%
ndbmgmd/ mysqlndbcluster	0.27%	17.99%	0.24%	18.02%
ndbmgmd/db-infra-monitor-svc	1.50%	21.29%	1.50%	21.09%
ndbmtd/ mysqlndbcluster	18.70%	93.10%	19.21%	93.08%
ndbmtd/db-backup-executor-svc	0.10%	2.73%	0.10%	2.73%
ndbmtd/db-infra-monitor-svc	8.25%	21.78%	6.50%	21.58%
ndbmysqld/ mysqlndbcluster	6.02%	18.46%	5.66%	20.31%
ndbmysqld/init-sidecar	3.00%	0.78%	3.00%	0.78%
ndbmysqld/db-infra-monitor-svc	3.50%	30.08%	3.50%	28.32%
mysql-cluster-site2-site1-replication-svc/site2-site1-replication-svc	None	None	0.40%	2.58%
mysql-cluster-site2-site1-replication-svc/db-infra-monitor-svc	None	None	2.00%	19.53%

3.4.4.3 Results

The following table provides observation data for the performance test that can be used for benchmark testing:

Table 3-236 Latency observations for the call flows

NF Service	Latency at Site1 (Milliseconds)	Latency at Site2 (Milliseconds)
PCRF_Policyds	0.00	0.00
PCRF_Binding	16.2	18.7
PCRF_Diam_connector	0.00	0.00
PCRF_Core_JDBC_Latency	3.71	4.42

Table 3-237 Latency observations in percentile for Diameter call flow

50th Percentile (at Site1)	99th Percentile (at Site1)	50th Percentile (at Site2)	99th Percentile (at Site2)
0.00	0.04	0.00	0.08

Table 3-238 Latency obervations for cnDBTier services

Site-Slave Node	cnDBTier Replication Slave Delay (seconds)
Site1-ndbmysqld	0-1
Site2-ndbmysqld	0-1

3.5 PCF Call Model 5

3.5.1 Test Scenario: PCF Call Model on Single-Site Setup, Handling 30K TPS Traffic with Binding Feature Enabled

This test was run to benchmark the performance and capacity of PCF call model with 30K traffic on a single site. For this setup, Aspen Service Mesh (ASM) was disabled, Binding feature was enabled. User Connecttor microservice restart with a duration of 4.0 hours.

3.5.1.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Ingress + Egress)	30K TPS on a single site Non ASM PCF Setup
ASM	Disable
Traffic Ratio	IGW-11,EGW-26,Diam-in 9,Diam-Out 3IGW-11 ,EGW-26,Diam-in=9,Diam-out - 3
Deployment Model	PCF 1 at Site1

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model

Table 3-239 Traffic distribution

Traffic	TPS
Ingress Gateway	6637
Egress Gateway	15988
Diam In	5279
Diam out	1844
Total	29747

Table 3-240 Traffic distribution to Policy databases

Number of Entries	TPS
occnp_pcf_sm.AppSession	132704
occnp_pcf_sm.SmPolicyAssociation	434302
occnp_pcf_sm.SmPolicyAssociation$EX	0
occnp_policyds.pdssubscriber	434475
occnp_policyds.pdssubscriber$EX	0
occnp_policyds.pdsprofile	324110
occnp_policyds.pdsprofile$EX	0
occnp_binding.contextbinding	434668
ooccnp_binding.contextbinding$EX	0
occnp_binding.dependentcontextbinding	77294
occnp_binding.dependentcontextbinding$EX	0

Table 3-241 Traffic distribution at Policy services

Policy Service	Avg TPS/MPS
Ingress Gateway(MPS)	12075.40103
Egress Gateway(MPS)	28537.36981
SM Service(MPS)	44669.88753
AM Service(MPS)	0.00000
UE Service(MPS)	0.00000
PDS(MPS)	12643.96131
Pre Service(MPS)	0.00000
Nrf Discovery(MPS)	0.00000
CHF Connector(MPS)	6591.08083
UDR Connector(MPS)	0.00000
Binding(MPS)	12064.61603

