Oracle® Communications

Networks Data Analytics Function Solution Guide

Release 24.2.2
F96708-02
November 2024

Oracle Communications Networks Data Analytics Function Solution Guide, Release 24.2.2

F96708-02

Contents

My Oracle Support

My Oracle Support (https://support.oracle.com) is your initial point of contact for all product support and training needs. A representative at Customer Access Support can assist you with My Oracle Support registration.

Call the Customer Access Support main number at 1-800-223-1711 (toll-free in the US), or call the Oracle Support hotline for your local country from the list at http://www.oracle.com/us/support/contact/index.html. When calling, make the selections in the sequence shown below on the Support telephone menu:

- For Technical issues such as creating a new Service Request (SR), select **1**.
- For Non-technical issues such as registration or assistance with My Oracle Support, select **2**.
- For Hardware, Networking and Solaris Operating System Support, select **3**.

You are connected to a live agent who can assist you with My Oracle Support registration and opening a support ticket.

My Oracle Support is available 24 hours a day, 7 days a week, 365 days a year.

Acronyms

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

Table Acronyms

Acronym	Description
3GPP	3rd Generation Partnership Project
5GC	5G Core Network
5GS	5G System
AF	Application Function
API	Application Programming Interface
AMF	Access and Mobility Management Function
AnLF	Analytics Logical Function
CAP4C	Converged Analytics Platform for Communication
CNC	Cloud Native Core
CNE	Oracle Communications Cloud Native Core, Cloud Native Environment
CSP	Communications Service Provider
FE	Front End
FQDN	Fully Qualified Domain Name
GUI	Graphical User Interface
HTTPS	Hypertext Transfer Protocol Secure
KPI	Key Performance Indicator
HA	High Availability
IMSI	International Mobile Subscriber Identity
K8s	Kubernetes
MDT	Mobile Data Terminal
ME	Monitoring Events
MICO	Mobile Initiated Connection Only
ML	Machine Learning
MLOPs	Machine Learning Operations
MTLF	Model Training Logical Function
Network Slice	A logical network that provides specific network capabilities and network characteristics.
NEF	Oracle Communications Cloud Native Core, Network Exposure Function
NF	Network Function
NRF	Oracle Communications Cloud Native Core, Network Repository Function
NSI	Network Slice instance. A set of Network Function instances and the required resources (such as compute, storage and networking resources) which form a deployed Network Slice.
NSSF	Oracle Communications Cloud Native Core, Network Slice Selection Function
OCNWDAF	Oracle Communications Networks Data Analytics Function

Table (Cont.) Acronyms

Acronym	Description
OAM	Operations, Administration, and Maintenance
PLMN	Public Land Mobile Network
RAN	Radio Access Network
REST	Representational State Transfer
SBA	Service Based Architecture
SBI	Service Based Interface
SMF	Session Management Function
SNMP	Simple Network Management Protocol
SUPI	Subscription Permanent Identifier
UDM	Unified Data Management
UE	User Equipment
UPF	User Plane Function
UDR	Oracle Communications Cloud Native Core, Unified Data Repository
UDM	Unified Data Management
URI	Uniform Resource Identifier

What's New in This Guide

This section introduces the documentation updates for Release 24.2.x in Oracle Communications Networks Data Analytics Function Solution Guide.

Release 24.2.2 - F96708-02, November 2024

There are no updates in this document.

Release 24.2.0 - F96708-01, July 2024

Updated the release version to 24.2.0.

1 Introduction

This document provides information about the role of Oracle Communications Network Data Analytics Function (OCNWDAF) in 5G Service Based Architecture (SBA) and how to configure and use the OCNWDAF functionality and services.

1.1 Overview

Oracle Communications Network Data Analytics Function (OCNWDAF) is a Network Function in the 5G core network of the 5G Network Architecture.

