

Oracle® Communications

Cloud Native Core, Network Repository

Function Benchmarking Guide



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ORACLE®

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Preface

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Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
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Acronyms

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

Table Acronyms

Term	Definition
ASM	Aspen Service Mesh
B	Bytes
CA	Certificate Authority
CNE	Cloud Native Environment
CPU	Central Processing Unit
KB	Kilo Bytes
LB	Load Balancer
NF	Network Function
NRF	Oracle Communications Cloud Native Core, Network Repository Function
OSO	Operations Services Overlay
RAM	Random Access Memory
RTT	Round Trip Time
SBA	Service Based Architecture
Set	A set comprises of multiple Georedundant NRF sites
TLS	Transport Layer Security
XFCC	x-forwarded-client-cert

What's New in This Guide

This section lists the documentation updates for release 25.1.2xx.

Release 25.1.202- G37249-02, October 2025

Generic Updates

- Updated the cnDBTier and the ASM versions in the [System Software](#) section.
- Updated the NRF version test constraint, Average HTTP Request Packet Size, Average HTTP Response Packet Size, and Average size of NF Profiles in the [Software Test Constraints](#) section.
- Updated the image in the [Multiset Test Topology \(NRF Growth\)](#) section by replacing the NRF simulator with NRF Set 2.

Benchmark Testing Updates

- Updated the [NRF Features](#) section to include the following features:
 - Egress Gateway Pod Protection Using Rate Limiting
 - Ingress Gateway Pod Protection
- Added a note to the Egress Gateway Pod Throttling feature in the [NRF Features](#) section to use the Egress Gateway Pod Protection Using Rate Limiting feature.
- Updated the following sections in the [53K TPS per NRF Set/106K TPS for Two NRF Sets](#) chapter:
 - [NRF Services Resource Requirements](#)
 - [cnDBTier Resource Requirements per NRF Deployment](#)
 - [State Data Quantum at NRF](#)
 - [Call-Mix](#)
 - [NF Count Per NF Types](#)
 - [Discovery TPS per NfType and Number of Profiles in Response](#)
 - [Test Observations](#)
 - [NRF Resource Utilization](#)
 - [cnDBTier Services Resource Utilization](#)
 - [Latency Observations](#)
- Added the [NRF Configuration](#) section to suggest the NRF recommended configuration for certain features.

Release 25.1.200- G37249-01, July 2025

Generic Updates

- Updated the cnDBTier version in the [System Software](#) section.
- Updated the NRF version test constraint, Average HTTP Request Packet Size, Average HTTP Response Packet Size, and Average size of NF Profiles in the [Software Test Constraints](#) section.

Benchmark Testing Updates

- Updated the [NRF Features](#) section.
- Updated the [CNE Common Services Resource Utilization](#) section.
- Updated the following sections in the Observations for 51.6K TPS chapter:
 - STATE Data Quantum at NRF before Performance Run Begins
 - Call-Mix
 - NF Count Per NF Types
 - Discovery TPS per NfType and Number of Profiles in Response
 - Test Observations
 - NRF Resource Utilization
 - cnDBTier Services Resource Utilization
 - Latency Observations
- Updated the following sections in the Observations for 51.6K+ 5K TPS chapter:
 - NRF Services Resource Requirements
 - STATE Data Quantum at NRF before Performance Run Begins
 - Call-Mix
 - NF Count Per NF Types
 - Discovery TPS per NfType and Number of Profiles in Response
 - Test Observations
 - NRF Resource Utilization
 - cnDBTier Services Resource Utilization
 - Latency Observations
- Added the following sections for the Observations for 5K TPS chapter:
 - NRF Services Resource Requirements
 - Call-Mix
 - Test Observations
 - NRF Resource Utilization

1

Introduction

Oracle Communications Cloud Native Core Network Repository Function (NRF) is one of the main components of the 5G Service Based Architecture (SBA). NRF maintains an updated repository of all the Network Functions (NFs) available in the operator's network along with the services provided by each NFs in the 5G core. NRF instantiates, scales, and terminates the services with minimal or no manual intervention.

For more information about NRF architecture, see *Oracle Communications Cloud Native Core, Network Repository Function User Guide*.

1.1 Purpose and Scope

This document describes the measurements that are used to perform the performance evaluation of NRF, microservices, and deployment environment setup software such as Aspen Service Mesh (ASM), Operations Services Overlay (OSO), Cloud Native Environment (CNE), and so on.

This document provides the following information:

- Benchmark NRF performance and capacity
- Benchmark data from our labs
- Key metrics used to manage NRF performance and capacity

Note

The performance and capacity of the NRF system may vary based on the call model, Feature or Interface configuration, and underlying CNE and hardware environment.