Policy Configurations

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-242 Policy configurations

Name	Status
Bulwark	Disabled
Binding	Enabled
Subscriber State Variable (SSV)	Disabled
Validate_user	Enabled
Alternate Route	Enabled
Audit	Enabled
Compression (Binding & SM Service)	Disabled
SYSTEM.COLLISION.DETECTION	Disabled

Policy Interfaces

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-243 Policy interfaces

Feature Name	Status
Subscriber Tracing[For 100 subscriber]	Enabled
N36 UDR subscription (N7/N15-Nudr)	Enabled
UDR on-demand nrf discovery	NA
CHF (SM-Nchf)	Enabled
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Binding Feature	Enabled

Policy Microservices Resources

Table 3-244 Policy microservices Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
Appinfo	2	1	1	0.5	1
Binding Service	2	6	6	1	8
Diameter Connector	4	4	4	1	2
Diameter Gateway	2	4	4	1	2
Audit Service	1	1	2	1	1
CM Service	1	4	4	0.5	2
Config Service	1	4	4	0.5	2
Egress Gateway	8	4	4	4	6
Ingress Gateway	8	4	4	4	6

Table 3-244 (Cont.) Policy microservices Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
NRF Client NF Discovery	1	4	4	0.5	2
NRF Client Management	1	1	1	1	1
Query Service	1	1	2	1	1
PRE	13	4	4	0.5	2
SM Service	9	8	8	1	4
PDS	8	6	6	1	4
UDR Connector	2	6	6	1	4
CHF Connector/ User Service	2	1	4	6	6

cnDBTier Microservices Resources

Table 3-245 CnDBTier Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
ndbappmysqld	4	12	12	24	24
ndbmgmd	2	4	4	10	10
ndbmtd	8	8	8	42	42
db-infra-monitor-svc	1	200	200	500	500
db-backup-manager-svc	1	100	100	128	128

3.5.1.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-246 CPU/Memory Utilization by Policy Microservices

App/ Container	CPU	Memory
AppInfo	3.80%	24.71%
Binding Service	24.36%	23.96%
Diameter Connector	29.76%	49.39%
CHF Connector	33.37%	39.40%
Config Service	3.14%	42.07%
Egress Gateway	46.77%	28.76%
Ingress Gateway	53.61%	55.54%
NRF Client NF Discovery	0.07%	31.45%
NRF Client NF Management	0.30%	46.00%
UDR Connector	19.05%	22.53%
Audit Service	0.15%	46.29%
CM Service	0.47%	34.08%
PDS	39.39%	45.96%
PRE Service	19.81%	85.36%
Query Service	0.05%	25.83%
AM Service	0.05%	13.18%
SM Service	57.00%	89.29%
UE Service	0.40%	34.96%
Performance	1.00%	13.18%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-247 CPU/Memory Utilization by CnDBTier services

Service	CPU	Memory
ndbappmysqld/mysqlndbcluster	60.41%	38.09%
ndbappmysqld/init-sidecar	2.00%	0.39%
ndbmgmd/mysqlndbcluster	0.18%	20.12%
ndbmgmd/db-infra-monitor-svc	2.00%	9.38%
ndbmtd/mysqlndbcluster	36.65%	82.12%
ndbmtd/db-backup-executor-svc	0.10%	2.31%
ndbmtd/db-infra-monitor-svc	2.37%	9.08%
ocpcf-oc-diam-gateway/diam-gateway	18.56%	35.06%

3.5.1.3 Results

Table 3-248 Average latency observations

Scenario	Average Latency (ms)	Peak Latency (ms)
create-dnn_ims	28.631	28.733
N7-dnn_internet_1st	1527.421	2239.414