About Oracle Communications Networks Data Analytics Function

Many Communications Service Providers (CSPs) are deploying analytics tools in their networks. However, the deployment of these tools can be complex due to their inconsistent approaches to collecting (and transmitting) data, and gathering insights on Network Functions using non-standardized proprietary interfaces. Consequently, the level of intelligence that can be gleaned from and applied back to the network and other parts of the business is limited; this impacts the pace at which CSPs can achieve their strategic objectives. With the 3rd Generation Partnership Project (3GPP) based analytics function designed to provide analytics to drive actional insights, CSPs will have the opportunities to address the challenges.

The Oracle Communications Network Data Analytics Function (OCNWDAF) is a 3GPP defined 5G Network Function (NF) that assists in collecting and analyzing data in a 5G network. The OCNWDAF enables the CSPs to collect and analyze the data in the network through an analytics function. The 5G technology requires prescriptive analytics to drive closed-loop automation and self-healing networks. In a 5G network, the consumers and producers of data are 5G NFs, AFs and OAM. The OCNWDAF broadly supports the following functions:

- OCNWDAF collects data from Access and Mobility Management Function (AMF), Session Management Function (SMF), and Network Repository Function (NRF) in the network. The data is collected directly from the NFs.
- The OCNWDAF is designed to provide analytics information to consumer NFs.

A 5G network contains a vast number of devices and sensors generating an enormous amount of data. The OCNWDAF function allows the CSPs to efficiently monitor, manage, automate, and optimize their network operations by the data collected and analytics generated across the network. The OCNWDAF also helps the CSPs in achieving the operational efficiency and provides an enhanced service experience.

The analytics information provided by the OCNWDAF is either statistical information on past (or current) events or predictive information which can be used to balance the resources on the network. The OCNWDAF can predict the User Equipments (UEs) location and also detect if the UE is in an abnormal location. Based on the analytics information collected, the CSPs can roll out new services or modify the existing services without waiting for a network maintenance window. This ensures significantly fewer chances of the network experiencing downtime.

An OCNWDAF consumer can avail analytics information for different analytic events. Alternatively, the consumers can subscribe or unsubscribe for specific analytics information as a one-time event or periodically get notified when a specifically defined event (for example, a threshold is breached) is detected.

The NRF discovers the OCNWDAF instances for the consumers in the network. The OCNWDAF information can also be locally configured on the consumers. The OCNWDAF selection function in the consumers select an OCNWDAF instance among available OCNWDAF instances. Different OCNWDAF instances present in the 5G network can be configured to provide a specific type of analytics information. This information about the OCNWDAF instance is described in the OCNWDAF profile stored in the NRF. The consumers that need specific analytics types query the NRF and include the Analytics ID based on its required data.

OCNWDAF is a highly scalable and agile 5G Core (5GC) network function. It not only supports the 3GPP recommended functionalities but also offers the openness in integrating with any data source (for example, data lake, common message bus, and so on), publishing analytics reports to any consumer through industry leading messaging frameworks such as Kafka. It has the potential to offer any analytics use case, including non-3GPP use cases that CSPs may require in future. OCNWDAF offers advanced deep learning capabilities such as neural networks and balancing resources versus accuracy with its two-prong ML strategy.

> **Note**
>
> The performance and capacity of the OCNWDAF system may vary based on the call model, Feature/Interface configuration, and underlying CNE and hardware environment.

1.2 References

For more information about OCNWDAF, refer to the following documents:

