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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

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shall not indicates an interdiction (prohibition) to do something

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should indicates a recommendation to do something

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may indicates permission to do something

need not indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can indicates that something is possible

cannot indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

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 management aspects of edge computing including concepts, use cases, requirements and procedural flows that covers lifecycle management, provisioning, performance assurance and fault supervision for edge computing.

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.

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

[2]   3GPP TS 23.558: "Architecture for enabling Edge Applications".

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

[4]   3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[5]   3GPP TS 28.532: "Management and orchestration; Generic management services".

[6]   ETSI GS NFV-IFA 013 V3.4.1 "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Os-Ma-nfvo reference point -Interface and Information Model Specification".

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

[8]   3GPP TS 28.550: "Management and orchestration; Performance assurance".

[9]   3GPP TS 28.531: "Management and orchestration; Provisioning".

[10]   3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[11]   3GPP TS 23.501: "System architecture for the 5G System (5GS); Stage 2".

[12]   3GPP TS 28.658: "Telecommunications management; Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Network Resource Model (NRM) Integration Reference Point (IRP): Information Service (IS)".

[13]   3GPP TS 38.300: "NR; Overall description; Stage-2".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 3GPP 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 3GPP TR 21.905 [1].

Edge Computing: A concept, as described in 3GPP TS 23.501 [4], that enables operator and 3rd party services to be hosted close to the UE's access point of attachment, to achieve an efficient service delivery through the reduced end-to-end latency and load on the transport network.

Edge Computing Service Provider: A mobile network operator offering Edge Computing service.

Edge Data Network: A local Data Network that supports the architecture for enabling edge applications.

ECSP Management System: is a part of 3GPP management system that utilizes 3GPP defined management services to enable consumers (e.g., ASP. ECSP) to orchestrate and manage the EDN.

PLMN Management System: is a part of 3GPP Management System that utilizes 3GPP defined management services to enable consumers (e.g., PLMN operator) to orchestrate and manage the mobile networks.

3.2   Symbols

Void.

3.3   Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

ASP	Application Service Provider
DN	Data Network
DNAI	Data Network Access Identifier
DNN	Data Network Name
EAS	Edge Application Server
ECS	Edge Configuration Server
ECSP	Edge Computing Service Provider
EDN	Edge Data Network
FQDN	Fully Qualified Domain Name
GSM	Global System for Mobile Communications
GSMA	GSM Association

4   Concepts and overview

4.1   Concept of edge computing management

The edge computing services are provided by edge computing service providers (ECSP), application service providers (ASP), and PLMN operators (see annex B in TS 23.558 [1]), where ASP is responsible for the creation of edge application servers (EAS) and application clients (AC), ECSP is responsible for the deployment of edge data networks (EDN) that contain EAS and EES, and PLMN operator is responsible for the deployment of 5G network functions, such as 5GC and 5G NR.

Figure 4.1-1 describes the edge computing management framework that contains PLMN management system and ECSP management system. ECSP management system, as the producer, provides management services enabling ASP and ECSP consumers to orchestrate and manage EDN NFs (e.g., EAS, EES, and ECS). PLMN management system, as the producer, provides management services enabling ECSP management system to interconnect EDN NFs with 5GC NFs (e.g., PCF, UPF, NEF). Both ECSP management system and PLMN management system communicate with ETSI NFV MANO to perform lifecycle management functions.
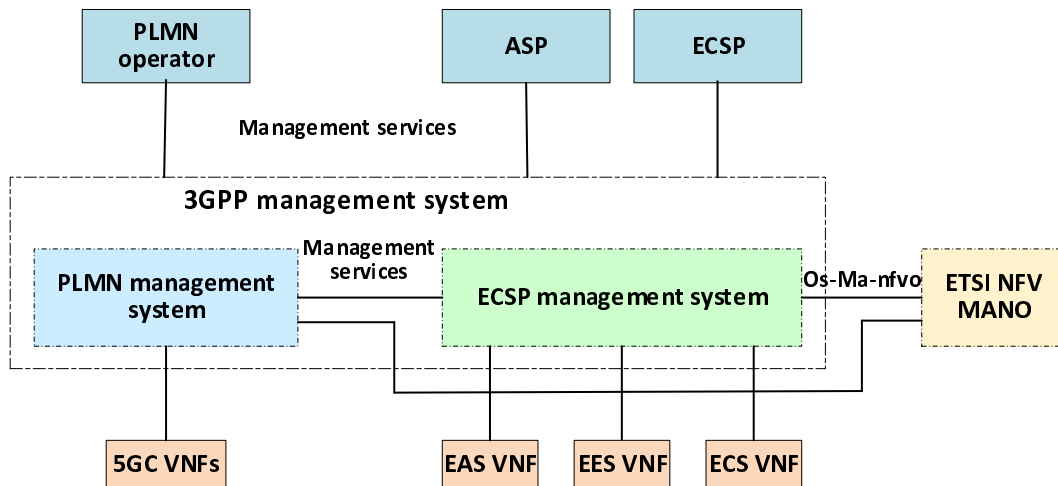
Figure 4.1-1: Edge computing management framework

5 Edge Computing Management (ECM) capabilities

5.1 Lifecycle management

5.1.1 Description

The lifecycle management of the edge components is to be enabled by the 3GPP Management System. The lifecycle management includes instantiation, termination, modification and query of the edge components.

5.1.2 EAS deployment

The goal of this use case is to enable ASP to deploy the EAS in the EDN, by requesting the provisioning MnS producer with the deployment requirements (e.g. the topological or geographical service areas, software image information, QoS, affinity/anti-affinity with other EAS, etc.) to deploy the EAS. The provisioning MnS producer returns a response indicating the operation is in progress to prevent the consumer from waiting, as the deployment in the edge cloud may take a while. Since, there can be multiple Edge Data Network (EDN) present/serving a particular edge location. This makes it critical for application service provider to have their EAS deployed at appropriate EDN(s) to provide high performance services for the UE. Therefore, provisioning MnS producer analyses the deployment requirements to determine where (i.e. on which EDN) and how many EAS VNF instance(s) should be instantiated, and requests the NFVO in ETSI NFV MANO to instantiate the EAS VNF instance(s). The provisioning MnS producer sends a notification to ASP indicating the result of instantiation (e.g. success, failure) when a notification is received from NFVO indicating the result of instantiation operation.

5.1.3 EAS termination

The goal of this use case is to enable ASP to terminate the EAS in the EDN, by requesting the provisioning MnS producer to terminate the EAS VNF instance. The provisioning MnS producer requests the NFVO in ETSI NFV MANO to terminate the EAS VNF instances. The provisioning MnS producer sends a notification to ASP indicating the termination is in progress when a notification is received from NFVO indicating the start of termination operation. The provisioning MnS producer sends another notification to ASP indicating the result of termination (e.g. success, failure) when a notification is received from NFVO indicating the result of termination operation.

5.1.4 Query EAS information

The goal of this use case is to enable ASP to query the EAS information in the EDN, by requesting the provisioning MnS producer to query the EAS instance. Upon receiving the query request, the provisioning MnS producer sends the EAS instance information to ASP.

5.1.5 EAS modification

The goal of this use case is to enable ASP to modify the EAS in the EDN, by requesting the provisioning MnS producer to modify the EAS instance. If the modification requires the change (e.g. scale) for the virtualized resource of the EAS VNF instance, the provisioning MnS producer requests the NFVO in ETSI NFV MANO for the appropriate operation of the EAS VNF instances. The provisioning MnS producer sends a notification to ASP indicating the attribute(s) change of the EAS instance.

5.1.6 EES Deployment

The provisioning MnS producer is requested to instantiate the EES, as 3GPP network functions, aiming to server the particular location. The instantiated EES may serve one or multiple EAS.

A consumer request for EES(s) instantiation providing EES deployment requirements. The provisioning MnS producer determines the EDN where the EES(s) will be instantiated, instantiate the EES VNF and establish the connection with 5GC network functions. The provisioning MnS producer will accept the request and notify the consumer about the instantiation in-progress. Thereafter, the notification will be sent to indicate the successful EES instantiation.

5.1.7 EES Termination

The goal is to enable the termination of one or more EES(s) on the EDN. A consumer consumes the provisioning MnS to terminate the EES with the EES identifier. The provisioning MnS producer terminates the EES VNF based on the EES identifier, and disconnects the EES from the 5GC network functions. The provisioning MnS producer will accept the request and notify the consumer about the termination in-progress. Thereafter, the notification will be sent to indicate that the EES has been terminated successfully.

5.1.8 Query EES information

The goal of this use case is to enable a consumer to query the EES information in the EDN, by requesting the provisioning MnS producer to query the EES instance. Upon receiving the query request, the provisioning MnS producer sends the EES instance information to the consumer.

5.1.9 EES Modification

The goal of this use case is to enable a consumer to modify the EES in the EDN, by requesting the provisioning MnS producer to modify the EES instance. If the modification requires the change (e.g. scale) for the virtualized resource of the EES VNF instance, the provisioning MnS producer requests the NFVO in ETSI NFV MANO for the appropriate operation of the EES VNF instances. The provisioning MnS producer sends a notification to the consumer indicating the attribute(s) change of the EES instance.

5.1.10 ECS Deployment

The goal is to enable the instantiation of one or more ECS. To support deployed EDN, operator will deploy ECS serving one or multiple EES. A consumer request for ECS(s) instantiation providing ECS deployment requirements. The provisioning MnS producer instantiate the ECS VNF and establish the required connection with 5GC network functions. The notifications will be sent to indicate that the ECS has been instantiated successfully.

5.1.11 ECS Termination

The goal is to enable the termination of one or more ECS. A consumer consumes the provisioning service to terminate the ECS with the ECS identifier. The provisioning MnS producer terminates the ECS VNF based on the ECS identifier, and disconnects the ECS from the 5GC network functions. The notification will be sent to indicate that the ECS has been terminated successfully.

5.1.12 Query ECS information

The goal of this use case is to enable a consumer to query the ECS instance information, by requesting the provisioning MnS producer to query the ECS instance. Upon receiving the query request, the provisioning MnS producer sends the ECS instance information to the consumer.

5.1.13 ECS Modification

The goal of this use case is to enable a consumer to modify the ECS instance, by requesting the provisioning MnS producer to modify the ECS instance. If the modification requires the change (e.g. scale) for the virtualized resource of the ECS VNF instance, the provisioning MnS producer requests the NFVO in ETSI NFV MANO for the appropriate operation of the ECS VNF instances. The provisioning MnS producer sends a notification to the consumer indicating the attribute(s) change of the ECS instance.

5.1.14 Requirements

Requirement label	Description	Related use case(s)
REQ-EAS-INST-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to request the deployment of EAS based on the given deployment requirements.	EAS Deployment
REQ-EAS-INST-FUN-2	Generic Provisioning MnS Producer should have the capability to deploy EAS at a suitable EDN which can support the EAS requirements e.g. serving location, required latency, affinity/anti-affinity with other EAS, service continuity.	EAS Deployment
REQ-EAS-INST-FUN-3	Generic provisioning MnS producer should have a capability to inform the authorized consumer about the progress of instantiation as the response to the deployment request.	EAS Deployment
REQ-EAS-INST-FUN-4	Generic provisioning MnS producer should have a capability to notify the authorized consumer the result (e.g. success, failure) of instantiation operation.	EAS Deployment
REQ-EAS-TERM-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to request the termination of the EAS VNF instance.	EAS Termination
REQ-EAS-TERM-FUN-2	Generic provisioning MnS producer should have a capability to inform the authorized consumer about the progress of termination as the response to the termination request.	EAS Termination
REQ-EAS-TERM-FUN-3	Generic provisioning MnS producer should have a capability to notify the authorized consumer the result (e.g. success, failure) of termination operation.	EAS Termination
REQ-EAS-QUERY-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to obtain the EAS instance information.	Query EAS information
REQ-EAS-MOD-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to request the modification of the EAS instance.	EAS Modification
REQ-EES-INST-FUN-1	Generic provisioning MnS producer should have the capability to instantiate the EES, as per request from authorized consumers.	EES Deployment
REQ-EES-INST-FUN-2	Generic provisioning MnS producer should have the capability to send the notification indicating the status of EES instantiation	EES Deployment
REQ-EES-INST-FUN-3	Generic provisioning MnS producer should have the capability to relate instantiated EES with one or multiple served EAS(s).	EES Deployment
REQ-EES-TERM-FUN-1	Generic provisioning MnS producer should have the capability to terminate the EES with the EES identifier, as per request from authorized consumers	EES Termination
REQ-EES-TERM-FUN-2	Generic provisioning MnS producer should have the capability to send the notification indicating the status of EES termination	EES Termination
REQ-EES-QUERY-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to obtain the EES instance information.	Query EES information
REQ-EES-MOD-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to request the modification of the EES instance.	EES Modification
REQ-EES-TERM-FUN-3	Generic provisioning MnS producer should have a capability to inform the authorized consumer about the progress of EES instantiation as the response to the deployment request.	EES Deployment

Requirement label	Description	Related use case(s)
REQ-EES-TERM-FUN-4	Generic provisioning MnS producer should have a capability to inform the authorized consumer about the progress of EES termination as the response to the termination request.	EES Termination
REQ-ECS-INST-FUN-1	Generic provisioning MnS producer should have the capability to instantiate the ECS, as per request from authorized consumers.	ECS Deployment
REQ-ECS-INST-FUN-2	Generic provisioning MnS producer should have the capability to send the notification indicating the status of ECS Instantiation.	ECS Deployment
REQ-ECS-INST-FUN-3	Generic provisioning MnS producer should have the capability to relate instantiated ECS with one or multiple served EES(s).	ECS Deployment
REQ-ECS-TERM-FUN-1	Generic provisioning MnS producer should have the capability to terminate the ECS with the ECS identifier, as per request from authorized consumers.	ECS Termination
REQ-ECS-TERM-FUN-2	Generic provisioning MnS producer should have the capability to send the notification indicating the status of ECS termination.	ECS Termination
REQ-ECS-TERM-FUN-3	Generic provisioning MnS producer should have a capability to inform the authorized consumer about the progress of ECS instantiation as the response to the deployment request.	ECS Termination
REQ-ECS-TERM-FUN-4	Generic provisioning MnS producer should have a capability to inform the authorized consumer about the progress of ECS termination as the response to the termination request.	ECS Termination
REQ-ECS-QUERY-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to obtain the ECS instance information.	Query ECS information
REQ-ECS-MOD-FUN-1	Generic provisioning MnS producer should have a capability allowing an authorized consumer to request the modification of the ECS instance.	ECS Modification

5.2   Performance assurance

5.2.1   Description

The clause contains use cases associated with performance assurance.

5.2.2   EAS performance assurance

The goal of this use case is to provide a mechanism for EAS to publish KPIs or measurements, as per requirements shown in Table 5.2.2-1 (see clause 5.2.10.2 in TS 23.558 [2]).

Table 5.2.2-1: Edge Application Server Service KPIs

Information element	Status	Description
Maximum Request rate	O	Maximum request rate from the Application Client supported by the server.
Maximum Response time	O	The maximum response time advertised for the Application Client's service requests.
Availability	O	Advertised percentage of time the server is available for the Application Client's use.
Available Compute	O	The maximum compute resource available for the Application Client.
Available Graphical Compute	O	The maximum graphical compute resource available for the Application Client.
Available Memory	O	The maximum memory resource available for the Application Client.
Available Storage	O	The maximum storage resource available for the Application Client.
Connection Bandwidth	O	The connection bandwidth in Kbit/s advertised for the Application Client's use.
NOTE: The maximum response time includes the round-trip time of the request and response packet, the processing time at the server and the time required by the server to consume 3GPP Core Network capabilities, if any.		

A consumer, such as ASP, would consume performance assurance MnS to request the ECSP management system to collect EAS KPIs and measurements. The performance assurance MnS producer at ECSP management system will report the measurements to the consumer.

5.2.3   5GC NF measurements to evaluate EAS performance

The goal is to enable ECSP management system to collect the measurements of 5GC NFs (e.g. UPF, PCF, …) that are needed to evaluate the EAS performance. For example, the ECSP management system can correlate the 5GC NF and EAS measurements to determine the root cause of poor EAS performance. ECSP management system, as the consumer would consume performance assurance MnS to request the PLMN management system to collect 5GC NF measurements that are related to EAS performance. The performance assurance MnS producer at PLMN management system will report the measurements to the consumer.

