Oracle® Communications

Cloud Native Core Security Guide

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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.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
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Acronyms

The following table lists the acronyms and the terminologies used in the document:

Table Acronyms and Terminologies

Acronym	Description
5GC	5th Generation Core
ACME	Automatic Certificate Management Environment
BSF	Binding Support Function
cnDBTier	Cloud Native Database Tier
CNE	Cloud Native Environment
CNCC	Cloud Native Configuration Console
cnDRA	Cloud Native Diameter Routing Agent
DNSSEC	Domain Name System Security Extensions
DNS	Domain Name System
ETCD	The name “etcd” originated from two ideas, the unix “/etc” folder and “d"istributed systems. The “/etc” folder is a place to store configuration data for a single system whereas etcd stores configuration information for large scale distributed systems. Hence, a “d"istributed “/etc” is “etcd”.
FQDN	fully qualified domain name
GPG	Gnu Privacy Guard
iLO	Integrated Lights Out
Kyverno	Kyverno is a policy engine designed for Kubernetes.
mTLS	Mutual Transport Layer Security
NAPTR	Name Authority Pointer
NEF	Network Exposure Function
NF	Network Function. A functional building block within a network infrastructure, which has well defined external interfaces and well defined functional behavior. In practical terms, a network function is often a network node or physical appliance.
NRF	Network Repository Function
NSSF	Network Slice Selection Function
CNE	Oracle Communications Cloud Native Core, Cloud Native Environment
OCIR	Oracle Cloud Infrastructure Registry
OCCM	Oracle Communications Certificate Management
OSSA	Oracle Software Security Assurance
OWASP	Open Web Application Security Project
PCF	Policy Control Function
PKI	Public Key Infrastructure
SCP	Service Communication Proxy
SEPP	Security Edge Protection Proxy
ToR	Top-of-Rack Switching
UDR	Unified Data Repository
UDSF	Unstructured Data Storage Function

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Table (Cont.) Acronyms and Terminologies

Acronym	Description
YUM	Yellow Dog Updater, Modified is an open-source Linux package management application.

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What's New in This Guide

This section introduces the documentation updates for Release 25.2.2xx in Oracle Communications Cloud Native Core, Security Guide.

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- Added the following procedures in the Cloud Native Environment (CNE) Specific Security Recommendations and Guidelines section:
  - Bastion Host SSH (Port 22) Exposure Recommendations
  - IP Forwarding for CNLB
  - CNLB Egress/Ingress Bypass Recommendations
  - Container Registry Authentication Recommendations
  - su Command - Password Prompt
  - Deprecation Notice - ingress-nginx Retirement
- Added the security guidelines for OSO in the Operations Services Overlay (OSO) Specific Security Recommendations section.
- Added an entry for OSO in the Table 2-3 table in the Cloud Native Core Network Functions section.
- Added the Hosted SEPP related certificate updates in the Security Edge Protection Proxy (SEPP) Specific Security Recommendations and Guidelines section.
- Added OCI Adaptor Port Flows.

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1 Introduction

The Security Guide provides an overview of the security relevant information that applies to Cloud Native Core Network Functions. In case there are specific aspects for the underlying scenarios or applications, these are described in an NF specific chapters. This document contains recommendations (short statements on how to operate and manage the CNC software) and procedures (step-by-step instructions to assist the customer in tailoring or hardening the CNC system).

Install the CNC system software as "secure by default" where possible. In the few cases where this isn't possible, an installion time checklist procedure is created and listed on the Cloud Native Core Security Checklist. It is a short list of post-installation hardening activities that must be performed by the customer before placing the system into operation. The recommendations and other procedures found in this document are optional, and must be considered in the context of your organization's approved security policies.

This security guide also provides a simplified trust model for the system.

1.1 Audience

- Technology consultants
- Installers
- Security consultants
- System administrators

1.2 References

The following references provide additional background on product operations and support:

- *Oracle Communications Cloud Native Core, Binding Support Function Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Configuration Console Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Network Exposure Function Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Network Repository Function Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Network Slice Selection Function Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Networks Data Analytics Function Installation Guide*
- *Oracle Communications Cloud Native Core, Policy Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Provisioning Gateway Guide*

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- *Oracle Communications Cloud Native Core, Service Communication Proxy Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Security Edge Protection Proxy Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Unified Data Repository Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide*

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2 Overview

Deployment Environment

The 5G Cloud Native Core provides a variety of possible configuration and deployment environments:

Table 2-1 Deployment Environment

Type	Host	CNE	Description
Bare Metal	CNE-Supported Infrastructure	CNE	In this environment, a Kubernetes Cloud Native Environment is hosted directly on the bare metal hardware, while some other elements (DB or Bastion) are hosted using virtualized servers.
vCNE (Virtualized CNE)	Customer Hypervisor (KVM/VMware ESXi)	CNE	In this environment, all the system elements are hosted in virtualized servers deployed on a customer provided Openstack environment. The CNE is deployed on the openstack infrastructure.
Cloud	Customer CNE	Customer CNE	In this environment, the customer provides the CNE and deploys the 5G NFs directly into the environment. The Oracle provided common services and cnDBTier are used; equivalent functionality is provided by the customer.

Note

- Oracle Communications CNE provides basic CNE environment for on-premise deployment.
- Customer CNE provides CNE environment for running not just 5G microservices but also any kind of service, not just 5G. For example- observability frameworks or 4G microservices.
- With Customer CNE, a customer is responsible for ensuring the security of a Customer CNE.

Note

The cloud environment security recommendations and procedures focus on the CNE reference environment. Customers providing their own CNE must have security procedures already in place.

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2.1 Cloud Native Core Network Functions

Network Function security is prescribed by the relevant 4G and 5G standards. This document details the administrative steps required to ensure secure 5G network operations.

Table 2-2 4G and 5G Network Functions

Network Functions	Abbreviation	Description	3GPP Standard
Network Repository Function	NRF	NRF provides registration, discovery, and authorization services to all the Network Functions (NF) in the 5G core network.	• 3GPP TS 29.510 v15.5 • 3GPP TS 29.510 v16.3.0 • 3GPP TS 29.510 v16.7
Service Communication Proxy	SCP	SCP provides a 5G-aware service mesh.	• 3GPP TS 29.500 R16 v16.6.0
Network Slice Selection Function	NSSF	NSSF works with the Access and Mobility Function (AMF) to select the network slice to be used by the User Equipment (UE).	• 3GPP TS 29.531 v15.5.0 • 3GPP TS 29.531 v16.5.0 • 3GPP TS 29.531 v16.8.0 • 3GPP TS 29.501 v16.10.0 • 3GPP TS 29.502 v16.10.0
Security Edge Protection Proxy	SEPP	In the roaming architecture, the home and visited networks are connected via the Security Edge Protection Proxy (SEPP) to manage the control plane of the inter-network interconnect.	• 3GPP TS 23.501 v17.6.0 • 3GPP TS 23.502 v17.6.0 • 3GPP TS 29.500 v17.8.0 • 3GPP TS 29.501 v17.7.0 • 3GPP TS 29.573 v17.6.0 • 3GPP TS 29.510 v17.7.0 • 3GPP TS 33.501 v17.7.0 • 3GPP TS 33.117 v17.1.0 • 3GPP TS 33.210 v17.1.0

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Table 2-2 (Cont.) 4G and 5G Network Functions

Network Functions	Abbreviation	Description	3GPP Standard
Unified Data Repository	UDR/ UDSF	UDR is a repository of subscriber information, and is used by various NFs (including UDR, PCF, and NEF). The UDSF is a part of the Unified Data Management Function (UDF) and is used to store state information for Network Functions (NF).	• 3GPP TS 29.505 v15.4.0 • 3GPP TS 29.504 v16.2.0 • 3GPP TS 29.519 v16.2.0 • 3GPP TS 29.511 v17.2.0
Unified Data Repository (UDR) as Subscriber Location Function (SLF).	SLF	SLF supports the storage and retrieval of subscriber information through the nudr interface.	NA

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Table 2-2 (Cont.) 4G and 5G Network Functions

Network Functions	Abbreviation	Description	3GPP Standard
Network Exposure Function	NEF	Securely exposes network capabilities and events to Application Functions (AF).	• 3GPP TS 29.338 v 17.1.0 • 3GPP TS 23.040 v 17.2.0 • 3GPP TS 29.122 v 16.10.0 , 17.10.0 • 3GPP TS 23.222 v 16.9.0 • 3GPP TS 23.501 v 16.10.0 • 3GPP TS 23.502 v 16.10.0 • 3GPP TS 29.514 v 16.10.0 • 3GPP TS 29.521 v 16.10 • 3GPP TS 29.503 v 16.14.0 • 3GPP TS 29.515 v 16.7 • 3GPP TS 29.222 v 16.5.0 • 3GPP TS 29.500 v 16.6.0 • 3GPP TS 29.501 v 16.6.0 • 3GPP TS 29.522 v 16.10.0, 17.10.0 • 3GPP TS 29.510 v 16.6.0 • 3GPP TS 29.591 v 16.3.0 • 3GPP TS 29.518 v 16.14.0

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Table 2-2 (Cont.) 4G and 5G Network Functions

Network Functions	Abbreviation	Description	3GPP Standard
			• 3GPP TS 33.501 v 17.7.0 • 3GPP TS 29.504 v 16.10.0 • 3GPP TS 29.519 v 16.11.0 • 3GPP TS 29.508 v 16.11.0 • 3GPP TS 23.682 v 16.9.0 • 3GPP TS 29.337 v 16.1.0 • 3GPP TS 29.214 v 16.7.0 • 3GPP TS 32.291 v16.14 • 3GPP TS 32.290 v16.10.0 • 3GPP TS 32.254 v16.6.0

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Table 2-2 (Cont.) 4G and 5G Network Functions

Network Functions	Abbreviation	Description	3GPP Standard
Policy Control Function	PCF	Implements a unified policy framework for implementing control plane rules.	• 3GPP TS 23.501 • 3GPP TS 23.502 • 3GPP TS 23.503 • 3GPP TS 29.500 • 3GPP TS 29.504 • 3GPP TS 29.510 • 3GPP TS 29.507 • 3GPP TS 29.512 • 3GPP TS 29.513 • 3GPP TS 29.514 • 3GPP TS 29.519 • 3GPP TS 29.521 • 3GPP TS 29.525 • 3GPP TS 29.594 • 3GPP TS 29.214
Binding Support Function	BSF	Provides PCF binding (mapping and selection) for User Equipment (UE).	• 3GPP TS 23.501 v17.7.0 • 3GPP TS 23.502 v17.7 • 3GPP TS 23.503 V17.7 • 3GPP TS 29.500 v17.7.0 • 3GPP TS 29.510 v17.7 • 3GPP TS 29.513 V17.7 • 3GPP TS 29.521 v17.7.0 • 3GPP TS 33.501 V17.7.0

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Table 2-2 (Cont.) 4G and 5G Network Functions

Network Functions	Abbreviation	Description	3GPP Standard
Oracle Communications Cloud Native Core, Certificate Management	OCCM	Supports automation of certificate lifecycle management.	• 3GPP TS 33.310-h30 • 3GPP TR 33.876 v.0.3.0
Cloud Native Core Console	CNC C	Configuration and Operations portal and proxy for CNC NFs and components.	NA

Table 2-3 5G Common Services

Network Function	Abbreviation	Description
Ingress Gateway, Egress Gateway, Alternative Routing Service	APIGW	Ingress and Egress Gateways for NFs
Automatic Test Suite	ATS	Automated Test Suite
Oracle Communications DBTier	cnDBTier	Containerized deployment and automation of MySQL Cluster database technology
Oracle Communications Certificate Manager	OCCM	Certificate Management
Oracle Communication Cloud Native Core OCI Adaptor	OCI Adaptor	Oracle Communications Cloud Native Core OCI Adaptor
Operations Services Overlay	OSO	OSO installs and configures common operation services. For example, you can install and configure Prometheus and its components like AlertManager in a previously installed Kubernetes cluster.
Network Repository Function - Client	NRF-Client	Product: Oracle Communications Cloud Native Core - 5G and Subcomponent: NRF-Client
Mediation	Mediation	Mediation modifies 5G Service Based Interface (SBI) message content, which includes HTTP2 header values and JSON message body, based on the user-defined mediation rule sets

2.2 Secure Development Practices

Given below are the practices followed for a secure development environment:

2.2.1 Vulnerability Handling

For details about the vulnerability handling, refer Oracle Critical Patch Update Program. The primary mechanism to backport fixes for security vulnerabilities in Oracle products is quarterly Critical Patch Update (CPU) program.

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In general, the CNC Software is on a quarterly release cycle, with each release providing feature updates and fixes and updates to relevant third party software. These quarterly releases provide cumulative patch updates.

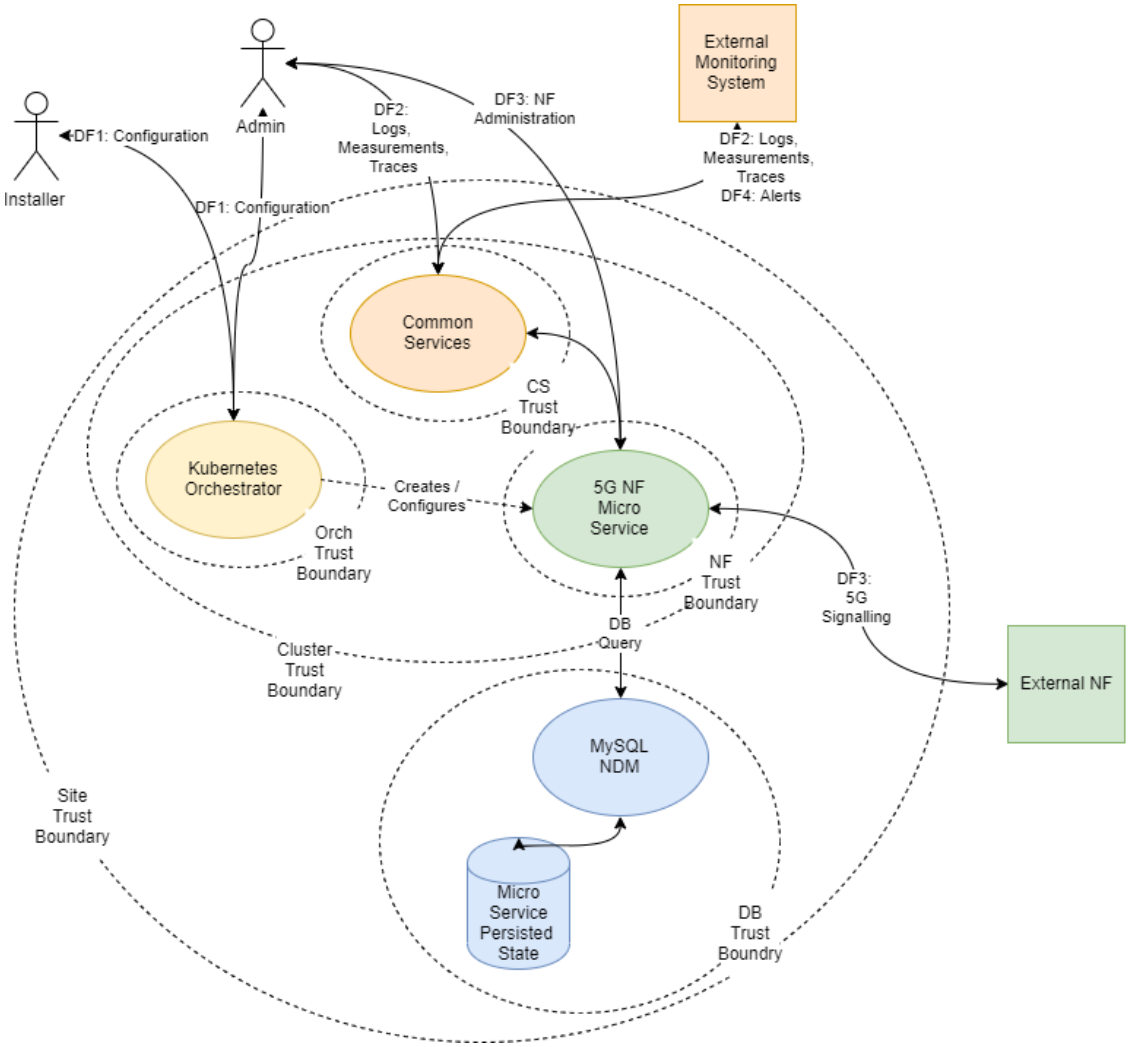
You should have procedures in place to deploy security updates for each release cycle. For more information, see Implementing Security Recommendations and Guidelines.

2.3 Trust Model

The following Trust Model depicts the reference trust model (regardless of the target environment). The model describes the critical access points and controls site deployment.

While the model shows a single 5G NF microservice deployed, several NFs are also deployed in individual clusters.

2.3.1 Context diagram



2.3.2 Key Trust Boundaries

Trust Boundaries identify areas at a similar level of trust and isolate them from other areas at a different level of trust. Following are the key trust boundaries:

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Table 2-4 Key Trust Boundaries

Trust Boundary	Includes	Access Control
Site Trust Boundary	All the NFs and other supporting elements for a given site.	Cluster Access Policies are implemented using some kind of Access Control Group (or Security Group) mechanism.
Cluster Trust Boundary	All the compute elements for a given cluster	Network Policies control traffic ingress and egress. Pod Security Policies manage the workloads allowed in the cluster (For example, no pods requiring privilege escalation).
DB Trust Boundary	All the cnDBTier elements for a given cluster	Firewall Policies control traffic ingress and egress. DB grants access and other permission mechanisms that provide authorization for users.
Orchestrator Trust Boundary (Orch Trust Boundary)	The orchestration interface and keys	Firewall Policies control the access to a Bastion server which provides orchestration services. Access to the Bastion host uses Secure Socket Shell (SSH) protocol. The cluster orchestration keys are stored on the Bastion host.
CS Trust Boundary	The common services implementing logging, tracing, and measurements.	Each of the common services provides independent Graphical User Interfaces (GUIs) that are currently open. The customer may want to introduce an api-gateway, implement authentication and authorization mechanisms to protect the OAM (Operations, Administrations, and Maintenance) data. The common services can be configured to use Transport Layer Security (TLS). When TLS is used, certificates must be generated and deployed through the orchestrator.
NF Trust Boundaries	A collection of 5G Network Functions deployed as a service.	5G NF microservices provide Signaling access through a TLS protected HTTP2 interface. The certificates for these interfaces are managed via the certificate manager.

2.3.3 External Data Flows

The following are external data flows:

Table 2-5 External Data Flows

Data Flow	Protocol	Description
DF1: Configuration	SSH	The installer or administrator accesses the orchestration system hosted on the Bastion Server. The installer or administrator must use ssh keys to access the bastion to a special orchestration account (not root). Password access is not allowed.
DF2: Logs, Measurements, Traces	HTTP/HTTPS	The administrator or operator interacts with the common services using web interfaces.
DF3: 5G Signaling	HTTP2 (w/TLS)	All signaling interaction between NFs at a site and NFs at an external site is sent through TLS protected HTTP2.
DF4: Alerts	SNMP (Trap)	Alerting is performed using SNMP traps.

The complete list of network flows including service types and ports are available in Port Flow Appendix.

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3

Implementing Security Recommendations and Guidelines

3.1 Common Security Recommendations and Guidelines

This section provides details of the common security recommendations and guidelines, irrespective of the NFs.

3.1.1 4G and 5G Application Authentication and Authorization

Mutual Transport Layer Security (mTLS) is a type of authentication in which the two parties in a connection authenticate each other using the TLS protocol. mTLS ensures that the traffic is secure and trusted in both directions between a client and server. Cloud Native Core NFs support integration with platform service meshes and Mutual Transport Layer Security (mTLS) may be provided by the platform service mesh, thereby securing communication flows between all applications that participate in the platform service mesh. mTLS also encrypts the data flows so that only the endpoints of the mTLS session can access the contents of the communication data.

4G and 5G NFs use Mutual Transport Layer Security (mTLS) authentication to secure communication. All NFs require to establish a trust relationship with all peers by exchanging and trusting peer root or intermediate certificates. The peer certificates must be available in the truststore (K8s Secrets) to establish secure communication.

4G and 5G NFs also support manual importation and a semiautomatic import using the cert-manager external provider.

3.1.2 cnDBTier Security Recommendations and Guidelines

The cnDBTier provides a highly available multisite database that stores NF state and configuration. When installed, the MySQL DB is configured with a root account whose password is randomly generated. Each NF must have additional accounts for that particular NF.

The following procedures are specific to the CNE environment, used in baremetal and some cloud deployment models.

The procedures in this section explain the following:

cnDBTier Security Recommendations and Procedures

After the installation, the cnDBTier system security instance must be audited prior to placing the system into service. This primarily consists of changing credentials and sequestering SSH keys to trusted servers. The following table lists all the the credentials that need to be checked, changed, and retained:

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Table 3-1 Credentials

Credential Name	Type	Associated Resource	Initial Setting	Credential Rotation
Replication	User/ Password	DB Replication Service	dbtpasswd asks for a brand new password when installing DB Tier	reset at new installation
Backup Encryption	User/ Password	DB Backup Executor Service	dbtpasswd asks for a brand new password when installing DB Tier	reset at new installation
MySQL Root Secret	User/ Password	MySQL	dbtpasswd asks for a brand new password when installing DB Tier	reset at new installation
DB-monitor Secret	K8s Secret	DB Monitor Service	dbtpasswd asks for a brand new password when installing DB Tier	reset at new installation
SSH Keys	username/SSH key	DB Backup Executor Service	SSH Keys required for secure transfer of cnDBTier backups	reset at new installation
SSH Keys	username/SSH key	DB Replication Service	SSH Keys required for replication connections between sites	reset at new installation
TDE Password	User/ Password	DB Data Service	password required for Transparent Data Encryption service	reset at new installation
TDE Secret	K8s Secret	DB Data Service	Created with TDE password for Transparent Data Encryption service	reset at new installation
HTTPS KeyStore password	certificate/ password	Replication Management K8s Service	Created during x.509/SSL certificate creation procedure	reset at new installation
HTTPS Secret	K8s Secret	Replication Management K8s Service	user creates http secret using keystore password	reset at new installation

If factory or Oracle defaults were used for any of these credentials, they should be changed prior to placing the system into operation. The customer should then store these credentials in a safe a secure way off site. It is recommended that the customer may plan a regular schedule for updating (rotating) these credentials.

Specific procedures and recommendations for cnDBTier credential management are the following:

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> **Note**
>
> **Plan Credential Rotation**: It is important to plan ahead a recurrent credential rotation. Follow the quoted procedures in this guideline, schedule and perform manual credential rotation.The timespan to rotate them depends on your password policies, but it is recommended at most one year to update the credentials.

Password Security Recommendations

Password Policy setup

Ensure that your password meets the following password policy requirements:

- Password must be between 20 and 32 characters in length.
- Password must contain at least one lower case letter.
- Password must contain at least one upper case letter.
- Password must include at least one digit.
- Password must include at least one of the following special characters: `,%~+.:_/-`

> **Note**
>
> - **MySQL Password Autogeneration**: MySQL has the feature to autogenerate password. If that feature is used, the password policy given above must be met.
> - **Compling with Password Policy**: If a character does not meet one of the above complexity requirements, it is not supported, and it may break the functionality of this script.
> - **Password Management**: In order to keep track of the inserted passwords, it is highly recommended to use a password manager.
> - **Use unique passwords**: It is highly recommended to use a unique password for each CNE password. Avoid reusing passwords, specially for root access.
> - It is highly recommended to use password encryption for MySQL.

Credential Management Procedures

Changing cnDBTier passwords

Review and follow maintenance procedures:

The cnDBTier User Guide provides detailed procedures on how to manage passwords and secrets. Deviations from the standard install time configuration are not recommended. Refer to the " **Managing Passwords and Secrets**" chapter in the "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Modifying cnDBTier Password Encryption Key

This procedure describes how to modify the encryption key used to encrypt the replication username and password.

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> **Note**
>
> **Use the same encryption key across all other mate sites**
> If you update an encryption key on one site, ensure that you use the same encryption key across all the other mate sites.
>
> - Refer to the "Modifying cnDBTier Password Encryption Key" chapter in "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Changing cnDBTier Passwords

This section provides the procedures to change cnDBTier passwords such as root user, occneuser, and occnerepluser passwords in a stand alone and multisite georeplication setup using the `dbtpasswd` bash script.

> **Note**
>
> **Scope of the password change**:
>
> - The password changes are applicable only to the current site and are not replicated in the mate sites.
> - Ensure that your password meets the password policy in the section Password Policy setup.
> - Any character that does not meet the complexity requirements mentioned in the previous note is not supported as it may break the functionality of the `dbtpasswd` script.

Changing a cnDBTier password involves the following steps:

1. Adding a new password in MySQL.

   > **Note**
   >
   > - The old password is active until the pods are restarted and the transitional operations are complete.
   > - This is achieved by the MySQL dual password feature, which first adds the new password and keeps the old MySQL password, until all database values and secrets are changed and the pods are restarted.
   > - Both the passwords are valid until the old password is discarded explicitly.
   > - MySQL dual password is not supported for changing the root password.

2. Replacing the current or old password with the new password in Kubernetes secret.
3. Restarting the configured cnDBTier pods to use the new Kubernetes secret (This step is not applicable while changing an NF password).
4. Discarding the old password in MySQL.

The `dbtpasswd` bash script automates these steps and provides a single script to change all cnDBTier passwords at once.

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You can use `dbtpasswd` to:

- change one or more cnDBTier passwords in a single site or cluster. Changing a cnDBTier password on a site includes changing the password in MySQL and Kubernetes secret, restarting all required cnDBTier pods, and updating passwords on cnDBTier database tables if necessary.
- change passwords on a live cluster with no service interruption.
- change NF passwords. However, when changing an NF password, *dbtpasswd* can change the password in the Kubernetes secret and database only. You have to manually restart NF pods as a separate user action.

Refer to the "Changing All cnDBTier Passwords" chapter in "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Changing all cnDBTier Passwords in Phases

If there is a need to change all cnDBTier passwords, but in different stages or phases, follow the next procedure that will change the passwords one step at a time.

This procedure uses `dbtpasswd` bash script, which automates these steps and provides a single script to change all cnDBTier passwords at once.

