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Multi-access Edge Computing (MEC); Application Mobility Service API

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Multi-access Edge Computing (MEC).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document provides a specification for end-to-end MEC application mobility support in a multi-access edge system. The present document describes information flows, required information and operations. The present document also specifies the necessary API with the data model and data format.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI GS MEC 001: "Multi-access Edge Computing (MEC); Terminology".

[2] ETSI GS MEC 002: "Multi-access Edge Computing (MEC); Phase 2: Use Cases and Requirements".

[3] ETSI GS MEC 003: "Multi-access Edge Computing (MEC); Framework and Reference Architecture".

[4] ETSI GS MEC 009: "Multi-access Edge Computing (MEC); General principles, patterns and common aspects of MEC Service APIs".

[5] ETSI GS MEC 011: "Multi-access Edge Computing (MEC); Edge Platform Application Enablement".

[6] ETSI GS MEC 012: "Multi-access Edge Computing (MEC); Radio Network Information API".

[7] ETSI GS MEC 010-2: "Multi-access Edge Computing (MEC); MEC Management; Part 2: Application lifecycle, rules and requirements management".

[8] IETF RFC 6749: "The OAuth 2.0 Authorization Framework".

NOTE: Available at https://tools.ietf.org/html/rfc6749.

[9] IETF RFC 6750: "The OAuth 2.0 Authorization Framework: Bearer Token Usage".

NOTE: Available at https://tools.ietf.org/html/rfc6750.

[10] IETF RFC 5246: "The Transport Layer Security (TLS) Protocol Version 1.2".

NOTE: Available at https://tools.ietf.org/html/rfc5246.

[11] IETF RFC 8446: "The Transport Layer Security (TLS) Protocol Version 1.3".

NOTE: Available at https://tools.ietf.org/html/rfc8446.

[12] IETF RFC 8259: "The JavaScript Object Notation (JSON) Data Interchange Format".

NOTE: Available at https://www.rfc-editor.org/info/rfc8259.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GS MEC 016: "Multi-access Edge Computing (MEC); Device application interface".

[i.2] OpenAPI™ Specification.

NOTE: Available at https://github.com/OAI/OpenAPI-Specification.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GS MEC 001 [1] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS MEC 001 [1] and the following apply:

AMS	Application Mobility Service
S-App	Source - Application instance
S-DP	Source - Data Plane
S-MEP	Source - MEC Platforms
S-MEPM	Source - MEC Platform Manager
T-App	Target - Application instance
T-DP	Target - Data Plane
T-MEP	Target - MEC Platforms
T-MEPM	Target - MEC Platform Manager
TEID	Tunnel End point IDentifier

4 Specification level requirements

4.1 Introduction

Application mobility is a unique feature of MEC system, which supports relocation of user context and/or application instance from one MEC host to another, or between a MEC host and a Cloud, especially when the MEC host is attached to mobile operator's networks. As a mobile device connected to a mobile network moves around within the network, it can result in the device connecting to the network entity associated to a different MEC host from the serving host. Consequently, there is necessity of relocating the application instance and/or user context associated to the device to a new MEC host to continue offering the best performance of service.

ETSI GS MEC 002 [2] describes some use cases related to application mobility or smart relocation, and associated requirements for MEC system to relocate the application instance and/or context to the "right" MEC host for optimizing the performance.

Application mobility may involve multiple MEC functional entities to relocate application instances and transfer user and application specific information within or between the MEC systems. Relocation decisions may be based on device mobility, customer profiles, application preferences and/or MEC infrastructure capability.

4.2 Functional requirements

Table 4.2-1 summarizes the functional requirements related to application mobility specified in ETSI GS MEC 002 [2].