Since an PLMN operator may not want to expose certain measurements (e.g. measurements for 5GC NF(s) not relevant to EAS) to 3rd party operators, like ECSP, the PLMN management system should be able to select specific measurements to be reported to the consumer.

5.2.4   ECS performance assurance

The goal of this use case is to provide a mechanism for ECS performance assurance. ECS performance can be based on various functionalities defined for ECS in (see clause 6.3.4 of [2]). The measurement/KPI should be defined for each functionality, that can be collected as and when required.

A consumer, such as ECSP Management system, would consume performance assurance MnS to request the PLMN management system to collect ECS KPIs and measurements. The performance assurance MnS producer at PLMN management system will report the measurements to the consumer.

5.2.5   EES performance assurance

The goal of this use case is to provide a mechanism for EES performance assurance. EES performance can be based on various functionalities defined for EES in (see clause 6.3.4 of [2]). The measurement/KPI should be defined for each functionality, that can be collected as and when required.

A consumer, such as ECSP Management system, would consume performance assurance MnS to request the PLMN management system to collect EES KPIs and measurements. The performance assurance MnS producer at PLMN management system will report the measurements to the consumer.

5.2.6   Requirements

Requirement label	Description	Related use case(s)
REQ-EAS-PA-FUN-1	Performance assurance MnS producer should have a capability allowing an authorized consumer to request the collection of EAS KPIs and measurements.	EAS performance assurance
REQ-EAS-PA-FUN-2	Performance assurance MnS producer should have a capability to report EAS KPIs and measurements to authorized consumer(s).	EAS performance assurance
REQ-5GCNF-PA-FUN-1	Performance assurance MnS producer should have a capability allowing an authorized consumer to request the collection of 5GC NF(s) (e.g. UPF, PCF, …) measurements that may affect the EAS performance.	5GC NF measurements to evaluate EAS performance
REQ-EAS-5GCNF -FUN-2	Performance assurance MnS producer should have a capability allowing the selection of specific 5GC NF(s) (e.g. UPF, PCF, …) measurements to be reported to authorized consumer(s).	5GC NF measurements to evaluate EAS performance
REQ-ECS-PA-FUN-2	Performance assurance MnS producer should have a capability to report ECS KPIs and measurements to authorized consumer(s).	ECS performance assurance
REQ-EES-PA-FUN-2	Performance assurance MnS producer should have a capability to report EES KPIs and measurements to authorized consumer(s).	EES performance assurance

5.3 Fault supervision

5.3.1 Description

The clause contains use cases associated with fault supervision.

5.3.2 EDN NF performance impacted by 5GC NF alarms

The goal is to enable ECSP management system to receive 5GC NFs (e.g. UPF, PCF, NEF, SCEF, …) alarms that may impact the EDN NFs (e.g. EAS, EES) performance from PLMN management system. ECSP management system can correlate the 5GC NF alarms to determine the root causes for poor EDN NF performance. ECSP management system subscribes to receive 5GC NF alarms from PLMN management system. PLMN management system sends the NF alarm notification to ECSP management system when it detects 5GC NF alarms.

5.3.3 5GC NF issues resulted from EDN NF alarms

The goal is to enable PLMN management system to receive EDN NFs (e.g. EAS, EES, ECS) alarms that may generate issues in 5GC NFs (e.g. UPF, PCF, NEF, SCEF, …) that are supporting EDN from ECSP management system. PLMN management system can correlate the EDN NF alarms to determine the root causes for 5GC NF issues. PLMN management system subscribes to receive EDN NF alarms from ECSP management system. ECSP management system sends the NF alarm notification to PLMN management system when it detects EDN NF alarms.

5.3.4 Requirements

Requirement label	Description	Related use case(s)
REQ-EDNNF-FS-FUN-1	Fault supervision MnS producer should have a capability allowing an authorized consumer to subscribe to receive alarms of 5GC NFs that are supporting edge computing applications.	EDN NF performance impacted by 5GC NF alarms
REQ-EDNNF-FS-FUN-2	Fault supervision MnS producer should have a capability to send the 5GC NF alarm notification to authorized consumer(s).	EDN NF performance impacted by 5GC NF alarms
REQ-5GCNF-FS-FUN-1	Fault supervision MnS producer should have a capability allowing an authorized consumer to subscribe to receive alarms of EDN NFs that may generate issues in 5GC NFs.	5GC NF issues resulted from EDN NF alarms
REQ-5GCNF-FS-FUN-2	Fault supervision MnS producer should have a capability to send the EDN NF alarm notification to authorized consumer(s).	5GC NF issues resulted from EDN NF alarms

5.4 5GC NF Provisioning

5.4.1 Description

The clause contains use cases associated with provisioning.

5.4.2 EDN NF 5GC connection provisioning

The goal is to enable ECSP management system to request PLMN management system to query the connection information of EDN NFs (i.e., EAS, EES, ECS) to 5GC NFs, as specified in clauses 6.3.2, 6.3.4, 6.4.6 in TS 23.558 [2], where EES, ECS, and EAS are interacting with 3GPP Core Network for accessing the capabilities of network functions either directly (e.g. via PCF) or indirectly (e.g. via SCEF/NEF/SCEF+NEF).

Figure 5.x.2-1 shows an example of edge computing networks. EDN #1 is trusted by PLMN operators; therefore, EAS #1 and EES #1 are acting as the trusted AF, and are authorized to interfaces to PCF directly in via the N5 reference point (see clause 4.2.3 in TS 23.501 [11]), or via Edge-7 and Edge-2 interfaces (see clause 6.2 in TS 23.558). EDN #2 is not trusted by PLMN operators; therefore, EAS #2 and EES #2 are acting as the untrusted AF, and are not authorized to interfaces to PCF directly (See clause 5.6.7.1 TS 23.501 [11]), and need to interface to NEF / SCEF via the N33

reference point (see Figure 4.2.3-5 in TS 23.501), or via Edge-7 and Edge-2 interfaces. ECS should be able to connect to NEF / SCEF via the edge-8 interface (see clause 6.3.4 in TS 23.558 [2]).

Figure 5.4.2-1: Edge computing networks

ECSP management system requests PLMN management system to identify the PCF, NEF, or SCEF to which the EDN NFs need to interface. The request should include the EDN identifier and the service area requirements (i.e., EDN service area, EES service area, and EAS service area (see clause 7.3.3 in TS 23.558 [2])). PLMN management system finds and returns the connection information (i.e., the IP addresses and DN of PCF, NEF, SCEF) to ECSP management system, based on the requirements. ECSP management system then connects EAS, ECS, and EES to 5GC NFs via the connection information given by PLMN management system, according to Figure 5.4.2-1.

5.4.3   Configuration needed for EAS registration

The goal is to enable a consumer to configure EASID and EES address for the EAS that are required as the pre-conditions of EAS registration procedure (see clause 8.4.3.2.1 in TS 23.558 [2]). A consumer (e.g. ASP, ECSP) requests ECSP management system to configure the EASID and EES address attributes in EASFunction IOC. ECSP management system configures the EASID and EES address attributes in EASFunction MOI, and returns the attribute change notification to the consumer.

5.4.4   EAS to connect with UPF

The goal is to enable ECSP management system to connect a newly deployed EAS to a UPF. Figure 5.4.4-1 shows that EASs are deployed in the local part of the Data Network (DN) that are connected to UPF to carry the user traffic via the N6 interface (see clause 6.3.3 in TS 23.501 [11]). ECSP management system requests PLMN management system to connect a newly deployed EAS to a UPF with EAS IP address, EAS service area requirements (see clause 7.3.3.6 in TS 23.558 [2])), and list of DNAI and N6 traffic routing requirements ((see Table 8.2.4.1 in TS 23.558 [2])). PLMN management system finds a UPF among the UPF(s) being deployed that meets the service area requirements (e.g. UPF #2 is found to connect to EAS #2). In the case that no UPF can be found (e.g. EAS #3), PLMN management system will deploy a new UPF (e.g. UPF #3) and then configure the SMF to add the UPF to the list of available UPF(s) (see clause 6.3.3.2 in TS 23.501 [11]). PLMN management system connects the UPF to the EAS, and return the UPF information (e.g. IP addresses and DN of the UPF) to the ECSP management system.

Figure 5.4.4-1: EASs to connect with UPFs

5.4.5 Requirements

Requirement label	Description	Related use case(s)
REQ-PROV-FUN-1	Generic provisioning MnS producer should have the capability allowing authorized consumer to query the connection information of 5GC functions, such as the IP addresses and DN of PCF, NEF, SCEF, by providing EDN identifier and service area requirements.	EDN NF to access 5GC NF
REQ-PROV-FUN-2	Generic provisioning MnS producer should have the capability to return to the authorized consumer with the connection information of 5GC functions, such as the IP addresses and DN of PCF, NEF, SCEF, based on the requirements.	EDN NF to access 5GC NF
REQ-PROV-FUN-3	Generic provisioning MnS producer should have the capability to establish the connection relationship between EAS, EES, and ECS and 5GC NFs via PCF, NEF, or SCEF.	EDN NF to access 5GC NF
REQ-PROV-FUN-4	Generic provisioning MnS producer should have the capability allowing authorized consumer to configure the EASID and EES address attributes for EAS.	Configuration needed for EAS registration
REQ-PROV-FUN-5	Generic provisioning MnS producer should have the capability to send a notification to the consumer, indicating that the attributes have been changed.	Configuration needed for EAS registration
REQ-PROV-FUN-6	Generic provisioning MnS producer should have the capability allowing authorized consumer to provide information for connecting the EAS to UPF by providing EAS IP address, EAS service area requirements and list of DNAI and N6 traffic routing requirements.	EAS to connect with UPF
REQ-PROV-FUN-7	Generic provisioning MnS producer should have the capability to return to the authorized consumer with the UPF connection information of 5GC functions, such as the IP addresses and DN of UPF, based on the requirements.	EAS to connect with UPF
REQ-PROV-FUN-8	Generic provisioning MnS producer should have the capability to connect the EAS to UPF.	EAS to connect with UPF

6 Edge NRM

6.1 Information Model definitions for Edge NRM

6.1.1 Imported information entities and local labels

Label reference	Local label
TS 28.622 [4], IOC, `Top`	`Top`
TS 28.622 [4], IOC, `SubNetwork`	`SubNetwork`
TS 28.622 [4], IOC, `ManagedFunction`	`ManagedFunction`
TS 28.541 [3], IOC, PCFFunction	PCFFunction
TS 28.541 [3], IOC, NEFFunction	NEFFunction
TS 28.541 [3], IOC, UPFunction	UPFFunction
TS 28.541 [3], IOC, EP_N5	EP_N5
TS 28.541 [3], IOC, EP_N33	EP_N33
TS 28.541 [3], IOC, EP_N6	EP_N6
TS 28.541 [3], `dataType, tAI`	`tAI`
TS 28.658 [12], dataType, `PLMNId`	`PLMNId`

6.2 Class diagram

6.2.1 Relationships
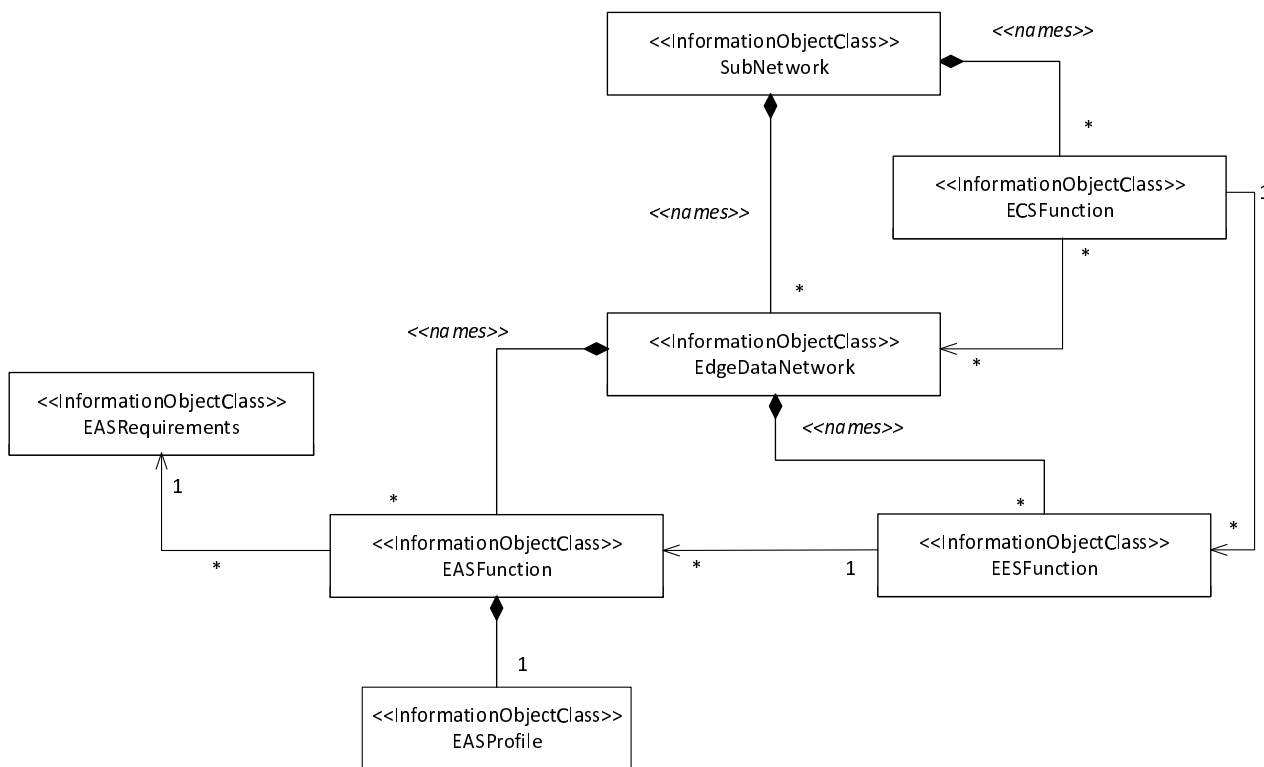
Figure 6.2.1-1: Edge NRM relationship diagram
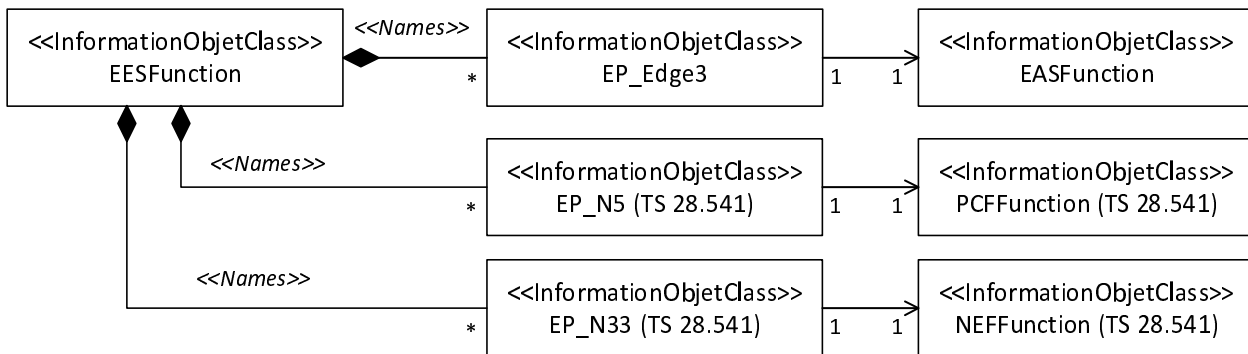
Figure 6.2.1-3: Transport view of EES NRM
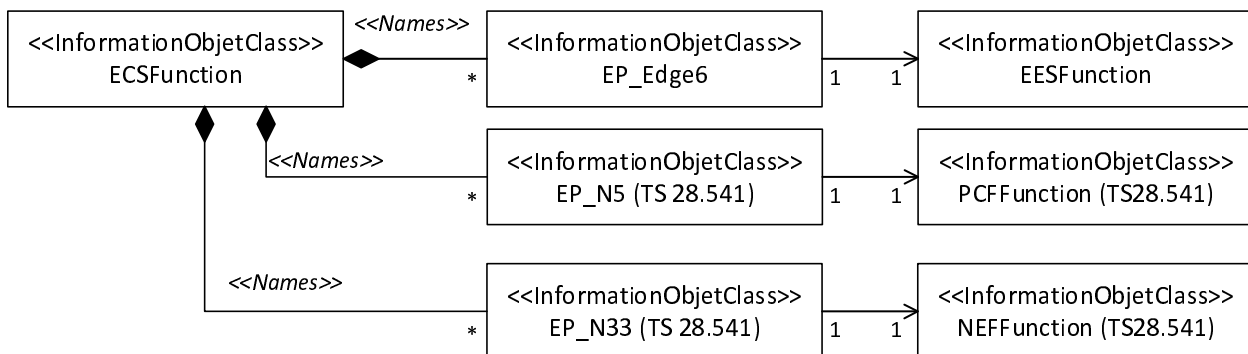
Figure 6.2.1-4: Transport view of ECS NRM
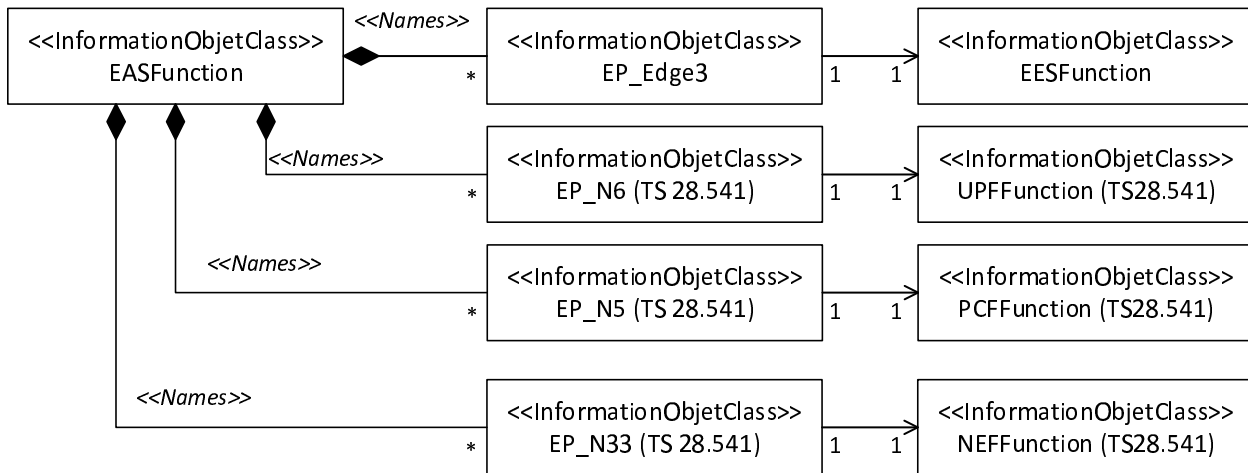
Figure 6.2.1-5: Transport view of EAS NRM

