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**5G;
Study on alignment with ETSI MEC
for edge computing management
(3GPP TR 28.903 version 18.0.1 Release 18)**



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Foreword

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- 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:

- shall** indicates a mandatory requirement to do something
- shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

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- should** indicates a recommendation to do something
- should not** indicates a recommendation not to do something
- may** indicates permission to do something
- need not** indicates permission not to do something

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- 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 studies the solutions to support alignment with ETSI MEC from the management perspective for edge computing.

It also identifies potential issues and solutions to support GSMA OPG [2] requirement in coordination with ETSI MEC [3].

2 References

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

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

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] GSMA Operator Platform Telco Edge Requirements - <https://www.gsma.com/futurenetworks/wp-content/uploads/2022/04/GSMA-Operator-Platform-Telco-Edge-Requirements-2022-v2.0.pdf>.
- [3] ETSI GS MEC 010-2 (V2.2.1) (2022-02): "Multi-access Edge Computing (MEC); MEC Management; Part 2: Application lifecycle, rules and requirements management".
- [4] ETSI GS MEC 003: "Multi-access Edge Computing (MEC); Framework and Reference Architecture".
- [5] 3GPP TS 23.558: "Architecture for enabling Edge Applications".
- [6] 3GPP TS 28.538: "Management and orchestration; Edge Computing Management (ECM)".
- [7] ETSI GS NFV-IFA 013 (V4.3.1): "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Os-Ma-nfvo reference point -Interface and Information Model Specification".
- [8] GSMA Operator Platform – East-Westbound Interface APIs - <https://www.gsma.com/futurenetworks/resources/platform-group-4-0-federation-api-1-0-0-yaml/>.
- [9] 3GPP TS 28.533: "Management and orchestration; Architecture framework".
- [10] 3GPP TS 28.532: "Management and orchestration; Generic Management Service".
- [11] 3GPP TR 28.817: "Management and orchestration; Study on access control for management service".
- [12] 3GPP TR 28.824: "Management and orchestration; Study on network slice management capability exposure".
- [13] 3GPP TR 23.700-98 (V1.0.0): "Study on Enhanced architecture for enabling Edge Applications".
- [14] ETSI GS NFV-IFA 011 (V4.3.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; VNF Descriptor and Packaging Specification".
- [15] ETSI GS NFV-IFA 014 (V4.3.1): "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Network Service Templates Specification".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

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

3.2 Symbols

Void

3.3 Abbreviations

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

4 Related Work in Other SDOs

4.1 ETSI MEC

Multi-access Edge Computing (MEC) framework as specified in ETSI GS MEC 003 [4] enables the implementation of MEC applications as software-only entities that run on top of a Virtualisation infrastructure, which is located in or close to the network edge.

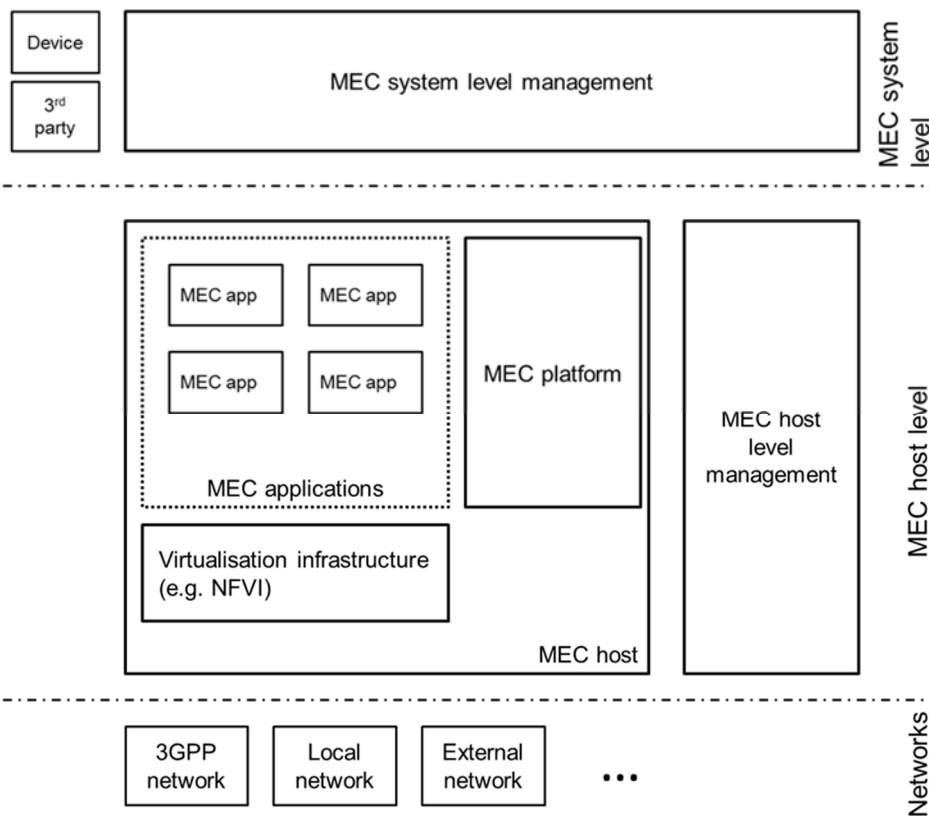


Figure 4.1-1: Multi-access Edge Computing framework

Figure 4.1-1 shows the MEC framework as defined in [4], it mainly contains several components,

The MEC host is an entity that contains a MEC platform and a Virtualisation infrastructure which provides compute, storage, and network resources, for the purpose of running MEC applications.

The MEC platform is the collection of essential functionality required to run MEC applications on a particular Virtualisation infrastructure and enable them to provide and consume MEC services. The MEC platform can also provide services.

MEC applications are instantiated on the Virtualisation infrastructure of the MEC host based on configuration or requests validated by the MEC management.

The MEC system level management includes the MEC orchestrator as its core component, which has an overview of the complete MEC system. When relying on the NFV Orchestrator (NFVO) for resource orchestration and for orchestration of the set of MEC application VNFs, the MEC Orchestrator (MEO) is replaced by a MEC Application Orchestrator (MEAO), the architecture is described in clause 6.2.2 of [4].

The MEC host level management comprises the MEC platform manager and the Virtualisation infrastructure manager, and handles the management of the MEC specific functionality of a particular MEC host and the applications running on it.