- Refer to the "Changing All cnDBTier Passwords in Stages" chapter in "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Changing NF Password in different NF Namespace

This section provides the procedures to change an NF password when the secret is stored in an NF namespace that is different from the cnDBTier namespace.

> **Note**
>
> **Enter current password of NF Secret**: When the output prompts for the current password, enter the current password in the NF secret.

Refer to the "Changing an NF Password" chapter in "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Modifying cnDBTier Backup Encryption Password

This section provides the procedure to modify the cnDBTier backup encryption password.

You can use `dbtpasswd` to:

- change one or more cnDBTier passwords in a single site or cluster. Changing a cnDBTier password on a site includes changing the password in MySQL and Kubernetes secret, restarting all required cnDBTier pods, and updating passwords on cnDBTier database tables if necessary.
- change passwords on a live cluster with no service interruption.
- change NF passwords. However, when changing an NF password, *dbtpasswd* can change the password in the Kubernetes secret and database only. You have to manually restart NF pods as a separate user action

Refer to the "Modifying cnDBTier Backup Encryption Password" in Section "Maintenance Procedures" in

Oracle Communications Cloud Native Core, cnDBTier User Guide.

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Keys and Certificates Management Procedures

Modifying SSH Keys for Transferring Backups

This section provides the procedure to modify Secure Shell (SSH) keys for securely transferring cnDBTier backups.

Perform the following steps to move the existing SSH keys to the backup directory and delete the existing SSH secrets:

- Refer to the " Modifying SSH Keys for Transferring Backups" chapter in the "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Modifying Transparent Data Encryption (TDE) password
This section provides the procedure to modify the Transparent Data Encryption (TDE) password. The Transport Data Encryption (TDE) feature in cnDBTier allows you to encrypt data stored in data nodes. When TDE is enabled, the backup data record and log files written by each data node are encrypted using a password and a salt that is randomly generated.

- Refer to the " Modifying Transparent Data Encryption Password" chapter in the "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

Creating HTTPS or TLS Certificates for Encrypted Connection
This section provides the procedure to create certificates that are used for encrypting connection between replication channels using TLS or HTTPS.

> **Note**
>
> **Compliance with Certificates Industry Standards**: Certificate creation and utilization must adhere to the standards specified in https://datatracker.ietf.org/doc/html/rfc5280, https://datatracker.ietf.org/doc/html/rfc8446, and https://datatracker.ietf.org/doc/html/rfc2818.

This procedure uses openssl to create certificates.

- Refer to the "Creating HTTPS or TLS Certificates for Encrypted Connection" chapter in the "Appendix" in *Oracle Communications Cloud Native Core, cnDBTier Installation, Upgrade and Fault Recovery Guide*.

Modifying HTTPS Certificates
This section provides the procedure to modify HTTPS certificates:

Perform the following steps to move the existing SSH keys to the backup directory and delete the existing SSH secrets:

1. Create a new certificate by following the sample procedure provided in the "Creating HTTPS or TLS Certificates for Encrypted Connection" chapter in the "Appendix" in *Oracle Communications Cloud Native Core, cnDBTier Installation, Upgrade and Fault Recovery Guide*.
2. Refer to the " Modifying HTTPS Certificates" chapter in the "Maintenance Procedures" in *Oracle Communications Cloud Native Core, cnDBTier User Guide*.

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Operational Security Recommendations

Accessing to MySQL Database through command line

Whenever you are accessing to the cnDBTier applications or pods, consider the following scenarios:

> **Note**
>
> Password in the command shell
>
> Avoid storing the password in the Bash history. Prefer using commands without the password or mask the password within the command, and then wait for the application to ask you the password.

Example on how to properly use the mysql command login, where Password is not provided but inserted after the command was sent.

```
$ kubectl -n cluster1 exec -it ndbmysqld-1 -- bash
$ mysql -h 127.0.0.1 -uroot -p
Password:
mysql> SHOW REPLICA STATUS\G;
```

Use a unique credential for DB CLI Access: When creating user accounts to access the DB and perform business logic operations, it is highly recommended to create a unique username and password to access to the DB CLI. Having a unique account for DB CLI access reduces the exposure of the NF User accounts and helps avoiding potential attacks to the DB CLI account.

Avoid using root account for DB CLI: Following the recommendation above, it is highly recommended not to use the root account for any DB CLI operations. This keeps safe the root credential from any possible stealing or misplacement, and avoids unauthorized access.

Importance of cnDBTier Password Encryption

In the SOME specific cases the cnDBTier deployment should have password encryption disabled, Refer to "Appendix - Disabling Password Encryption" section in *Oracle Communications Cloud Native Core, cnDBTier Installation, Upgrade, and Fault Recovery Guide*.

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Importance of Transport Data Encryption Password

> **Note**
>
> **Transport Data Encryption (TDE)**:The Transport Data Encryption (TDE) feature in cnDBTier is an effective solution that allows you to encrypt data stored in data nodes, which handles sensitive information. When TDE is enabled, the backup data record and log files written by each data node are encrypted using a password and a Salt that is randomly generated. This encryption process utilizes a key derivation function (KDF) with the PBKDF2-SHA256 algorithm to generate a symmetric encryption key for each file.
>
> **Enabling TDE**: It is highly recommended to enable TDE in cnDBTier, as this provides encryption to database files on disk. This mechanism makes sensitive data inaccessible to unauthorized users.

Network Security Recommendations and Procedures

Network Security Recommendations

cnDBTier support HTTPS connection on all the cnDBTier microservices, except the MySQL client connections to the NDB App MySQL (ndbappmysqld) servers, as those connections do not use http.

> **Note**
>
> - **Customizing cnDBTier to use HTTPS**: Review "Customizing cnDBTier" section from *Oracle Communications Cloud Native Core, cnDBTier Installation, Upgrade, and Fault Recovery Guide* to review the network policies.
> - **Enable HTTPS**: It is highly recommended to use https connections to elevate the security posture of the connections.

Network Policies Recommendations

> **Note**
>
> - **Customizing cnDBTier to use HTTPS**: Review the "Global Parameters" from "Customizing cnDBTier" section from *Oracle Communications Cloud Native Core, cnDBTier Installation, Upgrade, and Fault Recovery Guide* to review the network policies.
> - **Network Policies**: It is highly recommended to enable and configure cnDBTier network policies, per your specific needs.

The Kubernetes network policies are a crucial feature for controlling and securing network traffic within a Kubernetes cluster. cnDBTier has implemented Network policies in their services, in order to enhance security and control incoming and outgoing traffic. Network policies have been implemented from 24.2.x release onwards.

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- db-backup-manager-svc
- db-monitor-svc
- MySQL Cluster Pods
  - ndbmgmd
  - ndbmtd
  - ndbmysqld
  - ndbappmysqld
- helm test
- Pre Upgrade hook
- Post Upgrade hook
- Leader Replication Service
- Replication Service (Non Leader)
- Post Install hook
- Post Rollback hook

3.1.3 Cloud Native Core Gateway Services Specific Security Recommendations and Guidelines

This section provides Ingress and Egress Gateways specific security recommendations and guidelines. Security recommendations common to all 5G and 4G are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- Enabling TLS and Ciphers in Ingress/Egress Gateway
- Certificate Management and Dynamic reload of certificates in Gateways
- Gateway Services Access Token Secret Configuration
- Gateway Services Access Token Secret Update
- Gateway Services MySQL Secret Configuration
  - Kubernetes Secret Creation for Gateway Services Privileged Database Users
  - Kubernetes Secret Update for Gateway Services Privileged Database Users
  - Kubernetes Secret Creation for Gateway Services Application Database User
  - Kubernetes Secret Update for the Gateway Services Application Database Users
- Network Policies

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Enabling TLS and Ciphers in Ingress and Egress Gateway

Use the following procedure to enable TLS and Ciphers:

1. Helm configuration to enable TLS:
   To open HTTPS port in Ingress Gateway, set the `enableIncomingHttps` parameter to true.

   To configure the HTTPS client in Ingress Gateway, set the `enableOutgoingHttps` parameter to true.
2. Create the following files:
   a. RSA or ECDSA Private key (Example: `rsa_private_key_pkcs1.pem`)
   b. Truststore password (Example:`trust.txt`)
   c. Key store password (Example: `key.txt`)
   d. Certificate chain for truststore (Example: `caroot.cer`)
   e. Signed server certificate (Example: `ocingress.cer`) or Signed client certificate (Example: `ocegress.cer`)

   > **Note**
   >
   > Creation of private keys, certificates, and passwords is at the discretion of user.

3. Run the following command to create secret:

   ```
   $ kubectl create secret generic ocingress-secret --from-
   file=rsa_private_key_pkcs1.pem
   --from-file=trust.txt --from-file=key.txt --from-file=ocingress.cer --from-
   file=caroot.cer -n ocingress
   ```

4. Enable the cipher suites:
   - Cipher Suites to be enabled on Server side (Ingress Gateway).
   - Cipher Suites to be enabled on Client side (Egress Gateway).

   Cipher Suites:

   ```
   TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
   TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384
   TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256
   TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
   TLS_ECDHE_RSA_WITH_CHACHA20_POLY1305_SHA256
   ```

Certificate Management and Dynamic Reload of Certificates in Gateway Services

Whenever certificates get compromised or a new certificate chain is required to be added to the truststore, you can update the key and truststore used by the application.

To update the key and the truststore, update or replace the secret:

```
$ kubectl create secret generic ocingress-secret --from-
file=rsa_private_key_pkcs1.pem
 --from-file=trust.txt --from-file=key.txt --from-file=tmp.cer --from-
```


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```
file=caroot.cer --dry-run -o yaml
 -n ocingress| kubectl replace -f - -n ocingress
```

Whenever there is an update in the certificate chain or signed certificate placed in secret, Kubernetes watcher implemented in update container checks for a change in file state and replaces the key and truststore accordingly in the mounted shared volume.

Dynamic reload of certificates is not supported in Ingress Gateway as of now, so a manual restart of pod is required when any update in the configuration is made with respect to https.

In case of Egress Gateway, update container will trigger the rest endpoint to reload key and truststore dynamically. Then Egress Gateway will pickup new store files from shared volume and reload trust and key managers. Egress Gateway will use the replaced store to establish new connections and gracefully terminate existing connections by sending a GOAWAY frame.

Gateway Services Access Token Secret Configuration

Use the following procedure to create an Access token secret:

1. Create the following files:
   - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for Gateway Services
   - RSA private keys for algorithm RS256 and corresponding valid public certificates for Gateway Services

   > **Note**
   >
   > Creation of private keys, certificates and passwords are at the discretion of user.

2. Log in to Bastion Host or server from where you can run kubectl commands.
3. Create a namespace for the secret by performing the following procedure:
   a. Verify if the required namespace already exists in the system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required namespace is available. If not available, create the namespace using the following command:

      > **Note**
      >
      > This is an optional step. In case required namespace already exists, proceed with next procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      Example:

      ```
      $ kubectl create namespace ocegress
      ```

4. Create Kubernetes secret for the Access token by performing the following steps:
   a. To create Kubernetes secret for HTTPS, the following files are required:

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- ECDSA private keys for algorithm ES256 and corresponding valid public certificates for Gateway Services
- RSA private keys for algorithm RS256 and corresponding valid public certificates for Gateway Services

> **Note**
>
> Creation process for private keys, certificates and passwords is at the user's or operators discretion. Unencrypted key and certificates is only supported. PKCS1 and PKCS8 are the only supported versions for RSA. PKCS8 is the only supported version for ECDSA.

b. Run the following command to create secret. The names used below are the same as provided in the `custom_values.yaml` file in Gateway Services deployment:

```
$ kubectl create secret generic <ocegressaccesstoken-secret-name>  --
from-file=<ecdsa_private_key.pem>
 --from-file=<rsa_private_key.pem>  --from-file=<ssl_truststore.txt> --
from-file=<keystore_password.txt>
  --from-file=rsa_certificate.crt --from-file=<ecdsa_certificate.crt> -
n <Namespace of ocegress AccessToken secret>
```

> **Note**
>
> Note down the command used during the creation of Kubernetes secret. This command will be used for future references.

```
$ kubectl create secret generic ocegressaccesstoken-secret  --from-
file=ecdsa_private_key.pem
--from-file=rsa_private_key.pem  --from-file=ssl_truststore.txt --from-
file=keystore_password.txt  --from-file=
rsa_certificate.crt --from-file=ecdsa_certificate.crt -n ocegress
```

c. Run the following command to verify if the secret is created:

```
$ kubectl describe secret <ocegressaccesstoken-secret-name> -n
<Namespace of Gateway Services AccessToken secret>
```

Example:

```
 $ kubectl describe secret ocegressaccesstoken-secret -n ocegress
```

Gateway Services Access Token Secret Update

Use the following procedure to update the Access token secret:

1. Update the following files:
   - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for Gateway Services

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- RSA private keys for algorithm RS256 and corresponding valid public certificates for Gateway Services

> **Note**
>
> Update of private keys, certificates and passwords are at the discretion of user.

2. Log in to Bastion Host or server from where you can run `kubectl` commands.
3. Update the secret with new or updated details by performing the following procedure:
   a. Copy the exact command used in above section during creation of secret.
   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of Access Token secret>".
   c. Create secret command must look like:

```
$ kubectl create secret generic <ocegressaccesstoken-secret> --from-
file=<ecdsa_private_key.pem>
--from-file=<rsa_private_key.pem> --from-file=<rsa_certificate.crt> --
from-file=<ecdsa_certificate.crt>
 --dry-run -o yaml -n <Namespace of ocegress deployment> | kubectl
replace -f - -n <Namespace of ocegress deployment>
```

   Example: The names used below are the same as provided in the `custom_values.yaml` in Gateway Services deployment:

```
$ kubectl create secret generic ocegressaccesstoken-secret --from-
file=ecdsa_private_key.pem
--from-file=rsa_private_key.pem --from-file=rsa_certificate.crt --from-
file=ecdsa_certificate.crt
--dry-run -o yaml -n ocegress | kubectl replace -f - -n ocegress
```

   d. Run the updated command.
   e. After successful secret update, the following message is displayed:

```
secret/<ocegressaccesstoken-secret> replaced
```

Gateway Services MySQL Secret Configuration

This section describes the secret creation for following types of Gateway Services users. Different users have different sets of permissions.

- Gateway Services privileged user: This user category has a complete set of permissions. The user can perform DDL and DML operations to install, upgrade, roll back or delete operations.
- Gateway Services application user: This user category has fewer sets of permissions and is used by Gateway Services applications during service operations handling. This user cannot create, alter, and drop the database and tables.

Kubernetes Secret Creation for Gateway Services Privileged Database Users

This section provides procedures to create Kubernetes secrets for accessing the Gateway Services database for the privileged user.

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1. Log in to Bastion Host or server from where you can run the `kubectl` commands.
2. Create a namespace for the secret by performing the following procedure:
   a. Verify if the required namespace already exists in the system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if the required namespace is available. If not available, create the namespace using the following command:

      > **Note**
      >
      > This is an optional step. In case the required namespace already exists, proceed with the next set of procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      For example:

      ```
      $ kubectl create namespace ocegress
      ```

3. Create a Kubernetes secret for privileged users as follows:
   a. Create a Kubernetes secret for MySQL:

      ```
       $ kubectl create secret generic <privileged user secret name>
       --from-literal=dbUsername=<Gateway Services Privileged MySQL database
      username>
      --from-literal=dbPassword=<Gateway Services Privileged MySQL User
      database password>
      --from-literal=appDbName=<Gateway Services MySQL database name>
      --from-literal=networkScopedDbName=<Gateway Services MySQL Network
      database name>
      --from-literal=commonConfigDbName=<Gateway Services MySQL Common
      Configuration DB> -n
      <Namespace of Gateway Services deployment>
      ```

      > **Note**
      >
      > Note down the command used during the creation of the Kubernetes secret. This command is used for future references.

      Example:

      ```
      $ kubectl create secret generic privilegeduser-secret --from-
      literal=dbUsername=ocegressPrivilegedUsr
      --from-literal=dbPassword=ocegressPrivilegedPasswd --from-
      literal=appDbName=ocegressApplicationDB --from-literal
      ```


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```
=networkScopedDbName=ocegressNetworkDB --from-
literal=commonConfigDbName=commonConfigurationDB -n ocegress
```

b. Verify the secret created using above command:

```
$ kubectl describe secret <database secret name> -n <Namespace of
Gateway Services deployment>
```

Example:

```
$ kubectl describe secret privilegeduser-secret -n ocegress
```

Kubernetes Secret Update for Gateway Services Privileged Database Users

This section provides procedures to update Kubernetes secrets for accessing the Gateway Services database for the privileged user.

1. Log in to Bastion Host or server from where you can run the `kubectl` commands.
2. Update Kubernetes secret for privileged user as follows:
   a. Copy the exact command used in section during creation of secret:

```
$ kubectl create secret generic <privileged user secret name>
--from-literal=dbUsername=<Gateway Services Privileged MySQL database
username>
--from-literal=dbPassword=<Gateway Services Privileged MySQL database
password>
--from-literal=appDbName=<Gateway Services MySQL database name>
--from-literal=networkScopedDbName=<Gateway Services MySQL Network
database name>
--from-literal=commonConfigDbName=<Gateway Services MySQL Common
Configuration DB> -n
<Namespace of Gateway Services deployment>
```

   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of MySQL secret>". After update, the command will be as follows:

```
$ kubectl create secret generic <privileged user secret name>
--from-literal=dbUsername=<Gateway Services Privileged MySQL database
username>
--from-literal=dbPassword=<Gateway Services Privileged MySQL database
password>
--from-literal=appDbName=<Gateway Services MySQL database name>
--from-literal=networkScopedDbName=<Gateway Services MySQL Network
database name>
--from-literal=commonConfigDbName=<Gateway Services MySQL Common
Configuration DB> --dry-run -o yaml
-n <Namespace of Gateway Services deployment> | kubectl replace -f - -n
<Namespace of Gateway Services deployment>
```

   c. Run the updated command. The following message is displayed:

```
secret/<database secret name> replaced
```


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Kubernetes Secret Creation for Gateway Services Application Database User

This section provides procedures to create Kubernetes secrets for accessing the Gateway Services database for the application database user.

1. Log in to Bastion Host or server from where you can run the `kubectl` commands.
2. Create a namespace for the secret by performing the following procedure:
   a. Verify if the required namespace already exists in the system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required the namespace is available. If not available, create the namespace using the following command:

      > **Note**
      >
      > This is an optional step. In case the required namespace already exists, proceed with the next set of procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      Example:

      ```
      $ kubectl create namespace ocegress
      ```

3. Create a Kubernetes secret for the Gateway Services application database user for configuring records as follows:
   a. Create a Kubernetes secret for the Gateway Services application database user:

      ```
      $ kubectl create secret generic <appuser-secret name> --from-
      literal=dbUsername=<Gateway Services APPLICATION User Name> --from-
      literal=dbPassword=<Password for Gateway Services APPLICATION User> --
      from-literal=appDbName=<Gateway Services Application Database> -n
      <Namespace of Gateway Services deployment>
      ```

      > **Note**
      >
      > Note down the command used during the creation of Kubernetes secret. This command will be used for future references.

      Example:

      ```
      $ kubectl create secret generic appuser-secret --from-
      literal=dbUsername=GatewayServicesApplicationUsr --from-
      literal=dbPassword=GatewayServicesApplicationPasswd --from-
      literal=appDbName=GatewayServicesApplicationDB -n ocegress
      ```


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b. Verify the secret creation:

```
$ kubectl describe secret <appuser-secret name> -n <Namespace of
Gateway Services deployment>
```

Example:

```
$ kubectl describe secret appuser-secret -n ocegress
```

Kubernetes Secret Update for the Gateway Services Application Database Users

This section provides procedures to update Kubernetes secrets for accessing the Gateway Services database for the application database user.

1. Log in to Bastion Host or server from where you can run the `kubectl` commands.
2. This section explains how you can update the Kubernetes secret.
   a. Copy the exact command used in above section during creation of secret:

```
$ kubectl create secret generic <appuser-secret name> --from-
literal=dbUsername=<Gateway Services APPLICATION
 User Name> --from-literal=dbPassword=<Password for Gateway Services
APPLICATION User> --from-literal=appDbName=<Gateway Services
Application Database> -n <Namespace of Gateway Services deployment>
```

   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of MySQL secret>". After update, the command will be as follows:

```
$ kubectl create secret generic <database secret name> --from-
literal=dbUsername=<Gateway Services APPLICATION
User Name> --from-literal=dbPassword=<Password for Gateway Services
APPLICATION User> --from-literal=appDbName=<Gateway Services
Application Database> --dry-run -o yaml -n <Namespace of Gateway
Services deployment> | kubectl replace -f - -n <Namespace
of Gateway Services deployment>
```

   c. Run the updated command. The following message is displayed:

```
secret/<database secret name> replaced
```

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

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For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

3.1.4 Automated Test Suite (ATS) Specific Security Recommendations and Guidelines

This section provides Oracle Communications Cloud Native Core Automated Test Suite (ATS) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedure is: Configuring ATS Kubernetes Secret for HTTPS or TLS.

> **Note**
>
> You must perform the above mentioned procedure for secure GUI and API of ATS.

Configuring ATS Kubernetes Secret for HTTPS or TLS

> **Note**
>
> Do not use the same credentials in different Kubernetes secrets, and the passwords stored in the secrets must follow the password policy requirements.

1. Log in to Bastion Host or server from where the `kubectl` command can be run.
2. Create the following files:
   a. Create a private key, for example, `rsa_private_key_pkcs1.pem`.
   b. Certificate chain for trust store, for example, `caroot.cer`.
   c. Create a signed certificate, for example, `ssl_certificate.crt`.

      > **Note**
      >
      > The creation of keys and certificates are on the discretion of the users.

   d. Create `.p12` format and `jks` format files from above created certificates for Jenkins.
3. Run the following command to verify the required namespace that already exists in the system:

   ```
   kubectl get namespaces
   ```


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4. In the output of the above command, check if the required namespace is available. If unavailable, run the following command to create the namespace:

> **Note**
>
> This is an optional step. In case the required namespace already exists, skip this step.

```
kubectl create namespace <required namespace>
```

Example:

```
kubectl create namespace ocscp
```

5. Run the following command to create the secrets:

```
kubectl create secret generic <secret_name> --from-file=<jks_format_file>
--from-file=<signed.certificate> --from-file=<rsa_private_key_pkcs1.pem> --
from-file=<caroot.cer> -n <namespace>
```

Example:

```
kubectl create secret generic ocats-tls-secret --from-
file=jenkinsserver.jks --from-file=ssl_rsa_certificate.crt --from-
file=rsa_private_key_pkcs1.key --from-file=caroot.cer -n scpsvc
```

3.1.5 Oracle Communications Certificate Management (OCCM) Specific Security Recommendations and Guidelines

This section provides Oracle Communications Certificate Management (OCCM) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

Global Service Account Configuration

This section is optional and it describes how to manually create a service account, role, and rolebinding.

A custom service account can be provided for OCCM deployment in global.serviceAccountName of `occm_custom_values_<version>.yaml`.

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A custom service account can be provided for helm in global.serviceAccountName:

```
global:
  dockerRegistry: cgbu-occncc-dev-docker.dockerhub-phx.oci.oraclecorp.com
  serviceAccountName: ""
```

Configuring Global Service Account to Manage NF Certificates with OCCM and NF in the Same Namespace

A sample OCCM Service account yaml file to create custom service account is as follows:

```
## Service account yaml file for occm-sa
apiVersion: v1
kind: ServiceAccount
metadata:
  name: occm-sa
  namespace: occm
  annotations: {}
---
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: occm-role
  namespace: occm
rules:
- apiGroups:
  - "" # "" indicates the core API group
  resources:
  - services
  - configmaps
  - pods
  - secrets
  - endpoints
  verbs:
  - get
  - watch
  - list
  - create
  - delete
---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: occm-rolebinding
  namespace: occm
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: occm-role
subjects:
- kind: ServiceAccount
  name: occm-sa
  namespace: occm
```


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Configuring Global Service Account to Manage NF Certificates with OCCM and NF in Separate Namespaces

OCCM provides support for key and certificate management in multiple namespaces.

In this deployment model, OCCM is deployed in namespace different from the components namespaces managed by it. It needs privileges to read, write, and delete Kubernetes secrets in the managed namespaces.

This is achieved by creating multiple namespace specific roles and binding them to the service account for OCCM.

