Oracle® Communications

Cloud Native Core, Converged Policy Benchmarking Guide

Release 24.2.4

G13628-03

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Contents

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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 24.2.x in *Oracle Communications Cloud Native Core, Converged Policy Benchmarking Guide*.

Release 24.2.4 - G13628-03, March 2025

Updated the PCF Call Model 2 chapter with optimization parameters for configuring cnDBTier Helm.

Added Test Scenario: PCF SM Call Model on Two-Site GeoRedundant setup, with 41K TPS Traffic on Site-1 and ASM Enabled test scenario for SM.

Release 24.2.1 - G13628-02, November 2024

Updated the deployment details used for benchmarking Converged Policy 24.2.1 performance and capacity of Policy data Deployed Components section.

Updated the Test Scenario: PCF AM/UE Call Model on Two-Site Georedundant Setup, with Each Site Handling 30K TPS Traffic and ASM Enabled section with optimization parameters for Ingress and Egress gateway.

Added the following and test scenarios:

- Test Scenario: PCF SM Call Model on Two-Site GeoRedundant setup, with each site handling 43K TPS traffic and ASM Enabled
- Test Scenario: PCF AM/UE Call Model on Two-Site Georedundant Setup, with Single-Site Handling 75K TPS Traffic and ASM Enabled

Release 24.2.0 - G13628-01, August 2024

Updated the deployment details used for benchmarking Converged Policy 24.2.0 performance and capacity of Policy data Deployed Components section.

Added the following and test scenarios:

- Test Scenario: Policy Call Model on Two-Site Georedundant Setup, with 15K TPS Traffic on Two Sites
- Test Scenario: PCF Call Model on Single-Site Setup, Handling 30K TPS Traffic with Binding Feature Disabled
- Test Scenario: 10K TPS Diameter Ingress Gateway and 17K TPS Egress Gateway TPS Traffic with Usage Monitoring Enabled

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) 23.3.3 and BareMetal can be used for performing benchmark tests.

Table 2-1   Observability Services

Service Name	Version
OpenSearch	2.11.0
Fluentd	1.16.2
Prometheus	2.51.1
Grafana	9.5.3
Jaeger	1.52.0

Cloud Native Orchestrator

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

cnDBTier

cnDBTier 24.2.4 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	24.2.4
cnDBTier	24.2.4
OSO	No
CNE	23.3.3

