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Contents

Foreword

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will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document specifies the MDA capabilities with corresponding analytics inputs and analytics outputs (reports), as well as processes and requirements for MDAS (Management Data Analytics Service), historical data handling for MDA, and ML support for MDA.

The present document also describes the MDA functionality and service framework, and MDA role in the management loop.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] Void

[3] 3GPP TS 28.535: "Management and orchestration; Management services for communication service assurance; Requirements".

[4] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[5] 3GPP TS 28.554: "Management and orchestration;5G end to end Key Performance Indicators (KPI)".

[6] 3GPP TS 32.422: "Telecommunication management; Subscriber and equipment trace; Trace control and configuration management".

[7] 3GPP TS 32.423: "Telecommunication management; Subscriber and equipment trace; Trace data definition and management".

[8] 3GPP TS 28.405: "Telecommunication management; Quality of Experience (QoE) measurement collection; Control and configuration".

[9] 3GPP TS 28.406: "Telecommunication management; Quality of Experience (QoE) measurement collection; Information definition and transport".

[10] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[11] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[12] 3GPP TS 32.425: "Telecommunication management; Performance Management (PM); Performance measurements Evolved Universal Terrestrial Radio Access Network (E-UTRAN)".

[13] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[14] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[15] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[16] 3GPP TS 28.658: "Telecommunication management; Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[17] 3GPP TS 28.662: "Telecommunication management; Generic Radio Access Network (RAN) Network Resource Model (NRM); Information Service (IS)".

[18] 3GPP TS 32.156: "Telecommunication management; Fixed Mobile Convergence (FMC) Model Repertoire".

[19] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[20] 3GPP TS 28.511: "Telecommunication management; Configuration Management (CM) for mobile networks that include virtualized network functions; Procedures".

[21] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[22] 3GPP TS 26.247: "Transparent end-to-end Packet-switched Streaming Service (PSS); Progressive Download and Dynamic Adaptive Streaming over HTTP (3GP-DASH)".

[23] 3GPP TS 26.114: "IP Multimedia Subsystem (IMS); Multimedia telephony; Media handling and interaction".

[24] 3GPP TS 28.105: "Management and orchestration; Artificial Intelligence/Machine Learning (AI/ML) management".

[25] 3GPP TS 32.160: "Management and orchestration; Management service template".

[26] ETSI GS NFV-IFA 011 (V3.3.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; VNF Descriptor and Packaging Specification".

[27] Recommendation ITU-T X.733: "Information technology - Open Systems Interconnection - Systems Management: Alarm reporting function".

[28] 3GPP TS 23.501: "System Architecture for the 5G System (5GS); Stage 2".

[29] 3GPP TS 28.623: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Solution Set (SS) definitions".

[30] 3GPP TS 28.558: "Management and orchestration; UE level measurements for 5G system".

[31] 3GPP TS 38.423: "Xn application protocol (XnAP)"

[32] 3GPP TS 28.538: " Management and orchestration; Edge Computing Management (ECM)".

[33] 3GPP TS 28.111: "Management and orchestration; Fault Management (FM)".

[34] ETSI GS NFV-SOL 025 (V5.2.1): "Network Functions Virtualisation (NFV) Release 5; Protocols and Data Models; Specification of protocol and data model solutions for Telco Cloud data analytics service".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

MDA capability: analytics capability corresponding to analytics of a set of analytics input data to provide analytics output data

MDA Type: type of analytics corresponding to specific MDA capability

3.2 Symbols

Void

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

AI	Artificial Intelligence
ATSSS	Access Traffic Steering-Switching-Splitting
CHO	Conditional Handover
DAPS	Dual Active Protocol Stack
MDA MnS	MDA Management service
MDA	Management Data Analytics
MDAF	Management Data Analytics Function
MDAS	Management Data Analytics Service
ML	Machine Learning

4 Concepts and overview

4.1 Overview

Management Data Analytics (MDA), as a key enabler of automation and intelligence, is considered a foundational capability for mobile networks and services management and orchestration.

The MDA provides a capability of processing and analysing data related to network and service events and status including e.g. performance measurements, KPIs, Trace/MDT/RLF/RCEF/RRC reports, QoE reports, alarms, configuration data, network analytics data, and service experience data from AFs, etc. to provide analytics output, i.e. statistics or predictions,, root cause analysis issues, and may also include recommendations to enable necessary actions for network and service operations. The MDA output is provided by the MDAS (Management Data analytics Service) producer to the corresponding consumer(s) that requested the analytics.

The MDA can identify ongoing issues impacting the performance of the network and services, and help to identify in advance potential issues that may cause potential failure and/or performance degradation. The MDA can also assist to predict the network and service demand to enable the timely resource provisioning and deployments which would allow fast time-to-market network and service deployments.

Management Data Analytics Service (MDAS), the services exposed by the MDA, can be consumed by various consumers, including for instance MnFs (i.e. MnS producers/consumers for network and service management), NFs (e.g. NWDAF), SON functions, network and service optimization tools/functions, SLS assurance functions, human operators, and AFs, etc.

NOTE: Throughout the present document the terms, MDAS and MDA MnS are equivalent and may be used interchangeably.

5 MDA functionality and service framework

5.1 General framework

MDA MnS (also referred to as MDAS) in the context of SBMA enables any authorized consumer to request and receive analytics as illustrated in Figure 5.1-1.

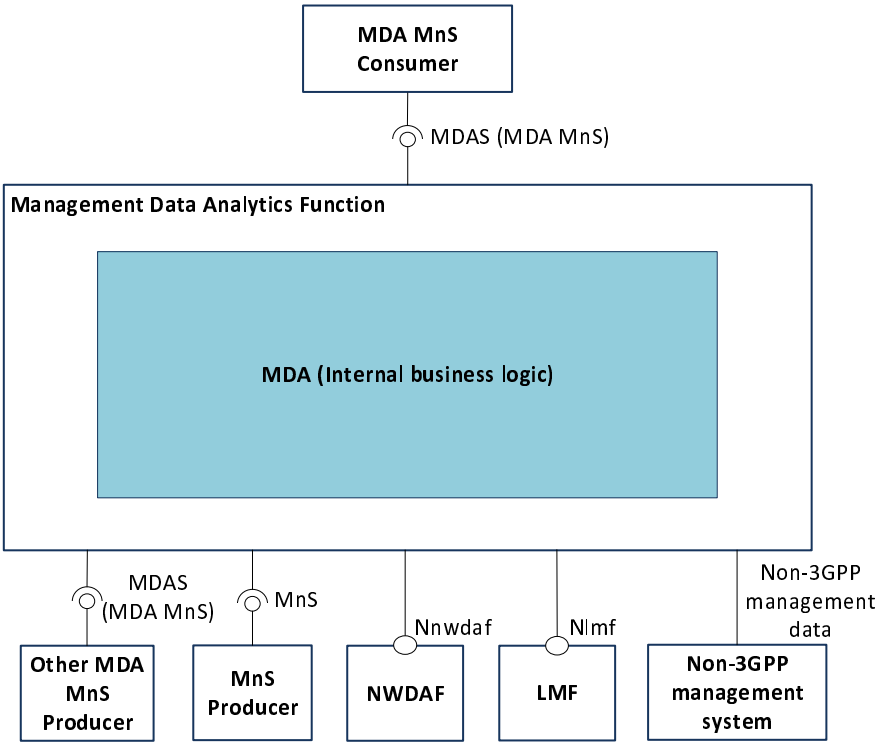


Figure 5.1-1: MDA functional overview and service framework

A management function (MDAF) may play the roles of MDA MnS producer, MDA MnS consumer, other MnS consumer, NWDAF consumer and LMF service consumer, and may also interact with other non-3GPP management systems.

The internal business logic related to MDA leverages the current and historical data related to:

- Performance Measurements (PM) as per TS 28.552 [4] and Key Performance Indicators (KPIs) as per TS 28.554 [5].
- Trace/MDT/RLF/RCEF/RRC reports, as per TS 32.422 [6] and TS 32.423 [7].
- QoE and service experience data as per TS 28.405 [8] and TS 28.406 [9].
- Analytics data offered by NWDAF as per TS 23.288 [10] including 5GC data and external web/app-based information (e.g. web crawler that provides online news) from AF.
- Alarm information and notifications as per TS 28.111 [33].
- CM information and notifications.
- UE location information provided by LMF as per TS 23.273 [14].
- MDA reports from other MDA MnS producers.
- Management data from non-3GPP systems.

Analytics output from the MDA internal business logic are made available by the management functions (MDAFs) playing the role of MDA MnS producers to the authorized consumers, (including but not limited to other management functions, network functions/entities, NWDAF, SON functions, optimization tools and human operators).

5.2 Interaction with CN and RAN domains

The MDA MnS producer provides analytics data for management purposes based on input data related to different types of NFs or entities in the network, e.g. data reported from gNB and/or specific core network function(s). Depending on the use case and when needed, the MDA MnS producer may use the analytics results produced by NWDAF as input.

Management Data Analytics Function (MDAF) may act as 3GPP domain-specific (e.g. RAN or CN) or as 3GPP cross-domain MDA MnS producer. Figure 5.2-1 illustrates the example of coordination between NWDAF, gNB and MDA MnS producer(s) for data analytics purpose.

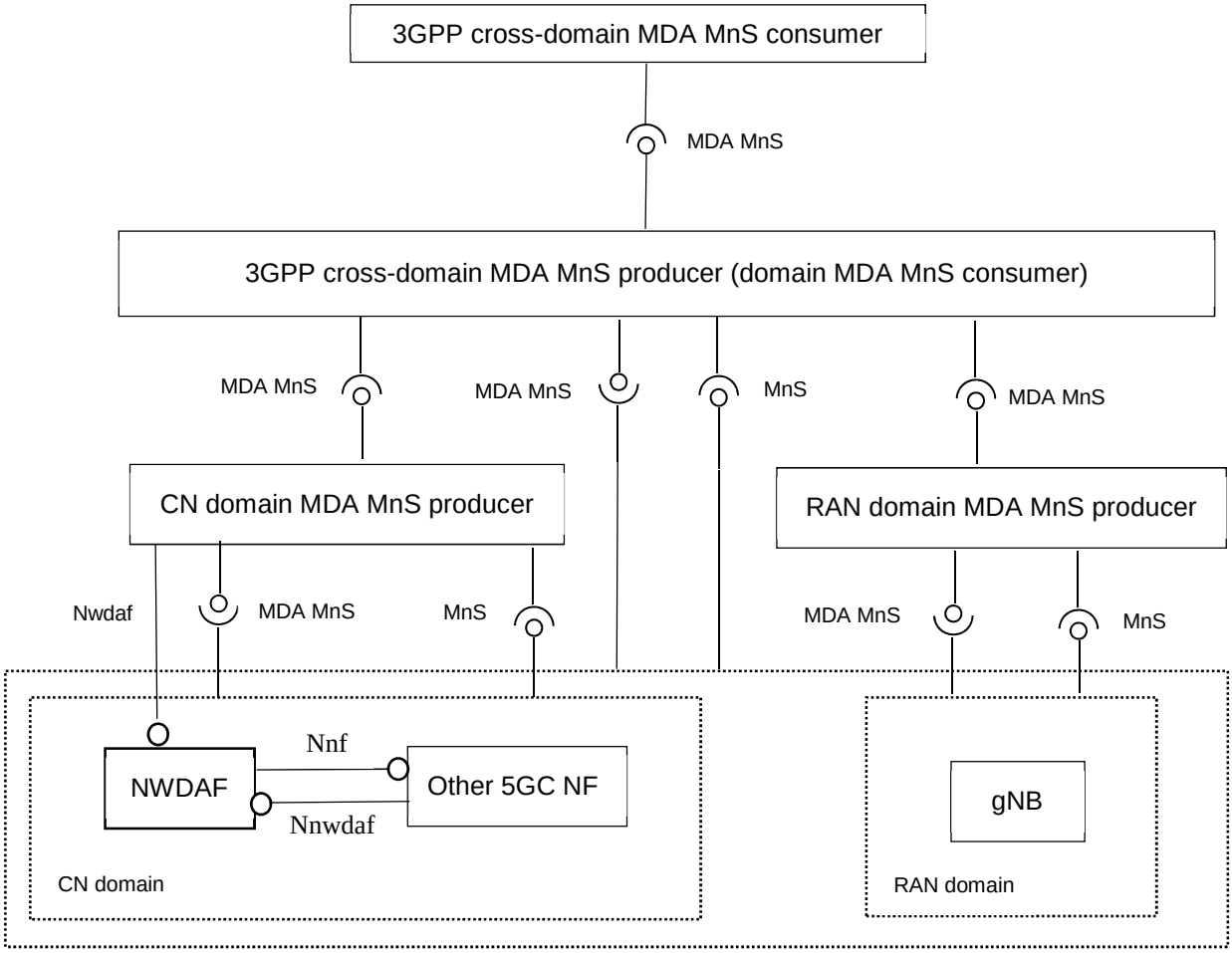


Figure 5.2-1: Example of coordination between NWDAF, gNB and MDAS (MDA MnS) producer

Any authorized MnS consumers get access to MDA reports by interacting with MDA MnS producers. These scenarios include but are not limited to the following:

- The NWDAF, leveraging MDA reports (e.g. for control purposes and other 5GC NFs), interacts with MDA MnS producers.
- The gNB may consume the MDA MnS for RAN control purpose.
- The 3GPP cross domain MDA MnS Producer may consume (acting as Domain MDA MnS consumer) MDA MnS provided by domain-specific (RAN and/or CN) MDA MnS producer(s) and produce MDA MnS that may be consumed by 3GPP cross-domain MDA MnS consumer(s).

The management function (MDAF) playing the role of domain MDA MnS producer may interact with 5GC and RAN MnSs and NFs to receive analytics inputs per MDA capability, including:

- The CN Domain MDA MnS producer may consume the service provided by NWDAF and other 5GC NFs for MDA purpose.
- The RAN Domain MDA MnS producer may consume the MnS provided by/for gNB for MDA purpose.

The management function (MDAF) playing the role of 3GPP cross domain MDA MnS producer consumes 5GC domain MDA, RAN domain MDA, 5GC MnS and RAN MnS to receive analytics inputs per each MDA use case/capability including:

- The cross domain MDA MnS producer may consume the MDA MnS provided by RAN and/or CN domains.

- The cross domain MDA MnS producer may consume MnS provided by RAN and/or CN domains, and produce MDA MnS that may be consumed by 3GPP cross-domain MDA MnS consumer(s).

5.3 Deployment of multiple MDAs

Multiple MDA instances may be deployed according to deployment needs.

The 3GPP cross domain management may consume MDA MnS provided by core network management as shown in Figure 5.3-1.

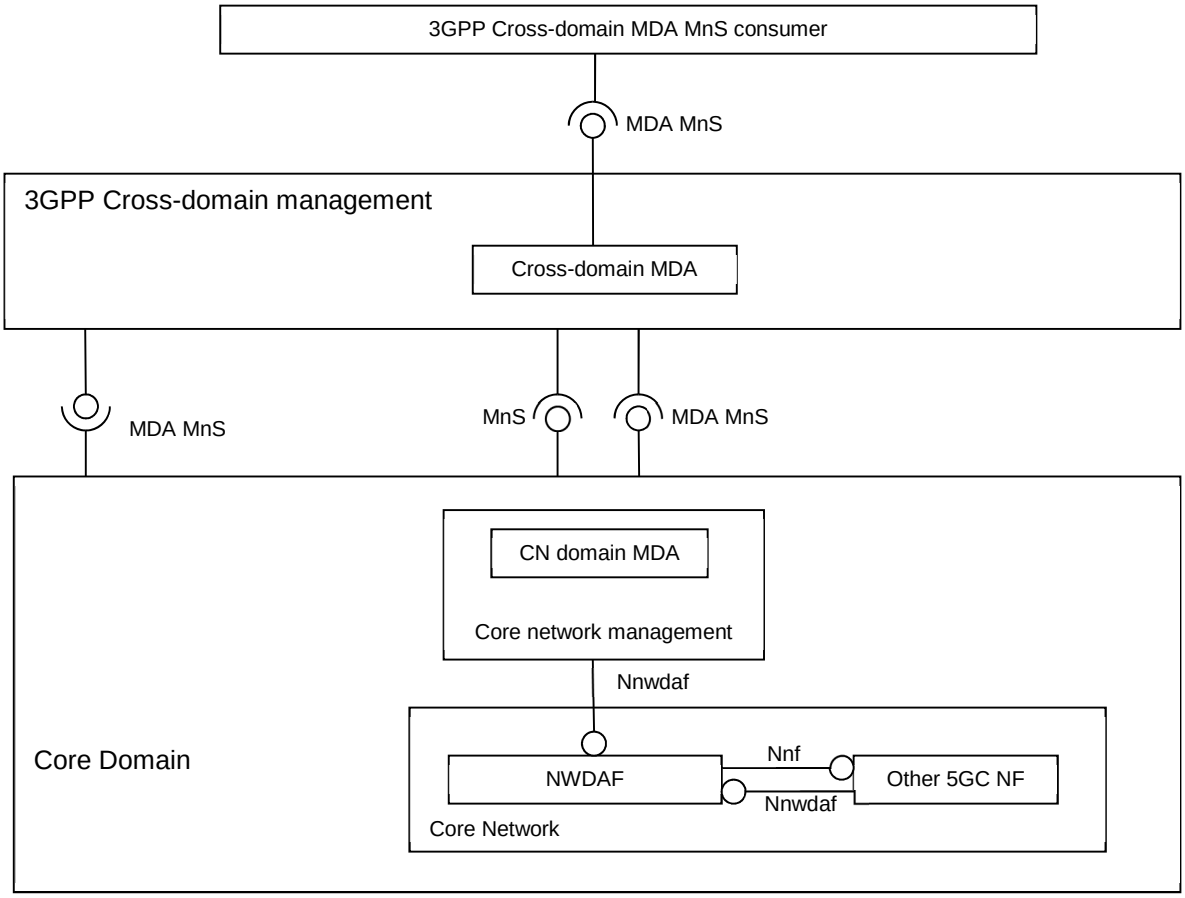


Figure 5.3-1 Example of coordination cross-domain MDA and Core network domain MDA

The management function (MDAF) playing the role of 3GPP cross domain MDA MnS producer interacts with CN domain MDA per each MDA use case/capability as follows:

- The cross-domain MDA MnS producer may consume the CN domain MDA MnS.

- The cross-domain MDA MnS producer may consume MnS provided by CN domains, and produce MDA MnS that may be consumed by 3GPP cross-domain MDA MnS consumer(s).

The management function (MDAF) playing the role of CN domain MDA MnS producer interacts with MnS producers per each use case/capability as follows:

- The CN domain MDA MnS producer may consume analytics results produced by NWDAF, MnS provided by CN domain management, other MDA MnS producers, management data derived by subnetwork management function(s), and management data derived by element management function(s).

The 3GPP cross domain management may consume MDA MnS provided by RAN management as shown in Figure 5.3-2.

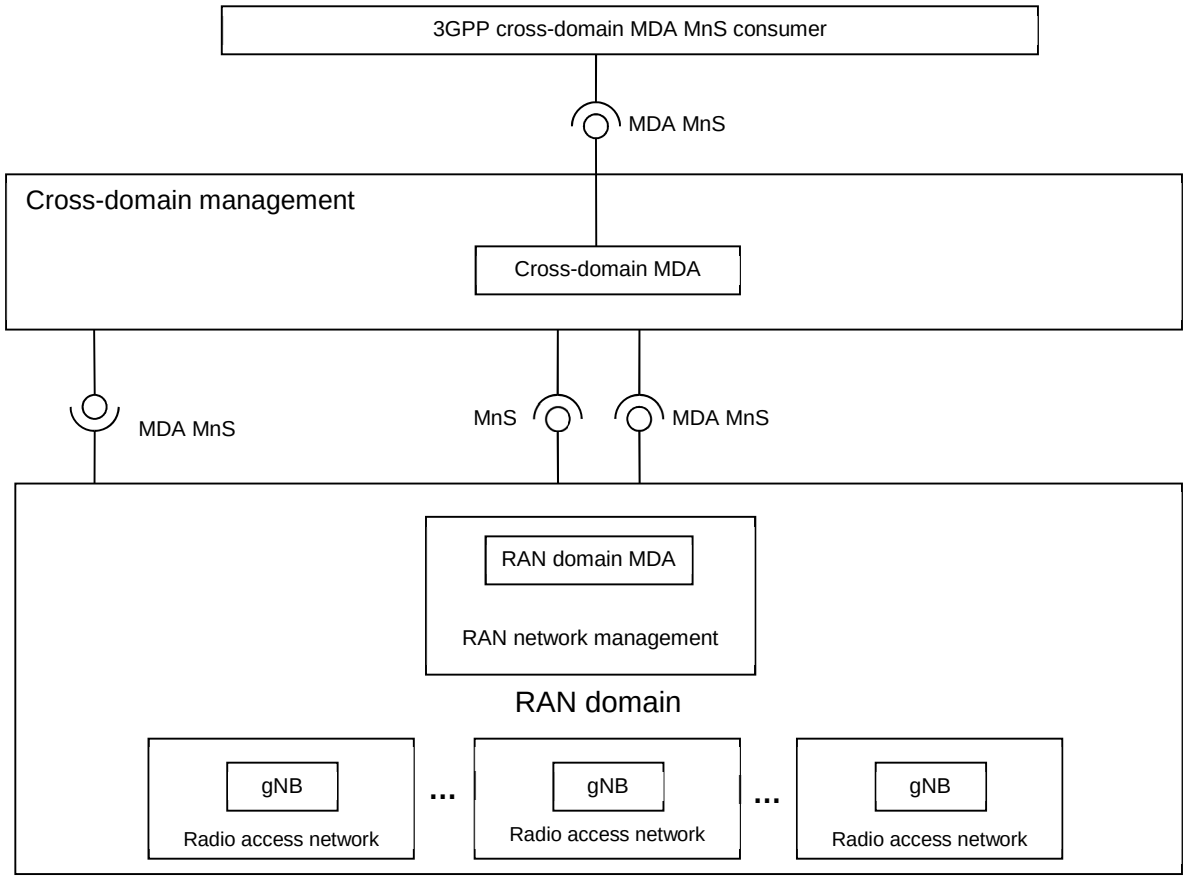


Figure 5.3-2: Example of coordination cross-domain MDA and RAN domain MDA

The management function (MDAF) playing the role of 3GPP cross domain MDA MnS producer interacts with RAN domain MDA per each MDA use case/capability as follows:

- The cross domain MDA MnS producer may consume the RAN domain MDA MnS.
- The cross domain MDA MnS producer may consume MnS provided by RAN domains, and produce MDA MnS that may be consumed by 3GPP cross-domain MDA MnS consumer(s).

The management function (MDAF) playing the role of RAN domain MDA MnS producer interacts with MnS producers per each use case/capability as follows:

- The RAN domain MDA MnS producer may consume MnS provided by RAN domain management, other MDA MnS producers, management data derived by subnetwork management function(s), and management data derived by element management function(s).

5.4 Network Context

An MDA MnS producer provides analytics with respect to a particular network context, i.e. network status, under which data is collected to produce analytics. For example, a prediction of load in an area of interest may differ when all gNBs and potential additional RATs are operating compared to case where certain gNBs or other RATs are experiencing a fault or are powered off to save energy. The analytics conducted and produced by the MDA MnS producer for these two example scenarios would be different and directly affected by the specific status of network. Although the network status (context) affects the produced analytics conducted by the MDA producer, awareness of the network context would fall on the consumer side to complement the obtained analytics results. This network context, reflecting network status at the time of enabling data collection, is important for the MDA MnS consumer to understand the network conditions related to the obtained analytics and hence be able to use such analytics more efficiently.

The MDA MnS consumer cannot expect the MDA producer to provide the network context, because the network context interest of each MDA MnS consumer may differ depending on the usage and purpose of analytics. The usage can include a proprietary algorithm that assist a decision-making process. For example, a load balancing algorithm may require the load and mobility information among neighbouring gNB whereas other load balancing algorithms may also require load and mobility information from a greater geographical area.

In addition, the selection of the parameters and their combinations may prove to be impractical for the MDA MnS producer to prepare and provide. Hence, it is efficient for the MDA MnS producer to prepare only the MDA output without including any network context and allow the MDA MnS consumer to obtain the required network context, to complement the obtained analytics, using conventional configuration management procedures as described in TS 28.511 [20] and TS 28.531 [21].

5.5 Historical data handling for MDA

Historical analytics reports may be saved and retrieved for use at later times by a MDA MnS consumer, and historical analytics input (enabling) data (along with current analytics input data) may be used for analytics by MDA MnS producer. Such a historical data usage may be applicable to both or one of the MDA MnS producer and MDA MnS consumer side.

NOTE: Historical data refers to (a) historical analytics reports that have been produced in the past, and (b) historical analytics input (enabling) data that had been collected in the past.

5.6 AI/ML support for MDA

The MDA process may utilize AI/ML technologies. An MDA Function may optionally be deployed as one or more AI/ML inference function(s) in which the relevant ML entities are used for inference per the corresponding MDA capability. Specifications for MDA ML model training to enable ML model deployments are given in TS 28.105 [24].

6 MDA in management loop

6.1 MDA role in the management loop

Intelligence in Analytics, played by MDA, in the management loop which can be open loop (operator controlled) or closed loop (autonomous) see TS 28.535 [3]) as shown in Figure 6.1-1, generates value by processing and analysis of management and network data, where AI and ML techniques may be utilized (see TS 28.105 [24]).

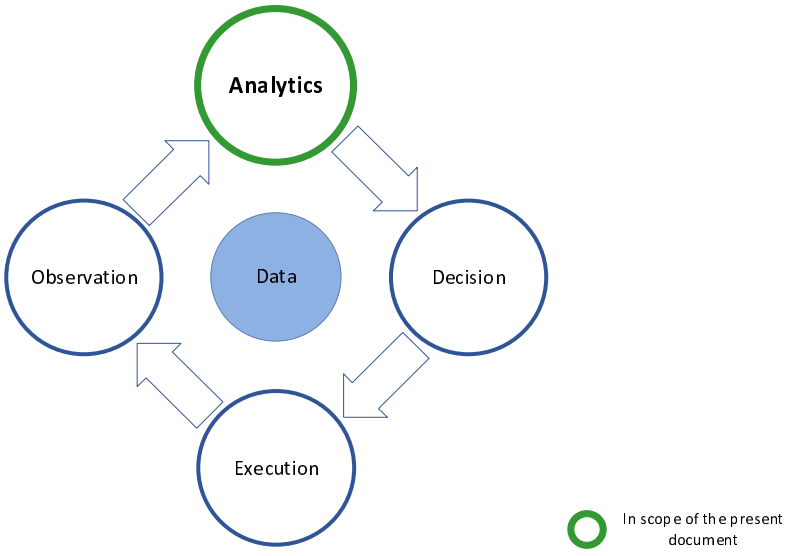


Figure 6.1-1: Analytics in management loop

The management loop constitutes of a number of elements including analytics, these elements are briefly described below:

Observation: The observation of the managed networks and services. It involves monitoring and collection of events, status and performance information of the managed networks and services, and providing the data.

Analytics: The data analytics capabilities for the managed networks and services. MDA plays the role of Analytics in the management loop. It prepares, processes, and analyses the collected data or time series of the collected data related to the managed networks and services. MDA reports may contain root cause analysis of ongoing issues, predictions of potential issues and corresponding relevant causes and recommended actions for preventions, and/or prediction of network and/or service demands.

Decision: The decision making element for the management actions applied to the managed networks and services. The decisions and subsequent management actions are based on the analytics reports (provided by MDA) and other management data (e.g., historical decisions). The decision may be made by the consumer of MDAS (in the closed management control loop), or by a human operator (in the case of open management loop). The decision may include e.g. what actions to take, and when to take the actions.

Execution: The execution element of management actions. During the execution step, the actions are applied to the managed networks and services, and the results of the executed actions are reported (e.g. notifications, logs).

6.2 MDA role in the management loop for service assurance

MDA represents Analytics roles in the management control loop for communications service assurance TS 28.535 [3]. The management and control of resources used by a communication service and the assurance of the communication service level agreements (e.g., per SLS) is provided by the management control loop involving different management services produced by the management system, which includes MDA service (MDAS, or MDA MnS). The MDAS (MDA MnS) may be produced based on a combination of information including e.g., the user quality of service experience, network performance and network resource utilization analysis and the SLS.

The MDAS complements other services in the management loop in order to perform SLS communication service assurance. Prior to the operation phase, the MDA role in the management control loop is to prepare, process and analyse the data related to the managed communication service, in order to provide the analytics output (analytics report) which may include prediction and feasibility checks of network resource requirements to meet the SLS.

During the operation phase, the MDA can identify ongoing issues impacting the performance of the communication service as per SLS requirements and identify potential risks caused by potential failure and/or performance degradation. The MDA can also predict the network and service demand to maintain delivery of communication service as per contracted SLS.

6.3 MDA role in cross-domain service assurance

Cross-domain MDA may base its analysis on the outputs from one or multiple single-domain MDA including analytics output and other input data (e.g., PM and alarm notifications.). To facilitate service assurance the cross-domain MDA may consume output from one or multiple single-domain MDA(s). Figure 6.3-1 shows the simplest case, where a cross-domain MDA consumes the results of single-domain MDA(s).

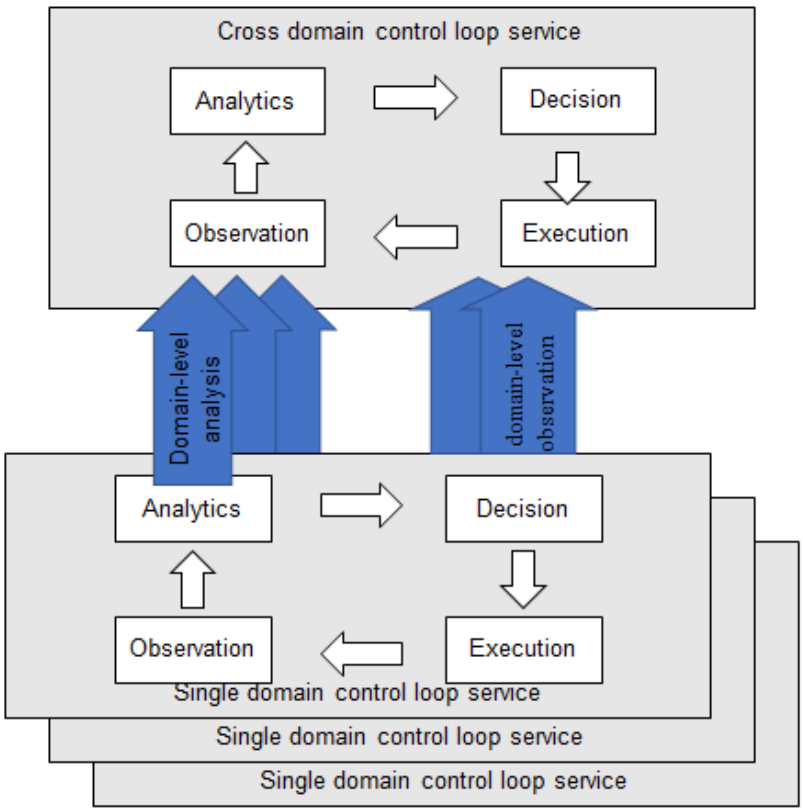


Figure 6.3-1 Cross-domain MDA based on single-domain MDA

Figure 6.3-2 shows the case where a cross-domain MDA incorporates the results of single-domain MDA(s) which are embedded within single-domain control loopservice(s). Service assurance control loop services may be performed at single-domain where analytics part is done by MDA. The cross-domain MDA may further leverage the output from one or more single-domain control loop services for the analytics of the e2e service.