1.2 References

Following are the reference documents:

- *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Operations Services Overlay Installation and Upgrade Guide*
- *Oracle Communications Cloud Native Core, cnDBTier User Guide*
- *Oracle Communications Cloud Native Core, Network Repository Function User Guide*
- *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*
- *Oracle Communications Cloud Native Core, Network Repository Function Troubleshooting Guide*
- *Oracle Communications Cloud Native Core, Network Repository Function Network Impact Report*

- *Oracle Communications Cloud Native Configuration Console User Guide*
- *Oracle Communications 5G Automated Test Suite Guide*
- *Oracle Communication Cloud Native Core, Data Collector User Guide*

2

Deployment Environment

This section provides information about the cloud native infrastructure used for Oracle Communications Cloud Native Core, Network Repository Function (NRF) benchmarking.

2.1 Deployed Components

This section provides details about the deployed components.

2.1.1 Hardware Details

This section describes the hardware details.

Table 2-1 Hardware Details

Nodes	Type
Master Nodes	ORACLE SERVER X8-2
Top of Rack Switch	Cisco 93108TC-EX
Worker Nodes	ORACLE SERVER X8-2

2.1.2 System Software

This section describes the system software details.

Table 2-2 System Software

System Software	Details
Operating System (+Kernel Version)	5.15.0-105.125.6.2.2.el8uek.x86_64 Oracle Linux Server 8.8
Hypervisor	BareMetal Server
CNE	23.4.1
OSO	NA
Kubernetes	1.27.x
ASM	1.21.6
cnDBTier	25.1.201

2.1.3 Observability Services

This section describes the observability services used for NRF benchmarking.

Table 2-3 Observability Services

Service Name	Version
OpenSearch	2.3.0
OpenSearch Dashboard	2.3.0
FluentBit	1.9.4
Fluentd OpenSearch	1.16.2
Kyverno	1.9.0
Grafana	9.5.3
Prometheus	2.44.0
Jaeger	1.45.0

2.2 Resource Requirements

The CPU and RAM resources that each service consumes are constrained, so that they do not consume excess resources that could be used by applications. Each service is initially allocated a CPU and RAM at the time of deployment and is allowed to grow to a specified upper limit of each resource while it continues to run. For services where little growth is expected, or where increasing the CPU or RAM underneath a running application might cause an unacceptable service disruption, the initial allocation and upper limit are set to the same value. The resource requests and limits are given below:

Note

Max replica count of a service must be adjusted as per the target TPS.

2.2.1 CNE Common Applications

This section describes the CNE common applications.

Table 2-4 CNE Common Applications

Service	Pod replica #	CPU/Pod		Memory (Mi)	
		Requests	Limit	Requests	Limit
Prometheus	2	2000	2000	4096	4096
Prometheus Node Exporter	1 per node	800	800	512	512
Prometheus Operator	1	100	200	100	200
Prometheus AlertManager	2	20	20	64	64
Prometheus Kube State Metrics	1	20	20	32	100
Promxy	1	100	100	512	512
OpenSearch Master	3	1000	1000	2048	2048
OpenSearch Data	3	1000	1000	16384	16384

Table 2-4 (Cont.) CNE Common Applications

Service	Pod replica #	CPU/Pod		Memory (Mi)	
		Requests	Limit	Requests	Limit
OpenSearch Client	3	1000	1000	2048	2048
OpenSearch Dashboard	1	100	100	512	512
occne-metrics-server	1	100	100	200	200
occne-alertmanager-snmp-notifier	1	100	100	128	128
Fluentd OpenSearch	1 per worker node	500	500	1024	1024
Jaeger Agent	1 per worker node	256	500	128	512
Jaeger Collector	1	500	1250	512	1024
Jaeger query	1	256	500	128	512
MetalLB Controller	1	100	100	100	100
MetalLB Speaker	1 per worker node	100	100	100	100
LB Controller (vCNE only)	1	10	500	128	1024
Egress Controller (vCNE only)	1 per worker node	10	1000	200	500
Bastion Controller	1	10	200	128	256
Kyverno	3	100	200	256	512

2.2.2 NRF Services

Table 2-5 NRF Services Resource Requirements

Service Name	Min Pod Replica Count per NRF
Helm test	1
<helm-release-name>-nfregistration	2
<helm-release-name>-nfdiscovery	2
<helm-release-name>-nfsubscription	2
<helm-release-name>-nrfauditor	2
<helm-release-name>-nrfconfiguration	1
<helm-release-name>-nfaccess token	2
<helm-release-name>-nrfartisan	1
<helm-release-name>-nrftcachedata	2
<helm-release-name>-ingressgateway	2
<helm-release-name>-egressgateway	2
<helm-release-name>-alternate-route	2
<helm-release-name>-appinfo	2
<helm-release-name>-perfinfo	2

Where, <helm-release-name> is prefixed in each microservice name. For example, if helm-release-name is "ocnrf", then nfregistration microservice name is "ocnrf-nfregistration".

For more information about other resource requirements, see *Oracle Communications Cloud Native Core, Network Repository Function Installation, Upgrade, and Fault Recovery Guide*.