- *Oracle Communications Networks Data Analytics Function User Guide*
- *Oracle Communications Networks Data Analytics Function Installation, Upgrade, and Fault Recovery Guide*
- *Oracle Communications Networks Data Analytics Function Troubleshooting Guide*
- *3GPP Technical Specification 23.288, Architecture enhancements for 5G System (5GS) to support network data analytics services*
- *3GPP Technical Specification 29.520, 5G System Network Data Analytics Services*
- *3GPP Technical Specification 29.571, 5G System Common Data Types for Service Based Interfaces*
- *3GPP Technical Specification 29.508, 5G System Session Management Event Exposure Service*
- *3GPP Technical Specification 29.518, 5G System Access and Mobility Management Services*
- *3GPP Technical Specification 33.521, 5G Security Assurance Specification (SCAS) Network Data Analytics Function (NWDAF)*
- *3GPP Technical Specification 33.926, Security Assurance Specification (SCAS) threats and critical assets in 3GPP network product classes*
- *3GPP Technical Specification 33.117, Catalog of general security assurance requirements*
- *3GPP Technical Specification 23.501, System architecture for the 5G System (5GS)*
- *3GPP Technical Specification 23.502, Procedures for the 5G System (5GS)*

- *3GPP Technical Specification 28.532, Management and orchestration Generic management services*
- *3GPP Technical Specification 28.550, Management and orchestration Performance assurance*
- *3GPP Technical Specification 28.552, Management and orchestration 5G performance measurements*
- *3GPP Technical Specification 28.554, Management and orchestration 5G end to end Key Performance Indicators (KPI)*
- *3GPP Technical Specification 28.662, Telecommunication management; Generic Radio Access Network (RAN) Network Resource Model (NRM) Integration Reference Point (IRP) Information Service (IS)*
- *3GPP Technical Specification 28.623, Telecommunication management Generic Network Resource Model (NRM) Integration Reference Point (IRP) Solution Set (SS) definitions*
- *3GPP Technical Specification 32.404, Telecommunication management Performance Management (PM) Performance measurements, Definitions and template*

2
OCNWDAF Architecture

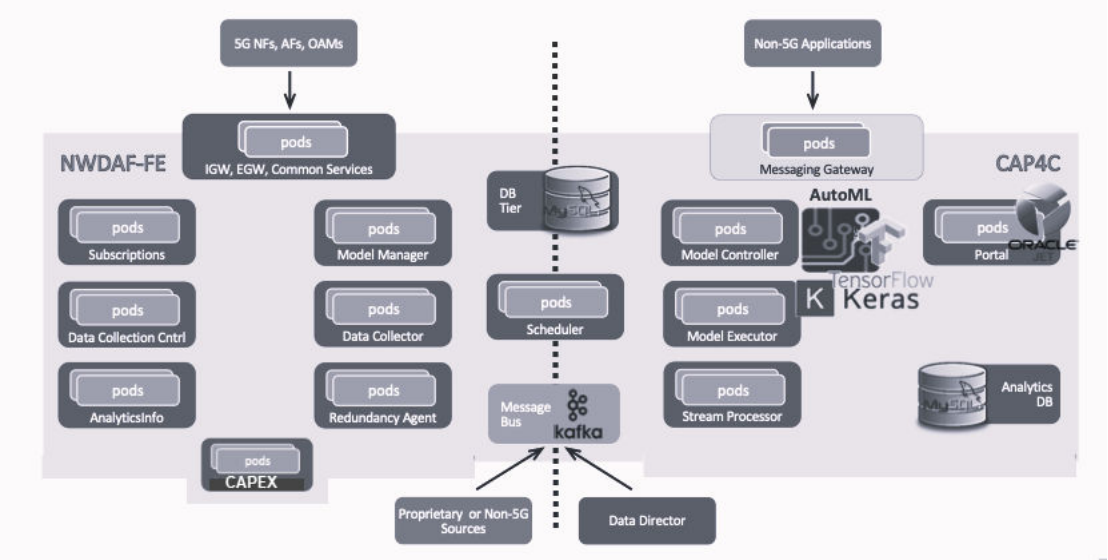
This chapter describes the Oracle Communications Network Data Analytics Function (OCNWDAF) architecture.

2.1 Oracle Communications Networks Data Analytics Function Architecture

OCNWDAF comprises of various microservices deployed in a Kubernetes based Cloud Native Environment (for example, CNE). The environment has some common services for logs (or metrics) collection, analysis, graphs or charts visualization, and so on. The OCNWDAF uses standard interfaces from the Service Based Architecture (SBA) to collect data through subscription or request model from other Network Functions (NFs). The microservices integrate with the environment and provide the necessary data analytics.