In Annex C of TS 23.558 [5], both EDGEAPP and ETSI MEC can provide support for hosting different edge applications, it further indicates that "Both EAS and MEC application are application servers and can provide similar application specific functionalities. EAS utilizes the services of EES as specified in the present document whereas MEC application utilizes the services provided by MEC platform as specified in ETSI GS MEC 003 [4]. The EAS and MEC application can be collocated in an implementation."

4.2 GSMA OPG

The Operator Platform (OP) is defined by GSMA OPG [2], it facilitates access to the Edge Cloud capability of an Operator or federation of operators and their partners.

The architecture scope under definition is shown below,

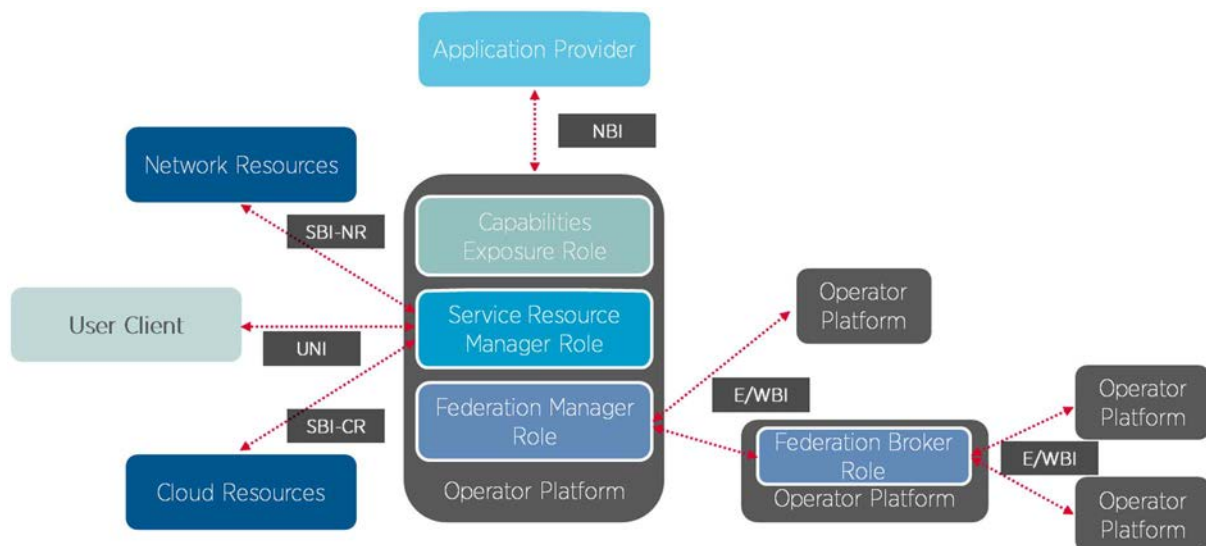


Figure 4.2-1: OP Roles and Interfaces Reference Architecture

This study is focused on the NBI and E/WBI requirements as defined in [2]. The NBI is the interface between the application provider and the Capabilities Exposure Role in the Operator Platform, it allows an OP to advertise the above cloud capabilities that it can provide to application providers. In addition, the NBI allows an application provider to reserve a set of resources or request an Edge Cloud service with the resources and features that they require and for the OP to accept or reject the request. The E/WBI interface provides the capabilities with regards to federation management between Ops. This includes managing the federation relationship between Ops, and other capabilities applicable between federated Ops, such as EAS deployment, resource sharing and resource reservation.

In this study, it is assumed that the application provider as described in [2] maps to ASP in TS 28.538 [6], and the Operator Platform as described in [2] maps to ECSP management system in TS 28.538 [6].

The table 4.2-1 provides the mapping of concepts (not exhaustive) defined in TS 28.538 [6] with the concepts defined in GSMA OPG [2].

Table 4.2-1

GSMA[2]	ECM(TS 28.538)	Comment/Observations
Edge Application	EAS	Edge Application and EAS are both referring to the application running in the edge.
Application Provider	Application Service Provider	Application Provider and Application Service Provider both referring to the application providers producing and requesting for the deployment of the applications.
Edge Cloud	EDN	The Applications are instantiated on an OP managed Edge Cloud/Cloudlet. The edge Cloud contain resources utilized to provide edge services. EAS are instantiated on an EDN. Since, the EAS are mapped to Applications; EDN can be mapped to Edge Cloud.
Operator Platform	ECSP Management System	Both Operator Platform (Capability Exposure Role) and the ECSP Management System are the entities which exposes interface and management service towards ASP.
Northbound Interface	Management services for Edge Computing lifecycle management	NBI maps to management service, enabling LCM for EAS, exposed towards ASP. NOTE: The term "NBI" does not relates to edge computing only, rather it is a generic term which can apply elsewhere.

5 Issue investigations and potential solutions for alignment with ETSI MEC

5.1 Key Issue# 1: Management of collocated platforms for EES and MEC platform

5.1.1 Description

As described in [5], one of the deployment option is that the EES and MEC platform can be collocated in an implementation.

The EES instantiation procedure is described in clause 7.1.4 of TS 28.538 [6], which the PLMN operator or ECSP requests the EES instantiation via provisioning MnS to ECSP management system, the simplified procedure is show in Figure 5.1.1-1.

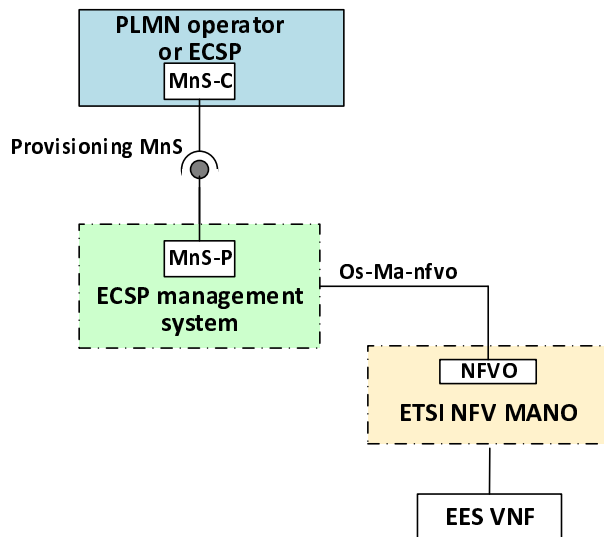


Figure 5.1.1-1: EES deployment procedure

The MEC platform as described in ETSI GS MEC 003 [4] can be deployed as a VNF by using ETSI NFV MANO, the simplified procedure is show in Figure 5.1.1-2.