6.2.2 Inheritance
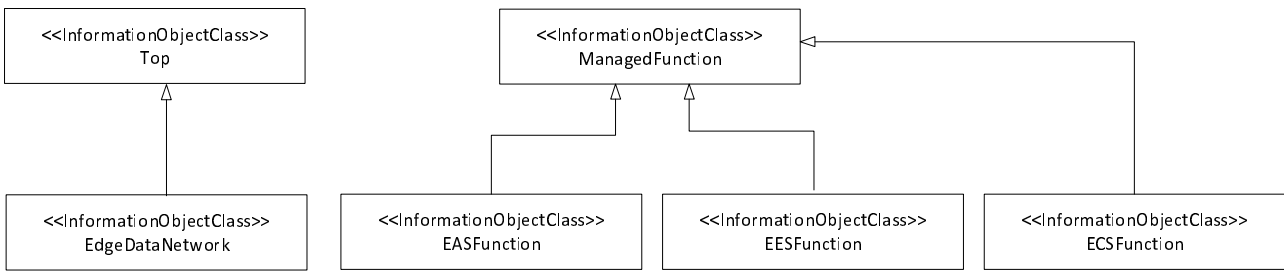
Figure 6.2.2-1: Edge Inheritance Relationship

6.3 Class definition

6.3.1 EASFunction

6.3.1.1 Definition

This IOC represent the properties of a EAS in a 3GPP network. For more information about EAS, see 3GPP TS 23.558.

6.3.1.2 Attributes

The EASFunction IOC includes attributes inherited from ManagedFunction IOC (defined in TS 28.622 [4]) and the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
eASIdentifier	M	T	T	F	T
eASAddress	M	T	T	F	T
eESAddress	M	T	T	F	T
Attribute related to role					
eASRequirementsRef	M	T	T	F	T

6.3.1.3 Attribute constraints

None.

6.3.1.4 Notifications

The common notifications defined in clause 5.5 of TS 28.541 [3] are valid for this IOC, without exceptions or additions.

6.3.2 EASRequirements

6.3.2.1 Definition

This represent the requirements needed to deploy EAS(s).

6.3.2.2 Attributes

The EASRequirements IOC includes attributes inherited from Top IOC (defined in TS 28.622[4]) and the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
requiredEASservingLocation	M	T	T	F	T
softwareImageInfo	M	T	T	F	T
affinityAntiAffinity	M	T	T	F	T
serviceContinuity	M	T	T	F	T
virtualResource	M	T	T	F	T

Editor's note: which entity is responsible for creating VNFD based on the deployment requirement as shown in the above figure (e.g., softwareImageInfo and virtualResource) is FFS.

6.3.2.3   Attribute constraints

None.

6.3.2.4   Notifications

The common notifications defined in clause 5.5 of TS 28.541 [3] are valid for this IOC, without exceptions or additions.

6.3.3   ServingLocation <<dataType>>

6.3.3.1   Definition

This datatype represents the location which is to be served by the node.

6.3.3.2   Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
geographicalLocation	CM	T	T	F	T
topologicalLocation	CM	T	T	F	T

6.3.3.3   Attribute constraints

Name	Definition
geographicalLocation Support Qualifier	Condition: If the serving location is defined as Geographical Service Area [2].
topologicalLocation Support Qualifier	Condition: If the serving location is defined as Topological Service Area [2].

NOTE: Only one of the attributes is needed.

6.3.3.4   Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.4   GeoLoc <<dataType>>

6.3.4.1   Definition

This datatype represent the geographical location.

6.3.4.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
geographicalCoordinates	CM	T	T	F	T
civicLocations	CM	T	T	F	T

6.3.4.3 Attribute constraints

Name	Definition
geographicalCoordinates Support Qualifier	Condition: If the serving location is defined as geographical coordinates [2].
civicLocationsSupport Qualifier	Condition: If the serving location is defined as civic locations [2].

NOTE: Only one of the attributes is needed.

6.3.4.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.5 ECSFunction

6.3.5.1 Definition

This IOC represents the ECS functionality for supporting Edge Computing. For more information about the ECS, see 3GPP TS 23.558 [2].

6.3.5.2 Attributes

The ECSFunction IOC includes attributes inherited from ManagedFunction IOC (defined in TS 28.622 [4]) and the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
ecsAddress	M	T	T	F	T
providerIdentifier	O	T	T	F	T
softwareImageInfo	M	T	T	F	T
Attribute related to role					
edgeDataNetworkRef	M	T	T	F	T
eESFunctionRef	M	T	T	F	T

6.3.5.3 Attribute constraints

None.

6.3.5.4 Notifications

The common notifications defined in clause 5.5 of TS 28.541 [3] are valid for this IOC, without exceptions or additions.

6.3.6 EDNConnectionInfo <<datatype>>

6.3.6.1 Definition

This datatype represent the EDN connection information.

6.3.6.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
dNN	M	T	T	F	T
eDNServiceArea	M	T	T	F	T

6.3.6.3 Attribute constraints

None.

6.3.6.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.7 TopologicalServiceArea <<dataType>>

6.3.7.1 Definition

This datatype represents the topological service area.

6.3.7.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
cellIDList	CM	T	T	F	T
trackingAreaIdList	CM	T	T	F	T
servingPLMN	CM	T	T	F	T

6.3.7.3 Attribute constraints

Name	Definition
cellIDList Support Qualifier	Condition: If the serving location is defined as cell IDs [2].
trackingAreaIdList Support Qualifier	Condition: If the serving location is defined as tracking area IDs [2].
servingPLMN Support Qualifier	Condition: If the serving location is defined as PLMN ID [2].

NOTE: Only one of the attributes is needed.

6.3.7.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.8 GeographicalCoordinates <<dataType>>

6.3.8.1 Definition

This datatype represents the geographical coordinates.

6.3.8.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
latitude	M	T	T	F	T
longitude	M	T	T	F	T

6.3.8.3 Attribute constraints

None.

6.3.8.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.9 SoftwareImageInfo <<dataType>>

6.3.9.1 Definition

This datatype represents the software image information.

6.3.9.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
minimumDisk	M	T	T	F	T
minimumRAM	M	T	T	F	T
diskFormat	M	T	T	F	T
operatingSystem	M	T	T	F	T
Attribute related to role					
swImageRef	M	T	T	F	T

6.3.9.3 Attribute constraints

None.

6.3.9.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.10 EdgeDataNetwork

6.3.10.1 Definition

This IOC represent the EDN information for supporting Edge Computing. For more information about EDN, see 3GPP TS 23.558 [2].

6.3.10.2 Attributes

The EdgeDataNetwork IOC includes attributes inherited from Top IOC (defined in TS 28.622[4]) and the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
ednIdentifier	M	T	T	F	T
eDNConnectionInfo	M	T	T	F	T

6.3.10.3 Attribute constraints

None.

6.3.10.4 Notifications

The common notifications defined in subclause 5.5 of TS 28.541 [3] are valid for this IOC, without exceptions or additions.

6.3.11 AffinityAntiAffinity <<datatype>>

6.3.11.1 Definition

This datatype represent the affinity and anti-affinity requirements of the EAS with other EAS on the same EDN.

6.3.11.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
affinityEAS	M	T	T	F	T
antiAffinityEAS	M	T	T	F	T

6.3.11.3 Attribute constraints

None.

6.3.11.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.12 VirtualResource <<datatype>>

6.3.12.1 Definition

This datatype represent the virtual resource requirements of an EAS.

6.3.12.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
virtualMemory	M	T	T	F	T
virtualDisk	M	T	T	F	T
virtualCPU	M	T	T	F	T

6.3.12.3 Attribute constraints

None.

6.3.12.4 Notifications

The clause 5.5, in TS 28.541[3], of the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

6.3.13 EESFunction

6.3.13.1 Definition

This IOC represent the properties of a EES in a 3GPP network. For more information about EES, see 3GPP TS 23.558.

6.3.13.2 Attributes

The EESFunction IOC includes attributes inherited from ManagedFunction IOC (defined in TS 28.622 [4]) and the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
eESIdentifier	M	T	T	F	T
eESServingLocation	M	T	T	F	T
eESAddress	M	T	T	F	T
softwareImageInfo	M	T	T	F	T
serviceContinuitySupport	M	T	T	F	T
Attribute related to role					
eASFunctonRef	M	T	T	F	T

6.3.13.3 Attribute constraints

None.

6.3.13.4 Notifications

The common notifications defined in clause 5.5 of TS 28.541 [3] are valid for this IOC, without exceptions or additions.

6.4 Attribute definition

6.4.1 Attribute Properties

Attribute Name	Documentation and Allowed Values	Properties
eASIdentifier	It refers to EASID that identifies a particular application (e.g. SA6Video, SA6Game, … etc.) (see clause 7.2.4 in TS 23.558 [2]).	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
eASAddress	One or more URLs and/or IP Address(es) of EAS(s) (See TS 23.558 [2]). allowedValues: N/A	type: String multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A isNullable: False
eASRequirementsRef	This is the DN of EASRequirements. allowedValues: Not applicable	type: DN multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
edgeDataNetworkRef	This holds a list of DN of EdgeDataNetwork.	type: DN multiplicity: 1..* isOrdered: N/A isUnique: True defaultValue: None isNullable: False
requiredEASservingLocation	It defines the location where the EAS service should be available (see clause 7.3.3.6 in TS 23.558 [2]).	type: ServingLocation multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
geographicalLocation	This refers to the Geographical Service Area, (see clause 7.3.3.3 in TS 23.558 [2] that is defined as a datatype (see clause 6.3.4). allowedValues: N/A	type: GeoLoc multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
latitude	This defines the single latitude coordinate.	type: Float multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
longitude	This defines the single longitude coordinate.	type: Float multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
civicLocation	This defines the civic locations, such as: a well-known buildings, parks, arenas, civic addresses, or ZIP code etc (see clause 7.3.3.3 in TS 23.558 [2]).	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
topologicalLocation	This refers to the Topological Service Area, (see clause 7.3.3.2 in TS 23.558 [2]) that is defined as a datatype (see clause 6.3.7). allowedValues: N/A	type: TopologicalServiceArea multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
geographicalCoordinates	This refers to the Topological Service Area, (see clause 7.3.3.2 in TS 23.558 [2]) that is defined as a datatype (see clause 6.3.8). allowedValues: N/A	type: GeographicalCoordinates multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
softwareImageInfo	This refers to the software image information (e.g. software image location, minimum RAM, disk requirements) (see clause 7.1.6.5 in ETSI NFV IFA-011 [7]). It is defined as a datatype (see clause 6.3.9). allowedValues: N/A	type: SoftwareImageInfo multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
swImageRef	It indicates the reference to the actual software image that is represented by URL (see clause 7.1.6.5 in ETSI NFV IFA-011 [7]).	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
minimumDisk	It indicates the minimum disk size requirement for the EAS software (see clause 7.1.6.5 in ETSI NFV IFA-011 [7]). The unit is Megabyte.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
minimumRAM	It indicates the minimum RAM size requirement for the EAS software (see clause 7.1.6.5 in ETSI NFV IFA-011 [7]). The unit is Megabyte.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
diskFormat	It indicates the disk format requirement for the EAS software (see clause 7.1.6.5 in ETSI NFV IFA-011 [7]).	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
operatingSystem	It indicates the operating system requirement for the EAS software (see clause 7.1.6.5 in ETSI NFV IFA-011 [7]).	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
cellIDList	It represents the list of NR cells. The cell ID, together with the gNB Identifier (using gNBId of the parent GNBCUCPFunction or GNBDUFunction or ExternalCUCPFunction), identifies a NR cell within a PLMN. This is the NR Cell Identity (NCI). See subclause 8.2 of TS 38.300 [13]. AllowedValues: Not applicable	type: Integer multiplicity: * isOrdered: N/A isUnique: Yes defaultValue: None isNullable: True
trackingAreaIdList	It represents the list of tracking areas within a PLMN.	type: TAI multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
servingPLMN	It specifies the PLMN to be served.	type: PLMNId multiplicity: 1 isOrdered: F isUnique: N/A defaultValue: None isNullable: True
ecsAddress	One or more URLs and/or IP Address(es) of ECS(s) (See TS 23.558 [2]). allowedValues: N/A	type: String multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A isNullable: False
providerIdentifier	The identifier of the ECSP that provides the ECS (See TS 23.558 [2]). allowedValues: N/A	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A isNullable: False
eDNConnectionInfo	It defines the set of information needed to connect to an EDN.	type: EDNConnectionInfo multiplicity: 1..* isOrdered: N/A isUnique: True defaultValue: None **isNullable: False**
eDNServiceArea	This parameter defines the service location for the EDN (see clause 7.3.3.4 in TS 23.558 [2]).	type: ServingLocation multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
ednIdentifier	The identifier of the edge data network (See TS 23.558 [2]). allowedValues: N/A	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A **isNullable: False**
affinityAntiAffinity	This parameter defines the affinity and anti-requirements of the EAS with other EAS on the same EDN.	type: AffinityAntiAffinity multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
affinityEAS	This parameter defines the EAS identifier with which the affinity is required.	type: String multiplicity: 1...* isOrdered: N/A isUnique: True defaultValue: None isNullable: False
antiAffinityEAS	This parameter defines the EAS identifier with which the anti-affinity is required.	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
serviceContinuity	This parameter defines if the service continuity is required by the EAS. If the value is TRUE, the EAS will be deployed with an EES supporting service continuity.	type: Boolean multiplicity: 1...* isOrdered: N/A isUnique: True defaultValue: False isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
`virtualResource`	This parameter defines the virtual resource requirements of an EAS.	type: VirtualResource multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`virtualMemory`	It indicates the minimum virtual memory size requirements for EAS in megabytes. (see clause 7.1.9.3.2.2 in ETSI NFV IFA-011 [7]).	type: Integer multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`virtualDisk`	It indicates the minimum virtual disk storage requirement for the EAS (see clause 7.1.9.4.3.2 in ETSI NFV IFA-011 [7]).	type: Integer multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`virtualCPU`	It indicates the virtual CPU requirement for the EAS (see clause 7.1.9.2.3.2 in ETSI NFV IFA-011 [7]).	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`eESAddress`	One or more URLs and/or IP Address(es) of EES(s) (See TS 23.558 [2]). allowedValues: N/A	type: String multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A isNullable: False
`eESIdentifier`	It identifies the EES, see 3GPP TS 23.558.	type: String multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`eASFunctionRef`	This is the DN of `EASFunction`. allowedValues: DN of the `EASFunction MOI.`	type: DN multiplicity: 1..* isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`serviceContinuitySupport`	This parameter defines whether the EES supports service continuity, see 3GPP TS 23.558	type: Boolen multiplicity: 1 isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`eESservingLocation`	It defines the serving location for an EES.	type: ServingLocation multiplicity: 1..* isOrdered: N/A isUnique: True defaultValue: None isNullable: False
`eESAddress`	One or more URLs and/or IP Address(es) of EES(s) (See TS 23.558 [2]). allowedValues: N/A	type: String multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None allowedValues: N/A isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
`eESFunctionRef`	This is the DN of `EESFunction`. allowedValues: DN of the `EESFunction MOI`.	type: DN multiplicity: 1..* isOrdered: N/A isUnique: True defaultValue: None isNullable: False

7 Procedural Flows

7.1 Lifecycle management

7.1.1 Description

The clause contains procedures associated with lifecycle management.