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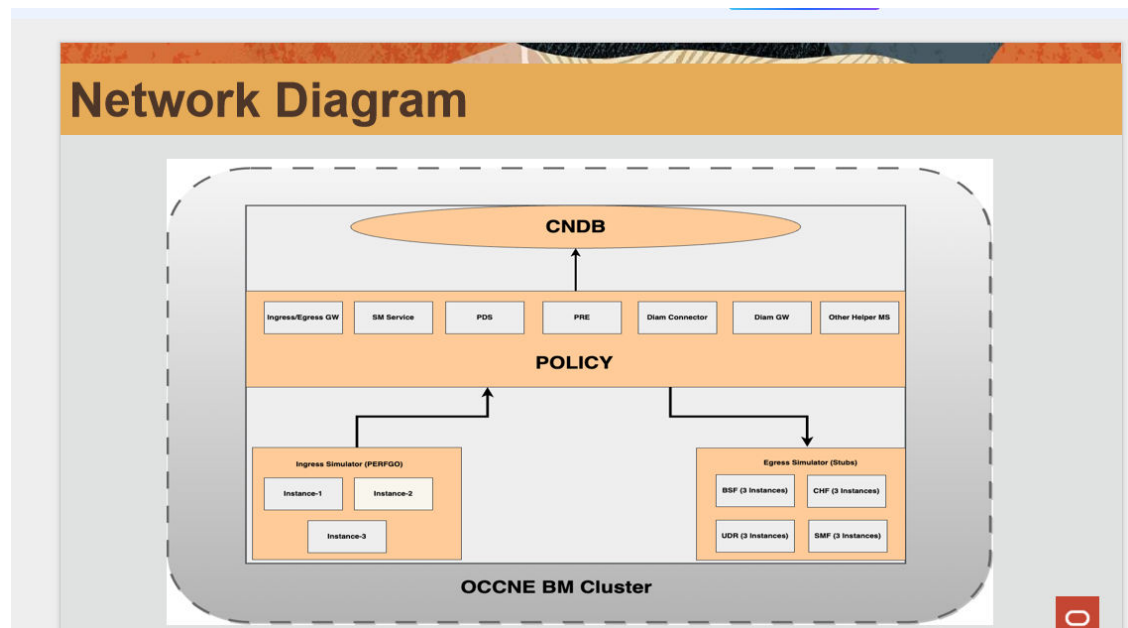
Figure 2-2   Policy Deployment in Two-Site GR Setup
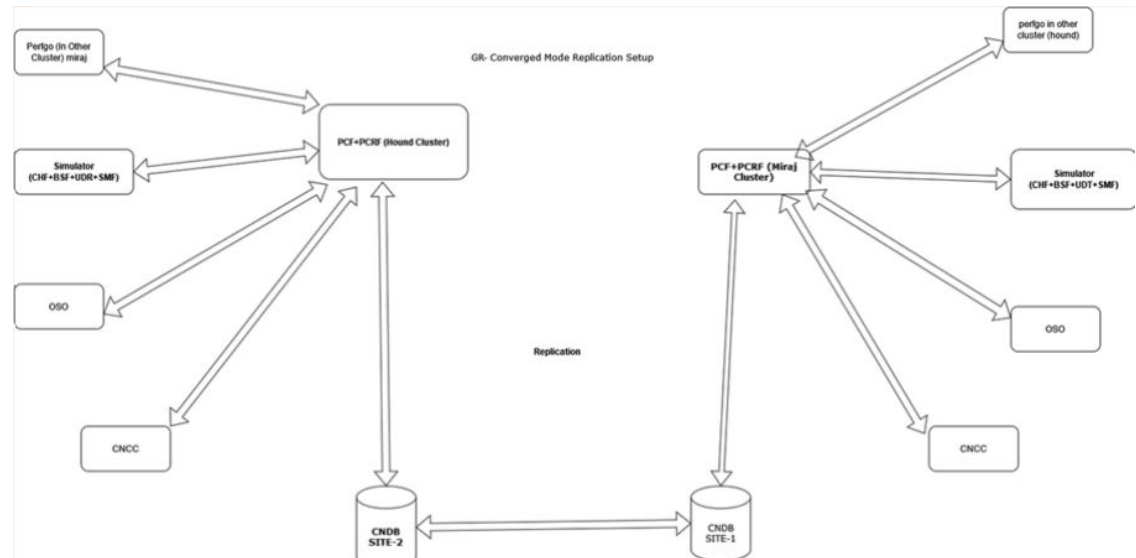
Figure 2-3   Policy Deployment in Four-Site GR Setup
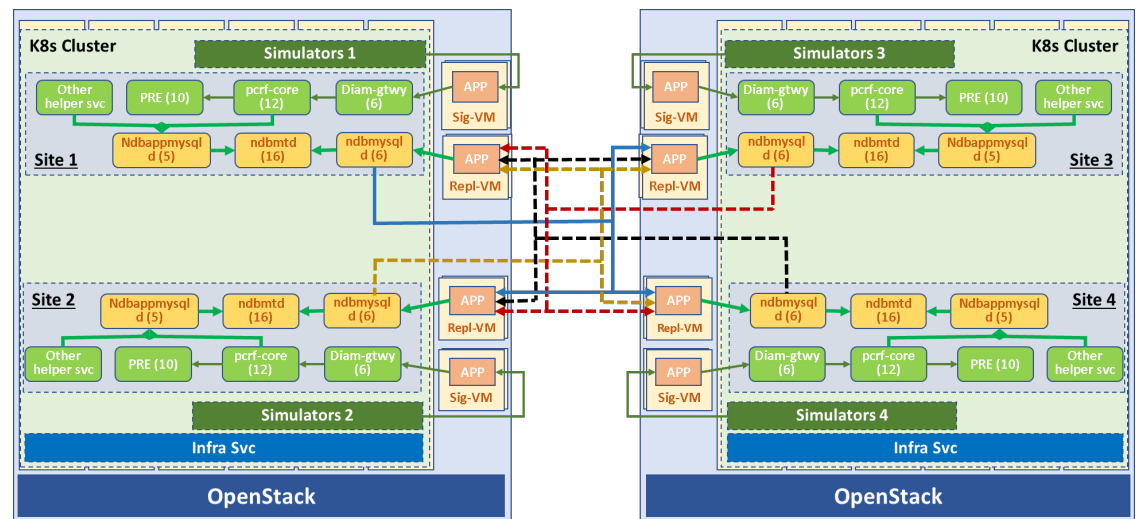
3