- **AUTOMATIC Service Account Configuration:** Roles and role bindings are created for each namespace specified using the `occmAccessedNamespaces` field in `occm_custom_values.yaml`. A service account for OCCM is created automatically and the roles created are assigned using the corresponding role binding.
  Namespaces managed by OCCM service account:

  ```
  occmAccessedNamespaces:
    - ns1
    - ns2
  ```

  > **Note**
  >
  > Automatic Service Account Configuration is applicable for Single Namespace Management as well

- **Custom Service Account Configuration:** A custom service account can also be configured against the `serviceAccountName` field in occm_custom_values.yaml. If this is provided, automatic service account creation doesn't get triggered. The `occmManagedNamespaces` field doesn't need to be configured.
  A sample OCCM service account yaml file for creating a custom service account is as follows:

  ```
  apiVersion: v1
  kind: Namespace
  metadata:
    name: ns1
  ---
  apiVersion: v1
  kind: Namespace
  metadata:
    name: ns2
  ---
  apiVersion: v1
  kind: ServiceAccount
  metadata:
    name: occm-sa
    namespace: occm
    annotations: {}
  ---

  apiVersion: rbac.authorization.k8s.io/v1
  kind: Role
  metadata:
  ```


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```
  namespace: ns1
  name: occm-secret-writer-role
rules:
- apiGroups:
  - "" # "" indicates the core API group
  resources:
  - secrets
  verbs:
  - get
  - watch
  - list
  - create
  - update
  - delete
---

apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  namespace: ns2
  name: occm-secret-writer-role
rules:
- apiGroups:
  - "" # "" indicates the core API group
  resources:
  - secrets
  verbs:
  - get
  - watch
  - list
  - create
  - update
  - delete

---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: occm-secret-writer-rolebinding
  namespace: ns1
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: occm-secret-writer-role
subjects:
- kind: ServiceAccount
  name: occm-sa
  namespace: occm
---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: occm-secret-writer-rolebinding
  namespace: ns2
roleRef:
  apiGroup: rbac.authorization.k8s.io
```


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```
    kind: Role
    name: occm-secret-writer-role
  subjects:
  - kind: ServiceAccount
    name: occm-sa
    namespace: occm
```

Helm Test Service Account Configuration

helmTestServiceAccountName is an optional field in the `occm_custom_values_<version>.yaml` file It should be added only if helm kubernetes resource is enabled. Custom service account can be provided for helm in `global.helmTestServiceAccountName:`:

```
global:
  helmTestServiceAccountName: occm-helmtest-serviceaccount
```

A sample helm test service account yaml file is as follows:

```
helm test service account apiVersion: v1
kind: ServiceAccount
metadata:
  name: occm-helmtest-serviceaccount
  namespace: occm
  annotations: {}
---
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: occm-helmtest-role
  namespace: occm
rules:
- apiGroups:
  - "" # "" indicates the core API group
  resources:
  - services
  - configmaps
  - pods
  - secrets
  - endpoints
  - serviceaccounts
  verbs:
  - get
  - watch
  - list
- apiGroups:
  - policy
  resources:
  - poddisruptionbudgets
  verbs:
  - get
  - watch
  - list
  - update
- apiGroups:
```


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```
  - apps
  resources:
  - deployments
  - statefulsets
  verbs:
  - get
  - watch
  - list
  - update
- apiGroups:
  - autoscaling
  resources:
  - horizontalpodautoscalers
  verbs:
  - get
  - watch
  - list
  - update
- apiGroups:
  - rbac.authorization.k8s.io
  resources:
  - roles
  - rolebindings
  verbs:
  - get
  - watch
  - list
  - update
- apiGroups:
  - monitoring.coreos.com
  resources:
  - prometheusrules
  verbs:
  - get
  - watch
  - list
  - update

---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: occm-helmtest-rolebinding
  namespace: occm
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: occm-helmtest-role
subjects:
- kind: ServiceAccount
  name: occm-helmtest-serviceaccount
  namespace: occm
```


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Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Certificate Management Installation, Upgrade, and Fault Recovery Guide.*

TLS configuration

OCCM does not directly interact with other NF microservices. The access is only through the CNC Console.

> **Note**
>
> - OCCM supports authentication of the CA generating the certificates using the CMPv2 MAC based and signing mechanism.
> - As an additional layer of security encryption of the traffic between OCCM and Certificate Authority using HTTPs is supported.
> - Configuration options are provided at REST API and helm deployment level. Refer to installation and user guide for details on configuration options.

For more information on TLS configuration, see CNC Console IAM LDAP Configuration in the Cloud Native Configuration Console (CNCC) Specific Security Recommendations and Guidelines section.

Network Port Flows

For information on network port flows for OCCM, see "Network Port Flows" in *Oracle Communications Cloud Native Core Certificate Management Installation, Upgrade, and Fault Recovery Guide.*

3.1.6 OCI Adaptor Specific Security Recommendations and Guidelines

This section provides OCI Adaptor specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

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> **Note**
>
> OCI Adaptor is deployed on OCI tenancy owned and managed by the customer. Therefore, customer is expected to develop an OCI security concept on their own.

OCI Adapter Registry Pull Secret (Automated)

While deploying OCI Adaptor, a registry pull secret must get created automatically (using Helm) and is used to pull OCI Adapter images from private Oracle Cloud Infrastructure Registry (OCIR).

Table 3-2 OCI Adaptor Secret

Secret Name	Secret Type	Secret Content
ocir-container-registry-secret	kubernetes.io/dockerconfigjson	**registry_name**: Must be provided by the user on OCI RM Stack UI. **registry_username**: Must be provided by the user on OCI RM Stack UI. **registry_password**: Must be provided by the user on OCI RM Stack UI.

3.1.7 Cloud Native Configuration Console (CNC Console) Specific Security Recommendations and Guidelines

This section provides Cloud Native Configuration Console (CNC Console) specific security recommendations and procedures. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines Section.

> **Note**
>
> kubectl commands might vary based on the platform deployment. Replace kubectl with Kubernetes environment-specific command line tool to configure Kubernetes resources through kube-api server. The instructions provided in this document are as per the Oracle Communications Cloud Native Environment (CNE) version of kube-api server.

> **Caution**
>
> User, computer and applications, and character encoding settings may cause an issue when copy-pasting commands or any content from PDF. PDF reader version also affects the copy-pasting functionality. It is recommended to verify the pasted content especially when the hyphens or any special characters are part of the copied content.

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> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- CNC Console IAM MySQL Secret Configuration
- CNC Console IAM Default User (Admin) Secret Configuration
- OCI IAM Secret Configuration
- CNC Console IAM LDAPS Secret Configuration
- CNC Console IAM LDAP Configuration
- CNC Console TLS Secret configuration
- CNC Console Core Secret Configuration to Enable HTTPS
- CNC Console IAM SAML Configuration
- OCI IAM SAML Configuration
  - Adding a SAML Identity Provider in OCI IAM
  - JIT Configuration in OCI IAM
- Configuring Role Mapping in OCI IAM
- Network Policies

CNC Console IAM MySQL Secret Configuration

Use the following procedure to create MySQL Kubernetes secret:

1. Log in to Bastion Host or server from where kubectl can be executed
2. Create namespace for the secret by running the following commands:
   a. Verify whether the required namespace already exists in system by running the following command:

      ```
      $ kubectl get namespaces
      ```

   b. If the output of the above command does not display the required namespace, create the namespace by running following command:

      ```
      $ kubectl create namespace <required namespace>
      ```

      Example:

      ```
      $ kubectl create namespace cncc
      ```

3. Run the following command to create the Kubernetes secret for MySQL:

   ```
   kubectl create secret generic <database secret name> --from-
   literal=dbUserNameKey=<CNCC
   ```


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```
Mysql database username> --from-literal=dbPasswordKey=<CNCC Mysql database
password> -n <Namespace of MySQL secret
```

Example:

```
$ kubectl create secret generic cncc-db-secret --from-
literal=dbUserNameKey=root --from-
literal=dbPasswordKey=mypass -n cncc
```

4. Run the following command to verify the secret creation:

```
$ kubectl describe secret <database secret name> -n <Namespace of MySQL
secret>
```

Example:

```
$ kubectl describe secret cncc-db-secret -n cncc
```

CNC Console IAM Default User (Admin) Secret Configuration

> **Note**
>
> Not applicable for OCI deployment.

Use the following procedure to create default user (Admin) secret :

1. Log in to Bastion Host or server from where kubectl can be executed
2. Create namespace for the secret by running the following commands:
   Verify whether the required namespace already exists in system by running the following command:

```
$ kubectl get namespaces
```

3. If the output of the above command does not display the required namespace then create the namespace by running following command:

```
$ kubectl create namespace <required namespace>
```

Example:

```
$ kubectl create namespace cncc
```

4. Run the following command to create the Kubernetes secret for MySQL for Admin User:

```
$ kubectl create secret generic <secret-name> --from-
literal=iamAdminPasswordKey=<password> --namespace <namespace>
```


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Example:

```
$ kubectl create secret generic cncc-iam-secret --from-
literal=iamAdminPasswordKey=cncciampasswordvalue --namespace cncc
```

5. Run the following command to verify the secret creation:

```
$ kubectl describe secret <secret name> -n <namespace>
```

Example:

```
$ kubectl describe secret cncc-iam-secret -n cncc
```

OCI IAM Secret Configuration

> **Note**
>
> This section is applicable only for OCI deployment.

1. Login to Bastion Host or server from where kubectl can be run.
2. Run the following commands to create the oci iam secret:
   a. Run the following command to create the Kubernetes secret for OCI IAM clientId and clientSecret:

```
$ kubectl create secret generic <secret-name> --from-
literal=clientId='<clientId>' --from-
literal=clientSecret='<clientSecret>' --namespace <namespace>
```

   b. Run the following command to verify whether the secret is created:

```
$ kubectl describe secret <secret name> -n <namespace>
```

Example:

```
$ kubectl create secret generic oci-iam-secret --from-
literal=clientId='269d98xxxxbb5064' --from-
literal=clientSecret='6779exxxxx9602' --namespace cncc
$ kubectl describe secret oci-iam-secret -n cncc
```

OCI IAM Admin Secret Configuration

> **Note**
>
> This section is applicable only for OCI deployment.

1. Login to Bastion Host or server from where kubectl can be run.
2. Run the following commands to create the oci iam secret:

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a. Run the following command to create the Kubernetes secret for OCI IAM username and password:

```
$ kubectl create secret generic <secret-name> --from-
literal=username='<username>' --from-literal=password='<password>' --
namespace <namespace>
```

b. Run the following command to verify whether the secret is created:

```
$ kubectl describe secret <secret name> -n <namespace>
```

Example:

```
$ kubectl create secret generic oci-iam-admin-secret --from-
literal=username=admin --from-literal=password='adminpass' --namespace
cncc
$ kubectl describe secret oci-iam-admin-secret -n cncc
```

CNC Console IAM LDAPS Secret Configuration

Use the following procedure to create the secrets to enable LDAPS:

> **Note**
>
> The value of `ssl_truststore.txt` and `ssl_truststore-password-key` value must be same.

1. Log in to Bastion Host or server from where kubectl can be run.
2. Create namespace for the secret by running the following commands:
   Verify whether the required namespace already exists in system by running the following command:

   ```
   $ kubectl get namespaces
   ```

   If the output of the above command does not display the required namespace then create the namespace by running following command:

   ```
   $ kubectl create namespace <required namespace>
   ```

   Example:

   ```
   $ kubectl create namespace cncc
   ```

3. Create a secret by running the following command:

   ```
   kubectl create secret generic <secret-name> --from-file=<caroot.cer>
   --from-file=ssl_truststore.txt --from-literal=ssl_truststore-password-
   key=<password> --namespace cncc
   ```


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> **Note**
>
> The command is used for Kubernetes secret updates in future.

Example:

```
$ kubectl create secret generic cncc-iam-kc-root-ca --from-file=caroot.cer
      --from-file=ssl_truststore.txt --from-literal=ssl_truststore-
password-key=<password> --namespace
      cncc
```

Run the following to display the sample ssl_truststore.txt:

```
echo <password> > ssl_truststore.txt
```

4. On successfully running the above command, the following message is displayed: *secret/cncc-iam-kc-root-ca created*
5. Run the following command to verify the secret creation:

```
$ kubectl describe secret cncc-iam-kc-root-ca -n cncc
```

CNC Console IAM LDAP Configuration

Use the following procedure to configure CNC Console IAM LDAP :

1. Set up User Federation with CNC Console IAM by running following steps:
   a. Log in to CNC Console IAM application.
   b. Select **Cncc Realms** and then select **User Federation**; User federation Screen appears.
   c. Fill the necessary parameters and save.
   d. New buttons (**Synchronize changed users**, **Synchronize all users**, **Remove imported**, **Unlink users**) appear next to the **Save** and **Cancel**.
   e. If a user has to be imported to CNCC-IAM, Click **Synchronize all users**.
   f. The user can view the imported users by clicking **Users** under **Manage** in the left pane and click **View all users** in the right pane.
2. Steps to add Group-Mapper and Assign Roles:
   a. Log in to CNC Console IAM application.
   b. Select **Cncc Realms** and then select **User Federation**; User federation Screen appears.
   c. Click **Configure** and select **User Federation**. Click **ldap** (Console Display Name) and select the **Mappers** tab, and click **Create**.
   d. The Add User federation mapper page appears. Select '**group-ldap-mapper**' as **Mapper Type** from dropdown menu. Click **Save**.
   e. Enter the details in the new screen and Save.
   f. New buttons **Synchronize LDAP Groups to Keyclaok** and **Synchronize Keyclaok Groups to LDAP** appear.

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g. Click **Synchronize LDAP Groups to Keyclaok**.

h. Select the **Groups** in the left pane and click the **View all groups** in the right pane.

i. Click any group and then click **Edit**. The following tabs appear: **Settings**, **Attributes**, **Role Mappings**, and **Members**.

j. Select **Role Mapping** tab to see a list of roles that are pre-defined in cncc-iam.

k. Select one or more roles from **Available Roles** and assign it to the group.

CNC Console TLS Secret configuration

Use the following procedure to configure CNC C TLS Secret:

1. To create Kubernetes secret for HTTPS, the following files are required:
   - ECDSA private key and CA signed certificate of CNC Console (if initial Algorithm is ES256)
   - RSA private key and CA signed certificate of CNC Console (if initial Algorithm is RSA256)
   - TrustStore password file
   - KeyStore password file
   - CA certificate
2. Create a secret by running the following command:

   ```
   $ kubectl create secret generic <secret-name> --
   fromfile=<ssl_ecdsa_private_key.pem>
         --from-file=<rsa_private_key_pkcs1.pem> --
   fromfile=<ssl_truststore.txt>
         --from-file=<ssl_keystore.txt> --from-file=<caroot.cer> --
   fromfile=<ssl_rsa_certificate.crt>
         --from-file=<ssl_ecdsa_certificate.crt> -n <Namespace of CNCC IAM
   Ingress Gateway
       secret>
   ```

   Example:

   ```
   $ kubectl create secret generic cncc-iam-ingress-secret
         --fromfile=ssl_ecdsa_private_key.pem  --from-
   file=rsa_private_key_pkcs1.pem
         --fromfile=ssl_truststore.txt --from-file=ssl_keystore.txt --from-
   file=caroot.cer
         --fromfile=ssl_rsa_certificate.crt --from-
   file=ssl_ecdsa_certificate.crt -n
       cncc
   ```

   On successfully running the above command, the following message will be displayed:

   ```
   secret/cncc-iam-ingress-secret created
   ```

   Run the following command to verify the secret creation:

   ```
   $ kubectl describe secret cncc-iam-ingress-secret -n cncc
   ```

3. This section explains how to update the secrets for enabling HTTPS, if they already exist:

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Create a secret by running the following command:

```
$ kubectl create secret generic <secret-name> --
fromfile=<ssl_ecdsa_private_key.pem>
      --from-file=<rsa_private_key_pkcs1.pem> --
fromfile=<ssl_truststore.txt>
      --from-file=<ssl_keystore.txt> --from-file=<caroot.cer> --
fromfile=<ssl_rsa_certificate.crt>
      --from-file=<ssl_ecdsa_certificate.crt> --dry-run -o yaml -n
<Namespace of CNCC IAM Ingress
      Gateway secret> | kubectl replace -f - -n <Namespace of CNCC IAM
Ingress Gateway
    secret>
```

Example:

```
$ kubectl create secret generic cncc-iam-ingress-secret
      --fromfile=ssl_ecdsa_private_key.pem  --from-
file=rsa_private_key_pkcs1.pem
      --fromfile=ssl_truststore.txt --from-file=ssl_keystore.txt --from-
file=caroot.cer
      --fromfile=ssl_rsa_certificate.crt --from-
file=ssl_ecdsa_certificate.crt --dry-run -o yaml -n
      cncc | kubectl replace -f - -n cncc
```

On successfully running the above command, the following message will be displayed:

```
secret/cncc-iam-ingress-secret replaced
```

CNC Console Core Secret Configuration to Enable HTTPS

> **Note**
>
> Not applicable for OCI deployment.

Use the following procedure to configure CNC Console Core Secret to Enable HTTPS:

1. To create Kubernetes secret for HTTPS, the following files are required:
   - ECDSA private key and CA signed certificate of CNC Console (if initial Algorithm is ES256)
   - RSA private key and CA signed certificate of CNC Console (if initial Algorithm is RSA256)
   - TrustStore password file
   - KeyStore password file
   - CA certificate
2. Create a secret by running the following command:

```
$ kubectl create secret generic <secret-name> --
fromfile=<ssl_ecdsa_private_key.pem>
      --from-file=<rsa_private_key_pkcs1.pem> --
fromfile=<ssl_truststore.txt>
```


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```
      --from-file=<ssl_keystore.txt> --from-file=<caroot.cer> --
fromfile=<ssl_rsa_certificate.crt>
      --from-file=<ssl_ecdsa_certificate.crt> -n <Namespace of CNCC Core
Ingress Gateway
    secret>
```

Example:

```
kubectl create secret generic cncc-core-ingress-secret --
fromfile=ssl_ecdsa_private_key.pem
      --from-file=rsa_private_key_pkcs1.pem --fromfile=ssl_truststore.txt
      --from-file=ssl_keystore.txt --from-file=caroot.cer --
fromfile=ssl_rsa_certificate.crt
      --from-file=ssl_ecdsa_certificate.crt -n cncc
```

On successfully running the above command, the following message will be displayed:

```
secret/cncc-core-ingress-secret created
```

Run the following command to verify the secret creation:

```
$ kubectl describe secret cncc-core-ingress-secret -n cncc
```

3. This section explains how to update the secrets for enabling HTTPS if they already exist: Create a secret by running the following command:

```
$ kubectl create secret generic <secret-name> --
fromfile=<ssl_ecdsa_private_key.pem>
      --from-file=<rsa_private_key_pkcs1.pem> --
fromfile=<ssl_truststore.txt>
      --from-file=<ssl_keystore.txt> --from-file=<caroot.cer> --
fromfile=<ssl_rsa_certificate.crt>
      --from-file=<ssl_ecdsa_certificate.crt> --dry-run -o yaml -n
<Namespace of CNCC Core Ingress
      Gateway secret> | kubectl replace -f - -n <Namespace of CNCC Core
Ingress Gateway
    secret>
```

Example:

```
$ kubectl create secret generic cncc-core-ingress-secret
      --fromfile=ssl_ecdsa_private_key.pem  --from-
file=rsa_private_key_pkcs1.pem
      --fromfile=ssl_truststore.txt --from-file=ssl_keystore.txt --from-
file=caroot.cer
      --fromfile=ssl_rsa_certificate.crt --from-
file=ssl_ecdsa_certificate.crt --dry-run -o yaml -n
      cncc | kubectl replace -f - -n cncc
```

On successfully running the above command, the following message will be displayed:

```
secret/cncc-core-ingress-secret replaced
```


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CNC Console IAM SAML Configuration

Use the following procedure to configure CNC Console IAM SAML:

1. To configure SAML identity provider **(IdP)** in CNC Console IAM, log in to CNC Console IAM Console using admin credentials provided during installation of CNC Console IAM .
2. Select **Cncc** realm and the **Identity Provider** tab in the left pane. **Identity Providers** screen appears in the right pane.
3. From the **Add provider** drop down list select the **saml** entry and the **Add Identity Provider** screen appears.
4. To create custom 'First Login Flow', click **Authentication** tab In the left pane. The **Authentication** screen appears.
5. Click **New** at the right pane. **Create Top Level Form** screen appears.
   Enter the appropriate alias and click **Save**.
6. The **Authentication** screen with the newly created custom flow selected in the drop down list appears. Click **Add Execution** in the right pane .
7. **Create Authenticator Execution** screen appears.
   Select **Create User If Unique** from the **Provider** drop down list. Click **Save**.
8. The **Authentication** screen appears with the newly created custom flow selected in the drop down. Under **Requirement** section, select **Alternative**.
9. Select **Identity Provider** in the left pane. Select the custom flow from **First Login Flow** drop down list.

OCI IAM SAML Configuration

SAML (Security Assertion Markup Language) enables applications to authenticate a user using an identity provider. The identity provider authenticates the user and returns the assertion information about the authenticated user and the authentication event to the application. If the user tries to access any other application that uses the same identity provider for user authentication, the user shall not be required to log in a second time and will be granted access. This is the principle of SSO (Single Sign On).

> **Note**
>
> - OCI IAM provides option to implement SAML SSO. This is an optional step.
> - Applicable only for OCI deployment.

The following section describes the steps to implement SAML SSO in OCI IAM.

Adding a SAML Identity Provider in OCI IAM

1. Navigate to the identity domain: Open the navigation menu and click **Identity & Security**. Under **Identity**, click **Domains**.
2. Click the name of the identity domain that you want to work in. You might need to change the compartment to find the domain that you want.
3. Then, click **Security** and then **Identity providers**.
4. Click **Add IdP**, and then click **Add SAML IdP**.

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5. Enter the following information:
   - **Name**: Enter the name of the IdP.
   - (Optional) **Description**: Enter a description of the IdP.
   - (Optional) **Identity provider icon**: Drag and drop a supported image, or click **select one** to browse for the image.
6. Click **Next**.
7. On the **Exchange metadata** screen, do one of the following:
   - **Import IdP metadata**: Select this option if you have an XML file exported from your IdP. Drag and drop the XML file to upload the metadata, or click **select one** to browse for the metadata file.
   - **Enter IdP metadata**: Select this option if you want to manually enter the IdP metadata. Provide the following details:
     - **Identity provider issuer URI**
     - **SSO service URI**
     - **SSO service binding**
     - **Upload identity provider signing certificate**
     - **Enable global logout**
     - **Identity provider logout request URL**
     - **Identity provider logout response URL**
8. On the **Map User Identity Screen,** keep the **Requested Name ID Format** as **None**
9. Map user's identity attributes received from the IdP to an Oracle Cloud Infrastructure identity domain. Mapping options vary based on identity provider. You might be able to directly assign an IdP value to an Oracle Cloud Infrastructure identity domain value. For example, **NameID** might map to **UserName**. If you select SAML assertion attribute as the source, select the Assertion attribute name and then enter the Oracle Cloud Infrastructure identity domain.
10. Click **Submit**.
11. On the **Review and create** screen, review your SAML identity provider settings. If the settings are correct, click **Create**. Click **Edit** next to the set of settings, if you need to change them.
12. The console displays a message when the SAML identity provider is created. You can do the following from the overview page:
    - Click **Test** to verify that the SAML SSO connection is working correctly.
    - Click **Activate** to activate the IdP so the identity domain can use it.
    - Click **Assign to IdP policy rule** to assign this SAML identity provider to an existing policy rule you have created.
13. Click **Close**.

- At this point, the SAML IDP is configured, but any user created in SAML IDP needs to be created in OCI IAM in-order to allow a successful Login
- In order to directly login to CNCC Core via SAML IdP, JIT Provisioning needs to configured (Just-In-Time)

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1. OCI IAMs SAML Metadata can be exported, by clicking on "Export SAML Metadata" on the "Identity Providers" Tab as shown above.
2. The exported file, can be used to configure SAML Client in an IdP

3. JIT Configuration in OCI IAM
JIT stands for Jut-In-Time Provisioning. It allows the federated user to be created in OCI IAM users List whenever a federated user logs in for the first time. Follow below steps to configure this in OCI-IAM

1. On the IDP Configuration Page, click **Configure JIT**
2. Enable Just-In_Time(JIT) provisioning
3. Select one/both of the following options as required:
   - **Create a new identity domain user**: Create an identity user in the identity domain, if the user doesn't exist when sign in with the identity provider.
   - **Update the existing identity domain user**: Merge and overwrite identity domain user account data from the mapped IdP. The existing data is overwritten by the user data from the IdP.
4. In the **Map user attributes** area , map a user account from the IdP to a user account from the identity domain.
   a. Select a value in the **IdP user attribute type** row.
      - If you select **Attribute**, then enter the IdP user attribute name.
      - If you select **NameID**, you don't need to enter the IdP user attribute name.
   b. (Optional) Select the identity domain user attribute.
   c. (Optional) Add more identity domain attributes.
5. For example, as per above screenshot **NameID value** to **userName** is the default mapping, and the **name** to **familyName** mapping is configured by the user.
   - OCI IAM will look for an attribute named ***name***in the Assertions coming from SAML IdP, as mentioned below:

```
<saml:AttributeStatement>
      <saml:Attribute FriendlyName="name"
                      Name="name"
                      NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-
format:basic">
        <saml:AttributeValue xmlns:xs="http://www.w3.org/2001/XMLSchema"
                             xmlns:xsi="http://www.w3.org/2001/
XMLSchema-instance"
                             xsi:type="xs:string">SamlUser</
saml:AttributeValue>
      </saml:Attribute>
```

The user needs to make sure the SAML IDP is populating these attributes in the assertions , else JIT Configuring will not work, thus failing the SAML SSO Authentication

4. Configuring Role Mapping in OCI-IAM
Role Mapping for SAML in OCI IAM is configured as a part of JIT Provisioning configuration. Below mentioned steps can be followed

1. On the IDP Configuration Page, click **Configure JIT**
2. To enable group mapping, **click Assign group mapping**

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3. For **Group membership attribute name** enter the IdP attribute name that contains group memberships.
4. To import the group settings, select one of the following options:
   - **Define explicit group mapping**: This option requires you to provide the group name to map between the IdP and identity domain. If you select this option, enter the IdP group name and select an available identity domain group name.
   - **Assign implicit group mapping**: This option maps an IdP group to an identity domain group that has the same name. No other action is required.
     - OCI-IAM reads Roles as Groups, "Group membership attribute name" has assigned as **groups**
     - After this CNC Console (OCI-IAM) Groups can be mapped to the IdP Groups as mentioned in the below screenshot
5. Under **Assignment rules**, specify actions to take when assigning group memeberships:
   a. If users are assigned to existing groups, select whether to merge with existing group memberships or replace existing group memberships.
6. When a group isn't found, select to take one of the following actions:
   a. **Ignore the missing group**: The user successfully signs in.
   b. **Fail the entire request**: The sign-in attempt fails.
7. Click **Save Changes**.

- OCI-IAM will be reading Groups from the SAML Assertions.
- As the Role Mapping is created through 'groups' attribute name, OCI-IAM will look for 'groups' attribute in SAML Assertions.
- Ensure the IDP is sending the required attributes in assertions

5. Assigning Idp to Identity provider (IdP) policies

1. Under your domain , click **Security** and then **Idp policies.**
2. Create **Idp policy** if required else use **Default Identity Provider Policy**.
3. Under your **Identity Provider Policy ,** click on Add **Idp Rule** to create a new Rule if required else to use **Default IDP Rule** click on the **Edit IdP rule**.
4. Assign the name of IdP under **Assign identity providers**.
5. Click **Save** to save the changes and exit.

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

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For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Configuration Console, Installation, Upgrade, and Fault Recovery Guide*.

Network Port Flows

For information on network port flows for CNC Console, see "CNC Console Microservices to Port Mapping" in *Oracle Communications Cloud Native Configuration Console Installation, Upgrade, and Fault Recovery Guide.*

3.1.8 Cloud Native Environment (CNE) Specific Security Recommendations and Guidelines

After installation, audit the CNE security system stance before deploying the system into service. This primarily consists of changing credentials and unique SSH keys to trusted servers. The following table lists all the credentials that need to be checked, changed, and retained:

> **Note**
>
> kubectl commands might vary based on the platform deployment. Replace kubectl with Kubernetes environment-specific command line tool to configure Kubernetes resources through kube-api server. The instructions provided in this document are as per the Oracle Communications Cloud Native Core, Cloud Native Environment (CNE) version of kube-api server.

> **Caution**
>
> User, computer and applications, and character encoding settings may cause an issue when copy-pasting commands or any content from PDF. PDF reader version also affects the copy-pasting functionality. It is recommended to verify the pasted content especially when the hyphens or any special characters are part of the copied content.

Table 3-3 Credentials

Credential Name	Deployment	Credential Type	Associated Resource	Initial Setting for Credential Type	Credential Rotation
TOR Switch	BareMetal Only	username and password	Cisco Top or Rack Switch	username and password from PreFlight Checklist	Reset postinstallation
Enclosure Switch	BareMetal Only	username and password	HP Enclosure Switch	username and password from PreFlight Checklist	Reset postinstallation
OA Admin	BareMetal Only	username and password	On-board Administrator Console	username and password from PreFlight Checklist	Reset postinstallation
ILO Admin	BareMetal Only	username and password	HP Integrated Lights Out Manger	username and password from PreFlight Checklist	Reset postinstallation

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Table 3-3 (Cont.) Credentials

Credential Name	Deployment	Credential Type	Associated Resource	Initial Setting for Credential Type	Credential Rotation
GRUB	BareMetal Only	username and password	Bootloader	Set to Customer input during server installation	Reset post-install
Server Super User (root)	All	username and password	Server Super User	Set to well-known Oracle default during server installation	Reset postinstallation
Server Super User (admusr)	All	username and password	Server Super User	Set to well-known Oracle default during server installation	Reset postinstallation
Server Admin User SSH	All	SSH Key Pair	Server Admin User	Key Pair generated at install time	Can rotate keys at any time; key distribution manual procedure

If factory or Oracle defaults were used for any of these credentials, they must be changed before placing the system into operation. The customer must store these credentials safely and securely offsite. It is recommended that the customer must plan a regular schedule for updating (rotating) these credentials. Specific procedures and recommendations for CNE credential management are provided below:

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

- Network Security Recommendations and Procedures
  - Network Policies Recommendations
  - DNS Recommendations
  - Credential Management Procedures
    - Platform Agnostics Installation
    - Setting Top Of Rack Switch Credentials
    - Setting Enclosure Switch Credentials
- Bastion Host SSH (Port 22) Exposure Recommendations
  - Benefits of Exposing SSH Access
  - Security Risks of Exposing SSH (Port 22)
  - Best Pratices: Restrict SSH (Port 22) Exposure Recommendations
  - Potential Risks of Restricting SSH Access
  - OCCNE Supported Method to Restrict SSH (Port 22) Access
- IP Forwarding for CNLB

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Network Security Recommendations and Procedures

Network Policies Recommendations

> **Note**
>
> **Recommendation**: It is recommended to keep the default configuration for the network policies to provide an extra security layer on the common services.

CNE has implemented network policies on common services. The network policies created during installation or upgrade to 24.2.x. on the following services:

- AlertManager
- Prometheus
- Grafana
- Jaeger
- OpenSearch

DNS Recommendations

At present, CNE supports three options for DNS:

1. External DNS via Bastion Host forwarding to external server.
2. Local (internal) DNS with DNS server on Bastion host.
3. DNS Enhancement through CNLB.

CNE's Bastion Host has the Domain Name System Security Extensions (DNSSEC) feature. DNSSEC adds a layer of trust on top of DNS, by providing authentication. When a FQDN is looked into the DNS resolver, then DNS performs an extra validation by authenticating the information of the published of the FQDN.

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Note

- **Enable DNSSEC for Enhanced DNS Authentication**:

  You must enable DNSSEC to add authentication into the DNS resolution. CNE has enabled by default the DNSSEC, but disabled by default the validation of the DNS records using DNSSEC. It is important to enable the feature once your infrastructure can provide authentication whenever an FQDN is being resolved by the DNS server. Having it enabled ensures that the resolved FQDN comes from a valid party.

- **DNS Enhancement through CNLB - Requests outside of cluster**:
  When DNS requests target external domains (as configured in the platform, for example, using coredns_external_zones), CoreDNS forwards these requests through the CNLB. CNLB then routes the requests out of the cluster to user-managed external DNS servers.

  The security of these external DNS requests depends on whether TLS (Transport Layer Security) is enabled for the connection.

  Warning: Without TLS, DNS queries are transmitted in plain text and are vulnerable to interception or tampering.

- **TLS Support for CNLB External DNS Requests**:
  CNE supports TLS for DNS communication between the cluster and external DNS servers.

  Customers can configure external domains to require TLS, ensuring encrypted and secure communication. To be effective, the external DNS servers must also support and accept TLS connections.

- **Enable TLS for CNLB External DNS Communication**:
  To secure DNS traffic routed via CNLB, it is strongly recommended to enable TLS. This ensures that DNS queries are encrypted, significantly reducing the risk of data interception or manipulation. Customers should ensure their external DNS servers are configured to support TLS.

- **Network Requirements for DNS Communication**:
  External DNS servers must allow inbound traffic on port 53/UDP, which is required for standard DNS queries and responses. If TLS is enabled, ensure that port 53/TCP or the appropriate TLS port is also open and accessible. If these ports are blocked or misconfigured, DNS resolution for external domains will fail.

- **External DNS Servers**: External DNS servers are managed outside of Oracle's control. It is the organization's responsibility to secure, maintain, and monitor their external DNS infrastructure.

Not enabling DNSSEC increases the risk of a DNS hijacking attacks.

Credential Management Procedures

Platform Agnostics Installation

BareMetal CNE supports Platform Agnostics installation from the release 25.1.1xx onwards.

For more information about BareMetal deployment model, see "BareMetal Deployment" chapter, under section "Deployment Models" in the *Oracle Communications Cloud Native Core, Cloud Native Environment User Guide*.

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For more about Platform Agnostics installation, see "Platform Agnostic Installation CNE 24.3.1+" chapter under section "Maintenance Procedures" in *Oracle Communications Cloud Native Core, Cloud Native Environment User Guide*.

> **Note**
>
> **Implications of Platform Agnostics and Passwords**
>
> If the BareMetal CNE deployment was performed under Platform Agnostics Installation, all the servers passwords and hardware passwords (for example, ToR Switch) will be customer responsibility. CNE neither creates nor updates any of the servers passwords.

CNE Configuration File for Managing Sensitive Data

Starting with version 25.1.2xx, the installation and upgrade procedures have been updated. Sensitive data used for the deployment of CNE is now recorded in a single CNE inventory file named `secrets.ini`.

CNE automation procedures such as installation, upgrade, and recovery use the information in the `secrets.ini` file to provision servers and virtual machines, install cloud native components, and configure all elements within the cluster to ensure it aligns with CNE platform specifications.

The `secrets.ini` file must be properly configured to ensure the successful completion of installation, upgrade, and recovery procedures.

Recommendation: Review Installation and Upgrade Procedures

It is strongly recommended to review the Installation and Upgrade procedures, with particular attention to the correct configuration of the `secrets.ini` file.

Depending on your deployment type, refer to the appropriate sections in the *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide.*

- File Preparation: Refer to "Inventory File Preparation" in Appendix A.
- Bare Metal Deployment: Refer to "Performing Automated Installation" in Installing CNE.
- VMware Deployment: Refer to "Predeployment Configuration for VMware" in Installing CNE.
- OpenStack Deployment: Refer to "Deploying CNE Cluster in OpenStack Environment" in Installing CNE.

Recommendation: Delete secrets.ini File After Procedure Completion

Ensure that once the installation or upgrade procedure is finished, the `secrets.ini` file is deleted and no longer present within the cluster. Leaving this file in place increases the risk of credential leakage to unauthorized users.

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Setting Top Of Rack Switch Credentials

> **Note**
>
> **Recommendation**: Follow the configuring the TOR switches procedures.
>
> The *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide* provides the detailed procedures of how to configure the TOR switches and configure them for remote monitoring. Deviations from the standard installation time configurations are not recommended.

For more information, see *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide.*
This procedure is used to set the credentials on the cisco TOR switch as deployed with the BareMetal deployment option. Steps for creating and deleting accounts and for setting account passwords are given below:

For more details, refer to Nexus commands to configure Top of Rack switch username and password.

1. Log in to the TOR switch (from the Bastion Host):

```
$ ssh <username>@<switch IP address>

User Access Verification
Password: <password>

Cisco Nexus Operating System (NX-OS) Software
TAC support: http://www.cisco.com/tac
...
...
<switch name>#
```

2. Change the password for <username>:

```
# configure
Enter configuration commands, one per line. End with CNTL/Z.
(config)# username <username> password <newpassword>
(config)#exit
```

3. Create a new user (if required):

```
# configure
Enter configuration commands, one per line. End with CNTL/Z.
(config)# username <newusername> password <newpassword> role [network-
operator|network-admin|vdc-admin|vdc-operator]
(config)#exit
```


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4. Verify the account changes by exiting the ssh session (type exit) and repeat step 1.

```
# exit
Connection to <switch IP address> closed.
$
$ ssh <newusername>@<switch IP address>
User Access Verification
Password: <newpassword>

Cisco Nexus Operating System (NX-OS) Software
TAC support: http://www.cisco.com/tac
...
...
<switch name>#
```

5. Delete an unrequired user account:

```
# configure
Enter configuration commands, one per line. End with CNTL/Z.
(config)# no username <username>
(config)#exit
```

6. Change the enable secret:

```
(config)# enable secret <newenablepassword>
(config)# exit
```

7. Save the configuration changes:

```
# copy running-config startup-config
[########################################] 100%
Copy complete, now saving to disk (please wait)...
Copy complete.
```

> **Note**
>
> - Change TOR passwords before placing site into service: The TOR switch credentials show the changes prior to placing the site into service.
> - Use Strong Passwords: The Network Administrator must choose complex TOR Switch passwords as per their organization's security guidelines.

Setting Enclosure Switch Credentials

This procedure is used to set the credentials on the HP enclosure switch as deployed with the BareMetal deployment option. Steps for creating and deleting accounts and for setting account passwords is given below. For additional information, refer to *HP commands to configure enclosure switch username and password* section in the *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide.* .

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Setting Enclosure Switch Credentials

1. Log in to the iLO with username and password (from the procedure):

```
[root@winterfell ~]# ssh <username>@<iLO address>
<username>@<iLO address>'s password: <password>
User:<username> logged-in to ...(<iLO address> / <ipv6 address>)

iLO Advanced 2.61 at  Jul 27 2018
Server Name: <server name>
Server Power: On

</>hpiLO->
</>hpiLO-> set /map1/accounts1/<username> password=<newpassword>

status=0
status_tag=COMMAND COMPLETED
Tue Aug 20 13:27:08 2019

</>hpiLO->
```

2. Change the password for the current username:

```
[switchname]local-user <username>class <currentclass>
[switchname-luser-manage-<username>]password simple <newpassword>
[switchname-luser-manage-<username>]quit
```

3. Create a new user account:

```
</>hpiLO-> create /map1/accounts1 username=<newusername>
password=<newpassword> group=admin,config,oemHP_rc,oemHP_power,oemHP_vm
status=0
status_tag=COMMAND COMPLETED
Tue Aug 20 13:47:56 2019

User added successfully.
```

4. Verify the account changes by exiting the ssh session (type exit) and repeat step 1.

```
</>hpiLO-> exit

status=0
status_tag=COMMAND COMPLETED
Tue Aug 20 13:30:52 2019




CLI session stopped
Received disconnect from <iLO address> port 22:11:  Client Disconnect
Disconnected from <iLO address> port 22

[bastion host]# ssh <newusername>@<iLO address>
<newusername>@<iLO address>'s password: <newpassword>
User:<newusername> logged-in to ...(<iLO address> / <ipv6 address>)
```


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```
iLO Advanced 2.61 at  Jul 27 2018
Server Name: <server name>
Server Power: On

</>hpiLO->
```

5. Delete the user account that is not required:

```
</>hpiLO-> delete /map1/accounts1/<username>

status=0
status_tag=COMMAND COMPLETED
Tue Aug 20 13:59:04 2019

User deleted successfully.
```

> **Note**
>
> - Set Enclosure Switch Credentials before Placing Into Service: The HP Enclosure switch credentials show are to be changed prior to placing the site into service.
> - Use Strong Passwords: The Network Administrator must choose complex Enclosure Switch passwords as per their organization's security guidelines.

Bastion Host SSH (Port 22) Exposure Recommendations

In many Kubernetes environments, SSH access is required for administrative tasks such as troubleshooting, configuration, and maintenance. Exposing SSH on port 22 allows administrators to access the bastion host from any network, making management easier. This is commonly done when quick access is needed for managing clusters or nodes, especially in environments with dynamic IP addresses or publicly reachable networks.

Benefits of Exposing SSH Access

- **Easier Remote Management**: Exposing SSH allows administrators to quickly connect to the bastion host from any location, providing flexibility and efficiency in managing the environment.
- **Operational Flexibility**: For organizations with multiple administrators, exposing SSH can assist in remote troubleshooting and configuration tasks without requiring a VPN or private network setup.

Security Risks of Exposing SSH (Port 22)

While exposing SSH can provide operational advantages, it also introduces several security risks:

- **Increased Attack Surface**: Exposing port 22 to the public internet increases the risk of brute-force attacks, credential-based attacks, and the potential exploitation of SSH vulnerabilities.
- **Brute-Force and Credential Attacks**: With open SSH access, the system becomes vulnerable to brute-force login attempts, where attackers try to guess or steal admin passwords through automated means.

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- **Denial of Service (DoS)**: Exposing port 22 could make the system a target for DoS attacks, where attackers flood the service with connection attempts, potentially causing performance degradation or unavailability.
- **Misconfiguration Risks**: Exposing SSH to multiple interfaces or dynamic IP addresses could lead to misconfigurations in network security (such as firewall rules or routing), which might accidentally lock administrators out or leave the system exposed to attack.

Best Practices for Restricting SSH (Port 22) Exposure
To mitigate the security risks of exposing SSH, the following best practices should be followed:

- **Limit SSH Exposure to a Single Management IP**: Restrict SSH access to a specific, trusted, non-public IP or interface. This significantly reduces the risk of unauthorized access and ensures that SSH connections are only allowed from known sources.
- **Disable External SSH Exposure**: If possible, completely disable SSH exposure to the public internet. Instead, administrators should access the system via secure private connectivity, such as a VPN or a dedicated private network.
- **Use Private Networks for Admin Access**: For Kubernetes clusters, it's advisable to restrict SSH access through private network interfaces only. This ensures that administrative access is not exposed to public networks, enhancing security.

Potential Risks of Restricting SSH Access
While restricting SSH access is a recommended security practice, it comes with certain challenges:

- **Loss of Access Due to Misconfiguration**: If the wrong IP or interface is selected for SSH access, or if the routing/firewall rules are not properly configured, there is a risk of losing access to the bastion host.
- **Added Complexity in Multi-Administrator Environments**: In environments with multiple administrators or teams, restricting SSH access can complicate remote troubleshooting. It’s important to plan and coordinate access policies carefully to avoid operational issues.

To mitigate these challenges, implementing an effective access control strategy—such as using VPNs, Identity and Access Management (IAM) systems, or multi-factor authentication (MFA)—is recommended.

OCCNE Supported Method to Restrict SSH (Port 22) Access
For users configuring OCCNE, we provide detailed instructions on how to set up restrictions for SSH (port 22). This method ensures that access is limited to specific interfaces, thereby enhancing security and reducing the attack surface.

For more details about the configuration, see 'Configuring SSHD ListenAddress' section in the *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide*.

IP Forwarding for CNLB

IP forwarding (also referred to as routing) is a network function that allows a node to pass incoming network packets from one interface to another. When IP forwarding is enabled, the node acts as a gateway, facilitating communication between different network segments. This feature is essential in environments like Kubernetes, where multiple networks must interact, such as the flow of traffic between containers, services, and external networks.

Important: When deploying CNLB, IP forwarding must be enabled on all cluster nodes and must remain active for proper functionality. This ensures seamless communication across networks and between different parts of the infrastructure.

CNLB Egress/Ingress Bypass Recommendations

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In OpenStack-based OC-CNE 25.2.200 deployments, we introduce support for CNLB Egress and Ingress Bypass, which directly exposes Network Function (NF) pods to external traffic. This feature should be implemented carefully to maintain security.

The following best practices are strongly recommended for customers implementing CNLB Egress and Ingress Bypass:

- **Ensure Proper Pods Configuration**: It is crucial to implement robust network-level security controls to restrict and safeguard access to the exposed NF pods. This ensures that only authorized traffic can reach the pods, minimizing potential security vulnerabilities.
- **Ensure Proper Pods Testing**: Before exposing NF pods to external traffic, thoroughly test and harden them to address any security issues. This includes performing vulnerability scans and other security assessments to ensure the pods are secure.

Risks of Exposing Pods to External Networks
Bypassing configurations expose NF pods directly to external networks, which significantly increases the security risk to those pods. This configuration should be used with caution, and security measures should be enforced to prevent unauthorized access and attacks on the exposed resources.

Hosting Environment Security Recommendations and Procedures

The best way to keep your CNE environment secure is to keep it updated. New CNE releases are typically carried out every three months. The CNE upgrade does not affect the service and typically installs the newer versions of:

- Host OSs
- Kubernetes and associated containers
- Common service containers

The upgrade process ensures that the uplifts do not affect active service. See *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide* for more details.

> ⚠ **Caution**
>
> Following are some repository management recommendations:
>
> - Do not perform any YUM updates on hosts outside of the upgrade pipeline, as this can interfere and affect negatively the cluster.
> - Some updates may require system reboots to complete and thus should only be performed on nodes not actively providing service.
> - The Oracle Linux 9 (OL9) security guide is available at: https://docs.oracle.com/cd/F61088_01/security/. This guide provides additional details for specific security procedures, several of the procedures found in the general OL9 guide are not appropriate for the CNE environment. Contact My Oracle Support before attempting any hardening activity that are not recommended.

Repository Management Recommendations

As part of the CNE installation, a central repository must be set. The central repository must contain the following:

- HTTP Repository: Serves Python binaries and other required packages.

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- YUM Oracle Repository: Serves YUM packages. This is a mirror from Oracle Yum Repository.
- Container Image Repository: Provides the images required for a successful Kubernetes cluster deployment.

This central repository hosts the required artifacts for a successful CNE installation and upgrade procedure.

System Update (YUM) Recommendations:

- Keep central YUM repositories updated:
  - Ensure that you update the YUM packages in the central repositories to the latest version. YUM updates are performed whenever you install or upgrade CNE. Keeping the YUM repository up-to-date ensures that the fixes for all publish vulnerabilities are applied.
  - The deployed YUM Oracle server is a mirror from official Oracle YUM repository. There are secure mechanisms that are already implemented when performing the retrieval of this repository (for example, the usage of Gnu Privacy Guard (GPG) keys and HTTPS connection). The security controls are part of the unbreakable Linux network. For more information about, GPG keys, see https://linux.oracle.com/security/gpg/index.html.
- Scan YUM Server prior installation:
  When you complete setting up a central repository, scan the YUM Oracle server located at the central repository. For more information about setting up the central repository, see the "Setting Up a Central Repository" section in *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide*.

  It is a good practice to retrieve the YUM Oracle Server in a secure way from Oracle's server. For more information, see https://linux.oracle.com/security/gpg/index.htm.

  Use any of Software Composition Analysis tools (such as Trivy or Grype) to perform the scan. If needed, you may perform a Malware scan to the Yum server with any malware scanning tool.

Container Repository Recommendations

Scan Container Registry prior installation:

When you complete setting up a central repository, scan the container registry located at the central repository. For more information about setting up the central repository, see the "Setting Up a Central Repository" section in *Oracle Communications Cloud Native Core, Cloud Native Environment Installation, Upgrade, and Fault Recovery Guide.*

Use any of Software Composition Analysis tools (such as Trivy or Grype) to perform the scan. All images are scanned and vulnerabilities assessed at product development time, but new exploits / vulnerabilities may be reported / fixed later.

Scan tools typically use a database of known vulnerabilities. Refer to tool vendor for instructions on creating off-line (internet isolated) vulnerability databases.

- Scan docker image repositories regularly: Scan your docker image repositories regularly using a tool such as clair or anchore-engine. All images are scanned and vulnerabilities are assessed at product development time, but new exploits or vulnerabilities may be reported or fixed later.

  Scan tools use a database of known vulnerabilities. Refer to tool vendor for instructions on creating off-line (internet isolated) vulnerability databases.

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Container Registry Authentication Recommendations

The OCCNE bastion host includes a local container registry used to store and manage the container images required for Kubernetes cluster deployments. By default, this registry employs TLS (Transport Layer Security) for secure communication, but it does not enforce authentication, which can leave the registry vulnerable to unauthorized access.

Recommendation: Enable User-Password Authentication
To enhance security and prevent unauthorized access to the registry, it is highly recommended that customers enable basic authentication (user:pass) on the container registry. This will require users to authenticate with a username and password before they can pull or push images, ensuring that only authorized users have access to the registry.

Bastion Registry Credentials Process
For detailed instructions on how to configure and change bastion registry credentials, refer to the OCCNE Maintenance - Change Bastion Registry Credentials guide.

Credential Management Specific Procedures

The given below procedures to manage your credentials:

Setting HP Onboard Administrator (OA) Credentials.

This procedure is applicable only to BareMetal deployments. This procedure is used to set the credentials on the HP Onboard Administrator as deployed with the BareMetal deployment option. Steps for creating and deleting accounts and for setting account passwords are shown. For additional information, refer to *HP commands to configure OA username and password* section in the *https://support.hpe.com*.

1. Log in to the OA:

```
$ ssh <username>@<OA address>
```

> **Note**
>
> This is a private system. Do not attempt to log in unless you are unauthorized user. Any authorized or unauthorized access and use may be monitored and can result in criminal or civil prosecution under applicable law.

```
$ ssh <username>@<OA address>
------------------------------------------------------------------------------
--
WARNING: This is a private system.  Do not attempt to login unless you are
an
authorized user.  Any authorized or unauthorized access and use may be
moni-
tored and can result in criminal or civil prosecution under applicable law.
------------------------------------------------------------------------------
--
Firmware Version: 4.85
Built:04/06/2018@06:14OA
 Bay Number:1
OA Role: Active
<username>@<OA address>'s password: <password>
```


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```
HPE BladeSystem Onboard Administrator
(C) Copyright 2006-2018 Hewlett Packard Enterprise Development LP
Type 'HELP' to display a list of valid commands.
Type 'HELP <command>' to display detailed information about a specific
command.
Type 'HELP HELP' to display more detailed information about the help
system.
OA-A45D36FD5FB1>
```

2. Change the current password:

```
OA-A45D36FD5FB1> set password <newpassword>
```

Output:

```
Changed password for the"<username>"user account.
```

3. Add new user:

```
OA-A45D36FD5FB1> add user <newusername>
New Password: <newpassword>
Confirm : <newpassword>
```

Sample output:

```
User"<newusername>"created.
You may set user privileges with the 'SET USER ACCESS' and 'ASSIGN'
commands.
```

4. Set user privilages:

```
OA-A45D36FD5FB1> set user access <newusername> [ADMINISTRATOR|OPERATOR|
USER]
```

Sample output:

```
"<newusername>" has been given [administrator|operator|user] level
privileges.
```

5. Assign full access to the enclosure for the user:

```
OA-A45D36FD5FB1> assign server all <newusername>
```


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Sample output:

```
<newusername> has been granted access to the valid requested bay(s
```

```
OA-A45D36FD5FB1> assign interconnect all <newusername>
```

Sample output:

```
<newusername> has been granted access to the valid requested bay(s)
```

```
OA-A45D36FD5FB1> assign oa <newusername>
```

Sample output:

```
<newusername> has been granted access to the OA.
```

6. Verify the new account:

```
OA-A45D36FD5FB1> exit
```

Sample output:

```
Connection to <OA address> closed.
[bastion host]# ssh <newusername>@<OA address>
WARNING: This is a private system. Do not attempt to log in unless you are
unauthorized user.
Any authorized or unauthorized access and use may be monitored and can
result in criminal or
civil prosecution under applicable law.
Firmware Version : 4.85
Built : 04/06/2018 @ 06:14
OA Bay Number : 1
OA Role : Active
<newusername>@<OA address>'s password: <newpassword>
HPE BladeSystem Onboard Administrator
(C) Copyright 2006-2018 Hewlett Packard Enterprise Development LP
Type 'HELP' to display a list of valid commands.
Type 'HELP <command>' to display detailed information about a specific
command.
Type 'HELP HELP' to display more detailed information about the help
system.
```

7. Delete the user account that is not required:

```
OA-A45D36FD5FB1> remove user <username>
```

Sample output:

```
Entering anything other than 'YES' will result in the command not
executing.
```


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```
Are you sure you want to remove testuser1? yes
User"<username>"removed.
```

Setting HP Integrated Lights Out Manger (ILO) Credentials

This procedure is applicable only to BareMetal deployments. This procedure is used to set the credentials on the HP Integrated Lights Out Managers as deployed with the BareMetal deployment option. Steps for creating and deleting accounts and for setting account passwords is shown.