7.1.2 EAS lifecycle management

7.1.2.1 EAS deployment

Figure 7.1.2.1-1 depicts a procedure that describes how an ASP can consume provisioning MnS to instantiate the EAS. It is assumed that both ASP and ECSP consumers have subscribed to the producer of provisioning MnS to receive notifications.
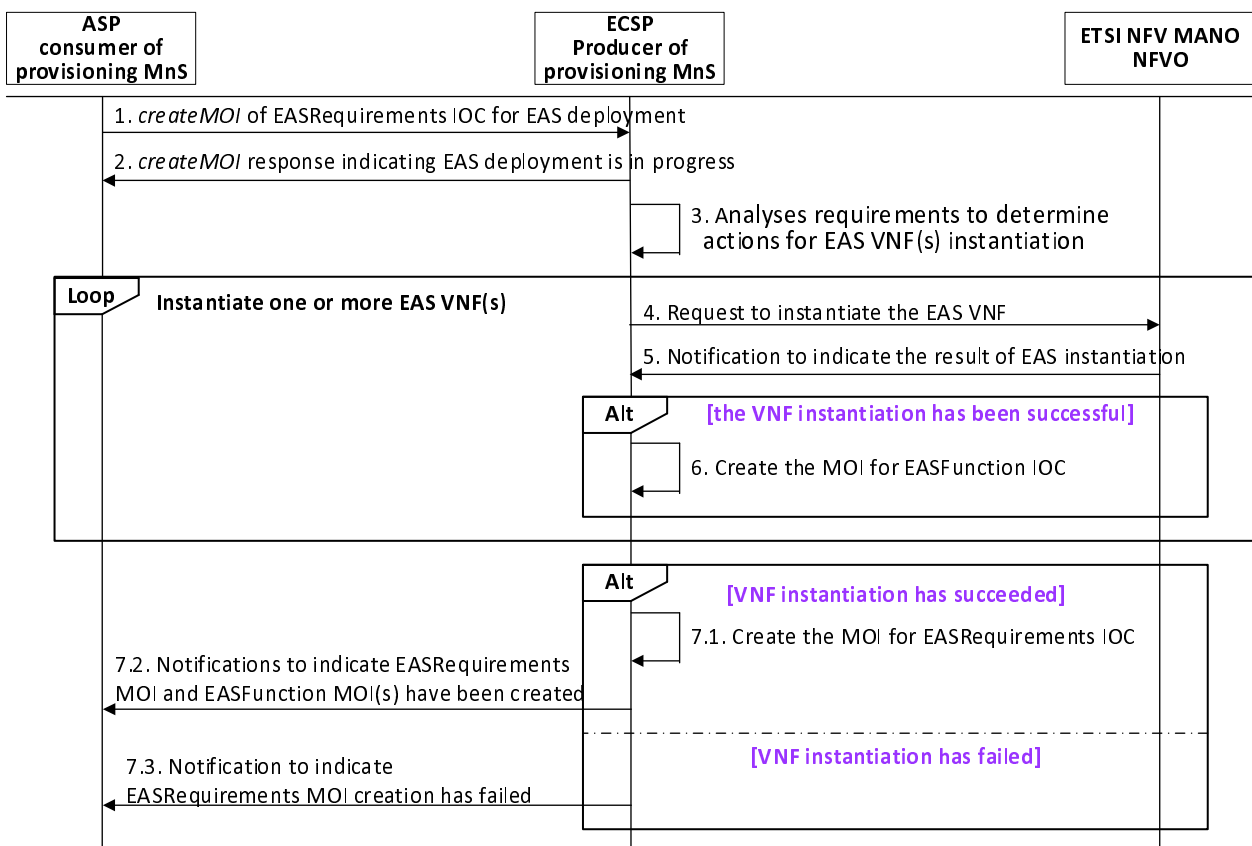

Figure 7.1.2.1-1: EAS deployment

1. ASP consumes the provisioning MnS with *createMOI* operation (see clause 11.1.1.1. in TS 28.532 [w]) for EASRequirements IOC to request ECSP provisioning MnS producer to start the EAS VNF instantiation, where

the EASRequirements IOC contains the deployment requirements, including (but not limited to) the following attributes:

- the service areas (i.e., geographical, or topological) where the UEs can access the edge computing service (see clause 7.3.3 in TS 28.558 [2]).

- Software image information and virtual resource information (e.g. software image location, minimum RAM, disk requirements) (see clause 7.1.6.5 and 7.1.9 in ETSI NFV IFA-011 [7]).

- QoS requirements (e.g. bandwidth, end-to-end latency).

- service continuity requirements (e.g. whether service continuity is required).

- Affinity/Anti-affinity: The affinity and ant-affinity requirements for the EAS with other existing EAS on the target EDN.

2. ECSP provisioning MnS producer sends a response to the ASP indicating that the instantiation operation is in progress.

3. ECSP provisioning MnS producer analyses the deployment requirements to determine which EDN and how many EAS instance(s) should be instantiated to satisfy the deployment requirements, and downloads the EAS VNF software image from the software image location. The EDN can be selected either by considering the individual requirement or by grouping the multiple requirements as single selection criteria.

4. ECSP provisioning MnS producer invokes the *InstantiateNsRequest* or UpdateNsRequest operation (see clause 7.3.3 and 7.3.5 in ETSI GS NFV-IFA 013 [6]) to request NFVO via the Os-Ma-nfvo interface to instantiate a NS instance including the EAS VNF instance.

Editor's note: which entity is responsible for creating VNFD based on the deployment requirement (e.g., softwareImageInfo and virtualResource) is FFS.

5. NFVO sends a notification to ECSP provisioning MnS producer indicating the result of instantiation procedure (see clause 7.3.3.4 and 7.3.5.4 of ETSI GS NFV-IFA 013 [6]).

6. If the VNF instantiation has been successful, ECSP provisioning MnS producer creates the MOI for EASFunction IOC.

7. If all VNF instance(s) have been successfully instantiated, then:

7.1. ECSP provisioning MnS producer creates the MOI for EASRequirements IOC.

7.2. ECSP provisioning MnS producer notifies ASP about the successful instantiation of EAS with the creation of MOIs for the EASRequirement IOC and EASFunction(s) IOC.

Otherwise:

7.3 ECSP provisioning MnS producer notifies ASP about the un-successful instantiation of the EAS.

7.1.2.2   EAS termination

Figure 7.1.2.2-1 depicts a procedure that describes how an ASP can consume provisioning MnS to terminate the EAS VNF. It is assumed that both ASP and ECSP consumers have subscribed to the producer of provisioning MnS to receive notifications.
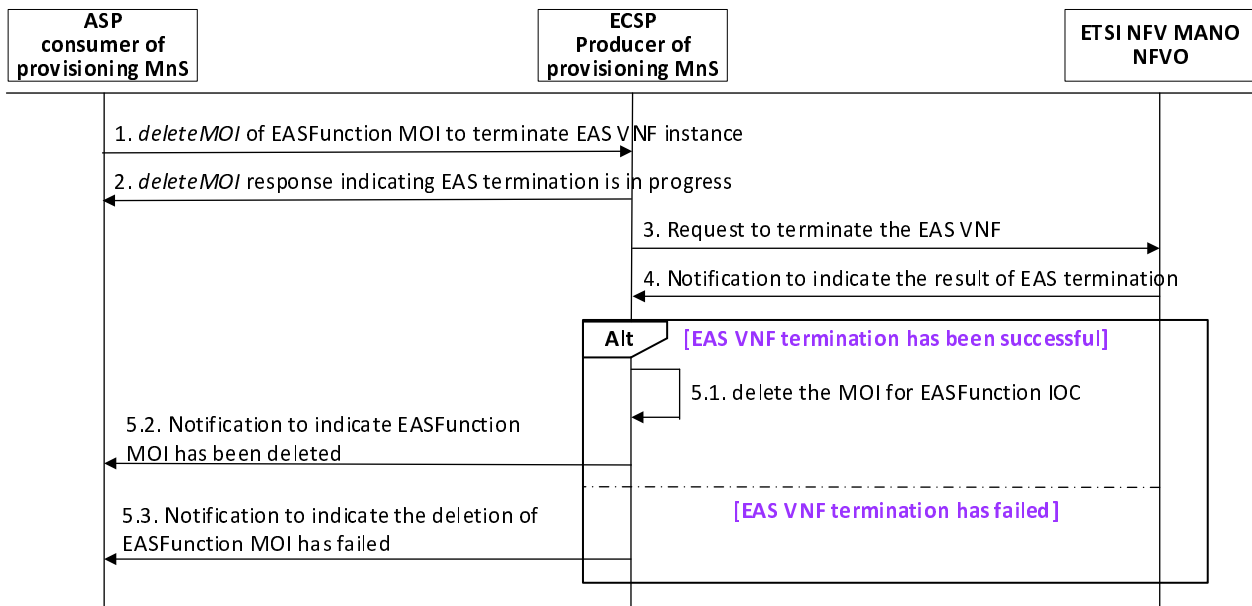
Figure 7.1.2.2-1: EAS termination

1. ASP consumes the provisioning MnS with *deleteMOI* (see clause 11.1.1.4. in TS 28.532 [5]) operation for EASFunction MOI to request ECSP provisioning MnS producer to start the EAS VNF termination.

2. ECSP provisioning MnS producer sends a response to the ASP indicating that the termination operation is in progress.

3. ECSP provisioning MnS producer invokes the *TerminateNsRequest* or UpdateNsRequest operation (see clauses 7.3.7 and 7.3.5 in ETSI GS NFV-IFA 013 [6]) to request NFVO via the Os-Ma-nfvo interface to terminate EAS VNF instance.

4. NFVO sends the NS Lifecycle Change notification to ECSP provisioning MnS producer indicating the result of termination procedure (see clause 7.3.12 of ETSI GS NFV-IFA 013 [6]).

5. If the VNF termination has been successful then:

    5.1. ECSP provisioning MnS producer deletes the MOI for EASFunction IOC ,if all the related EASFunction MOIs have been deleted, the EASRequirement IOC shall also be deleted.

    5.2. ECSP provisioning MnS producer notifies ASP about the successful termination of the EAS.

Otherwise :

    5.3. ECSP provisioning MnS producer notifies ASP about the un-successful termination of the EAS.

7.1.3   ECS lifecycle management

7.1.3.1   ECS deployment

Figure 7.1.3.1-1 shows that the PLMN operator or ECSP as the consumer requests the ECS instantiation via the provisioning MnS.
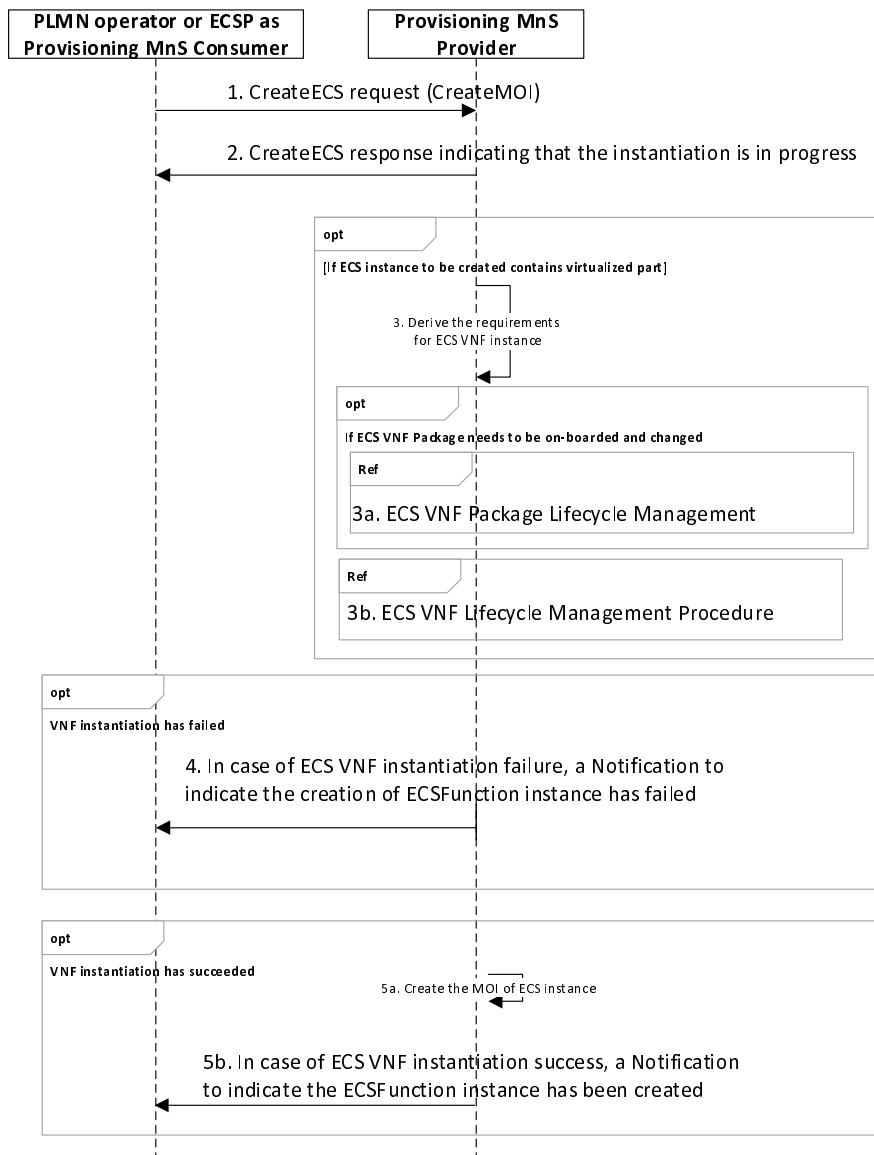
Figure 7.1.3.1-1: ECS deployment procedure

1. Provisioning MnS Producer receives a request (this will use createMOI operation defined in 3GPP TS 28.532 [5]) with ECS related requirements. The following are the list of requirements, which can be provided with the request as part of attributeListIn parameter of createMOI operation.

   a. ecsAddress: the URLs and/or IP Address(es) of ECS.

   b. providerIdentifier: Identifying the ECSP that provides the ECS.