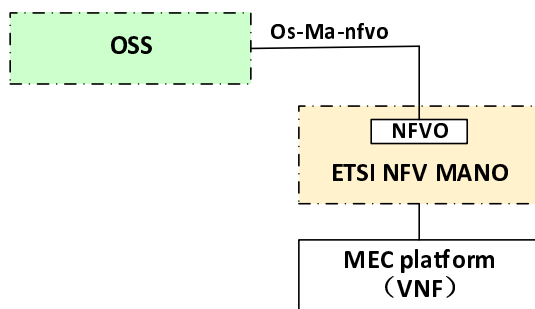


Figure 5.1.1-2: MEC platform deployment procedure

In the collocated scenario, the EES and MEC platform can be deployed in the same Physical/NFV Infrastructure by the same operator. The MEC platform can be deployed first, then the operator can deploy the EES at the same Physical/NFV Infrastructure where the MEC platform is deployed.

5.1.2 Potential Requirements

REQ-EES-deployment-1: ECSP management system shall have the capability to instantiate the EES to a specific Physical/NFV Infrastructure that collocated with MEC platform.

5.1.3 Potential solutions

5.1.3.1 Potential solution#1

In this option, a PLMN operator deploys both EES and MEC platform in the same EDN.

A NSD (Network Service Descriptor) which contains both EES and MEC platform information (e.g. VnfdId) is used by the PLMN operator. Within the NSD, the VnfProfiles (see clause 6.3.3 of ETSI GS NFV-IFA 014 [15]) of EES and MEC platform contain the same affinityOrAntiAffinityGroupId, which could be defined as the following:

affinityOrAntiAffinity: AFFINITY

scope: NFVI_NODE

The MEC platform can be deployed first, then for EES instantiation, ECSP management system uses the NSD as described above for requesting instantiation of EES VNF to be collocated with the MEC platform by interworking with ETSI NFV MANO.

5.1.3.2 Solution evaluation

This solution does not have any impact on the current EES deployment procedure.

5.2 Key Issue# 2: Application lifecycle management

5.2.1 Description

TS 28.538 [6] specifies the EAS lifecycle management procedure by interworking with ETSI NFV MANO by invoking InstantiateNsRequest or UpdateNsRequest operation as specified in ETSI NFV IFA 013 [7]. An NFV Network Service (NS) as defined by ETSI NFV is a composition of Network Functions (NF) (VNF or PNF).

With ETSI MEC [3], MEO (when ETSI NFV is not involved) or MEAO (when ETSI NFV is involved) provides the application instance lifecycle management interface, which is similar to VNF LCM interface. The consumer of MEO or MEAO does not need to take creation of NS into consideration when requesting creation of an application instance.

The main issue related to application LCM is the following:

- 1) When and how ECSP management system create an NS when receiving the creating EAS request from ASP.
- 2) Whether the application instance lifecycle management interface produced by MEO or MEAO could be used for EAS lifecycle management.

5.2.2 Potential solutions

5.2.2.1 Potential solution#1

5.2.2.1.1 Description

This solution addresses the first issue for the application lifecycle management.

In this solution, ECSP management system automatically creates an NSD for EAS creation. The procedure can refer to Figure 7.1.2.1-1 in TS 28.538 [6]. For the same ASP, ECSP management system could use a single NS for all its EAS VNFs instantiation. For example, after step 7 in Figure 7.1.2.1-1 in TS 28.538 [6], when the same ASP requests to deploy another EAS, ECSP management system could decide to use the same NS as created in step 4, and invokes UpdateNsRequest operation with NFVO for instantiating a new EAS VNF instance.

5.2.2.1.2 Solution evaluation

This solution does not impact the current EAS deployment procedure, creation of NSD is only the internal procedure in ECSP management system.

5.2.2.2 Potential solution# mapping application lifecycle management operation produced by MEO/MEAO with EAS LCM requirements

5.2.2.2.1 Description

This solution addresses the second issue for the application lifecycle management.

The application lifecycle management interface produced by MEO/MEAO is described in clause 6.3.1 in ETSI GS MEC 010-2 [3], which contains the following operations:

- Create application instance identifier.
- Application instantiation.
- Application instance terminate.
- Delete application instance identifier.
- Query application instance information.
- Change application instance state.
- Query application lifecycle operation Status.
- Subscribe to notifications relating to application lifecycle management.

The EAS lifecycle management requirements are described in clause 5.1.14 in TS 28.538 [6], the below table describes the mapping between EAS lifecycle management requirement and appropriate application lifecycle management operation produced by MEO/MEAO.

Table 5.2.2.2.1-1: Mapping between EAS lifecycle management requirement and application lifecycle management operation produced by MEO/MEAO

Requirement label	Description	Related use case(s)	Mapping with operation produced by MEO/MEAO
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	Can be achieved by Application instantiation operation
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	Can be achieved by virtualComputeDescriptor, osContainerDescriptor, virtualStorageDescriptor, locationConstraints information included in Application instantiation operation.
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	Can be achieved by Query application lifecycle operation Status operation.
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	Can be achieved by Subscribe to notifications relating to application lifecycle management
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	Can be achieved by Delete application instance identifier operation

Requirement label	Description	Related use case(s)	Mapping with operation produced by MEO/MEAO
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	Can be achieved by Query application lifecycle operation Status operation.
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	Can be achieved by Subscribe to notifications relating to application lifecycle management
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	Can be achieved by Query application instance 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	Can be achieved by Change application instance state operation.

This solution proposes the EAS lifecycle management requirements to be achieved by application lifecycle management operation produced by MEO/MEAO based on Table 5.2.2.2.1-1.

5.2.2.2.2 Solution evaluation

This solution is based on the mapping of EAS lifecycle management requirements with application lifecycle management operations produced by MEO/MEAO as described in Table 5.2.2.2.1-1. This solution requires ECSP management system acts as the consumer of application lifecycle management operation produced by MEO/MEAO, no required changes for the architecture of ECSP management system.