Table 3-248 (Cont.) Average latency observations

Scenario	Average Latency (ms)	Peak Latency (ms)
N7-dnn_internet_2nd	1518.459	1990.823
N7-dnn_internet_3rd	1567.876	1967.632
delete-dnn_ims	14.595	14.666
Overall	931.397	2239.414

Table 3-249 Average NF service latency

NF Service Latency (In Seconds)	Avg
PCF_IGW_Latency	0.01588
PCF_POLICYPDS_Latency	0.01112
PCF_UDRCONNECTOR_Latency	0.00237
PCF_NRFCLIENT_Latency	0.00000
PCF_EGRESS_Latency	0.00060

3.5.2 Test Scenario: PCF Call Model on Single-Site Setup, Handling 30K TPS Traffic with Binding Feature Disabled

This test was run to benchmark the performance and capacity of PCF call model with 30K traffic on a single site. For this setup, Aspen Service Mesh (ASM) was disabled, Binding feature was disabled.

3.5.2.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Ingress + Egress)	30K TPS on a single site Non ASM PCF Setup
ASM	Disable
Traffic Ratio	IGW-11,EGW-26,Diam-in 9,Diam-Out 3IGW-11 ,EGW-26,Diam-in=9,Diam-out - 3
Deployment Model	PCF 1 at Site1

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6

- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model

Table 3-250 Traffic distribution

Traffic	TPS
Ingress Gateway	6637
Egress Gateway	15988
Diam In	5279
Diam out	1844
Total	29747

Table 3-251 Traffic distribution to Policy databases

Number of Entries	TPS
occnp_pcf_sm.AppSession	132704
occnp_pcf_sm.SmPolicyAssociation	434302
occnp_pcf_sm.SmPolicyAssociation$EX	0
occnp_policyds.pdssubscriber	434475
occnp_policyds.pdssubscriber$EX	0
occnp_policyds.pdsprofile	324110
occnp_policyds.pdsprofile$EX	0
occnp_binding.contextbinding	434668
ooccnp_binding.contextbinding$EX	0
occnp_binding.dependentcontextbinding	77294
occnp_binding.dependentcontextbinding$EX	0

Table 3-252 Traffic distribution at Policy services

Policy Service	Avg TPS/MPS
Ingress Gateway(MPS)	13294.09
Egress Gateway(MPS)	30644.41
SM Service(MPS)	46777.97
AM Service(MPS)	0.00
UE Service(MPS)	0.00
PDS(MPS)	13115.32
CHF Connector(MPS)	6452.53
UDR Connector(MPS)	3638.04
Binding(MPS)	0.00

Policy Configurations

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-253 Policy configurations

Name	Status
Bulwark	Disabled
Binding	Disabled
Subscriber State Variable (SSV)	Enabled
Validate_user	Enabled
Alternate Route	Enabled
Audit	Enabled
Compression (Binding & SM Service)	Disabled
SYSTEM.COLLISION.DETECTION	Disabled

Policy Interfaces

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-254 Policy interfaces

Feature Name	Status
Subscriber Tracing[For 100 subscriber]	Enabled
N36 UDR subscription (N7/N15-Nudr)	Enabled
UDR on-demand nrf discovery	NA
CHF (SM-Nchf)	Enabled
BSF (N7-Nbsf)	NA
AMF on demand nrf discovery	NA
LDAP (Gx-LDAP)	NA
Binding Feature	Disabled

Policy Microservices Resources

Table 3-255 Policy microservices Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
Appinfo	2	1	1	0.5	1
Binding Service	2	6	6	8	8
Diameter Connector	4	4	4	1	2
Diameter Gateway	4	4	4	1	2
Audit Service	1	2	2	4	4
CM Service	1	4	4	0.5	2
Config Service	1	4	4	0.5	2
Egress Gateway	8	4	4	6	6
Ingress Gateway	8	4	4	6	6