2. Provisioning MnS Producer returns a response indicating that the instantiation operation is in progress.

3. The NF instance creation procedure as described in clause 7.10 of [5] is reused to instantiate the ECS VNF instance with the requirements captured in the ECSFunction IOC.

4. In case of ECS VNF instantiation failure, a Notification to indicate the creation of ECSFunction instance has failed.

5. In case of ECS VNF instantiation success, the producer creates the MOI (Managed Object Instance) for ECSFunction IOC. The MOI shall contain attributes as defined in ECSFunction IOC. The Provisioning MnS Producer sends a Notification to indicate the ECSFunction instance has been created.

7.1.3.2   ECS termination

Figure 7.1.3.2-1 shows that the PLMN operator or ECSP as the consumer requests the ECS termination via the provisioning MnS.
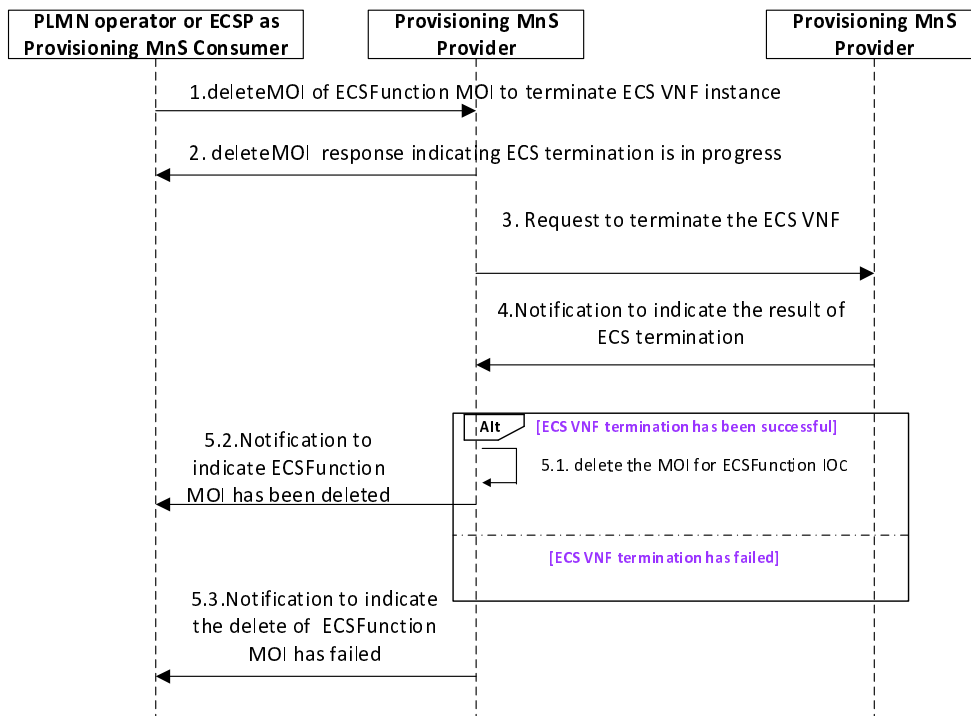

Figure 7.1.3.2-1: ECS termination procedure

1. PLMN operator or ECSP consumes the provisioning MnS with deleteMOI operation (see clause 11.1.1.4. in TS 28.532 [5]) for ECSFunction MOI to request ECSP management system provisioning MnS producer to terminate the ECS VNF instance.

2. ECSP management system provisioning MnS producer sends a response to the consumer indicating that the termination operation is in progress.

3. ECSP management system provisioning MnS producer invokes the TerminateNsRequest or UpdateNsRequest operation (see clause 7.3.7 and 7.3.5 in ETSI GS NFV-IFA 013 [6]) to request NFVO via the Os-Ma-nfvo interface to terminate ECS VNF instance.

4. NFVO sends the NS Lifecycle Change notification to ECSP provisioning MnS producer indicating the result of termination procedure (see clause 7.3.12 of ETSI GS NFV-IFA 013 [6]).

5. If the VNF termination has been successful then:

   5.1. ECSP management system provisioning MnS producer deletes the MOI for ECSFunction IOC.

   5.2. ECSP management system provisioning MnS producer notifies the consumer about the successful termination of the ECS.

   Otherwise :

   5.3. ECSP management system provisioning MnS producer notifies the consumer about the un-successful termination of the ECS.

7.1.4   EES lifecycle management

7.1.4.1   EES deployment

Figure 7.1.4.1-1 shows that the PLMN operator or ECSP as the consumer requests the EES instantiation via the provisioning MnS.

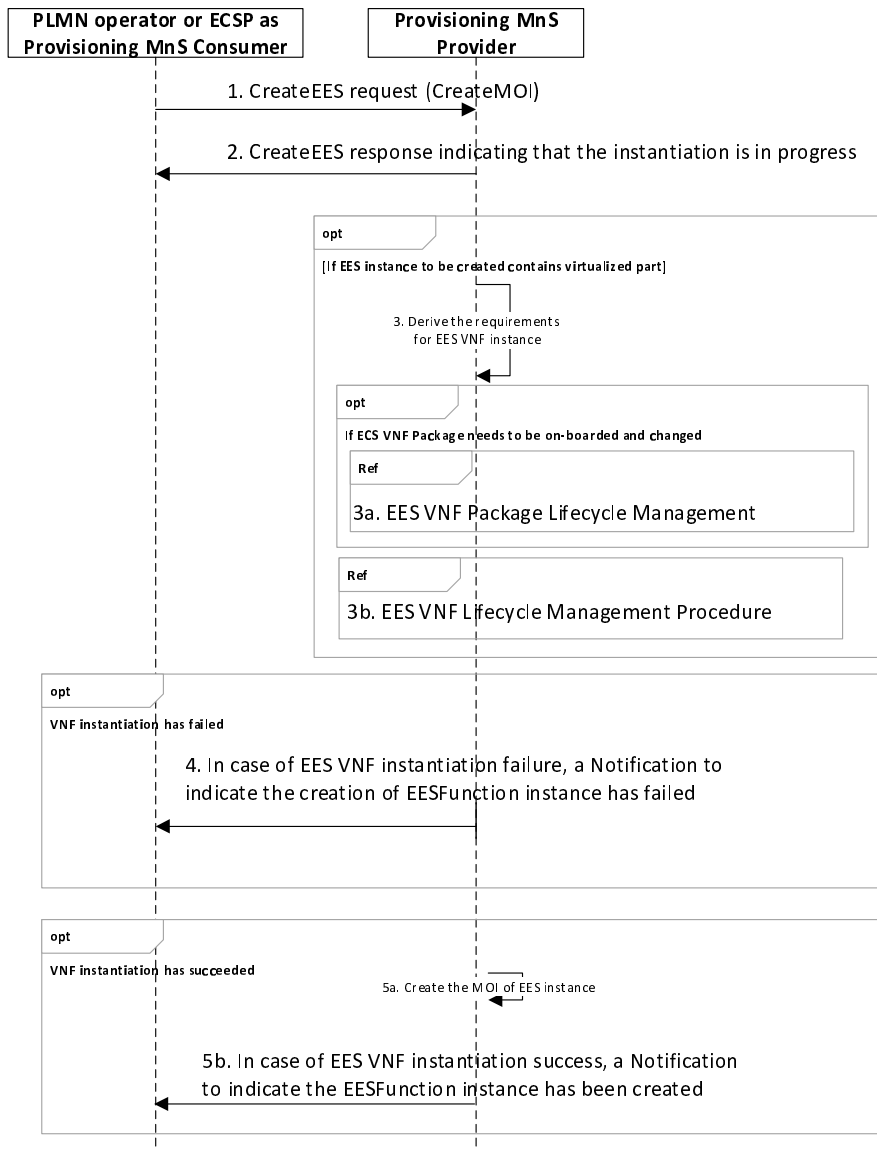**Figure 7.1.4.1-1: EES deployment procedure**

1. Provisioning MnS Producer receives a request (this will use createMOI operation defined in 3GPP TS 28.532 [5]) with EES related requirements. The following are the list of requirements, which can be provided with the request as part of attributeListIn parameter of createMOI operation.

   a. EDN identifier: Identifying the EDN to contain the EES in.

b. EAS identifier: Identifying the list of EAS registered with the EES. This is optional depending on the availability of the EAS.

2. Provisioning MnS Producer returns a response indicating that the instantiation operation is in progress

3. The NF instance creation procedure as described in clause 7.10 of [5] is reused to instantiate the EES VNF instance with the requirements provided in the instantiation request.

4. In case of EES VNF instantiation failure, a Notification to indicate the creation of EESFunction instance has failed.

5. In case of EES VNF instantiation success, the producer creates the MOI (Managed Object Instance) for EESFunction IOC. The MOI shall contain attributes as defined in EESFunction IOC. The Provisioning MnS Producer sends a Notification to indicate the EESFunction instance has been created.

7.1.4.2 EES termination

Figure 7.1.4.2-1 shows that the PLMN operator or ECSP as the consumer requests the EES termination via the provisioning MnS.
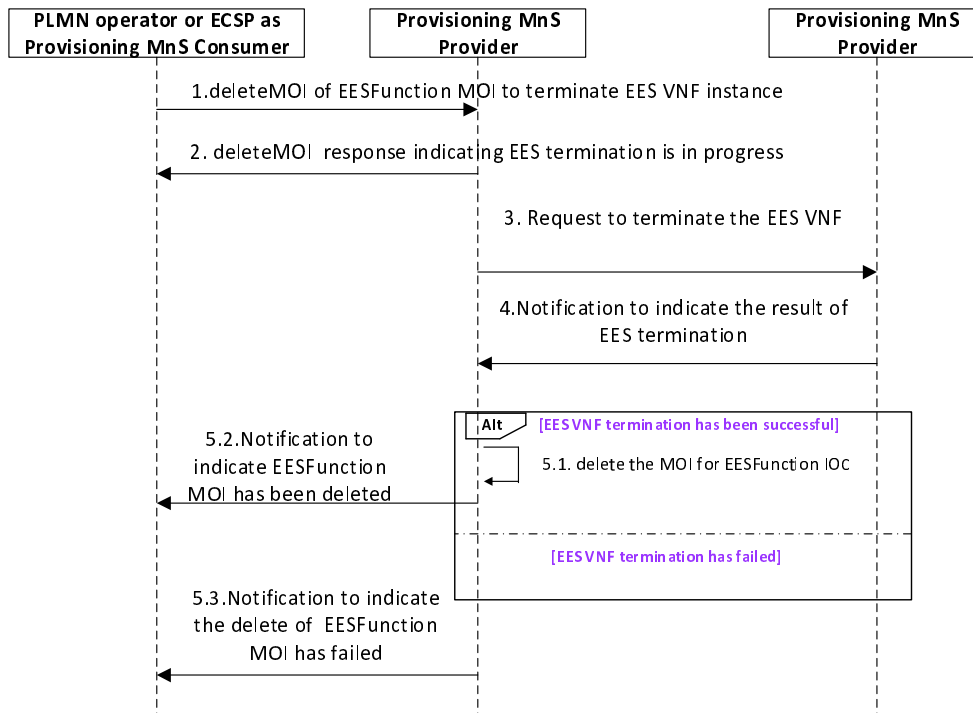
Figure 7.1.4.2-1: EES termination procedure

1. PLMN operator or ECSP consumes the provisioning MnS with deleteMOI operation (see clause 11.1.1.4. in TS 28.532 [5]) for EESFunction MOI to request ECSP management system provisioning MnS producer to terminate the EES VNF instance.

2. ECSP management system provisioning MnS producer sends a response to the consumer indicating that the termination operation is in progress.

3. ECSP management system provisioning MnS producer invokes the TerminateNsRequest or UpdateNsRequest operation (see clauses 7.3.7 and 7.3.5 in ETSI GS NFV-IFA 013 [6]) to request NFVO via the Os-Ma-nfvo interface to terminate EES VNF instance.

4. NFVO sends the NS Lifecycle Change notification to ECSP provisioning MnS producer indicating the result of termination procedure (see clause 7.3.12 of ETSI GS NFV-IFA 013 [6]).

5. If the VNF termination has been successful then:

5.1. ECSP management system provisioning MnS producer deletes the MOI for EESFunction IOC.

5.2. ECSP management system provisioning MnS producer notifies the consumer about the successful termination of the EES.

Otherwise :

5.3. ECSP management system provisioning MnS producer notifies the consumer about the un-successful termination of the EES.

7.2 Performance assurance

7.2.1 Description

The clause contains procedures associated with performance assurance.

7.2.2 EAS performance assurance

7.2.2.1 Measurement collection via performance job control

Figure 7.2.2.1-1 depicts a procedure that describes how an ASP can consume performance assurance MnS to collect the EAS measurements via performance job control.

Figure 7.2.2.1-1: Measurement collection via performance job control

1. ASP, as the consumer of performance assurance MnS, consumes the measurement job control MnS with `createMeasurementJob` operation (see TS 28.550 [8]) to request ECSP management system, as the producer of performance assurance MnS, to collect EAS measurements. The `createMeasurementJob` operation also includes a reportingMethod attribute to indicating the report method (i.e., performance data file or by performance data streaming).

2. ECSP management system returns the output parameter with jobId to indicate the PM job been created.

3. If this PM job is based on performance file reporting service, then

   3.1. ASP invokes the `subscribe` operation (see clause 12.6.1.1.1 in TS 28.532 [5]) to subscribe to receive notifications from the ECSP management system.

3.2. ECSP management system sends a `notifyFileReady` notification (see clause 11.6.1.1 in TS 28.532 [5]) to ASP to indicate the performance data file is ready.

3.3. ASP fetches the EAS measurement data from the MnS producer.

Otherwise (performance data streaming service)

3.4. ECSP management system invokes the `establishStreamingConnection` operation (see clause 11.5.1.1 in TS 28.532 [5]) to establish a streaming connection with ASP for sending the streaming data.

3.5 ECSP management system collects the EAS measurement data and invokes the `reportStreamData` operation (see clause 11.5.1.3 in TS 28.532 [5]) to send the streaming data to ASP.