6 Issue investigations and potential solutions for alignment with GSMA OPG

6.1 Key Issue# 1: Issue for resource reservation

6.1.1 Description

As described in clause 2.2.2.3 of GSMA OPG [2], resource reservation is one of its NBI requirements, it indicates that,

- 1) The OP (Operator Platform) shall enable Application Providers to express the resource (e.g., compute, networking, storage, acceleration) requirements that the Application Provider wants to be guaranteed.
- 2) The NBI shall allow an Application provider to request a set of resources to be booked.
- 3) The NBI allows an Application Provider to reserve resources ahead of the application onboarding and unrelated to any specific application, only related to the Application Provider themselves. The NBI allows an Application Provider to consume the reserved resources when onboarding a new application, creating the association between the resources and the application (resources allocation). The NBI allows an Application Provider to delete their reservation.

TS 28.538 [6] defines the lifecycle management procedure for EAS with ETSI NFV MANO, while the resource reservation related to the ASP requirements is not specified in [6].

It is important to investigate the method for ASP to request the resource reservation.

6.1.2 Potential Requirements

REQ-resource-reservation-1: ECSP management system shall have a capability allowing ASP to request resource reservation related to virtualisation resources (e.g., compute, networking, storage, acceleration).

REQ-resource-reservation-2: ECSP management system shall have a capability to reserve a set of resources for ASP unrelated to any specific application.

6.1.3 Potential solutions

6.1.3.1 Potential solution#1

In this solution, a new IOC called ResourceReservationJob is suggested to be sent to ECSP management system for resource reservation. Figure 6.1.3.1-1 depicts the main steps for ASP asking for resource reservation.

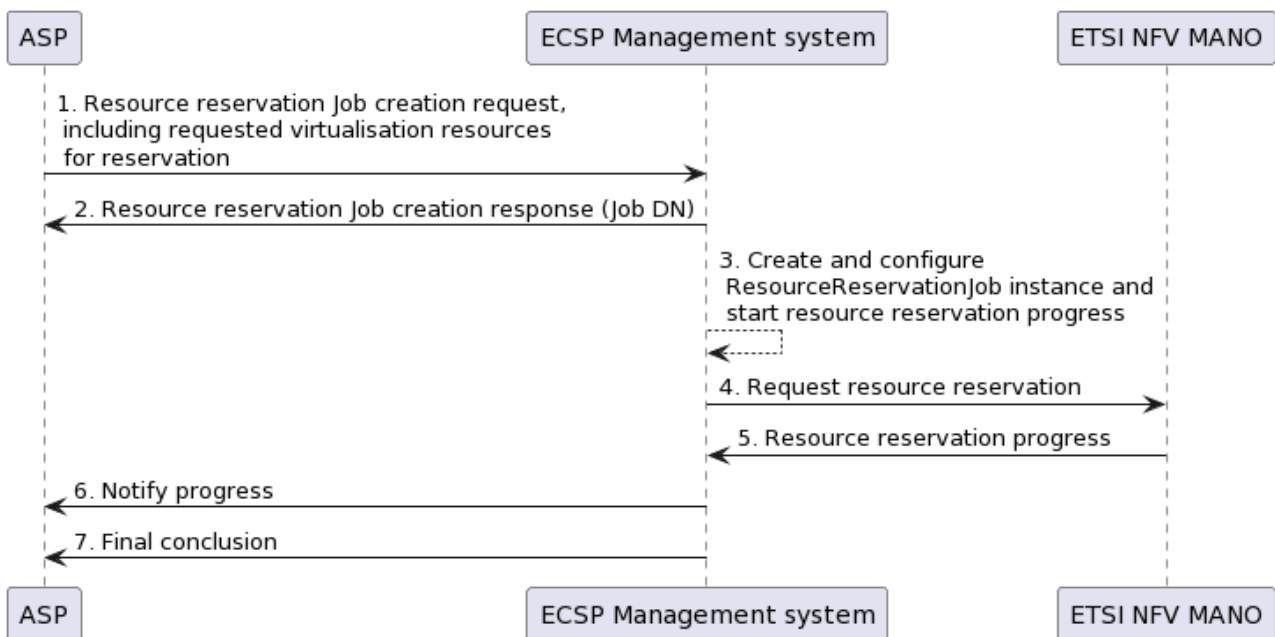


Figure 6.1.3.1-1

1. ECSP management system receives a resource reservation job creation request (createMOI operation for creation ResourceReservationJob), the ResourceReservationJob contains the following attributes, but not limited to,
 - Location at which the resource are to be reserved;
 - compute resource for reservation, including GPU resource;
 - storage resource for reservation;
 - networking resource for reservation;
 - Hardware accelerators resource for reservation;
 - expiration time.
2. ECSP management system sends the ResourceReservationJob creation response to ASP for the received Job DN.
3. ECSP management system creates the ResourceReservationJob instance and configures the attribute from the request and ECSP management system starts the executing the resource reservation process.
4. ECSP management system request resource reservation (See clause 7.3.3 in ETSI GS NFV-IFA 013 [7] by interworking with ETSI NFV MANO.
5. Response with the progress of the requested resource reservation.

6. ECSP management system sends notification of the progress of the requested resource reservation job.
7. ECSP management system sends the final notification with the reservation status.

6.1.3.2 Solution evaluation

This solution introduces a new ResourceReservationJob IOC which can be used by ASP to request resource reservation. ECSP management system needs to support ResourceReservationJob IOC and create a ResourceReservationJob instance based on the request from ASP. The information included in ResourceReservationJob IOC could be location information, expiration time, reservation status and virtualized resource information required for reservation, including compute, storage, networking, GPU and Hardware accelerators resource.

6.2 Key Issue#2: Issue for federation management

6.2.1 Description

GSMA requirements related to federation management are divided into E/WBI requirements and Federation Manager Role requirements, which are introduced in clause 5.1.2 and clause 5.2.3 of [2] respectively.

- Based on the description in clause 5.1.2 of [2]:
 - The Federation Management functionality within the Operator Platform (OP) enables it to interact with other OP instances, often in different geographies, thereby providing access for the Application Providers to a larger footprint of Edge Clouds, a more extensive set of subscribers and multiple Operator capabilities.
 - This Key issue is about enabling two OPs establishing federation relationship between each other and sharing available location(s) at which the edge services are provided, resource available at each location, federation expiry etc.
 - The OP which initiates federation relationship is called leading/originated OP. The OP which receives federation relationship request is called partner OP.

The following functionalities are enabled with established federation relationship:

- Federated EAS resource reservation management: This is intended for an OP to reserve resources for an application provider, with the other OP, when the application provider initiates the reservation using NBI.
- Federated EAS deployment and termination: This will be used by an OP to instantiate an application to edge clouds of other OP as requested by application provider over NBI.
- EDN sharing: This is intended for OPs to share EDN among each other.