The following diagram depicts the OCNWDAF architecture:

Figure 2-1 OCNWDAF Architecture



The OCNWDAF architecture aligns with 3GPP Release 17 Technical Specifications.

OCNWDAF Front End

The OCNWDAF Front End (FE) interacts with 5G NFs to gather information through the Service Based Architecture (SBA) or Service Based Interface (SBI) defined in 3GPP 23.288 and 29.520 Technical Specifications.

- Collects data from 5G NFs

- Provides the data to backend Converged Analytics Platform for Communication (CAP4C)
- Collects the processed analytics information from CAP4C
- Provides the analytics information to the consumer NFs and Application Functions (AFs)

Converged Analytics Platform for Communication (CAP4C)

The Analytics Engine, CAP4C is the core of the OCNWDAF, it supports data collection from the Front End (FE) module. Machine Learning (ML) models process the collected data. The Analytics Engine performs predictive or descriptive data analysis and provides analytics information through real-time stream processing.

- Processes data from the Front End (FE) or data received from the OCNADD
- Examines streaming data in real time to allow thresholding and other use cases
- Generates OCNWDAF analytics information (Statistical, Predictive, and Abnormal Behavior)
- Automates machine learning models
- Provides visualization and reports

Oracle Communications Network Analytics Data Director (OCNADD)

- Receives messages from Oracle NFs such as SCP, SEPP, and NRF.
- Captures the call flow messages transmitted between the control plane NFs.
- Filters data from the call flows and sends it to the CAP4C.

A few common services are deployed with the OCNWDAF. The common services are also used by other 5G NFs along with OCNWDAF.

Ingress Gateway

This microservice is an entry point for accessing OCNWDAF supported service operations and provides the functionality of an OAuth validator.

Egress Gateway

This microservice is responsible to route OCNWDAF initiated egress messages to other NFs.

For more information about Ingress and Egress Gateway, see *Oracle Communications Cloud Native Core, Cloud Native Environment User Guide*.

Scheduler

Offers scheduling services for timed events such as periodic consumer report notifications.

Model Manager

- Tracks the analytics requests, timeframes, and data items required within the training data set to train the respective ML models
- Sends model training requests to the CAP4C and tracks the Machine Learning (ML) models that CAP4C builds

Analytics Subscription Service
Enables service consumers to subscribe or unsubscribe to different analytics from the OCNWDAF. It handles all the subscription requests from the consumers and updates or cancels the subscription requests from the consumers. The subscription service sends notifications to the NFs, AFs, and OAM when the subscribed event occurs in the network.

Analytics Information Service

This service enables consumers to request and obtain different analytics information from the OCNWDAF based on the 3GPP defined AnalyticsInfo API. This service is based on the REST API request-response model. This service handles the request for analytics based on the AnalyticsID. The service responds to the request and provides the analytics information if the requested analytics information is available.

Data Collection

The OCNWDAF retrieves data from various sources (for example, NFs such as AMF and SMF). Network analytics is computed using this data. The Data Collection Controller and Data Collection microservices perform data collection for the OCNWDAF. These microservices ensure the OCNWDAF obtains the appropriate data with the proper granularity.

- **Data Collection Controller Service**: This service subscribes to all NFs, manages the subscriptions, and updates the Analytics Subscription service. It also manages and prioritizes data collection between 3GPP NFs and the Data Director (OCNADD). The OCNADD has a higher priority than the 3GPP NFs.
- **Data Collection Service**: This service collects data from the producer NFs and streams it to the CAP4C for further processing.

NRF Client Service

NRF Client integrates with the NRF for OCNWDAF registration, discovery, and service status or load information, along with application and performance information services. NRF discovery helps in the on-demand discovery of network functions. NRF management helps in the autonomous discovery of NFs.