7.2.2.2 Measurement collection via configurable measurement control

Figure 7.2.2.2-1 depicts a procedure that describes how an ASP can consume performance assurance MnS to collect the EAS measurements via configurable measurement control.
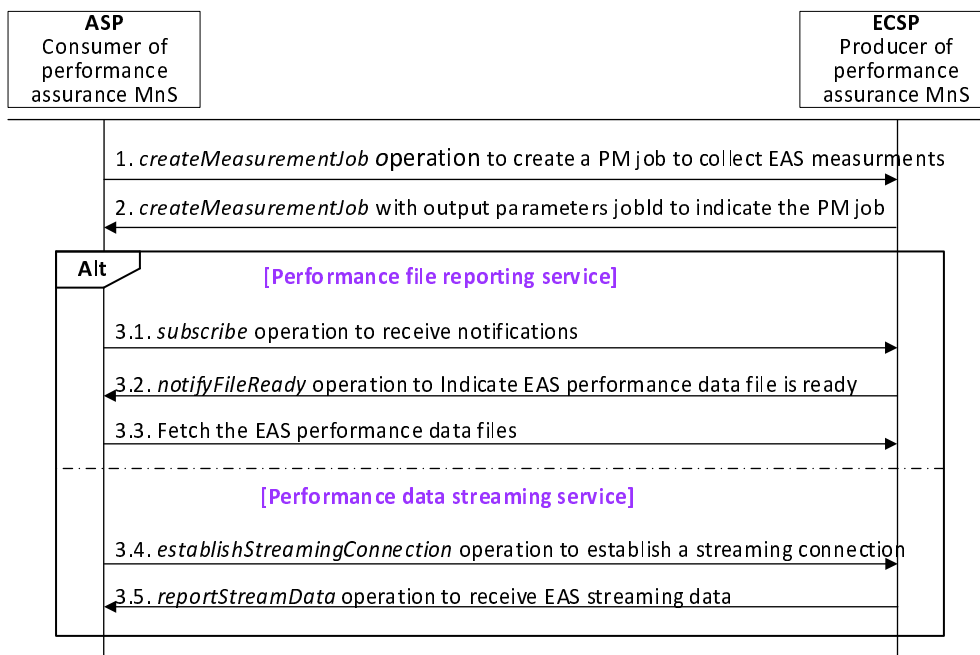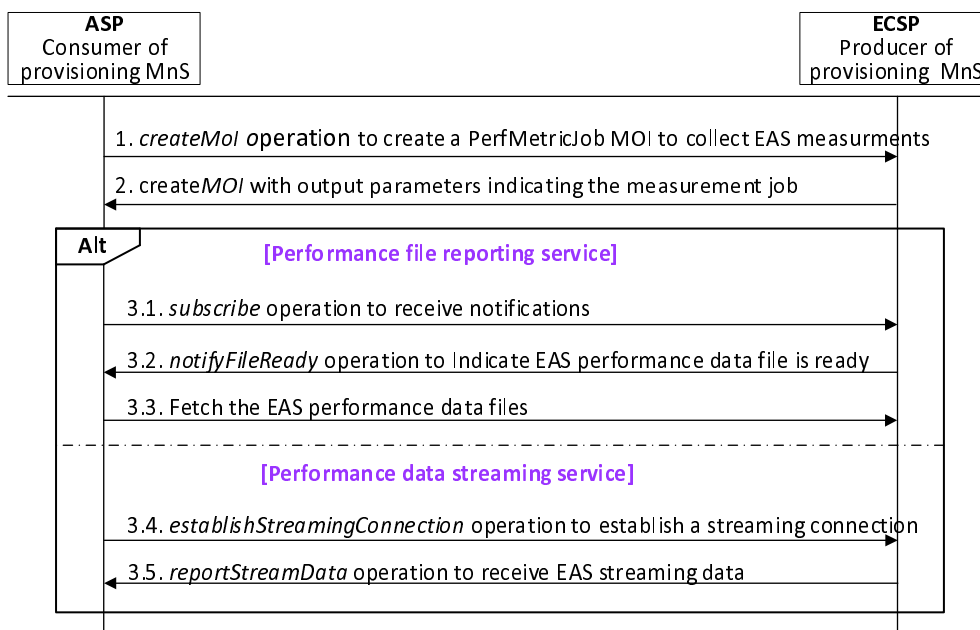

Figure 7.2.2.2-1: Measurements collection via configurable measurement control

1. ASP, as the consumer of provisioning MnS, consumes the provisioning MnS with `createMOI` operation for `PerfMetricJob` IOC to request ECSP management system, as the producer of provisioning MnS, to collect EAS measurements. The `PerfMetricJob` MOI includes a ReportingCtrl attribute (See clause 4.3.33 in TS 28.622 [4]) to indicating the report method (i.e., performance data file or by performance data streaming).

2. ECSP management system returns the output parameter with jobId to indicate the PM job been created.

3. If this PM job is based on performance file reporting service, then:

3.1. ASP invokes the `subscribe` operation (see clause 12.6.1.1.1 in TS 28.532 [5]) to subscribe to receive notifications from the ECSP management system.

3.2. ECSP management system sends a `notifyFileReady` notification to ASP to indicate the performance data file is ready.

3.3. ASP fetches the EAS measurement data from the MnS producer.

Otherwise (performance data streaming service)

3.4. ECSP management system invokes the `establishStreamingConnection` operation to establish a streaming connection with ASP for sending the streaming data.

3.5. ECSP management system collects the EAS measurement data and invokes the `reportStreamData` operation to send the streaming data to ASP.

7.2.3   5GC NF measurements to evaluate EAS performance

7.2.3.1   Measurement collection via performance job control

Figure 7.2.3.1-1 depicts a procedure that describes how an ECSP management system can consume performance assurance MnS to collect the 5GC NF measurements from PLMN management system via performance job control.
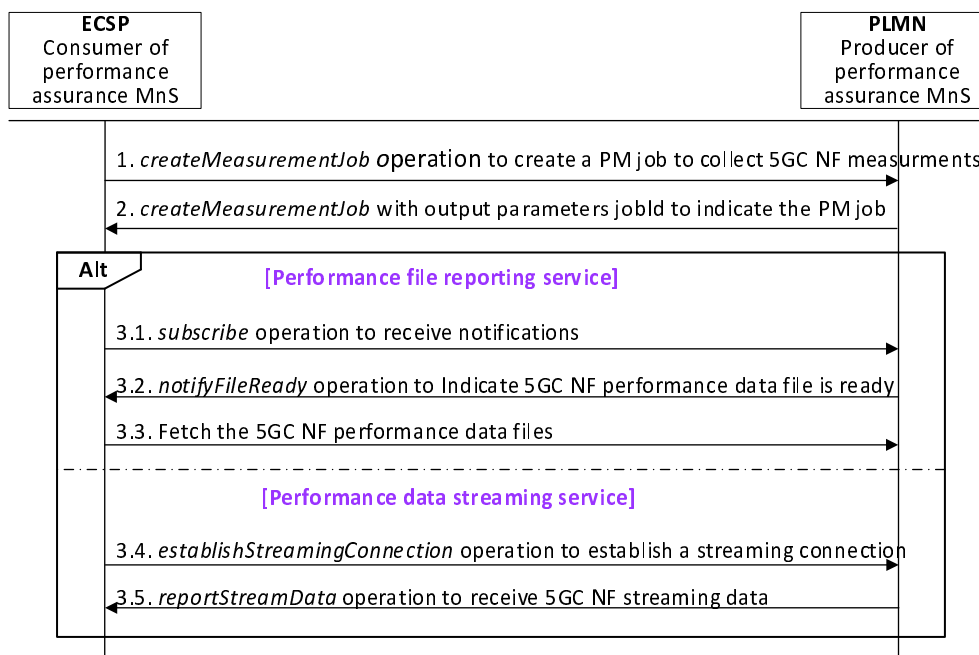

Figure 7.2.3.1-1: Measurements collection via performance job control

1. ECSP management system, as the consumer of performance assurance MnS, consumes the measurement job control MnS with `createMeasurementJob` operation (see TS 28.550 [8]) to request ECSP management system, as the producer of performance assurance MnS, to collect 5GC NF measurements that may impact EAS performance. The `createMeasurementJob` operation also includes a reportingMethod attribute to indicating the report method (i.e., performance data file or by performance data streaming).

2. PLMN management system returns the output parameter with jobId to indicate the PM job been created.

3. If this PM job is based on performance file reporting service, then

   3.1. ECSP management system invokes the `subscribe` operation (see clause 12.6.1.1.1 in TS 28.532 [5]) to subscribe to receive notifications from the PLMN management system.

   3.2. PLMN management system sends a `notifyFileReady` notification to ASP to indicate the performance data file is ready.

   3.3. ECSP management system fetches the 5GC NF measurement data from the MnS producer.

   Otherwise (performance data streaming service)

   3.4. PLMN management system invokes the `establishStreamingConnection` operation to establish a streaming connection with ECSP management system for sending the streaming data.

   3.5 PLMN management system collects the measurement data and invokes the `reportStreamData` operation to send the 5GC NF streaming data to ECSP management system.

7.2.3.2   Measurement collection via configurable measurement control

Figure 7.2.3.2-1 depicts a procedure that describes how an ECSP management system can consume performance assurance MnS to collect the 5GC NF measurements from PLMN management system via configurable measurement control.
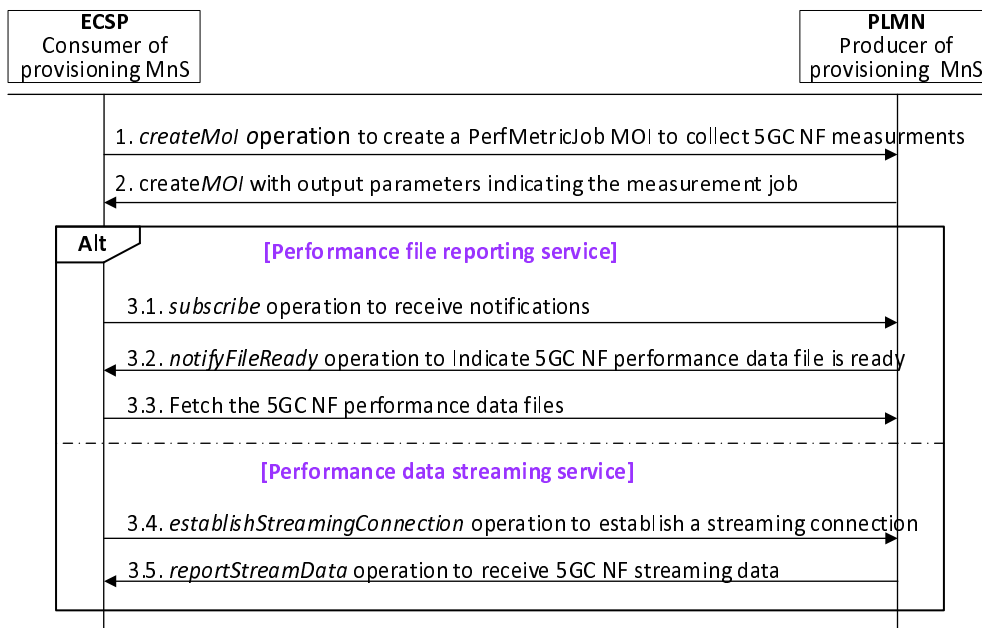

Figure 7.2.3.2-1: Measurement collection via configurable measurement control

1. ECSP management system, as the consumer of provisioning MnS, consumes the provisioning MnS with `createMOI` operation for `PerfMetricJob` IOC to request ECSP management system, as the producer of provisioning MnS, to collect 5GC NF measurements that may impact EAS performance. The `PerfMetricJob` MOI includes a ReportingCtrl attribute (See clause 4.3.33 in TS 28.622 [4]) to indicating the report method (i.e., performance data file or by performance data streaming).

2. PLMN management system returns the output parameter with jobId to indicate the PM job been created.

3. If this PM job is based on performance file reporting service, then

   3.1. ECSP management system invokes the `subscribe` operation (see clause 12.6.1.1.1 in TS 28.532 [5]) to subscribe to receive notifications from the PLMN management system.

   3.2. PLMN management system sends a `notifyFileReady` notification to ASP to indicate the performance data file is ready.

   3.3. ECSP management system fetches the 5GC NF measurement data from the MnS producer.

   Otherwise (performance data streaming service)

   3.4. PLMN management system invokes the `establishStreamingConnection` operation to establish a streaming connection with ASP for sending the streaming data.

   3.5. PLMN management system collects the measurement data and invokes the `reportStreamData` operation to send the 5GC NF streaming data to ECSP management system.

7.2.4   ECS performance assurance

7.2.4.1   Measurement collection via performance job control

The mechanism used for collecting EAS measurements, as defined in clause 7.2.2.1, via performance job control are used for collecting ECS measurements too. ECSP consumer can request ECSP management system for collecting ECS measurements using measurement job control MnS with createMeasurementJob operation (see TS 28.550 [8]). The

measurements are delivered to the consumer either using File data reporting service or Streaming data reporting service as defined in [5].

7.2.4.2 Measurement collection via configurable measurement control

The mechanism used for collecting EAS measurements, as defined in clause 7.2.2.2, via configurable measurement control are used for collecting ECS measurements too. ECSP consumer can request ECSP management system for collecting ECS measurements using `createMOI` operation for `PerfMetricJob` IOC [4]. The measurements are delivered to the consumer either using File data reporting service or Streaming data reporting service as defined in [5].

7.2.5 EES performance assurance

7.2.5.1 Measurement collection via performance job control

The mechanism used for collecting EAS measurements, as defined in clause 7.2.2.1, via performance job control are used for collecting EES measurements too. Any management consumer can request for collecting EES measurements using measurement job control MnS with createMeasurementJob operation (see TS 28.550 [8]). The measurements are delivered to the consumer either using File data reporting service or Streaming data reporting service as defined in [5].

7.2.5.2 Measurement collection via configurable measurement control

The mechanism used for collecting EAS measurements, as defined in clause 7.2.2.2, via configurable measurement control are used for collecting EES measurements too. Any management consumer can request for collecting EES measurements using `createMOI` operation for `PerfMetricJob` IOC [4]. The measurements are delivered to the consumer either using File data reporting service or Streaming data reporting service as defined in [5].

7.3 Fault supervision

7.3.1 Description

The clause contains procedures associated with Fault supervision.

7.3.2 EDN NF performance impacted by 5GC NF alarm

Figure 7.3.2-1 depicts a procedure to describe how an ECSP management system can consume fault supervision MnS to receive 5GC NF alarms.
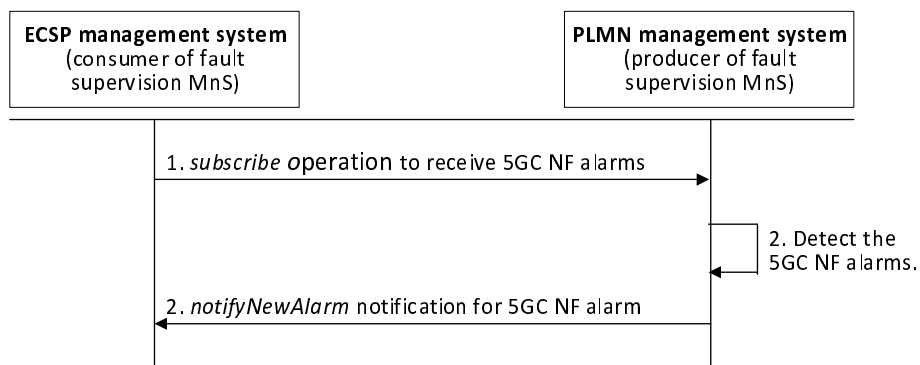

Figure 7.3.2-1: EDN NF performance impacted by 5GC NF alarm

1. ECSP, as the consumer of fault supervision MnS, consumes the generic fault supervision MnS with `subscribe` operation (see TS 28.532 [5]) to subscribe to receive 5GC NFs (i.e., UPF, PCF, NEF, SCEF) alarms.

2. PLMN management system detects the 5GC NF alarms.

3. PLMN management system detects sends `notifyNewAlarm` notification to indicate the 5GC NF alarms being detected.

7.3.3   5GC NF issues resulted from EDN NF alarms

Figure 7.3.3-1 depicts a procedure to describe how an PLMN management system can consume fault supervision MnS to receive EDN NF alarms.
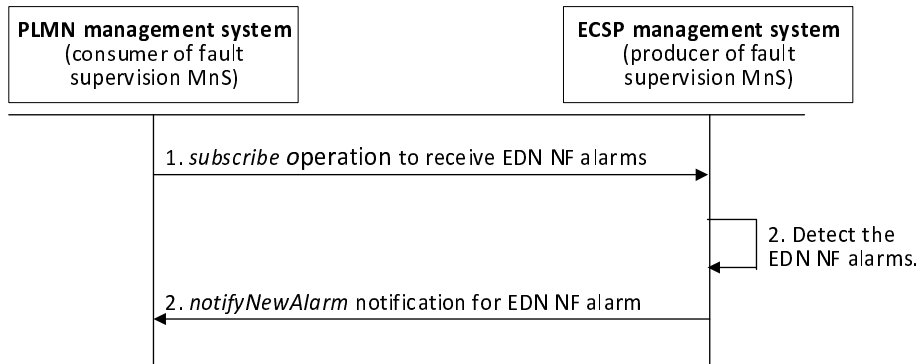
Figure 7.3.3-1: 5GC NF issues resulted from EDN NF alarms

1. ECSP, as the consumer of fault supervision MnS, consumes the generic fault supervision MnS with `subscribe` operation (see TS 28.532 [5]) to subscribe to receive EDN NFs (i.e., EAS, EES, ECS) alarms.

2. PLMN management system detects the EDN NF alarms.

3. PLMN management system detects sends `notifyNewAlarm` notification to indicate the EDN NF alarms being detected.

7.4   Provisioning

7.4.1   Description

The clause contains procedures associated with provisioning.