Based on the description in clause 5.2.3 of [2]:

GSMA E/WBI API definition [8] provides information on various API and associated parameters and data models to achieve GSMA federation requirements.

Table 6.2.1-1 concludes the Federation Manager Role requirements and related E/WBI APIs, and shows the comparison with 3GPP management capabilities. The requirement of Settlement is set for charging system and is therefore not shown in table below.

Table 6.2.1-1

GSMA Federation Manager Role requirement and corresponding API	GSMA E/WBI API	3GPP management capability	Gap analysis
Federation and platform interconnection – General: <i>This capability is achieved by the federation E/WBI interface; to interconnect OPs belonging to different operators, enterprises or others. The communication between federated entities shall support a distributed tracking mechanism that allows end-to-end tracking across these federated entities.</i> (see clause 5.2.3.1.1 of [2])	East/West Bound Interface Management API	MnS for federation requirements is FFS.	GSMA defines East/West Bound Interface Management API (clause 3.1.1 of [8]) and OP data model (clause 3.1.1.7 of [8]) to realize the handshake between two Ops, while TR 28.824 [12] has discussed the MnS consumer (i.e. API invoker) registration mechanism by reusing CAPIF. There could be an enhancement in 3GPP on (external) MnS consumer management to catch OP features after evaluating the East/West Bound Interface Management API.
Federation and platform interconnection - Authentication/authorisation: <i>Federating OPs are likely to belong to different entities in different security domains. Therefore, the capability to exchange authentication and authorisation between federated OPs is required.</i> (see clause 5.2.3.1.2 of [2])	No API definition for Authentication/authorisation	Access control between MnS producer and MnS consumer (TS 28.533 [9])	GSMA E/WBI API definition [8] does not define API for Authentication/authorisation purpose. 3GPP describes the Access control between MnS producer and MnS consumer in clause 4.9 of TS 28.533 [9]. TR 28.817 [11] and TR 28.824 [12] discussed the access control for (external) MnS consumers, of which the normative work could be used to satisfy this requirement. SA5 may actively coordinate the outcome of access control with GSMA and evaluate whether the work can be reused by GSMA.

6.2.2 Potential Requirements

REQ-FUN-Federation-1: ECSP management system shall have a capability to establishing federation relationship with the (external) MnS consumer (e.g. partner operator platforms).

REQ-FUN-Federation-2: ECSP management system shall enable federation relationship to include appropriate information including (not limited to) location(s) at which the edge services are provided, resource available at each location, federation expiry.

REQ-FUN-Federation-3: ECSP management system shall have a capability to remove existing federation relationship with the (external) MnS consumer(e.g. partner operator platforms).

6.2.3 Potential Solutions

The solution proposes the following set of IOCs to manage the Edge Federation between multiple ECSP Management systems.

The Participating Operator Platform (P-OP) is the operator who provides its EDN to be shared with Leading Operator Platform (L-OP). Both P-OP and L-OP are considered as two different ECSP Management System.

The EdgeFederation IOC is defined as the IOC representing the set of federation maintained by either the P-OP or L-OP. This IOC when instantiated represents a set of available federations. This IOC may contain the attributes related with L-OP and P-OP identifier.

The OperatorEdgeFederation IOC contains attributes to support the edge federation. An instance of OperatorEdgeFederation IOC should be created and configured for each federation to be maintained/provided by the P-OP or L-OP. When configured the attributes override those in parent EdgeFederation instance. This IOC when instantiated represents a particular available federation. This IOC may contain attributes related with L-OP and P-OP identifier, federation identifier, federation expiry, offered edge resources, accepted edge resources and allocated resource quota of L-OP.

The OperatorEdgeDataNetwork IOC is, optionally defined to contain attributes to support an available edge data network. An instance of OperatorEdgeDataNetwork IOC should be created and configured for each EDN shared with another operator. When configured the attributes override those in the associated EdgeDataNetwork instance. The attribute of this IOC are same as defined for EdgeDataNetwork IOC in TS 28.538. This IOC when instantiated represents a particular EDN shared with the L-OP.

In order to establish the federation, the L-OP request P-OP to create an instance of EdgeFederation IOC. L-OP can then query for the offered edge resources and update the accepted edge resources accordingly. Based on the accepted edge resource, producer instantiate OperatorEdgeDataNetwork IOC to represent the accepted edge resource which is shared with the L-OP. The federation relationship established can be updated by the L-OP at any point of time in future.

In order to remove existing federation relationship, the L-OP request P-OP to delete an existing instance of EdgeFederation IOC, this will also result in deletion of related OperatorEdgeDataNetwork MOI.

Note: The agreed federation information (e.g. offered EDN and selected EDN) should be available to L-OP also so that L-OP can decide if it want to deploy an EAS on P-OPs network if and when required.

6.3 Key Issue#3: EDN Sharing

6.3.1 Description

Once the federation relationship is established, the P-OPs can share the EDN available in its network with L-OP. An OP can select some of the EDN from the offered list and register that with the other OP. This will imply that the OP may use the edge resources available in the registered EDN only.

This is crucial to investigate in the method and solutions used for EDN sharing management. It is to be discussed whether it require enhancement to edge NRM and the procedures defined in TS 28.538.

6.3.2 Potential Requirements

REQ-FUN-NBI-1: ECSP management system shall enable sharing of available EDN with other ECSP management system.

REQ-FUN-NBI-1: ECSP management system shall disable sharing of available EDN with other ECSP management system.

6.3.3 Potential Solutions

As part of federation establishment, the P-OP shares its EDN(s) with L-OP in order to share its edge resources with L-OP. For details please check solution in clause 6.2.3.

6.4 Key Issue#4: Federated EAS resource reservation management

6.4.1 Description

This is intended for an OP to reserve resources for an application provider, with other OP, when the application provider initiate the reservation using NBI. The application provider can request reservation of resources with partner OP on per location basis. The partner OP can reserve resources for a given application provider from the allocated quota for the leading OP. The partner OP may have allocated resources for the leading OP during the EDN registration process. Once the resource reservation request is approved by the partner OP, the reserved resource information is provided to the leading OP for application provider to use. Application provider can use the reserved resource while instantiating the application in the partner OP zones.

This is crucial to investigate in the method and solutions used for resource reservation management. It is to be discussed whether it require enhancement to edge NRM and the procedures defined in TS 28.538.