Table 3-255 (Cont.) Policy microservices Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
NRF Client NF Discovery	1	4	4	0.5	2
NRF Client Management	1	1	1	1	1
Query Service	1	2	2	1	1
PRE	13	4	4	4	4
SM Service	9	8	8	6	6
PDS	8	6	6	6	6
UDR Connector	2	6	6	4	4
CHF Connector/ User Service	2	6	6	4	4

cnDBTier Microservices Resources

Table 3-256 CnDBTier Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
ndbappmysqld	4	12	12	28	28
ndbmgmd	2	4	4	9	12
ndbmtd	8	8	8	42	42
db-infra-monitor-svc	1	200	200	500	500
db-backup-manager-svc	1	100	100	128	128

3.5.2.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-257 CPU/Memory Utilization by Policy Microservices

App/ Container	CPU	Memory
AppInfo	4.00%	25.40%
Diameter Connector	39.80%	75.70%
CHF Connector	57.30%	58.90%
Config Service	2.78%	3.60%
Egress Gateway	47.50%	26.90%
Ingress Gateway	53.60%	42.42%
NRF Client NF Discovery	0.102%	33.59%
NRF Client NF Management	0.214%	41.6%
UDR Connector	25.50%	71.90%
Audit Service	0.669%	46.3%
CM Service	0.38%	34.16%
PDS	48.67%	64.20%
PRE Service	15.9%	49.6%
Query Service	0.0357%	25.12%
AM Service	0.02%	14.96%
SM Service	64.60%	76.23%
UE Service	0.387%	34.57%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-258 CPU/Memory Utilization by CnDBTier services

Service	CPU	Memory
ndbappmysqld/mysqlndbcluster	51.50%	44.70%
ndbmgmd/db-infra-monitor-svc	10.30%	16.90%
ndbmtd/mysqlndbcluster	35.1%	72.60%
ndbmtd/db-backup-executor-svc	35.1%	2.32%
ndbmtd/db-infra-monitor-svc	35.1%	13.60%

3.5.2.3 Results

Table 3-259 Average latency observations

Scenario	Average Latency (ms)	Peak Latency (ms)
create-dnn_ims	54.142	66.775
N7-dnn_internet_1st	20.316	22.226
N7-dnn_internet_2nd	23.517	26.133
N7-dnn_internet_3rd	20.071	21.323
delete-dnn_ims	29.722	47.689
Overall	29.554	66.775

Table 3-260 Average NF service latency

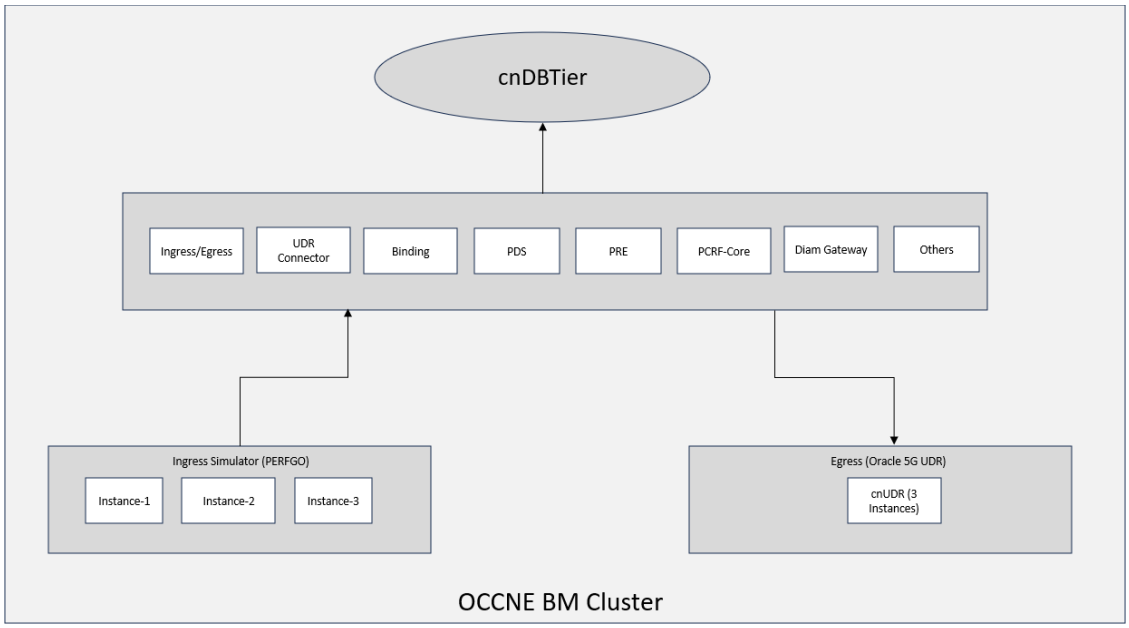
NF Service Latency (In Seconds)	Avg
PCF_IGW_Latency	17.45
PCF_POLICYPDS_Latency	16.85
PCF_UDRCONNECTOR_Latency	2.19
PCF_NRFCLIENT_Latency	0.00
PCF_EGRESS_Latency	0.51