7.4.2   Configuration needed for EAS registration

Figure 7.4.2-1 depicts a procedure to describe how a consumer can consume provisioning MnS to request ECSP management system to configure the EASID and EES address that are required for EAS registration procedure (see clause 8.4.3.2.1 in TS 23.558 [2]). It is assumed that the EASFunction MOI has been created.
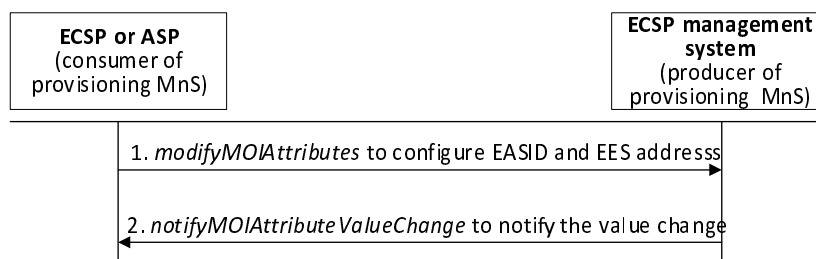
Figure 7.4.2-1: Configuration needed for EAS registration

1. A consumer (i.e., ASP or ECSP) consumes the provisioning MnS with `modifyMOIAttributes` operation (see TS 28.532 [5]) to configure the EASID (clause 7.2.4 in TS 23.558 [2]) and EES address (e.g. URI).

2. ECSP management system returns `notifyMOIAttributes` to notify the consumer that attributes have been changed.

7.4.3 EDN NF 5GC connection provisioning

Figure 7.4.3-1 depicts a procedure to describe how ECSP management system can consume provisioning MnS to request PLMN management system to query the connection information of EDN NFs (i.e., EAS, EES, ECS) to 5GC NFs, as specified in clauses 6.3.2, 6.3.4, 6.4.6 in TS 23.558 [2]. To support the connection of EDN NFs to 5GC NFs, EcmConnectionInfo IOC should contain the following attributes:

- EDN identifier: used to determine whether the EDN is trusted by PLMN operators.- EAS, EES, and ECS IP address: indicate the indicate the EAS, EES, and ECS IP address.

- Service area requirements: including EDN service area, EES service area, and EAS service area (see clause 7.3.3 in TS 23.558 [2]) representing the service areas for ECS, EES, and EAS, respectively.

- ECM connection type: indicate the control plane connection.

- 5GC NF Connection information list: each entry in the list should contain the following attributes:

    - Accessing NF type: the NF (i.e., PCF, NEF, or SCEF) where the EDN NFs should interface to access the 5GC NFs.

    - IP address: the IP address of the accessing NF.

    - 5GC NF DN: the DN of the accessing NF that needs to be configured in EASFunction IOC, EESFunction IOC, and ECSFunction IOC to indicate where the EDN NFs are connected.

Figure 7.4.3-1: EDN NF to access 5GC NF

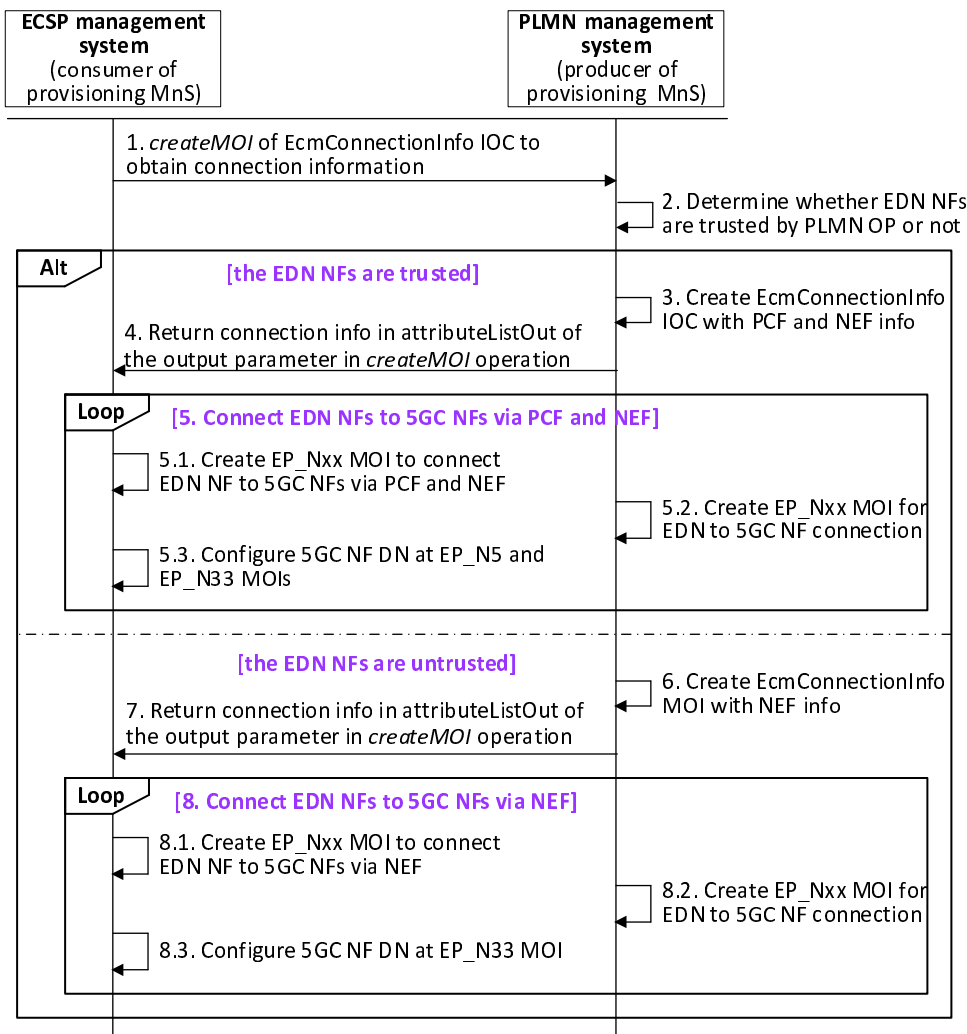1. ECSP management system consumes the provisioning MnS with *createMOI* operation (see clause 11.1.1.1. in TS 28.532 [5]) for EcmConnectionInfo IOC to request PLMN management system to provide the connection information. EcmConnectionInfo IOC includes EDN identifier, and service area requirements (i.e., EDN service area, EES service area, and EAS service area).

2. PLMN management system determines whether the EAS and EES are trusted by PLMN operators, based on the EDN identifier `ednIdentifier`.

 If the EDN NFs are trusted by PLMN operators, then performs the following steps.

3. PLMN management system found the PCF(s) based on EES service area `eESServiceArea`, and EAS service area `requiredEASservingLocation`, and NEF(s) based on EDN service area `eDNServiceArea`, and then creates the EcmConnectionInfo MOI with connection information for PCF and NEF, including the IP address and DN.

4. PLMN management system returns the connection information in the `attributeListOut` of the output parameter in *createMOI* operation to ECSP management system.

5. Connects EDN NFs to 5GC NFs via PCF and NEF.

    5.1 ECSP management system executes the following actions to connect EAS / EES to PCF and ECS to NEF:

    - create EP_N5 MOI with EAS IP address in `localAddress`, and PCF IP address in `remoteAddress` to connect EAS to PCF.

    - create EP_N5 MOI with EES IP address in `localAddress`, and PCF IP address in `remoteAddress` to connect EES to PCF.

    - create EP_N33 MOI with ECS IP address in `localAddress`, and NEF IP address in `remoteAddress` to connect ECS to NEF.

    5.2 PLMN management system executes the following actions to add the EAS and EES connections to PCF and the ECS connection to NEF:

    - create EP_N5 MOI with PCF IP address in localAddress, and EAS IP address easAddress in remoteAddress.

    - create EP_N5 MOI with PCF IP address in localAddress, and EES IP address eecsAddress in remoteAddress.

    - create EP_N33 MOI with NEF IP address in localAddress, and ECS IP address ecsAddress in remoteAddress.

    NOTE: There is no sequence dependency between steps 5.1 and 5.2.

    5.3 ECSP management system performs the following configuration operations:

    - configure the `farEndEntity` in EP_N5 MOI with the PCF DN.

    - configure the `farEndEntity` in EP_N5 MOI with the PCF DN.

    - configure the `farEndEntity` in EP_N33 MOI with the NEF DN.

 If the EDN NFs are untrusted by PLMN operators, then performs the following steps:

6. PLMN management system found the NEF(s) based on EES service area, EAS service area, EDN service area, and then creates the EcmConnectionInfo MOI with connection information for NEF, including the IP address and DN.

7. PLMN management system returns the connection information in the attributeListOut of the output parameter in *createMOI* operation to ECSP management system.

8. Connects EDN NFs to 5GC NFs via NEF.

    8.1 ECSP management system executes the following actions to connect EAS, EES, and ECS to NEF:

- create EP_N33 MOI with EAS IP address in `localAddress`, and NEF IP address in `remoteAddress` to connect EAS to PCF.

- create EP_N33 MOI with EES IP address in `localAddress`, and NEF IP address in `remoteAddress` to connect EES to PCF.

- create EP_N33 MOI with ECS IP address in `localAddress`, and NEF IP address in `remoteAddress` to connect ECS to NEF.

8.2 PLMN management system executes the following actions to add the EAS, EES, and ECS connections to NEF:

- create EP_N33 MOI with NEF IP address in `localAddress`, and EAS IP address `easAddress` in `remoteAddress`.

- create EP_N33 MOI with NEF IP address in `localAddress`, and EES IP address `eesAddress` in `remoteAddress`.

- create EP_N33 MOI with NEF IP address in `localAddress`, and ECS IP address `ecsAddress` in `remoteAddress`.

8.3 ECSP management system performs the following configuration operations:

- configure the `farEndEntity` in EP_N33 MOI with the NEF DN.

- configure the `farEndEntity` in EP_N33 MOI with the NEF DN.

- configure the `farEndEntity` in EP_N33 with the NEF DN.

7.4.4 EAS to connect to UPF

Figure 7.4.4-1 depicts a procedure to describe how ECSP management system can consume provisioning MnS to request PLMN management system to connect EAS to UPF for transporting the user traffic via the N6 interface (see clause (see clause 4.2.3 in TS 23.501 [11]). To support the connection of EAS NF to UPF NF, EcmConnectionInfo IOC should include the following attributes:

- EAS IP address: indicate the UPF IP address.

- EAS and EDN service area requirements: EAS service area (see clause 7.3.3 in TS 23.558 [2]).

- ECM connection type: indicate the user plane connection

- N6 traffic routing list: each entry in the list should contain the following attributes (see clause 8.2.4 in TS 23.558 [2]):

  - DNAI: DNAI(s) associated with the EAS.

  - N6 traffic routing requirements: N6 traffic routing information corresponding to each EAS DNAI.

- UPF Connection information: contains the following attributes:

  - UPF IP address: the IP address of the accessing NF.

  - UPF DN: the UPF DN to be configured in EASFunction IOC to indicate where the UPF is connected.
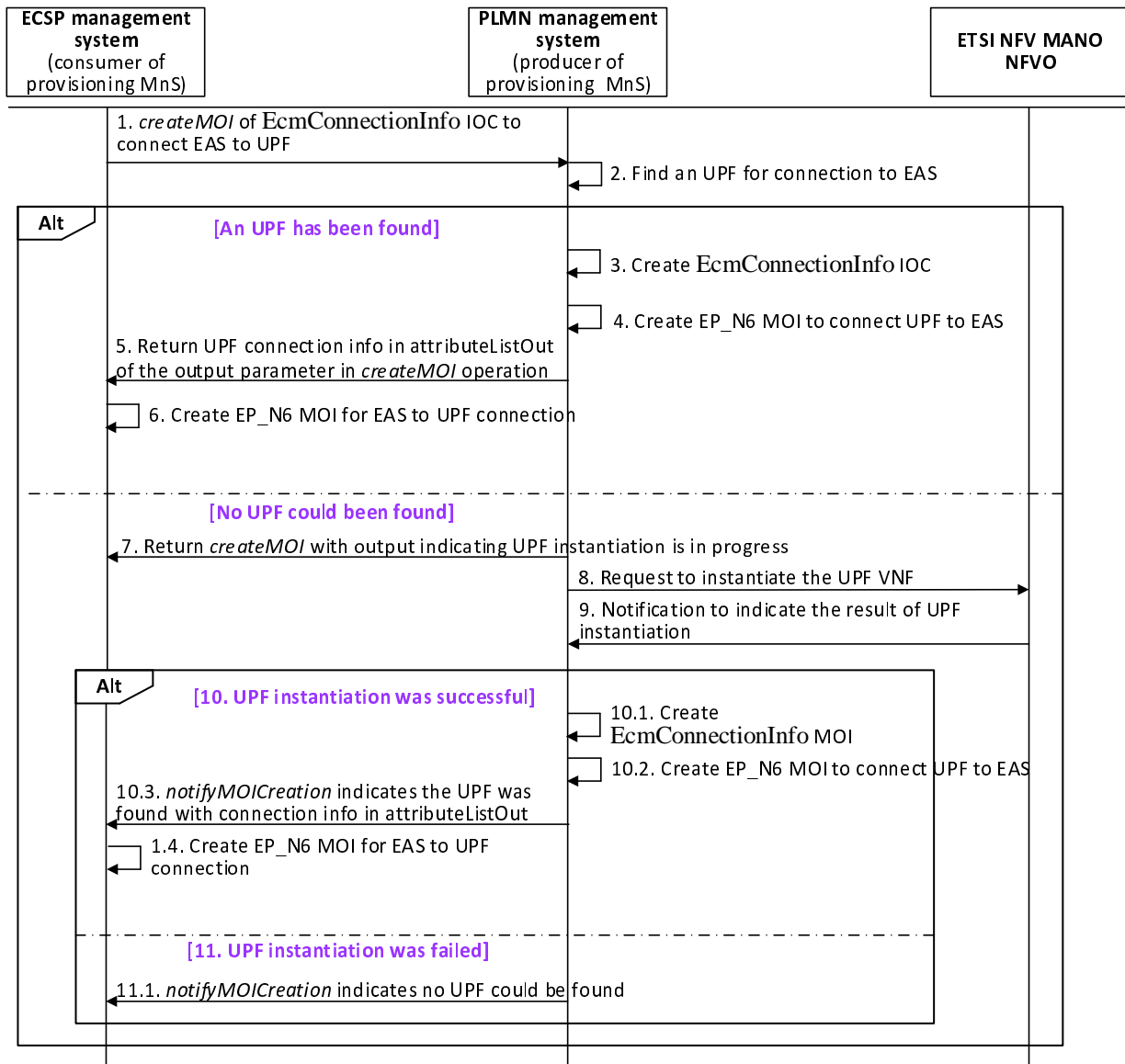
Figure 7.4.4-1: EAS to connect to UPF

1. ECSP management system consumes the provisioning MnS with *createMOI* operation (see clause 11.1.1.1. in TS 28.532 [5]) for EcmConnectionInfo IOC to request PLMN management system to connect the EAS to an UPF. EcmConnectionInfo includes EAS IP address, EAS service area, EDN service area, N6 traffic routing requiremments and ecmConnectionType with value USERPLANE.

2. PLMN management system finds a UPF based on the EAS and EDN service areas.and N6 traffic routing requirements.

If an UPF can be found, then performs the following steps:

3. PLMN management system creates the EcmConnectionInfo MOI with uPFConnectionInfo, including UPF IP address and UPF DN.

4. PLMN management system create EP_N6 MOI with UPF IP address in `localAddress`, and EAS IP address in `remoteAddress` to connect UPF to EAS.

5. PLMN management system returns the UPF connection information in the `attributeListOut` of the output parameter in *createMOI* operation to ECSP management system.

6. ECSP management system create EP_N6 MOI with EAS IP address in `localAddress`, and UPF IP address in `remoteAddress`.

If an UPF cannot be found, then performs the following steps:

7. PLMN management system returns the output parameters for *createMOI* operation to indicate the UPF instantiation is in progress.

8. PLMN management system invokes the *InstantiateNsRequest* operation (see clause 7.3.3 in ETSI GS NFV-IFA 013 [6]) to request NFVO via the Os-Ma-nfvo interface to instantiate a NS instance including the UPF VNF instance.