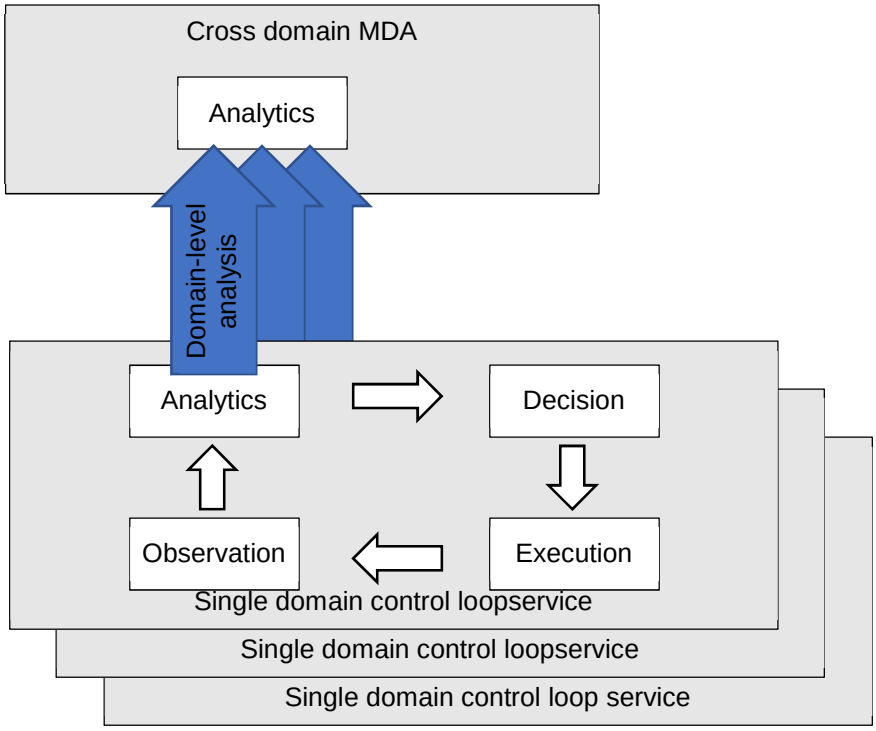


Figure 6.3-2: Cross-domain MDA based on single-domain control loopservice

Figure 6.3-3 shows the case where a cross-domain MDA is part of a cross-domain control loop service. Also in this case, cross-domain MDA consumes the results of single-domain MDA(s). Service assurance control loop service may be performed at the cross-domain level in which the analytics is done by MDA. The cross-domain control loop may consume output from one or more multiple single-domain MDA(s) for the e2e service.

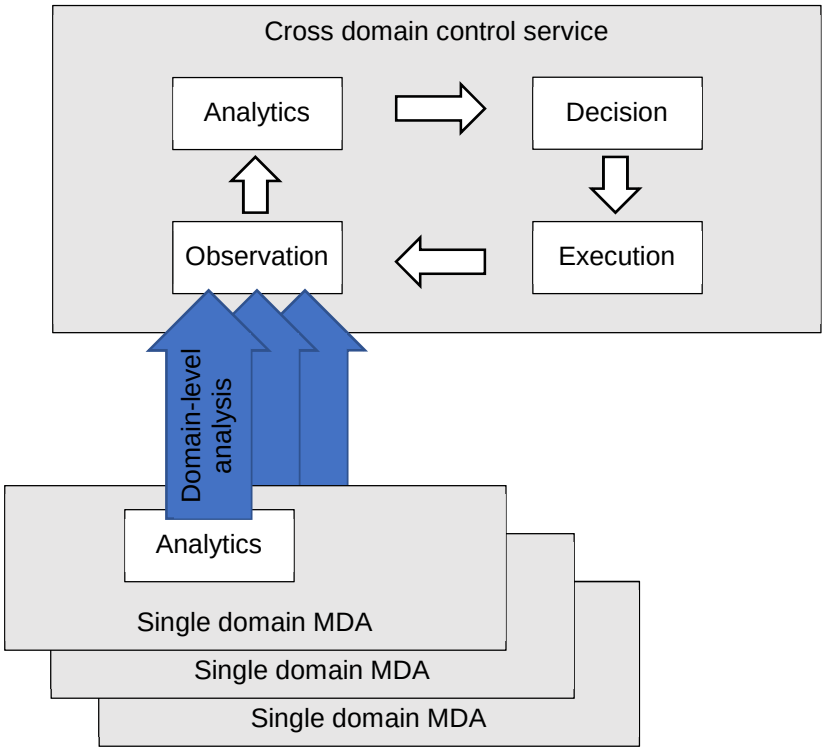


Figure 6.3-3: Cross-domain control loop service based on single-domain MDA(s)

Figure 6.3-4 shows another case where a cross-domain MDA is part of a cross-domain control service. In this case, cross-domain MDA consumes the results of single-domain MDA(s) which are embedded within single-domain control service(s). Service assurance control loop service may be conducted at both levels where analytics is done by MDA, i.e. at the cross-domain and single-domain. The cross-domain MDA may consume output from one or more single-domain MDA(s) for the e2e service.

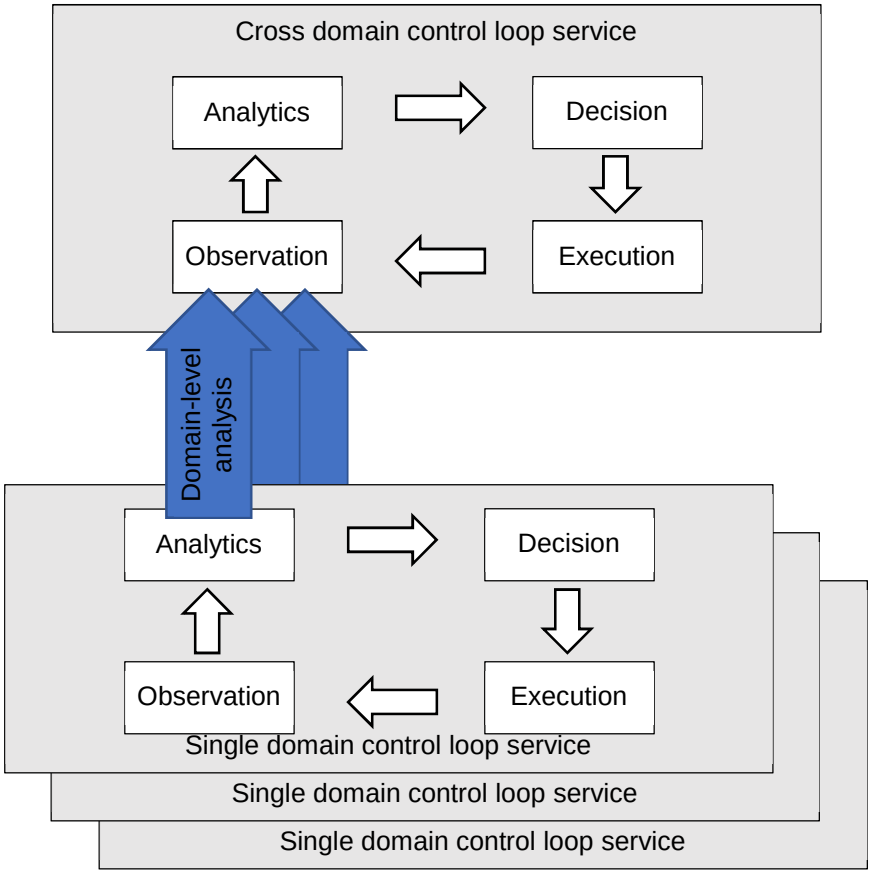


Figure 6.3-4: Cross-domain control loop service based on single-domain control loop service(s)

7 Use cases and requirements for MDA capabilities and services

7.1 General

The following clauses describe the use cases and requirements for MDA capabilities and MDA MnSs. The MDA capabilities are grouped under specific categories.

7.2 MDA capabilities

7.2.1 Coverage related analytics

7.2.1.1 Coverage problem analysis

7.2.1.1.1 Description

This MDA capability is for analysis of coverage related problem.

7.2.1.1.2 Use case

The RAN coverage problem may cause UEs to be out of service or result in a downgrade of network performance offered to the UEs, such as failure of random access, paging, RRC connection establishment or handover, low data throughput, abnormal releases of RRC connection or UE context, and dissatisfied QoE.

There are various types of coverage problems, e.g. weak coverage, a coverage hole, a pilot pollution, an overshoot coverage, or a DL and UL channel coverage mismatch, etc., caused by different sorts of reasons, such as insufficient or weak transmission power, blocked by constructions and/or restricted by terrain.

The 5G related coverage problem may exist in NR, in E-UTRA or both.

To unravel a coverage problem, it is necessary for MDAS consumer to determine the details about when and where the problem occurred or likely to occur, and the type and cause(s) of the problem. Therefore, it is desirable for MDA to correlate and analyze multifold data (such as performance measurements, MDT reports, RLF reports, RCEF reports, UE location reports, together with the geographical, terrain and configuration data of the RAN) to detect and describe the problem with detailed information.

The RAN coverage related problems can cause network performance degradation and in the extreme cases can result into service degradation. So besides identifying the problems after they have happened, it is also necessary to proactively avoid the RAN coverage related problems well before they occur.

To avoid coverage related problems or to proactively undertake actions to avoid their occurrence, the consumer of MDA MnS may wish to know the characteristics and quality of the coverage of the RAN. This may be expressed graphically on a Map, called a Radio Environment Map, that shows the coverage quality for a set of cells. Such a map may be constructed e.g. to show the RSRP or the SINR of the cells as derived from the observed UE performance and/or from radio configuration parameters of the cells including transmit powers, antenna gains, antenna tilts, etc. It is desirable that the MDAS producer can provide the Radio Environment Map in an appropriate graphical form.

Moreover, where a new RAN node is provisioned, the MDAS producer should be able to take into considerations the coverage of existing cells as defined by a Radio Environment Map and derive the configuration of the new cell(s) and the existing cells to optimize the coverage. Image analytics should help to identify the most optimized set of initial radio configurations that can be assigned to a new RAN NE.

To help MDAS consumer to solve the coverage problem as quickly as possible, MDA may also provide, along with the description of the problem, the recommended remedy actions (e.g. reconfigure or add cells, beams, antennas, etc.).

7.2.1.1.3 Requirements

Table 7.2.1.1.3-1

Requirement label	Description	Related use case(s)
REQ-COV_MDA-01	MDA capability for coverage problem analysis shall include providing analytics for issues including, weak coverage, coverage holes, pilot pollution, overshoot coverage, or DL and UL channel coverage mismatch.	Coverage problem analysis
REQ-COV_MDA-02	MDA capability for coverage problem analysis shall include providing analytics for area specific coverage problem analysis.	Coverage problem analysis
REQ-COV_MDA-03	MDA capability for coverage problem analysis shall include providing a radio environment map that graphically describes the radio coverage characteristics (e.g. RSRP or SINR) of the selected cluster of cells.	Coverage problem analysis
REQ-COV_MDA-04	MDA capability for coverage problem analysis shall include providing optimum configurations of a RAN node based on the radio environment map that graphically describes the radio coverage characteristics (e.g. RSRP or SINR) of a selected cluster of cells.	Coverage problem analysis

7.2.1.2 Slice coverage analysis

7.2.1.2.1 Description

This MDA capability is for the slice coverage analysis.

7.2.1.2.2 Use case

The slice coverage is one of the indicators when a 3rd party (i.e. slice tenant) issues a slice request and is mapped into the desired geographical coverage area with the available radio coverage which depends on the base station planning and deployment. In order to map the desired slice coverage perfectly, MDA can be used to optimize the slice coverage on the slice instantiation and runtime considering:

i) slice-aware statistics, e.g. slice-UE distributions and mobility patterns;

ii) slice SLA; and

iii) access node capabilities.

In 5G the notion of coverage is represented by a set of one or more Tracking Areas (TAs), which are contained in a Registration Area (RA), which is assigned to a UE once it registers to the network. Depending on the MDA MnS producer output, TA and RA planning, i.e. grouping cells to form a TA and then TAs to an RA, can be optimized and the RAN parameters can be adjusted to shape the cell edges and load distribution. The main objective is to fulfill a given slice SLA involving as few cells as possible by leveraging the benefits of adjusting cell configurations for satisfying the desired coverage.

7.2.1.2.3 Requirements

Table 7.2.1.2.3-1

Requirement label	Description	Related use case(s)
REQ-NS_COV_MDA-01	MDA capability for slice coverage analysis shall include providing analytics output describing the slice coverage and slice availability.	Slice coverage analysis
REQ-NS_COV_MDA-02	MDA capability for slice coverage analysis shall include providing analytics of the mapping between slice coverage and actual radio deployment.	Slice coverage analysis
REQ-NS_COV_MDA-03	MDA capability for slice coverage analysis shall include providing recommended actions that involve options to reconfigure TA and/or RAN attributes including HO parameters, cell reselection parameters, beam configuration, computing resource and slice support in a cell.	Slice coverage analysis

7.2.1.3 Paging optimization analysis

7.2.1.3.1 Description

This MDA capability is for enabling various functionalities related to paging optimization.

7.2.1.3.2 Use Case

As per the current procedures, if the UE goes Out-Of-Coverage (OOC) the paging which was initiated by the network Access and Mobility Management Function (AMF) fails. The re-attempts continue to fail until UE enters the coverage and respond to the paging attempts. This repetitive paging attempts result in the wastage of network resources. As an example, the use case includes a user or a group of users getting into an area, with no cellular coverage on a regular basis for a considerably long duration, for e.g. the user gets into a shielded room for some testing purpose every day for a defined period. The Network initiated paging for such users will fail until they are back in the area with cellular coverage. This would result in in-efficient network resource usage.

It is desirable to use MDAS (Management data analytic service) to optimize the current paging procedures in 5G networks. MDAS producer provides an analytics output containing the user(s) paging analytics indicating the time window at which a group of users are OOC on a regular basis at the particular location. MDAS producer also provides the geographical map within which the UEs would experience paging issues and hence will not be able to respond on a network-initiated paging. Based on the provided MDA output, MDAS consumer (e.g. AMF, gNB) decides on whether, when and where to initiate or not to initiate the paging procedures, thereby ensuring the efficient paging procedures and optimal network resource utilization, as paging can be initiated only when there are more chances for it to be successful.

7.2.1.3.3 Requirements

Table 7.2.1.3.3-1

Requirement label	Description	Related use case(s)
REQ-PAG_MDA-01	MDA capability for paging optimization analysis shall include providing analytics output describing paging result patterns for a group of users.	Paging optimization analysis
REQ-PAG_MDA-02	MDA capability for paging optimization analysis shall include providing analytics output describing paging result patterns based on geographical area.	Paging optimization analysis
REQ-PAG_MDA-03	MDA capability for paging optimization analysis shall include providing analytics output describing the paging result patterns based on successful and un-successful paging attempts at a particular time and duration based on geographical area.	Paging optimization analysis
REQ-PAG_MDA-04	MDA capability for paging optimization analysis shall include providing analytics output describing the paging result patters to contain the following information: - Identification of a group of users. - Identify the geographical area of concern. - Prediction of the time window during which UE is out-of-coverage periodically. - Prediction of the last known location before UE going out-of-coverage periodically. - The recommended action which may suggest stopping paging the UE for Daily-OOC-Duration at Daily-OOC-Location.	Paging optimization analysis

7.2.2 SLS analysis

7.2.2.1 Service experience analysis

7.2.2.1.1 Description

This MDA capability is for the service experience analysis.

7.2.2.1.2 Use case

Service experience of end user is key indicator that directly reflects the user satisfaction degree. In 5G system, the diversity of network services is expanding all the time and the requirements of different services especially from vertical users are being standardized. Considering these diverse requirements and expectation from end user perspective (e.g. priorities of SLA related attributes such as latency, throughput, maximum number of users or different required values of these attributes), the service experience as a comprehensive indicator need to be extensively analysed.

7.2.2.1.3 Requirements

Table 7.2.2.1.3-1

Requirement label	Description	Related use case(s)
REQ-SER_EXP_MDA-01	MDA capability for service experience analysis shall include identifying the source of service experience issue, e.g. RAN issue, CN issue, TN issue, UE issue, service provider issue.	Service experience analysis
REQ-SER_EXP_MDA-02	MDA capability for service experience analysis shall include providing the analytics output with following information describing the current service experience aspects and potentially future prediction: - The predicted future service experience and/or observed service experience statistics. - Service experience degradation root cause analysis.	Service experience analysis
REQ-SER_EXP_MDA-03	MDA capability for service experience analysis shall include providing the level of service experience.	Service experience analysis
REQ-SER_EXP_MDA-04	MDA capability for service experience analysis shall include providing the recommendation for improving service experience.	Service experience analysis
REQ-SER_EXP_MDA-05	MDA capability for service analysis should include the ability to provide service experience analysis across or within domains.	Service experience analysis

7.2.2.2 Network slice throughput analysis

7.2.2.2.1 Description

This MDA capability is for the network slice throughput analysis.

7.2.2.2.2 Use case

Throughput is of great importance which represents the end users' experiences and also reflects the network problems, e.g. low UE throughput may be caused by resource shortage. In order to satisfy the requirements of dL/ulThptPerSlice in the ServiceProfile, MDAS may be utilized for throughput related analysis/predictions for network slice instance.

MDAS producer allows the consumer to request analytics of network slice throughput related issues and identify the corresponding root cause(s) to assist throughput assurance. Network slice throughput analysis can be for a specific domain and/or for cross-domain. Domain-specific MDAS producer analyses the network slice subnet throughput, while the cross-domain MDAS producer analyses the network slice throughput. The two level MDAS producers, i.e. domain-specific and cross-domain may work in coordination to assure the optimum throughput performance.

7.2.2.2.3 Requirements

Table 7.2.2.2.3-1

Requirement label	Description	Related use case(s)
REQ-THR_MDA-1	MDA capability for network slice throughput analysis shall include identifying the network slice throughput issues, including those RAN-related and CN-related issues.	Network slice throughput analysis
REQ-THR_MDA -2	MDA capability for network slice throughput analysis shall include providing the root cause analysis of the network slice throughput issue(s).	Network slice throughput analysis
REQ-THR_MDA -3	MDA capability for network slice throughput analysis shall include providing the analytics output of the network slice throughput which contain the following information: - Network slice throughput statistics. - Network slice throughput predictions.	Network slice throughput analysis
REQ-THR_MDA-04	MDA capability for network slice throughput analysis shall include providing the prompt when the network slice throughput exceeds or falls below a certain threshold.	Network slice throughput analysis

7.2.2.3 Network slice traffic prediction

7.2.2.3.1 Description

This MDA capability is for the prediction of network slice traffic patterns.

7.2.2.3.2 Use case

It is desirable to use MDAS to get the network slice traffic predictions including individual traffic load predictions on each of the constituent network function instance present in the network slice. The traffic load predictions per constituent network function instances can be used for better resource provisioning of the network slice. For example, resources can be pre-configured considering the predicted traffic on the network slice.

7.2.2.3.3 Requirements

Table 7.2.2.3.3-1

Requirement label	Description	Related use case(s)
REQ-TRA_MDA--01	MDA capability for network slice traffic prediction shall include providing analytics output describing traffic load prediction of the network slice including traffic load prediction for each of its constituent network function instances.	Network slice traffic prediction
REQ-TRA_MDA-02	MDA capability for network slice traffic prediction shall include providing analytics output describing traffic load prediction for the network slice which include the following information: - Predicted uplink and downlink throughput on each User Plane Function instance (UPF) in the network slice. - Predicted number of Packet Data Unit (PDU) session for each Session Management Function (SMF) instance in the network slice. - Predicted number of UE or Registered subscriptions for each AMF instance in the network slice. - Predicted maximum packet size for each UPF instance in the network slice. - Predicted UE uplink and downlink throughput on each gNodeB (gNB) instance in the network slice. - Predicted number of UE for each gNB/NR cell instance in the network slice.	Network slice traffic prediction

7.2.2.4 E2E latency analysis

7.2.2.4.1 Description

This MDA capability is for E2E latency related issue analysis.

7.2.2.4.2 Use case

E2E latency is an important parameter for URLLC services. User data packets should be successfully delivered within certain time constraints to satisfy the end users requirements. Latency could be impacted by the network capability and network configurations. These factors may be the root cause if the latency requirements cannot be achieved. Packet transmission latency may dynamically change if these factors change. The latency requirement should be assured even if some of the network conditions may degrade. It is important for the MDAS producer to analyze the latency related issues to support SLS assurance.

7.2.2.4.3 Requirements

Table 7.2.2.4.3-1

Requirement label	Description	Related use case(s)
REQ-LAT_MDA-01	MDA capability for E2E latency analytics shall include identifying the type of the E2E latency issue, including, RAN- related latency issue, CN-related latency issue, TN-related latency issue, UE-related latency issue and service provider originated latency issue.	E2E latency analytics
REQ-LAT_MDA-02	MDA capability for E2E latency analytics shall include providing the root cause analysis of the E2E latency issue.	E2E latency analytics
REQ-LAT_MDA-03	MDA capability for E2E latency analytics shall include providing the recommended actions to solve the E2E latency issue.	E2E latency analytics

7.2.2.5 Network slice load analysis

7.2.2.5.1 Description

This MDA capability is for network slice load analysis.

7.2.2.5.2 Use cases

Network slice load may vary during different time periods. Therefore, network resources allocated initially could not always satisfy the traffic requirements, for example, the network slice may be overloaded or underutilized. Overload of signalling in control plane and/or user data congestion in user plane will lead to underperforming network. Besides, allocating excessive resources for network slice with light load will decrease resource efficiency.

The analysis of network slice load should consider the load of services with different characteristics (e.g. QoS information, service priority), load distribution to derive the corresponding resource requirements. Load distribution analytic result may be provided, e.g. load distribution for network slices, different locations and/or time periods etc.

Traffics and resources related performance measurements and UE measurements can be utilized by MDAS producer to identify degradation of the performance measurements and KPI documented in an SLS due to load issues, e.g. radio resource utilization. MDAS producer may further provide recommendations to the network slice load issue. This analytics results can be considered as an input to support SLA assurance to perform further evaluation.

7.2.2.5.3 Requirements

Table 7.2.2.5.3-1

Requirement label	Description	Related use case(s)
REQ-NS_LOAD_MDA-01	MDA capability for network slice load analytics shall include identifying the domain of the network slice load issue, including, RAN issue, CN issue and TN-related issues.	network slice load analytics
REQ-NS_LOAD_MDA-02	MDA capability for network slice load analytics shall include identifying the phase of the network slice load issue, e.g. historic/ongoing/potential network slice load issue.	network slice load analytics
REQ-NS_LOAD_MDA-03	MDA capability for network slice load analytics shall include identifying the state of the network slice load issue, e.g. overload/underutilized network slice load issue.	network slice load analytics
REQ-NS_LOAD_MDA-04	MDA capability for network slice load analytics shall include identifying the list of the network entities which are involved in the network slice load issue.	network slice load analytics
REQ-NS_LOAD_MDA-05	MDA capability for network slice load analytics shall include providing analytics related to network slice load within specified time schedules and geographic locations or target objects.	network slice load analytics
REQ-NS_LOAD_MDA-06	MDA capability for network slice load analytics shall include providing the root cause and recommended actions to the network slice load issue.	network slice load analytics

7.2.2.6 UE throughput analysis

7.2.2.6.1 Description

This MDA capability is for analysis of UE throughput to identify the traffic congestions.

7.2.2.6.2 Description

With the development of diverse communication services and the increasing number of connections, user data volume demanded by end users grows rapidly. As the user traffic increases, user experience deteriorates significantly. Therefore, UE throughput related measurements need to be analysed to identify the potential traffic congestion time and place by monitoring the network and provide the corresponding optimization recommendation that can be implemented to avoid potential traffic congestion.

Two types of traffic congestion as follows.

- Regular traffic congestion: Congestion that have heavy traffic which occurs at a fixed time or place every day, for example, during peak hours of daily morning, heavy traffic will result in a degraded user experience
- Non-Regular traffic congestion: user traffic increases sharply in a specific area, for example, in commercial activities and sports events, a large number of users gather for a period of time, resulting in rate experience deterioration.

The occurrence of such traffic congestion problem may seriously affect user experience and can be detected based on the UE throughput related measurements analysis.

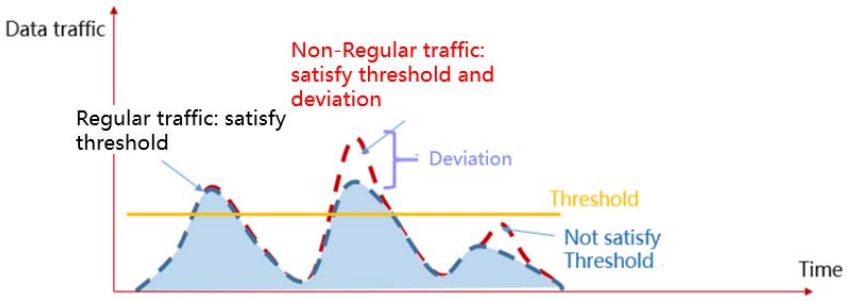


Figure 7.2.2.6.2-1 UE throughput analytics

Due to the complexity of 5G network and wireless environment, multiple types of performance deterioration are related with high user traffic volume. In such scenarios, the related performance measurements such as UE throughput, Radio resource utilization (i.e PRB utilization), number of RRC Connections can be used to analyze the situation. As shown in the Figure 7.2.2.6.2-1, if the preset threshold is reached, it may be considered that there is a traffic congestion problem. The user experience related performance should be analysed and identified to help to resolve improve the user experience. In this case, the consumer may need to be able to set the policy to help producer to analyze the congestion problems. The policy could be, for example, the threshold of the UE throughput related performance measurements (threshold and absolute deviation of the traffic in the figure).

The MDAS producer for radio network may also provide the traffic congestion severity and the recommendations to solve the UE throughput issues identified by the analytics congestion scenarios. The traffic congestion severity may be for example the value can be critical, major, minor, warning etc. The recommended actions may be for example to change the mobility parameters (e.g. MRO or LBO) or antenna RF parameters (e.g. CCO) such as downtilt and azimuth to where they are needed.

7.2.2.6.3 Requirements

Table 7.2.2.6.3-1

Requirement label	Description	Related use case(s)
REQ-UEThR_MDA-01	MDA capability for UE throughput analysis should include providing analytics for traffic congestion problems including Regular traffic congestion and Non-Regular traffic congestion.	UE throughput analytics
REQ-UEThR_MDA-02	MDA capability for UE throughput analysis should be able to provide the analytics output including traffic congestion type, traffic congestion severity level, the start time and end time of the traffic congestion, the geographical area and location where the traffic congestion has happened, as well as the possible recommended actions to solve the potential traffic congestion problem.	UE throughput analytics

7.2.2.7 Edge computing performance analysis

7.2.2.7.1 Description

This MDA capability is for the edge computing performance analysis.

7.2.2.7.2 Use case

For edge applications such as remote control and automation vehicles, the performance (e.g. latency) to an end user is contributed by both the network side and the Edge Computing side. The latency between UE and EAS needs to be controlled to satisfy the consumer requirements.

It is desirable that the latency between UE and EAS can be estimated by MDA. MDAS consumer sends the request for latency analysis to MDAS producer, MDAS producer correlates and analyses multi-fold data (such as EDN NF (e.g. EAS, EES) performance measurements, 5GC NF measurement and alarm related to edge computing performance, together with the geographical and configuration data of edge computing). The MDAS producer provides the analysis report that include estimating latency between UE and EAS.

7.2.2.7.3 Requirements

Table 7.2.2.7.3-1

Requirement label	Description	Related use case(s)
REQ-ECP_ANA-1	MDA capability for edge computing performance analytics should analyze and report the estimated latency between UE and EAS.	Edge computing performance analysis

7.2.2.8 Traffic congestion prediction based on UE throughput

7.2.2.8.1 Description

This MDA capability is for the traffic congestion prediction based on UE throughput.

7.2.2.8.2 Use case

The use case focuses on proactive identification and mitigation of traffic congestion by analysing UE throughput data.

A surge in user traffic within a specific area, such as a shopping mall, concert venue, or stadium, can lead to network congestion. As user density and data demands increase, cell resources become strained, resulting in a decline in UE throughput. Without timely intervention, congestion intensifies, leading to service degradation and impacting user experience.

The use case leverages MDA to analyse real-time and historical UE throughput performance data to predict traffic congestion. Based on the prediction results, the MDA may recommend appropriate mitigation measures (e.g. transfer

some UE traffic from congested cells to neighbouring cells with lighter loads) to maintain network performance and ensure user experience.

7.2.2.8.3 Requirements

Table 7.2.2.8.3-1

Requirement label	Description	Related use case(s)
REQ-CONG_MDA-01	MDA capability for traffic congestion prediction analytics based on UE throughput should include providing the prediction of network traffic congestion for various time granularities and geographical scopes.	Traffic congestion prediction analysis based on UE throughput
REQ-CONG_MDA-02	MDA capability for traffic congestion prediction analytics based on UE throughput should include recommending appropriate mitigation measures.	Traffic congestion prediction analysis based on UE throughput

7.2.3 MDA assisted fault management

7.2.3.1 Failure prediction

7.2.3.1.1 Description

This MDA capability is for failure prediction.

7.2.3.1.2 Use case

There are multiple sources of faults which may cause the 5G system to fail to provide the expected service. These faults and the associated failures need extensive troubleshooting. In order to reduce network and service failure time and performance degradation, it is necessary to supervise the status of various network functions and resources, and predict the running trend of network and potential failures to intervene in advance. These predictions can be used by the management system to autonomously maintain the health of the network, e.g. speedy recovery actions on a network function related to the predicted potential failure.

Due to the fact that failure prediction could depend on the existing alarm incidents and relevant historical and real-time data (performance measurement information, configuration data, network topology information, etc.), there is a possibility for MDA to be used in conjunction with AI/ML technologies and model training to predict potential failures.

In order to avoid the occurrence of failures and abnormal network status, it is necessary for consumers of analytics to obtain the required details of potential failure and the corresponding degradation trend (abnormal KPI, performance measurement information, possible alarm type, fault root cause, etc.). Therefore, MDA, may in conjunction with AI/ML technology, be required to obtain basic health maintenance knowledge (e.g. the relationship between the failures or potential failures and the related maintenance actions) through predefined expertise or model training, so as to effectively predict potential failures. The basic health maintenance knowledge could be updated with feedback. The consumer of analytics could provide the performance crossing threshold information and resource usage threshold information to MDAS producer for calculating and collecting the statistics result, e.g. percentage of time when the performance KPI exceeds the threshold, and percentage of time when resource usage of the NF is beyond the threshold. Such statistics information helps the MDAS consumer to know whether the NF is in the overloaded state which could potentially cause network failure. Furthermore, the statistics information can be combined with historical data and ML model for MDAS producer to perform failure prediction of the NF (e.g. to predict potential NF impact from a signalling storm).

Besides the MDA capability to obtain basic health maintenance relationships between the service failure and related potential failures at network levels, the MDA capability for failure prediction may take role of coordination in cross domain. When MDA capability takes role of coordination in cross domain, the MDA capability for failure prediction can collect analytics output of failure prediction from single domain management and provide recommendation actions accordingly.

Along with the predicted fault, the information such as the trend of the predicted fault and the duration of the predicted fault are helpful for the consumers to seamlessly correlate the predicted failure and the actual failure when it occurs in the system.

If necessary, MDA could also provide corresponding recommended actions for failure prevention. In case the producer of MDA MnS is unable to recommend an action for failure prevention, it may be useful to recommend collecting additional management data.