2.2.3 cnDBTier Services

Table 2-6 cnDBTier Services Resource Requirements

Service Name	Min Pod Replica Count per cnDBTier
MGMT (ndbmgmd)	2
DB (ndbmtd)	4
SQL (ndbmysqld)	2
SQL (ndbappmysqld)	2
Monitor Service (db-monitor-svc)	1
Backup Manager Service (db-backup-manager-svc)	1
Replication Service - Leader	1
Replication Service - Other	0

Note

There is a change in the Memory/Pod resource requirement for Monitor Service (db-monitor-svc) and SQL (ndbappmysqld) services.

For more information about other resource requirements and recommended parameter values, see *Oracle Communications Cloud Native Core, Network Repository Function Installation, Upgrade, and Fault Recovery Guide*.

3

Test Topology

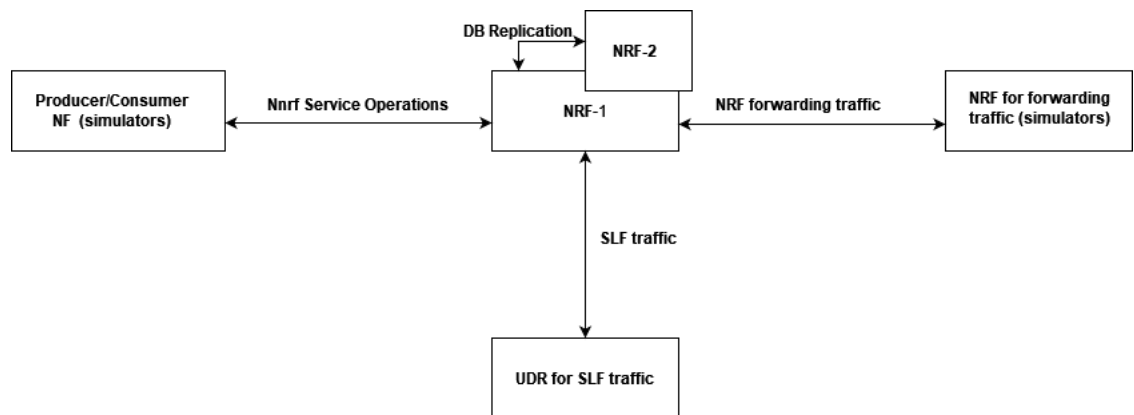
This section describes the topology used for testing Oracle Communications Cloud Native Core, Network Repository Function (NRF).

3.1 Single Set Test Topology

The following image represents the test topology consisting of the following components:

- Two-site NRF
- UDR for SLF traffic
- Producer/Consumer NF for Nnrf service operations (simulators)
- NRF for forwarding to a different segment (simulators)

Figure 3-1 Single Set Test Topology



1. Producer NF sends NfRegister, NfHeartbeat, NfUpdate, and NfDeregister requests to NRF.
2. Consumer NF sends NfStatusSubscribe, NfStatusSubscribe (PATCH), NfStatusUnsubscribe, NfDiscover, NfAccessToken, NfProfileRetrieval, and NfListRetrieval requests to NRF.
3. NRF sends request to UDR for processing SLF based discovery query.
4. NRF sends response to all service requests it receives.
5. NRF triggers NfStatusNotify to all the Consumer NFs who have created subscription.
6. NRF forwards NfDiscovery requests to the NRF simulator.

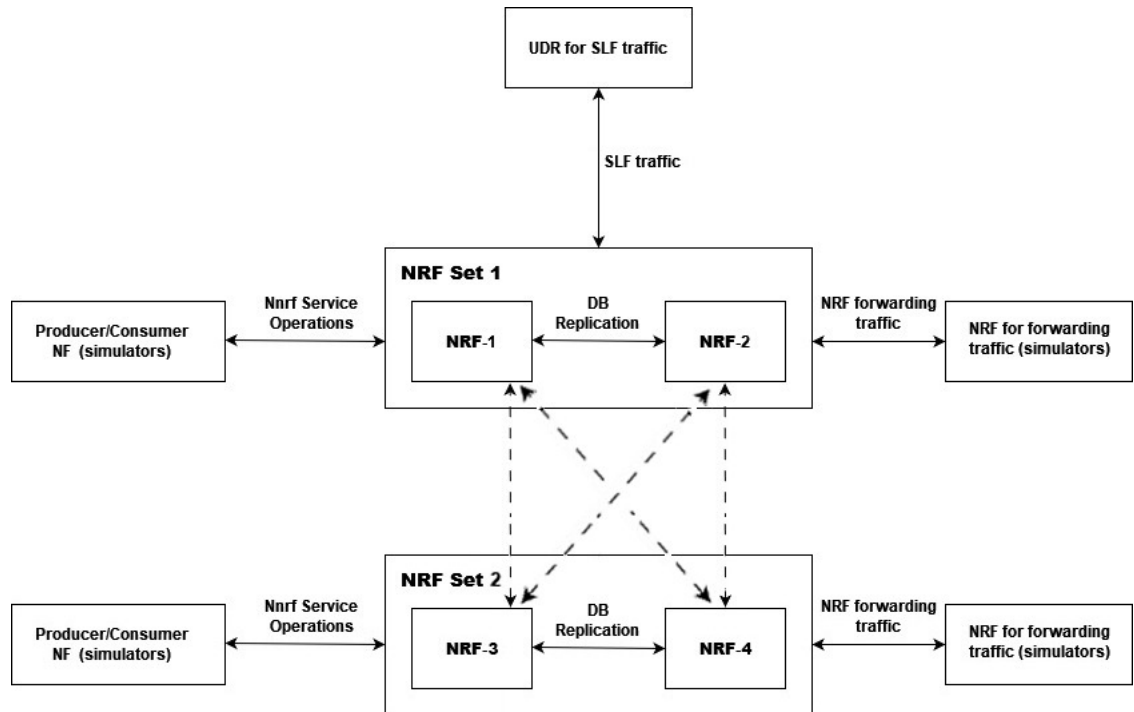
3.2 Multiset Test Topology (NRF Growth)