3.6 PCF Call Model 6

3.6.1 Test Scenario: 10K TPS Diameter Ingress Gateway and 17K TPS Egress Gateway TPS Traffic with Usage Monitoring Enabled

This test was run to benchmark the performance and capacity of PCF call model with 10K TPS Diameter Ingress Gateway and 17K TPS Diameter Egress Gateway TPS Traffic with Usage Monitoring Enabled.

Figure 3-2 Policy Deployment in a single site Setup:



3.6.1.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Ingress + Egress)	27K TPS on a single site Non ASM PCF Setup
ASM	Disable
Traffic Ratio	PCF 10K Diameter Ingress Gateway TPS and 17K Egress Gateway TPS
Deployment Model	PCF as a standalone

Project Details

The Policy Design editor based on the Blockly interface was used to set the Policy project for each of the Policy services. The complexity level of Policy Project configured for this run was **High.**

Complexity Level Definition:

- Low – No usage of loops in Blockly logic, no JSON operations, and no complex Java Script code in object expression/statement expression.
- Medium – Usage of loops in Blockly logic, Policy table wildcard match <= 3 fields, MatchList < 3, and 3 < RegEx match < 6
- High – JSON Operations – Custom, complex Java script code in object Expression/ statement expression, Policy table wildcard match > 3 fields, MatchLists >= 3, and RegEx mat >= 6

Call Model

Table 3-261 Traffic distribution

Traffic	TPS
Ingress Gateway	1000
Egress Gateway	17000
Diam In	10000
Diam out	0
Total	29747

Table 3-262 Traffic distribution to Policy databases

Number of Entries	TPS
occnp_policyds.pdssubscriber	3084338
occnp_policyds.pdssubscriber$EX	0
occnp_policyds.pdsprofile	2278801
occnp_policyds.pdsprofile$EX	0
occnp_binding.contextbinding	82382
ooccnp_binding.contextbinding$EX	0
occnp_binding.dependentcontextbinding	0
occnp_binding.dependentcontextbinding$EX	0
occnp_pcrf_core.gxsession	82351
occnp_pcrf_core.gxsession$EX	0
occnp_usagemon.UmContext	737281

Table 3-262 (Cont.) Traffic distribution to Policy databases

Number of Entries	TPS
occnp_usagemon.UmContext$EX	0

Policy Configurations

Following PCF configurations were either enabled or disabled for running this call flow:

Table 3-263 Policy configurations

Name	Status
Binding	Disabled
Validate_user	Enabled
Usage Monitoring	Enabled
PRE	Enabled

Policy Interfaces

Following Policy interfaces were either enabled or disabled for running this call flow:

Table 3-264 Policy interfaces

Feature Name	Status
N36 UDR subscription (N7/N15-Nudr)	Enabled
UDR on-demand nrf discovery	Disabled
LDAP (Gx-LDAP)	NA
Binding Feature	Disabled