The comprehensive collection of all potentially related management data from deployed field entities is time-consuming and resource intensive. Therefore, it is advisable to collect more relevant management data pre-emptively, enabling effective debugging and root cause analysis to mitigate future failure occurrences. To support robust root cause analysis, it is essential to collect specific management data that facilitates the identification and resolution of predicted failures.

7.2.3.1.3 Requirements

Table 7.2.3.1.3-1

Requirement label	Description	Related use case(s)
REQ-FAILURE_PRED_MDA-01	Void	Void
REQ-FAILURE_PRED_MDA-02	MDA capability for failure prediction shall be able to obtain basic health maintenance knowledges (including, the relationship between the failures or potential failures and the related maintenance actions) through predefined expertise or model training.	Failure prediction
REQ-FAILURE_PRED_MDA-03	MDA capability for failure prediction shall be able to provide the analytics output including predictions of potential service failures, as well as the possible recommendation actions to prevent failures.	Failure Prediction
REQ-FAILURE_PRED_MDA-04	MDA capability for failure prediction should include the ability to predict failures across or within domains and provide analytics outputs for predicted failures.	Failure Prediction
REQ-FAILURE_PRED_MDA-05	MDA capability for failure prediction should be able to provide the analytics output including information used for failure prediction based on the threshold information provided by the consumer.	Failure Prediction
REQ-FAILURE_PRED_MDA-06	MDA capability for failure prediction should have a capability to indicate the management data to be collected for the predicted failure.	Failure Prediction
REQ-FAILURE_PRED_MDA-07	MDA capability for failure prediction should be able to provide the analytics output including trend indication about the predicted failure and predicted end time of the failure.	Failure Prediction

7.2.3.2 Service failure recovery

7.2.3.2.1 Description

This MDA capability is for service failure recovery.

7.2.3.2.2 Use case

There are multiple sources of faults which may cause the 5G system to fail to provide the expected services. The potential management actions to support network service recovery are operational activities, such as switching to redundancy NF(s), modifying NF configuration(s) based on different scenarios. When a service interruption disaster occurs (e.g. massive call disconnections), it is important for MDA to provide analytics to suggest management actions to quickly restore services while avoiding causing other problems (e.g. signalling overload) during the recovery process. The analysis of failure recovery can be used by the management system to resolve service interruptions in an orderly manner.

As an example, in case that the service interruption occurs, the MDA can provide analysis of the possible recovery plan and the recommended actions (e.g., engaging standby NF(s), changing configuration of core network NF etc.) for service recovery.

7.2.3.2.3 Requirements

Table 7.2.3.2.3-1

Requirement label	Description	Related use case(s)
REQ-FAILURE_RECOV_MDA-01	MDA capability for failure recovery shall be able to collect, filter and analyse alarm information, KPI information and configuration information as inputs for analytics and provide the analytics output.	Service failure recovery
REQ-FAILURE_RECOV_MDA-02	MDA capability for failure recovery shall be able to provide the analytics output including the possible recommended actions to prevent failures or restore services.	Service failure recovery

7.2.4 MDA assisted Energy Saving

7.2.4.1 Energy saving analysis

7.2.4.1.1 Description

This MDA capability is for the energy saving analysis.

7.2.4.1.2 Use cases

Operators are aiming at decreasing power consumption in 5G networks to lower their operational expense with energy saving management solutions. Energy saving is achieved by activating the energy saving mode of the NR capacity booster cell or 5GC NFs (e.g. UPF etc.). The energy saving decision making is typically based on the load information of the related cells/UPFs, the energy saving policies set by operators and the energy saving recommendations provided by MDAS producer. To achieve an optimized balance between the energy consumption and the network performance, MDA can be used to assist the MDAS consumer to make energy saving decisions.

To make the energy saving decision, it is necessary for MDAS consumer to determine where the energy efficiency issues (e.g. high energy consumption, low energy efficiency) exist, and the cause of the energy efficiency issues. Therefore, it is desirable for MDA to correlate and analyze the energy saving related performance measurements (e.g. PDCP data volume of cells, power consumption, etc.) and the network analysis data (e.g. observed service experience related network data analytics) to provide the analytics results which indicate current network energy efficiency. In some low-traffic scenarios, MDA MnS consumers may expect to reduce energy consumption to save energy. In this case, the MDA MnS consumer may request the MDAS producer to report only high energy consumption issue related analytics results. When the consumer expects to improve energy efficiency, although it may lead to high energy consumption in network or in certain parts of network, then the related issue is the low energy efficiency one. In that case, the consumer may request analytics results related to low energy efficiency issue. So, the target could be to enhance the performance of NF for a given energy consumption. This will result in higher Energy Efficiency of network.

To make the energy saving decision, it is necessary for MDAS consumer to determine which Energy Efficiency (EE) KPI related factor(s) (e.g. traffic load, end-to-end latency, active UE numbers, etc.) are affected or potentially affected. The MDAS producer can utilize historical data to predict the EE KPI related factors (e.g. load variation of cells at some future time, etc.). The prediction result of these information can then be used by operators to make energy-saving decision to guarantee the service experience.

The MDAS producer may also provide energy saving related recommendation with the energy saving state to the MDAS consumer. Under the energy saving state, the required network performance and network experience should be guaranteed. Therefore, it is important to formulate appropriate energy saving policies (start time, dynamic threshold setting, base station parameter configuration, etc.). The MDAS consumer may take the recommendations with the energy saving state into account for making analysis or making energy saving decisions. After the recommendations have been executed, the MDA producer may start evaluating and further analyzing network management data to optimize the recommendations.

7.2.4.1.3 Requirements

Table 7.2.4.1.3-1

Requirement label	Description	Related use case(s)
REQ-ES_MDA-01	MDA capability for energy saving analysis shall include identifying the energy efficiency issue (including high energy consumption, low energy efficiency), and identify the cell/NFs or location area of where the indicated energy efficiency issue exists.	Energy saving analysis
REQ-ES_MDA-02	MDA capability for energy saving analysis shall include identifying the root cause of the energy efficiency issue when necessary.	Energy saving analysis
REQ-ES_MDA-03	MDA capability for energy saving analysis shall include utilizing the network status analysis and predictions information of the energy efficiency KPI factors (including, traffic load trends) to assist achieving energy saving.	Energy saving analysis
REQ-ES_MDA-04	MDA capability for energy saving analysis shall include providing the energy saving recommendation, including policies and configuration actions to guarantee the network performance and end user service experience.	Energy saving analysis

7.2.5 MDA assisted mobility management

7.2.5.1 Mobility performance analysis

7.2.5.1.1 Description

This MDA capability is for the mobility performance analysis.

7.2.5.1.2 Use case

The mobility performance related problems may result from too-early/too-late/ping-pong handovers due to inappropriate handover parameters. MDAS can be used to analyse service experience and network performance during handover period in different mobility scenarios. MDAS producer may also be capable to provide the recommendations of optimal handover parameters to MDAS consumer.

In different NSA and SA deployment architecture scenarios, handover mechanisms (e.g. DAPS, CHO or RACH-less handover) will have different impacts on the mobility performance. The analytics report to identify the most optimal handover mechanism may be provided by MDAS producer.

7.2.5.1.3 Requirements

Table 7.2.5.1.3-1

Requirement label	Description	Related use case(s)
REQ-MRO_MDA-01	MDA capability for mobility performance issue analysis shall include providing the mobility performance in NSA and SA deployment architectures.	Mobility performance issue analysis
REQ-MRO_MDA-02	MDA capability for mobility performance issue analysis shall include providing the mobility issue analysis including too-early handovers, too-late handovers and ping-pong handovers.	Mobility performance issue analysis
REQ-MRO_MDA-03	MDA capability for mobility performance issue analysis shall include identifying the most optimal handover mechanism including DAPS, CHO or RACH-less handover.	Mobility performance issue analysis
REQ-MRO_MDA-04	MDA capability for mobility performance issue analysis shall include providing the area specific mobility performance analysis.	Mobility performance issue analysis

7.2.5.2 Handover optimization analysis

7.2.5.2.1 Description

This MDA capability is for the handover optimization analysis.

7.2.5.2.2 Use cases

7.2.5.2.2.1 Handover optimization

Current handover procedures are mainly based on radio conditions for selecting the target gNB upon a handover. The target gNB accepts or rejects the Handover (HO) request depending on various conditions. In virtualized environment, the HO may be rejected due to inadequate available resources within the target gNB. The notion of resources may include virtual resources (e.g. compute, memory) and/or radio resources (e.g. PRB, RRC connected users). If the HO request is rejected, a UE will try to connect to a different gNB until the request is successfully accepted. Several target gNBs can be tried until the request is successfully accepted. This process can result in wastage of UE and network resources, while it may also introduce service disruption due to increased latency and Radio Link Failures (RLFs). It also introduces inefficiency in the HO or other network procedures.

To address this handover optimization issue, it is desirable to use MDA (Management Data Analytics) to provision and/or select a particular target gNB for handover in order to reduce or even avoid HO rejections. The MDAS producer provides a HO optimization analytics output containing the current and future/predicted resource consumption, resources capabilities and other KPIs' status for the available target gNB(s). The analytics output also provides recommended actions to optimize the target gNB for handover. This may include resource re-configuration or the updated selection criteria for target gNB. Based on the output, the MDAS consumer adjusts (e.g. scale-out/up the virtual resource, re-schedule/optimize radio resource) the resources before continuing with the handover and/or adjusts the selection criteria of the target gNB by also considering the overlapping coverages of inter-frequency and inter-RAT deployments.

It is desired that the MDA supports analytics that enables the consumer to request analytics on real or predicted signal measurements, on real or predicted user speeds, on learned and predicted user trajectories or paths, or any combination of these aspects. The predicted user speed and predicted trajectory mentioned here are referring to the predicted outputs on the same as described in TS 38.423 [31].

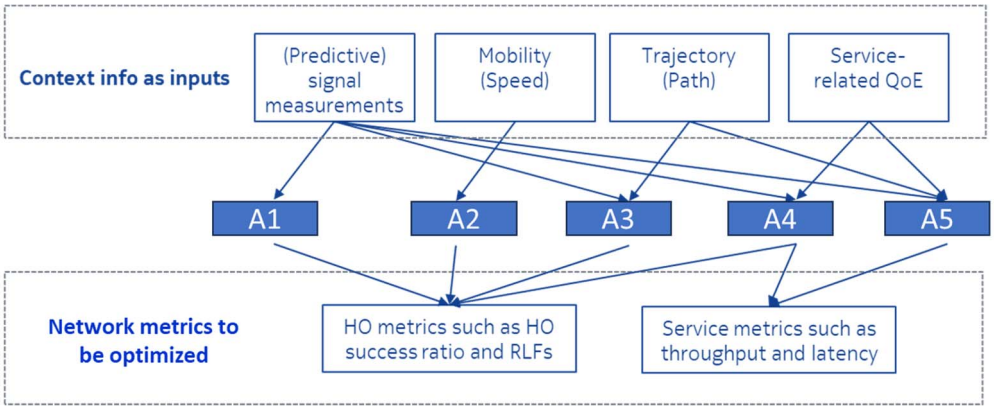


Figure 7.2.5.2.2.1-1: Examples of various context information and HO performance metrics can be used for handover optimization through different combinations A1 to A5.

7.2.5.2.2.2 Handover optimization based on UE Load

The target node, eNB, may not have adequate resources to accept certain handover requests. In the context of network virtualization, these resources may include not only legacy radio resources, but also virtual resources such as processor and memory. Handover optimization can benefit from knowledge about the projected UE load on the target cell including additional radio and virtual resources.

7.2.5.2.3 Requirements

Table 7.2.5.2.3-1

Requirement label	Description	Related use case(s)
REQ-MOB_MDA-01	MDA capability for handover optimization shall include providing the analytics output related to current statistics and future predictions of virtual resource consumption of gNB.	Handover optimization
REQ-MOB_MDA-02	MDA capability for handover optimization shall include providing the analytics output related to current statistics and future predictions of radio resource consumption of gNB.	Handover optimization
REQ-MOB_MDA-03	MDA capability for handover optimization shall include providing an analytics output indicating a selection priority for the target cell, among a set of candidate inter-frequency cells.	Handover optimization
REQ-MOB_MDA-04	MDA capability for handover optimization shall include providing an analytics output indicating a list of target cells to spare, i.e. avoid, a handover for an indicated time period.	Handover optimization
REQ-MOB_MDA-05	MDA capability for handover optimization shall include providing the analytics output describing inter-frequency target cell selection for handover including information for provisioning or selecting a target gNB with respect to a specific service or slice, if the same Network Slice Instance (NSI) is available in both the current and target gNB.	Handover optimization
REQ-MOB_MDA-06	MDA capability for handover optimization shall include providing the analytics output describing inter-frequency target cell selection for handover including indication of current and expected QoE (for the UE) at the current and target gNB.	Handover optimization
REQ-MOB_MDA-07	MDA capability for handover optimization shall include providing the analytics output including the following information that can be used to optimize handover decisions: - Indication on whether the target gNB is optimal for handover. - Recommended action to optimize the target gNB and/or the selection of the target gNB for handover.	Handover optimization
REQ-MOB_MDA-08	MDA capability for handover optimization shall include providing an analytics output indicating the projected UE load with respect to virtual resource and radio resource on the target cell.	Handover optimization based on UE Load
REQ-MOB_MDA-09	MDA capability for handover optimization should have a capability of allowing the use the predicted signal measurements, predicted user speeds and predicted user trajectories for providing recommendations for handover analytics.	Handover optimization
REQ-MOB_MDA-10	MDA capability for handover optimization should have a capability of allowing the consumer to use the service characteristics.	Handover optimization

7.2.5.3 Inter-gNB beam selection optimization

7.2.5.3.1 Description

This MDA capability is for inter-gNB beam selection optimization.

7.2.5.3.2 Use case

With the deployment of 5G networks, Massive MIMO has been used on a large scale. Beamforming, as a key technology to reduce user interference, which can suppress interference signals in non-target directions and enhance sound signals in target directions, is always combined with Massive MIMO to further decrease interference. A cell can make use of multiple beams for serving residing users (SSB or CSI-RS) with each user served by a single beam at a time. The cell level quality can be represented as an aggregated metric over one or more beams. So, although handover is performed between two 5G cells, the granularity of handover can be further broken down to beam level.

The handover of beams could be performed if the network resource or the user's state have changed to obtain better network performance. Beam optimization includes the handover between different beams and configuration of beam parameters.

In order to avoid selecting the wrong beam to perform RACH on the target cell and causing RLF of the UE, MDA can be used to recommend a means to prioritize and/or select the beam in case of handover for a specific target cell. MDA

can provide a beam level HO optimization analysis considering information on the handover performance of different beam combinations between the source and target cell pairs. Beams of the target cell with a successful handover are preferred in the selection.

MDA could also provide recommended actions and priority options for beam selection. Based on the recommended actions, the MDA MnS consumer adjusts the priorities for the beam selection at HO, i.e. the beam combinations that are likely to succeed are prioritized, less optimal beam combinations are down prioritized. The target cell may also obtain analytics to allocate RACH resources in a way that ensures HO success.

In order to optimize antenna and beam configuration, so as to reduce energy loss and enhance network performance, MDA can be used to analyze the current network status.

7.2.5.3.3 Requirements

Table 7.2.5.3.3-1

Requirement label	Description	Related use case(s)
REQ-HO_BEAM_OPT-01	MDA capability for inter-gNB beam selection optimization shall include providing the analytics of the handover performance of beam pair combinations between cell pairs.	Inter-gNB beam selection optimization
REQ-HO_BEAM_OPT-02	MDA capability for inter-gNB beam selection optimization shall include providing an indication if a beam pair is to be prioritized or down prioritized.	Inter-gNB beam selection optimization
REQ-HO_BEAM_OPT-03	MDA capability for inter-gNB beam selection optimization shall include providing feasible antenna and beam configuration analysis.	Inter-gNB beam selection optimization

7.2.6 MDA assisted critical maintenance management

7.2.6.1 RAN Node Software Upgrade

7.2.6.1.1 Description

This MDA capability is for network critical maintenance during RAN node software upgrade process.

7.2.6.1.2 Use case

As per the current mechanism of software upgrade at RAN node results in service disruption or huge operational cost. Consider a scenario, when a RAN Node is required to shut down manually to undergo critical maintenance for a very short duration of time. Software upgrade can be one such critical maintenance scenario. In such cases, all the resources (bearer, security functions, mobility management) that are managed by this RAN Node need to be purged and reconfigured at another RAN Node (standby RAN Node) or if another RAN Node is not available then resources will be reconfigured again when former RAN Node comes up after software upgrade. Both the situations lead to additional operational expenses and data loss. Operational expense in terms of all the resources to be released/attached again and data loss for all GBR sessions/bearer.

It is expected to use MDAS to optimize the procedure of software upgrade at RAN Node by providing the right time to execute the required upgrade. The software upgrade should be automatically initiated by the OAM system, once configured, during the time frame when the expected impacts are minimum i.e. at the optimal time when there would be minimum expected operational cost and data loss. The Optimal Time (current or futuristic) can be derived by collecting and analysing the data related to DRBs including GBR/non-GBR, state, modification count, ongoing handover etc. MDAS can utilize historical data and AI/ML (e.g. time series based) algorithm to derive the future optimal time frame for software upgrade.

NOTE: RAN Node above refers to CU-CP in case of gNB split case.

7.2.6.1.3 Requirements

Table 7.2.6.1.3-1

Requirement label	Description	Related use case(s)
REQ-SWA_MDA-01	MDA capability for RAN Node software upgrade shall include providing the DRB info analytics output describing the DRBs info at a particular RAN Node(s).	RAN Node software upgrade
REQ-SWA_MDA-02	MDA capability for RAN Node software upgrade shall include providing the DRB info analytics output describing the DRB info based on the following DRB characteristics; type (GBR/non-GBR), state (idle/active), modification count (indicating number of times, this bearer has gone for modification since its creation), handover in-progress (indicates whether the bearer is undergoing handover or not).	RAN Node software upgrade
REQ-SWA_MDA-03	MDA capability for RAN Node software upgrade shall include providing output describing the DRB info that contain the following information: - Time frame/duration at which the output is generated. - Whether RAN Node is optimal for upgrade at present. - Whether RAN Node will be optimal for upgrade during a future time frame. This will also provide a future frame. - Total number of GBR and non-GBR DRBs at future point of time frame. This will also provide a future frame.	RAN Node software upgrade

7.2.6.2 Software upgrade validation capability

7.2.6.2.1 Description

This usecase deals with validating the software upgrade.

7.2.6.2.2 Use Case

Upgrades in the network including software upgrades are typically conducted during less busy times such as night time. Once the software upgrade is done, it needs to be validated before it can be confirmed. The validation window following the upgrade can be large because it involves a series of pre-and post-checks. The validation process requires checking for performance measurements and KPIs for any degradation.

MDAS analytics can be used to validate the SW upgrade. The validation involves monitoring and evaluating the set of Key Performance Indicators (KPIs) to create analytic results that can be used to validate the software upgrade automatically and consistently.

7.2.6.2.3 Requirements

Table 7.2.6.2.3-1

Requirement label	Description	Related use case(s)
REQ-SWA_FUN-01	The MDA MnS producer should enable an authorized consumer to request for an analytics report predicting the success or failure of a software upgrade. Note: Validation of a software upgrade involves monitoring and evaluating the set of Key Performance Indicators (KPIs) to create analytic results that can be used to predict the success or failure of a software upgrade.	Software upgrade validation capability

7.2.7 Resource related analytics

7.2.7.1 NF resource utilization analysis

7.2.7.1.1 Description

This MDA capability is for analysis of resource utilization of 3GPP NFs.

7.2.7.1.2 Use case

The 3GPP system is a resource limited system, no matter whether the NF is working on virtualized resources or physical resources.

Resource shortage would affect the QoS and potentially impact users' quality of experience (QoE), e.g., by lowering the users' data throughput, prolonging the users' data delay, raising the rejections for the establishment of new connections (e.g., RRC connection), sessions (e.g., PDU session) and resources (e.g., QoS flows, DRBs, etc.) and increasing the drops of the existing connections, sessions, and resources. This may also consequently lead to risking or failing SLAs.

On the other hand, resource excess would cause wastage that leads to additional CapEx and OpEx.

Therefore, it is imperative to ensure optimum and efficient resource utilization for the NFs.

The resource utilization of an NF is heavily dependent on load or traffic patterns, which could vary in different coverage areas (e.g., business area, entertainment area, and residential area) and in different time periods (weekdays and time of the day). It is desirable that the spare resource of the low-usage areas can be allocated to the busy areas. It is expected that MDA can perform an analysis of the resource utilization for physical resources or virtualized resources for the 3GPP NFs (in a specific domain or cross domains) to indicate the resource usage patterns in the past and predict the resource usage trend for some time periods in the future. The physical resources to be analyzed may include hardware resources (e.g., CPU), DL and UL PRBs (for gNB), etc., while the virtualized resources to be analyzed may include virtual CPU, virtual memory, virtual disk, etc. It is also very useful that MDA correlates the resource analytics across 3GPP NFs and provides recommendations that can be utilized to efficiently orchestrate the resources among NFs between the low usage and high usage areas for some time periods. The recommended actions could be for example to optimise, i.e., increase or decrease the capacity of gNB to enhance allocation of the physical resources or to schedule the "scale in" and "scale out" of VNFs via ETSI MANO system to optimize the allocation of the virtualized resources.

7.2.7.1.3 Requirements

Table 7.2.7.1.3-1

Requirement label	Description	Related use case(s)
REQ-RES_UTI_ANA-01	MDA capability for resource utilization analysis shall include identifying the 3GPP NFs with low usage of physical resources (see Note 1).	NF resource utilization analysis
REQ-RES_UTI_ANA-02	MDA capability for resource utilization analysis shall include identifying the 3GPP NFs with high usage of physical resources (see Note 1).	NF resource utilization analysis
REQ-RES_UTI_ANA-03	MDA capability for resource utilization analysis shall include providing the prediction of physical resource usage for a 3GPP NF (see Note 1).	NF resource utilization analysis
REQ-RES_UTI_ANA-04	MDA capability for resource utilization analysis shall include identifying the 3GPP NFs with low usage of virtualized resources (see Note 2).	NF resource utilization analysis
REQ-RES_UTI_ANA-05	MDA capability for resource utilization analysis shall include identifying the 3GPP NFs with high usage of virtualized resources (see Note 2).	NF resource utilization analysis
REQ-RES_UTI_ANA-06	MDA capability for resource utilization analysis shall include providing the prediction of virtualized resource usage for a 3GPP NF (see Note 2).	NF resource utilization analysis
REQ-RES_UTI_ANA-07	MDA capability for resource utilization analysis shall include providing recommended actions to manage and orchestrate one or more 3GPP NFs. e.g. to orchestrate the resource allocation or load balancing for one or multiple 3GPP NFs.	NF resource utilization analysis

NOTE 1: The requirement is valid only if the subject 3GPP NF uses physical resources.

NOTE 2: The requirement is valid only if the subject 3GPP NF uses virtualized resources.

7.2.7.2 Control plane congestion analysis

7.2.7.2.1 Description

This MDA capability is for analysis of control plane congestion.

7.2.7.2.2 Use case

As described in TS 23.501 [28], a 5GC NF can become overloaded when it is operating over its nominal capacity resulting in diminished performance (including impacts to handling of incoming and outgoing traffic). Some mechanism, such as control plane congestion control as described in TS 23.501 [28] is designed for the purpose of avoiding and handling of 5GC NF overload. For example, as described in clause 5.19.7 of TS 23.501 [28], when the AMF is under overload conditions, it may reject the received request from the UE depending on various aspects. And the UE will send a new request after some time. It is possible that the new request will be rejected again because of the load of the AMF. In virtualized environment, the signaling request may be rejected due to inadequacy of available resources at the target 5GC NF e.g. AMF or SMF. If such situation can not be resolved, it will probably cause signalling storm for the whole network and affect the services (e.g. calls and data connections) provided by the network.

It is desirable to use MDA to assist control plane congestion analysis in order to detect, prevent or resolve identified congestion issue happened at the control plane. MDAS producer may utilize the collected PM, FM, network topology data, virtual resource information provided from ETSI NFV MANO etc. for control plane congestion analysis and provides analytics report containing identified or predicted congestion issue for the target 5GC NF (e.g. AMF, SMF). The analytics report also provides recommended actions to optimize the target 5GC NF for avoiding or resolving congestion issue. Based on the recommendation in the report, 3GPP management system can adjust (e.g., scale-up the virtual resource) the resources to better facilitate processing of the received control plane messages. MDA MnS consumer may need to take further action on control plane congestion issue based on the analytics output from MDAF. The root cause of the congestion issue and the predicted duration of congestion issue may be of interest to the consumer and can be provided in the analytics report.

7.2.7.2.3 Requirements

Table 7.2.7.2.3-1

Requirement label	Description	Related use case(s)
REQ-CP_ANA-01	MDA capability for control plane congestion analysis shall include identifying the 3GPP 5GC NFs with congestion issue.	Control plane congestion analysis
REQ-CP_ANA-02	MDA capability for control plane congestion analysis shall include providing the prediction of congestion issue for a 3GPP 5GC NF.	Control plane congestion analysis
REQ-CP_ANA-03	MDA capability for control plane congestion analysis shall include providing recommended actions to prevent congestion issue for 3GPP 5GC NFs.	Control plane congestion analysis
REQ-CP_ANA-04	MDA capability for control plane congestion analysis shall include providing recommended actions to resolve identified congestion issue for 3GPP 5GC NFs.	Control plane congestion analysis
REQ-CP_ANA-05	MDA capability for control plane congestion analysis should include providing root cause of the congestion issue and the predicted duration of congestion issue.	Control plane congestion analysis

7.2.7.3 Edge application deployment location analysis

7.2.7.3.1 Description

This MDA capability is for analyzing which existing edge data network should be used to deploy an edge application server.

7.2.7.3.2 Use case

With the rapid development of edge computing, an increasing number of applications require deployment at the network edge to meet the demands for low latency, high bandwidth, and localized data processing. However, selecting the optimal edge deployment location is a complex issue that involves considering multiple factors such as QoS requirements, network resource information and UE distribution. Currently, edge application deployment locations primarily rely on operator experience and manual configuration, lacking automated and intelligent decision support. This can lead to deployment location that fail to fully leverage the advantages of edge computing.

The use case aims to utilize MDA analytics capabilities to provide data-driven decision support for selecting which existing edge data network server should be used to deploy an edge application server. MDA can collect and analyse related data (including performance measurement from RAN(e.g. UE throughput, latency, coverage), EDNs connection

information, available EDNs virtual resource information, UE location information, QoE data) to recommend the existing edge data network that best satisfies user experience requirements for deploying an edge application server.

7.2.7.3.3 Requirements

Table 7.2.7.3.3-1

Requirement label	Description	Related use case(s)
REQ-EDGE-APP-LOCATION-01	3GPP management system should provide a capability for edge application deployment location analysis to recommend the location of existing edge data network which is most suitable for deploying an edge application server.	Edge application deployment location analysis

7.2.8 Prediction and statistics of Management data

7.2.8.1 Description

This use case is for the analytics (predictions and statistics) of the management data including 5G PMs defined in TS 28.552 [4] and 5G KPIs defined in TS 28.554 [5].

7.2.8.2 Use case

Certain scenarios might need a prediction or statistics on existing management data, e.g. prediction or statistics of single or multiple PMs and KPIs. The MnS consumer of this use case (who may also be a MnS producer) might be interested in the analytics (statistics or prediction) on existing management data (PMs and KPIs) which can be then consumed to produce services on other use cases such as mobility optimization or load balancing etc. The MnS consumer gets a specific type of prediction or statistics (e.g., mean, standard deviation, correlation, etc.) of specific management data (PMs/KPIs) on network objects.

Statistics of the management data include the statistical calculation on the data themselves over a period in the past and/or statistics of management data following a sliding window procedure to produce statistics. Predictions of management data may include predictions of the data themselves over a future period, and/or predictions of the data following a sliding window procedure.

To monitor the threshold crossings of performance metric values related to specified managed objects, the consumer may firstly configure the performance metric threshold. If the threshold is configured too high or too low or does not change with fluctuation of the actual traffic, there may be alarms generated. The potential correlation information (statistics and/or predictions) may be used to assess the configuration of threshold and possible to support the auto-configuration of the threshold.

With the threshold assessment result, MDA may additionally provide the recommended actions to optimize threshold configuration.

The main objective of this use case is to provide analytics (statistics and/or predictions) on the existing management data.

7.2.8.3 Requirements

Table 7.2.8.3-1

Requirement label	Description	Related use case(s)
REQ-SPM_MDA-01	MDA capability for management data analytics shall be able to produce predictions for the requested management data.	Prediction and statistics of Management data
REQ-SPM_MDA-02	MDA capability for management data analytics shall be able to produce statistics for the requested management data.	Prediction and statistics of Management data
REQ-SPM_MDA-0A	MDA capability for management data analytics should be able to provide the threshold configuration assessment analytics that evaluates the validity of threshold configuration, the analytics should include recommended actions to optimize threshold configuration.	Prediction and statistics of Management data

7.2.9 Correlation analytics of Management data

7.2.9.1 Measurement data correlation analytics for ML model training

7.2.9.1.1 Description

This MDA capability is for correlation analysis of Measurement data.

7.2.9.1.2 Use case

For ML model training, collecting a large volume of measurement data instances does not necessarily enhance training performance. The measurement data collected for ML model training may exhibit high correlation (linear or non-linear), resulting in significant redundancy. Consequently, using the entire dataset for model training can lead to unnecessary consumption of computational resources and energy.

Optimizing training data preparation based on correlation analysis and redundancy information can be very helpful. Correlation analysis can identify redundancy patterns within the measurement data for ML model training, enabling more efficient model training. This may be achieved in the following ways:

- For a given task (e.g. analytics, model training), correlation analysis can identify relationships among the data, resulting in a reduced dataset that can be used for training the ML model. This approach may improve training efficiency while managing the impact on model performance compared to using the full dataset. The analysis may also provide recommendations, such as optimizing data collection for training purposes.

- Regularly updating the correlation analytics may be required, as correlation relationships may evolve over time. This is very useful when there is a recurring need to re-train the ML model.

7.2.9.1.3 Requirements

Table 7.2.9.1.3-1

Requirement label	Description	Related use case(s)
REQ-DATA-CORRELATION-1	MDA capability for data correlation analytics for ML model training should include a capability to provide the measurement data redundancy analysis including which measurement data correlate to which measurement data, the indication of redundancy, and recommendation to optimize training data collection.	Measurement data correlation analytics for ML model training (clause 7.2.9.1)

7.2.9.2 Analytics for NF Scaling and dimensioning

7.2.9.2.1 Description

This MDA capability is for NF Scaling and dimensioning.

7.2.9.2.2 Use case

Performance metrics (performance measurements, KPIs) generated by a Network Function (NF) or related NFs may exhibit correlation and association patterns. These patterns can be leveraged to derive NF(s) correlation or dependency relationships, which are valuable inputs for network performance optimization scenarios such as scaling and dimensioning.

- To facilitate performance optimization scenarios, such as Network Function (NF) or NF group scaling and dimensioning, the management system should provide correlation/association analytics of NF and/or related NFs measurement data, yielding NF dependency/correlation patterns related to scaling and network resource utilization, and generate actionable recommendations for performance optimization, including NF/NF group scaling and dimensioning.
- Correlation analytics may be refreshed regularly as correlation relationships can vary across different locations and time periods.