The following image represents the test topology consisting of the following components:

- Two NRF Sets with one NRF Set having two NRF sites and the other set with one NRF site.

- UDR for SLF traffic
- Producer/Consumer NF for Nnrf service operations (simulators)
- NRF for forwarding to a different segment (simulators)

Figure 3-2 Multiset Test Topology (NRF Growth)



1. Producer NF sends NfRegister, NfHeartbeat, NfUpdate, and NfDeregister requests to NRF.
2. Consumer NF sends NfStatusSubscribe, NfStatusSubscribe (PATCH), NfStatusUnsubscribe, NfDiscover, NfAccessToken, NfProfileRetrieval, and NfListRetrieval requests to NRF.
3. NRF sends request to UDR for processing SLF based discovery query.
4. NRF sends response to all service requests it receives.
5. NRF triggers NfStatusNotify to all the Consumer NFs who have created subscription.
6. NRF forwards NfDiscovery requests to the NRF simulator.
7. NRF Set 1 retrieves the remote set state data from NRF Set 2 and vice versa.

4

Benchmark Testing

This section describes the environment used for benchmarking Oracle Communications Cloud Native Core, Network Repository Function (NRF). Benchmarking is performed with the settings described in this section.

The default values or recommendations for any required software or resource are available from third-party vendors. The operators may choose different values.

4.1 Overview

To qualify the test run, the following elements are considered:

- Pod restart
- CPU and Memory utilization
- Error rate
- Ingress and egress traffic rate
- Success rate
- Message request and response processing time
- Infrastructure resource requirements and utilization

4.2 NRF Features

The following table lists the features that are enabled during benchmarking.

Table 4-1 NRF Features

NRF Features	Feature Status	Notes
Subscriber Location Function	ENABLED	SLF is enabled for 3 NfTypes (AUSF, UDR, and UDM) in slfLookupConfig.
SLF Selection from Registered NF Profiles	ENABLED	Dynamic SLF feature is enabled.
Access Token Caching during SLF Query	ENABLED	Access Token Caching during SLF Query is enabled with 24 hour validity period based caching. For more information about the accessTokenCacheEnabled under slfOptions, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Overload Control	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Preferred Locality Feature Set	ENABLED	Extended Preferred locality is configured with 2 locationTypes, 8 locationMappings, 56 preferredLocationDetails.
NRF Forwarding per NF Type/ Service Type	ENABLED for UDM	Forwarding is enabled for discovery services. 1 host is present in nrfHostConfig and 1 rule is present in forwardingRulesConfig.

Table 4-1 (Cont.) NRF Features

NRF Features	Feature Status	Notes
EmptyList in Discovery Response	ENABLED	EmptyList feature is enabled and discoveryValidityPeriodCf under nfDiscoveryOptions is configured with 5 rules.
Access Token Request Authorization	ENABLED	AuthFeature is enabled with 8 rules in authRulesConfig under nfAccessTokenOptions.
Pod Protection Support for NRF Subscription Microservice	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Subscription Limit	ENABLED	Set the subscription limit to 1000. For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
User-Agent Header for Outgoing Requests	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
NRF to Pick Port from ipEndpoints and FQDN from the NF Service or NF level when Selecting SLF	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
ASM Sidecar	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Maximum Number of Profiles in Discovery Response	ENABLED	Set the value as 12 for the profilesCountInDiscoveryResponse parameter. For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> . Note: If the value is greater than 12, there will be a performance impact.
NRF Georedundancy	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
NRF Growth	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
SLF Routing using SCP	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function Rest Specification Guide</i> .
Discovery Validity	ENABLED	Discovery validity feature is enabled with a value as 1 minute (for all NF Types). For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Access Token Expiry Time	NA	The expiry duration for a NRF signed certificate. The limit is 24 hours. For more information about NRF Access Token Service Usage Details, see <i>Oracle Communications Cloud Native Core, Network Repository Function User Guide</i> .
Load Change Threshold for Notifications from NRF	NA	This feature is configured using nfNotifyLoadThreshold parameter. Set the value to 10%. For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .

Table 4-1 (Cont.) NRF Features

NRF Features	Feature Status	Notes
Monitoring the Availability of SCP Using SCP Health APIs	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
NRF to Retry Alternate Producer to Support Maximum Diversity	NA	The value of <i>maxSlfAttempts</i> parameter is set to 1 and the value of <i>useAlternateScp</i> parameter is set to true. For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Error Response Enhancement	NA	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Error Log Enhancements	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
NRF support for A_PFD DataSetId in registration and discovery (DataSetId Enhancements)	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
NFService Priority Update	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Subscriber Identity in messages (3GPP-SBI-Correlation-Info)	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Ingress Gateway Pod Protection	DISABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> . Note: The Ingress Gateway Pod Protection using Rate Limiting feature is recommended over the Ingress Gateway Pod Protection feature.
Egress Gateway Pod Throttling	DISABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function Installation, Upgrade and Fault Recovery Guide</i> . Note: The Egress Gateway Pod Protection using Rate Limiting feature is recommended over the Egress Gateway Pod Throttling feature.
NF Profile Size Limit	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Ingress Gateway Pod Protection Using Rate Limiting	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .
Egress Gateway Pod Protection Using Rate Limiting	ENABLED	For more information about the configuration, see <i>Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide</i> .

Note

Apart from these features being enabled, rest of the feature configurations have been set to their default values. For more information about the feature configurations, see *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*. For more information about the features, see *Oracle Communications Cloud Native Core, Network Repository Function User Guide*.

4.3 Software Test Constraints

Table 4-2 Software Test Constraints

Test Constraint	Details
NRF Version	25.1.202
Average HTTP Request Packet Size	~630 to 15000 bytes (Based on NfRegister Request)
Average HTTP Response Packet Size	~5500-131000 bytes (Discovery Response with nfProfiles)
Average NF Heartbeats Timer per NF	30s
Average size of NF Profiles	~630 to 15000 bytes

4.4 Service Operations

This section list the various service operations with the required query parameters.

NfDiscover Service Operation

The NfDiscover service operations are sent with the following query parameters:

- Target-nf-type, guami, and requester-nssais
- Target-nf-type, requester-nf-type, routing-indicator, and group-id-list
- Target-nf-type, requester-nf-type, supi, and service-names
- Target-nf-type, requester-nf-type, and service-names
- Target-nf-type, requester-nf-type, and group-id-list
- Target-nf-type and pgw
- Target-nf-type, requester-nf-type, supi, and service-names
- Target-nf-type, requester-nf-type, and service-names
- Target-nf-type, dnn, snssai, TAI, and pgw-ind
- Target-nf-type, SUPI, group-id-list, and service-names
- Target-nf-type, dnn, snssai, preferred-locality, and service-names
- Target-nf-type and guami
- Target-nf-type, requester-nf-type, and preferred-locality
- Target-nf-type, requester-nf-type, preferred-locality, and SUPI
- Target-nf-type, requester-nf-type, SUPI, group-id-list, requester-nf-type, and data-set

- Target-nf-type, requester-nf-type, routing-indicator, group-id-list, and service-names

4.5 CNE Common Services Resource Utilization

The following table describes CNE microservices and their utilization.

Table 4-3 CNE Common Services Resource Utilization

CNE Observability Services	Pod Count
occne-prometheus-server-1	2
occne-opensearch-cluster	10
occne-prometheus-node-exporter	16

4.6 53K TPS per NRF Set/106K TPS for Two NRF Sets

The per set capacity of NRF is 53K TPS. Higher TPS rate can be achieved by deploying additional NRF sets. This section provides the details for 106K TPS.

4.6.1 NRF Services Resource Requirements

This section provides the NRF services resource requirement per NRF deployment.

① Note

Changes in the resource requirements are highlighted in bold.

Table 4-4 NRF Services Resource Requirements

Service Name	Min Pod Replica	Max Pod Replica	Min CPU/Pod	Max CPU/Pod	Min Memory/Pod (in Gi)	Max Memory/Pod (in Gi)	Min (Mi) Ephemeral Storage	Max (Gi) Ephemeral Storage
Helm test	1	1	1	2	1	2	78.1	1
<helm-release-name>-nfregistration	2	2	4	4	3	3	78.1	1
<helm-release-name>-nfdiscovery	2	90	8	8	5	5	78.1	2
<helm-release-name>-nfsubscription	2	2	2	2	3	3	78.1	1
<helm-release-name>-nrfauditor	2	2	2	2	3	3	78.1	1