6.4.2 Potential Requirements

REQ-FUN-NBI-1: ECSP management system shall have a capability enabling ASP to request reservation of resources with other ECSP management system on per EDN basis.

REQ-FUN-NBI-1: ECSP management system shall have a capability enabling ASP to request deletion and updating of the reservation made with other ECSP management system.

6.4.3 Potential Solutions

The solution proposes to use the resource reservation procedures as described in clause 6.1.2. After receiving the creation of ResourceReservationJob request form the ASP, the L-OP (acts as ECSP management system) will check if there is shared EDN available to use at the particular location as described in the request based on the established federation relationships with other OPs (the solution for federation management can refer to clause 6.2.3). The L-OP will forward the create ResourceReservationJob request to the P-OP. Once the P-OP receives the request it will follow the resource reservation procedures as described in clause 6.1.2.

When ASP needs to modify or delete the reserved resources at other OP, the ASP can use modifyMOIAttributes or deleteMOI operation (see clause 11.1.1.3 and clause 11.1.1.4 in TS 28.532 [10]) for ResourceReservationJob MOI, then the L-OP will forward the request to the P-OP.

6.5 Key Issue#5: Federated EAS deployment and termination

6.5.1 Description

E/WBI controls the launch and termination of applications on a partner OP. This will be used by a leading OP to instantiate an application to edge clouds (EDN) of partner OP as requested by application provider over NBI. A leading OP makes the application instantiation result available on the NBI interface. Partner OP also providea the application instance status over E/WBI to leading OP which leading OP may expose to application providers on NBI.

This is crucial to investigate in the method and solutions used for application management on other OPs. It is to be discussed whether it require enhancement to edge NRM and the procedures defined in TS 28.538 [6].

6.5.2 Potential Requirements

REQ-FUN-EWBI-EAS-1: ECSP management system shall have a capability to deploy the EAS on the edge network owned by other ECSP.

REQ-FUN-EWBI-EAS-2: ECSP management system shall have a capability to terminate the EAS on the edge network owned by other ECSP.

6.5.3 Potential Solutions

The solution for REQ-FUN-NBI-1 proposes to use the existing procedures for EAS deployment with the enhanced EASRequirements IOC. After receiving the EAS deployment request from the ASP, the L-OP will check if it can deploy the EAS at one of its own EDN. If not, L-OP will select a P-OP based on the federation relationships which it maintains with multiple P-Ops. The L-OP will send a request to deploy an EAS containing attributes indicating the federation. Once the P-OP receives the request it will follow the EAS deployment procedure as defined in TS 28.538 [6].

The solution for REQ-FUN-NBI-2 proposes to use the existing procedures for EAS termination. After receiving the EAS termination request from the ASP, the L-OP will check the EAS if it belongs to its own EDN. If not, L-OP will send a request to terminate the EAS to the P-OP based on the federation relationships with the P-OP. Once the P-OP receives the request it will follow the EAS termination procedure as defined in TS 28.538 [6].

6.6 Key Issue# 6: Virtual Infrastructure Resource Requirements

6.6.1 Description

As described in clause 5.1.1.2.2 of GSMA OPG [2], the OP supports the Infrastructure resource requirements from the Application providers. This includes CPU, memory, storage, hypervisor and networking definition used by the application. In relation to this, an ASP can provide required infrastructure resources for an EAS while requesting to deploy the same.

6.6.2 Potential Requirements

REQ-FUN-NBI-1: ECSP management system shall have a capability allowing EAS to declare its requirements on the virtual infrastructure.

6.6.3 Potential Solution

The solution requires a capability where ASP can declare its requirements on the virtual infrastructure. EAS is considered as a VNF and deployed by interworking with ETSI NFV MANO as described in TS 28.538 [6]. The VNFD as specified by ETSI NFV MANO in ETSI GS NFV-IFA 011 [14] contains the virtual resource requirements information including CPU, memory, storage, hypervisor and networking resources, it also supports different virtual infrastructure requirements to realize a VNF, such as virtual machine and containers. So the information contained in the VNFD can fulfil the requirement from EAS. In this solution, it requires to add VNFD information in EASRequirements IOC.

6.7 Key Issue# 7: Querying Available Edge Services

6.7.1 Description

- As described in Clause 5.1.1.3 of GSMA OPG [2], OP shall provide the following capabilities to the Application Provider: An OP shall offer a range of quality policies so that an Application Provider can choose the performance that their application requires. These policies are defined based on objectively measured end-to-end parameters that include performance aspects of both the network and the Cloudlet, such as latency and packet loss (measured as average statistics).
- The NBI shall enable a request-response mechanism through which the Application Provider can state a geographical point where a typical user could be and get informed of the mean latency performance expected.
- The OP shall describe the capabilities of the Edge Cloud including the geographical zones where it is provided and the type and "granularity" of edge cloud and network service (typically generic Compute, memory, storage, and specialised compute, such as GPU and future resource types).

The above requirements is calling for a mechanism using which the available edge service and their characteristics (e.g. available SLS, infrastructure resources) are described. This information could be anchored at a particular location i.e. edge service and their characteristics available at a particular location.

6.7.2 Potential Requirements

REQ-FUN-PLOC-1: ECSP management system shall have a capability allowing ASP to query the available edge services locations and their capabilities including available SLA and infrastructure resources.

6.7.3 Potential Solution

The solution requires introduction of the following information in the EdgeDataNetwork IOC.

- Geographical location
- Available compute resources
- Available SLS

The Edge PoP can be queried by ASP to know what edge resources are available in what locations. ASP can then take a decision on where its EAS to be deployed.

With regard to available compute resources, the ECSP management system can interact with ETSI NFV MANO by calling Query NFVI capacity operation as defined in ETSI GS NFV-IFA 013 [7].

6.8 Key Issue# 8: SLA Requirements Key Issue

6.8.1 Description

As described in clause 5.1.1.2.2 of GSMA OPG [2], the OP shall support the SLA requirements from the Application providers. A SLA description allows an Application Provider to describe the physical constraints in an edge network that should be met for the application to run successfully and provide a correct Quality of Experience (QoE) for the end-user at the UE. The SLA requirements include the following properties:

- Bandwidth, bidirectional data rate between UE and backend application.
- Latency, the round trip delay between UE and backend application.

In relation to this, the ASP can declare such requirements for an EAS. The EAS need to be deployed at an EDN which can satisfy these requirements.