7.2.9.2.3 Requirements

Table 7.2.9.2.3-1

Requirement label	Description	Related use case(s)
REQ-DATA-CORRELATION-02	MDA capability for correlation analytics for NF scaling and dimensioning should include the capability for NF dependency/correlation pattern recognition with respect to NF(s) scaling or NF resource usage for dimensioning.	Analytics for NF Scaling and dimensioning (clause 7.2.9.2)
REQ-DATA-CORRELATION-03	MDA capability for correlation analytics for NF scaling and dimensioning should be able to provide recommendations for NF(s) scaling and dimensioning optimization in a coordinated manner.	Analytics for NF Scaling and dimensioning (clause 7.2.9.2)

7.2.10 Traffic Steering Analytics

7.2.10.1 Description

This MDA capability is for the analytics on the usage of ATSSS and N4 rules and provide recommendations on most suitable ATSSS/N4 rules based on the analytics and predictions performed.

7.2.10.2 Use case

ATSSS feature introduced the concept of Multi Access PDU session, a PDU session for which the data traffic can be served over one or more concurrent accesses (3GPP access, trusted non-3GPP access and untrusted non-3GPP access). Using these services, the UE can access 5G services via 3GPP/non-3GPP access methods.

After the establishment of a MA PDU Session, and when there are user-plane resources on both access networks, the UE applies network-provided policy (i.e. ATSSS rules) and considers local conditions (such as network interface availability, signal loss conditions, user preferences, etc.) for deciding how to distribute the uplink traffic across the two access networks. Similarly, the UPF anchor of the MA PDU session applies network-provided policy (i.e. N4 rules) and feedback information received from the UE via the user-plane (such as access network Unavailability or Availability) for deciding how to distribute the downlink traffic across the two access networks. When there are user-plane resources on only one access network, the UE applies the ATSSS rules and considers local conditions for triggering the establishment or activation of the user plane resources over another access.

In order to optimally steer the traffic across different accesses and based on the load conditions, the network derives a set of rules that are communicated to UE (ATSSS rules) and UPF (N4 rules) as guidance on how to steer the traffic under certain conditions. The PCF derives the ATSSS policy and sends it to SMF in case of dynamic PCC (policy and charging control) enabled. SMF then converts it to ATSSS rules for UEs (UL traffic) and N4 rules for the UPF (DL traffic). These rules are then enforced by the UPF in DL and by the UE in UL to send the PDU packets. The rules contain thresholds values for selection of certain access types including the instruction of which steering modes to be used. If the PCC is not used, then the rules are framed by the SMF based on the local configurations. The structure of the ATSSS rules is described in the table 5.32.8-1 of TS 23.501 [28].

The network derives these rules only based on immediate performance measurements (e.g. RTT and packet loss) and local configuration at SMF. i.e. besides considering the radio link performance data, the traffic steering analytics solution derives traffic steering decisions based on the Quality of Service or Quality of Experience (QoS/E) characteristics of the related service at the UE. The rules do not capture holistic view on the past network traffic trends, the history, and trends of the performance measurements (RTT and packet loss) from the past and situation on different accesses, ATSSS/N4 rules usage statistics, impact on available accesses, nor the predictions of the network behaviour in the future. Therefore, the derived rules may be suboptimal and may lead to network degradation. The MDA can predict the optimal rules and the consumer (e.g. UPF or SMF) decides to apply these rules for the MAPDU sessions.

7.2.10.3 Requirements

Table 7.2.10.3-1

Requirement label	Description	Related use case(s)
REQ-TRF_STR_MDA-01	MDA capability for traffic steering analytics shall be able to produce recommendations on ATSSS rules and N4 rules and their precedence for a (set of) network slice(s) or network slice subnet(s).	Traffic Steering Analytics

7.3 MDA MnS

7.3.1 MDA request and control

7.3.1.1 Description

The MDA request and control allow any authorized MDA MnS consumer to request management data analytics.

7.3.1.2 Use case

The MDA MnS consumer can request the MDA MnS producer to provide MDA output for a list of specified MDA type of analytics, i.e. MDA type, which corresponds to an MDA capability, which is to support analytics for a set of data or analytics for a certain PM, KPI, trace or QoE data. The MDA MnS consumer may introduce control attributes related to the MDA output with respect to the geographical location (i.e. area scope) and/or the target objects, e.g. managed elements, time schedule for obtaining an MDA output, time conditions related to the preparation of MDA output (i.e. time schedule for start, end and duration of analytics, etc.), and potential filter conditions to be met before an MDA output is made available, e.g. load or delay threshold crossing related to a target object. The geographical location indicates an area of interest for obtaining MDA output and/or target objects include affected objects or objects of interest for obtaining MDA output.

The MDA MnS consumer may control the MDA output attributes related to, e.g. time schedule, geographical location, target objects, etc., and has the capability to modify them at any point in time. The MDA MnS consumer can request the MDA MnS producer to generate an MDA output that contains numeric output results, e.g. average, normal distribution, etc., recommendation options, e.g. potential handover target cells, or root cause analysis, e.g. alarm prediction.

The MDA MnS consumer can be informed with an acknowledgment if the request was successful. If the request was not successful, the consumer is informed about potential errors indicating the reasons. The attributes related to time can provide the flexibility to configure the MDA reporting control to provide analytics indefinitely. The MDA MnS consumer should delete the MDA request MOI after the requested analytics has been performed. The MDA MnS consumer can also deactivate the MDA reporting control request once it is no longer needed.

7.3.1.3 Requirements

Table 7.3.1.3-1

Requirement label	Description	Related use case(s)
REQ-MDA-CONT-01	The MDA MnS producer shall have the capability to allow any authorized MDA MnS consumer to request MDA output, while indicating its selection on the MDA type.	**All use cases**
REQ-MDA-CONT-02	The MDA MnS producer shall have the capability to allow any authorized MDA MnS consumer to request MDA output, while indicating its selection on the reporting time schedule.	**All use cases**
REQ-MDA-CONT-03	The MDA MnS producer shall have the capability to allow any authorized MDA MnS consumer to request MDA output, while indicating its selection on geographic location and/or the target objects if applicable.	**All use cases**
REQ-MDA-CONT-04	The MDA MnS producer shall have the capability to allow any authorized MDA MnS consumer to request MDA output, while indicating its selection on the time schedule related to specific part of MDA results.	**All use cases**
REQ-MDA-CONT-05	The MDA MnS producer shall have the capability to allow any authorized MDA MnS consumer to modify the attributes related to the requested MDA output.	**All use cases**
REQ-MDA-CONT-6	The MDA MnS producer shall have the capability to allow any authorized MDA MnS consumer to specify filter conditions on target objects based on threshold crossing for MDA output when this is applicable.	**All use cases**

7.3.2 Obtaining MDA Output

7.3.2.1 Description

Following a successful MDA request any authorized MDA MnS consumer can obtain management data analytics from the corresponding MDA MnS producer. The MDA MnS consumer can control the MDA output by modifying the attributes related to the MDA request at any point in time.

7.3.2.2 Use case

The MDA MnS producer allow consumers to obtain MDA output when the conditions indicated in the MDA request are met. The level of details and granularity of MDA output results would depend on the MDA request and nature of MDA capability. Therefore an MDA output can vary in complexity and may contain one or more MDA results, which may be:

i) numeric, e.g. average, etc.;

ii) recommendation options, e.g. potential handover target cells; or

iii) root cause analysis, e.g. alarm prediction.

These results may be related to one or more MDA types, which correspond to MDA capabilities, and can also contain information regarding the time schedule or the validity time of the provided MDA output.

MDA MnS producer may allow consumers to request and obtain different MDA output results. The MDA MnS producer may also allow consumers to obtain information regarding the geographical location and/or the target objects, e.g. managed elements, related to the provided MDA result - from the corresponding element.

The MDA MnS producer may allow consumers options to obtain MDA output results either by pulling or pushing mechanisms. Any MDA output may be obtained once it is prepared or when the specified MDA request and control conditions are met.

7.3.2.3 Requirements

Table 7.3.2.3-1

Requirement label	Description	Related use case(s)
REQ-MDA_REP-01	The MDA MnS producer shall have a capability allowing MDA MnS consumers to obtain analytics output per the MDA request.	**All use cases**
REQ-MDA_REP-02	The MDA MnS producer shall have a capability allowing MDA MnS consumers to indicate if produced analytics output shall be pushed to the MDA MnS consumer or whether the MDA MnS consumer pulls the data.	**All use cases**
REQ-MDA_REP-03	The MDA MnS producer shall allow MDA MnS consumer to obtain the geographical location and/or the target objects related to the MDA output if applicable.	**All use cases**
REQ-MDA_REP-04	The MDA MnS producer shall allow MDA MnS consumer to obtain time schedule information related to the MDA output.	**All use cases**

7.3.3 Filtering analytics recommendations

7.3.3.1 Description

The MDA MnS consumer may configure the MDA request in the MDA MnS producer to avoid providing recommendation on certain entities.

7.3.3.2 Use Case

When MDA provides prescriptive recommendations, the recommendations may include actions targeted towards entities for which the MDA MnS consumer cannot execute actions.

In some cases, this may cause erroneous behaviour. As an example, ACCL (Assurance Closed Control Loop) may receive recommendations from MDA which are in conflict with the ACCL "CLDisallowedList" indicating the objects for which the ACCL should not take any actions. If ACCL is only able to act on a subset of the recommendations received from MDA, ACCL will not be able to implement the full change as recommended by MDA. This could result in an incomplete solution to an issue. At worst, this could cause imbalance or oscillation within the network.

As another example, the recommendations provided by EnergySavingAnalysis may recommend multiple changes across the network which are intended to balance the network load as efficiently as possible to reduce energy usage. However, the MDA MnS consumer may not be authorized to change/configure all of the recommended RAN and/or CN nodes. This is unlikely to attain the expected reduction in energy usage and may cause imbalanced traffic in the network.

These problems may be avoided if the MDA MnS consumer could specify a set of objects for which no actions can be taken and thus no recommendations should be provided. The MDA MnS consumer could also indicate the objects, for which it does not want to receive recommendations, based on a geographical area. Recommendations should not be provided for the object(s) in that geographical area.

7.3.3.3 Requirements

Table 7.3.3.3-1

Requirement label	Description	Related use case(s)
REQ-MDA_FILT-01	The MDA MnS producer shall have a capability to allow an authorized MDA MnS consumer to indicate the scope for which no recommendations shall be included in the analytics report.	**All use cases**

8 Data definitions for MDA capabilities

8.1 Introduction

8.1.1 MDA Types

The output of MDA can be related to a particular capability as described in clause 7, where an MDA type can indicate a specific MDA capability corresponding to a predefined use case(s).

The MDA capabilities may also support analytics of a set of data or analytics for certain PMs, KPIs, trace data, QoE or other type of data. Analytics related to the set of data relies on multiple raw, or already processed input data enabling an MDA MnS producer to provide more complex MDA output. Analytics related to certain set of data including PMs, KPIs, trace or QoE data may rely on these specific categories of data.

MDA MnS consumers may request and obtain output for MDA types related to analytics of a set of data or analytics for certain PMs, KPIs, trace or QoE data.

8.2 About analytics

8.2.1 About enabling data

Analytics are capability-specific, and the present document provides the enabling data for each MDA capability in the respective tables. It is not restrictive or mandatory to use the analytics inputs exactly the same as the provided enabling data (including historical and current data) for implementation, and other (additional or different) data are also allowed in order to facilitate the production of analytics outputs.

8.2.2 About analytics outputs

For analytics outputs, there are:

1) common information elements that can be generated by MDA and be applicable for all MDA capabilities;
2) capability-specific information elements; and
3) optionally, vendor specific extensions.

The common information elements are provided in clause 8.3, and the capability-specific information elements are provided per MDA capability in clause 8.4 of the present document. The properties of “isReadable”, “isWritable”, “isInvariant”, “isNotifyable” for the Information elements in Analytics output follow the definition for `mDAOutputIEValue` in clause 9.4.6.2.

8.3 Common information elements of analytics outputs

8.3.0 General

There are some information elements that are common for all analytics outputs and MDA capabilities, i.e. these common information elements form a subset of all analytics outputs of all MDA capabilities.

8.3.1 Common information element definitions

The common information elements of the analytics outputs are defined in Table 8.3.1-1.

Table 8.3.1-1: Common information elements of analytics outputs

Information element	Definition	Support qualifier	Properties
analyticsId	The identifier of the analytics output.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
analyticsOutputGeneration Time	It indicates the time when the analytics output is generated.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.4 Data definitions per MDA capability

8.4.1 Coverage related analytics

8.4.1.1 Coverage problem analysis

8.4.1.1.1 MDA type

The MDA type for coverage problem analysis is: CoverageAnalytics.CoverageProblemAnalysis.

8.4.1.1.2 Enabling data

The enabling data for CoverageAnalytics.CoverageProblemAnalysis MDA type are provided in table 8.4.1.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.1.1.2-1: Enabling data for coverage problem analysis

Data category	Description	References
Performance measurements	SS-RSRP distribution per SSB (beam) of serving NR cell	SS-RSRP distribution per SSB (clause 5.1.1.22.1 of TS 28.552 [4]).
	SS-RSRP distribution per SSB (beam) of neighbor NR cell	SS-RSRP distribution per SSB of neighbor NR cell (clause 5.1.1.22.2 of TS 28.552 [4])
	RSRP distribution of neighbor E-UTRA cell for an NR cell	RSRP distribution per neighbor E-UTRAN cell (clause 5.1.1.22.3 of TS 28.552 [4])
	Power headroom distribution for NR cell	Type 1 power headroom distribution (clause 5.1.1.26.1 of TS 28.552 [4]).
	Wideband CQI distribution for NR cell	Wideband CQI distribution (clause 5.1.1.11.1 of TS 28.552 [4]).
	Timing Advance distribution for NR cell	Timing Advance distribution for NR Cell (clause 5.1.1.33.1 of TS 28.552 [4])
	Number of UE Context Release Request (gNB-DU initiated)	Number of UE Context Release Request (gNB-DU initiated) (clause 5.1.3.5.1 of TS 28.552 [4]).
	Number of UE Context Release Request per SSB (gNB-DU initiated)	Number of UE Context Release Request (gNB-DU initiated) (clause 5.1.3.5.1 of TS 28.552 [4]).
	Number of UE Context Release Requests (gNB-CU initiated)	Number of UE Context Release Request (gNB-CU initiated) (clause 5.1.3.5.2 of TS 28.552 [4]).

Data category	Description	References
	Number of UE Context Release Requests per SSB (gNB-CU initiated)	Number of UE Context Release Request (gNB-CU initiated) (clause 5.1.3.5.2 of TS 28.552 [4]).
	RSRP related measurements for ng-eNB	RSRP related measurements (clause 6.1 of TS 32.425 [12]).
	UE power headroom related measurements for ng-eNB	UE power headroom related measurements (clause 6.3 of TS 32.425 [12]).
	Wideband CQI distribution for ng-eNB	Wideband CQI distribution (clause 4.10.1.1 of TS 32.425 [12]).
	Average sub-band CQI for ng-eNB	Average sub-band CQI (clause 4.10.1.2 of TS 32.425 [12]).
	UE Rx - Tx time difference related measurements for ng-eNB	UE Rx - Tx time difference related measurements (clause 6.4 of TS 32.425 [12]).
	AOA related measurements for ng-eNB	AOA related measurements (clause 6.5 of TS 32.425 [12]).
	Timing Advance distribution for ng-eNB	Timing Advance Distribution (clause 4.10.2 of TS 32.425 [12]).
	Number of UE CONTEXT Release Request initiated by ng-eNodeB	Number of UE CONTEXT Release Request initiated by eNodeB/RN (clause 4.1.5.1 of TS 32.425 [12]).
MDT reports	MDT reports containing RSRPs of the serving cell and neighbour cells, and UE location.	RSRPs and UE location of M1 measurements for NR in TS 32.422 [6] and TS 32.423 [7].
RLF reports	RLF reports containing RSRPs of the last serving cell and neighbour cells, and UE location.	RLF data collection and RLF reporting in TS 32.422 [6], and rlf-Report-r16 in TS 38.331 [13].
RCEF reports	RCEF reports containing RSRPs of NR cell where the RRC connection establishment failed and neighbour cells, and UE location.	RCEF data collection and RCEF reporting in TS 32.422 [6], and ConnEstFailReport-r16 in TS 38.331 [13].
RRC reports	RRC reports containing RSRPs of the last serving cell and neighbour cells, and UE location.	RRC data collection and RRC reporting in TS 32.422 [6].
UE location reports	UE location information provided by the LMF services which can be used to correlate with the MDT reports.	The UE location information provided by LMF via service-based interface (see TS 23.273 [14]).
Geographical data	The geographical information (longitude, latitude, altitude) of the deployed RAN (NG-RAN and E-UTRAN).	The geographical information (longitude, latitude, altitude) information (see the peeParametersList attribute of the ManagedFunction IOC in TS 28.622 [19]).
Configuration data	The NRMs containing the attributes affecting the coverage for (NG-RAN and E-UTRAN).	`NRCellDU` IOC, `NRSectorCarrier` IOC, BWP IOC, `CommonBeamformingFunction` IOC, and `Beam` IOC in TS 28.541 [15]; `EUtranGenericCell` IOC in TS 28.658 [16]; `SectorEquipmentFunction` IOC, `AntennaFunction` IOC, and `TMAFunction` IOC in TS 28.662 [17].

8.4.1.1.3 Analytics output

The specific information elements of the analytics output for coverage problem analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.1.1.3-1.

Table 8.4.1.1.3-1: Analytics output for coverage problem analysis

Information element	Definition	Support qualifier	Properties
coverageProblemId	The identifier of the coverage problem.	M	type: String multiplicity: 1

Information element	Definition	Support qualifier	Properties
			isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
coverageProblemType	Indication of type of the coverage Problem. allowedValues: WEAK_COVERAGE, COVERAGE_HOLE, PILOT_POLLUTION, OVERSHOOT_COVERAGE, DL_ULCHANNEL_COVERAGE_MISMATCH, OTHER.	M	type: enumeration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
coverageProblemAreas	Geographical location areas where the coverage problem occurred.	O	type: GeoArea (see TS 28.622 [19]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
problematicCells	The CGIs of cells where the coverage problem occurred.	M	type: Integer multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
recommendedActions	The recommended actions to solve the coverage problem. The recommended action may be (but not limited to): - creation of new beam(s), or cell(s); - change the transmission power of the NR sector carrier; - delete some unwanted beam(s) or cell(s).	M	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
radioEnvironmentMap	The graphical description of the observed radio coverage characteristics. The graphic may be for the RSRP or SINR of the selected cluster of cells mapped against the physical geographical information (longitude, latitude, altitude) of the area where the RAN (NG-RAN and E-UTRAN) cells are deployed.	O	type: RadioEnvironmentMap multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
cellConfigurations	The cell configurations for a new cell or reconfigurations of existing cells derived based on the characteristics in the radioEnvironmentMap. The cell configurations are the changes to the NRMs attributes affecting the cell coverage (NG-RAN and E-UTRAN). Allowed values: attribute name and values as defined in one of the following: `NRCellDU` IOC, `NRSectorCarrier` IOC, `BWP` IOC, `CommonBeamformingFunction` IOC, and `Beam` IOC in TS 28.541 [15]; `EUtranGenericCell` IOC in TS 28.658 [16]; `SectorEquipmentFunction` IOC,	O	type: AttributeValuePair multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Information element	Definition	Support qualifier	Properties
	`AntennaFunction` IOC, and `TMAFunction` IOC in TS 28.662 [17].		

8.4.1.2 Paging Optimization

8.4.1.2.1 MDA type

The MDA type for Capability-Paging Optimization: CoverageAnalytics.PagingOptimization.

8.4.1.2.2 Enabling data

The enabling data for paging optimization are provided in table 8.4.1.2.2-1.

Table 8.4.1.2.2-1: Enabling data for Paging Optimization Analysis

Data category	Description	References
MDT reports	MDT reports indicating UE location information	MDT measurements defined in TS 32.422 [6] and TS 32.423 [7].
Performance measurements	Measurement for 5G Paging from AMF	See clause 5.2.5.2 in TS 28.552 [4].

8.4.1.2.3 Analytics output

The specific information elements of the analytics output for paging optimization, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.1.2.3-1.

Table 8.4.1.2.3-1: Analytics output for paging optimization analysis

Information element	Definition	Support qualifier	Properties
oOCDuration	This specify the time window during which UE is out-of-coverage.	M	type: ProjectionDuration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
oOCLocation	This specifies the last known location of the UEs before it goes out-of-coverage. This would be within the area indicated by the "areaScope" of the MDA request.	CM	type: GeoCoordinate multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
oOCMap	This specifies the geographical region within which the paging issues are experienced by a group of UEs. This would be within the area indicated by the "areaScope" of the MDA request.	CM	type: GeoArea (see TS 28.622 [19]) multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.2 SLS analysis

8.4.2.1 Service experience analysis

8.4.2.1.1 MDA type

The MDA type for Capability-Service experience analysis is: SLSAnalysis.ServiceExperienceAnalysis.

8.4.2.1.2 Enabling data

The enabling data for SLSAnalysis.ServiceExperienceAnalysis MDA type are provided in table 8.4.2.1.2-1.

Table 8.4.2.1.2-1: Enabling data for service experience analysis

Data category	Description	References
Performance measurements	Average e2e uplink/downlink delay for a network slice	Average e2e uplink/downlink delay for a network slice (in clause 6.3.1.8 in TS 28.554 [5]).
	Integrated uplink/downlink delay in RAN	Integrated downlink delay in RAN (clause 6.3.1.2 in TS 28.554 [5]); Integrated uplink delay in RAN (clause 6.3.1.7 in TS 28.554 [5]).
	Round-trip packet delay	Round-trip packet delay between PSA UPF and NG-RAN (clause 5.4.8 in TS 28.552 [4]).
	UL/DL throughput for network and Network Slice Instance	Upstream throughput for network and Network Slice Instance (clause 6.3.2 in TS 28.554 [5]); Downstream throughput for Single Network Slice Instance (clause 6.3.3 in TS 28.554 [5]).
	RAN UE Throughput	RAN UE Throughput (clause 6.3.6 in TS 28.554 [5])
	Throughput at N3 interface	Upstream Throughput at N3 interface (clause 6.3.4 in TS28.554 [5]); Downstream Throughput at N3 interface (clause 6.3.5 in TS28.554 [5]).
QoE Data	The QoE data of the different services	QoE data (TS 26.247 [22] and TS 26.114 [23] can be acquired through the procedures defined in TS 28.405 [8]).

8.4.2.1.3 Analytics output

The specific information elements of the analytics output for service experience analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.1.3-1.

Table 8.4.2.1.3-1: Analytics output for Service experience analysis

Information element	Definition	Support qualifier	Properties
serviceExperienceId	The identifier indicates the analytics report is related with service experience analysis.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
serviceInformation	This field include the service information related to this analysis such as service name. See NOTE 1.	O	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
serviceExperienceIssueType	Indication of the service experience issue type. allowedValues: - RAN_ISSUE; - CN_ISSUE; - OTHER_ISSUE	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
affectedObjects	The managed object instances where the service experience is applicable, e.g. SubNetwork Instance, NetworkSlice Instance, NetworkSlice subnetwork Instance. The subset values of this field may be different due to cross domain management and domain management.	O	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
serviceExperienceStatistics	The statistics of the level of service experience for a service in a certain time period, e.g. there are five levels which are represented by 1, 2, 3, 4, 5 where level 1 represents the users are enduring bad experience while level 5 represents the users' requirements are perfectly satisfied. allowedValues:LEVEL_1, LEVEL_2, LEVEL_3, LEVEL_4, LEVEL_5	O	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
serviceExperiencePredictions	The predictions of the level of service experience for a service in a certain time period.	O	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
NOTE 1: This field of serviceInformation is used for MDA MnS producer to include the names of e2e services (e.g., browsing, video streaming etc.) and detail information (specific information of an e2e service).			

8.4.2.2 Network slice throughput analysis

8.4.2.2.1 MDA type

The MDA type for Capability-Network slice throughput analysis is: SLSAnalysis.NetworkSliceThroughputAnalysis.

8.4.2.2.2 Enabling data

The enabling data for SLSAnalysis.NetworkSliceThroughputAnalysis MDA type are provided in table 8.4.2.2.2-1.

Table 8.4.2.2.2-1: Enabling data for network slice throughput analysis

Data category	Description	References
Performance measurements	UL/DL throughput for network and Network Slice Instance	Upstream throughput for network and Network Slice Instance as defined in clause 6.3.2 in TS 28.554 [5]; Downstream throughput for Single Network Slice Instance as defined in clause 6.3.3 in TS 28.554 [5].
	RAN UE Throughput	RAN UE Throughput as defined in clause 6.3.6 in TS 28.554 [5].
	Throughput at N3 interface	Upstream Throughput at N3 interface as defined in clause 6.3.4 in TS 28.554 [5]; Downstream Throughput at N3 interface as defined in clause 6.3.5 in TS 28.554 [5].

8.4.2.2.3 Analytics output

The specific information elements of the analytics output for network slice throughput analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.2.3-1.

Table 8.4.2.2.3-1: Analytics output for network slice throughput analysis

Information element	Definition	Support qualifier	Properties
networkSliceThroughputAnalysisId	Network slice throughput analysis identifier	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceThroughputIssueType	Indication of the network slice throughput issue type allowedValues: NONE, RAN_ISSUE, CN_ISSUE, BOTH_RAN_CN_ISSUE	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceThroughputUserStatistics	The statistics of the UL and/or DL network slice throughput in a certain time period. The value indicates the average percentage of users, for which the required SLS throughput is met. allowedValues: 0 to 100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceThroughputTimeStatistics	The statistics of the UL and/or DL network slice throughput in a certain time period. The value indicates the average percentage of time, during which the required SLS throughput is met. allowedValues: 0 to 100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceThroughputUserPredictions	The predictions of the UL and/or DL network slice throughput in a certain time period. The value indicates the average percentage of users, for which the required SLS throughput is predicted to be met. allowedValues: 0 to 100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceThroughputTimePredictions	The predictions of the UL and/or DL network slice throughput in a certain time period. The value indicates the average percentage of time, during which the required SLS throughput is predicted to be met. allowedValues: 0 to 100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.4.2.3 Network slice traffic prediction

8.4.2.3.1 MDA type

The MDA type for capability Network slice traffic prediction is: SLSAnalysis.NetworkSliceTrafficAnalysis.

8.4.2.3.2 Enabling data

The enabling data for SLSAnalysis.NetworkSliceTrafficAnalysis MDA type are provided in table 8.4.2.3.2-1.

Table 8.4.2.3.2-1: Enabling data for network slice traffic prediction analysis

Data category	Description	References
Performance measurements	UL/DL throughput for network slice.	Upstream throughput for network and Network Slice Instance (clause 6.3.2 in TS 28.554 [5]); Downstream throughput for Single Network Slice Instance (clause 6.3.3 in TS 28.554 [5]).
	Number of incoming and outgoing octets of GTP packet on N3	See clauses 5.4.1.4 and 5.4.1.3 in TS 28.552 [4]).
	UL/DL UE throughput for network slice	RAN UE Throughput (clause 6.3.6 in TS 28.554 [5]).
	Number of PDU sessions of network slice	Mean number of PDU sessions of network and network Slice Instance (clause 6.4.1 in TS 28.554 [5]).
	Number of registered subscribers of a network slice instance	Mean registered subscribers of network and network slice through AMF (see clause 6.2.1 in TS 28.554 [5]).
	Maximum packet size for a network slice	Maximum packet size for a network slice (see clause 6.3.11 of TS 28.541 [15]).

8.4.2.3.3 Analytics output

The specific information elements of the analytics output for network slice traffic prediction analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.3.3-1.

Table 8.4.2.3.3-1: Analytics output for network slice traffic prediction analysis

Information element	Definition	Support qualifier	Properties
trafficProjections	This specifies the traffic projections for a slice.	M	type: TrafficProjections multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.2.4 E2E latency analysis

8.4.2.4.1 MDA type

The MDA type for Capability-E2E latency analysis is: SLSAnalysis.E2ElatencyAnalysis.

8.4.2.4.2 Enabling data

The enabling data for SLSAnalysis.E2ElatencyAnalysis MDA type are provided in table 8.4.2.4.2-1.

Table 8.4.2.4.2-1: Enabling data for E2E latency analysis

Data category	Description	References
Performance measurements	Average e2e UL/DL delay for a network slice	Average e2e uplink delay for a network slice (clause 6.3.1.8.1 in TS 28.554 [5]); Average e2e downlink delay for a network slice (clause 6.3.1.8.2 in TS 28.554 [5]).
	Integrated uplink/downlink delay in RAN	Integrated downlink delay in RAN (clause 6.3.1.2 in TS 28.554 [5]); Integrated uplink delay in RAN (clause 6.3.1.7 in TS 28.554 [5]).
	Round-trip Packet Delay	Round-trip packet delay between PSA UPF and NG-RAN (clause 5.4.8 TS 28.552 [4]).

8.4.2.4.3 Analytics output

The specific information elements of the analytics output for E2E latency analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.4.3-1.

Table 8.4.2.4.3-1: Analytics output for E2E latency analysis

Information element	Definition	Support qualifier	Properties
e2ELatencyIssueId	The identifier indicates the output is for E2E latency issue analysis	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
e2ELatencyIssueType	Indication the type of the E2E latency issue. allowedValues: RAN_LATENCY_ISSUE, CN_LATENCY_ISSUE	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
affectedObjects	The managed object instances of subnetwork, managed elements or network slices where the latency issue happens	O	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.2.5 Network slice load analysis

8.4.2.5.1 MDA type

The MDA type for Capability- Network slice load analysis is: SLSAnalysis.NetworkSliceLoadAnalysis.

8.4.2.5.2 Enabling data

The enabling data for SLSAnalysis.NetworkSliceLoadAnalysis MDA type are provided in table 8.4.2.5.2-1.

Table 8.4.2.5.2-1: Enabling data for network slice load analysis

Data category	Description	References
Performance measurements	Number of PDU sessions of network slice	Mean number of PDU sessions of network and network Slice Instance (clause 6.4.1 in TS 28.554 [5]).
	Number of PDU Sessions successfully setup	Number of PDU Sessions successfully setup (clause 5.1.1.5 in TS28.552 [4]).
	Mean Number of PDU sessions	Number of PDU sessions (Mean) (clause 5.3.1.1 in TS 28.552 [4]).
Network Data Analytics	Analysis results from the control plane produced by NWDAF	Analytics data from NWDAF in TS 23.288 [10] including e.g. Slice load level related network data analytics clause 6.3, and the analytics for user plane performance (i.e. average/maximum traffic rate, average/maximum packet delay, average packet loss rate in clause 6.14.
Configuration data	MOIs of the cells, NW slice/NW slice subnet, 5GC NFs	NRM information TS 28.541 [15].

8.4.2.5.3 Analytics output

The specific information elements of the analytics output for network slice load analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.5.3-1.

Table 8.4.2.5.3-1: Analytics output for network slice load analysis

Information element	Definition	Support qualifier	Properties
networkSliceLoadIssueId	The identifier indicates the output is for Network slice instance load analysis	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceLoadIssueDomain	Indicates the domain of the network slice instance load issue allowedValues: - RAN_ISSUE; - CN_ISSUE	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceLoadIssuePhase	Indicates the phase of the network slice instance load issue allowedValues: HISTORIC_NETWORK_SLICE_LOAD_ISSUE , ONGOING_NETWORK_SLICE_LOAD_ISSUE , POTENTIAL_NETWORK_SLICE_LOAD_ISSUE	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
networkSliceLoadIssueType	Indicates the type of the network slice instance load issue allowedValues: OVERLOAD_NETWORK_SLICE_LOAD_ISSUE, UNDERUTILIZED_NETWORK_SLICE_LOAD_ISSUE	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
affectedObjects	The managed object instances involved in the network slice instance load problem	O	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
networkSliceLoadDistribution	Describes the detailed load distribution or predictive distribution, e.g. load distribution for a network slice instance at a certain location or in a certain time period	O	type: Integer multiplicity: * isOrdered: True isUnique: False defaultValue: None isNullable: False

8.4.2.6 UE throughput analysis

8.4.2.6.1 MDA type

The MDA type for UE throughput analysis is: UEThroughputAnalysis.TrafficCongestionProblemAnalysis.