1. Log in to the iLO:

   ```
   $ ssh <username>@<iLO address>
   ```

   Sample output:

   ```
   <username>@<iLO address>'s password: <password>User:<username>
   logged-in to ...(<iLO address> / <ipv6 address>)
   iLO Advanced2.61at Jul272018
   Server Name: <server name>
   Server Power: On
   </>hpiLO->
   ```

2. Change the current password:

   ```
   </>hpiLO-> set /map1/accounts1/ <username> password= <newpassword>
   status=0
   status_tag=COMMAND COMPLETED
   Tue Aug2013:27:082019
   </>hpiLO->
   ```

3. Create a new user account:

   ```
   </>hpiLO-> create /map1/accounts1 username= <newusername> password=
   <newpassword>
   group=admin,config,oemHP_rc,oemHP_power,oemHP_vm
   status=0
   status_tag=COMMAND COMPLETED
   Tue Aug2013:47:562019
   User added successfully.
   ```

4. Verify the new user account:

   ```
   </>hpiLO-> exit
   status=0
   status_tag=COMMAND COMPLETED
   Tue Aug2013:30:522019CLI session stoppedReceived disconnect from <iLO
   address> port22:11: Client Disconnect
   Disconnected from <iLO address> port22
   [bastion host]# ssh <newusername>@<iLO address>
   <newusername>@<iLO address>'s password: <newpassword>
   User:<newusername> logged-in to ...(<iLO address> / <ipv6 address>)
   iLO Advanced2.61at Jul272018
   ```


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```
Server Name: <server name>Server
 Power: On</>hpiLO->
```

5. Delete the user account that is not required:

```
</>hpiLO-> delete /map1/accounts1/ <username>
status=0
status_tag=COMMAND COMPLETED
Tue Aug2013:59:042019
User deleted successfully.
```

Setting Root Passwords for All Cluster Nodes

The procedure to reset the root account requires that the administrator log in to each and every server. This procedure is applicable to all CNE deployments.

To reset the root account, perform the following steps for each and every server in the cluster:

1. Log in to the next server:

```
$ ssh admusr@ <cluster server IP>
```

2. Perform the root password change:

```
$ sudo passwd root
```

```
New password: <new password>
Retype new password: <new password>
Retype new password:<new password>
```

3. Repeat step 1 and step 2 for each and every server in the cluster.

> **Note**
>
> The administrator (admusr) account is provided without a usable password hash. Thus requiring the use of SSH keys to access the account. The SUDO user access is configured without the requirement of a password. If you would like to enable the SUDO passwords for the administrator, you also need to assign a password to the administrator account using a procedure very similar to the one outlined above.

Reset or Delete Credentials for the admusr account on Each and Every Server

The procedure to reset or delete the admusr account. This procedure requires root privileges and must be applied on each and every server.

To reset or delete the admusr account, perform the following steps for each and every server in the cluster:

1. Log in to the next server:

```
$ ssh admusr@ <cluster server IP>
```


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or

```
$ ssh cloud-user@<cluster server IP>
```

2. Perform the root password change:

   Admusr:

   ```
   $ sudo passwd -l admusr
   New password: <new password>
   Retype new password: <new password>
   Retype new password: <new password>
   ```

   Cloud-user:

   ```
   $ sudo passwd -l cloud-user
   New password: <new password>
   Retype new password: <new password>
   Retype new password: <new password>
   ```

3. Repeat step 1 and step 2 for each and every server in the cluster.

Updating admusr SSH Keys for All Cluster Nodes

There are two sets of SSH keys used in a deployed cluster: The key used to access the and the key used to access the cluster servers. This procedure is applicable to all CNE deployments.

These key-pairs are generated at install time and are only usable on the cluster they were generated for. The public key portion of the key pair is typically provided to administrators who will manage the cluster. The key pair used to access the cluster servers should be kept local to the cluster:

Table 3-4 Updating admusr SSH Keys

Key Pair Name	Public Key Distribution	Private Key Distribution
Bastion Host	Place copy in the authorized_keys file on the .	**Cluster Admin**: Place in the cluster admin key agent (e.g., ssh-agent or pageant) external to the cluster. Do not copy to any host on the cluster.
Cluster Hosts	Place a copy in the authorized_keys files on each and every cluster host; do not configure on the .	**Bastion Host**: `~admusr/.ssh` directory. This will be used when performing orchestration activities (install / upgrade).

To replace either of these key pairs starts with an openssh request to generate a new keypair:

```
$ ssh-keygen -b 4096 -t rsa -C "New SSH Key" -f /var/occne/cluster/
<cluster_name>/.ssh/new_occne_id_rsa -q -N ""
```

This command generates the following key pair:

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Table 3-5 Key pair

Key Name	Purpose
new_CNE_id_rsa	The private key
new_CNE_id_rsa.pub	The public key

Updating the keys

1. Log in to the and generate a new key pair using the ssh-keygen command given above:

   ```
   $ ssh-keygen -b 4096 -t rsa -C "New SSH Key" -f /var/occne/cluster/
   <cluster_name>/.ssh/new_occne_id_rsa -q -N ""
   ```

2. Copy the private key portion of the key off cluster and make it available to your ssh agent of choice or store it in the .ssh directory of your client machine. See instructions for your specific SSH client (for example, putty or openssh)
3. Add the new public key to the authorized key file on the :

   ```
   $ cat ~/.ssh/new_CNE_id_rsa.pub >> ~/.ssh/authorized_keys
   ```

4. Confirm the permissions of the .ssh directory and files:

   ```
   $ ls -la ~/.ssh
   total 32
   drwx------. 2 admusr admusr 4096 Feb 25 15:48 .
   drwx------. 42 admusr admusr4096 Feb 24 15:14 ..
   -rw-------. 1 admusr admusr 796 Jan 28 14:43 authorized_keys
   -rw-------. 2 admusr admusr 545 Feb 12 13:58 config
   -rw-------. 1 admusr admusr 3239 Feb 25 15:48 new_CNE_id_rsa
   -rw-r--r–. 1 admusr admusr 737 Feb 25 15:48 new_CNE_id_rsa.pub
   ```

   In general, the .ssh directory should be mode 700 and the files under that directory should be mode 600.
5. Confirm that the new key works. Remove the old key from your ssh client's agent (see instructions for your client) and confirm that you can still log in.
6. Assuming that you were able to Log in using the new key pair, remove the old key pair from the authorized_keys file using your favorite editor.

   In general, the authorized_keys file should at this point have two keys in it - the old one and the new one. The new one should be at the bottom.

> **Note**
>
> Access to Bastion Host container registry is TLS enabled and only CNE has access to it.

Change Kubernetes Secrets Encryption Key

The procedure is to change the key used to encrypt Secrets stored in the CNE Kubernetes cluster. Secret encryption is enabled by default during CNE install or upgrade.

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To change Kubernetes secrets encryption key, perform the following steps:

1. Locate in Bastion host:

   ```
   $ ssh <username>@<OA address>
   ```

2. Generate a new key with Approved Oracle Linux Randomness:

   ```
   $ NEW_KEY=$(head -c 32 /dev/urandom | base64)
   ```

3. Generate a new key with Approved Oracle Linux Randomness:

   ```
   $ KEY_NAME=$(cat /dev/random | tr -dc '[:alnum:]' | head -c 10)
   ```

4. Run the following command:

   ```
   $ kubectl get nodes | awk '/control-plane/ {print $1}' | xargs -I{} ssh {}
   " sudo sed -i '/keys:$/a\        - name: key_$KEY_NAME\n\
   secret: $NEW_KEY' /etc/kubernetes/ssl/secrets_encryption.yaml; sudo
   cat /etc/kubernetes/ssl/secrets_encryption.yaml"
   ```

   Output shows new encryption key, key name and the contents of /etc/kubernetes/ssl/secrets_encryption.yaml file:

   ```
   This site is for the exclusive use of Oracle and its authorized customers
   and partners. Use of this site by customers and partners is subject to the
   Terms of Use and Privacy Policy for this site, as well as your contract
   with Oracle. Use of this site by Oracle employees is subject to company
   policies, including the Code of Conduct. Unauthorized access or breach of
   these terms may result in termination of your authorization to use this
   site and/or civil and criminal penalties.
   kind: EncryptionConfig
   apiVersion: v1
   resources:
     - resources:
       - secrets

       providers:
       - secretbox:
           keys:
           - name: key_ZOJ1Hf5OCx
             secret: l+CaDTmMkC85LwJRiWJ0LQPYVtOyZ0TdtNZ2ij+kuGA=
           - name: key
             secret: ZXJ1Ulk2U0xSbWkwejdreTlJWkFrZmpJZjhBRzg4U00=
       - identity: {}
       1m
   5
   ```


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5. Restart api server by executing following command. This ensures that all the new secrets will be encrypted with the new key.

   ```
   kubectl get nodes | awk '/control-plane/ {print $1}' | xargs -I{} ssh {} "
   sudo mv /etc/kubernetes/manifests/kube-apiserver.yaml ~; sleep 2; sudo mv
   ~/kube-apiserver.yaml /etc/kubernetes/manifests"
   ```

6. Run the following command to encrypt all the existing secrets with a new key:

   ```
   $kubectl get secrets --all-namespaces -o json | kubectl replace -f-
   ```

   Output:

   ```
   secret/CNE-cert-manager-webhook-ca replaced
   ...
   secret/sh.helm.release.v1.CNE-tracer.v1 replaced
   secret/webhook-server-cert replaced
   Error from server (Conflict): error when replacing "STDIN": Operation
   cannot be fulfilled on secrets "alertmanager-CNE-kube-prom-stack-kube-
   alertmanager-generated": the object has been modified; please apply your
   changes to the latest version and try again
   Error from server (Conflict): error when replacing "STDIN": Operation
   cannot be fulfilled on secrets "alertmanager-CNE-kube-prom-stack-kube-
   alertmanager-tls-assets-0": the object has been modified; please apply
   your changes to the latest version and try again
   Error from server (Conflict): error when replacing "STDIN": Operation
   cannot be fulfilled on secrets "alertmanager-CNE-kube-prom-stack-kube-
   alertmanager-web-config": the object has been modified; please apply your
   changes to the latest version and try again
   ```

   > **Note**
   >
   > There may exist some errors depending on how the secret was created, but you can verify the content of encrypted secret using the following commands.

7. For each controller node (i.e. ctrl-1), locate in the controller node.
8. Run (with sudo) the following command. This shows all existing secrets that would launch this command from a controller node after select any secret to verify the information related the new encryption key, using **cert** and **key pem** files:

   ```
   sudo ETCDCTL_API=3 /usr/local/bin/etcdctl --cert /etc/ssl/etcd/ssl/<cert
   pem file> --key /etc/ssl/etcd/ssl/<key pem file> get --keys-only=true --
   prefix /registry/secrets
   ```

9. To verify whether the new key is being used for encrypting existing secrets by running the following command from a controller node: Replace **<cert pem file>**, **<key pem file>** and **<secret>** with their corresponding values.

   ```
   sudo ETCDCTL_API=3 /usr/local/bin/etcdctl --cert /etc/ssl/etcd/ssl/<cert
   pem file> --key /etc/ssl/etcd/ssl/<key pem file> get /registry/secrets/
   <namespace>/<secret> -w fields | grep Value
   ```


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Output:

```
[cloud-user@CNE3-user-k8s-ctrl-3 ~]$ sudo ETCDCTL_API=3 /usr/local/bin/
etcdctl
--cert /etc/ssl/etcd/ssl/node-CNE3-user-k8s-ctrl-1.pem
--key /etc/ssl/etcd/ssl/node-CNE3-user-k8s-ctrl-1-key.pem get /registry/
secrets/default/secret1 -w fields | grep Value
"Value" : "k8s:enc:secretbox:v1:key_ZOJ1Hf5OCx:<ENCRYPTED_DATA>"

In this example, the new key key_ZOJ1Hf5OCx is being used to encrypt
secret1 secret.
```

10. Repeat steps 8 and 9 for each and every **controller** server in the cluster.

General Security Administration Recommendations and Procedures

> **Note**
>
> **Record configuration changes**: In a disaster recovery scenario, Oracle provided procedures will only restore base system behavior (they will not include restoration of an special configurations or tweaks). We recommend that all post-delivery customization be logged or automated using tools such as Ansible.

Password Requirements Administration Procedures

The following are the recommended password requirements:

- Must have length between 20 and 32 characters
- Must include at least one lower case letter
- Must include at least one upper case letter
- Must include at least one digit
- Must include at least one of the mentioned special characters: ,%~+.:_/-

The password policy can vary depending on your local policies or IT directives.

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Note

- **GRUB Password Policies**:
  - The password must contain at least eight characters.
  - The password must contain uppercase and lowercase characters.
  - The password must contain at least special character except single and double quotes. For example `~ @ # ^ * - _ + [ { } ] : . / ? % = !`
  - The password must contain at least two digits.
- **Password Policy Appliance**: It is highly recommended to follow the local password policies (that is, how a password must be created and the management of it). In case there is no local password policies exist, follow the given password policy.
- **Plan Credential Rotation**: It is important to plan ahead a recurrent credential rotation. Follow the quoted procedures in this guideline, schedule and perform manual credential rotation.The timespan to rotate them depends on your password policies, but it is recommended at most one year to update the credentials.
- **Password Management**: In order to keep track of the inserted passwords, it is highly recommended to use a password manager.
- **Use Unique passwords**: It is highly recommended to use a unique password for each CNE password. Avoid reusing passwords, specially for root access.

Password Login Policy Administration Procedures

In general, the host environments use a user account named **admusr** (cloud-user in vCNE deployments) which is not configured with a password; the only way to access this account is using SSH keys.

Note

- **Use SSH Keys rather than passwords**: We recommend using SSH keys rather than passwords for all non-root accounts. The root account cannot be accessed via ssh; the only access is through the console.
- **Root Password Well Secured**: For the root account, we recommend setting a password and storing it off-site to be used only for break-glass console access to the host.

User Administration Recommendations

Customers may want to create additional accounts to manage separate concerns (Example: a dbadmin account, a k8sadmin account, and so on). This can be done using normal Linux user administration procedures.

SSHD Policy Administration Procedures

The customer may want to create augment the standard sshd configuration to perform additional hardening; this can be done using normal Linux ssh administration procedures. In a

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disaster recovery scenario, Oracle provided procedures will only restore base system behavior (they will not include restoration of an special configurations or tweaks).

> **Note**
>
> **Review changes with Oracle Support**: We recommend reviewing any planned changes to sshd configuration with your Oracle Support contact. Improper sshd configuration can either open the system up to attacks or prevent proper system operation.

Auditd Policy Administration Procedures

Customers may want to augment the standard auditd configuration to perform additional monitoring; this can be done using normal Linux auditd administration procedures. Place all customizations in a separate file in the `/etc/audit/rules.d` directory, do not modify any of the other existing audit configuration files.

> **Note**
>
> By default, the OCCNE installation sets the `audit_backlog_limit` to 8192. This setting controls the maximum number of audit events that the Linux kernel can hold in its audit buffer. If this limit is exceeded, older events are discarded. Adjust this value if you need to retain more events in the buffer, but be mindful of system performance when increasing the backlog.

SELinux Recommendations

SELinux Documentation
For detailed instructions on checking the current status of SELinux on your hosts, refer to the following documentation:

SELinux Checking Documentation.

> **Note**
>
> During the installation process, OCCNE sets SELinux to "permissive" mode by default. This setting allows SELinux to log security events without enforcing policies, which is important for compatibility with Kubernetes workflows and other essential services.

Security Recommendation
It is strongly recommended to leave SELinux in "permissive" mode. Setting it to "enforcing" may interfere with the normal functioning of OCCNE and Kubernetes, leading to potential issues or service disruptions. Maintaining it in "permissive" mode ensures that OCCNE operates as expected.

su Command - Password Prompt

(Work-around)
As part of hardening OCCNE, the usage of the su command is restricted. On the bastion host, you may encounter a situation where sudo su prompts for the root password. This behavior is expected due to the security hardening in place.

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Work-around
Important: If absolutely necessary, the following command can bypass this restriction:

```
sudo sed -i 's/^auth[[:space:]]*required[[:space:]]*pam_rootok.so/auth
sufficient pam_rootok.so/' /etc/pam.d/su
```

This command reverses the intended security hardening fix, which can potentially reduce the overall security of the system. Only use this work-around if it is absolutely required, and ensure you understand that doing so decreases system security by allowing less restricted access to the root account.

Container Security Recommendations and Procedures

The following are the container security recommendations and procedures:

Container Repository Management Recommendations and Procedures
The following are the container repository management recommendations and procedures:

System Update (Container) Recommendations

> **Note**
>
> Recommendation: Keep central Image repositories up-to-date.
>
> Keep central repositories up-to-date with latest recommended container packages; container updates are performed on-site whenever a fresh install or upgrade is performed. An up-to-date container repository is required for both fresh install and upgrade operations.

General Container Security Administration Recommendations and Procedures

Kubernetes Control Plane Certification Administration Procedures
Recommendation: keep monitoring the Kubernetes Certificates expire date.

Kubernetes uses many different TLS certificates to secure access to internal services. These certificates are automatically renewed during upgrade. However, if upgrade is not performed regularly, these certificates may expire and cause the Kubernetes cluster to fail. For more details, refer to the Renewing Kubernetes Certificates procedure in*Oracle Communications Cloud Native Core, Cloud Native Environment User Guide*.

Kubernetes Policy Engine (Kyverno)

CNE is deploying Kyverno. This provides policies to ensure that malicious applications do not corrupt the Kubernetes controller, worker nodes and cluster data.

Policies can be used to control and monitor workloads running on CNE, and also can be used to audit workloads running on Kubernetes. Kyverno framework is deployed as common service in CNE.

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> **Note**
>
> - **Importance of Kyveno**
>   - CNE has deployed a set of baseline policies, in order to guarantee an essential set of controls from known privilege escalations.
>   - In the end, these will represent the minimum standard of Policy protection that all OC-CNE cluster will have by default.
>   - Kyverno policies should not be modified nor disabled, otherwise the security risk is heavily increased and it is open to unknown attacks.
> - **Kyverno default setting**: From 23.2.x and onwards, CNE has set all the Kyverno policies validation mode as "enforced". This means that, if a policy is being violated, the "enforce" mode will block any resource creation or updates that does not comply.
> - **Keep the Kyverno metrics ON**: Keeping Kyverno metrics ON populates the Grafana's dashboards with the Policy enforcement and compliance monitoring.

Deprecation Notice - ingress-nginx Retirement (March 2026)
The Kubernetes SIG Network and the Security Response Committee have announced that ingress-nginx will reach End-of-Life (EOL) in March 2026.

While OCCNE does not use ingress-nginx by default, if it is part of your deployments, we strongly recommend migrating to an alternative solution before the retirement date.

ingress-nginx Retirement
After March 2026, the community will no longer provide security patches or updates for ingress-nginx. Continuing to use it beyond this date may expose your Kubernetes clusters to unpatched security vulnerabilities, which could lead to potential risks.

Common Service Security Recommendations and Procedures

The CNE Common Services bundle integrates various third-party components, each utilizing different approaches. Within these common services, there is a subset known as Observability Services:

- Grafana
- Prometheus
- Alert Manager
- Opensearch
- Jaeger

CNC Console Integration with CNE

The CNC Console is a module that offers the following capabilities:

- Graphical user interface (GUI) for NF Supporting API only
- Unified GUI access for NFs across and within Kubernetes (K8s) clusters
- Hyperlink support for reverse-proxy-friendly K8s services
- Secure access to both GUI and APIs

CNC Console Security Features

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The CNC Console (CNCC) includes robust security features encompassing authentication, authorization, and access control:

- Authentication can be done using SAML SSO, LDAP, or local identity storage.
- RBAC (Role Based Access Control) access control is provided.

CNCC provide two kinds of logs for security and audit.

- Audit log containing user authentication/access details.
- Security log contains the complete request/response

In addition, CNC Console can enable HTTPS connection.

Enhance Security with CNC Console
Integrating CNC Console (CNCC) with CNE significantly strengthens the overall security posture. While CNE delivers monitoring capabilities, CNCC ensures secure, role-based access to common services, particularly the observability services.

Key benefits of CNE and CNC Console integration include:

- Authentication using CNCC IAM
- Configurated CNCC GUI, based on authorization roles

CNE Common Services can be set to enable HTTPS communication.

It is recommended to install CNC Console, in order to have the features listed above within CNE.

CNC Console Integration
To install the CNC Console, refer to the *Cloud Native Configuration Console Installation, Upgrade, and Fault Recovery Guide*.

For deployment configurations examples, refer to the "Common Service Instances Configuration Examples" section in the "Common Service Single Cluster Deployment Instance Configuration Examples" chapter, in *Cloud Native Configuration Console Installation, Upgrade, and Fault Recovery Guide*.
For additional guidance, refer to the "Implementing Security Recommendations and Guidelines" section in the Cloud Native Configuration Console (CNC Console) Specific Security Recommendations and Guidelines chapter.

GitOps - Public API Server Endpoint Security Procedures

OC-CNE 25.2.200 introduces an optional occne-apiserver-proxy service that exposes the Kubernetes API server externally, enabling GitOps workflows. This service operates an mTLS-enabled NGINX reverse proxy within the occne-infra namespace. Since the proxy provides direct access to the control plane, robust security controls are strongly recommended. This section complements, but does not replace, existing recommendations in Network Security and Container Security sections.

Mandatory Security Controls

- **Mutual TLS (mTLS)**: Must be enabled end-to-end between the CD tool and occne-apiserver-proxy.
- **Bastion Host Certification**: The bastion host must be provisioned with a CA certificate, server key, and server certificate, all signed by the same CA before the proxy is enabled.

Customer Responsibility: Certificate Management
Important Note: Customers are fully responsible for the provisioning, maintenance, and rotation of certificates.

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Certificate Rotation: Certificates must be rotated at least once every 12 months. For guidance on the rotation of secrets-encryption keys, see 'Change Kubernetes Secrets Encryption Key' section.

Recommended Security Controls

- **GitOps Recommendation 1**:
  - Keep the occne-apiserver-proxy internal whenever possible. If public exposure is necessary, prefer publishing via a VPN or private link over exposing it to the open internet.
- **GitOps Recommendation 2**:
  - Protect the Git repository with branch protection rules and require signed commits.
- **GitOps Recommendation 3**:
  - Utilize Kyverno Policies (which are enabled by default) to:
    * Ensure that only the CD tool's ServiceAccount can create or update resources in production namespaces.
    * Block the deployment of privileged pods or hostPath mounts through GitOps.
- **GitOps Recommendation 4**:
  - Regularly scan CD tool container images stored in your central registry using tools like Trivy or Grype. Refer to 'Container Repository Recommendations' for scanning details.
- **GitOps Recommendation 5**:
  - Enable DNSSEC validation on the bastion host resolver to prevent external Git repository tampering. Refer to 'DNS Recommendations' section for DNSSEC setup.
- **GitOps Recommendation 6**:
  - Store all CI/CD credentials in an enterprise password manager and rotate them according to 'Password Requirements Administration Procedures' section.

Important Considerations: occne-apiserver-proxy ServiceAccount and RBAC Scope
When the occne-apiserver-proxy service is activated, OCCNE automatically creates a ServiceAccount (apiserver-proxy) in the occne-infra namespace and binds it to the ClusterRole `nginx-apiserver-cluster-admin`.

Critical Warning:

This ClusterRole grants full cluster-admin privileges, enabling access to all resources and non-resource URLs across all API groups. Since the proxy allows external CD tools to interact with the Kubernetes API via the NGINX pod (where the ServiceAccount token is mounted), unauthorized access to this token could lead to unrestricted API access.

Administrators must ensure the ServiceAccount token remains secret to prevent unauthorized access and control.

3.1.9 Operations Services Overlay (OSO) Specific Security Recommendations

This section provides Oracle Communications Cloud Native Core, Operations Services Overlay (OSO) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

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> **Note**
>
> kubectl commands might vary based on the platform deployment. Replace kubectl with Kubernetes environment-specific command line tool to configure Kubernetes resources through kube-api server. The instructions provided in this document are as per the Oracle Communications Cloud Native Core, Operations Services Overlay (OSO) version of kube-api server.

> **Caution**
>
> User, computer and applications, and character encoding settings may cause an issue when copy-pasting commands or any content from PDF. PDF reader version also affects the copy-pasting functionality. It is recommended to verify the pasted content especially when the hyphens or any special characters are part of the copied content.

This supplements the Cloud Native Environment (CNE) Specific Security Recommendations and Guidelines when deploying OSO. It introduces additional security considerations. All hardening measures already documented for CNE remain fully applicable and are not repeated here.

Alert Processing Microservice (APM) Service Security Recommendations

The APM is a lightweight module within OSO, responsible for preparing and publishing messages from Alert Manager (ALM) to Kafka. It is an asynchronous, single-threaded service, optimized for high-throughput message delivery, and efficient message delivery.

Kafka Connectivity and Encryption

The APM service establishes connections with Kafka over secure, encrypted channels to ensure confidentiality and integrity of message data.

SASL/Auth for Kafka Cluster

SASL (Simple Authentication and Security Layer) provides a standard framework for adding authentication and optional data integrity and encryption, for network protocols. When combined with TLS, SASL enhances secure communication between the APM service and Kafka clusters.

> **Note**
>
> To maintain credential security, store `sasl.username` and `sasl.password` credentials in a Kubernetes secret. This protects sensitive information from being exposed in plaintext configuration files. For more details about APM service, see *Oracle Communications Cloud Native Core, Operations Services Overlay Installation and Upgrade Guide*.

Secrets and Credential Management

- Follow Credential Management Specific Procedures for rotation cadence and storage location of sensitive material (For example, enterprise password manager).
- Renew certificates at least annually and maintains CA integrity.

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> **Note**
>
> It is recommended to renew certificates every 90 days.

Performance Tuning and Security Recommendations

APM defaults (batching, linger, and retries) strike a balance between throughput and resource usage. Excessive increase on these parameters can:

- Amplify memory consumption, making the pod a DoS target.
- Increase batching latency delaying alert delivery and masking potential failures.

> **Note**
>
> Before tuning configuration parameters, it is recommended to perform capacity and threat modeling as these modifications can impact the behavior of the Kafka producer and APM's messaging workflow.

OpenShift Security Context Constraints (SCC)

When deploying OSO on RedHat OpenShift users must keep in mind the platform's mandatory SCC enforcement. The default SCC:

- Enables user-namespaces, remapping the container's declared User Id/ Group Id (UID/ GID) to a high, non-deterministic UID (For example, 100341380000) and often setting GID to 0 (root).
- Forces pods to run as runAsNonRoot and any files not world-readable executable become inaccessible.

3.2 Cloud Native Core Network Function Specific Security Recommendations and Guidelines

> **Note**
>
> kubectl commands might vary based on the platform deployment. Replace kubectl with Kubernetes environment-specific command line tool to configure Kubernetes resources through kube-api server. The instructions provided in this document are as per the Oracle Communications Cloud Native Core, Cloud Native Environment (CNE) version of kube-api server.

> **Caution**
>
> User, computer and applications, and character encoding settings may cause an issue when copy-pasting commands or any content from PDF. PDF reader version also affects the copy-pasting functionality. It is recommended to verify the pasted content especially when the hyphens or any special characters are part of the copied content.

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3.2.1 Network Repository Function (NRF) Specific Security Recommendations and Guidelines

This section provides Network Repository Function (NRF) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- NRF Access Token Secret Configuration
- NRF Access Token Secret Update
- NRF MySQL Secret configuration
  - Kubernetes secret creation for NRF privileged database user
  - Kubernetes secret update for NRF privileged database user
  - Kubernetes secret creation for NRF application database user
  - Kubernetes secret update for NRF application database user
  - Creating Secrets for DNS NAPTR - Alternate route service
- Network Policies

NRF Access Token Secret Configuration

Use the following procedure to create access token secret:

1. Create the following files:
   - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for NRF
   - RSA private keys for algorithm RS256 and corresponding valid public certificates for NRF

   Note: Creation of private keys, certificates, and passwords are at the discretion of user.
2. Log in to Bastion Host or server from where kubectl can be executed.
3. Create namespace for the secret by performing the following steps:
   a. Verify required namespace already exists in system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required namespace is available. If not available, create the namespace using following the command:

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Note: This is an optional step. In case required namespace already exists, proceed with next procedures.