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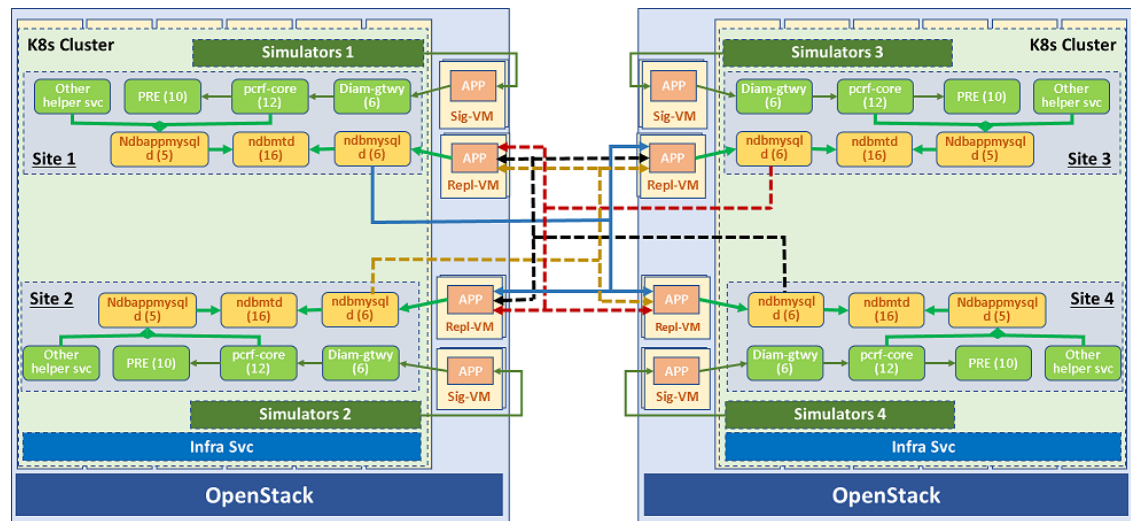
To test this PCRF call model, the Policy application is deployed in converged mode on a four-site georedundant site. The cnDBTier database and PCRF application are replicated on all the four-sites. The database replication is used to perform data synchronization between databases over the replication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

3.2 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 3-22   Configuring cnDBTier Helm Parameters

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

Table 3-22   (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value
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 3-23   Test Case Parmeters

Parameters	Values
Call Rate	30K TPS on Single site
Execution Time	17 Hours
ASM	Enable
Traffic Ratio	1:0:1 (AM/UE Create: AM/UE Update: AM/UE delete)
Active Subscribers	~10000000

Table 3-24   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 3-25   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 3-26   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
AMF on demand nrf discovery	Disable
LDAP (Gx-LDAP)	Disable
Sy (PCF N7-Sy)	Enable

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Table 3-27   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 3-28   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
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

Table 3-28 (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
Alternate Route Service	2	2	2	4	4
Bulwark Service	8	8	1	4	3

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

Table 3-29 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 3-30 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%

Table 3-30   (Cont.) Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site1
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 3-31   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 3-32   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 3-33   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 3-34   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 3-35   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 3-36   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

Table 3-36   (Cont.) Call Model

Service Name	AM Service			UE Service			Total MPS	Total TPS
	Ingress	Egress	Total MPS	Ingress	Egress	Total MPS		
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 3-37   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 3-38   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 3-39   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