Table 4-4 (Cont.) NRF Services Resource Requirements

Service Name	Min Pod Replica	Max Pod Replica	Min CPU/Pod	Max CPU/Pod	Min Memory/Pod (in Gi)	Max Memory/Pod (in Gi)	Min (Mi) Ephemeral Storage	Max (Gi) Ephemeral Storage
<helm-release-name>-nrfconfiguration	1	1	2	2	2	2	78.1	1
<helm-release-name>-nrfaccess token	2	2	2	2	2	2	78.1	1
<helm-release-name>-nrfartisan	1	1	2	2	2	2	78.1	1
<helm-release-name>-nrfcachedata	2	2	4	4	4	4	78.1	1
<helm-release-name>-ingressgateway	2	34	4	4	5	5	78.1	1
<helm-release-name>-egressgateway	2	30	4	4	4	4	78.1	1
<helm-release-name>-alternate-route	2	2	2	2	4	4	78.1	1
<helm-release-name>-appinfo	2	2	1	1	1	1	78.1	1
<helm-release-name>-perfinfo	2	2	1	1	1	1	78.1	1

Table 4-5 Service Mesh Sidecar Resource Requirements

Service Name	CPU/Pod		Memory/Pod (in G)		Concurrency
	Min	Max	Min	Max	
Helm test	0	0	0	0	NA
<helm-release-name>-nrfregistration	2	2	3	3	2

Table 4-5 (Cont.) Service Mesh Sidecar Resource Requirements

Service Name	CPU/Pod		Memory/Pod (in G)		Concurren- cy
	Min	Max	Min	Max	
<helm-release-name>-nfdiscovery	2	2	3	3	4
<helm-release-name>-nfssubscription	2	2	3	3	2
<helm-release-name>-nrfauditor	2	2	3	3	2
<helm-release-name>-nrfconfiguration	2	2	3	3	2
<helm-release-name>-nrfaccesstoken	2	2	3	3	2
<helm-release-name>-nrfartisan	2	2	3	3	2
<helm-release-name>-nrfcachedata	2	2	3	3	2
<helm-release-name>-ingressgateway	4	4	3	3	8
<helm-release-name>-egressgateway	4	4	3	3	8
<helm-release-name>-alternate-route	2	2	3	3	2
<helm-release-name>-appinfo	2	2	3	3	2
<helm-release-name>-perfinfo	2	2	3	3	2

4.6.2 cnDBTier Resource Requirements per NRF Deployment

This section provides the details of cnDBTier services resource requirements.

Note

Changes in the resource requirements are highlighted in bold.

The following table describes the resources required by cnDBTier pods to perform NRF benchmark tests.

Table 4-6 cnDBTier Services Resource Requirements

Service Name	Pod Rep lica #	CPU/Pod		Memory/Pod (in Gi)		PVC Size (in Gi)		Ephemeral Storage	
		Min	Max	Min	Max	PVC1	PVC2	Min (Mi)	Max (Gi)
MGMT (ndbmgmd)	2	4	4	8	10	15	NA	90	1
DB (ndbmt)	4	4	4	5	5	4	5	90	1
SQL (ndbmysqld)	2	4	4	20	20	13	NA	90	1
SQL (ndbappmysqld)	2	8	8	3	3	1	NA	90	1
Monitor Service (db-monitor-svc)	1	4	4	4	4	NA	NA	90	1

Table 4-6 (Cont.) cnDBTier Services Resource Requirements

Service Name	Pod Rep lica #	CPU/Pod		Memory/Pod (in Gi)		PVC Size (in Gi)		Ephemeral Storage	
	Min	Min	Max	Min	Max	PVC1	PVC2	Min (Mi)	Max (Gi)
Backup Manager Service (db-backup-manager-svc)	1	1	1	1	1	NA	NA	90	1
Replication Service - Leader	1	2	2	12	12	4	NA	90	1
Replication Service - Other	0	0.6	1	1	2	NA	NA	90	1

The following table describes the resources required by cnDBTier service mesh sidecar to perform NRF benchmark tests.

Table 4-7 Service Mesh Sidecar

Service Name	CPU		Memory (in Gi)		Concurre ncy
	Min	Max	Min	Max	
MGMT (ndbmcmd)	2	2	1	1	8
DB (ndbmttd)	2	2	1	1	8
SQL (ndbmssqld)	2	2	1	1	8
SQL (ndbapssqld)	4	4	1	1	8
Monitor Service (db-monitor-svc)	2	2	1	1	2
Backup Manager Service (db-backup-manager-svc)	2	2	1	1	2
Replication Service-Leader	2	2	1	1	2
Replication Service-Other	2	2	1	1	2

The following default values are added for the service mesh specific annotations in the `ocnrf_dbtier_CNDBTIER_VERSION_custom_values_NRF_VERSION.yaml` file.

The following table describes the default values for resources required by cnDBTier service mesh sidecar to perform NRF benchmark tests.