```
$ kubectl create namespace <required namespace>
```

Example:

```
$ kubectl create namespace ocnrf
```

4. Create Kubernetes secret for Access token by performing the following steps:
   a. To create Kubernetes secret for HTTPS, following files are required:
      - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for NRF
      - RSA private keys for algorithm RS256 and corresponding valid public certificates for NRF

      > **Note**
      >
      > Creation process for private keys, certificates and passwords is based on the discretion of the user or operator. Only unencrypted keys and certificates are supported. PKCS1 and PKCS8 are the only supported versions for RSA, and PKCS8 is the only supported version for ECDSA.

   b. Run the following command to create secret. The names used below are same as provided in custom values.yaml in NRF deployment:

```
$ kubectl create secret generic <ocnrfaccesstoken-secret-name>  --from-
file=<ecdsa_private_key.pem>
 --from-file=<rsa_private_key.pem>  --from-file=<ssl_truststore.txt> --
from-file=<keystore_password.txt>
  --from-file=rsa_certificate.crt --from-file=<ecdsa_certificate.crt> -
n <Namespace of NRF AccessToken secret>
```

Note: Note down the command used during the creation of Kubernetes secret, this command will be used for updates in future.

```
$ kubectl create secret generic ocnrfaccesstoken-secret  --from-
file=ecdsa_private_key.pem
--from-file=rsa_private_key.pem  --from-file=ssl_truststore.txt --from-
file=keystore_password.txt  --from-file=
rsa_certificate.crt --from-file=ecdsa_certificate.crt -n ocnrf
```

   c. Run the following command to verify secret created:

```
$ kubectl describe secret <ocnrfaccesstoken-secret-name> -n <Namespace
of NRF AccessToken secret>
```

Example:

```
 $ kubectl describe secret ocnrfaccesstoken-secret -n ocnrf
```


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NRF Access Token Secret Update

Use the following procedure to update access token secret:

1. Update the following files:
   - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for NRF
   - RSA private keys for algorithm RS256 and corresponding valid public certificates for NRF

   Note: Updating private keys, certificates, and passwords are at the user's discretion.
2. Log in to Bastion Host or server from where kubectl can be executed.
3. Update the secret with new or updated details by performing the following steps:
   a. Copy the exact command used in above section during creation of secret.
   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of Access Token secret>".
   c. Sample format of the create secret command is given below:

```
$ kubectl create secret generic <ocnrfaccesstoken-secret> --from-
file=<ecdsa_private_key.pem>
 --from-file=<rsa_private_key.pem> --from-file=<rsa_certificate.crt> --
from-file=<ecdsa_certificate.crt>
 --dry-run -o yaml -n <Namespace of NRF deployment> | kubectl replace -
f - -n <Namespace of NRF deployment>
```

   Example: The names used below are same as provided in custom_values.yaml in NRF deployment:

```
$ kubectl create secret generic ocnrfaccesstoken-secret --from-
file=ecdsa_private_key.pem
 --from-file=rsa_private_key.pem --from-file=rsa_certificate.crt --from-
file=ecdsa_certificate.crt
--dry-run -o yaml -n ocnrf | kubectl replace -f - -n ocnrf
```

   d. Run the updated command.
   e. After successful secret update, the following message is displayed:

```
secret/<ocnrfaccesstoken-secret> replaced
```

NRF MySQL Secret Configuration

This section describes the secret creation for two types of NRF users. Different users have different sets of permissions.

- NRF privileged user: This user category has the complete set of permissions. The user can perform DDL and DML operations to install, upgrade, roll back or delete operations.
- NRF application user: This user category has fewer permissions and is used by NRF applications during service operations handling. The user can insert, update, get, and remove the records but cannot create, alter, and drop the database and tables.

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Kubernetes secret creation for NRF privileged database user

This section explains the steps to create Kubernetes secrets for accessing NRF database for the privileged user.

1. Log in to Bastion Host or server from where kubectl can be executed.
2. Create namespace for the secret by performing the following steps:
   a. Verify if required namespace already exists in the system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required namespace is available. If not available, create the namespace using the following command:
      Note: This is an optional step. In case required namespace already exists, proceed with next procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      For example:

      ```
      $ kubectl create namespace ocnrf
      ```

3. Create Kubernetes secret for privileged user as follows:
   a. Create Kubernetes secret for MySQL:

      ```
      $ kubectl create secret generic <privileged user secret name> --from-
      literal=dbUsername=<NRF Privileged Mysql database username> --from-
      literal=dbPassword=<NRF Privileged Mysql User database passsword> --
      from-literal=appDbName=<NRF Mysql database name> --from-
      literal=networkScopedDbName=<NRF Mysql Network database name> --from-
      literal=commonConfigDbName=<NRF Mysql Common Configuration DB> --from-
      literal=leaderElectionDbName=<Perf-Info DB> -n <Namespace of NRF
      deployment>
      ```

      > **Note**
      >
      > Note down the command used during the creation of Kubernetes secret, this command is used for updates in future.

      Example:

      ```
      $ kubectl create secret generic privilegeduser-secret --
      fromliteral=dbUsername=nrfPrivilegedUsr --
      fromliteral=dbPassword=nrfPrivilegedPasswd --
      fromliteral=appDbName=nrfApplicationDB --
      fromliteral=networkScopedDbName=nrfNetworkDB --
      fromliteral=commonConfigDbName=commonConfigurationDB --
      fromliteral=leaderElectionDbName=leaderElectionDB -n ocnrf
      ```


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b. Verify the secret created using above command:

```
$ kubectl describe secret <database secret name> -n <Namespace of NRF
deployment>
```

Example:

```
$ kubectl describe secret privilegeduser-secret -n ocnrf
```

Kubernetes secret update for NRF privileged database user

This section explains the steps to update Kubernetes secrets for accessing NRF database for the privileged user.

1. Log in to Bastion Host or server from where kubectl can be executed.
2. This section describes the steps to update the secrets. Update Kubernetes secret for privileged user as follows:
   a. Copy the exact command used in section during creation of secret:

```
$ kubectl create secret generic <privileged user secret name>
--from-literal=dbUsername=<NRF Privileged MySQL database username>
--from-literal=dbPassword=<NRF Privileged MySQL database password>
--from-literal=appDbName=<NRF MySQL database name>
--from-literal=networkScopedDbName=<NRF MySQL Network database name>
--from-literal=commonConfigDbName=<NRF MySQL Common Configuration DB> -
n
<Namespace of NRF deployment>
```

   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of MySQL secret>". After update, the command will be as follows:

```
$ kubectl create secret generic <privileged user secret name>
--from-literal=dbUsername=<NRF Privileged MySQL database username>
--from-literal=dbPassword=<NRF Privileged MySQL database password>
--from-literal=appDbName=<NRF MySQL database name>
--from-literal=networkScopedDbName=<NRF MySQL Network database name>
--from-literal=commonConfigDbName=<NRF MySQL Common Configuration DB> --
dry-run -o yaml
-n <Namespace of NRF deployment> | kubectl replace -f - -n <Namespace
of NRF deployment>
```

   c. Run the updated command. The following message is displayed:

```
secret/<database secret name> replaced
```

Kubernetes secret creation for NRF application database user

This section explains the steps to create Kubernetes secrets for accessing NRF database for the application database user.

1. Log in to Bastion Host or server from where kubectl can be executed.
2. Create namespace for the secret by performing the following steps:

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a. Verify if required namespace already exists in the system:

```
$ kubectl get namespaces
```

b. In the output of the above command, check if required namespace is available. If not available, create the namespace using the following command:
Note: This is an optional step. In case required namespace already exists, proceed with next procedures.

```
$ kubectl create namespace <required namespace>
```

Example:

```
$ kubectl create namespace ocnrf
```

3. Create Kubernetes secret for NRF application database user for configuring records is as follows:

a. Create Kubernetes secret for NRF application database user:

```
$ kubectl create secret generic <appuser-secret name> --from-
literal=dbUsername=<NRF APPLICATION User Name> --from-
literal=dbPassword=<Password for NRF APPLICATION User> --from-
literal=appDbName=<NRF Application Database> -n <Namespace of NRF
deployment>
```

> **Note**
>
> Note down the command used during the creation of Kubernetes secret, this command will be used for updates in future.

Example:

```
$ kubectl create secret generic appuser-secret --from-
literal=dbUsername=nrfApplicationUsr --from-
literal=dbPassword=nrfApplicationPasswd --from-
literal=appDbName=nrfApplicationDB -n ocnrf
```

b. Verify the secret creation:

```
$ kubectl describe secret <appuser-secret name> -n <Namespace of NRF
deployment>
```

Example:

```
$ kubectl describe secret appuser-secret -n ocnrf
```

Kubernetes secret update for NRF application database user

This section explains the steps to update Kubernetes secrets for accessing NRF database for the application database user.

1. Log in to Bastion Host or server from where kubectl can be executed.

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2. This section explains how to update the Kubernetes secret.
   a. Copy the exact command used in above section during creation of secret:

      ```
      $ kubectl create secret generic <appuser-secret name> --from-
      literal=dbUsername=<NRF APPLICATION
       User Name> --from-literal=dbPassword=<Password for NRF APPLICATION
      User> --from-literal=appDbName=<NRF
      Application Database> -n <Namespace of NRF deployment>
      ```

   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of MySQL secret>". After update, the command will be as follows:

      ```
      $ kubectl create secret generic <database secret name> --from-
      literal=dbUsername=<NRF APPLICATION
      User Name> --from-literal=dbPassword=<Password for NRF APPLICATION
      User> --from-literal=appDbName=<NRF
      Application Database> --dry-run -o yaml -n <Namespace of NRF
      deployment> | kubectl replace -f - -n <Namespace
      of NRF deployment>
      ```

   c. Run the updated command. The following message is displayed:

      ```
      secret/<database secret name> replaced
      ```

Creating Secrets for DNS NAPTR - Alternate route service

This section provides information about how to create secret for DNS NAPTR in Alternate Route service.

1. Run the following command to create secret:

   ```
   $ kubectl create secret generic <DNS NAPTR Secret> --from-
   literal=tsigKey=<tsig key generated of DNS Server> --from-
   literal=algorithm=<Algorithm used to generate key> --from-
   literal=keyName=<key-name used while generating key> -n <Namespace of NRF
   deployment>
   ```

   > **Note**
   >
   > Note down the command used during the creation of the secret. Use the command for updating the secrets in the future.

   Example:

   ```
   $ kubectl create secret generic tsig-secret  --from-
   literal=tsigKey=kUVdLp2SYshV/mkE985LEePLt3/
   K4vhM63suWJXA9T6DAl3hJFQQpKAcK5imcIKjI5IVyYk2AJBkq3qtQvRTGw== --from-
   literal=algorithm=hmac-sha256 --from-literal=keyName=ocnrf-tsig -n ocnrf
   ```


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2. Run the following command to verify the secret created:

```
$ kubectl describe secret <DNS NAPTR Secret> -n <Namespace of NRF
deployment>
```

Example:

```
$ kubectl describe secret tsig-secret -n ocnrf
```

> **Note**
>
> Creating DNS Server Key is on discretion of the operator.

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Network Repository Function Installation, Upgrade, and Fault Recovery Guide*.

3.2.2 Service Communication Proxy (SCP) Specific Security Recommendations and Guidelines

This section provides Oracle Communications Cloud Native Core, Service Communication Proxy (SCP) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G Network Functions (NFs) are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

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> **Note**
>
> You must perform the following procedures in the same sequence as described in the "Installing SCP" section in *Oracle Communications Cloud Native Core, Service Communication Proxy Installation, Upgrade, and Fault Recovery Guide*.

Configuring Database for SCP

The following SCP users have different sets of permissions:

- SCP privileged user: This user category has a complete set of permissions. The user can perform Data Definition Language (DDL) and Data Manipulation Language (DML) operations to install, upgrade, roll back or delete operations.
- SCP application user: This user category has fewer permissions and is used by SCP applications during service operations handling. The user can insert, update, get, and remove the records. This user cannot create, alter, and drop the database and tables.

This section explains how database administrators can create users and database in a single and multisite deployment.

> **Note**
>
> While performing a fresh installation, if SCP is already deployed, purge the deployment and remove the database and users that were used for the previous deployment.

1. Log in to the MySQL server and ensure that there is a privileged user (<privileged user>) with the privileges similar to a root user.
2. On each SQL node, run the following command to verify that the privileged user has the required permissions to allow connections from remote hosts:

```
mysql>select host from mysql.user where User='<privileged username>';
+------+
| host |
+------+
| % |
+------+
1 rowinset(0.00 sec)
```

3. If you do not see '%' in the output of the above mentioned query, then run the following command to modify this field to allow connections to remote host:

```
mysql>update mysql.user set host='%' where User='<privileged username>';
Query OK, 0rowsaffected (0.00 sec)
Rowsmatched: 1 Changed: 0 Warnings: 0
```


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```
mysql> flush privileges;
Query OK, 0rowsaffected (0.06 sec)
```

> **Note**
>
> Perform this step on each SQL node.

4. To automatically create an application user, backup database, and application database, ensure that the `createUser` parameter in the `ocscp_values.yaml` file is set to `true`. To manually create an application user, application database, and backup database, set the `createUser` parameter to `false` in the `ocscp_values.yaml` file.
   By default, the `createUser` parameter value is set to `true`.
5. Run the following commands to create an application and backup database:
   - For application database:

     ```
     CREATE DATABASE <scp_dbname>;
     ```

     Example:

     ```
     CREATE DATABASE ocscpdb;
     ```

   - For backup database:

     ```
     CREATE DATABASE <scp_backupdbname>;
     ```

     Example:

     ```
     CREATE DATABASE ocscpbackupdb;
     ```

6. Run the following command to create an application user and assign privileges:

   ```
   CREATE USER '<username>'@'%' IDENTIFIED BY '<password>';
   GRANT SELECT, INSERT, DELETE, UPDATE ON <scp_dbname>.* TO <username>@'%';
   ```

   Where,
   - `<scp_dbname>` is the database name.
   - `<username>` is the database username.

   Example:

   ```
   CREATE USER 'scpApplicationUsr'@'%' IDENTIFIED BY 'scpApplicationPasswd';
   GRANT SELECT, INSERT, DELETE, UPDATE ON ocscpdb.* TO scpApplicationUsr@'%';
   ```

7. Run the following command to grant NDB_STORED_USER permission to the application user:

   ```
   GRANT NDB_STORED_USER ON *.* TO '<username>'@'%' WITH GRANT OPTION ;
   ```

   Example:

   ```
   GRANT NDB_STORED_USER ON *.* TO 'scpApplicationUsr'@'%' WITH GRANT OPTION ;
   ```


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> **Note**
>
> During a fresh SCP installation, the application database and backup database must be removed manually by running the following command:
>
> ```
> drop database <dbname>;
> ```

SCP Kubernetes Secret Configuration

> **Note**
>
> Do not use the same credentials in different Kubernetes secrets, and the passwords stored in the secrets must follow the password policy requirements as recommended in Changing cnDBTier Passwords in the cnDBTier Security Recommendations and Guidelines section.

Creating and Updating Kubernetes Secret for Privileged Database User

This section explains how to create and update Kubernetes secret for privileged user to access the database.

1. Run the following command to create Kubernetes secret:

   ```
   kubectl create secret generic <secret name> --from-
   literal=DB_USERNAME=<privileged user> --from-
   literal=DB_PASSWORD=<privileged user password> --from-literal=DB_NAME=<scp
   application db> --from-literal=RELEASE_DB_NAME=<scp backup db> -n <scp
   namespace>
   ```

   Where,

   - `<secret name>` is the secret name of the Privileged User.
   - `<privileged user>` is the username of the Privileged User.
   - `<privileged user password>` is the password of the Privileged User.
   - `<scp backup db>` is the backup database name.
   - `<scp namespace>` is the namespace of SCP deployment.

   > **Note**
   >
   > Note down the command used during the creation of Kubernetes secret. This command is used for updating the secrets in the later releases.

   Example:

   ```
   kubectl create secret generic privilegeduser-secret --from-
   literal=DB_USERNAME=scpPrivilegedUsr --from-
   literal=DB_PASSWORD=scpPrivilegedPasswd --from-literal=DB_NAME=ocscpdb --from-
   literal=RELEASE_DB_NAME=ocscpbackupdb -n scpsvc
   ```


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2. Run the following command to verify the secret created:

   ```
   kubectl describe secret <secret name> -n <scp namespace>
   ```

   Where,

   - `<secret name>` is the secret name of the Privileged user.
   - `<scp namespace>` is the namespace of SCP deployment.

   Example:

   ```
   kubectl describe secret privilegeduser-secret -n ocscp
   ```

   Sample output:

   ```
   Name:         privilegeduser-secret
   Namespace:    ocscp
   Labels:       <none>
   Annotations:  <none>

   Type:  Opaque

   Data
   ====
   mysql-password:  10 bytes
   mysql-username:  17 bytes
   ```

Creating and Updating Kubernetes Secret for Application Database User

This section explains how to create and update Kubernetes secret for application user to access the database.

1. Run the following command to create a Kubernetes secret:

   ```
   kubectl create secret generic <secret name> --from-
   literal=DB_USERNAME=<application user> --from-
   literal=DB_PASSWORD=<application user password> --from-
   literal=DB_NAME=<scp application db> -n <scp namespace>
   ```

   Where,

   - `<secret name>` is the secret name of the Privileged User.
   - `<application user>` is the username of the Application User.
   - `<application user password>` is the password of the Application User.
   - `<scp application db>` is the application database name.
   - `<scp namespace>` is the namespace of SCP deployment.

   > **Note**
   >
   > Note down the command used during the creation of Kubernetes secret. This command is used for updating the secrets in the later releases.

   Example:

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```
kubectl create secret generic appuser-secret --from-
literal=DB_USERNAME=scpApplicationUsr --from-
literal=DB_PASSWORD=scpApplicationPasswd --from-literal=DB_NAME=ocscpdb -n
scpsvc
```

2. Run the following command to verify the secret created:

   ```
   kubectl describe secret <application user secret name> -n <namespace>
   ```

   Where,

   - `<application user secret name>` is the secret name of the application user.
   - `<scp namespace>` is the namespace of SCP deployment.

   Example:

   ```
   kubectl describe secret appuser-secret -n ocscp
   ```

   Sample output:

   ```
   Name:         appuser-secret
   Namespace:    ocscp
   Labels:       <none>
   Annotations:  <none>

   Type:  Opaque

   Data
   ====
   mysql-password:  10 bytes
   mysql-username:  7 bytes
   ```

Configuring SSL or TLS Certificates to Enable HTTPS

The Secure Sockets Layer (SSL) and Transport Layer Security (TLS) certificates must be configured in SCP to enable Hypertext Transfer Protocol Secure (HTTPS). These certificates must be stored in Kubernetes secret and the secret name must be provided in the `sbiProxySslConfigurations` section of the `custom-values.yaml` file.

Perform the following procedure to configure SSL or TLS certificates for enabling HTTPS in SCP. You must perform this procedure before:

- fresh installation of SCP.
- performing an SCP upgrade.

You must have the following files to create Kubernetes secret for HTTPS:

- ECDSA private key and CA signed certificate of SCP if initialAlgorithm is ES256
- RSA private key and CA signed certificate of SCP if initialAlgorithm is RS256
- TrustStore password file
- KeyStore password file
- CA Root file

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> **Note**
>
> - The process to create the private keys, certificates, and passwords is at the operators' discretion.
> - The passwords for TrustStore and KeyStore must be stored in the respective password files.
> - Perform this procedure before enabling HTTPS in SCP.

You can create Kubernetes secret for enabling HTTPS in SCP using one of the following methods:

- Managing Kubernetes secret manually
- Managing Kubernetes secret through OCCM

Managing Kubernetes Secret Manually

1. To create Kubernetes secret manually, run the following command:

   ```
   kubectl create secret generic <ocscp-secret-name> --from-file=<rsa private
   key file name> --from-file=<ssl truststore file name> --from-file=<ssl
   keystore file name> --from-file=<CA root bundle> --from-file=<ssl rsa
   certificate file name> -n <Namespace of OCSCP deployment>
   ```

   > **Note**
   >
   > Note down the command used during the creation of Kubernetes secret. This command is used for the subsequent updates.

   Example:

   ```
   kubectl create secret generic server-primary-ocscp-secret --from-
   file=server_rsa_private_key_pkcs1.pem --from-file=server_ocscp.cer --from-
   file=server_caroot.cer --from-file=trust.txt --from-file=key.txt -
   n $NAMESPACE
   kubectl create secret generic default-primary-ocscp-secret --from-
   file=client_rsa_private_key_pkcs1.pem --from-file=client_ocscp.cer --from-
   file=caroot.cer --from-file=trust.txt --from-file=key.txt -n $NAMESPACE
   ```

   > **Note**
   >
   > It is recommended to use the same Kubernetes secret name for the primary client and the primary server as mentioned in the example. In case you change `<ocscp-secret-name>`, then update the `k8SecretName` parameter under the `sbiProxySslConfigurations` section in the `custom-values.yaml` file. For more information about `sbiProxySslConfigurations` parameters, see "Global parameters" in *Oracle Communications Cloud Native Core, Service Communication Proxy Installation, Upgrade, and Fault Recovery Guide*.

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2. Run the following command to verify the Kubernetes secret created:

   ```
   kubectl describe secret <ocscp-secret-name> -n <Namespace of OCSCP
   deployment>
   ```

   Example:

   ```
   kubectl describe secret ocscp-secret -n ocscp
   ```

3. Perform the following tasks to add, remove, or modify TLS or SSL certificates in Kubernetes secret:

   > **Note**
   >
   > You must have the certificates and files that you want to add or update in the Kubernetes secret.

   - To add a certificate, run the following command:

     ```
     TLS_CRT=$(base64 < "<certificate-name>" | tr -d '\n')
     kubectl patch secret <secret-name> -p "{\"data\":{\"<certificate-
     name>\":\"${TLS_CRT}\"}}"
     ```

     Where,

     – `<certificate-name>` is the certificate file name.

     – `<secret-name>` is the name of the Kubernetes secret, for example, ocscp-secret.

     Example:

     If you want to add a Certificate Authority (CA) Root from the `caroot.cer` file to the ocscp-secret, run the following command:

     ```
     TLS_CRT=$(base64 < "caroot.cer" | tr -d '\n')
     kubectl patch secret ocscp-secret  -p "{\"data\":{\"caroot.cer\":\"$
     {TLS_CRT}\"}}" -n scpsvc
     ```

     Similarly, you can also add other certificates and keys to the ocscp-secret.

   - To update an existing certificate, run the following command:

     ```
     TLS_CRT=$(base64 < "<updated-certificate-name>" | tr -d '\n')
     kubectl patch secret <secret-name> -p "{\"data\":{\"<certificate-
     name>\":\"${TLS_CRT}\"}}"
     ```

     Where, `<updated-certificate-name>` is the certificate file that contains the updated content.

     Example:

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If you want to update the privatekey present in the `rsa_private_key_pkcs1.pem` file to the ocscp-secret, run the following command:

```
TLS_CRT=$(base64 < "rsa_private_key_pkcs1.pem" | tr -d '\n')
kubectl patch secret ocscp-secret -p "{\"data\":
{\"rsa_private_key_pkcs1.pem\":\"${TLS_CRT}\"}}" -n scpsvc
```

Similarly, you can also update other certificates and keys to the ocscp-secret.

- To remove an existing certificate, run the following command:

  ```
  kubectl patch secret <secret-name> -p "{\"data\":{\"<certificate-
  name>\":null}}"
  ```

  Where, `<certificate-name>` is the name of the certificate to be removed.

  The certificate must be removed when it expires or needs to be revoked.

  Example:

  To remove the CA Root from the ocscp-secret, run the following command:

  ```
  kubectl patch secret ocscp-secret  -p "{\"data\":
  {\"caroot.cer\":null}}" -n scpsvc
  ```

  Similarly, you can also remove other certificates and keys from the ocscp-secret.

The certificate update and renewal impacts are as follows:

- Updating, adding, or deleting the certificate, terminates all the existing connections gracefully and reestablishes new connections for new requests.
- When the certificates expires, no new connections are established for new requests, however, the existing connections remain active. After the renewal of the certificates as described in the previous step, all the existing connections are gracefully terminated. And, new connections are established with the renewed certificates.

Managing Kubernetes Secret Through OCCM

To create the Kubernetes secret using Oracle Communications Cloud Native Core, Certificate Management (OCCM), see "Managing Certificates" in *Oracle Communications Cloud Native Core, Certificate Management User Guide*, and then patch the Kubernetes secret created by OCCM to add keyStore password and trustStore password files by running the following commands:

1. To patch the Kubernetes secret created with the keyStore password file:

   ```
   TLS_CRT=$(base64 < "key.txt" | tr -d '\n')
   kubectl patch secret server-primary-ocscp-secret-occm -n scpsvc -p
   "{\"data\":{\"key.txt\":\"${TLS_CRT}\"}}"
   ```

   Where, `key.txt` is the KeyStore password file that contains KeyStore password.

2. To patch the Kubernetes secret created with the trustStore password file:

   ```
   TLS_CRT=$(base64 < "trust.txt" | tr -d '\n')
   kubectl patch secret server-primary-ocscp-secret-occm -n scpsvc -p
   "{\"data\":{\"trust.txt\":\"${TLS_CRT}\"}}"
   ```


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Where, `trust.txt` is the TrustStore password file that contains TrustStore password.

> **Note**
>
> To monitor the lifecycle management of the certificates through OCCM, do not patch the Kubernetes secret manually to update the TLS certificate or keys. It must be done through the OCCM GUI.

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core,Service Communication Proxy Installation, Upgrade, and Fault Recovery Guide*.

3.2.3 Network Exposure Function (NEF) Specific Security Recommendations and Guidelines

This section provides specific recommendations and guidelines for Network Exposure Function (NEF) security. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- NEF Access Token Secret Configuration
- NEF Access Token Secret Update
- NEF MySQL Secret configuration
  - Kubernetes secret creation for NEF privileged database user
  - Kubernetes secret update for NEF privileged database user

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  - Kubernetes secret creation for NEF application database user
  - Kubernetes secret update for NEF application database user
- Network Policies

NEF Access Token Secret Configuration

Use the following procedure to create an Access token secret :

1. Create the following files:
   - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for NEF
   - RSA private keys for algorithm RS256 and corresponding valid public certificates for NEF

   Note: Creation of private keys, certificates and passwords are at the discretion of user.
2. Log in to Bastion Host or server from where you can run kubectl commands.
3. Create a namespace for the secret by performing the following steps:
   a. Verify if the required namespace already exists in the system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required namespace is available. If not available, create the namespace using the following command:
      Note: This is an optional step. In case required namespace already exists, proceed with next procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      Example:

      ```
      $ kubectl create namespace ocnef
      ```

4. Create Kubernetes secret for the Access token by performing the following steps:
   a. To create Kubernetes secret for HTTPS, following files are required:
      - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for NEF
      - RSA private keys for algorithm RS256 and corresponding valid public certificates for NEF

      > **Note**
      >
      > Creation process for private keys, certificates and passwords is at the user's or operators discretion. Unencrypted key and certificates is only supported. PKCS1 and PKCS8 are the only supported versions for RSA. PKCS8 is the only supported version for ECDSA.

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b. Run the following command to create secret. The names used below are same as provided in custom values.yaml in NEF deployment:

```
$ kubectl create secret generic <ocnefaccesstoken-secret-name>  --from-
file=<ecdsa_private_key.pem>
 --from-file=<rsa_private_key.pem>  --from-file=<ssl_truststore.txt> --
from-file=<keystore_password.txt>
  --from-file=rsa_certificate.crt --from-file=<ecdsa_certificate.crt> -
n <Namespace of ocnef AccessToken secret>
```

Note: Note down the command used during the creation of Kubernetes secret, this command will be used for updates in future.