Table 3-39   (Cont.) PCRF Interfaces

Feature Name	Status
Usage Monitoring (Gx)	NA
Subscriber HTTP Notifier (Gx)	NA

Table 3-40   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
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

Table 3-40   (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 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 3-41   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
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 3-42   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%

Table 3-42   (Cont.) Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site1
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 3-43   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 3-44   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 3-45   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 3-46   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 3-47   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

Table 3-47 (Cont.) PCF Interfaces

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

Table 3-48 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 3-49 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 3-50   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`

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

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

Table 3-50   (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration

FragmentLogFileSize	128M	`additionalndbconfigurati`
		`ons:`
		`    ndb:`
		
		`FragmentLogFileSize:`
		`128M`

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

ndb_allow_copying_alter_table	ON	`additionalndbconfigurati`
		`ons:`
		`  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 3-51   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

Table 3-51   (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
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
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

Table 3-51   (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
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 3-52   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 3-53   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%
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%

Table 3-53   (Cont.) Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
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 3-54   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 3-55   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 3-56   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 3-57   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
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

Table 3-57   (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	
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 3-58   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 3-59   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 3-60   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 3-61   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 3-62   Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
| binlog_cache_size | 10485760 | ```
additionalndbconfigurati
ons:
  mysqld:

binlog_cache_size:
'10485760'
``` |
| ConnectCheckIntervalDelay | 500 | ```
additionalndbconfigurati
ons:
     ndb:

ConnectCheckIntervalDela
y: 500
``` |

Table 3-62   (Cont.) Configuring cnDBTier Helm Parameters

Helm Parameter	Value	cnDBTier Helm Configuration
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```
binlogthreadstore.capacity	5	```db-monitor-svc: binlogthreadstore: capacity: 5```

Table 3-62   (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 3-63   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

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Table 3-63   (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	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 3-64   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

Table 3-64   (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
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 3-65   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 3-66   cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ndbappmysqld	42%/80%	37%/80%
ndbmgmd	0%/80%	0%/80%

Table 3-66   (Cont.) cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ndbmtd	32%/80%	31%/80%
ndbmysqld	4%/80%	4%/80%

3.2.4.3 Results

Table 3-67   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 SM Call Model on Two-Site GeoRedundant setup, with 41K TPS Traffic on Site-1 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+Diameter) traffic of 41K TPS on either site. For this setup Aspen Service Mesh (ASM) was enabled.

3.2.5.1 Test Case and Setup Details

Table 3-68   Test Case Parmeters

Parameters	Values
Call Rate (Ingress + Egress + Diameter)	41K TPS on Site-1
ASM	Enable
Traffic Ratio	• Internet – 1:15:1 (Create:Update:Delete) • IMS – 1:8:1 (Create:Update:Delete) • App - 1:0:1 (Create:Update:Delete) • Admin - 1:0:1 (Create:Update:Delete)
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 3-69   PCF Configuration

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

Table 3-70   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 3-71   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 3-72   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 3-73   Configuring cnDBTier Helm Parameters

Helm Parameter	Value
global.additionalndbconfigurations.mysqld.binlog_cache_size	10485760
global.additionalndbconfigurations.ndb.ConnectCheckIntervalDelay	0
global.additionalndbconfigurations.ndb.NoOfFragmentLogFiles	64
global.additionalndbconfigurations.ndb.NoOfFragmentLogParts	4
global.additionalndbconfigurations.ndb.MaxNoOfExecutionThreads	11
global.additionalndbconfigurations.ndb.FragmentLogFileSize	32M
db-monitor-svc.binlogthreadstore.capacity	5
global.additionalndbconfigurations.mysqld.ndb_allow_copying_alter_table	ON
global.additionalndbconfigurations.ndb.HeartbeatIntervalDbDb	1250