Redundancy Agent

This microservice maintains communication and controls responsibilities between the mated sites in a georedundant deployment. If there are more than two sites, then the Redundancy Agent is responsible for assigning the hierarchy of control.

Capex Service

This microservice processes the available data and identifies metrics like the active UEs per cell and the aggregated tracking area, the user plane resources (the UPFs) servicing the tracking area, and optionally, the UPFs or AMFs or SMF NF load servicing the tracking area.

cnDBTier MySQL database

cnDBTier performs general configuration, stores microservice data including dynamic data such as states, subscriptions, work lists, and data used for reporting.

Analytics database

This database is based on the MySQL cluster and stores relational and time-series data. The relational data represents all the objects within the telecommunication network, such as UEs, slices, cells, NFs, and so on, and their relationships with each other. The time-series data represents all the KPIs, measurements, and event data collected over time and used in streaming analytics and training ML models.

Kafka

A reliable and scalable distributed event streaming platform. It is used for internal as well as external delivery and consumption of data and events. It exports special measurements and events to external consumers. It also imports measurements and events from operator sources such as a messaging bus and data lake.

Stream Processors

Cleans, merges, and splits data as required and examines data in windows to detect threshold crossings or perform complex calculations.

Model Controller

Receives model generation or execution requests from the OCNWDAF FE. The Model Controller manages and allocates work to the Model Executor pool.

Model Executor

The Model Executor accesses the information in the database based on the instructions received by the Model Controller and trains the ML models.

OCNWDAF Portal

Performs the following functions:

- Manages the OCNWDAF dashboards
- Accepts operator input for configuration such as adding new network slices, geofences, and so on.
- Provides visualization of analytics information

2.2 OCNWDAF Architecture Principles

The OCNWDAF is built using Cloud Native principles. The OCNWDAF is deployed as Cloud Native Core Network Function (NF), similar to other 5G NFs. The OCNWDAF follows best practices for both the industry and customers. For example:

- OCNWDAF is based on the microservice architecture. The Front End (FE) and Converged Analytics Platform for Communication (CAP4C) are built using a set of microservices.
- The microservices are designed to perform one specific task or job.
- The microservices interact through standard interfaces (HTTP or messaging through Kafka).
- The microservices can be scaled up or down according to Kubernetes programmed rules.
- No root or elevated access is required.

Modular, Flexible, and Scalable Architecture

The flexibility of an analytics solution depends on the following factors:

- Flexibility in data collection or ingestion
- Ability to support diversified use cases
- Availability of analytics feed to the consumer (on demand, periodic, so on)

The OCNWDAF supports the above mentioned characteristics beyond what is defined in 3GPP Technical Specification for Data Analytics NFs.

- To support diversified use cases (for example, other than those defined by 3GPP), OCNWDAFs concept of separation of CAP4C from the FE provides the flexibility to support any use case category. The flexibility in creating ML models, training or retraining, model validation and benchmarking, and automated deployment make OCNWDAF the best breed.
- OCNWDAF provides the analytics report (on demand or periodic) to the consumers in different ways. For example, in the case of 3GPP network elements, the analytics report is provided through 3GPP defined (TS 23.288, TS 29.520) SBI interface.

- The OCNWDAF is evolving along the lines of 3GPP specifications and customer use case requirements. OCNWDAF is developed as an open and flexible analytics platform to meet customers' future use case requirements.
- The entire OCNWDAF functionality is modular and independent. Interactions between these entities are enabled through REST APIs, the streaming framework, the time-series database, or the cnDBTier. Direct messaging through REST (where synchronous communication is necessary) or messaging through Kafka (when the communication is asynchronous). Configuration data, dynamic data, and time-based data is stored by one entity and can be accessed by another for usage or display.

3
OCNWDAF Interaction with 5G NFs and AF

This chapter describes how the OCNWDAF interacts with 5G NFs and AFs in the 5G environment.