6.8.2 Potential Requirements

REQ-FUN-NBI-1: ECSP management system shall have a capability allowing EAS to declare its SLA requirements, in terms of bandwidth and latency, for the data connection with the UE.

REQ-FUN-NBI-1: ECSP management system shall be able to select an EDN based on the SLA requirements of an EAS.

6.8.3 Potential Solution

The solution requires adding SLA requirements in EASRequirements IOC. This will enable ASP to provide expected SLA from the edge infrastructure. The following need to be added in the EASRequirements IOC:

- Bandwidth
- Latency

6.9 Key Issue# 9: EAS relocation policies Key Issue

6.9.1 Description

As described in clause 5.2.2.3 of GSMA OPG [2], because of the OP's measurements or knowledge, or hints from the application about performance degradations, the OP may decide that a different edge compute resource can better host the Edge Application. The EAS relocation trigger from OP are related with lifecycle management of its edge compute resources (for example, the overload of an edge compute resource, a failure or planned maintenance, a new or expanded edge compute resource, an issue with the network for its edge compute resource). The OP should be cognisant of the policy indication from the Application Provider about its sensitivity to a change of the edge compute resource hosting the Edge Application.

As described in clause 5.1.1.2.2 of GSMA OPG [2], the NBI allows an Application Provider to specify their support for a stateful or stateless Edge Application, i.e. whether the Edge Application can be moved from one edge compute resource to another and this with or without prior notification.

The Application Provider indicates the following policies:

- Its Edge Application cannot be moved from one edge compute resource to another;
- Its Edge Application can be moved from one edge compute resource to another, without any notification;
- Its Edge Application can be moved from one edge compute resource to another with prior notification.

When the policy is that a change of edge compute resource can be done with prior notification, the OP decides that a change of edge compute resource is needed and selects the new edge compute resource. In this case, the application chooses the exact timing of the move and is responsible for transferring the application state from one edge compute resource to another. Further, it is stated that when required, notifying the Application Provider on a recommended change of edge compute resource, the Application Provider is responsible for determining the exact timing of the change. The application may indicate that it cannot currently handle mobility. Then, the OP can cancel the mobility procedure.

TS 28.538 [6] does not support this yet. This requires an EAS to be moved from one (source) EDN to another (target) EDN. This will involve terminating EAS from the source EDN and then instantiating EAS on the target EDN. This involves the following issues to be addressed:

- How the ASP will provide the policies.
- How the existing application context is retained from source to target EAS.

6.9.2 Potential Requirements

REQ-FUN-MOB-1: ECSP management system shall have a capability allowing EAS to declare its mobility policies indicating whether EAS can be moved from one EDN to another

REQ-FUN-MOB-2: ECSP management system shall have a capability allowing EAS to declare its mobility policies indicating whether EAS can be moved from one EDN to another, without any notification.

REQ-FUN-MOB-3: ECSP management system shall have a capability allowing EAS to declare its mobility policies indicating whether EAS can be moved from one EDN to another, with prior notification.

REQ-FUN-MOB-4: ECSP management system shall have a capability allowing ASP to reject the EAS relocation on receiving the relocation notification.

REQ-FUN-MOB-5: ECSP management system shall have a capability allowing scheduling of an EAS relocation.

6.9.3 Potential Solution

The ASP can provide its preferences or policies for EAS relocation as part of EASRequirement IOC. The policy can dictate whether the EAS can be relocated or not. If it can be relocated does it require prior notification to be sent to the authorized entities? The solution also requires relocation trigger information, decided by ECMS (ECSP Management System), to be included in EASFunction IOC. This information dictates whether EAS should be relocated immediately or at some future point of time. ECMS decides to relocate an EAS for any appropriate purpose e.g. the overload of an edge compute resource, a failure or planned maintenance, a new or expanded edge compute resource, an issue with the network for its edge compute resource.

Once decided to relocate the EAS, ECMS considers the relocation policy and trigger information. If the EAS is to be relocated immediately and the relocation policy allows it, ECMS selects the appropriate EDN and instantiate the relocation procedure. That will include instantiating the EAS on the selected EDN as specified in TS 28.538 [6] and then terminate the existing EAS instance. If the relocation policy states that a prior notification is to be provided ECMS notifies all authorized receivers using notifyMOIAttributeValueChanged notification, against updates on relocation trigger information in EASFunction IOC, as specified in TS 28.532. The notification will be sent before instantiating the relocation procedure. The consumer can reject the relocation by updating the value of attribute RelocationRejectByConsumer to TRUE.

It is proposed to add the following in EASRequirements IOC

- Attribute RelocationPolicy with allowed values as follows
 - Yes: This dictates that an EAS can be relocated as and when required
 - No: This dictates an EAS cannot be relocated at all
 - YesWNotify: This indicates that an EAS can be relocated with a prior notification

The solution also requires the following information to be included in the EASFunction IOC

- 1) RelocationTriggerInfo
 - a) ImmediateTrigger: It is a Boolean attribute with default value as FALSE. A value TRUE would indicate to ECMS that an EAS should be relocated immediately.
 - b) FuturisticTriggerInfo: It is a complex attribute with
 - 1) A Boolean attribute with default value as FALSE. A value TRUE would indicate to ECMS that an EAS should be relocated.
 - 2) A time stamp indicating a futuristic time at which the EAS should be relocated.

Note: Whether ASP should be able to update RelocationTriggerInfo is not addressed in the present document.

- 2) RelocationRejectByConsumer: A Boolean attribute which can be updated by the consumer, on receiving the notifyMOIAttributeValueChanged notification, to indicate its disagreement with the relocation. The value TRUE indicate that the consumer do not agree with the relocation. The default value is FALSE.

6.10 Key Issue# 10: Application Resource Catalogue

6.10.1 Description

- 1) As described in Clause 3.5.1.3 of GSMA OPG [2], OP shall provide ASP with application resource catalogue with all the available application and their characteristics. The following requirements relates to application resource catalogue in GSMA. The NBI shall allow applications providers to access the resource catalogue. The Resource catalogue shall consider local resources (CPU, memory, storage).
- 2) The OP offers Application Providers a registry to store their application images and update or delete them. The registry may be centralised or distributed, depending upon the Application Provider's needs to reduce boot time and recovery

TS 28.538 [6] does not address the requirements related with application resource catalogue. An ASP can first upload all the application related artifacts (e.g. image) to a catalogue and then query the catalogue to know what all applications are already available and if there is one which can satisfy ASPs requirements.