8.4.2.6.2 Enabling data

The enabling data for UEThroughputAnalysis.TrafficCongestionProblemAnalysis MDA type are provided in table 8.4.2.6.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.2.6.2-1: Enabling data for Traffic Congestion Problem analysis

Data category	Description	References
Performance measurements	UE Throughput	UE Throughput including DL and UL throughput in gNB (clause 5.1.1.3 in TS 28.552 [4])
	Radio resource utilization	Radio resource utilization including DL and UL PRB usage (clause 5.1.1.2 in TS 28.552 [4])
	RRC connection number	RRC connection number (clause 5.1.1.4 in TS 28.552 [4])
MDT reports	MDT reports containing RSRPs of the serving cell and neighbour cells, and UE location.	RSRPs and UE location of M1 measurements for NR in TS 32.422 [6] and TS 32.423 [7].
Geographical data	The geographical information (longitude, latitude, altitude) of the deployed RAN.	The geographical information (longitude, latitude, altitude) information (see the peeParametersList attribute of the ManagedFunction IOC in TS 28.622 [19]).

8.4.2.6.3 Analytics output

The specific information elements of the analytics output for traffic congestion problem analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.6.3-1.

Table 8.4.2.6.3-1: Analytics output for Traffic Congestion Problem analysis

Information element	Definition	Support qualifier	Properties
trafficCongestionId	The identifier indicates the analytics report is related with UE throughput analysis.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trafficCongestionType	Traffic congestion type including Non-regular traffic congestion and regular traffic congestion. allowedValues: - NON_REGULAR_TRAFFIC_CONGESTION - REGULAR_TRAFFIC_CONGESTION	O	type: ENUM multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
timeDuration	It indicates the time duration related to a traffic congestion	O	type: TimeWindow multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trafficCongestionAreas	Geographical location areas where the congestion occurred.	O	type: GeoArea (see TS 28.622 [19]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Information element	Definition	Support qualifier	Properties
severityLevel	This field holds the value to indicate relative level of the congestion. allowedValues: SLIGHT CONGESTION, MODERATE CONGESTION, SEVERE CONGESTION	O	type: ENUM multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
recommendedActions	This field holds the recommended actions to recovery. The recommended action may be (but not limited to): change the mobility parameters (e.g. MRO or LBO) or antenna RF parameters (e.g. CCO) such as downtilt and azimuth	O	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.2.7 Edge computing performance analysis

8.4.2.7.1 MDA type

The MDA type for Edge computing performance analysis is: SLSAnalysis.EdgeComputingPerformanceAnalysis.

8.4.2.7.2 Enabling data

The enabling data for SLSAnalysis.EdgeComputingPerformanceAnalysis MDA type are provided in table 8.4.2.7.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.2.7.2-1: Enabling data for edge computing performance analysis

Data category	Description	References
Performance measurements	Packet Delay on air-interface	Average delay DL air-interface(clause 5.1.1.1.1 TS 28.552 [4]);(Average delay UL on over-the-air interface(clause 5.1.1.1.3 TS 28.552 [4])
	Round-trip GTP Data Packet Delay on N3 interface	Round-trip delay on a N3 interface on PSA UPF(see clause 5.4.1.9 in TS 28.552 [4])
	GTP packets delay in UPF	GTP packets delay within the PSA UPF(see clause 5.4.5 in TS 28.552[4]).
	Round-trip Packet Delay	Round-trip packet delay between PSA UPF and NG-RAN (see clause 5.4.8 in TS 28.552 [4]).
	Integrated uplink/downlink delay in RAN	Integrated downlink delay in RAN (clause 6.3.1.2 in TS 28.554 [5]); Integrated uplink delay in RAN (see clause 6.3.1.7 in TS 28.554 [5]).
UE location reports	UE location information provided by the LMF services which can be used to correlate with the MDT reports.	The UE location information provided by LMF via service-based interface (see TS 23.273 [14]).
EAS Service location	It defines the location where the EAS service should be available	requiredEASservingLocation (see clause 7.3.3.6 in TS 28.538 [32]).

8.4.2.7.3 Analytics output

The specific information elements of the analytics output for edge computing performance analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.8.3-1.

Table 8.4.2.7.3-1: Analytics output for edge computing performance analysis

Information element	Definition	Support qualifier	Properties
UE2EASLatency	It indicates the estimated latency between UE and EAS. Expressed in milliseconds	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A isNullable: False

8.4.2.8 Edge application deployment location analysis

8.4.2.8.1 MDA type

The MDA type for Edge application deployment location analysis is: SLSAnalysis.EdgeApplicationDeploymentLocationAnalysis.

8.4.2.8.2 Enabling data

The enabling data for SLSAnalysis.EdgeApplicationDeploymentLocationAnalysis MDA type are provided in table 8.4.2.8.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.2.8.2-1: Enabling data for edge application deployment location

Data category	Description	References
Performance measurements	Packet Delay on air-interface	Average delay DL air-interface (clause 5.1.1.1.1 TS 28.552 [4]); (Average delay UL on over-the-air interface (clause 5.1.1.1.3 TS 28.552 [4])
	Round-trip Packet Delay	Round-trip packet delay between PSA UPF and NG-RAN (clause 5.4.8 TS 28.552 [4]).
	Registered subscribers measurement	Registered subscribers measurement as defined in clause 5.2.1 in Ts 28.552[4]
	Integrated uplink/downlink delay in RAN	Integrated downlink delay in RAN (clause 6.3.1.2 in TS 28.554 [5]); Integrated uplink delay in RAN (clause 6.3.1.7 in TS 28.554 [5]).
	UL/DL throughput for network and Network Slice Instance	Upstream throughput for network and Network Slice Instance as defined in clause 6.3.2 in TS 28.554 [5]; Downstream throughput for Single Network Slice Instance as defined in clause 6.3.3 in TS 28.554 [5].
	RAN UE Throughput	RAN UE Throughput as defined in clause 6.3.6 in TS 28.554 [5].
	Throughput at N3 interface	Upstream Throughput at N3 interface as defined in clause 6.3.4 in TS 28.554 [5]; Downstream Throughput at N3 interface as defined in clause 6.3.5 in TS 28.554 [5].
UE location reports	UE location information provided by the LMF services which can be used to correlate with the MDT reports.	The UE location information provided by LMF via service-based interface (see TS 23.273 [14]).
QoE Data	The QoE data of the different services	QoE data (TS 26.247 [22] and TS 26.114 [23] can be acquired through the procedures defined in TS 28.405 [8]).
EDN Identifier	It defines the identifier of the edge data network	ednIdentifier as defined in clause 6.3.10 in TS 28.538 [32]
EDN Connection Information	It defines the set of information needed to connect to an EDN.	eDNConnectionInfo as defined in clause 6.3.10 in TS 28.538 [32]
Available Edge Virtual Resources	It defines the available edge virtual resources managed by an EDN	availableEdgeVirtualResources as defined in clause 6.3.10 in TS 28.538 [32]

8.4.2.8.3 Analytics output

The specific information elements of the analytics output for edge application deployment location analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.8.3-1.

Table 8.4.2.8.3-1: Analytics output for edge application deployment location

Information element	Definition	Support qualifier	Properties
recommendedEDN	Edge Data Network where the EAS is recommended to be deployed	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.4.2.9 Traffic congestion prediction analysis

8.4.2.9.1 MDA type

The MDA type for Traffic congestion prediction analysis is: SLSAnalysis.TrafficCongestionPredictionAnalysis.

8.4.2.9.2 Enabling data

The enabling data for SLSAnalysis.TrafficCongestionPredictionAnalysis MDA type are provided in table 8.4.2.9.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.2.9.2-1: Enabling data for traffic congestion prediction analysis

Data category	Description	References
Performance measurement	Radio resource utilization	Radio resource utilization as defined in clause 5.1.1.2 in TS 28.552 [4].
	RRC connection establishment related measurements	RRC connection establishment related measurements as defined in clause 5.1.1.15 in TS 28.552 [4].
	RAN UE Throughput	RAN UE Throughput as defined in clause 6.3.6 in TS 28.554 [5].
UE location reports	UE location information provided by the LMF services which can be used to correlate with the MDT reports.	The UE location information provided by LMF via service-based interface (see TS 23.273 [14]).
Configuration data	cellIndividualOffset, isHOAllowed and isMLBAllowed of corresponding NRCellRelation(s).	NRM information TS 28.541 [15].
Geographical data	The geographical information (longitude, latitude, altitude) of the deployed RAN (NG-RAN and E-UTRAN).	The geographical information (longitude, latitude, altitude) information (see the peeParametersList attribute of the ManagedFunction IOC in TS 28.622 [19]).

8.4.2.9.3 Analytics output

The specific information elements of the analytics output for traffic congestion prediction analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.2.9.3-1.

Table 8.4.2.9.3-1: Analytics output for traffic congestion prediction analysis

Information element	Definition	Support qualifier	Properties
congestionPredictionId	The identifier of the traffic congestion prediction.	M	type: String multiplicity: 1 isOrdered: False isUnique: True defaultValue: None isNullable: False
congestionPredictionArea	Geographical location areas where the traffic congestion is predicted to occur.	O	type: GeoArea (see TS 28.622 [19]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
congestionPredictionAffectedCells	The CGIs of cells where the traffic congestion is predicted to occur.	O	type: NRCGI (see TS28.541 [15]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Information element	Definition	Support qualifier	Properties
congestionPredictionStartTime	The predicted start time of the traffic congestion.	O	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
congestionPredictionEndTime	The predicted end time of the traffic congestion .	O	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
recommendedActions	The recommended actions to mitigate the predicted traffic congestion. The recommended action may include (but not limited to) adjusting and configuring the parameters using load balancing and/or mobility optimiation (e.g. cellIndividualOffset, isHOAllowed and isMLBAllowed of corresponding NRCellRelation(s), maximumDeviationHoTrigger of corresponding DMROFunction).	O	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.3 MDA assisted fault management

8.4.3.1 MDA assisted failure prediction

8.4.3.1.1 MDA type

The MDA type for failure prediction analysis is: MDAAssistedFaultManagement.FailurePrediction.

8.4.3.1.2 Enabling data

The enabling data for MDAAssistedFaultManagement.FailurePrediction MDA type are provided in table 8.4.3.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.3.1.2-1: Enabling data for failure prediction analysis

Data category	Description	References
Performance measurements	The deteriorated performance or the abnormal performance measurements based on certain performance monitoring threshold. 3GPP management system may monitor a set of performance measurements and their thresholds, so as to support the analytics of prediction of a network service failure.	The performance measurements as defined in TS 28.552 [4]
Alarm notifications	Alarm information, e.g. the alarm notification of network functions.	Alarm information and notifications as per TS 28.111 [33]
Configuration data	MOIs of the cells and 5GC NFs.	TS 28.541 [15]
Network topology	The topology of the network deployment,	Topology relationship derived from NRMs defined in TS 28.541 [15], e.g., containment/naming relationship and transport relationship.
Network analytics data	The control plane analysis result from the NWDAF, e.g. observed service experience related network data analytics.	TS 23.288 [10]

8.4.3.1.3 Analytics output

The specific information elements of the analytics output for failure prediction and service failure recovery analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.3.1.3-1.

Table 8.4.3.1.3-1: Analytics output for failure prediction analysis

Information element	Definition	Support qualifier	Properties
failurePredictionObject	Indication of NR cells or NFs where the failure related issues occurred or potentially occur.	M	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
potentialFailureType	Indication of type of issues that can cause the failures. NOTE 1: The values can be defined as a list of example values: "Operational Violation", "Physical Violation" and "Time Domain Violation". See alarmType described in TS 28.111 [33]	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
potentialFailureCause	Indication of the cause of predicted failure. Allowed values: Refer to probableCause defined in TS 28.111 [33]	O	type: String or Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
eventTime	This field holds the time of potential failure predicted. Examples: "20:15:00", "20:15:00-08:00" (for 8 hours behind UTC).	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
issueID	This filed holds the ID of this failure prediction which is reported. When reports, this identifier can be used to provide the information to management system to maintain.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
perceivedSeverity	This field holds the value to indicate relative level of urgency for operator attention. NOTE 2: The value can be CRITICAL, MAJOR, MINOR, WARNING, INTERMEDIATE, CLEARED, see Recommendation ITU-T X.733 [27].	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
`managementDataCollectionRecommendations`	This indicates a list of recommended management data which may be collected to aid diagnosis of the predicted failure. allowedValues: N/A	M	type: `ManagementDataCollectionInfo` multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
statisticsInfoList	It indicates a list of the calculated statistics information based on the threshold provided in the MDA request, e.g., percentage of time when the performance KPI exceeds the threshold.	O	type: Integer multiplicity: 0..* isOrdered: True isUnique: False defaultValue: None isNullable: False
recommendedActions	This field holds the recommended actions to failure prevention and recovery. The recommended action may be (but not limited to): Update 5GC NF (e.g., AMF and SMF) profile	O	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.4 MDA assisted energy saving

8.4.4.1 Energy saving analysis

8.4.4.1.1 MDA type

The MDA type for energy saving analysis is: MDAAssistedEnergySaving.EnergySavingAnalysis.

8.4.4.1.2 Enabling data

The enabling data for MDAAssistedEnergySaving.EnergySavingAnalysis MDA type are provided in table 8.4.4.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.4.1.2-1: Enabling data for energy saving analysis

Data category	Description	References
Performance measurements	PNF Power Consumption: power consumed over the measurement period	Clause 5.1.1.19.2 of TS 28.552 [4].
	PNF Energy consumption: energy consumed	Clause 5.1.1.19.3 of TS 28.552 [4].
	SS-RSRP distribution per SSB (beam) of serving NR cell	Clause 5.1.1.22.1 of TS 28.552 [4].
	SS-RSRP distribution per SSB (beam) of neighbor NR cell	Clause 5.1.1.22.1 of TS 28.552 [4].
	PDCP Data Volume of NR cells: PDCP data volume delivered in the downlink and uplink	Clause 5.1.2.1 and 5.1.3.6 of TS 28.552 [4]
	Traffic load variation: - PRB utilization rate; - RRC connection number; - etc.	Clause 5.1.1.2 and 5.1.1.4 of TS 28.552 [4].
	UE throughput: - UE throughput in downlink and uplink	Clause 5.1.1.3 of TS 28.552 [4].
	Delay related measurements of UPF	Clause 5.4 of TS 28.552 [4].
	Data volume of UPF	Clause 5.4 of TS 28.552 [4].
	Virtual resource usage of NF: The virtual CPU usage, virtual memory usage, virtual disk usage of virtual network functions	Clause 5.7.1 of TS 28.552 [4].
MDT reports	The RSRPs of UE measurements	RSRPs of M1 measurements in TS 32.422 [6] and TS 32.423 [7].
	The RSRQs of UE measurements	RSRQs of M1 measurements in TS 32.422 [6] and TS 32.423 [7].
	The UE location information	UE location of M1 measurements in TS 32.422 [6] and TS 32.423 [7].
QoE Data	The measurements that are collected are DASH and MTSI measurements	TS 28.406 [9].
Configuration data	MOIs of the cells, UPFs and SMFs	TS 28.541 [15].
Network analytics data	The control plane analysis result from the NWDAF, e.g. observed service experience related network data analytics	TS 23.288 [10].

8.4.4.1.3 Analytics output

The specific information elements of the analytics output for energy saving analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.4.1.3-1.

Table 8.4.4.1.3-1: Analytics output for energy saving analysis

Information element	Definition	Support qualifier	Properties
energyEfficiencyProblematicObject	Indication of NR cells or NFs where the energy efficiency issues occurred or potentially occur.	M	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
energyEfficiencyProblemType	Indication of type of the energy efficiency issues. allowedValues: HIGH_ENERGY_CONSUMPTION, LOW_ENERGY_CONSUMPTION, OTHER, UNKNOWN.	M	type: enumeration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trafficLoadTrends	The predictions of the trends of traffic load in a certain time period. The predictions include the traffic load of the issue cell(s) and neighboring cell(s).	M	type: TrafficLoadTrend multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
rANenergySavingRecommendations	For ES on NR cells. It may contain a set of: - Recommended NR Cell (ES-Cell) to enter energySaving state. - Recommended candidate cells with precedence for taking over the traffic of the ES-Cell. - The time to enter and terminate the energy saving state. - The load threshold to enter and terminate the energy saving state for the ES-Cell. This exist only in case of RAN energy saving is supported.	CM	type: EsRecommendationsOnNRcell multiplicity: 1..* isOrdered: True isUnique: True defaultValue: None isNullable: False
cNenergySavingRecommendations	For ES on UPFs. It contains a set of: - Recommended UPF (ES-UPF) to conduct energy saving. - Recommended candidate UPFs with precedence for taking over the traffic of the ES-UPF. - The time to conduct energy saving for the ES-UPF. This exist only in case of CN energy saving is supported.	CM	type: EsRecommendationsOnUPF multiplicity: 1..* isOrdered: True isUnique: True defaultValue: None isNullable: False
statisticsOfCellsEsState	The statistic result of current energy saving state of the cells at a certain time, which can be used by consumers to make analysis (e.g. observed service experience analysis made by NWDAF) or to make decision (e.g. enter/exit the energy saving state based on the current energy saving state).	O	type: StatisticOfCellEsState multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.5 MDA assisted mobility management

8.4.5.1 Mobility performance analysis

8.4.5.1.1 MDA type

The MDA type for mobility performance analysis is: MobilityManagementAnalytics.MobilityPerformanceAnalysis.

8.4.5.1.2 Enabling data

The enabling data for MobilityManagementAnalytics.MobilityPerformanceAnalysis MDA type are provided in table 8.4.5.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.5.1.2-1: Enabling data for mobility performance analysis

Data category	Description	References
Performance measurements	Inter-gNB handovers	Inter-gNB handovers (clause 5.1.1.6.1 of TS 28.552 [4]).
	Intra-gNB handovers	Inter-gNB handovers (clause 5.1.1.6.4 of TS 28.552 [4]).
	Inter-gNB DAPS handovers	Inter-gNB handovers (clause 5.1.1.6.2 of TS 28.552 [4]).
	Intra-gNB DAPS handovers	Inter-gNB handovers (clause 5.1.1.6.3 of TS 28.552 [4]).
	Inter-gNB conditional handovers	Inter-gNB handovers (clause 5.1.1.6.6 of TS 28.552 [4]).
	Intra-gNB conditional handovers	Inter-gNB handovers (clause 5.1.1.6.7 of TS 28.552 [4]).

8.4.5.1.3 Analytics output

The specific information elements of the analytics output (MDA report) for mobility performance analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.5.1.3-1.

Table 8.4.5.1.3-1: Analytics output for Mobility Performance analysis

Information element	Definition	Support qualifier	Properties
mobilityPerformance IssueIdentifier	The identifier of the mobility performance issue analysis;	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mobilityPerformance IssueRootCause	The root cause of mobility performance issues. allowedValues: TOO_LONG_MOBILITY_INTERRUPTION_TIME, POOR_COVERAGE_OF_THE_CELL_EDGE, INAPPROPRIATE_HANDOVER_PARAMETERS, OTHER.	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mobilityPerformance IssueLocation	Geographical location areas where the mobility performance issue occurred.	O	type: GeoArea (see TS 28.622 [19]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.5.2 Handover Optimization analysis

8.4.5.2.1 MDA type

The MDA type for handover optimization is: MobilityManagementAnalytics.HandoverOptimization.

8.4.5.2.2 Enabling data

The enabling data for handover optimization analysis are provided in table 8.4.5.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.5.2.2-1: Enabling data for handover optimization analysis

Data category	Description	References
Performance Measurements	Consumed virtual resources of target gNB	Virtualised resource usage measurement (clause 6.2 of TS 28.552 [4])
	The physical radio resource utilization of each target cells	Physical radio resource utilization of the target gNB, see clause 5.1.1.2 of TS 28.552 [4];
	PDCP Data Volume of NR cells	Clause 5.1.2.1 and 5.1.3.6 of TS 28.552 [4].
MDT reports	UE measurements related to RSRP, RSRQ, SINR (serving cell and neighbour cells) and UE location information	RSRPs, RSRQs and UE location of M1 measurements for NR in TS 32.422 [6] and TS 32.423 [7].
Predicted Signalling Measurements	Predicted signalling measurements for the target elements involved in the handover	Signalling based measurements are documented in 3GPP TS 32.422 [6]
Predicted User Trajectories	Predicted user trajectories for the UE involved in the handover	Usage of UE location and mobility projection is covered with 3GPP TS 38.423 [31]. The UE location prediction is available with NWDAF.

8.4.5.2.3 Analytics output

The specific information elements of the analytics output for handover optimization analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.5.2.3-1.

Table 8.4.5.2.3-1: Analytics output for handover optimization analysis

Information element	Definition	Support qualifier	Properties
hOTarget	This provides analytics report for each target cell, of a target gNB, for handover optimization.	M	type: HOTargetType multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.6 Maintenance management related analytics

8.4.6.1 Maintenance management analysis

8.4.6.1.1 MDA type

The MDA type for maintenance management is: Maintenance.MaintenanceAnalytics.

8.4.6.1.2 Enabling data

The enabling data for Maintenance.MaintenanceAnalytics MDA type are provided in table 8.4.6.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.6.1.2-1: Enabling data for maintenance analysis

Data category	Description	References
Performance Measurements	Number of Active DRB	Mean number of DRBs being allocated (clause 5.1.1.10.9 of TS 28.552 [4]).
	Number of bearers undergoing handover	Number of requested preparations for handovers from 5GS to EPS (clause 5.1.1.6.3.1 of TS 28.552 [4]). Number of requested resource allocations for handovers from EPS to 5GS (clause 5.1.1.6.3.4 of TS 28.552 [4]) Number of requested preparations for EPS fallback handovers (clause 5.1.1.6.3.10 of TS 28.552 [4]) Number of successful executions for EPS fallback handovers (clause 5.1.1.6.3.13 of TS 28.552 [4])
	Number of bearers being recovered from the error state	Editors Note: to be defined in TS 28.552.
	Number of successful bearer modification	Number of QoS flows attempted to modify (clause 5.1.1.13.4.1 of TS 28.552 [4])

8.4.6.1.3 Analytics output

The specific information elements of the analytics output for maintenance management analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.6.1.3-1.

Table 8.4.6.1.3-1: Analytics output for maintenance analysis

Information element	Definition	Support qualifier	Properties
currentUpgradeOptimal	This data type defines whether gNB can be upgrade at present	M	type: CurrentUpgrade multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: none isNullable: False
futureUpgradeOptimal	This data type defines whether the gNB can be upgrade in future and when	M	type: FutureUpgrade multiplicity: * isOrdered: False isUnique: True defaultValue: none isNullable: False
gNBID	This identifies the gNB See clause 4.4.1 of TS 28.541 [15].	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: none isNullable: False

8.4.6.2 Software upgrade validation analytics

8.4.6.2.1 MDA type

The MDA type for maintenance management is: Maintenance.SoftwareUpgradeValidationAnalytics.

8.4.6.2.2 Enabling data

The enabling data for Maintenance. SoftwareUpgradeValidationAnalytics MDA type are provided in table 8.4.6.2.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.6.2.2-1: Enabling data for maintenance analysis

Data category	Description	References
Performance Measurements	This specifies set of performance measurement related with managed entities (e.g gNB, AMF, SMF) and its related KPI's that has to be monitored (on timestamp basis) for generating the analytics report to validate the functionality of upgraded NF.	The performance measurements as defined in TS 28.552 [4]
	Consumed virtual resources of target node	Virtualised resource usage measurement (clause 6.2 of TS 28.552 [4])
Alarm notifications	Alarm information, e.g. the alarm notification of network functions.	Alarm information and notifications as per TS 28.111 [33]

8.4.6.2.3 Analytics output

The specific information elements of the analytics output for Software upgrade validation analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.6.2.3-1.

Table 8.4.6.2.3-1: Analytics output for maintenance analysis

Information element	Definition	Support qualifier	Properties
upgradeStatus	This indicates if the upgrade should be considered successful for a future point of time (indicated by the attribute `analyticsPeriod` in MDARequest). The value FALSE indicate the un-successful upgrade.	M	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: False isNullable: False

8.4.7 Resource related analytics

8.4.7.0 General

The present clause specifies the resource utilization analysis which can be provided by an MDAF, which can indicate the virtualized resource or physical resource usage patterns in the past and predict the resource usage trend for some time periods in the future. The analytics results, provided in the form of statistics or predictions, contain recommended actions to orchestrate the resource allocation for the NFs.

8.4.7.1 NF resource utilization analysis

8.4.7.1.1 Virtualized resource utilization analysis

8.4.7.1.1.1 MDA type

The MDA type for virtualized resource utilization analysis is:
ResourceAnalytics.virtualizedResourceUtilizationAnalysisNF.

8.4.7.1.1.2 Enabling data

The enabling data for virtualized resource utilization analysis are provided in table 8.4.7.1.1.2-1.

For general information about enabling data, see clause 8.2.1.

NOTE: The MDA output of ETSI NFV MANO as defined in ETSI GS NFV-SOL 025[34] should be used for virtualized resource analysis for 3GPP 5GC NFs.

Table 8.4.7.1.1.2-1: Enabling data for virtualized resource utilization analysis

Data category	Description	References
Performance measurements	VR (including Virtual CPU, Virtual Memory, and Virtual Disk) usage of NF	VR usage of NF (clause 5.7.1 of TS 28.552 [4])
	Connection Point data volumes of NF	Connection data volumes of NF (clause 5.7.2 of TS 28.552 [4])
	N3 interface data volume	N3 interface related measurements (clause 5.4.1 of TS 28.552 [4])
	N4 interface session establishments	N4 session establishments (clause 5.4.3.1 of TS 28.552 [4])
	N6 interface link usage	N6 related measurements (clause 5.4.2 of TS 28.552 [4])
	N9 interface data volume	GTP Data Packets and volume on N9 interface (clause 5.4.4.2 of TS 28.552 [4])
	Number of PDU sessions	Number of PDU sessions (mean) (clause 5.3.1.1 of TS 28.552 [4])
	Number of QoS flows	Mean number of QoS flows (clause 5.3.2.1.7 of TS 28.552 [4])
Configuration data	The NRMs of the analyzed NFs	The NRMs defined in TS 28.622 [19] and clause 5 of TS 28.541 [15].
Network Data Analytics	Analysis data from the control plane produced by NWDAF including NF load, observed/predicted service experience, user plane performance, and slice load level analytics.	Analytics data from NWDAF in TS 23.288 [10] including e.g. NF load analytics (clause 6.5), observed/ predicted service experience related network data analytics (clause 6.4), analytics for user plane performance (i.e. average/maximum traffic rate, average/maximum packet delay, average packet loss rate in clause 6.14), and Slice load level related network data analytics (clause 6.3).

8.4.7.1.1.3 Analytics output

The specific information elements of the analytics output for virtualized resource utilization analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.7.1.1.3-1.

Table 8.4.7.1.1.3-1: Analytics output for virtualized resource utilization analysis

Information element	Definition	Support qualifier	Properties
lowVRUsageNFs	The NFs with low virtualized resource usage (see Note 1) during some time periods in the past.	M	type: ResourceUsageNF multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
highVRUsageNFs	The NFs with high virtualized resource usage (see Note 1) during some time periods in the past.	M	type: ResourceUsageNF multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
predictedVRUsageForNFs	The predicted virtualized resource usage for NFs during some time periods in the future.	M	type: ResourceUsageNF multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
recommendedActions	The recommended actions to orchestrate the resource allocation for NFs. The recommended action may be (but not limited to): - scale in a list of NFs; - scale out a list of NFs.	M	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
NOTE 1: It is up to the MDA MnS producer to decide the thresholds for low and high usage.			

8.4.7.1.2 Physical resource utilization analysis

8.4.7.1.2.1 MDA type

The MDA type for physical resource utilization analysis is: ResourceAnalytics.PhysicalResourceUtilizationAnalysisNF.

8.4.7.1.2.2 Enabling data

The enabling data for physical resource utilization analysis are provided in table 8.4.7.1.2.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.7.1.2.2-1: Enabling data for physical resource utilization analysis

Data category	Description	References
Performance measurements	Radio resource utilization	Radio resource utilization (clause 5.1.1.2 of TS 28.552 [4])
	RRC connection number	RRC connection number (clause 5.1.1.4 of TS 28.552 [4])
	Mean number of PDU sessions in NR cell	Mean number of PDU sessions being allocated (clause 5.1.1.5.4 of TS 28.552 [4])
	Mean number of DRBs in NR cell	Mean number of DRBs being allocated (clause 5.1.1.10.9 of TS 28.552 [4])
	QoS flow release in NR cell	QoS flow release (clause 5.1.1.13.1 of TS 28.552 [4])
	Number of Active UEs	Number of Active UEs (clause 5.1.1.23 of TS 28.552 [4])
	PDCP Data Volume	PDCP Data Volume (clause 5.1.2.1 and 5.1.3.6 of TS 28.552 [4])

Data category	Description	References
Geographical data	The geographical information (longitude, latitude, altitude) of the deployed RAN (NG-RAN and E-UTRAN).	The geographical information (longitude, latitude, altitude) information (see the peeParametersList attribute of the ManagedFunction IOC in TS 28.622 [19]).
Configuration data	The NRMs of the analyzed gNB-CUs, and gNB-DUs	The GNBCUCPFunction, GNBCUUPFunction and GNBDUFunction defined in TS 28.622 [19] and TS 28.541 [15].
Network Data Analytics	Analysis data from the control plane produced by NWDAF including NF load, observed/predicted service experience, user plane performance, and slice load level analytics.	Analytics data from NWDAF in TS 23.288 [10] including e.g. NF load analytics (clause 6.5), observed/predicted service experience related network data analytics (clause 6.4), analytics for user plane performance (i.e. average/maximum traffic rate, average/maximum packet delay, average packet loss rate in clause 6.14), and Slice load level related network data analytics (clause 6.3).

8.4.7.1.2.3 Analytics output

The specific information elements of the analytics output for physical resource utilization analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.7.1.2.3-1.

Table 8.4.7.1.2.3-1: Analytics output for physical resource utilization analysis

Information element	Definition	Support qualifier	Properties
lowPRUsageNFs	The NFs with low physical resource usage (see Note 1) during some time periods in the past.	M	type: ResourceUsageNF multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
highPRUsageNFs	The NFs with high physical resource usage (see Note 1) during some time periods in the past.	M	type: ResourceUsageNF multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
predictedPRUsageForNFs	The predicted physical resource usage for NFs during some time periods in the future.	M	type: ResourceUsageNF multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
recommendedActions	The recommended actions to orchestrate the resource allocation for NFs. The recommended action may include (but not limited to) optimising the capacity of gNB (e.g., increasing or decreasing physical resources).	M	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
NOTE 1: It is up to the MDA MnS producer to decide the thresholds for low and high usage.			

8.4.7.1.3 5GC Control plane congestion analysis

8.4.7.1.3.1 MDA type

The MDA type for 5GC control plane congestion analysis is: ResourceAnalytics.5GCControlPlaneCongestionAnalysis.