Table 4-8 Default Values for Service Mesh Specific Annotations

Parameter Name	Annotations
mgm.annotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "2" sidecar.istio.io/proxyCPULimit: "2" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 8}' traffic.sidecar.istio.io/excludeInboundPorts: "8081" </pre>
ndb.annotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "2" sidecar.istio.io/proxyCPULimit: "2" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 8}' traffic.sidecar.istio.io/excludeInboundPorts: "8081" </pre>
api.annotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "2" sidecar.istio.io/proxyCPULimit: "2" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 8}' traffic.sidecar.istio.io/excludeInboundPorts: "8081" </pre>
ndbapp.annotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "4" sidecar.istio.io/proxyCPULimit: "4" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 8}' traffic.sidecar.istio.io/excludeInboundPorts: "8081" </pre>

Table 4-8 (Cont.) Default Values for Service Mesh Specific Annotations

Parameter Name	Annotations
db-replication-svc.podAnnotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "2" sidecar.istio.io/proxyCPULimit: "2" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 2}' </pre> Note: The annotations for db-replication-svc.podAnnotations varies depending on the replication cardinality. podAnnotations should be added for each such replication deployment section in the ocnrf_dbtier_CNDBTIER_VERSION_custom_values_NRF_VERSION.yaml file.
db-replication-svc.podAnnotations	<pre> traffic.sidecar.istio.io/excludeInboundPorts: "8081" </pre> The inbound ports are added only to the db-replication-svc (leader pod).
db-monitor-svc.podAnnotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "2" sidecar.istio.io/proxyCPULimit: "2" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 2}' traffic.sidecar.istio.io/excludeInboundPorts: "8081" </pre>
db-backup-manager-svc.pod.annotations	<pre> sidecar.istio.io/inject: "true" sidecar.istio.io/proxyCPU: "2" sidecar.istio.io/proxyCPULimit: "2" sidecar.istio.io/proxyMemory: "1Gi" sidecar.istio.io/proxyMemoryLimit: "1Gi" proxy.istio.io/config: '{concurrency: 2}' </pre>

4.6.3 State Data Quantum at NRF

Table 4-9 STATE Data Quantum at NRF

Parameters	Values	Details
Number of Subscriptions	1000 (500 for NRF set 1 + 500 for NRF set 2)	Subscriptions are created with the below conditions: - Subscription to a set of NF Instances identified by their NF Type - 253 - Subscription to a set of NF Instances identified by their NF Instance Id - 130 - Subscription to a set of NF Instances identified by their NF Set Id - 78 - Miscellaneous subscriptions - 39 - NotificationCondition with monitored attributes set to "/priority" or "/load". - reqNotifEvents set to NF_REGISTERED, NF_DEREGISTERED, NF_PROFILE_CHANGE

4.6.3.1 NF Count Per NF Types

The total number of NFs supported by per NRF set is 300. For two sets a total of 600 NFs are supported.

The following table lists the NF count per NF type along with the NF profile size.

Table 4-10 NF Count Per NF Types

Target-NF Types	NF Count	Profile Size (in bytes)
AMF	46	15000
AUSF	48	4640
BSF	3	1700
CBCF	3	11300
CHF	3	1800
GMLC	3	0630
LMF	3	2400
NEF	3	11300
PCF	79	1500-2500
SCP	27	1200
SLF	3	2100
SMF	148	15000
SMSF	3	11300
UDM	48	3200
UDR	180	1700-2000

4.6.4 Call-Mix

This section describes the various type of service requests with the required traffic distribution and targeted TPS per NRF set.

Table 4-11 Call-Mix

S.No	Type of Request	Traffic Distribution (in %)	Targeted TPS
A	NF Register	0.0094	5
B	NF Update	0.0810	43
C	NF Heartbeat	Not considered	155
D	NF Subscribe + Update Subscription	0.0377	20
E	NF Discover	97.24	51600
F	NRF Forwarded Discovery (Incoming)	10% of Incoming discovery traffic	0
G	% of traffic forwarded to remote PLMN (case Visited NRF)	0	Not included in this test.
H	% of traffic received from remote PLMN (case Home NRF)	0	Not included in this test.
I	SLF Query	88.4% of Discovery	45600
J	NF Access Token for SLF	Extra	1
K	NF Profile Retrieval	2.280	1210
L	NF List Retrieval	0.0358	19
M	NF Status Notify	4.0612	2155
N	NF Status UnSubscribe	0.0056	3
O	NF DeRegister	0.0056	3
P	NF Access Token for Consumers	0.0188	10
Q	NRF Forwarding (Outgoing)	10% of discovery traffic	5160

Table 4-12 Total Traffic

Traffic Type	Message Considered	Targeted TPS
Total Incoming Traffic	A + B + C + D + E + F + G + H + J + K + L + N + O + P	53069
Total Outgoing Traffic	I + J + M + Q	52916

4.6.4.1 Discovery TPS per NfType and Number of Profiles in Response

The following table indicates the discovery TPS per NfType per NRF set and the number of profiles sent in the response.