ⓘ **Note**

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

Table 3-74   Policy Microservices Resources

Service Name	CPU Limit Per Pod	CPU Request Per Pod	Memory Limit Per Pod (Gi)	Memory Request Per Pod (Gi)	Min Replicas	Max Replicas
Appinfo	2	2	1	0.5	2	2
Appinfo-Istio	2	2	2	2	2	2
Audit Service	2	2	4	4	2	2
Audit Service-Istio	2	2	2	2	2	2
CM Service	4	2	2	0.5	2	2
CM Service-Istio	2	2	2	2	2	2
Config Service	4	4	2	0.5	2	2
Config Service-Istio	2	2	2	2	2	2
Egress Gateway	8	8	6	6	9	9
Egress Gateway-Istio	4	4	2	2	9	9
Ingress Gateway	5	5	6	6	29	29
Ingress Gateway-Istio	2.5	2.5	2	2	29	29
Nrf Client Management	1	1	1	1	2	2
Nrf Client Management -Istio	2	2	2	2	2	2
Diameter Gateway	4	4	2	1	2	2
Diameter Gateway-Istio	2	2	2	2	2	2
Diameter Connector	4	4	2	1	2	2
Diameter Connector-Istio	2	2	2	2	2	2
Nrf Client Discovery	4	4	2	2	2	2
Nrf Client Discovery-Istio	2	2	2	2	2	2
Query Service	2	1	1	1	2	2
Query Service-Istio	2	2	2	2	2	2
Performance	1	1	1	0.5	2	2
PRE Service	4	4	4	4	39	39
PRE Service-Istio	1.5	1.5	2	2	39	39
SM Service	7	7	10	10	64	64

Table 3-74   (Cont.) Policy Microservices Resources

Service Name	CPU Limit Per Pod	CPU Request Per Pod	Memory Limit Per Pod (Gi)	Memory Request Per Pod (Gi)	Min Replicas	Max Replicas
SM Service-Istio	2.5	2.5	2	2	64	64
UDR Connector	6	6	4	4	8	8
UDR Connector-Istio	2	2	2	2	8	8
CHF Connector	6	6	4	4	4	4
CHF Connector-Istio	2	2	2	2	4	4
Binding Service	6	6	8	8	11	11
Binding Service-Istio	2.5	2.5	2	2	11	11
Alternate Route Service	2	2	4	2	2	2
Alternate Route Service-Istio	2	2	2	2	2	2
Bulwark Service	8	8	6	6	15	15
Bulwark Service-Istio	2.5	2.5	2	2	15	15

Table 3-75   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
ndbappmysqld-istio	3	3	2	2	18
ndbmgmd	3	3	8	8	2
ndbmgmd-istio	1	1	2	2	2
ndbmtd	10	10	132	132	10
ndbmtd-istio	4	4	2	2	10
ndbmysqld	4	4	24	24	0
ndbmysqld-istio	5	5	4	4	12

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

3.2.5.2 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 3-76   Policy Microservices Resource Utilization

Service	CPU (X/Y) - Site 1	CPU (X/Y) - Site 2
ocpcf-occnp-alternate route	32.90%%/26.37%	None
ocpcf-appinfo	2.45%/26.51%	None
ocpcf-bulwark	25.43%/23.64%	None
ocpcf-occnp-config-server	6.39%/45.14%	None
ocpcf-occnp-egress-gateway	15.74%/34.63%	None
ocpcf-occnp-ingress-gateway	19.09%/44.05%	None
ocpcf-occnp-nrf-client-nfdiscovery	3.78%/67.32%	None
ocpcf-occnp-nrf-client-nfmanagement	0.35%/49.46%	None
ocpcf-oc-binding	14.30%/39.18%	None
ocpcf-occnp-chf-connector	12.21%/22.02%	None
ocpcf-occnp-udr-connector	13.64%/30.17%	None
ocpcf-ocpm-audit-service	1.20%/22.68%	None
ocpcf-ocpm-policyds	23.23%/51.93%	None
ocpcf-ocpm-pre	23.32%/45.91%	None
ocpcf-pcf-smservice	27.51%/56.20%	None
ocpcf-ocpm-queryservice	0.05%/23.54%	None