8.4.7.1.3.2 Enabling data

The enabling data for ResourceAnalytics.5GCControlPlaneCongestionAnalysis MDA type are provided in table 8.4.7.1.3.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.7.1.3.2-1: Enabling data for 5GC control plane congestion analysis

Data category	Description	References
Performance measurements	Registration procedure related measurements for AMF.	Number of registration requests (clause 5.2.2 of TS 28.552 [4]) Mean time of Registration procedure (clause 5.2.2.9 of TS 28.552 [4])
	Service Request procedure related measurements for AMF.	Number of service requests (clause 5.2.3.3 and clause 5.2.3.4 of TS 28.552 [4])
	Number of PDU sessions measurements for SMF	Number of PDU sessions (clause 5.3.1 of TS 28.552 [4])
	QoS flows measurements for SMF	QoS flows monitoring (clause 5.3.2 of TS 28.552 [4])
	VR (including Virtual CPU, Virtual Memory, and Virtual Disk) usage of NF	VR usage of NF (clause 5.7.1 of TS 28.552 [4])
Alarm notifications	Alarm information, e.g. the alarm notification of network functions.	Alarm information and notifications as per TS 28.111 [33]
Configuration data	MOIs of 5GC NFs.	5GC NRM as defined in TS 28.541 [15]

8.4.7.1.3.3 Analytics output

The specific information elements of the analytics output for control plane congestion analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.7.1.3.3-1.

Table 8.4.7.1.3.3-1: Analytics output for 5GC control plane congestion analysis

Information element	Definition	Support qualifier	Properties
affectedObject	Indication of 5GC NFs where congestion issues occurred or potentially may occur.	M	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
cPCongestionIssueID	This field holds the ID of the control plane congestion issue which is reported.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
recommendedActions	The recommended actions to orchestrate the resource allocation for 5GC NFs. The recommended action may be (but not limited to): - scale out a list of 5GC NFs;	O	type: RecommendedAction multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
rootCause	The root cause of control plane congestion issue. Allowed values: NETWORK_FAILURE, SIGNALLING_OVERLOAD	O	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
predictedCongestionEndTime	It indicates the predicted end time of the congestion if the recommended actions are not performed.	O	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.4.8 Predictions of Management data

8.4.8.0 General

This clause specifies the predictions of PMs and KPIs which can be provided by an MDAF, which can predict mobility management performance, coverage related performance, SLS related performance and energy saving related performance. The analytics results, provided in the form of predictions, contain specific type of prediction of specific management data (PMs/KPIs) on network objects.

8.4.8.1 MDA assisted PM predictions

8.4.8.1.1 MDA type

The MDA type for predictions of management data is: Predictions.PMData.

8.4.8.1.2 Enabling data

8.4.8.1.2.1 Mobility management performance related predictions

The enabling data for mobility management related performance measurements are provided in table 8.4.8.1.2.1-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.8.1.2.1-1: Enabling data for mobility management related PMs

Data category	Description	References
Performance Measurements	Handover related performance measurements	Inter-gNB handovers (clause 5.1.1.6.1 of TS 28.552 [4]). Inter-gNB handovers (clause 5.1.1.6.4 of TS 28.552 [4]). Inter-gNB handovers (clause 5.1.1.6.2 of TS 28.552 [4]). Inter-gNB handovers (clause 5.1.1.6.3 of TS 28.552 [4]). Inter-gNB handovers (clause 5.1.1.6.6 of TS 28.552 [4]). Inter-gNB handovers (clause 5.1.1.6.7 of TS 28.552 [4]). Virtualised resource usage measurement (clause 6.2 of TS 28.552 [4]) Physical radio resource utilization of the target gNB, see clause 5.1.1.2 of TS 28.552 [4]; Clause 5.1.2.1 and 5.1.3.6 of TS 28.552 [4].
MDT reports	UE measurements related to RSRP, RSRQ, SINR (serving cell and neighbour cells) and UE location information	RSRPs, RSRQs and UE location of M1 measurements for NR in TS 32.422 [6] and TS 32.423 [7].

8.4.8.1.2.2 Coverage related predictions

The enabling data for coverage related performance measurements are provided in the table 8.4.8.1.2.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.8.1.2.2-1: Enabling data for coverage analytics related PMs

Data category	Description	References
Performance Measurements	Coverage related performance measurements	SS-RSRP distribution per SSB (clause 5.1.1.22.1 of TS 28.552 [4]). SS-RSRP distribution per SSB of neighbor NR cell (clause 5.1.1.22.2 of TS 28.552 [4]) RSRP distribution per neighbor E UTRAN cell (clause 5.1.1.22.3 of TS 28.552 [4]) Type 1 power headroom distribution (clause 5.1.1.26.1 of TS 28.552 [4]). Wideband CQI distribution (clause 5.1.1.11.1 of TS 28.552 [4]). Timing Advance distribution for NR Cell (clause 5.1.1.33.1 of TS 28.552 [4]) Number of UE Context Release Request (gNB-DU initiated) (clause 5.1.3.5.1 of TS 28.552 [4]). Number of UE Context Release Request (gNB-DU initiated) (clause 5.1.3.5.1 of TS 28.552 [4]). Number of UE Context Release Request (gNB-CU initiated) (clause 5.1.3.5.2 of TS 28.552 [4]). Number of UE Context Release Request (gNB-CU initiated) (clause 5.1.3.5.2 of TS 28.552 [4]). RSRP related measurements (clause 6.1 of TS 32.425 [12]). UE power headroom related measurements (clause 6.3 of TS 32.425 [12]). Wideband CQI distribution (clause 4.10.1.1 of TS 32.425 [12]). Average sub-band CQI (clause 4.10.1.2 of TS 32.425 [12]). UE Rx - Tx time difference related measurements (clause 6.4 of TS 32.425 [12]). AOA related measurements (clause 6.5 of TS 32.425 [12]). Timing Advance Distribution (clause 4.10.2 of TS 32.425 [12]). Number of UE CONTEXT Release Request initiated by eNodeB/RN (clause 4.1.5.1 of TS 32.425 [12]).
MDT reports	UE measurements related to RSRP, RSRQ, SINR (serving cell and neighbour cells) and UE location information	RSRPs and UE location of M1 measurements for NR in TS 32.422 [6] and TS 32.423 [7].

8.4.8.1.2.3 SLS related predictions

The enabling data for SLS related performance measurements are provided in the table 8.4.8.1.2.3-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.8.1.2.3-1: Enabling data for SLS related PMs

Data category	Description	References
Performance Measurements	SLS related performance measurements	RAN UE Throughput (clause 6.3.6 in TS 28.554 [5]). Mean number of PDU sessions of network and network Slice Instance (clause 6.4.1 in TS 28.554 [5]). Mean registered subscribers of network and network slice through AMF (see clause 6.2.1 in TS 28.554 [5]). Maximum packet size for a network slice subnet (see clause 6.3.11 of TS 28.541 [5]).
QoE data	The QoE data of the different services	QoE data (TS 26.247 [22] and TS 26.114 [23] can be acquired through the procedures defined in TS 28.405 [8]).

8.4.8.1.2.4 Energy Saving related predictions

The enabling data for energy saving related performance measurements are provided in the table 8.4.8.1.2.4-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.8.1.2.4-1: Enabling data for Energy Saving related PMs

Data category	Description	References
Performance Measurements	Energy saving related performance measurements	PNF Power Consumption: (Clause 5.1.1.19.2 of TS 28.552 [4].) PNF Energy consumption (Clause 5.1.1.19.3 of TS 28.552 [4].) SS-RSRP distribution per SSB (beam) of serving NR cell (Clause 5.1.1.22.1 of TS 28.552 [4].) SS-RSRP distribution per SSB (beam) of neighbor NR cell (Clause 5.1.1.22.1 of TS 28.552 [4].) PDCP Data Volume of NR cells (Clause 5.1.2.1 and 5.1.3.6 of TS 28.552 [4]) Traffic load variation (Clause 5.1.1.2 and 5.1.1.4 of TS 28.552 [4].) UE throughput (Clause 5.1.1.3 of TS 28.552 [4].) Delay related measurements of UPF (Clause 5.4 of TS 28.552 [4].) Data volume of UPF (Clause 5.4 of TS 28.552 [4].) Virtual resource usage of NF (Clause 5.7.1 of TS 28.552 [4].)
QoE data	The QoE data of the different services	The measurements that are collected are DASH and MTSI measurements (TS 28.406 [9]).

8.4.8.1.2.5 Critical Maintenance management related predictions

The enabling data for critical maintenance management related performance measurements are provided in the table 8.4.8.1.2.5-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.8.1.2.5-1: Enabling data for Critical Maintenance management related PMs

Data category	Description	References
Performance Measurements	Critical Maintenance management related performance measurements	Mean number of DRBs being allocated (clause 5.1.1.10.9 of TS 28.552 [4]).

		Number of requested preparations for handovers from 5GS to EPS (clause 5.1.1.6.3.1 of TS 28.552 [4]). Number of requested resource allocations for handovers from EPS to 5GS (clause 5.1.1.6.3.4 of TS 28.552 [4]) Number of requested preparations for EPS fallback handovers (clause 5.1.1.6.3.10 of TS 28.552 [4]) Number of successful executions for EPS fallback handovers (clause 5.1.1.6.3.13 of TS 28.552 [4]) Number of QoS flows attempted to modify (clause 5.1.1.13.4.1 of TS 28.552 [4])

8.4.8.1.2.6 Threshold assessment related statistics and predictions

The enabling data for threshold assessment and adjustment are provided in the table 8.4.8.1.2.6-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.8.1.2.6-1: Enabling data for assessment and adjustment related thresholds

Data category	Description	References
Performance measurements	The performance measurements, KPI related to certain performance threshold configurations. 3GPP management system may monitor a set of performance measurements, KPIs and their thresholds, to support the analytics of threshold assessments and recommend threshold adjustments.	Performance metrics include measurements defined in TS 28.552 [4] and KPIs defined in TS 28.554 [5]. For non-3GPP specified measurements the name is defined elsewhere.
Alarm notifications	Alarm information, e.g. the alarm notification of a cross threshold of measurement or KPI for a network functions.	Alarm information and notifications as per TS 28.111 [33]
Configuration data	MOIs of 5GC NFs, RAN NFs, Network Slice etc.	TS 28.541 [15]

8.4.8.1.3 Analytics output

The specific information elements of the analytics output for predictions, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.8.1.3-1.

Table 8.4.8.1.3-1: Analytics output for predictions

Information element	Definition	Support qualifier	Properties
pmPredictions	This information element defines the predicted values for the below performance measurements. - Mobility related performance measurements listed in table 8.4.5.1.2-1 and 8.4.5.2.2-1 in the current document. - Coverage related performance measurements listed in table 8.4.1.1.2-1 and 8.4.1.2.2-1 in the current document. - SLS related performance measurements listed in table 8.4.2.1.2-1, 8.4.2.2.2-1, 8.4.2.3.2-1, 8.4.2.4.2-1 and 8.4.2.5.2-1 in the current document. - Energy saving related performance measurements listed in table 8.4.4.1.2-1 in the current document. - Maintenance management related performance measurements listed in table 8.4.6.1.2-1 in the current document.	M	type: PmPrediction multiplicity: 1..* isOrdered: False isUnique: True defaultValue: none isNullable: False
`thresholdAssessment`	It indicates a threshold assessment from the management data correlation analysis for the provisioned threshold. allowedValue: N/A	O	type: `ThresholdAssessment` multiplicity: * isOrdered: False isUnique: True defaultValue: none isNullable: False
`thresholdAdjustmentRecommendations`	It indicates the recommendations of threshold adjustment. allowedValue: N/A	O	type: `RecommendedAction` multiplicity: * isOrdered: False isUnique: True defaultValue: none isNullable: False

8.4.9 ATSSS performance Analytics

8.4.9.1 Traffic Steering Analytics

8.4.9.1.1 MDA type

The MDA type for traffic steering analytics is: ATSSSPerformance.TrafficSteeringAnalytics

8.4.9.1.2 Enabling data

The enabling data for traffic steering analytics are provided in table 8.4.9.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.9.1.2-1: Enabling data for traffic steering analytics

Data category	Description	References
Performance measurements	Packet loss rate	DL packet loss rate on Uu interface (clause 5.1.1.35 of TS 28.552 [4])
	SDU loss rate and F1U loss rate	UL PDCP SDU loss rate and DL/UL F1-U packet loss rate (clause 5.1.3.1 of TS 28.552 [4])
	GTP packet loss rate	Incoming and outgoing GTP packet loss rate (clauses 5.4.1.7, 5.4.1.8 from TS 28.522 [4])
	Packet delay measurements	GTP packet delay (clause 5.4.1.9 from TS 28.552 [4])
	UE level performance measurements	packet delay and packet loss rate (clauses 6.2.2.1, 6.3.1.1, 6.3.1.2, 6.3.1.3 from [30])
MDT reports	MDT reports containing RSRPs of the serving cell and neighbour cells, and UE location.	M6 and M7 measurements for NR in TS 32.422 [6] and TS 32.423 [7].

8.4.9.1.3 Analytics output

The specific information elements of the analytics output for virtualized resource utilization analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.9.1.3-1.

Table 8.4.9.1.3-1: Analytics output for traffic steering analytics

Information element	Definition	Support qualifier	Properties
trafficSteeringRecommendations	Indicates the recommendations of the traffic steering rules.	M	type: TrafficSteeringRecommendation multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False

8.4.10 Correlation analytics

8.4.10.1 Measurement data correlation analytics for ML model training

8.4.10.1.1 MDA type

The MDA type for ML model training data Correlation analysis is: CorrelationAnalytics.TrainingDataAnalysis.

8.4.10.1.2 Enabling data

The enabling data for CorrelationAnalytics.TrainingDataAnalysis MDA type are provided in table 8.4.10.1.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.10.1.2-1: Enabling data for ML model training data Correlation analysis

Data category	Description	References
Performance measurements	The performance metric or KPI data used for ML model training.	The performance metric data defined in TS 28.552 [4], and KPI data defined in TS 28.554 [5]

8.4.10.1.3 Analytics output

The specific information elements of the analytics output for management data correlation analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.10.1.3-1.

Table 8.4.10.1.3-1: Analytics output for correlation analysis

Information element	Definition	Support qualifier	Properties
`measurementDataCorrelationRecommendation`	The attribute indicates measurement data correlation analytics recommendation. This attribute may carry null value, which may indicate no recommendation. allowedValues: N/A	M	type: `MeasurementDataCorrelationRecommendation` multiplicity: 0..* isOrdered: False isUnique: True defaultValue: None isNullable: False

8.4.10.2 Analytics for NF Scaling and dimensioning

8.4.10.2.1 MDA type

The MDA type for NF Scaling and dimensioning analysis is:
CorrelationAnalytics.NFScalingDimensioningDataAnalysis.

8.4.10.2.2 Enabling data

The enabling data for CorrelationAnalytics.NFScalingDimensioningDataAnalysis is provided in table 8.4.10.2.2-1.

For general information about enabling data, see clause 8.2.1.

Table 8.4.10.2.2-1: Enabling data for correlation analysis for NF Scaling and dimensioning

Data category	Description	References
Performance measurements	The performance metric or KPI data for management data correlation analysis for NF Scaling and dimensioning.	The performance metric data defined in TS 28.552 [4] And KPI data defined in TS 28.554 [5]
Geographical data	The geographical information (longitude, latitude, altitude) of the deployed 5GC Core NF.	The geographical information (longitude, latitude, altitude) information (it may be provided in the peeParametersList attribute of the ManagedFunction IOC in TS 28.622 [19]).
Configuration data	The NRMs of the 5GC NF, Network Slice, SliceSub Network	The 5GC Functions, slice related NRM defined in TS 28.541 [15].

8.4.10.2.3 Analytics output

The specific information elements of the analytics output for NF Scaling and dimensioning analysis, in addition to the common information elements of the analytics outputs (see clause 8.3), are provided in table 8.4.10.2.3-1.

Table 8.4.10.2.3-1: Analytics output for NF Scaling and dimensioning analysis

Information element	Definition	Support qualifier	Properties
`recommendedActions`	The recommended actions to change the resource allocation for NFs. The recommended action may be (but not limited to): - scale in a list of NFs; - scale out a list of NFs.	M	type: `RecommendedAction` multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.5 Data type definitions

8.5.1 `RecommendedAction <<dataType>>`

8.5.1.1 Definition

This data type specifies the type of recommended action in the analytics output.

8.5.1.2 Information elements

Table 8.5.1.2-1

Name	Definition	Support qualifier	Properties
recommended3GPPActions	It contains the recommendations actions concerning 3GPP defined operations on MOIs. The order of the list elements indicates the recommended order that the actions should be performed.	O	type: Recommended3GPPAction multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
recommendedNon3GPPActions	It contains the recommended actions related to non-3GPP operations for 3GPP management system to interact with non-3GPP management system. The order of the list elements indicates the recommended order that the actions should be performed.	O	type: String multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
recommendedHumanReadableActions	It contains the recommendations on human readable actions. The order of the list elements indicates the recommended order that the human readable actions should be performed. NOTE: Further details of recommended human readable actions are not specified.	O	type: String multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
actionInterval	It indicates the interval of the order of operations, for example, it may indicate the interval of the order of NF scaling operations. The unit is second. allowedValue: none zero Integer	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
timeWindow	It indicate the time window for the recommended operation. The order of the list elements indicates the recommended order that the actions should be performed. allowedValue: N/A	O	type: TimeWindow multiplicity: * isOrdered: True isUnique: False defaultValue: None isNullable: False

8.5.2 Recommended3GPPAction <<dataType>>

8.5.2.1 Definition

This data type specifies the data type of recommended 3GPP action. If multiple objects are recommended for creation, the creation of parent objects shall be recommended before the child objects.

8.5.2.2 Information elements

Table 8.5.2.2-1

Name	Definition	Support qualifier	Properties
mOInstance	Identifies the instance of a common ancestor object of the objects for which changes are recommended.	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
path	The "path" and "mOInstance" identify the object, and the attribute, attribute field or multi-value attribute element, that are recommended for creation, deletion or modification.	M	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
op	It specifies the type of operation that is recommended for the MOI specified by the mOInstance or its attributes. The operation describes what an MnS consumer is recommended to do.. Allowed values: "ADD" and "REMOVE" and "REPLACE". The operation describes what is recommended to do to the NRM. "ADD" shall be used for recommending the creation of an object or an attribute, attribute field or multi-value attribute element. "REMOVE" shall be used for recommending the deletion of an object or an attribute, attribute field or multi-value attribute element. "REPLACE" shall be used for recommending the replacement of an existing attribute value, attribute field value or multi-value attribute element.	M	type: enumeration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
value	If an object creation is recommended with "ADD", the "value" shall carry a complete representation of the object that is recommended to be created . If an object deletion is recommended with "REMOVE", the "value" shall be absent. It may optionally carry a complete representation of the object that is recommended to be deleted . If an attribute, attribute field or multi-value attribute element creation is recommended with "ADD", the "value" shall carry the value of the recommended attribute, attribute field or multi-value attribute element. If an attribute, attribute field or multi-value attribute element deletion is recommended with "REMOVE", the "value" shall be absent. If the replacement of an attribute, attribute field or multi-value attribute element value is recommended with "REPLACE", the "value" shall carry the new value of the attribute, attribute field or multi-value attribute element.	CM	type: AttributeValuePair (see TS 32.156 [18]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Name	Definition	Support qualifier	Properties
	If multiple objects are recommended for creation, the creation of parent objects shall be recommended before the child objects.		
additionalText	It provides the additional text for the recommended change.	O	type: string multiplicity: * isOrdered: False isUnique: False defaultValue: None isNullable: False

8.5.2.3 Constraints

Table 8.5.2.3-1

Name	Definition
value	Condition: value of op attribute is "add", or "replace".

8.5.3 TrafficLoadTrend <<dataType>>

8.5.3.1 Definition

This data type specifies the type of TrafficLoadTrend.

8.5.3.2 Information elements

Table 8.5.3.2-1

Name	Definition	Support qualifier	Properties
cellId	It indicates the cell for which the traffic load prediction is performed.	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
startTime	It indicates the start time that are used for traffic load prediction.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
endTime	It indicates the end time that are used for traffic load prediction.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trafficLoadList	It provides a list of PRB usage based on a specific granularity.	M	type: Integer multiplicity: 1..* isOrdered: True isUnique: False defaultValue: None isNullable: False

8.5.4 Void

8.5.5 EsRecommendationsOnNRcell <<dataType>>

8.5.5.1 Definition

This data type specifies the type of energy saving recommendations on NR cells.

8.5.5.2 Information elements

Table 8.5.5.2-1

Name	Definition	Support qualifier	Properties
esNRcell	It provides the DN of NR cell (ES-Cell) which is recommended to enter energySaving state.	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
candidateNRcells	It provides the DN of candidate NR cells which are recommended with precedence for taking over the traffic of ES-Cell.	M	type: DN multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
enterTime	It provides the recommended time to enter the energy saving state for the ES-Cell.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
endTime	It provides the recommended time to terminate the energy saving state for the ES-Cell.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trafficThresholds	It provides the recommended traffic threshold information. The ES-Cell can enter the energy saving state when the traffic is below the threshold value defined in the thresholdValue.	M	type: ThresholdInfo multiplicity: * isOrdered: False isUnique: False defaultValue: None isNullable: False

8.5.6 EsRecommendationsOnUPF <<dataType>>

8.5.6.1 Definition

This data type specifies the type of energy saving recommendations on UPFs.

8.5.6.2 Information elements

Table 8.5.6.2-1

Name	Definition	Support qualifier	Properties
esUPF	It provides the DN of UPF (ES-UPF) which is recommended to conduct energy saving.	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
candidateUPFs	It provides the DN of candidate UPFs which are recommended with precedence for taking over the traffic of ES-UPF.	O	type: DN multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
conductTime	It indicates the recommended time period to conduct energy saving for the ES-UPF.	M	type: TimeWindow multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.7 StatisticOfCellEsState <<dataType>>

8.5.7.1 Definition

This data type specifies the type of statistics of cells energy saving state in the analytics output.

8.5.7.2 Information elements

Table 8.5.7.2-1

Name	Definition	Support qualifier	Properties
cellId	It indicates the cell for which the statistics is performed.	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
startTime	It indicates the start time that are used for statistics.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
endTime	It indicates the end time that are used for statistics.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
ratioOfEsStateTime	It provides the ratio of the time when the cell is in the energy saving state to the total time between StartTime and EndTime.	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.8 CurrentUpgrade <<dataType>>

8.5.8.1 Definition

This data type specifies whether it is optimal to upgrade the gNB at present.

8.5.8.2 Information elements

Table 8.5.8.2-1

Name	Definition	Support qualifier	Properties
currentUpgradeOptimal	Boolean attribute indicating whether RAN Node can be upgrade at present.	M	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
numberOfGBRDRB	This specifies the total number of GBR bearer at present.	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
numberOfNonGBRDRB	This specifies the total number of non-GBR bearer at present.	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.9 FutureUpgrade <<dataType>>

8.5.9.1 Definition

This data type specifies whether it is optimal to upgrade the gNB at a future point of time.

8.5.9.2 Information elements

Table 8.5.9.2-1

Name	Definition	Support qualifier	Properties
futureUpgradeOptimal	Boolean attribute indicating whether RAN Node can be upgrade at a future point of time.	M	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
optimalTime	This specifies the future time period during which the gNB can be upgraded optimally. This shall be present only if the FutureUpgradeOptimal is TRUE.	CM	type: TimeWindow multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
numberOfGBRDRB	This specifies the total number of GBR bearer which will be present at the time stamp provided by the attribute OptimalTime. This shall be present only if the FutureUpgradeOptimal is TRUE.	CM	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Name	Definition	Support qualifier	Properties
numberOfNonGBRDRB	This specifies the total number of non-GBR bearer which will be present at the time stamp provided by the attribute OptimalTime. This shall be present only if the FutureUpgradeOptimal is TRUE.	CM	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.10 TrafficProjections <<dataType>>

8.5.10.1 Definition

This data type specifies the traffic projection for a slice.

8.5.10.2 Information elements

Table 8.5.10.2-1

Name	Definition	Support qualifier	Properties
projectionTime	The time duration for which the projections are made.	M	type: ProjectionDuration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
uPFProjections	This specifies the traffic projection of a UPF in the slice. It shall be present only if the analysis target contains CN part.	CM	type: UPFProj multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
gNBProjections	This specifies the traffic projection of a gNB in the slice. It shall be present only if the analysis target contains AN part.	CM	type: gNBProj multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
sMFProjections	This specifies the projected number of PDU session of a SMF in the slice. It shall be present only if the analysis target contains CN part.	CM	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
aMFProjections	This specifies the projected number of registered subscribers of an AMF in the slice. It shall be present only if the analysis target contains CN part.	CM	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.11 UPFProj <<dataType>>

8.5.11.1 Definition

This data type specifies the traffic projection for a UPF.

8.5.11.2 Information elements

Table 8.5.11.2-1

Name	Definition	Support qualifier	Properties
uLThroughput	The projected average UL throughput for a single UPF in the slice, over the time duration indicated by projectionTime attribute. The unit is kbit/s. This is the projection of the Upstream Throughput at N3 interface KPI defined in TS 28.554 [5]	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
dLThroughput	The projected average DL throughput for a single UPF in the slice, over the time duration indicated by projectionTime attribute. The unit is kbit/s. This is the projection of the Downstream Throughput at N3 interface KPI defined in TS 28.554 [5].	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
maxPktSize	The projected average maximum packet size for a single UPF in the slice, over the time duration indicated by projectionTime attribute.	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.12 gNBProj <<dataType>>

8.5.12.1 Definition

This data type specifies the traffic projection for a gNB.

8.5.12.2 Information elements

Table 8.5.12.2-1

Name	Definition	Support qualifier	Properties
uLUEThroughput	The projected average UL UE throughput in the slice, over the time duration indicated by projectionTime attribute. The unit is kbit/s. This is the projection of the UL RAN UE throughput KPI defined in TS 28.554 [5].	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
dLUEThroughput	The projected average DL throughput in the slice, over the time duration indicated by projectionTime attribute. The unit is kbit/s. This is the projection of the DL RAN UE throughput KPI defined in TS 28.554 [5].	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.13 HOTargetType <<dataType>>

8.5.13.1 Definition

This data type specifies the information about the target cell and gNB for handover.

The attribute isOptimal specify if the cell (served by gNB) is optimal for handover considering the current virtual, physical and radio resource consumption by the gNB and/or the cell. The value TRUE imply that the target is not resource deprived at present and can be selected for handover.

The attribute futureOptimalInfo specify if the cell (served by the gNB) will be optimal for handover at a future point of time considering the future virtual and radio resource consumption by the gNB and/or the cell. This will also provide projection of future virtual, and radio resource consumptions.

8.5.13.2 Information elements

Table 8.5.13.2-1

Name	Definition	Support qualifier	Properties
gNBId	See clause 4.4.1 of TS 28.541 [15].	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
cellLocalId	See clause 4.4.1 of TS 28.541 [15].	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
isOptimal	This specifies if the cell (served by the gNB) is optimal for handover with respect to the virtual and physical resource consumption of its gNB and its own radio resource consumption. The value TRUE indicates that the gNB is optimal at present. Allowed Values: TRUE and FALSE.	M	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: TRUE isNullable: False
futureOptimalInfo	This specifies related information when the cell is optimal for handover in future.	O	type: FutureOptimal multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.14 FutureOptimal <<dataType>>

8.5.14.1 Definition

This data type specifies the time duration for which the gNB is optimal for upgrade. This also provide virtual, physical and radio resource projections.

8.5.14.2 Information elements

Table 8.5.14.2-1

Name	Definition	Support qualifier	Properties
futureOptimalTime	This specifies the time duration during which the cell is optimal for handover.	M	type: ProjectionDuration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
projectedVResCon	This specifies the projected virtual resource consumption of the gNB. This exist only in case of virtual gNB.	CM	type: VirRes multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
projectedRResCon	This specifies the projected radio resource consumption of the cell.	M	type: RadRes multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.15 VirRes <<dataType>>

8.5.15.1 Definition

This data type specifies the virtual resource consumption.

8.5.15.2 Information elements

Table 8.5.15.2-1

Name	Definition	Support qualifier	Properties
virtualCPU	It indicates the average number of virtual CPU (see definition of numVirtualCpu in clause 7.1.9.2.3.2 of ETSI GS NFV-IFA 011 [26]) usage over the time duration indicated by `FutureOptimalTime` attribute.	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
virtualMemory	It indicates the average virtual memory size (see definition of virtualMemSize in clause 7.1.9.2.3.2 of ETSI GS NFV-IFA 011 [26]) usage over the time duration indicated by `FutureOptimalTime` attribute.	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
virtualDisk	It indicates the average virtual storage size (see definition of sizeOfStorage in clause 7.1.9.2.3.2 of ETSI GS NFV-IFA 011 [26]) usage over the time duration indicated by `FutureOptimalTime` attribute.	M	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.16 RadRes <<dataType>>

8.5.16.1 Definition

This data type specifies the radio resource consumption.

8.5.16.2 Information elements

Table 8.5.16.2-1

Name	Definition	Support qualifier	Properties
dLPRBUsage	This specifies the average total usage (in percentage) of Physical Resource Blocks (PRBs) on the downlink for any purpose, over the time duration indicated by projectionTime attribute.	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
uLPRBUsage	This specifies the average total usage (in percentage) of Physical Resource Blocks (PRBs) on the uplink for any purpose, over the time duration indicated by projectionTime attribute.	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.17 ProjectionDuration <<dataType>>

8.5.17.1 Definition

This data type specifies the time duration for which the projections are made.

8.5.17.2 Information elements

Table 8.5.17.2-1

Name	Definition	Support qualifier	Properties
fromTime	This specifies the timestamp from when the projection are made	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
toTime	This specifies the timestamp till when the projection are made	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.18 ResourceUsageNF <<dataType>>

8.5.18.1 Definition

This data type specifies the type of resource usage for an NF.

8.5.18.2 Information elements

Name	Definition	Support qualifier	Properties
nFId	It provides the DN of the NF (which can be a 5GC or an NG-RAN NF).	M	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
startTime	It indicates the start time of the time period.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
endTime	It indicates the end time of the time period.	M	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
overallResourceUsage	It provides the statistical or predicted overall average usage (in percentage) of all of the resources.	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
specificResourceUsage	It provides the statistical or predicted average usage of the specific type(s) of resources.	M	type: ResourceUsage multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.18.3 Constraints

None.

8.5.19 ResourceUsage <<dataType>>

8.5.19.1 Definition

This data type specifies the type of resource usage.

8.5.19.2 Information elements

Table 8.5.19.2-1

Name	Definition	Support qualifier	Properties
resourceType	It indicates the type of resource. allowedValues: “VirtualCpu”, “VirtualMemory”, “VirtualDisk”, “DLPRBTotal”, “ULPRBTotal”, or a vendor-specific value.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
meanUsage	It provides the mean usage or predicted mean usage (in percentage) of the resource (indicated by the “resourceType” information element).	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.19.3 Constraints

None.

8.5.20 PmPredictions <<dataType>>

8.5.20.1 Definition

This data type specifies PMs and its predicted values.

8.5.20.2 Information elements

Table 8.5.20.2-1

Name	Definition	Support qualifier	Properties
pmName	This specifies the name of the PM that is predicted.	M	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
pmPredictedValue	This specifies the predicted value of the PM specified by “pmName” attribute.	M	type: Integer/Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.21 CoverageCharacterization <<choice>>

8.5.21.1 Definition

This choice defines the coverage characterization in terms of wither RSRP or SINR.

8.5.21.2 Information elements

Table 8.5.21.2-1

Name	Definition	Support qualifier	Properties
rsrp	This specifies the RSRP value.	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
sinr	This specifies the SINR value.	M	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.22 RadioEnvironmentMap <<datatype>>

8.5.22.1 Definition

This data type specifies the graphical description of the observed radio coverage characteristics. The graphic may be for the RSRP or SINR of the selected cluster of cells mapped against the physical geographical information (longitude, latitude, altitude) of the area where the RAN (NG-RAN and E-UTRAN) cells are deployed.