Table 4-13 Discovery TPS per NfType and Number of Profiles in Response

Target-Nf Types	TPS (in %)	Absolute Discovery TPS	SLF Queries Posted	Number of Profiles in Response
AMF	4.19	2162.4	0	4
AUSF	0.40	204	0	6

Table 4-13 (Cont.) Discovery TPS per NfType and Number of Profiles in Response

Target-Nf Types	TPS (in %)	Absolute Discovery TPS	SLF Queries Posted	Number of Profiles in Response
BSF	0.00075	0.4	0	3
CBCF	0.0000	0	0	3
CHF	0.02	9.6	0	3
GMLC	0.0000	0	0	4
LMF	0.00299	1.6	0	4
NEF	0.0001	0.0516	0	3
PCF	0.37	191.4	0	10
SLF	0.00075	0.4	0	3
SMF	8.03	4143.4	0	4
SMSF	0.0001	0.0516	0	3
UDM	85.85	44297	44297	6
UDR	1.14	590.4	590.4	12

4.6.5 Test Observations

This section following table provides the details of test duration used for the benchmarking test.

Table 4-14 Test Observations

Parameter	Values
Test Duration	72 hours
Ingress incoming connections	337
Ingress outgoing connections	2.719K
Egress incoming connections	240
Egress outgoing connections	1.200K

4.6.6 NRF Resource Utilization

The following table describes NRF microservices and their utilization for 53K TPS per NRF set with 600 NFs in two sets.

Table 4-15 NRF Resource Utilization

NRF Microservices	Number of Pods	Average CPU	Average Memory
nfregistration	2	41%	43.9%
nfdiscovery	90	59%	47.5%
nfsubscription	2	41.8%	32%
nrfauditor	2	1.34%	23.2%
nrfconfiguration	1	2.09%	33.9%
nfaccesstoken	2	5.76%	39.4%
nrfartisan	1	0.10%	24.6%
nrfcachedata	2	48.0%	39.7%

Table 4-15 (Cont.) NRF Resource Utilization

NRF Microservices	Number of Pods	Average CPU	Average Memory
alternate-route	2	0.10%	17%
perf-info	2	8.65%	13.5%
appinfo	2	5.41%	26.3%
ingressgateway	34	63.0%	56.5%
egressgateway	30	62.0%	40.4%

Note

If you enable Message Feed feature at Ingress Gateway and Egress Gateway, approximately 33% pod capacity is impacted. The features enabled for this benchmark testing does not utilize alternate-route service.

4.6.7 cnDBTier Services Resource Utilization

The following table provides observed values of cnDBTier services.

Table 4-16 cnDBTier Services Resource Utilization

Service Name	Pod Count	Average CPU	Memory
SQL (ndbappmysqld)	2	17.8%	36%
DB (ndbmtd)	4	14.1%	87%
SQL (ndbmysqld)	2	1.7%	5%
MGMT (ndbmcmd)	2	0.3%	0.38%
Monitor Service (db-monitor-svc)	1	0.5%	11.3 %
Backup Manager Service (db-backup-manager-svc)	1	0.6%	9.5%

Table 4-17 cnDBTier Statistics

DBTier Statistics	Value
Disk Write operations per second	2.3K
Disk Read operations per second	10.2K
Transaction rates on data nodes	3.7K

4.6.8 Latency Observations

This section provides information about the latency observations.

Table 4-18 Latency Observations

Latency Parameters	99th Percentile (ms)	95th Percentile (ms)	90th Percentile (ms)	50th Percentile (ms)
Average Turnaround time at Ingress Gateway, Discovery Processing, and SLF Egress Transaction	200	196	191	151
Average Turnaround time for Discovery Processing and SLF Egress Transaction	200	195	190	150
Average Turnaround time for SLF Egress Transaction (see Note)	200	195	190	150

Note

Following simulators are used for performance measurement and their induced latency:

- NF simulator to NRF: 50ms
- NRF to forwarding simulator and forwarding simulator to NRF: 150ms
- NRF to another remote set NRF: 150 ms
- NRF to SLF: 150 ms

4.6.9 NRF Configuration

The configurations for the following features are specific for 53K TPS per NRF set. These features must be configured with the recommended values as mentioned in the *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*.

- Egress Gateway Pod Protection Using Rate Limiting- For more information about the configurations, see the following sections in *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*.
 - "Pod Protection By Rate Limiting" section in Egress Gateway Configuration
 - "Congestion Level Configuration" section in Ingress Gateway Configuration
- Ingress Gateway Pod Protection Using Rate Limiting - For more information about the configurations, see the following sections in *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*.
 - Pod Protection By Rate Limiting section in Ingress Gateway Configuration
 - Congestion Level Configuration section in Ingress Gateway Configuration
- Subscription Pod Protection- For more information about the configuration, see the "Pod Protection Options" section in *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*.
- Overload Control- For more information about the configurations, see the following sections in *Oracle Communications Cloud Native Core, Network Repository Function REST Specification Guide*.
 - Overload Level Threshold Configuration in Perf-Info
 - Discard Policy Configuration in Ingress Gateway Configuration
 - Policy Mapping Configuration in Ingress Gateway Configuration