Table 3-77   cnDBTier Services Resource Utilization

Name	CPU (X/Y) - Site1	CPU (X/Y) - Site2
ndbappmysqld	33.69%/39.51%	0.16%/24.91%
ndbmgmd	0.23%/25.37%	0.28%/25.40%
ndbmtd	52.08%/66.69%	8.63%/66.61%

3.2.5.3 Results

Table 3-78   Latency Observations

Services	Average Latency (ms)
Ingress	58.7
SM	53.2
PDS	24.9
UDR	3.28
NRFClient Discovery	0.15
CHF	2.95
Binding	27.0

Table 3-78   (Cont.) Latency Observations

Services	Average Latency (ms)
Diam-connector	1.09
Egress	0.53

3.2.6 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.

3.2.6.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

Parameters	Values
Call Rate (Ingress + Egress)	60K 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 3-79   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 3-80   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 3-81   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
Subscriber HTTP Notifier (Gx)	NA

Table 3-82   PCRF interfaces

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

Table 3-82   (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

The following Policy optimization parameters were configured for this run:

Table 3-83   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
``` |

Policy Microservices Resources

Table 3-84   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	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		
Performance	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 3-85   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
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

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Table 3-86   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 3-87   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

3.2.6.2 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 3-88   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%

Table 3-88 (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
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%
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%

Table 3-88   (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
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%
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 3-89   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%

3.2.6.3 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

3.2.7 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.

3.2.7.1 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 3-90   Traffic distribution

	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic
UE service	Site 1			Site 2		
	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 3-91   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 3-92   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 3-93   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 3-94   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```

Policy Microservices Resources

Table 3-95   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
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 3-96   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
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 3-97   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 3-98   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		

3.2.7.2 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 3-99   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%
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%

Table 3-99   (Cont.) CPU/Memory Utilization by Policy Microservices

Service	CPU (Site 1)	Memory (Site 1)	CPU (Site 2)	Memory (Site 2)
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%
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 3-100   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%

Table 3-100   (Cont.) CPU/Memory Utilization by CnDBTier services

App/Container	CPU (Site1)	Memory (Site1)	CPU (Site2)	Memory (Site2)
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%

3.2.7.3 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

3.2.8 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. APP Compression was enabled. 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.

3.2.8.1 Test Case and Setup Details

Testcase Parameters

The following table describes the testcase parameters and their values:

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 3-101   Traffic distribution

	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic	Ingress Gateway	Egress Gateway	Total Ingress/ Egress Traffic
UE service	Site 1			Site 2		
	8340	37530	45870	-	-	-
AM service	8340	20850	29190	-	-	-
Total			75060	-	-	-

Policy Configurations

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

Table 3-102   Policy microservices configuration

Name	Status
Bulwark	Enabled
Binding	Disabled
Local Subscriber State Variable (SSV)	Enabled
Validate_user	Disabled
Alternate Route	Disabled
Audit	Enabled
Compression (AM and SM Service)	Enabled

Table 3-102   (Cont.) Policy microservices configuration

Name	Status
SYSTEM.COLLISION.DETECTION	Enabled

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

Table 3-103   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 3-104   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 3-105   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`

Policy Microservices Resources

Table 3-106   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

Table 3-106   (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)
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	8	8	8Gi	8Gi	12	3	2 Gi
UE Service	8	8	6Gi	6Gi	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 3-107   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	27	2	2 Gi
Ingress Gateway	5	5	6Gi	6Gi	8	2.5	2Gi

Table 3-107   (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
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	8	8	8Gi	8Gi	9	3	2 Gi
UE Service	8	8	6Gi	6Gi	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 3-108   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

Table 3-108   (Cont.) 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
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 3-109   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		

3.2.8.2 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 3-110   CPU/Memory Utilization by Policy Microservices

Service	CPU	Memory
ocpcf-pcf-ueservice	61.7	58.4
ocpcf-bulwark	47.6	32.5
ocpcf-occnp-ingress-gateway	45.9	56.5
ocpcf-occnp-egress-gateway	45.2	23.1
ocpcf-ocpm-policyds	44.5	58.3
ocpcf-occnp-udr-connector	33.3	27.3
ocpcf-occnp-nrf-client-nfdiscovery	27.0	22.0
ocpcf-occnp-amservice	25.3	37.0
ocpcf-ocpm-pre	20.4	51.6
ocpcf-occnp-chf-connector	14.0	20.6
ocpcf-performance/perf-info	11.1	13.5
ocpcf-occnp-config-server	7.45	42.2
ocpcf-appinfo	4.00	25.3
ocpcf-pcf-cmservice	0.54	34.4
ocpcf-occnp-nrf-client-nfmanagement	0.35	48.1
ocpcf-pcf-smservice	0.17	39.7
ocpcf-ocpm-audit-service	0.15	13.2
ocpcf-occnp-alternate route	0.08	10.1
ocpcf-ocpm-queryservice	0.03	26.1

Observed CPU utilization Values of cnDBTier Services

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

Table 3-111   CPU/Memory Utilization by CnDBTier services