6.10.2 Potential Requirements

REQ-FUN-PLOC-1: ECSP management system should enable ASP to access the application (EAS) resource catalogue containing the available applications and their characteristics.

REQ-FUN-PLOC-2: ECSP management system should enable ASP to access the application (EAS) resource catalogue for uploading, updating, deleting and querying the application related artefacts (e.g. image).

6.10.3 Potential Solution

The solution requires a capability where ASP can upload and manage all the artifacts (e.g. image) related with the application with the ECSP/3GPP management system. The uploaded applications can be queried to know the details of available application inventory. All these functionalities can be fulfilled by VNF package management interface see clause 7.7 (such as Upload VNF Package operation, Query VNF package Info operation, Update VNF Package Info operation and Delete VNF Package operation) in ETSI GS NFV-IFA 013 [7] defined by ETSI ISG NFV. Hence, it is recommended to refer to the relevant specifications from ETSI ISG NFV to describe a solution of the use case.

7 Conclusion and recommendation

7.1 Conclusion and recommendation for alignment with ETSI MEC

7.1.1 Issue#1: Management of collocated platforms for EES and MEC platform

It is recommended ECSP management system could use the affinityOrAntiAffinity policy defined in ETSI NFV MANO when collocated platform for EES and MEC platform is required.

The detailed solution see clause 5.1.3.1.

7.1.2 Issue#2: Application lifecycle management

It is recommended ECSP management system could acts as the consumer of application lifecycle management operation produced by MEO/MEAO for EAS lifecycle management.

The detailed solution see clause 5.2.2.2.

7.2 Conclusion and recommendation for alignment with GSMA OPG

7.2.1 Issue#1: Issue for resource reservation

It is recommended to introduce a new ResourceReservationJob IOC for resource reservation. The information includes in ResourceReservationJob IOC could be location information, expiration time, reservation statuses and virtualized resource information required

The detailed solution see clause 6.1.3.

7.2.2 Issue#2: EAS federation management

It is recommended to enhance edge NRM to support management of federation information. For the detailed solution see clause 6.2.3.

7.2.3 Issue#3: EDN Sharing

This key issue is addressed as part of federation establishment Key issue. For the detailed solution see clause 6.3.3.

7.2.4 Issue#4: Federated EAS resource reservation management

It is recommended to use the resource reservation solution as described in clause 6.1.2 together with the federation management solution as described in clause 6.2.3 to support federated EAS resource reservation management.

The detailed solution see clause 6.4.3.

7.2.5 Issue#5: Federated EAS deployment and termination

It is recommended to use the existing procedures for EAS deployment and EAS termination with the enhanced EASRequirements IOC to support federated EAS deployment and termination management.

The detailed solution see clause 6.5.3.

7.2.6 Issue#6: Virtual Infrastructure Resource Requirements

It is recommended to introduce the VNFD information in EASRequirements IOC for supporting Virtual Infrastructure Resource Requirements when deploying a EAS.

The detailed solution see clause 6.6.3.

7.2.7 Issue#7: Querying Available Edge Services

It is recommended to enhance EdgeDataNetwork IOC and ECSP management system acts as the consumer to call Query NFVI capacity operation as defined in ETSI GS NFV-IFA 013 [7] to support allowing ASP Querying Available Edge Services for a specific location.

The detailed solution see clause 6.7.3.

7.2.8 Issue#8: SLA Requirements key issue

It is recommended to introduce the Bandwidth and Latency in the EASRequirements IOC for supporting SLA requirements when deploying a EAS. New performance measurements and KPIs related to Bandwidth and Latency between UE and EAS may need to be added.

The detailed solution see clause 6.8.3.

7.2.9 Issue#9: EAS relocation policies

It is recommended to enhance EASRequirements IOC and EASFunction IOC to support the EAS relocation policies and EAS relocation trigger information respectively.

The detailed solution see clause 6.9.3.

7.2.10 Issue#10: Application Resource Catalogue

It is recommended to refer to VNF package management interface defined by ETSI ISG NFV IFA 013[7] to support application resource catalogue management.

The detailed solution see clause 6.10.3.

Annex A (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2022.04	SA5#142e	S5-222103				Initial version of TR28.903	0.0.0
2022.04	SA5#142e	S5-222329 S5-222330	-	-	-	Add scope Add skeleton	0.1.0
2022.05	SA5#143e	S5-223267	-	-	-	Add background information of ETSI MEC	0.2.0
2022.07	SA5#144e	S5-224438 S5-224439 S5-224440 S5-224441				adding key issue for collocated management with MEC adding key issue for application lifecycle management adding key issue for resource reservation adding background information for GSMA OPG	0.3.0
2022.08	SA5#145e	S5-225872 S5-225873 S5-225874				add potential solution for EES and MEP collocation add potential solution for application LCM update background information for GSMA OPG	0.4.0
2023.03	SA5#147	S5-232860 S5-232861 S5-232862 S5-232863 S5-232864 S5-232865 S5-233046				E/WBI related Key Issues Add KI for Federation Management NBI Related Key Issues NBI Related Solutions add potential solution for resource reservation GSMA OP and ECM Concept Mapping add potential solution for application LCM with MEC	0.5.0
2023.04	SA5#148e	S5-233361 S5-233631 S5-233632 S5-233359 S5-233360 S5-233633 S5-233634 S5-233635				Add solution for virtual resource related issue Add recommendation for resource reservation related issue Add recommendation for SLA related issue Add recommendation for management for alignment with ETSI MEC Add recommendation for application resource catalogue issue Federated EAS Management Federation Management EAS Mobility	0.6.0
2023.05	SA5#149	S5-234091 S5-234570 S5-234571 S5-234572 S5-234573 S5-234574 S5-234575 S5-234576 S5-234577 S5-234578 S5-234579				editorial correction Add new requirements and solution for federation management Federated EAS resource reservation management rapporteur clean up Conclusion and Recommendations for EAS relocation policies Conclusion and Recommendations for Federation Management Federated EAS deployment and termination Modify requirements and solution for Application Resource solution for query available edge services update description of GSMA OPG Solution Conclusion and Recommendations for EDN Sharing	0.7.0
2023-06	SA#100	SP-230635				Presented for information and approval	1.0.0
2023-06	SA#100					Upgrade to change control version	18.0.0
2023-06	SA#100					EditHelp review	18.0.1

History

Document history		
V18.0.1	May 2024	Publication