Policy Microservices Resources

Table 3-265 Policy microservices Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
Appinfo	2	1	1	1	1
Binding Service	10	1	1	1	1
Diameter Connector	4	4	4	2	2
Diameter Gateway	2	4	4	2	2
Config Service	1	4	4	2	2
Egress Gateway	8	4	4	6	6
LDAP Gateway	0	3	4	1	2
Ingress Gateway	8	1	1	1	1

Table 3-265 (Cont.) Policy microservices Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
NRF Client NF Discovery	1	1	1	1	1
NRF Client Management	1	1	1	1	1
Audit Service	1	2	2	4	4
CM Service	1	4	4	0.5	2
PDS	8	6	6	6	6
PRE	13	4	4	4	4
Query Service	1	2	2	1	1
SM Service	9	8	8	6	6
PCRF-Core	10	8	8	8	8
Usage Monitoring	16	8	8	4	4
Performance	2	1	1	0.5	1
UDR Connector	10	6	6	4	4

cnDBTier Microservices Resources

Table 3-266 CnDBTier Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
ndbappmysqld	6	12	12	20	20
ndbmgmd	2	4	4	8	10
ndbmtd	6	12	12	75	75
ndbmysqld	2	4	4	16	16
db-infra-monitor-svc	1	4	4	4	4
db-backup-manager-svc	1	0.1	0.1	0.128	0.128

3.6.1.2 CPU Utilization

This section lists the CPU utilization for Policy and cnDBTier microservices. The CPU utilization is the ratio between the (total CPU utilization against total CPU request (X)) versus (target CPU Utilization (Y) configured for the pod).

Policy Microservices Resource Utilization

The following table describes the bench mark number as per the system maximum capacity utilization for Policy microservices.

The average CPU utilization is the ratio between the current usage of resource to the requested resources of the pod i.e., total sum of CPU utilized for service pods / total CPU requested for service pods.

Table 3-267 CPU/Memory Utilization by Policy Microservices

App/ Container	CPU	Memory
AppInfo	3.00%	25.00%
Diameter Connector	1.00%	12.00%
Diameter Gateway	18.60%	18.00%
Config Service	5.00%	19.00%
Egress Gateway	7.00%	18.00%
Ingress Gateway	0.00%	10.00%
NRF Client NF Discovery	0.00%	33.59%
NRF Client NF Management	0.00%	45.00%
UDR Connector	5.00%	24.00%
Audit Service	0.00%	28.70%
CM Service	3.50%	38.00%
PDS	6.00%	28.00%
PRE Service	8.00%	48.00%
Query Service	0.00%	23.00%
SM Service	0.00%	14.00%
Usage Monitoring	5.00%	67.00%

Observed CPU utilization Values of cnDBTier Services

The following table provides information about observed values of cnDBTier services.

Table 3-268 CPU/Memory Utilization by CnDBTier services

Service	CPU	Memory
ndbappmysqld/mysqlndbcluster	51.50%	44.70%
ndbmgmd/db-infra-monitor-svc	10.30%	16.90%
ndbmtd/mysqlndbcluster	35.1%	72.60%
ndbmtd/db-backup-executor-svc	35.1%	2.32%
ndbmtd/db-infra-monitor-svc	35.1%	13.60%

3.6.1.3 Results

Table 3-269 Average latency observations

Scenario	Average Latency (ms)	Peak Latency (ms)
Gx-init	130	260
Gx-Update_1st	103	207
Gx-Update_2nd	104	209
Gx-Update_3rd	104	208
Gx-Terminate	86	172
Overall	105	211

Table 3-270 Average NF service latency

NF Service Latency(In Seconds)	Avg (ms)
Ingress Gateway	31.8
PDS	83.8
UDR	22.4
Binding	51.8
Egress Gateway	20.4
Usage-Mon	94.4
PCRF-Core	3.84
Diameter Gateway	124
PRE	123