App/Container	CPU	Memory
ndbmtd	60.6	NA
ndbappmysqld	38.9	NA
ndbmysqld	5.85	29.4
ndbmgmd	0.165	25.4

3.2.8.3 Results

Average Latency Observations for the AM and UE call flow:

Call Flow	50th Percentile (ms)	95th Percentile (ms)
AM CREATE	50.4	103
AM DELETE	48.6	97.9
UE CREATE	71.0	126

Call Flow	50th Percentile (ms)	95th Percentile (ms)
UE DELETE	8.56	19.1

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

Service Name	TPS
Diameter Gateway	7.5K 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 PCF configurations were either enabled or disabled for running this call flow:

Table 3-112   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 3-113   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 3-114   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 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 3-115   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 3-116   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 3-117   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 3-117   (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 3-118   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 3-119   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 3-120   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 3-121   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 3-122   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 3-123   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 3-123   (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 3-124   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 3-125   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 3-126   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 3-127   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 3-128   Traffic distribution

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

Table 3-128   (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 3-129   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 3-130   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 3-131   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 3-132   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 3-133   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 3-134   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 3-134   (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 3-135   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 3-136   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 3-137   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 3-138   Policy microservices configuration

Service Name	Status
Binding	Enabled
PER	Disabled
SAL	Enabled

Table 3-138 (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 3-139 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 3-140 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 3-141   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 3-142   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 3-143   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 3-144   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 3-145   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 3-146   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 3-147   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 3-148   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 3-148   (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 3-149   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

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 3-150   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

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Table 3-150　(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 3-151　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 3-152　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 3-152   (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 3-153   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 3-154   Average PCRF Core JDBC Latency Observations

Site 1	Site 2
2.07 ms	2.03 ms

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 3-155   Traffic distribution

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

Table 3-156   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 3-157   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 3-158   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 3-159   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 3-160   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
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 3-161   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 3-162   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 3-163   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%

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Table 3-163   (Cont.) CPU/Memory Utilization by CnDBTier services

Service	CPU	Memory
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 3-164   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
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 3-165   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

Parameters	Values
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 3-166   Traffic distribution

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

Table 3-167   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 3-168   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 3-169   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 3-170   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 3-171   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
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 3-172   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 3-173   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 3-174   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 3-175   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 3-176   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 3-177   Traffic distribution

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

Table 3-178   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$EX	0
occnp_usagemon.UmContext	737281
occnp_usagemon.UmContext$EX	0

Policy Configurations

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

Table 3-179   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 3-180   Policy interfaces

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

Table 3-180   (Cont.) Policy interfaces

Feature Name	Status
LDAP (Gx-LDAP)	NA
Binding Feature	Disabled

Policy Microservices Resources

Table 3-181   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
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 3-182   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

Table 3-182   (Cont.) CnDBTier Resource allocation

Service Name	Replicas	CPU Request per Pod (#)	CPU Limit per Pod (#)	Memory Request per Pod (Gi)	Memory Limit per Pod (Gi)
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 3-183   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 3-184   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 3-185   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 3-186   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