8.5.22.2 Information elements

Table 8.5.22.2-1

Name	Definition	Support qualifier	Properties
geoCoordinate	This specifies the geo coordinates of a geographical location.	M	type: GeoCoordinate (see TS 28.622 [19]) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
coverageCharacterization	This specifies the coverage characterization using either RSRP or SINR.	M	type: CoverageCharacterization multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.23 TrafficSteeringRecommendation <<datatype>>

8.5.23.1 Definition

This data type specifies the traffic steering recommendation.

8.5.23.2 Information elements

Table 8.5.23.2-1

Name	Definition	Support qualifier	Properties
steeringMode	This specifies the recommended steering mode. Steering mode determines how the traffic of the matching SDF may be distributed across 3GPP and non-3GPP accesses Allowed Values: ACTIVE_STANDBY, SMALLEST_DELAY, LOAD_BALANCING, PRIORITY_BASED, REDUNDANT	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
steeringModeIndicator	This attribute indicates that the UE may change the default steering parameters provided as part of the Steering Mode component and may adjust the traffic steering based on its own decisions. The following are the possible values for this attribute, autonomous load-balance indicator and UE assistance indicator. UE assistance indicator is applicable only when "steeringMode" is set to "LOAD_BALANCING" Allowed values: AUTONOMOUS_LOAD_BALANCING_OPERATION, UE_ASSISTANCE_INDICATOR	M	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
steeringModeAssistanceInfo	This attribute provides the assistance information for the steering mode. If steering mode is recommended as ACTIVE_STANDBY, the active and standby components between 3GPP and non-3GPP is recommended. For instance, one possible option may be "Active 3GPP and non-3GPP standby". This indicates that the active steering mode is 3GPP and the non-3GPP is used as standby mode. If the steering mode is recommended as LOAD_BALANCING, the split of load between 3GPP and non-3GPP access methods may be recommended. For instance, the following may be an option. "90% over 3GPP and 10% over non-3GPP" or "0% over 3GPP and 100% over non-3GPP".	M	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
rttThreshold	This attribute indicates the RTT threshold beyond which the UE can decide autonomously to change the rules to maximize the bandwidth. This attribute is valid if the steering mode is recommended as, LOAD_BALANCING, PRIORITY_BASED, REDUNDANT. Expressed as a percentage Allowed values: 0 - 100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
packetLossThreshold	This attribute indicates the packet loss threshold beyond which the UE can decide autonomously to change the rules to maximize the bandwidth. This attribute is valid if the steering mode is recommended as LOAD_BALANCING, PRIORITY_BASED, REDUNDANT. Expressed as a percentage Allowed values: 0 - 100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.24 MeasurementDataCorrelationRecommendation <<dataType>>

8.5.24.1 Definition

This data type specifies the measurement data correlation analytics recommendation. The data type can be the contents of the analytics report representing the recommendations from MDA for the measurement data correlation analytics for ML model training.

8.5.24.2 Information elements

Table 8.5.24.2-1

Name	Definition	Support qualifier	Properties
recommendedMeasurementDataToCollect	The attribute indicates the measurement data which is recommended to be collected. allowedValues: The list may include metrics or set of metrics defined in TS 28.552 [4], TS 28.554 [5] and TS 32.422 [6]. For performance measurements defined in TS 28.552 [4] the name is constructed as the bullet e) of measurement definition with allowed measurement type. For trace metrics (including trace messages, MDT measurements (Immediate MDT, Logged MDT, Logged MBSFN MDT), RRC, RLF and RCEF reports) defined in TS 32.422 [6], the name (metric identifier) is defined in clause 10 of TS 32.422 [6]. For non-3GPP specified managment data the name is defined elsewhere.	M	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
recommendedMeasurementDataNotToCollect	The attribute indicates the measurement data which is recommended not to be collected. allowedValues: refer to allowed values in attribute recommendedMeasurementDataToCollect	M	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
modelPerformanceImpact	The attribute indicates the model performance impact. It is a percentage indicates the loss the model performance from trained MLModel with generated measurement data comparison to the performance trained with full measurement data. E.g., 3% means the model performance for the MLModel trained with generated measurement data is 3% worse than the performance trained with full measurement data. The consumer may use the value of this attribute to help decide on whether to accept or not accept the recommendation. allowedValues: 0..100	O	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

8.5.25 `ThresholdAssessment` <<dataType>>

8.5.25.1 Definition

This data type specifies the threshold assessment report.

8.5.25.2 Information elements

Table 8.5.25.2-1

Name	Definition	Support qualifier	Properties
`performanceMetrics`	It indicates list of performance metrics with threshold configuration issue. allowedValues: Performance metrics include measurements defined in TS 28.552 [4] and KPIs defined in TS 28.554 [5]. For non-3GPP specified measurements the name is defined elsewhere.	M	type: String multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
`timeWindow`	It indicates the time window that threshold may not be defined properly. allowedValues: N/A	O	type: `TimeWindow` multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: N/A isNullable: False
`confidenceScore`	It indicates the confidence of the analysis result. The numerical range is from 0 to 1, with higher values approaching 1 indicating greater confidence. allowedValues: numerical range is from 0 to 1	O	type: `Float` multiplicity: 1 isOrdered: NA isUnique: NA defaultValue: None isNullable: False

8.5.26 `ManagementDataCollectionInfo` <<dataType>>

8.5.26.1 Definition

This data type specifies the management data collection recommendation.

8.5.26.2 Information elements

Table 8.5.26.2-1

Name	Definition	Support qualifier	Properties
managementDataType	It indicates the type of management data to be collected. allowedValues: MEASUREMENT, KPI, TRACE_MDT, QOE	O	type: ENUM multiplicity:1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
managementData	This attribute indicates the list of management data that are to be collected. Refer to clause 4.3.50 TS 28.622[22] for details. allowedValues: N/A	O	Type: ManagementData (from TS 28.622[22]) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
targetEntities	In indicates list of DN for which entities that require data collection. allowedValues: N/A	O	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
collectionDuration	It indicates the duration of data collection. allowedValues: N/A	O	type: TimeWindow multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

8.6 Enumerations

8.6.1 MDAType <<enumeration>>

Table 8.6.1-1: <<enumeration>> MDAType

Enumeration value	Description
COVERAGE_ANALYTICS_COVERAGE_PROBLEM_ANALYSIS	Indicates that the MDA type for the Coverage problem analysis defined in clause 8.4.1.1
COVERAGE_ANALYTICS_PAGING_OPTIMIZATION	Indicates that the MDA type for the Paging Optimization defined in clause 8.4.1.2
SLS_ANALYSIS_SERVICE_EXPERIENCE_ANALYSIS	Indicates that the MDA type for the Service experience analysis defined in clause 8.4.2.1
SLS_ANALYSIS_NETWORK_SLICE_THROUGHPUT_ANALYSIS	Indicates that the MDA type for the Network slice throughput analysis defined in clause 8.4.2.2
SLS_ANALYSIS_NETWORK_SLICE_TRAFFIC_ANALYSIS	Indicates that the MDA type for the Network slice traffic prediction defined in clause 8.4.2.3
SLS_ANALYSIS_E2E_LATENCY_ANALYSIS	Indicates that the MDA type for the E2E latency analysis defined in clause 8.4.2.4
SLS_ANALYSIS_NETWORK_SLICE_LOAD_ANALYSIS	Indicates that the MDA type for the Network slice load analysis defined in clause 8.4.2.5
UE_THROUGHPUT_ANALYSIS_TRAFFIC_CONGESTION_PROBLEM_ANALYSIS	Indicates that the MDA type for the UE throughput analysis defined in clause 8.4.2.6
SLSANALYSIS_EDGE_APPLICATION_DEPLOYMENT_LOCATION_ANALYSIS	Indicates that the MDA type for the Edge application deployment location analysis defined in clause 8.4.2.7
SLSANALYSIS_EDGE_COMPUTING_PERFORMANCE_ANALYSIS	Indicates that the MDA type for the Edge Computing Performance Analysis defined in clause 8.4.2.8
SLSANALYSIS_TRAFFIC_CONGESTION_PREDICTION_ANALYSIS	Indicates that the MDA type for the traffic congestion prediction analysis defined in clause 8.4.2.9
MDA_ASSISTED_FAULT_MANAGEMENT_FAILURE_PREDICTION	Indicates that the MDA type for the MDA assisted failure prediction defined in clause 8.4.3.1
MDA_ASSISTED_ENERGY_SAVING_ENERGY_SAVING_ANALYSIS	Indicates that the MDA type for the Energy saving analysis defined in clause 8.4.4.1

MOBILITY_MANAGEMENT_ANALYTICS_MOBILITY_PERFORMANCE_ANALYSIS	Indicates that the MDA type for the Mobility performance analysis defined in clause 8.4.5.1
MOBILITY_MANAGEMENT_ANALYTICS_HANDOVER_OPTIMIZATION	Indicates that the MDA type for the Handover Optimization analysis defined in clause 8.4.5.2
MAINTENANCE_MAINTENANCE_ANALYTICS	Indicates that the MDA type for the Maintenance analytics defined in clause 8.4.6.1
MAINTENANCE_SOFTWARE_UPGRADE_VALIDATION_ANALYTICS	Indicates that the MDA type for the Software upgrade validation analytics defined in clause 8.4.6.2
RESOURCE_ANALYTICS_VIRTUALIZED_RESOURCE_UTILIZATION_ANALYSIS_NF	Indicates that the MDA type for the Virtualized resource utilization analysis defined in clause 8.4.7.1.1
RESOURCE_ANALYTICS_PHYSICAL_RESOURCE_UTILIZATION_ANALYSIS_NF	Indicates that the MDA type for the Physical resource utilization analysis defined in clause 8.4.7.1.2
RESOURCE_ANALYTICS_5GC_CONTROL_PLANE_CONGESTION_ANALYSIS	Indicates that the MDA type for the 5GC Control plane congestion analysis defined in clause 8.4.7.1.3
PREDICTIONS_PM_DATA	Indicates that the MDA type for the MDA assisted PM predictions defined in clause 8.4.8.1
ATSSS_PERFORMANCE_TRAFFIC_STEERING_ANALYTICS	Indicates that the MDA type for the Traffic steering analytics defined in clause 8.4.9.1
CORRELATION_ANALYTICS_TRAINING_DATA_ANALYSIS	Indicates that the MDA type for the Correlation analysis defined in clause 8.4.10.1
CORRELATION_ANALYTICS_NF_SCALING_DIMENSIONING_DATA_ANALYSIS	Indicates that the MDA type for the NF Scaling and dimensioning analysis defined in clause 8.4.10.2

9 Information model definitions for MDA

9.1 Imported and associated information entities

9.1.1 Imported information entities and local labels

Table 9.1.1-1

Label reference	Local label
TS 28.622 [19], IOC, `Top`	`Top`
TS 28.622 [19], IOC, `SubNetwork`	`SubNetwork`
TS 28.622 [19], IOC, `ManagedElement`	`ManagedElement`
TS 28.622 [19], IOC, `ManagedFunction`	`ManagedFunction`

9.1.2 Associated information entities and local labels

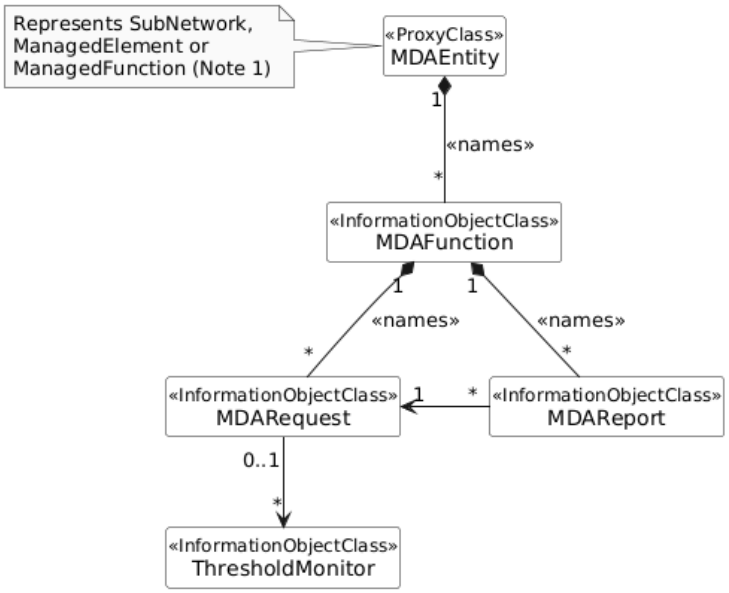
Table 9.1.2-1

Label reference	Local label
TS 28.105 [24], IOC, `AIMLInferenceFunction`	`AIMLInferenceFunction`
TS 28.105 [24], IOC, `MLModel`	`MLModel`

9.2 Class diagram

9.2.1 Relationships

This clause provides the relationships of relevant classes in UML.



NOTE 1: When the MDAEntity represents the `ManagedElement` or `ManagedFunction`, it means the MDAFunction is located in the NE/NF that the `ManagedElement` or `ManagedFunction` represents, but it does not mean the MDA is the feature of the NE/NF.

Figure 9.2.1-1: NRM fragment for MDA request and MDA report

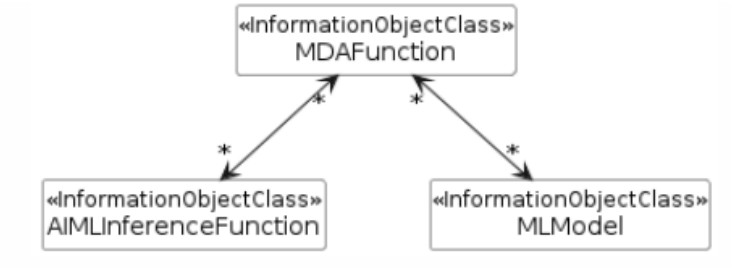


Figure 9.2.1-2: Relations for AI/ML supported MDA function

9.2.2 Inheritance

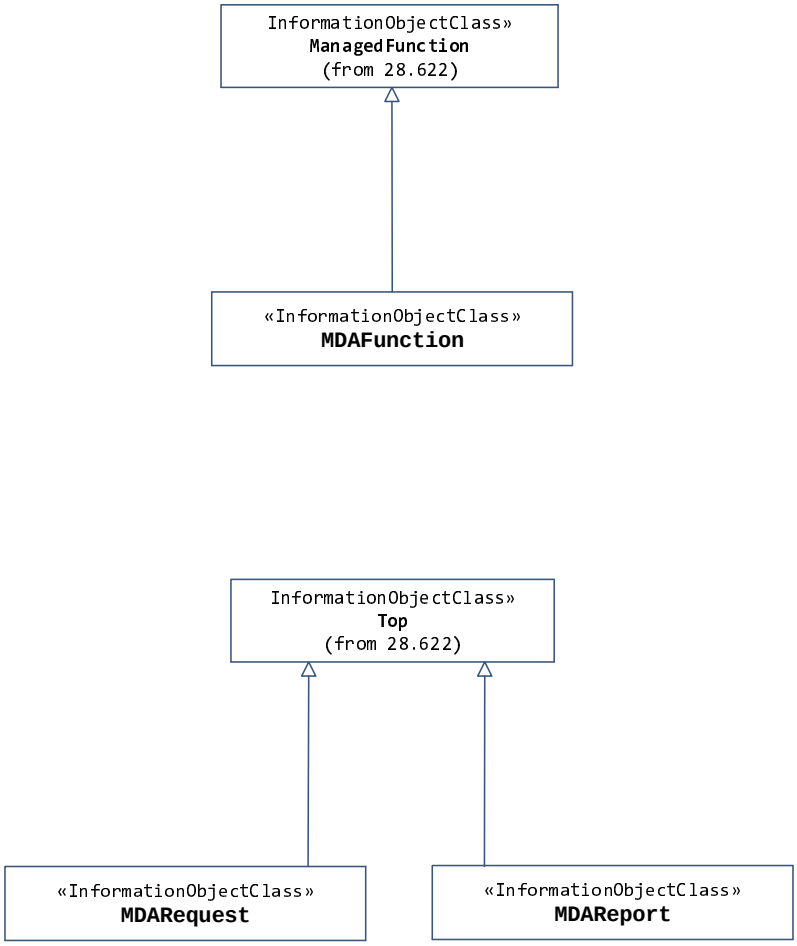


Figure 9.2.2-1: Inheritance Hierarchy

9.3 Class definitions

9.3.1 MDAFunction

9.3.1.1 Definition

The IOC MDAFunction represents the MDA function which supports one or more MDA capabilities. The MDA function may be supported by AI/ML. Attribute mLModelRefList indicates that AI/ML is supported for this function. Attribute AIMLInferenceFuntionRefList indicates that AI/ML Inference Function is supported for this function.

9.3.1.2 Attributes

The MDAFunction IOC includes the attributes inherited from ManagedFunction IOC (defined in TS 28.622 [19]) and the following attributes:

Table 9.3.1.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
supportedMDACapabilities	M	T	F	F	T
Attribute related to role					
mLModelRefList	CM	T	F	F	T
aIMLInferenceFunctionRefList	CM	T	F	F	T

9.3.1.3 Attribute constraints

Name	Definition
mLModelRefList	The condition is "The MDA function is supported by ML Model".
aIMLInferenceFunctionRefList	The condition is "The MDA function is supported by AI/ML inference function".

9.3.1.4 Notifications

The common notifications defined in clause 9.6 are valid for this IOC, without exceptions or additions.

9.3.2 MDARequest

9.3.2.1 Definition

The IOC MDARequest represents the MDA output request created by an MnS consumer.

The attribute requestedMDAOutputs contains one or multiple MDAOutputPerMDAType elements, and each MDAOutputPerMDAType element supports filtering of MDA output for a certain MDA type.

The attribute reportingTarget may contain the target address, which instructs the MDA MnS producer to create, on behalf of the MnS consumer, a subscription of MDA report.

The MDA MnS consumer may provide the performance threshold information to MDA MnS producer for collecting and reporting the statistics information related to failure prediction and/or traffic congestion. The attribute performanceThresholdInfo can contain one or multiple performance metrics information. If already existing ThresholdMonitor instances (e.g., ThresholdMonitor instance contained by MLTrainingFunction from TS 28.105 [24]) are available to use, the attribute thresholdMonitorRefList can be used.

The MDA MnS consumer may state a filter to exclude recommended actions targeted towards entities for which the MDA MnS consumer cannot execute actions. The IE "recommendationFilter" can contain a list of DNs as "ManagedEntitiesScope" or can contain a list of geographical areas indicating all the entities falling under these areas are not considered for analytics recommendations. The "recommendationFilter" indicates the list of objects for which no actions can be taken and thus no prescriptive recommendations should be given.

9.3.2.2 Attributes

The MDARequest IOC includes attributes inherited from Top IOC (defined in TS 28.622 [19]) and the following attributes:

Table 9.3.2.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
requestedMDAOutputs	M	T	T	F	T
reportingMethod	M	T	T	F	T
reportingTarget	M	T	T	F	T
analyticsScope	M	T	T	F	T
startTime	CM	T	T	F	T
stopTime	CM	T	T	F	T
recommendationFilter	O	T	T	F	T
performanceThresholdInfo	O	T	T	F	T
Attribute related to role					
thresholdMonitorRefList	O	T	T	F	T

9.3.2.3 Attribute constraints

Table 9.3.2.3-1

Name	Definition
startTime	Condition: at least one MDA output IE in requestedMDAOutputs attribute is requested based on the choice of granularityPeriod.
stopTime	Condition: at least one MDA output in requestedMDAOutputs attribute is requested based on the choice of granularityPeriod.

9.3.2.4 Notifications

The common notifications defined in clause 9.6 are valid for this IOC, without exceptions or additions.

9.3.3 MDAReport

9.3.3.1 Definition

The IOC MDAReport represents the report containing the outputs for one or more MDA types delivered to the MDA consumer.

9.3.3.2 Attributes

The MDAReport IOC includes attributes inherited from Top IOC (defined in TS 28.622 [19]) and the following attributes:

Table 9.3.3.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
mDAReportID	M	T	F	T	T
mDAOutputs	M	T	F	F	T
Attribute related to roles					

mDARequestRef	M	T	F	F	F
NOTE: The content represented by this IOC can be reported by notification, file and streaming.					

9.3.3.3 Attribute constraints

None.

9.3.3.4 Notifications

The common notifications defined in clause 9.6 are valid for this IOC, without exceptions or additions.

9.4 Data type definitions

9.4.1 MDAOutputPerMDAType <<dataType>>

9.4.1.1 Definition

This <<dataType>> represents the analytics output filters for each MDA type for an MDA request.

If only mDAType element is present (i.e. mDAOutputIEFilters element is not present), then all of the MDA output information elements for this mDAType (see analytics output definitions per MDA capability in clause 8) are requested.

if mDAOutputIEFilters element is present, then only the listed analytics output information elements are requested and shall be reported according to the corresponding threshold.

9.4.1.2 Attributes

Table 9.4.1.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
mDAType	M	T	T	F	T
mDAOutputIEFilters	O	T	T	F	T

9.4.1.3 Attribute constraints

None.

9.4.1.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.2 MDAOutputIEFilter <<dataType>>

9.4.2.1 Definition

This <<dataType>> represents the filter for an MDA output information element for an MDA request.

If only mDAOutputIEName element is present (i.e. filterValue and threshold elements are not present), then the MDA output information element indicated by the mDAOutputIEName is requested and reported without filter or threshold.

If filterValue element is present (only applicable when the MDA output information element indicated by mDAOutputIEName is non-numeric type (e.g. enum, string)), then the MDA output information element indicated by the mDAOutputIEName is only requested and reported when its value equals to the value of filterValue.

If threshold element is present (only applicable when the MDA output information element indicated by mDAOutputIEName is numeric type (e.g. integer, real)), then the MDA output information element indicated by the mDAOutputIEName is only requested and reported when its value reaches or crosses the threshold.

If analyticsPeriod element is present (only applicable when filterValue and threshold elements are not present), then the MDA output information element indicated by the mDAOutputIEName is only requested and reported, at specified time or periodically, i.e. when time reaches the indicated time schedule.

timeOut element is present optionally when an MDA MnS consumer needs an mDAOutputIEName element before a specified time only.

9.4.2.2 Attributes

Table 9.4.2.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
mDAOutputIEName	M	T	T	F	T
filterValue	CO	T	T	F	T
threshold	CO	T	T	F	T
analyticsPeriod	O	T	T	F	T
timeOut	O	T	T	F	T

9.4.2.3 Attribute constraints

Table 9.4.2.3-1

Name	Definition
filterValue	Condition: the MDA output information element indicated by the mDAOutputIEName element is non-numeric type (e.g. enum, string).
threshold	Condition: the MDA output information element indicated by the mDAOutputIEName element is numeric type (e.g. integer, real).

9.4.2.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.3 AnalyticsScopeType <<choice>>

9.4.3.1 Definition

This <<choice>> represents the scope of analytics.

When the managedEntitiesScope attribute is present, the MnS producer identify the analytics scope by the DNs of the managed entities.

When the areaScope attribute is present, the MnS producer identify the analytics scope by the geographical area information.

The managedEntitiesScope attribute and areaScope attribute shall not be present at the same time.

9.4.3.2 Attributes

Table 9.4.3.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
Choice_1 managedEntitiesScope	CM	T	T	F	T
Choice_2 areaScope	CM	T	T	F	T

9.4.3.3 Attribute constraints

Table 9.4.3.3-1

Name	Definition
Choice_1 managedEntitiesScope	Condition: the MDA MnS producer supports to identify the scope by managed entities.
Choice_2 areaScope	Condition: MDA MnS producer supports to identify the scope by geographical area information.

9.4.3.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.4 TimeWindow <<dataType>>

9.4.4.1 Definition

This <<dataType>> represents the time duration related to the MDA output sent to the MDA MnS consumer.

9.4.4.2 Attributes

Table 9.4.4.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
mDAOutputStartTime	M	T	T	F	T
mDAOutputEndTime	M	T	T	F	T

9.4.4.3 Attribute constraints

None.

9.4.4.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.5 MDAOutputs <<dataType>>

9.4.5.1 Definition

The <<dataType>> represents the MDA outputs created by a MDA MnS producer for a specific MDA type.

9.4.5.2 Attributes

Table 9.4.5.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
mDAType	M	T	F	F	T
mDAOutputList	M	T	F	F	T
analyticsWindow	M	T	F	F	T
confidenceDegree	O	T	F	F	T

9.4.5.3 Attribute constraints

None.

9.4.5.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.6 MDAOutputEntry <<dataType>>

9.4.6.1 Definition

This data type specifies an MDA output.

9.4.6.2 Attributes

Table 9.4.6.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
mDAOutputIEName	M	T	F	F	T
mDAOutputIEValue	M	T	F	F	T

9.4.6.3 Attribute constraints

None.

9.4.6.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.7 AnalyticsSchedule <<choice>>

9.4.7.1 Definition

The <<choice>> represents the time schedule for MDA.

When the timeDurations attribute is present, the MnS producer identifies the analytics schedule by the TimeWindow.

When the granularityPeriod attribute is present, the MnS producer identifies the analytics schedule by the granularity period (in unit of second).

9.4.7.2 Attributes

Table 9.4.7.2-1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
Choice_1 timeDurations	CM	T	T	F	T
Choice_2 granularityPeriod	CM	T	T	F	T

9.4.7.3 Attribute constraints

Table 9.4.7.3-1

Name	Definition
Choice_1 timeDurations	Condition: the MDA MnS producer supports to identify the time schedule by timeDurations.
Choice_2 granularityPeriod	Condition: the MDA MnS producer supports to identify the time schedule by granularityPeriod.

9.4.7.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.4.8 ThresholdInfo <<dataType>>

9.4.8.1 Definition

This data type defines a single threshold level.

9.4.8.2 Attributes

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
monitoredMDAOutputIE	M	T	T	F	T
thresholdDirection	M	T	T	F	T
thresholdValue	M	T	T	F	T
hysteresis	O	T	T	F	T

9.4.8.3 Attribute constraints

None

9.4.8.4 Notifications

The <<IOC>> using this <<dataType>> for one of its attributes, shall be applicable.

9.5 Attribute definitions

9.5.1 Attribute properties

Table 9.5.1-1

Attribute Name	Documentation and Allowed Values	Properties
mDAType	It indicates the MDA type (corresponding to the MDA capability). AllowedValues: the value of MDA type see clause 8.6.1 MDAType <<enumeration>>.	type: MDAType multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
requestedMDAOutputs	It indicates the requested analytics outputs for an MDA request.	type: MDAOutputPerMDAType multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mDAOutputIEFilters	It provides the filters for the analytics output information elements of an MDA type for an MDA request.	type: MDAOutputIEFilter multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mDAOutputIEName	It indicates the analytics output information element name. allowedValues: the analytics output information element names for each MDA type as specified in clause 8.	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
filterValue	It indicates the filter value for analytics output information element for an MDA request. The MDA output information element is only requested and reported when its value equals to the value of this attribute. allowedValues: depends on the definitions of the analytics output information element (see clause 8) indicated by mDAOutputIEName attribute.	The type for the corresponding mDAOutputIEName as defined in clause 8
threshold	It indicates the threshold for analytics output information element for an MDA request.	type: ThresholdInfo multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
analyticsPeriod	It indicates a list of time durations, or a time-period related to a time schedule for analytics.	type: AnalyticsSchedule multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
timeOut	It indicates a time until which an MDA MnS consumer needs to obtain an MDA output. Beyond this time the MDA output is no longer needed by the MDA MnS consumer.	type: DateTime (see TS 32.156 [18]) multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
reportingMethod	It indicates the reporting method of the analytics output selected by the MnS consumer. allowedValues: FILE, STREAMING, NOTIFICATION	type: Enum multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
reportingTarget	It indicates the reporting target of the MDA outputs. Allowed values: URI.	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
analyticsScope	It indicates the scope of the analytics requested by the MnS consumer.	type: AnalyticsScopeType multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None

Attribute Name	Documentation and Allowed Values	Properties
		isNullable: False
managedEntitiesScope	It indicates the scope of the analytics by the DNs of the managed entities. It carries the DN(s) of SubNetwork MOI(s), ManagedElement MOI(s), and/or the MOI(s) of the derivative IOCs of ManagedFunction (see TS 28.622 [19]). For each MOI provided by this attribute, the MOI itself and all of its subordinated MOIs are in the scope of analytics.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
areaScope	It indicates the scope of the analytics by the geographical area information.	type: GeoArea (see TS 28.622 [19]) multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
startTime	It indicates the start time of the periodical analytics requested by the MnS consumer.	type: DateTime (see TS 32.156 [18]) multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
stopTime	It indicates the stop time of the periodical analytics requested by the MnS consumer. This attribute shall contain a NULL value in case the analytics is requested for an indefinite time period.	type: DateTime (see TS 32.156 [18]) multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mDAReportID	It indicates the identifier for the MDAReport.	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mDAOutputList	It indicates a list of output results related to particular MDA type.	type: MDAOutputEntry multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
analyticsWindow	It indicates the time duration related to an MDA output. It can be in the past, when the analytics is statistics, or in the future for a prediction.	type: TimeWindow multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mDAOutputIEValue	It indicates the MDA output result that can be numeric or non-numeric.	The type for the corresponding mDAOutputIEName as defined in clause 8
confidenceDegree	A probability range that contains the degree of confidence in the analytics output statistics or prediction.	type: Real multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
supportedMDACapabilities	It indicates the MDA capabilities supported by the MDA function. AllowedValues: the value of MDA types defined for the MDA capabilities in clause 8.	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
mDAOutputs	It indicates the analytics output results of one or more MDA types delivered to MDA consumer.	type: MDAOutputs multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mDARequestRef	It indicates the DN of the MDARequest MOI for which the results are generated by the MDA producer.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
monitoredMDAOutputIE	It indicates the analytics output information element name monitored by a threshold. AllowedValues: the analytics output information element names for each MDA type as specified in clause 8.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
thresholdValue	It specifies the value against which the monitored MDA output information element is compared at a threshold level in case the hysteresis is zero.	type: Float or Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
hysteresis	It specifies the hysteresis of a threshold. If this attribute is present the monitored MDA output information element value is not compared against the threshold value as specified by the thresholdValue attribute but against a high and low threshold value given by highThresholdValue- = thresholdValue + hysteresis lowThresholdValue = thresholdValue - hysteresis When going up, the threshold is triggered when the MDA output information element value reaches or crosses the high threshold value. When going down, the threshold is triggered when the MDA output information element value reaches or crosses the low threshold value. allowedValues: values	type: Float or Integer multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
thresholdDirection	It indicates the direction of a threshold indicating the direction for which a threshold crossing triggers a threshold. When the threshold direction is configured to "UP", the associated treshold is triggered only when the subject MDA output information element value is going up upon reaching or crossing the threshold value. The treshold is not triggered, when the MDA output information element value is going down upon reaching or crossing the threshold value. Vice versa, when the threshold direction is configured to "DOWN", the associated treshold is triggered only when the MDA output information element value is going down upon reaching or crossing the threshold value. The treshold is not triggered, when the MDA output information element value is going up upon reaching or crossing the threshold value. When the threshold direction is set to "UP_AND_DOWN" the treshold is active in both direcions. In case a threshold with hysteresis is configured, the threshold direction attribute shall be set to "UP_AND_DOWN". allowedValues: - UP - DOWN - UP_AND_DOWN	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
mDAOutputStartTime	It indicates the analytics start time for an MDA output.	type: DateTime (see TS 32.156 [18]) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mDAOutputEndTime	It indicates the analytics end time for an MDA output.	type: DateTime (see TS 32.156 [18]) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
timeDurations	It indicates a list of time duration.	type: TimeWindow multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
granularityPeriod	It indicates the granularity period (in unit of second) of the analytics for an MDA output. In case of PM prediction, this indicates the granularity period of the prediction of the PMs.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLModelRefList	This attribute holds a DN list of MLModel (See TS 28.105 [24]).	type: DN multiplicity: 0..* isOrdered: False isUnique: True defaultValue: None isNullable: False
aIMLInferenceFunctionRefList	This attribute holds a DN list of AIMLInferenceFunction (See TS 28.105 [24])	type: DN multiplicity: 0..* isOrdered: False isUnique: True defaultValue: None isNullable: False
recommendationFilter	It indicates the entities for which no recommendation should be generated for the specific MDAOutputPerMDAType. This could be provided either as managedEntitiesScope or as areaScope.	type: AnalyticsScopeType multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
performanceThresholdInfo	It indicates the performance threshold information for collecting and reporting the statistics information.	type: ThresholdInfo (See TS 28.622 [19]) multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
thresholdMonitorRefList	This attribute holds a DN list of ThresholdMonitor (See TS 28.622 [19])	type: DN multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False

9.6 Common notifications

9.6.1 Configuration notifications

This clause presents a list of notifications, defined in TS 28.532 [11], that an MnS consumer may receive. The notification header attribute `objectClass/objectInstance` shall capture the DN of an instance of a class defined in the present document.