```
$ kubectl create secret generic ocnefaccesstoken-secret  --from-
file=ecdsa_private_key.pem
--from-file=rsa_private_key.pem  --from-file=ssl_truststore.txt --from-
file=keystore_password.txt  --from-file=
rsa_certificate.crt --from-file=ecdsa_certificate.crt -n ocnef
```

c. Run the following command to verify if the secret is created:

```
$ kubectl describe secret <ocnefaccesstoken-secret-name> -n <Namespace
of NEF AccessToken secret>
```

Example:

```
 $ kubectl describe secret ocnefaccesstoken-secret -n ocnef
```

NEF Access Token Secret Update

Use the following procedure to update the Access token secret:

1. Update the following files:
   - ECDSA private keys for algorithm ES256 and corresponding valid public certificates for NEF
   - RSA private keys for algorithm RS256 and corresponding valid public certificates for NEF

   Note: Update of private keys, certificates and passwords are at the discretion of user.
2. Log in to Bastion Host or server from where you can run kubectl commands.
3. Update the secret with new or updated details by performing the following steps:
   a. Copy the exact command used in above section during creation of secret.
   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of Access Token secret>".
   c. Create secret command must look like:

```
$ kubectl create secret generic <ocnefaccesstoken-secret> --from-
file=<ecdsa_private_key.pem>
--from-file=<rsa_private_key.pem> --from-file=<rsa_certificate.crt> --
from-file=<ecdsa_certificate.crt>
```


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```
 --dry-run -o yaml -n <Namespace of ocnef deployment> | kubectl replace
-f - -n <Namespace of ocnef deployment>
```

Example: The names used below are same as provided in custom_values.yaml in NEF deployment:

```
$ kubectl create secret generic ocnefaccesstoken-secret --from-
file=ecdsa_private_key.pem
--from-file=rsa_private_key.pem --from-file=rsa_certificate.crt --from-
file=ecdsa_certificate.crt
--dry-run -o yaml -n ocnef | kubectl replace -f - -n ocnef
```

d. Run the updated command.

e. After successful secret update, the following message is displayed:

```
secret/<ocnefaccesstoken-secret> replaced
```

NEF MySQL Secret Configuration

This section describes the secret creation for two types of NEF users. Different users have different sets of permissions.

- NEF privileged user: This user category has a complete set of permissions. The user can perform DDL and DML operations to install, upgrade, roll back or delete operations.
- NEF application user: This user category has fewer sets of permissions and is used by NEF applications during service operations handling. This user cannot create, alter, and drop the database and tables.

Kubernetes secret creation for NEF privileged database user

This section explains the steps to create Kubernetes secrets for accessing NEF database for the privileged user.

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. Create a namespace for the secret by performing the following steps:
   a. Verify if the required namespace already exists in the system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if the required namespace is available. If not available, create the namespace using the following command:
      Note: This is an optional step. In case the required namespace already exists, proceed with the next set of procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      For example:

      ```
      $ kubectl create namespace ocnef
      ```

3. Create a Kubernetes secret for privileged user as follows:

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a. Create a Kubernetes secret for MySQL:

```
 $ kubectl create secret generic <privileged user secret name>
 --from-literal=dbUsername=<NEF Privileged MySQL database username>
--from-literal=dbPassword=<NEF Privileged MySQL User database password>
--from-literal=appDbName=<NEF MySQL database name>
--from-literal=networkScopedDbName=<NEF MySQL Network database name>
--from-literal=commonConfigDbName=<NEF MySQL Common Configuration DB> -
n
<Namespace of NEF deployment>
```

> **Note**
>
> Note down the command used during the creation of the Kubernetes secret; this command is used for updates in the future.

Example:

```
$ kubectl create secret generic privilegeduser-secret --from-
literal=dbUsername=ocnefPrivilegedUsr
--from-literal=dbPassword=ocnefPrivilegedPasswd --from-
literal=appDbName=ocnefApplicationDB --from-literal
=networkScopedDbName=ocnefNetworkDB --from-
literal=commonConfigDbName=commonConfigurationDB -n ocnef
```

b. Verify the secret created using above command:

```
$ kubectl describe secret <database secret name> -n <Namespace of NEF
deployment>
```

Example:

```
$ kubectl describe secret privilegeduser-secret -n ocnef
```

Kubernetes secret update for NEF privileged database user

This section explains the steps to update Kubernetes secrets for accessing NEF database for the privileged user.

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. This section describes the steps to update the secrets. Update Kubernetes secret for privileged user as follows:
   a. Copy the exact command used in section during creation of secret:

```
$ kubectl create secret generic <privileged user secret name>
--from-literal=dbUsername=<NEF Privileged MySQL database username>
--from-literal=dbPassword=<NEF Privileged MySQL database password>
--from-literal=appDbName=<NEF MySQL database name>
--from-literal=networkScopedDbName=<NEF MySQL Network database name>
```


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```
--from-literal=commonConfigDbName=<NEF MySQL Common Configuration DB> -
n
<Namespace of NEF deployment>
```

b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of MySQL secret>". After update, the command will be as follows:

```
$ kubectl create secret generic <privileged user secret name>
--from-literal=dbUsername=<NEF Privileged MySQL database username>
--from-literal=dbPassword=<NEF Privileged MySQL database password>
--from-literal=appDbName=<NEF MySQL database name>
--from-literal=networkScopedDbName=<NEF MySQL Network database name>
--from-literal=commonConfigDbName=<NEF MySQL Common Configuration DB> --
dry-run -o yaml
-n <Namespace of NEF deployment> | kubectl replace -f - -n <Namespace
of NEF deployment>
```

c. Run the updated command. The following message is displayed:

```
secret/<database secret name> replaced
```

Kubernetes secret creation for NEF application database user

This section explains the steps to create Kubernetes secrets for accessing NEF database for the application database user.

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. Create a namespace for the secret by performing the following steps:
   a. Verify if the required namespace already exists in the system:

   ```
   $ kubectl get namespaces
   ```

   b. In the output of the above command, check if required the namespace is available. If not available, create the namespace using the following command:
   Note: This is an optional step. In case the required namespace already exists, proceed with the next set of procedures.

   ```
   $ kubectl create namespace <required namespace>
   ```

   Example:

   ```
   $ kubectl create namespace ocnef
   ```

3. Create a Kubernetes secret for NEF application database user for configuring records as follows:
   a. Create a Kubernetes secret for NEF application database user:

   ```
   $ kubectl create secret generic <appuser-secret name> --from-
   literal=dbUsername=<NEF APPLICATION User Name> --from-
   literal=dbPassword=<Password for NEF APPLICATION User> --from-
   literal=appDbName=<NEF Application Database> -n <Namespace of NEF
   deployment>
   ```


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> **Note**
>
> Note down the command used during the creation of Kubernetes secret, this command will be used for updates in future.

Example:

```
$ kubectl create secret generic appuser-secret --from-
literal=dbUsername=NEFApplicationUsr --from-
literal=dbPassword=NEFApplicationPasswd --from-
literal=appDbName=NEFApplicationDB -n ocnef
```

b. Verify the secret creation:

```
$ kubectl describe secret <appuser-secret name> -n <Namespace of NEF
deployment>
```

Example:

```
$ kubectl describe secret appuser-secret -n ocnef
```

Kubernetes secret update for NEF application database user

This section explains the steps to update Kubernetes secrets for accessing NEF database for the application database user.

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. This section explains how you can update the Kubernetes secret.
   a. Copy the exact command used in above section during creation of secret:

```
$ kubectl create secret generic <appuser-secret name> --from-
literal=dbUsername=<NEF APPLICATION
 User Name> --from-literal=dbPassword=<Password for NEF APPLICATION
User> --from-literal=appDbName=<NEF
Application Database> -n <Namespace of NEF deployment>
```

   b. Update the same command with string "--dry-run -o yaml" and "kubectl replace -f - -n <Namespace of MySQL secret>". After update, the command will be as follows:

```
$ kubectl create secret generic <database secret name> --from-
literal=dbUsername=<NEF APPLICATION
User Name> --from-literal=dbPassword=<Password for NEF APPLICATION
User> --from-literal=appDbName=<NEF
Application Database> --dry-run -o yaml -n <Namespace of NEF
deployment> | kubectl replace -f - -n <Namespace
of NEF deployment>
```

   c. Run the updated command. The following message is displayed:

```
secret/<database secret name> replaced
```


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Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Network Exposure Function Installation, Upgrade, and Fault Recovery Guide.*

3.2.4 Network Slice Selection Function (NSSF) Specific Security Recommendations and Guidelines

This section provides Network Slice Selection Function (NSSF) specific security recommendations and guidelines. Recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- NSSF Access Token Secret Configuration
- NSSF Access Token Secret Update
- NSSF MySQL Secret Configuration
  - Kubernetes Secret Creation for NSSF Privileged Database User
  - Kubernetes Secret Update for NSSF Privileged Database User
  - Kubernetes Secret Creation for NSSF Application Database User
  - Kubernetes Secret Update for NSSF Application Database User
- Network Policies

NSSF Access Token Secret Configuration

Use the following procedure to create access token secret:

1. Create the following files:

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- ECDSA private key (Example: `ecdsa_private_key_pkcs8.pem`)
- RSA private key (Example: `rsa_private_key_pkcs1.pem`)
- TrustStore password file (Example: `trustStorePassword.txt`)
- KeyStore password file (Example: `keyStorePassword.txt`)
- CA signed ECDSA NSSF certificate (Example: `ecdsa_ocnssf_certificate.crt`)
- CA signed RSA NSSF certificate (Example: `rsa_ocnssf_certificate.crt`)

Note: Creation of private keys, certificates and passwords are at the discretion of user.

2. Log in to Bastion Host or server from where kubectl can be run.
3. Create namespace for the secret by executing the following command:
```
$ kubectl create namespace ocnssf
```
4. Create Kubernetes secret for NF Access token by executing the following command:

```
$ kubectl create secret generic
         ocnssfaccesstoken-secret --from-file=ecdsa_private_key_pkcs8.pem
         --from-file=rsa_private_key_pkcs1.pem --from-
file=trustStorePassword.txt
         --from-file=keyStorePassword.txt --from-
file=ecdsa_ocnssf_certificate.crt--from-file=rsa_ocnssf_certificate.crt -n
      ocnssf
```

5. Verify that secret is created successfully by executing the following command:
```
$ kubectl describe secret ocnssfaccesstoken-secret -n ocnssf
```

NSSF Access Token Secret Update

Use the following procedure to update access token secret:

1. Update the following files:
   - ECDSA private key (Example: `ecdsa_private_key_pkcs8.pem`)
   - RSA private key (Example: `rsa_private_key_pkcs1.pem`)
   - TrustStore password file (Example: `trustStorePassword.txt`)
   - KeyStore password file (Example: `keyStorePassword.txt`)
   - CA signed ECDSA NSSF certificate (Example: `ecdsa_ocnssf_certificate.crt`)
   - CA signed RSA NSSF certificate (Example: `rsa_ocnssf_certificate.crt`)

   Note: Update private keys, certificates, and passwords are at the user's discretion.
2. Log in to Bastion Host or server from where kubectl can be run.
3. Update the secret with new or updated details by executing the following commands:
   Delete the secret:

   ```
   $ kubectl delete secret ocnssfaccesstoken-secret -n ocnssf
   ```

   Create the secret again with updated details:

   ```
   $ kubectl create secret generic ocnssfaccesstoken-secret --from-
   file=ecdsa_private_key_pkcs8.pem
    --from-file=rsa_private_key_pkcs1.pem --from-file=trustStorePassword.txt
   ```


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```
--from-file=keyStorePassword.txt
--from-file=ecdsa_ocnssf_certificate.crt--from-
file=rsa_ocnssf_certificate.crt -n ocnssf
```

NSSF MySQL Secret Configuration

Kubernetes Secret Creation for NSSF Privileged Database User

This section explains the steps to create Kubernetes secrets for accessing NSSF database for the privileged user.

1. Log in to Bastion Host or server from where kubectl can be run.
2. Create namespace for the secret by following:
   a. Verify required namespace already exists in system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required namespace is available. If not available, create the namespace using following command:
      Note: This is an optional step. In case required namespace already exists, proceed with next procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      For example:

      ```
      $ kubectl create namespace ocnssf
      ```

3. Create a yaml file with the username and password with the syntax as follows:

```
apiVersion: v1
kind: Secret
metadata:
name: <secret-name>
type: Opaque
data:
mysql-username: cm9vdA==
mysql-password: cm9vdHBhc3N3ZA==
```

> **Note**
>
> The values for "mysql-username" and "mysql-password" must be Base64 encoded.

4. Run `kubectl create -f <yaml_file_name> -n <namespace>` to create the secret.
5. Verify whether the secret is created by running the following command:
   `$ kubectl describe secret <secret-name> -n <namespace>`

Kubernetes Secret Update For NSSF Privileged Database User

This section explains the steps to update Kubernetes secrets for accessing NSSF database for the privileged user.

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1. Log in to Bastion Host or server from where kubectl can be run.
2. Delete the Kubernetes secret for MySQL:

   ```
   # Delete the secret
   $ kubectl delete secret <secret name> -n <namespace>
   ```

3. Update yaml file from step 3 in secret creation with new values for MySQL-username and MySQL-password
4. Run `kubectl create -f <yaml_file_name> -n <namespace>` to create the secret.
5. Verify whether the secret is created by running the following command:
   `$ kubectl describe secret <secret-name> -n <namespace>`

Kubernetes Secret Creation for NSSF Application Database User

This section explains the steps to create Kubernetes secrets for accessing NSSF database for the application database user.

1. Log in to Bastion Host or server from where kubectl can be run.
2. Create namespace for the secret by following:
   a. Verify required namespace already exists in system:

      ```
      $ kubectl get namespaces
      ```

   b. In the output of the above command, check if required namespace is available. If not available, create the namespace using following command:

      > **Note**
      >
      > This is an optional step. In case required namespace already exists, proceed with next procedures.

      ```
      $ kubectl create namespace <required namespace>
      ```

      For example:

      ```
      $ kubectl create namespace ocnssf
      ```

3. Create a yaml file with the username and password with the syntax as follows:

   ```
   apiVersion: v1
   kind: Secret
   metadata:
   name: <secret-name>
   type: Opaque
   data:
   mysql-username: bnNzZnVzZXI=
   mysql-password: bnNzZnBhc3N3ZA==
   ```


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> **Note**
>
> The values for "mysql-username" and "mysql-password" must be Base64 encoded.

4. Run `kubectl create -f <yaml_file_name> -n <namespace>` to create the secret.
5. Verify whether the secret is created by running the following command:
   `$ kubectl describe secret <secret-name> -n <namespace>`

Kubernetes Secret Update for NSSF Application Database User

This section explains the steps to update Kubernetes secrets for accessing NSSF database for the application database user.

1. Log in to Bastion Host or server from where kubectl can be run.
2. Delete the Kubernetes secret for MySQL:

   ```
   # Delete the secret
   $ kubectl delete secret <secret name> -n <namespace>
   ```

3. Update yaml file from step 3 in secret creation with new values for MySQL-username and MySQL-password
4. Run `kubectl create -f <yaml_file_name> -n <namespace>` to create the secret.
5. Verify whether the secret is created by running the following command:
   `$ kubectl describe secret <secret-name> -n <namespace>`

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Network Slice Selection Function Installation, Upgrade, and Fault Recovery Guide.*

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3.2.5 Security Edge Protection Proxy (SEPP) Security Recommendations and Procedures

This section provides Security Edge Protection Proxy (SEPP) specific security recommendations and procedures. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- SEPP Secret Configuration for HTTPS and HTTP over TLS
  - Creating Secret for HTTPS and HTTP over TLS
  - Updating Access Token Secret
- SEPP MySQL Secret Configuration
  - Creating Secret for MySQL
  - Updating Secret for MySQL
- Network Policies

SEPP Secret Configuration for HTTPS and HTTP over TLS

Use the following procedures to configure secret for HTTPS and HTTP over TLS and to update Access Token Secret:

Creating Secret for HTTPS and HTTP over TLS

Use the following procedure to create secret for HTTPS and HTTP over TLS:

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. Create the following files:
   - RSA or ECDSA Private key (For example: `rsa_private_key_pkcs1.pem`)
   - Truststore password (For example: `trust.txt`)
   - Key store password (For example: `key.txt`)
   - Certificate chain for truststore (For example: `caroot.cer`)
   - Signed server certificate (For example: `ocsepp.cer`) or Signed client certificate (For example: `ocsepp.cer`)

   Note: Creation of private keys, certificates, and passwords is at the discretion of the user.
3. To verify and create the Kubernetes namespace, do the following:
   a. Run the following command to verify if the required namespace exists in the system:

      ```
      $ kubectl get namespaces
      ```


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b. Run the following command to create a Kubernetes namespace if the output of the above command does not display the required namespace:

```
$ kubectl create namespace <required namespace>
```

> **Note**
>
> This is an optional step. In case the required namespace already exists, skip this procedure.

Example:

```
$ kubectl create namespace seppsvc
```

4. Run the following commands to create Kubernetes secrets in SEPP mode or Roaming Hub mode:

- For **Creating secrets**

```
$ kubectl create secret generic <secret-name>
                  --from-file=<ssl_ecdsa_private_key.pem> --from-
file=<rsa_private_key_pkcs1.pem>
                  --from-file=<ssl_truststore.txt> --from-
file=<ssl_keystore.txt> --from-file=<signed.cer>
                  --from-file=<caroot.cer> --from-
file=<ssl_rsa_certificate.crt> --from-file
                  <ssl_ecdsa_certificate.crt> -n <Namespace of SEPP
deployment>
```

- For **HTTP over TLS For n32 interface**

```
$ kubectl create secret generic ocsepp-n32-secret
                  --from-file=rsa_private_key_pkcs1.pem --from-
file=trust.txt --from-file=key.txt
                  --from-file=caroot.cer --from-
file=rsa_certificate.crt --from-file=ocsepp.cer -n
                  seppsvc
```

- For **HTTPS For Plmn interface**

```
$ kubectl create secret generic
                    ocsepp-plmn-secret --from-
file=rsa_private_key_pkcs1.pem --from-file=trust.txt
                    --from-file=key.txt --from-file=caroot.cer --from-
file=rsa_certificate.crt
                    --from-file=ocsepp.cer -n seppsvc
```

5. Run the following commands to create Kubernetes secrets in **Hosted SEPP mode**:

- For **Creating secrets**

```
$ kubectl create secret generic <secret-name>
                  --from-file=<ssl_ecdsa_private_key.pem> --from-
file=<rsa_private_key_pkcs1.pem>
                  --from-file=<ssl_truststore.txt> --from-
```


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```
file=<ssl_keystore.txt> --from-file=<signed.cer>
                  --from-file=<caroot.cer> --from-
file=<ssl_rsa_certificate.crt> --from-file
                  <ssl_ecdsa_certificate.crt> -n <Namespace of SEPP
deployment>
```

- For **HTTP over TLS For n32 interface**
  For **N32 Egress Gateway**

  ```
  kubectl create secret generic ocsepp-n32-egw-secret
                  --from-file=rsa_private_key_pkcs1.pem --from-
  file=trust.txt --from-file=key.txt
                  --from-file=caroot.cer --from-file=rsa_certificate.crt --
  from-file=ocsepp.cer -n
                  seppsvc
  ```

  For **N32 Ingress Gateway**

  ```
  kubectl create secret generic ocsepp-n32-igw-secret
                  --from-file=rsa_private_key_pkcs1.pem --from-
  file=trust.txt --from-file=key.txt
                  --from-file=caroot.cer --from-file=rsa_certificate.crt --
  from-file=ocsepp.cer -n
                  seppsvc
  ```

- For **HTTPS For Plmn interface**
  For **PLMN Egress Gateway**

  ```
  kubectl create secret generic
                    ocsepp-plmn-egw-secret --from-
  file=rsa_private_key_pkcs1.pem --from-file=trust.txt
                    --from-file=key.txt --from-file=caroot.cer --from-
  file=rsa_certificate.crt
                    --from-file=ocsepp.cer -n seppsvc
  ```

For **PLMN Ingress Gateway**

```
kubectl create secret generic
                  ocsepp-plmn-igw-secret --from-
file=rsa_private_key_pkcs1.pem --from-file=trust.txt
                  --from-file=key.txt --from-file=caroot.cer --from-
file=rsa_certificate.crt
                  --from-file=ocsepp.cer -n seppsvc
```

Updating Access Token Secret

Use the following procedure to update access token secret:

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. Update the secret with new or updated details.
   Run the following commands to create the secrets again with updated details:

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- for **HTTP over TLS For n32 interface**

```
$ kubectl create secret generic <n32 secret> --from-
file=rsa_private_key_pkcs1.pem
      --from-file=trust.txt --from-file=key.txt --from-file=caroot.cer
      --from-file=rsa_certificate.crt --from-file=ocsepp.cer --dry-run -
o yaml  -n seppsvc | kubectl replace -f - -n seppsvc
```

  Here, the <n32 secret> can be `ocsepp-n32-igw-secret` and `ocsepp-n32-egw-secret` in case of Hosted SEPP deployment. It must be `ocsepp-n32-secret` for the other deployment modes.

- for **HTTPS For PLMN interface**

```
$ kubectl create secret generic <plmn secret> --from-
file=rsa_private_key_pkcs1.pem
      --from-file=trust.txt --from-file=key.txt --from-file=caroot.cer
      --from-file=rsa_certificate.crt --from-file=ocsepp.cer --dry-run -
o yaml  -n seppsvc |
      kubectl replace -f - -n seppsvc
```

  Note: Update of private keys, certificates and passwords are at the discretion of the user.

Here, the <plmn secret> can be `ocsepp-plmn-igw-secret` and `ocsepp-plmn-egw-secret` in case of Hosted SEPP deployment. It must be `ocsepp-plmn-secret` for the other deployment modes.

Managing Secrets Through OCCM

To create the secrets using OCCM, see "Managing Certificates" in *Oracle Communications Cloud Native Core, Certificate Management User Guide*.

The secrets created by OCCM are then patched to add keyStore password and trustStore password files by running the following commands:

1. To patch the secrets created with the keyStore password file:

```
TLS_CRT=$(base64 < "key.txt" | tr -d '\n')
kubectl patch secret server-primary-seppsvc-secret-occm -n seppsvc -p
"{\"data\":{\"key.txt\":\"${TLS_CRT}\"}}"
```

   Where,

   - `key.txt` is the password file that contains KeyStore password.
   - `server-primary-ocsepp-secret-occm` is the secret created by OCCM.

2. To patch the secrets created with the trustStore password file:

```
TLS_CRT=$(base64 < "trust.txt" | tr -d '\n')
kubectl patch secret server-primary-ocsepp-secret-occm -n seppsvc -p
"{\"data\":{\"trust.txt\":\"${TLS_CRT}\"}}"
```

   Where,

   - `trust.txt` is the password file that contains TrustStore password.

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- `server-primary-ocsepp-secret-occm` is the secret created by OCCM.

> **Note**
>
> To monitor the lifecycle management of the certificates through OCCM, do not patch the Kubernetes secrets manually to update the TLS certificate or keys. It must be done through the OCCM GUI.

SEPP MySQL Secret Configuration

Creating Secret for MySQL

Use the following procedure to create MySQL Secret:

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. Create namespace for the secret. Skip this step, if already created.

   ```
   $ kubectl create namespace seppsvc
   ```

   Note: Creation of private keys, certificates and passwords are at the discretion of the user.
3. Create a yaml file with the username, password, and DB name with the syntax shown below:

   ```
   apiVersion: v1
   kind: Secret
   metadata:
     name: ocsepp-mysql-cred
   type: Opaque
   data:
     mysql-username: c2VwcF91c3I=
     mysql-password: RHVrdzFAbT8=
   ```

   > **Note**
   >
   > Note: The values for "mysql-username" and "mysql-password" should be Base64 encoded.

4. Run the following commands to create Kubernetes secrets:

   ```
   $ kubectl apply -f <yaml_file_name> -n <namespace>
   ```

   Or

   ```
   kubectl create secret generic <OCSEPP User secret name> --fromliteral=
   Mysql-username=<OCSEPP MySQL Database User Name> --fromliteral=
   mysql-password=<OCSEPP Mysql User Password > -n <Namespace>
   ```


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5. Verify the secret creation:

```
$ kubectl describe secret <secret-name> -n <namespace>
```

Updating Secret for MySQL

Use the following procedure to update MySQL Secret :

1. Log in to Bastion Host or server from where you can run kubectl commands.
2. Update the Kubernetes secret for MySQL:

```
# Delete the secret:

$ kubectl delete secret database-secret -n <namespace>



# Create the secret with updated details:

$ kubectl create secret generic <secretName> -from-literal=mysql-
username='<USR_NAME>'
--from-literal=mysql-password='<PWD>' -n <namespace>
```

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Security Edge Protection Proxy Installation, Upgrade, and Fault Recovery Guide*.

3.2.6 Unified Data Repository (UDR) and Unstructured Data Storage Function (UDSF) Specific Security Recommendations and Guidelines

This section provides Unified Data Repository (UDR), Unstructured Data Storage Function (UDSF), and Equipment Identity Register (EIR) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines Section.

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> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- Oauth Token Validation Configuration
  - Rest Configuration
  - Public key Update for Changed Access Token
  - Disabling the Signature Validation for Oauth
- UDR MySQL Kubernetes secret for storing Database Username and Password
- TLS Certificate for HTTPs Support
- Remote File Transfer Support
- Network Policies

Oauth Token Validation Configuration

Use the following procedure for Oauth Token validation configuration:

1. NRF creates access tokens using following private keys:
   - **ECDSA private key**
     Example:

     ```
     ecdsa_private_key_pkcs8.pem
     ```

   - **RSA private key**
     Example:

     ```
     rsa_private_key_pkcs1.pem
     ```

     In order to validate access token secret needs to be created and configured in ocudr ingress gateway with certificates fetched from nrf.

     Example:

     ```
     6faf1bbc-6e4a-4454-a507-a14ef8e1bc5c_ES256.crt
     ```

2. Log in to Bastion Host or server from where kubectl can be executed.
3. Create namespace for the secret.

   ```
   $ kubectl create namespace ocudr
   ```

4. Create Kubernetes secret for NF Access token validation

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> **Note**
>
> The file names in below command are same as in Step 1.