9. NFVO sends a notification to PLMN management system indicating the result of instantiation procedure (see clause 7.3.3.4 of ETSI GS NFV-IFA 013 [6]).

10. If the UPF has been instantiated, then performs the following steps:

    10.1. PLMN management system creates the EcmConnectionInfo MOI with UPF connection information, including UPF IP address and UPF DN.

    10.2. PLMN management system create EP_N6 MOI with UPF IP address in `localAddress`, and EAS IP address in `remoteAddress` to connect UPF to EAS.

    10.3 PLMN management system sends *notifyMOICreation* with UPF connection information in attributeList.

    10.4. ECSP management system create EP_N6 MOI with EAS IP address in `localAddress`, and UPF IP address in `remoteAddress`.

11. If the UPF has not been instantiated, then performs the following step:

    11.1 PLMN management system sends *notifyMOICreation* to ECSP management system to indicate no UPF can be found.

8 Management Service for Edge Computing

8.1 Provisioning

8.1.1 Lifecycle management

The management services for Edge Computing lifecycle management are listed in table 8.1.1-1.

Table 8.1.1-1: Management services for Edge Computing lifecycle management

MnS Component Type A (operations and notifications)	MnS Component Type B (information model)	Note
Operations and Notifications defined in clause 11.1.1 of TS 28.532 [5]: - createMOI operation - deleteMOI operation - getMOIAttributes operation - modifyMOIAttributes operation - notifyMOICreation Notification - notifyMOIDeletion Notification	Edge Computing information model defined in clause 6.3.	This management service enables its consumer to request lifecycle management of EAS, EES and ECS.

8.2 Performance Assurance

8.2.1 EAS performance assurance

8.2.1.1 MnS component type A

Table 8.2.1.1-1: EAS performance assurance type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1.1 of TS 28.532 [5]: - `createMOI` operation	It is supported by Provisioning MnS to create PerfMetricJob IOC, as defined in TS 28.531 [9].
Operations defined in clause 11.5 and 11.6 in TS 28.532 [3] and clause 6.1 of TS 28.550 [8]: - `createMeasurementJob` - `stopMeasurementJob` - `listMeasurementJobs` - `establishStreamingConnection` - `notifyFileReady` notification - `reportStreamData` operation	It is supported by Performance Assurance MnS for EAS, as defined in TS 28.550 [8].

8.2.1.2 MnS Component Type C definition

Performance measurements related EAS are captured in Table 8.2.1.2.-1:

Table 8.2.1.2-1. EAS related performance measurements

Performance measurements	Description	Related targets
Mean virtual CPU usage	Includes the mean usage of the underlying virtualized CPUs for a virtualized 3GPP NF (see clause 5.7.1.1.1 in TS 28.552 [10]).	
Mean virtual memory usage	Includes the mean usage of the underlying virtualized memories for a virtualized 3GPP NF (see clause 5.7.1.2.1 in TS 28.552 [10]).	
Mean virtual disk usage	Includes the mean usage of the underlying virtualized disks for a virtualized 3GPP NF (see clause 5.7.1.3.1 in TS 28.552 [10]).	
Data volume of incoming bytes to EAS	Includes the number of incoming bytes received by the EAS (see clause 5.7.2.1 in TS 28.552 [10]).	
Data volume of outgoing bytes to EAS	Includes the number of outgoing bytes received by the EAS (see clause 5.7.2.2 in TS 28.552 [10]).	
Data volume of incoming packets to EAS	Includes the number of incoming packets received by the EAS (see clause 5.7.2.3 in TS 28.552 [10]).	
Data volume of outgoing packets to EAS	Includes the number of outgoing packets received by the EAS (see clause 5.7.2.4 in TS 28.552 [10]).	

8.2.2 ECS performance assurance

8.2.2.1 MnS component type A

Table 8.2.2.1-1: ECS performance assurance type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1.1 of TS 28.532 [5]: - createMOI operation	It is supported by Provisioning MnS to create PerfMetricJob IOC, as defined in TS 28.531 [9].
Operations defined in clause 11.5 and 11.6 in TS 28.532 [3] and clause 6.1 of TS 28.550 [8]: - createMeasurementJob - stopMeasurementJob - listMeasurementJobs - establishStreamingConnection - notifyFileReady notification - reportStreamData operation	It is supported by Performance Assurance MnS for ECS, as defined in TS 28.550 [8].

8.2.2.2 MnS Component Type C definition

Performance measurements related ECS are captured in Table 8.2.1.2.-1:

Table 8.2.2.2-1. ECS related performance measurements

Performance measurements	Description	Related targets
Mean virtual CPU usage	Includes the mean usage of the underlying virtualized CPUs for a virtualized 3GPP NF (see clause 5.7.1.1.1 in TS 28.552 [10]).	
Mean virtual memory usage	Includes the mean usage of the underlying virtualized memories for a virtualized 3GPP NF (see clause 5.7.1.2.1 in TS 28.552 [10]).	
Mean virtual disk usage	Includes the mean usage of the underlying virtualized disks for a virtualized 3GPP NF (see clause 5.7.1.3.1 in TS 28.552 [10]).	
EES Registration	Includes the total, mean and successful number of EES Registration request processed by ECS (see clause 5.X.1 in TS 28.552 [10]).	
Service Provisioning	Includes the total, mean and successful number of service provisioning request processed by ECS (see clause 5.X.1 in TS 28.552 [10]).	

8.2.3 EES performance assurance

8.2.3.1 MnS component type A

Table 8.2.3.1-1: EES performance assurance type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1.1 of TS 28.532 [5]: - createMOI operation	It is supported by Provisioning MnS to create PerfMetricJob IOC, as defined in TS 28.531 [9].
Operations defined in clause 11.5 and 11.6 in TS 28.532 [3] and clause 6.1 of TS 28.550 [8]: - createMeasurementJob - stopMeasurementJob - listMeasurementJobs - establishStreamingConnection - notifyFileReady notification - reportStreamData operation	It is supported by Performance Assurance MnS for EES, as defined in TS 28.550 [8].

8.2.3.2 MnS Component Type C definition

Performance measurements related EES are captured in Table 8.2.3.2.-1:

Table 8.2.3.2-1. EES related performance measurements

Performance measurements	Description	Related targets
Mean virtual CPU usage	Includes the mean usage of the underlying virtualized CPUs for a virtualized 3GPP NF (see clause 5.7.1.1.1 in TS 28.552 [10]).	
Mean virtual memory usage	Includes the mean usage of the underlying virtualized memories for a virtualized 3GPP NF (see clause 5.7.1.2.1 in TS 28.552 [10]).	
Mean virtual disk usage	Includes the mean usage of the underlying virtualized disks for a virtualized 3GPP NF (see clause 5.7.1.3.1 in TS 28.552 [10]).	
EAS Registration	Includes the total, mean and successful number of EAS Registration request processed by ECS (see clause 5.X.1 in TS 28.552 [10]).	
EAS Discovery	Includes the total, mean and successful number of EAS discovery request processed by ECS (see clause 5.X.1 in TS 28.552 [10]).	
EEC Registration	Includes the total, mean and successful number of EEC Registration request processed by ECS (see clause 5.X.1 in TS 28.552 [10]).	

Annex A (normative): OpenAPI definition of edge NRM

A.1 General

This annex contains the OpenAPI definition of the Edge NRM in YAML format.

The Information Service (IS) of the Edge NRM is defined in clause 6.

Mapping rules to produce the OpenAPI definition based on the IS are defined in TS 32.160 [10].

A.2 Solution Set (SS) definitions

A.2.1 OpenAPI document "`TS28538_EdgeNrm.yaml`"

```
openapi: 3.0.1
info:
  title: 3GPP Edge NRM
  version: 17.3.0
  description: >-
    OAS 3.0.1 specification of the Edge NRM
    © 2023, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).
    All rights reserved.
externalDocs:
  description: 3GPP TS 28.538; Edge NRM
  url: http://www.3gpp.org/ftp/Specs/archive/28_series/28.538/
paths: {}
components:
  schemas:

#-------- Definition of types----------------------------------------------------
    ServingLocation:
      type: object
      properties:
        geographicalLocation:
          $ref: '#/components/schemas/GeoLoc'
        topologicalLocation:
          $ref: '#/components/schemas/TopologicalServiceArea'
    TopologicalServiceArea:
      type: object
      properties:
        cellIdList:
          type: array
          items:
            type: integer
        trackingAreaIdList:
          $ref: 'TS28541_NrNrm.yaml#/components/schemas/TaiList'
        servingPLMN:
          $ref: 'TS28623_ComDefs.yaml#/components/schemas/PlmnId'
    GeoLoc:
      type: object
      properties:
        geographicalCoordinates:
          $ref: '#/components/schemas/GeographicalCoordinates'
        civicLocation:
          type: string
    GeographicalCoordinates:
      type: object
      properties:
        lattitude:
          type: integer
        longitude:
          type: integer
    EDNConnectionInfo:
      type: object
      properties:
        dNN:
          type: string
```

```
            eDNServiceArea:
              $ref: '#/components/schemas/ServingLocation'
    AffinityAntiAffinity:
      type: object
      properties:
        affinityEAS:
          type: array
          items:
            type: string
        antiAffinityEAS:
          type: array
          items:
            type: string
    VirtualResource:
      type: object
      properties:
        virtualMemory:
          type: integer
        virtualDisk:
          type: integer
        virutalCPU:
          type: string
    SoftwareImageInfo:
      type: object
      properties:
        minimumDisk:
          type: integer
        minimumRAM:
          type: integer
        discFormat:
          type: string
        operatingSystem:
          type: string
        swImageRef:
          type: string

#-------- Definition of concrete IOCs -------------------------------------------
    MnS:
      oneOf:
        - type: object
          properties:
            SubNetwork:
              $ref: '#/components/schemas/SubNetwork-Multiple'

    SubNetwork-Single:
      allOf:
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
        - type: object
          properties:
            attributes:
              allOf:
                - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/SubNetwork-Attr'
        - type: object
          properties:
            Subnetwork:
              $ref: '#/components/schemas/SubNetwork-Multiple'
            ECSFunction:
              $ref: '#/components/schemas/ECSFunction-Multiple'
            EdgeDataNetwork:
              $ref: '#/components/schemas/EdgeDataNetwork-Multiple'
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/SubNetwork-ncO'

    EdgeDataNetwork-Single:
      allOf:
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
        - type: object
          properties:
            ednIdentifier:
              type: string
            eDNConnectionInfo:
              $ref: '#/components/schemas/EDNConnectionInfo'
        - type: object
          properties:
            EASFunction:
              $ref: '#/components/schemas/EASFunction-Multiple'
            EESFunction:
              $ref: '#/components/schemas/EESFunction-Multiple'
```

```
    EASFunction-Single:
      allOf:
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
        - type: object
          properties:
            attributes:
              allOf:
                - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/ManagedFunction-Attr'
                - type: object
                  properties:
                    eASIdentifier:
                      type: string
                    eESAddress:
                      type: array
                      items:
                        type: string
                    eASRequirementsRef:
                      $ref: 'TS28623_ComDefs.yaml#/components/schemas/Dn'
                    eASAddress:
                      type: array
                      items:
                        type: string
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/ManagedFunction-ncO'
    EESFunction-Single:
      allOf:
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
        - type: object
          properties:
            attributes:
              allOf:
                - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/ManagedFunction-Attr'
                - type: object
                  properties:
                    eESIdentifier:
                      type: string
                    eESServingLocation:
                      type: array
                      items:
                        $ref: '#/components/schemas/ServingLocation'
                    eESAddress:
                      type: array
                      items:
                        type: string
                    softwareImageInfo:
                      $ref: '#/components/schemas/SoftwareImageInfo'
                    serviceContinuitySupport:
                      type: boolean
                    eASFunctonRef:
                      $ref: 'TS28623_ComDefs.yaml#/components/schemas/DnList'
          - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/ManagedFunction-ncO'

    ECSFunction-Single:
      allOf:
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
        - type: object
          properties:
            attributes:
              allOf:
                - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/ManagedFunction-Attr'
                - type: object
                  properties:
                    eCSAddress:
                      type: string
                    providerIdentifier:
                      type: string
                    edgeDataNetworkRef:
                      $ref: 'TS28623_ComDefs.yaml#/components/schemas/DnList'
                    eESFuncitonRef:
                      $ref: 'TS28623_ComDefs.yaml#/components/schemas/DnList'
                    softwareImageInfo:
                      $ref: '#/components/schemas/SoftwareImageInfo'
          - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/ManagedFunction-ncO'

    EASRequirements-Single:
      allOf:
        - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
        - type: object
          properties:
```

```
                 requiredEASservingLocation:
                   $ref: '#/components/schemas/ServingLocation'
                 affinityAntiAffinity:
                   $ref: '#/components/schemas/AffinityAntiAffinity'
                 serviceContinuity:
                   type: boolean
                 virtualResource:
                   $ref: '#/components/schemas/VirtualResource'
                 softwareImageInfo:
                   $ref: '#/components/schemas/SoftwareImageInfo'

#-------- Definition of JSON arrays for name-contained IOCs ---------------------

     SubNetwork-Multiple:
       type: array
       items:
         $ref: '#/components/schemas/SubNetwork-Single'
     EASFunction-Multiple:
       type: array
       items:
         $ref: '#/components/schemas/EASFunction-Single'
     ECSFunction-Multiple:
       type: array
       items:
         $ref: '#/components/schemas/ECSFunction-Single'
     EESFunction-Multiple:
       type: array
       items:
         $ref: '#/components/schemas/EESFunction-Single'
     EdgeDataNetwork-Multiple:
       type: array
       items:
         $ref: '#/components/schemas/EdgeDataNetwork-Single'

#------------------------------- Definition -----------------------------------

     resources-edgeNrm:
       oneOf:
         - $ref: '#/components/schemas/MnS'
         - $ref: '#/components/schemas/SubNetwork-Single'
         - $ref: '#/components/schemas/EASFunction-Single'
         - $ref: '#/components/schemas/ECSFunction-Single'
         - $ref: '#/components/schemas/EESFunction-Single'
         - $ref: '#/components/schemas/EdgeDataNetwork-Single'
         - $ref: '#/components/schemas/EASRequirements-Single'
```

Annex B (informative):
Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2022-03	SA#95					Upgrade to change control version	17.0.0
2022-06	SA#96	SP-220564	0001	-	F	Fixing OpenAPI Discoverability issue in EdgeNrm.yaml stage 3	17.1.0
2022-06	SA#96	SP-220506	0002	-	C	Add the concept for edge computing management	17.1.0
2022-06	SA#96	SP-220506	0003	-	F	Add the missing procedure not implemented from approved pCR	17.1.0
2022-06	SA#96	SP-220506	0004	-	F	Add the terminologies for PLMN and ECSP management systems	17.1.0
2022-06	SA#96	SP-220564	0006	1	F	OpenAPI file name and dependence change for edgeNrm.yaml	17.1.0
2022-06	SA#96	SP-220506	0010	-	F	Notifications	17.1.0
2022-06	SA#96	SP-220506	0011	-	F	Notifications	17.1.0
2022-06	SA#96	SP-220506	0012	-	F	Update description of ECM LCM	17.1.0
2022-06	SA#96	SP-220506	0013	-	F	Update ECM NRM stage 2	17.1.0
2022-06	SA#96	SP-220506	0014	-	F	Update ECM NRM stage 3	17.1.0
2022-06	SA#96	SP-220506	0015	-	F	Correct EAS lifecycle management procedure	17.1.0
2023-03	SA#99	SP-230196	0028	-	F	Update stage 3 PlmnId reference	17.2.0
2023-06	SA#100	SP-230660	0034	1	F	Correct EAS to connect to UPF procedure	17.3.0
2023-06	SA#100	SP-230660	0035	-	F	Correction of ECM NRM	17.3.0
2023-09	SA#101	SP-230949	0039	-	F	Correction of EAS to connect with UPF UC	17.4.0

History

Document history		
V17.0.0	May 2022	Publication
V17.1.0	July 2022	Publication
V17.2.0	April 2023	Publication
V17.3.0	July 2023	Publication
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