3.1 Interaction with 5G NFs

The OCNWDAF interacts with Network Functions (NFs), Application Functions (AFs), and Operations, administration and management (OAMs) through the following gateways:

- The Ingress Gateway with functions such as Ingress connection management, TLS 1.2, and OAuth2.0.
- The Egress Gateway with functions such as Egress connection management Indirect, TLS 1.2 and OAuth2.0, retry and re-route in OCNWDAF Front End (FE). Also provide a Service Based Interface (SBI) for communication with other 5G NFs.

Ingress Gateway

This will be OCNWDAF's endpoint for accessing OCNWDAF services. Ambassador Proxy can be used as an API gateway. The Ingress Gateway provides the following capabilities:

- API path routing
- Proxy Service
- Load balancing
- Circuit breaking
- Security
- Internal microservices registry

Egress Gateway

All the outgoing communication from OCNWDAF to other NFs is routed through the Egress gateway.

3.2 Interaction with Application Functions (AFs)

The OCNWDAF can provide analytics reports to Application Functions (AFs).

If the AF is external, the communication between OCNWDAF and AF is carried out through the NEF. As defined in 3GPP TS 29.522, NEF supports CAPIF (Common API Framework) to ensure the external AF communicating with OCNWDAF is trusted.

The AF can obtain the analytics report from OCNWDAF through the services exposed by OCNWDAF (For instance, *Nnwdaf_AnalyticsInfo*).

4
OCNWDAF Features

This chapter describes OCNWDAF features.

4.1 Databases

The OCNWDAF uses the following databases:

- The cnDBTier is used for cross-site transactional, dynamic, or configuration data. The cnDBtier is one of the Oracle's 5G Common Services and it used by all Oracle 5G NFs.
- MySQL Enterprise is used as the Analytics Database. It stores all historical data as well as the ML models. The same data is available across all OCNWDAF sites, this ensures all sites support all queries.

4.2 Support for ML Algorithms

The OCNWDAF supports the industry's best ML frameworks, such as TensorFlow and scikit-learn. Many supported models, including Neural Networks and specialized versions such as Long Short Term Memory, are used.

Oracle’s AutoMLx is also used to determine the optimal algorithm for each analytics category. The algorithm is selected based on specific requirements such as the time required to train the ML model and the accuracy.

The OCNWDAF provides a GUI dashboard to select, train, and optimize one or more ML Models for a given analytics category. The user can select among multiple algorithms supported by each analytics category and run experiments to determine the best-suited ML model for each data set. ML models are evaluated by running experiments and metrics are generated. Metrics for each experiment is displayed on the dashboard. User can select the ML model based on these metrics. Multiple algorithms can be selected simultaneously to run experiments. For more information, see *Oracle Communications Networks Data Analytics Function User Guide*.

4.3 Support for ML Model and Repository

The main constraints of machine learning models are:

- The time necessary to train the model
- The accuracy observed from the model

We are focusing on a two-prong approach described below to ensure both the constraints are minimized:

- The ML models will be developed for the use cases and analytics categories will be used in a very general and broad manner. User can select the best suited algorithms for each analytics category and train the ML models.
- The ML models can automatically self-optimize by using the industry’s best hyper-parameter optimization algorithms. This ensures enhanced accuracy.

All models trained are stored in the Open Neural Network eXchange (ONNX) format. This format is used widely in the industry. Using this format enables future support for importing and exporting models.

4.4 OCNWDAF Multicloud Strategy

Oracle is a platinum member of the Cloud Native Computing Foundation (CNCF) and aligns with the CNCFs vision of an open, cloud-native, and standard approach to develop applications. Based in-depth understanding of service reliability, Oracle strives to create foundational platform services where applications are built to provide service reliability.

Oracle's OCNWDAF and Cloud Native Environment (CNE) are based on industries leading open-source services and tools, this enable operations and management of OCNWDAF in a production-grade environment. Oracle has adopted software architecture principles to support Communications Service Providers multicloud strategy.