Table 9.6.1-1

Name	Qualifier	Notes
`notifyMOICreation`	O	--
`notifyMOIDeletion`	O	--
`notifyMOIAttributeValueChanges`	O	--
`notifyEvent`	O	--

10 MDA related service components

10.1 MDA MnS Service components

10.1.1 General

The MDA MnS service components are defined below for both MDA request and control and for MDA reporting taking into consideration the requirements defined in clause 7.3, the MDA capability data definitions in clause 8 and information models for MDA defined in clause 9

10.1.2 MDA report request and control

10.1.2.1 Service components

Table 10.1.2.1-1: Components of MDA MnS for MDA request and control

Management service	Management service component type A	Management service component type B
MnS for MDA request and control	The operations and notifications can be referred in TS 28.532 [11]. Which can be supported by all use cases. Operation: - createMOI - getMOIAttributes - modifyMOIAttributes - deleteMOI Notification: - notifyMOICreation - notifyMOIDeletion - notifyMOIAttributeValueChanges - notifyEvent - notifyMOIChanges	MDARequest IOC defined in clause 9.3.2.

10.1.3 MDA reporting

10.1.3.1 Service components

Table 10.1.3.1-1: Components of MDA MnS for MDA reporting

Management service	Management service component type A	Management service component type B	Management service component type C
MnS for MDA reporting - File based reporting	The operations and notifications in TS 28.532 [11], clause 11.6 are applicable and shall be supported for all MDA capabilities. Operations: - subscribe - unsubscribe - listAvailableFiles Notifications: - notifyFileReady - notifyFilePreparationError	MDAReport IOC defined in clause 9.3.3.	The file containing the content defined by MDAReport IOC with the format specified in clause A.2.2.
MnS for MDA reporting - Streaming based reporting	The operations and notifications in TS 28.532 [11], clause 11.5 are applicable and shall be supported for all MDA capabilities. Operations: - establishStreamingConnection - terminateStreamingConnection - reportStreamData - addStream - deleteStream - getConnectionInfo - getStreamInfo	MDAReport IOC defined in clause 9.3.3.	The stream data containing the content defined by MDAReport IOC with the format specified in clause A.2.2.
MnS for MDA reporting - NRM notification based reporting	The following operations and notifications in TS 28.532 [11], clause 11.1 are applicable and shall be supported for all MDA capabilities. Operations: - getMOIAttributes Notifications: - notifyMOICreation - notifyMOIDeletion - notifyMOIChanges	MDAReport IOC defined in clause 9.3.3.	

11 Workflows for MDA management

11.1 MDA request and reporting workflow

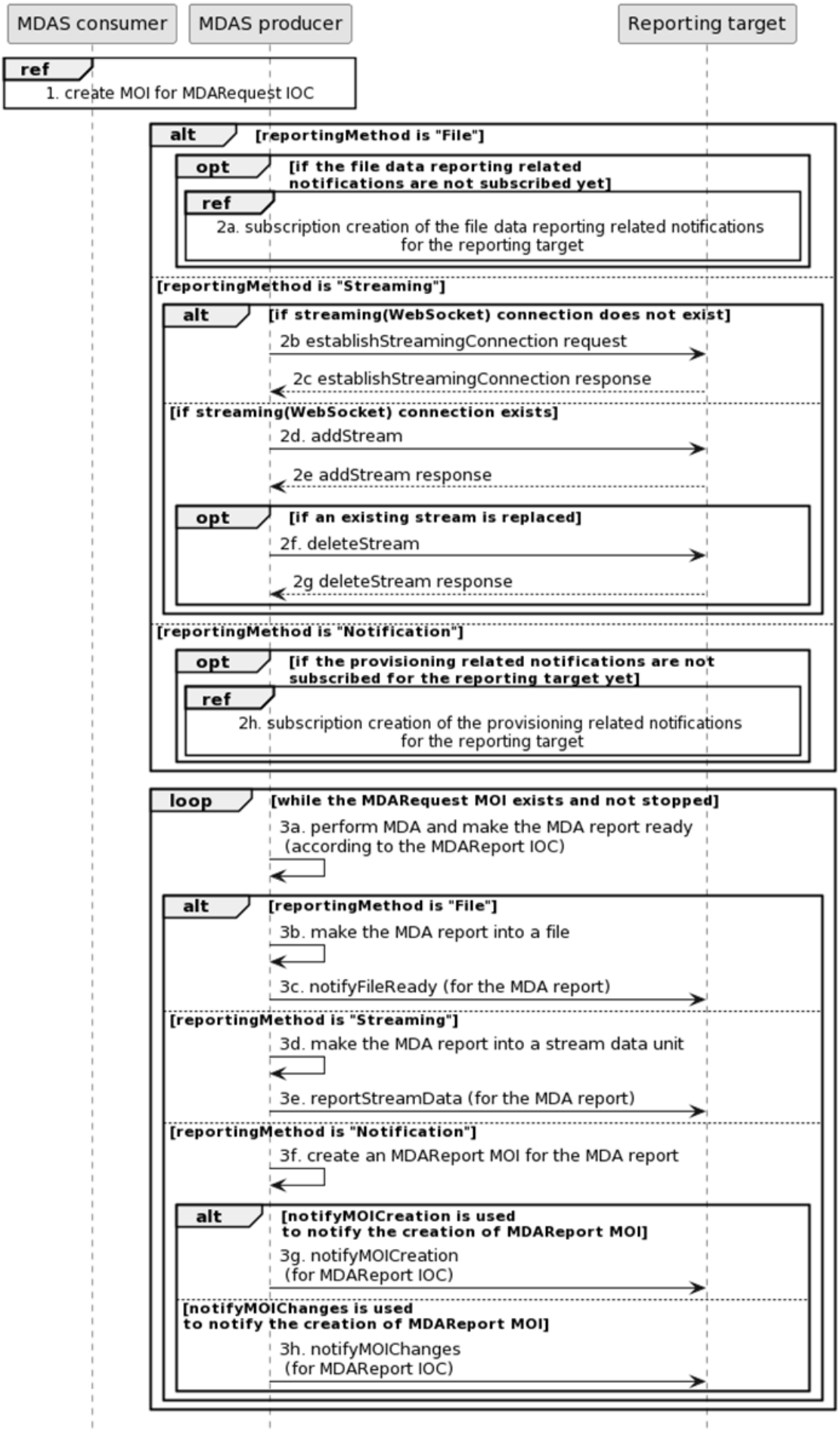

MDAS consumer
MDAS producer
Reporting target
ref
1. create MOI for MDARequest IOC
alt
[reportingMethod is "File"]
opt
[if the file data reporting related notifications are not subscribed yet]
ref
2a. subscription creation of the file data reporting related notifications for the reporting target
[reportingMethod is "Streaming"]
alt
[if streaming(WebSocket) connection does not exist]
2b establishStreamingConnection request
2c establishStreamingConnection response
[if streaming(WebSocket) connection exists]
2d. addStream
2e addStream response
opt
[if an existing stream is replaced]
2f. deleteStream
2g deleteStream response
[reportingMethod is "Notification"]
opt
[if the provisioning related notifications are not subscribed for the reporting target yet]
ref
2h. subscription creation of the provisioning related notifications for the reporting target
loop
[while the MDARequest MOI exists and not stopped]
3a. perform MDA and make the MDA report ready (according to the MDAReport IOC)
alt
[reportingMethod is "File"]
3b. make the MDA report into a file
3c. notifyFileReady (for the MDA report)
[reportingMethod is "Streaming"]
3d. make the MDA report into a stream data unit
3e. reportStreamData (for the MDA report)
[reportingMethod is "Notification"]
3f. create an MDAReport MOI for the MDA report
alt
[notifyMOICreation is used to notify the creation of MDAReport MOI]
3g. notifyMOICreation (for MDAReport IOC)
[notifyMOIChanges is used to notify the creation of MDAReport MOI]
3h. notifyMOIChanges (for MDAReport IOC)

Figure 11.1-1: Generic MDA request/reporting workflow

1 MDAS Producer creates MOI for MDARequest IOC (see createMOI operation defined in TS 28.532 [11]) for the MDAS Consumer with MDA request related information.

NOTE: Void

2. The MDAS producer subscribes to the relevant notifications or setup the streaming connections, per the selected reporting method (identified by reportingMethod attribute in the MDARequest MOI):

- If the reportingMethod designated in the MDARequest MOI is "File":

  2a. if subscription for the reporting target (specified by the reportingTarget attribute in the MDARequest MOI) do not exist, the MDAS producer subscribes to the file data reporting related notifications (see TS 28.532 [11]) for the reporting target;

- If the reportingMethod designated in the MDARequest MOI is "Streaming":

  2b/2c. if the streaming connection with the reporting target does not exist, the MDAS producer invokes the establishStreamingConnection operation (see TS 28.532 [11]) to setup the streaming connection with the streaming target;

  2d/2e. if the streaming connection with the reporting target exists, the MDAS producer invokes the addStream operation (see TS 28.532 [11]) to add the stream for the expected MDA reports. And,

  2f/2g. if the newly added stream is to replace an existing one, the MDAS producer invokes the deleteStream operation (see TS 28.532 [11]) to delete the stream.

  NOTE 1: the order of 2d/2e and 2f/2g is not significant and could be swapped too.

- If the reportingMethod designated in the MDARequest MOI is "Notification":

  2h. if subscription for the reporting target do not exist, the MDAS producer subscribes to the provisioning related notifications (see TS 28.532 [11]) for the reporting target.

NOTE 2: Although, the workflow assumes that different entities are playing the role of "MDAS Consumer" and "Reporting target", it is possible and allowed to have single entity playing the role of both "MDAS Consumer" and "Reporting target".

3. While the MDARequest is active, the MDAS Producer keeps performing MDA, and making the MDA report (see the MDAReport IOC defined in clause 9) according to the MDARequest MOI.

3a. the MDAS producer makes the MDA report ready and sends the MDA report to the reporting target per the selected reporting method (identified by reportingMethod attribute in the MDARequest MOI):

- If the reportingMethod designated in the MDARequest MOI is "File":

  3b. the MDAS producer makes the MDA report into a file;

  3c. the MDAS producer emits the notifyFileReady notification (see TS 28.532 [11]) to the reporting target for the MDA report.

- If the reportingMethod designated in the MDARequest MOI is "Streaming":

  3d. the MDAS producers makes the MDA report into a stream data unit;

  3e. invokes the reportStreamData operation (see TS 28.532 [11]) to the reporting target for the MDA report.

- If the reportingMethod designated in the MDARequest MOI is "Notification":

  3f. the MDAS producer creates and MDAReport MOI (see clause 9) for the MDA report;

  3g. if notifyMOICreation is used, the MDAS producer emits the notifyMOICreation notification (see TS 28.532 [11]) to the reporting target for the MDA report.

  3h. if notifyMOIChanges is used, the MDAS producer emits the notifyMOIChanges notification (see TS 28.532 [11]) to the reporting target for the MDA report.

12 Solution Set (SS)

The present document defines the following NRM Solution Set definitions for MDA:

12.1 RESTful HTTP-based solution set

he RESTful HTTP-based solution set for generic provisioning management service is defined in clause 12.1.1 in 3GPP TS 28.532 [11]. Corresponding className is MDARequest and MDAReport.

12.1.1 MDA request management

Table 12.1.1-1 describes the solution set to support MDA request management based on Table 12.1.1.1.1-1 in TS 28.532 [11].

Table 12.1.1-1: SS to support MDA request management

MDA request management	IS operation	HTTP Method	Resource URI
Create an MDA request	createMOI operation	PUT	{MnSRoot}/ProvMnS/{MnSVersion}/{URI-LDN-first-part}/{MDARequest}={id}
Delete an MDA request	deleteMOI operation	DELETE	{MnSRoot}/ProvMnS/{MnSVersion}/{URI-LDN-first-part}/{MDARequest}={id}
Modify an MDA request	modifyMOIAttributes operation	PUT PATCH	{MnSRoot}/ProvMnS/{MnSVersion}/{URI-LDN-first-part}/{MDARequest}={id}
Query an MDA request	getMOIAttributes operation	GET	{MnSRoot}/ProvMnS/{MnSVersion}/{URI-LDN-first-part}/{MDARequest}={id}

12.1.2 MDA report management

Table 12.1.2-1 describes the solution set to support MDA report management based on Table 12.1.1.1.1-1 in TS 28.532 [11].

Table 12.1.2-1: SS to support MDA report (notification-based) management

MDA report management	IS operation	HTTP Method	Resource URI
Query an MDA report	getMOIAttributes operation	GET	{MnSRoot}/ProvMnS/{MnSVersion}/{URI-LDN-first-part}/{MDAReport}={id}

12.2 OpenAPI specification

The OpenAPI/YAML definitions are specified in 3GPP Forge, refer to clause 4.3 of TS 28.623 [29] for the Forge location. An example of Forge location is: "https://forge.3gpp.org/rep/sa5/MnS/-/tree/Tag_Rel19_SA106/".

Directory: OpenAPI

File: TS28104_MdaNrm.yaml

File: TS28104_MdaReport.yaml

Annex A (normative): OpenAPI definitions of the MDA NRM and MDA report

A.1 General

This annex contains the OpenAPI definitions of the MDA NRM and MDA report in YAML format.

The information models of the MDA NRM and MDA report are defined in clause 9.

Mapping rules to produce the OpenAPI definition based on the information model are defined in TS 32.160 [25].

A.2 Solution Set (SS) definitions

A.2.1 OpenAPI document "TS28104_MdaNrm.yaml"

Note that clause 12 includes the location of TS28104_MdaNrm.yaml.

A.2.2 OpenAPI document "TS28104_MdaReport.yaml"

Note that clause 12 includes the location of TS28104_MdaReport.yaml

Annex B (informative): PlantUML source code

B.1 PlantUML code for MDA workflow

B1.0 Introduction

This annex contains the PlantUML source code for the MDA workflow specified in clause 11 of the present document.

B.1.1 PlantUML code for MDA requesting and reporting workflow

```
@startuml
skinparam shadowing false
skinparam monochrome true
hide footbox

participant "MDAS consumer" as MC
participant "MDAS producer" as MP
participant "Reporting target" as RT

ref over MP, MC : 1. create MOI for MDARequest IOC

Alt reportingMethod is "File"
opt if the file data reporting related \nnotifications are not subscribed yet
ref over MP, RT : 2a. subscription creation of the file data reporting related notifications \nfor
the reporting target
end

else reportingMethod is "Streaming"
alt if streaming(WebSocket) connection does not exist
MP -> RT: 2b establishStreamingConnection request
RT --> MP: 2c establishStreamingConnection response
else if streaming(WebSocket) connection exists
MP -> RT: 2d. addStream
RT --> MP: 2e addStream response
opt if an existing stream is replaced
MP -> RT: 2f. deleteStream
RT --> MP: 2g deleteStream response
end
end

else reportingMethod is "Notification"
opt if the provisioning related notifications are not \nsubscribed for the reporting target yet
ref over MP, RT : 2h. subscription creation of the provisioning related notifications \nfor the
reporting target
end

end

loop while the MDARequest MOI exists and not stopped
MP -> MP: 3a. perform MDA and make the MDA report ready \n (according to the MDAReport IOC)

Alt reportingMethod is "File"
MP -> MP: 3b. make the MDA report into a file
MP -> RT: 3c. notifyFileReady (for the MDA report)

else reportingMethod is "Streaming"
MP -> MP: 3d. make the MDA report into a stream data unit
MP -> RT: 3e. reportStreamData (for the MDA report)

else reportingMethod is "Notification"
MP -> MP: 3f. create an MDAReport MOI for the MDA report
Alt notifyMOICreation is used \nto notify the creation of MDAReport MOI
MP -> RT: 3g. notifyMOICreation \n (for MDAReport IOC)
else notifyMOIChanges is used \nto notify the creation of MDAReport MOI
MP -> RT: 3h. notifyMOIChanges \n (for MDAReport IOC)
end
```

```
end

end

@enduml
```

B.2 PlantUML code for class diagrams

B.2.1 General

The present annex contains the PlantUML source code for the NRM diagrams defined in clause 9 of the present document.

B.2.1 PlantUML code for Figure 9.2.1-2: Relations for AI/ML supported MDA function

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250
skinparam nodesep 60

class AIMLInferenceFunction <<InformationObjectClass>>
class MLModel <<InformationObjectClass>>
class MDAFunction  <<InformationObjectClass>>

MDAFunction "*" <--> "*" AIMLInferenceFunction
MDAFunction "*" <--> "*" MLModel

@enduml
```

B.2.2 PlantUML code for Figure 9.2.1-1 NRM fragment for MDA request and MDA report

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250
skinparam nodesep 60

class MDAEntity <<ProxyClass>>
class MDAFunction <<InformationObjectClass>>
class MDAReport <<InformationObjectClass>>
class MDARequest <<InformationObjectClass>>
class ThresholdMonitor <<InformationObjectClass>>


MDAEntity "1" *-- "*" MDAFunction : <<names>>
MDAFunction "1" *-- "*" MDAReport: <<names>>
MDAFunction "1" *-- "*" MDARequest: <<names>>


MDARequest "1" <-r- "*" MDAReport
MDARequest "0..1" --> "*" ThresholdMonitor

note left of MDAEntity
  Represents SubNetwork,
  ManagedElement or
```

```
  ManagedFunction (Note 1)
  end note

@enduml
```

Annex C (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2022-06	SA#96					Removal of comments	17.0.1
2022-09	SA#97e	SP-220850	0001	1	F	Rectifying attribute properties	17.1.0
2022-09	SA#97e	SP-220850	0013	-	F	Corrections to MDAOutputIEFilte	17.1.0
2022-09	SA#97e	SP-220850	0014	1	F	fix incorrect yaml file name in TS28.104	17.1.0
2022-09	SA#97e	SP-220851	0015	1	F	Correction of MDA request and reporting workflow	17.1.0
2022-09	SA#97e					Alignment with the code in FORGE (MCC)	17.1.1
2022-12	SA#98e	SP-221166	0017	-	F	Adding Stage 2 definitions of missing attributes	17.2.0
2022-12	SA#98e	SP-221166	0018	-	F	Changing recommendation attributes of time from type DateTime to TimeWindow	17.2.0
2022-12	SA#98e	SP-221166	0019	-	F	Adding appropriate reference to GeoArea from NRM definition - Stage 2 and Stage 3	17.2.0
2022-12	SA#98e	SP-221166	0020	-	F	Correcting the attribute properties for MDA request and response IOCs	17.2.0
2022-12	SA#98e	SP-221166	0024	-	F	Add the missing data type definition for threshold	17.2.0
2022-12	SA#98e	SP-221166	0025	1	F	Correction of definition for analytics window	17.2.0
2022-12	SA#98e	SP-221167	0026	-	F	Remove S-NSSAI from example of analytics output	17.2.0
2022-12	SA#98e	SP-221166	0029	1	F	Update MDA assisted energy saving	17.2.0
2023-03	SA#99	SP-230193	0030	-	F	Fixing inconsistencies in Energy Saving related attribute definitions	17.3.0
2023-03	SA#99	SP-230193	0031	-	F	Correct error of references number	17.3.0
2023-03	SA#99	SP-230193	0033	-	F	Correct errors in HOTargetType and NRM fragment note	17.3.0
2023-03	SA#99	SP-230193	0034		F	Improve definition of network slice throughput analysis	17.3.0
2023-03	SA#99	SP-230193	0040		F	Correct multiplicity of attribute mDAOutputIEName	17.3.0
2023-03	SA#99	SP-230193	0041	1	F	Correction of terminology	17.3.0
2023-06	SA#100	SP-230655	0044	-	F	Correcting attribute type for Recommended 3GPP action and MDA type for Paging Use case	17.4.0
2023-06	SA#100	SP-230655	0047	1	F	Correction of attributes in MDAOutputs dataType	17.4.0
2023-06	SA#100	SP-230655	0048	-	F	Remove duplicate mdaType in MDA report	17.4.0
2023-06	SA#100	SP-230655	0053	1	F	Corrections of the requirements on MDA capability	17.4.0
2023-06	SA#100	SP-230669	0050	1	B	Add information elements related to service experience analysis	18.0.0
2023-06	SA#100					Correction of a misimplemented CR	18.0.1
2023-09	SA#101	SP-230954	0055	-	A	Correcting datatype for Energy Saving Recommendation for NRCELL and UPF	18.1.0
2023-09	SA#101	SP-230955	0056	-	B	Update MDA capability of fault management for interruption scenario	18.1.0
2023-12	SA#102	SP-231467	0063	1	A	Correct issues for AnalyticsSchedule datatype	18.2.0
2023-12	SA#102	SP-231467	0065	1	A	Rel-18 CR TS 28.104 Correct issues for MDA information Model	18.2.0
2023-12	SA#102	SP-231467	0069	-	A	Correction on startTime and stopTime in MDARequest	18.2.0
2023-12	SA#102	SP-231467	0073	-	A	Correct issues for references of enabling data	18.2.0
2023-12	SA#102	SP-231467	0077	1	A	Rel-18 CR 28.104 Correction of attribute properties	18.2.0
2023-12						Alignment with the Forge	18.2.0
2024-03	SA#103	SP-240186	0078	-	F	TS28.104 Rel18 correction to Schema definition Issues for SubNetwork and ManagedElement of OpenAPI SS	18.3.0
2024-03	SA#103	SP-240155	0079	1	B	Add relations for NRMs related to AI/ML inference capabilities	18.3.0
2024-03	SA#103	SP-240163	0080	1	F	Rel-18 CR 28.104 correction on configuration data used as enabling data	18.3.0
2024-03	SA#103	SP-240163	0081	1	F	Rel-18 CR 28.104 correction on MDA request and reporting workflow	18.3.0
2024-03	SA#103	SP-240162	0083	1	A	Rel-18 CR 28.104 adding missing MDAEntity	18.3.0
2024-03	SA#103	SP-240162	0085	1	A	Rel-18 CR 28.104 correction on MDAReport IOC	18.3.0
2024-03	SA#103	SP-240163	0086	1	B	Add solution for MDA assisted service failure recovery	18.3.0
2024-03	SA#103	SP-240162	0088	1	A	Rel-18 CR 28.104 Fix error in definition of analyticsPeriod	18.3.0
2024-03	SA#103	SP-240208	0090	-	B	CR TS 28.104 Rel-18 eMDAS_Ph2 Further enhancements into the Management Data Analytics (Phase 2)	18.3.0
2024-06	SA#104	SP-240844	0091	1	F	Rel-18 CR TS 28.104 Clarify the definition of cPCongestionIssueID	18.4.0
2024-06	SA#104	SP-240808	0097	1	F	TS28.104 Rel18 Moving normative stage 3 to Forge	18.4.0
2024-06	SA#104	SP-240830	0098	1	F	Rel-18 CR TS 28.104 updates on the terminology for ML entity	18.4.0
2024-06	SA#104	SP-240803	0106	-	A	Rel 18 CR TS 28.104 Correct timeDurations attribute	18.4.0
2024-06	SA#104	SP-240803	0108	-	A	Correction on the term of fault prediction	18.4.0
2024-06	SA#104	SP-240808	0109	1	F	Rel-18 CR 28.104 Add missing bracket in diagram	18.4.0
2024-09	SA#105	SP-241162	0111	1	A	Rel-18 CR TS 28.104 correct the isWritable value of MDAOutputs	18.5.0
2024-09	SA#105	SP-241162	0113	-	A	Rel-18 CR TS 28.104 Correction of attribute property	18.5.0
2024-09	SA#105	SP-241173	0124	1	F	Rel-18 CR TS 28.104 Fix stage 3 MDAFunction properties	18.5.0
2024-09	SA#105	SP-241162	0126	1	A	Rel-18 CR TS 28.104 Correction to using data types	18.5.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2024-09	SA#105	SP-241162	0128	-	A	Rel-18 CR TS 28.104 Fix wrong attributes	18.5.0
2024-12	SA#106	SP-241631	0117	2	A	Rel-18 CR TS 28.104 Correct error in attribute properties of analyticsScope	18.6.0
2024-12	SA#106	SP-241631	0121	2	A	CR TS 28.104 Clarify MDA in management loop	18.6.0
2024-12	SA#106	SP-241631	0123	3	A	Rel-18 CR TS 28.104 Clarify Recommended3GPPAction	18.6.0
2024-12	SA#106	SP-241658	0133	1	A	Rel-18 CR TS 28.104 Fixing the non-existing datatype - "List"	18.6.0
2024-12	SA#106	SP-241658	0135	1	A	Rel-18 CR TS 28.104 Aligning ENUM literals as per the guidelines	18.6.0
2024-12	SA#106	SP-241645	0142		F	Rel-18 CR TS28.104 add MDAType Enumerations which are used as aIMLInferenceName	18.6.0
2024-12	SA#106	SP-241631	0153		A	Rel-18 CR 28.104 Fix mismatch between stage 2 and stage 3	18.6.0
2024-12	SA#106	SP-241664	0160		F	Rel 18 CR TS 28.104 Correct timeDurations support qualifier	18.6.0
2024-12	SA#106	SP-241639	0131	1	C	Rel-19 CR TS 28.104 Implement readonly attributes for openAPI SS	19.0.0
2024-12	SA#106	SP-241639	0138		F	Rel-19 CR 28.104 Enhance the isUnique property for stage 3 OpenAPI	19.0.0
2024-12	SA#106	SP-241664	0141	1	C	Rel 19 CR TS 28.104 Remove Support Qualifier from attribute constraints	19.0.0
2024-12	SA#106	SP-241639	0144	1	C	Rel-19 CR TS 28.104 add missing inheritence statement for IOC definition	19.0.0
2025-03	SA#107	SP-250159	0164	-	B	Rel19 CR TS28.104 New use case and solution on management data correlation analytics	19.1.0
2025-03	SA#107	SP-250159	0165	1	B	Rel19 CR TS28.104 add use case and requirement on management data correlation analytics for threshold assessment and adjustment	19.1.0
2025-03	SA#107	SP-250173	0167	1	A	Rel-19 CR TS 28.104 Correct the MDAType definition	19.1.0
2025-03	SA#107	SP-250148	0169	2	F	Rel-19 CR 28.104 Enhance stage 3 OpenAPI for isUnique property	19.1.0
2025-03	SA#107	SP-250159	0170	1	B	Rel19 CR TS28.104 add use case and requirement on correlation analytics for NF Scaling and dimensioning	19.1.0
2025-03	SA#107	SP-250159	0171	1	B	Rel19 CR TS28.104 add use case and requirement for predicted failures	19.1.0
2025-03	SA#107	SP-250159	0172	-	B	Rel-19 CR 28.104 adding threshold related requirements for Fault management	19.1.0
2025-03	SA#107	SP-250159	0173	1	B	Rel-19 CR 28.104 adding threshold information in the MDARequest	19.1.0
2025-03	SA#107	SP-250148	0174	-	D	Rel-19 CR TS 28.104 Fix corrupted descriptive text	19.1.0
2025-03	SA#107	SP-250159	0175	1	C	Rel-19 CR TS 28.104 Improvements to failure prediction	19.1.0
2025-03	SA#107	SP-250159	0176	-	B	Rel-19 CR TS 28.104 Update MDA capability for control plane congestion analysis	19.1.0
2025-03	SA#107	SP-250159	0177	1	B	Rel-19 CR TS 28.104 Update solution for control plane congestion analysis	19.1.0
2025-03	SA#107	SP-250159	0178	1	B	Rel-19 CR TS 28.104 add use case and requirements for UE throughput analysis	19.1.0
2025-03	SA#107	SP-250159	0179	1	B	Rel-19 CR TS 28.104 add solutions for UE throughput analysis	19.1.0
2025-03	SA#107	SP-250159	0181	1	C	Rel-19 CR TS 28.104 Add stage 3 definition for MDA Management	19.1.0
2025-03	SA#107	SP-250179	0182	1	B	Rel-19 CR 28.104 UC and Requirements for Software Upgrade Validation	19.1.0
2025-03	SA#107	SP-250159	0183	2	B	Rel-19 CR TS 28.104 New use case and solution on traffic steering analytics	19.1.0
2025-03	SA#107	SP-250159	0184	-	B	Rel-19 CR TS 28.104 Enhancing the failure prediction use case	19.1.0
2025-03	SA#107	SP-250159	0186	3	B	Rel-19 CR TS 28.104 New use case on Handover and service data correlation analytics	19.1.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2025-03	SA#107	SP-250148	0188	1	D	Rel 19 CR TS 28.104 Correct recommendationFilter attr	19.1.0
2025-06	SA#108	SP-250528	0214	1	B	Rel19 CR TS28.104 enhancement to stage 2 and stage 3 for clause 8	19.2.0
2025-06	SA#108	SP-250528	0215	1	B	Rel19 CR TS28.104 adding the new MDAType and correct the value format	19.2.0
2025-06	SA#108	SP-250529	0218	1	C	Rel-19 CR TS 28.104 add stage3 solution for mobility performance analysis and coverage problem analysis	19.2.0
2025-06	SA#108	SP-250529	0219	1	F	Rel-19 CR TS 28.104 enhance the discription of MDA request IOC to support UE throughput analysis	19.2.0
2025-06	SA#108	SP-250529	0220		F	Rel-19 CR TS 28.104 Fix errors in attribute definitions	19.2.0
2025-06	SA#108	SP-250529	0221	1	D	Rel-19 CR TS 28.104 Fix editorial errors	19.2.0
2025-06	SA#108	SP-250529	0222	1	F	Rel-19 CR TS 28.104 Update the use case for failure prediction	19.2.0
2025-06	SA#108	SP-250529	0223	1	F	Rel-19 CR TS 28.104 Enhancing service failure recovery	19.2.0
2025-06	SA#108	SP-250529	0224	1	F	Rel-19 CR 28.104 clarification on resource management	19.2.0
2025-06	SA#108	SP-250558	0225	1	F	Rel 19 CR TS 28.104 correct allowedValues for reportingMethod	19.2.0
2025-09	SA#109	SP-251113	0228	1	F	Rel-19 CR 28.104 Add missing illustration name	19.3.0
2025-09	SA#109	SP-251099	0229		D	Rel-19 CR TS 28.104 Correction on AIML descriptions	19.3.0
2025-09	SA#109	SP-251099	0230	1	F	Rel-19 CR TS 28.104 Add MDA type definition for ATSSS traffic steering analytics	19.3.0
2025-09	SA#109	SP-251099	0231	1	C	Rel-19 CR TS 28.104 add stage3 solution for UE throughput analysis	19.3.0

History

Document history		
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