```
$ kubectl create secret generic oauthsecret --from-file=6faf1bbc-6e4a-4454-
a507-a14ef8e1bc5c_ES256.crt-n ocudr
```

5. Run the following command to verify if the secret is created successfully:

```
$ kubectl describe secret oauthsecret -n ocudr
```

Rest Configuration

We need REST based configurations to distinguish certificates configured from different NRF and use them properly to validate token received from specific NRF. These configurations can be added from CNCC GUI which internally uses config API and payload as below:

```
“/udr/nf-common-component/v1/igw/oauthvalidatorconfiguration”

Payload:

{
              "keyIdList": [{

                            "keyId": "664b344e74294c8fa5d2e7dfaaaba407",
                            "kSecretName": "samplesecret1",
                            "certName": "samplecert1.crt",
                            "certAlgorithm": "ES256"
                          }],
              "instanceIdList": [{

                            "instanceId": "664b344e74294c8fa5d2e7dfaaaba407",
                            "kSecretName": "samplesecret2",
                            "certName": "samplecert2.crt",
                            "certAlgorithm": "ES256"

                             }],
              "oAuthValidationMode": "INSTANCEID_ONLY"

}
```

The multiple **keyId** and **instanceId** object of different NRFs can be configured.

Using **oAuthValidationMode** mode of validation can be selected.

Example: INSTANCEID_ONLY, KID_ONLY or KID_PREFERRED

KID_PREFERRED is a fall back mode where it checks for keyId in token, if token contains keyId then validation mode is KID_ONLY or else it falls back to INSTANCEID_ONLY.

Public key Update for Changed Access Token

Use the following procedure for public key update for changed access token:

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1. Log in to Bastion Host or server from where kubectl can be executed.
2. Update the secret with new or updated details:

```
# Delete the secret and recreate it
$ kubectl delete secret oauthsecret -n ocudr

# Fetch updated certificates from nrf

# Recreate the secret with updated details
$ kubectl create secret generic oauthsecret --from-file=0263663c-
f5c2-4d1b-9170-f7b1a9116337_ES256.crt

-n ocudr
```

3. Certificate configuration update request needs to be sent using CNCC GUI with the updated **keyIdList** and **instanceIdList** with new certificates.

Disabling the Signature Validation for Oauth

If **serviceMeshCheck** flag is enabled under ingress gateway in custom-values file, signature validation is disabled by default.

In this case, only header and payload are validated, and request is successful even if token has wrong signature.

UDR MySQL Kubernetes Secret for storing Database Username and Password

Use the following procedure to create MySQL Kubernetes secret for storing database username and password:

1. Log in to Bastion Host or server from where kubectl can be executed.
2. Create namespace for the MySQL secret. Skip this step, if already created.

```
 $ kubectl create namespace <namespace>
```

3. Run the following command for creating the secret:

```
kubectl create secret generic ocudr-secrets --from-literal=
dbname=<dbname> --from-literal=configdbname=<configdbname> --from-literal=
privilegedUsername=<privilegedUsername> --from-literal=
privilegedPassword=<privilegedPassword> --from-
literal=dsusername=<udruserName> --from-literal=
dspassword=<udruserPassword> --from-literal=encryptionKey='My secret
passphrase' -n <ocudr-namespace>
```

Example:

```
kubectl create secret generic ocudr-secrets --from-literal=dbname=udrdb --
from-literal=
configdbname=udrconfigdb --from-literal=privilegedUsername=root --from-
literal=
privilegedPassword=rootPasswd --from-literal=dsusername=udruser --from-
literal=dspassword=udrpasswd --from-literal=
encryptionKey='My secret passphrase' -n <ocudr-namespace>
```


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4. Verify the whether the secret is created by executing the following command:

```
$ kubectl describe secret <secret-name> -n <namespace>
```

TLS certificate for HTTPs support

UDR and EIR has two Ingress Gateway services to handle the signaling and provisioning traffic. Hence, you must configure two separate TLS certificates to support HTTPS on both the gateways.

For information on the procedure to enable TLS certificates, see Cloud Native Core - Ingress/Egress Gateways - Security Recommendations / Guidelines for TLS configuration.

Updating Keys and Certificates in the Existing Secrets

Prerequsite: The certificates and files that need to be updated must be present in the secret.

Perform the following steps to update the existing certificates in secrets:

1. Run the following command to add a certificate:

```
TLS_CRT=$(base64 < "<certificate-name>" | tr -d '\n')
kubectl patch secret <secret-name> -p "{\"data\":{\"<certificatename>\":\"$
{TLS_CRT}\"}}"
```

Here,

<certificate-name> is the certificate file name.

<secret-name> is the name of the secret, for example, `ocudr-gateway-secret`.

Example:

Run the following command to add a Certificate Authority (CA) Root from the `caroot.cer` file to the `ocudr-gateway-secret`.

```
TLS_CRT=$(base64 < "caroot.cer" | tr -d '\n')
kubectl patch secret ocudr-gateway-secret -p "{\"data\":{\"caroot.cer\":\"$
{TLS_CRT}\"}}" -n udr
```

Similarly, you can also add other certificates and keys to the `ocudr-gateway-secret`.

2. Run the following command to update an existing certificate:

```
TLS_CRT=$(base64 < "<updated-certificate-name>" | tr -d '\n')
kubectl patch secret <secret-name> -p "{\"data\":{\"<certificatename>\":\"$
{TLS_CRT}\"}}"
```

Here,

`<updated-certificate-name>` is the certificate file that contains the updated content.

Example:

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Run the following command to update the private key present in the `rsa_private_key_pkcs1.pem` file to the `ocudr-gateway-secret`:

```
TLS_CRT=$(base64 < "rsa_private_key_pkcs1.pem" | tr -d '\n')
kubectl patch secret ocudr-gateway-secret -p "{\"data\":
{\"rsa_private_key_pkcs1.pem\":\"${TLS_CRT}\"}}" -n udr
```

Similarly, you can also update other certificates and keys to the `ocudr-gateway-secret`.

3. Run the following command to remove an existing certificate:

```
kubectl patch secret <secret-name> -p "{\"data\":
{\"<certificatename>\":null}}"
```

Here,

<certificate-name> is the name of the certificate to be removed.

The certificate must be removed when it expires or needs to be revoked.

Example:

Run the following command to remove the CA Root from the ocudr-gateway-secret:

```
kubectl patch secret ocudr-gateway-secret -p "{\"data\":
{\"caroot.cer\":null}}" -n udr
```

Similarly, you can also remove other certificates and keys from the `ocudr-gateway-secret`.

> **Note**
>
> The following are the certificate update and renewal impacts:
>
> - Updating, adding, deleting the certificate, ot terminates all the existing connections gracefully and re-establishes new connections for new requests.
> - When the certificates expires, no new connections are established for new requests, however, the existing connections remain active. After the renewal of the certificates all the existing connections are gracefully terminated. And, new connections are established with the renewed certificates.

Remote File Transfer Support

UDR supports the transfer of files to the remote sever using Secure File Transfer Protocol (SFTP) in the subscriber bulk import tool and the subscriber export tool as below:

- In subscriber bulk import tool the files will be transferred from the remote server to Persistent Volume Claim (PVC) and vice versa using SFTP
- In subscriber export tool the files will be transferred from PVC to the remote server using SFTP

To support the file transfer, you must run the below command to configure the private and public keys in to the kuberenetes secrets. The operator will get the private and public keys from the remote server.

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Keys

```
kubectl create secret generic ocudr-ssh-private-key --from-file=id_rsa=/home/
cloud-user/ocudr/secrets/id_rsa -n <namespace>
kubectl create secret generic ocudr-ssh-public-key --from-file=id_rsa.pub=/
home/cloud-user/ocudr/secrets/id_rsa.pub -n <namespace>
```

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Unified Data Repository Installation, Upgrade, and Fault Recovery Guide* and *Oracle Communications Cloud Native Core, Unified Data Repository User Guide*.

3.2.7 Binding Support Function (BSF) Specific Security Recommendations and Guidelines

This section provides Binding Support Function (BSF) specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines Section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedure is:

- Creating BSF MySQL Kubernetes Secret for Storing Database Username and Password
- Network Policies

Creating BSF MySQL Kubernetes Secret for Storing Database Username and Password

Use the following procedure to create BSF MySQL Kubernetes secret for storing database username and password:

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1. Log in to Bastion Host or server from where kubectl can be Run.
2. Create namespace, if already does not exists, by entering the command:

   ```
   kubectl create namespace <namespace>
   ```

   where:

   `<namespace>` is the deployment BSF namespace.
3. Create a Kubernetes secret for an admin user and an application user. To create a Kubernetes secret for storing database username and password for these users follow the procedure below:

   Create a YAML file with the application user's username and password with the syntax shown below:

   > **Note**
   >
   > The values mentioned in the syntax are sample values.

   ```
   apiVersion: v1
               kind: Secret
               metadata:
               name: <secret-name>
               type: Opaque
               data:
               mysql-username: YnNmdXNy
               mysql-password: YnNmcGFzc3dk
   ```

   Create a YAML file with the admin user's username and password with the syntax shown below:

   > **Note**
   >
   > The values mentioned in the syntax are sample values.

   ```
   apiVersion: v1
             kind: Secret
             metadata:
             name: <secret-name>
             type: Opaque
             data:
              mysql-username: YnNmcHJpdmlsZWdlZHVzcg==
              mysql-password: YnNmcHJpdmlsZWdlZHBhc3N3ZA==
   ```

   > **Note**
   >
   > The values for **mysql-username** and **mysql-password** should be Base64 encoded

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4. Run the following command to create the secret:

   ```
   kubectl create -f <yaml_file_name> -n <namespace>
   ```

5. Verify whether the secret is created by executing the following command:

   ```
   $ kubectl describe secret <secret-name> -n <namespace>
   ```

For more information, see cnDBTier Security Recommendations and Guidelines.

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Binding Support Function Installation, Upgrade, and Fault Recovery Guide*.

3.2.8 Cloud Native Core Policy Specific Security Recommendations and Guidelines

This section provides Cloud Native Core Policy specific security recommendations and guidelines. Security recommendations common to all 4G and 5G NFs are available in the Common Security Recommendations and Guidelines Section.

> **Note**
>
> The following procedures can be performed by any authenticated user who has privileged access to the system. This user can create different roles for specific operations. For creation of role and role binding, see the NF or component-specific Installation and Upgrade Guide.

The procedures are:

- Access Token configuration
- Update Keys to Sign JSON Web Token (JWTs) for Access Token
- Create CNC Policy MySQL Kubernetes Secret for Storing Database Username and Password for Admin and Application Users
- Create a Kubernetes Secret for Storing LDAP credentials

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- Network Policies

Access Token configuration

Use the following procedure to create access token :

1. Create following files:
   - ECDSA private key (Example: `ecdsa_private_key_pkcs8.pem`)
   - RSA private key (Example: `rsa_private_key_pkcs1.pem`)
   - TrustStore password file (Example: `trustStorePassword.txt`)
   - KeyStore password file (Example: `keyStorePassword.txt`)
   - CA signed ECDSA OCPolicy certificate (Example: `ecdsa_occnp_certificate.crt`)
   - CA signed RSA OCPolicy certificate (Example: `rsa_occnp_certificate.crt`)
2. Log in to Bastion Host or server from where kubectl can be run.
3. Create namespace for the secret:

   ```
   $ kubectl create namespace occnp
   ```

4. Create Kubernetes secret for NF Access token :
   Note: The filenames in below command are same as in Step 1

   ```
   $ kubectl create secret generic ocpcfaccesstoken-secret --from-file=
   ecdsa_private_key_pkcs8.pem --from-file=rsa_private_key_pkcs1.pem --from-
   file=
   trustStorePassword.txt --from-file=keyStorePassword.txt --from-file=
   ecdsa_ocpcf_certificate.crt--from-file=rsa_ocpcf_certificate.crt -n ocpcf
   ```

5. Verify that secret is created successfully:

   ```
   $ kubectl describe secret ocpcfaccesstoken-secret -n ocpcf
   ```

Update Keys to Sign JSON Web Token (JWTs) for Access Token

Use the following procedure to update keys to sign JSON web token (JWTs) for access token:

1. Update the following files:
   - ECDSA private key (Example: `ecdsa_private_key_pkcs8.pem`)
   - RSA private key (Example: `rsa_private_key_pkcs1.pem`)
   - CA signed ECDSA OCPolicy certificate (Example: `ecdsa_occnp_certificate.crt`)
   - CA signed RSA OCPolicy certificate (Example: `rsa_occnp_certificate.crt`)

   > **Note**
   > Update of private keys, certificates and passwords are at the discretion of user

2. Log in to Bastion host or server from where kubectl can be run.
3. Update the secret with new or updated details by performing the following steps:

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- Delete the secret by executing the following command:

```
$ kubectl delete secret ocpcfaccesstoken-secret -n ocpcf
```

- Create the secret with updated details:

```
$ kubectl create secret generic ocpcfaccesstoken-secret
            --from-file=ecdsa_private_key_pkcs8.pem --from-
file=rsa_private_key_pkcs1.pem
            --from-file=trustStorePassword.txt --from-
file=keyStorePassword.txt
            --from-file=ecdsa_occnp_certificate.crt--from-
file=rsa_ocpcf_certificate.crt -n
            occnp
```

Create CNC Policy MySQL Kubernetes Secret for Storing Database Username and Password for Admin and Application Users

Use the following procedure to create OCPolicy MySQL Kubernetes secret for storing database username and password:

1. Log in to Bastion Host or server from where kubectl can be run.
2. Create namespace for the MySQL secret. Skip this step, if already created.

```
$ kubectl create namespace <namespace>
```

3. To create a Kubernetes secret for storing database username and password for an admin user and an application user:
   a. Create a YAML file with the application user's username and password with the syntax shown below:

> **Note**
>
> The values mentioned in the syntax are sample values.

```
apiVersion: v1
kind: Secret
metadata:
  name: occnp-db-pass
type: Opaque
data:
  mysql-username: b2NjbnB1c3I=
  mysql-password: b2NjbnBwYXNzd2Q=
```

   b. Create a YAML file with the admin user's username and password with the syntax shown below:

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> **Note**
>
> The values mentioned in the syntax are sample values.

```
apiVersion: v1
kind: Secret
metadata:
  name: occnp-admin-db-pass
type: Opaque
data:
  mysql-username: b2NjbnBhZG1pbnVzcg==
  mysql-password: b2NjbnBhZG1pbnBhc3N3ZA==
```

> **Note**
>
> `name` will be used to contain `dbCredSecretName` and `privilegedDbCredSecretName` parameters in the CNC Policy custom-values.yaml file.

> **Note**
>
> The values for `mysql-username` and `mysql-password` should be Base64 encoded.

c. Run the following commands to add the Kubernetes secrets in a namespace:

```
kubectl create -f yaml_file_name1 -n release_namespace
kubectl create -f yaml_file_name2 -n release_namespace
```

where:

- `release_namespace` is the deployment namespace used by the helm command.
- `yaml_file_name1` is a name of the YAML file that is created in step a.
- `yaml_file_name2` is a name of the YAML file that is created in step b.

4. Verify whether the secret is created by executing the following command:

```
$ kubectl describe secret <secret-name> -n <namespace>
```

For more information, see cnDBTier Security Recommendations and Guidelines.

Create a Kubernetes Secret for Storing LDAP credentials

Use the following procedure to create a Kubernetes secret for storing LDAP credentials:

1. Create a YAML file with the following syntax:

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> **Note**
>
> The values mentioned in the syntax are sample values.

```
apiVersion: v1
kind: Secret
metadata:
  name: secretarial
  labels:
    type: ocpm.secret.ldap
type: Opaque
stringData:
  name: "ldap1"
  password: "camiant"
  authDn: "uid=PolicyServer,ou=samplename,c=hu,o=samplename"
```

where:

- `name` is the configured LDAP server name.
- `password` is the LDAP credential for that data source.
- `authDN` is the authentication DN for that LDAP data source.
- `samplename` is the sample operator name.

2. Create the secret by executing the following command:

   ```
   kubectl apply -f yaml_file_name -n <namespace>
   ```

   Here:

   - `yaml_file_name` is a name of the YAML file that is created in step 1.
   - `<namespace>` is the deployment namespace used by the helm command.

Network Policies

The network policies allow ingress or egress rules to be defined based on Kubernetes resources such as Pod, Namespace, IP, and Ports. These rules are selected based on Kubernetes labels in the application. These network policies enforces access restrictions for all the applicable data flows except communication from Kubernetes node to pod for invoking container probe.

> **Note**
>
> Configuring network policy is optional. Based on the security requirements, network policy can be configured.

For more information on the network policy, see https://kubernetes.io/docs/concepts/services-networking/network-policies/.

For more information on configuring the network policy, see *Oracle Communications Cloud Native Core, Converged Policy Installation, Upgrade, and Fault Recovery Guide*.

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A

Cloud Native Core Network Port Flows

This section describes network port flows for the Cloud Native Core.

Network Port Flows

- Cluster IP addresses are reachable outside of the cluster and are typically assigned by using a Network Load Balancer.
- Node IP addresses are reachable from the bastion host (and may be exposed outside of the cluster).

CNE Port Flows

Table A-1 CNE Port Flows

Name	Server/ Container	Ingress Port ext[:int]/ Proto	TLS	Cluster IP (Service IP)	Node IP	Notes
SSH Access	ALL	22/TCP	Y		SSH Access	Administrative SSH Access; no root / key only.
Repository	Bastion Host	80/TCP, 443/TCP, 5000/TCP	Y		Repository Access	Access repositories (YUM, Docker, Helm, etc.)
Jenkins CD	Bastion Host	8080/TCP	N		CD Pipeline Access	Access CD Pipeline GUI
Jenkins M2M	Bastion Host	50000/TCP	N		Jenkins M2M	CD Pipeline Operations
RPC Bind	All	111/TCP, UDP	N		RPCBind	Used for installation; pxe booting of NFS mounted images
BGP	K8s Nodes	179/TCP	N		BGP	Used on bare metal environments in load balancing
MySQL Query	MySQL SQL Node	3306/TCP	N	Replication Traffic	Microservice SQL Access	The SQL Query interfaces are used for 5G NFs to access the database and for remote sites to replicate data
Ceph	Ceph CSI Metric	9080/TCP, 9081/TCP, 9090/TCP, 9091/TCP	N		All Cluster Nodes	Used to monitor the CSI performance of the Ceph storage backend.
ILO	ILO Management Port	443/TCP	Y		Installation / Management	This interface is used to manage the frame; it provided low level management for all of the frame HW assets

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Table A-1 (Cont.) CNE Port Flows

Name	Server/ Container	Ingress Port ext[:int]/ Proto	TLS	Cluster IP (Service IP)	Node IP	Notes
Kube API Server	K8s Master Nodes	6443/TCP	Y		K8s Orchestration	The Kube API Server provides an orchestration API for the management creation of K8s resources.
Kubelet cAdvisor	K8s Nodes	4149/TCP	Y		Container Metrics	Default cAdvisor port used to query container metrics
Kubelet API	K8s Nodes	10250/TCP	Y		Control Plane Node Access	API which allows full node access
Kube-scheduler	K8s Nodes	10251/TCP	N		Scheduler Access	Serve HTTP insecurely
Kube-controller	K8s Nodes	10252/TCP	N		Controller Access	Serve HTTP insecurely
Kube-proxy	K8s Nodes	10256/TCP	N		Health Check	Health check server for Kube Proxy
Kube-proxy	K8s Nodes	30000-32767	N		Service Access	The default service node port range
Kube-controller	K8s Nodes	10257/TCP	Y		Controller Access	HTTPS Access
Kube-Scheduler	K8s Node	10259/TCP	Y		Scheduler Access	HTTPS Access

OCI Adaptor Port Flows

Table A-2 OCI Adaptor Port Flows

Name	Server / Container	Ingress Port	TLS?	Service Type
oci-adaptor-mgmt-agent	K8s Node	None	NA	ClusterIP
oci-adaptor-logan	K8s Node	None	NA	NA
metrics-server	K8s Node	443/TCP	N	ClusterIP
oci-adaptor-opentelemetry-collector-agent	K8s Node	6831/UDP 14250/TCP 14268/TCP 4318/TCP 9411/TCP	N	ClusterIP

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NF Port Flows

Table A-3 NF Port Flows

Name	Server / Container	Ingress Port [external:]internal	TLS?	Service IP	Node IP	Notes
5G NRF	K8s Nodes / NRF Service	80/TCP 443/TCP	Y	IngressGateway	NfRegistration NfSubscription NfDiscovery NfAccessToken EgressGateway NrfConfiguration	5G NRF
5G SCP	Kubernetes Nodes/SCP Worker	8000/TCP	N		5G Proxy	5G SCP Proxy
5G SCP	Kubernetes Nodes/scp-configuration	8082/TCP	N	Proxy Configuration		5G SCP Proxy Configuration
5G SCP	Kubernetes Nodes/Istio	/TCP	N		Mesh State Sharing	5G SCP Mesh Management
5G NSSF	K8s Nodes / NSSF Service	80/TCP 443/TCP	Y	NSSF configuration IngressGateway	NS-selection, NS-availability, NS-subscription EgressGateway NRF-Client	5G NSSF
5G UDR/ UDSF	K8s Nodes / UDR Service	80/TCP 443/TCP	Y	UDR Configuration Ingress gateway	Nudr-dr/ Nudr-prov	5G UDR

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Table A-3 (Cont.) NF Port Flows

Name	Server / Container	Ingress Port [external:]internal	TLS?	Service IP	Node IP	Notes
5G SEPP	K8s Nodes / SEPP Service	80/TCP 443/TCP	Y	plmn-ingress-gateway n32-ingress-gateway config-mgr-svc	• n32-egress-gateway • plmn-egress-gateway • pn32c-svc • cn32c-svc • pn32f-svc • cn32f-svc • nfmediation-svc • nfdiscovery • nfmanagement • coherence-svc • perf-info • app-info • alternate-rte-svc • config-mgr-svc	5G SEPP
5G PCF	K8s Nodes / PCF Service	80/TCP 443/TCP	Y	ingress_gateway	• pcf-pcf-amservice • pcf-pcf-smservice • pcf-pcf-ueservice • pcf-occnp-nrf-client	5G Policy
5G BSF	K8s Nodes / PCF Service	80/TCP 443/TCP	Y	ingress_gateway	• ocpm-cm-service • ocpm-queryservice	5G BSF

Common Service Port Flows

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Table A-4 Common Service Port Flows

Name	Server / Container	Ingress Port ext[:int]/ proto	TLS ?	Service IP (LP)	Node IP	Comments
5G CNCATS	K8s Node	8080/ TCP8443/ TCP5001/TCP	Y	GUI & ATS API	• ocats-service	• Provides GUI and API abilities to the ATS service. • TLS is enabled on ports 8443 and 5001, – only one of 8443 and 8080 is allocated depending on type of deployment(TLS or not)

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