- The Cloud Native Framework represents a collection of shared services which OCNWDAF uses. Oracle maintains a reference Cloud Native Framework utilizing a selection of open-source components and tools for development. The deployment CNE must provide all the Cloud Native Framework services but is free to select the specific version and component providing the service. For example, Oracle's OCNWDAF supports operation with CSPs' version of Prometheus and can support either Jaeger or Zipkin for distributed tracing. A DevOps CI/CD model is supported to ensure OCNWDAF is thoroughly tested and is fully operational in the deployment environment.
- Kubernetes' environment provides runtime and lifecycle management services. Like the Cloud Native Framework, Oracle maintains a reference Kubernetes environment but allows CSPs to select the specific version used in the deployment CNE. OCNWDAF runs in a containerized environment, uses Kubernetes DNS for service discovery, and can support a variety of Container Network Interfaces which integrate Oracle NFs networking requirements with the deployment SDN environment. The services lifecycle is controlled, deployment specific configuration is permitted and environment files are dynamically associated with the OCNWDAF. Helm charts are used for packaging the component microservices into the OCNWDAF applications. The configured repository handles the versioning available for each service and component microservices. Operators can enable Kubernetes deployments to manage the lifecycle of the OCNWDAF, including the initial roll-out of the service, roll-out of a canary release to validate a new version, and roll-out of an upgrade to a new version.
- Oracle continuously delivers new functionality into the Oracle Portal. Customers are notified and may choose to trigger their CI/CD workflow to deploy the new functionality. Oracles Communications Global Business Unit implements and executes automated unit tests for each component and service as part of the build process. Automated integration tests are run using the reference Cloud Native Framework to ensure that each component's runtime services and exposed APIs operate as expected. Other automated integration tests ensure APIs and NF components are functional and the overall business logic of the NF is operational. Oracle CGBU includes the subset of these test artefacts (which validate operation with the runtime environment and Cloud Native Framework) with the images of the NF components. Customers can incorporate these automated tests in the target deployment environment.
- Oracle Communications Automated Test Tools and Scripts (ATS) helps operators to automate the complete testing lifecycle of 5G NFs. This aids in accelerating innovation as software delivery times are significantly shortened. There is a considerable benefit in deploying an automated testing solution in terms of cost, effort, and overall test coverage. With the adoption of DevOps and CI/CD in the Telecommunication domain, number of software releases has significantly increased thus making manual testing very challenging.

Oracle Communications ATS helps operators to execute functional, regression and performance test cases easily without user intervention. As a result, operators can quickly deploy new software releases and rapidly roll out new features.

5
OCNWDAF Analytics

This chapter describes the OCNWDAF analytics information.

5.1 OCNWDAF Analytics

An OCNWDAF consumer can avail analytics information or reports for various events in the network. The consumers can subscribe (or unsubscribe) to the OCNWDAF to obtain specific analytics reports as a one-time event or periodically get notified when a defined event is detected. The analytics information provided by the OCNWDAF is either statistical information on past events or predictive information which can be used to balance the resources in the network.

The OCNWDAF assists in collecting and analyzing data in a 5G network. The OCNWDAF currently supports NFs as data producers but the data consumers can be not only be 5G NFs but AFs and OAM can also be consumers of analytics information. The OCNWDAF allows the Communications Service providers (CSPs) to efficiently monitor, manage, automate, and optimise their network operations by analysing the data collected across the network.

Listed below are the type of analytics reports that OCNWDAF can provide:

- Historical analytics
- Future analytics
- Reports when a thresholds are crossed
- Predictions on network behaviour and resource usage
- Detection of abnormal events in the network

The OCNWDAF provides the following analytics information:

- Slice Load level information
- UE mobility information
- UE Abnormal behaviour information (unexpected UE location, UE movement with respect to a geofence area)
- NF Load Level Analytics
- Network Performance Analytics
- User Data Congestion Analytics (only statistical analytics)
- QoS Sustainability Analytics
- Capex Optimization Analytics