Table 4.2-1: Functional requirements

Numbering		Functional requirement description
AppMobility01	[Mobility-01]	The MEC system shall be able to maintain connectivity between a UE and an application instance when the UE performs a handover to another cell associated with the same MEC host.
AppMobility02	[Mobility-02]	The MEC system shall be able to maintain connectivity between a UE and an application instance when the UE performs a handover to another cell not associated with the same MEC host.
AppMobility03	[Mobility-03]	The MEC platform may use available radio network information to optimize the mobility procedures required to support service continuity.
AppMobility04	[Mobility-04]	The MEC platform may use available core network information to optimize the mobility procedures required to support service continuity.
AppMobility05	[Connectivity-02]	The MEC system shall support two instances of a MEC application running on different MEC hosts to communicate with each other.
AppMobility06	[Connectivity-03]	The MEC platform shall be able to allow an authorized MEC application to communicate with another MEC application located on another MEC host.
AppMobility07	[SmartReloc-03]	When the MEC system supports the feature SmartRelocation, the MEC management shall support the relocation of a MEC application instance from one MEC host to a different host within the system.
AppMobility08	[SmartReloc-04]	When the MEC system supports the feature SmartRelocation, a MEC host may support the relocation of a MEC application instance from a different host (within the system) to this particular host, and from this particular host to a different host (within the system).
AppMobility09	[SmartReloc-05]	When the MEC system supports the feature SmartRelocation, the system shall be able to move MEC application instances between MEC hosts in order to continue to satisfy the requirements of the MEC application.
AppMobility10	[SmartReloc-06]	When the MEC system supports the feature SmartRelocation, and based on a request from the UE, the system shall be able to relocate a MEC application running in a cloud environment to a MEC host fulfilling the requirements of the MEC application, and relocate a MEC application from a MEC host to a cloud environment outside the MEC system.
NOTE: The numbering of requirement in [ ] refers to the corresponding requirement in ETSI GS MEC 002 [2].		

5 Description of the services (informative)

5.1 Introduction

Application Mobility Service support may be considered as part of the service continuity support, for which the service to the user will resume and continue when the application instance is made available in the target MEC host and the user context, if needed, is transferred to the application instance there.

The characteristics of the service produced by the server application determines whether or not user context transfer is required for service continuity. For a stateless server application there is no state, i.e. user context, to transfer. For a stateful server application the user context may have to be transferred to the target application instance.

NOTE 1: The specification of the user context is outside the scope of the present document.

Application mobility support includes the following high level actions: the instantiation of the application in the target MEC host, if needed, and the transfer of user context, if needed, to the target application instance.

NOTE 2: The scenario of application mobility between two MEC systems and between the MEC system and an external cloud system is not specified in the present document.

Application mobility may involve multiple functional entities in MEC system, depending on different implementation approaches:

1) Application self-controlled user context transfer: The application itself, i.e. the server application instance (i.e. MEC application), or the client side application instance, or the centralized cloud instance, if available, may synchronize the user context in the target server application instance when necessary.

NOTE 3: For server application instances to resynchronize the user context the precondition is for MEC to enable the connectivity between the peer server application instances.

NOTE 4: The determination of the need for synchronization as well as the synchronization of the user context are application implementation dependent, and are outside the scope of the present document.

2) Device application assisted user context transfer: Device application initiates/triggers the application mobility and keeps the user context in the client during the relocation. The MEC system is the decision maker about the application mobility. Once the application is instantiated on the new MEC host, the application client will communicate with the server application instance directly to transfer and synchronize the user context.

NOTE 5: The user context transfer and synchronization are outside the scope of the present document.

3) MEC assisted user context transfer: MEC system triggers the application mobility. MEC system may facilitate the transfer of the user context to the target application instance.

Support of application mobility also depends on the application capability. An application instance may be dedicated to serve a single user; or it may serve multiple users simultaneously, such as multicast service to a group of users, or broadcast service to all the users associated to the MEC host.

Clause 5 provides descriptions of service for the three high level approaches described above. In addition, high level information flows for application mobility in different scenarios are provided. The high level information flows are then split into individual procedures to be defined in the present specification or in other MEC specifications. When possible, it is recommended to reuse the existing procedures, data models and APIs for application mobility.

5.2 End to end application mobility information flows

The high level Application Mobility Service information flow for intra MEC system is shown in figure 5.2-1.

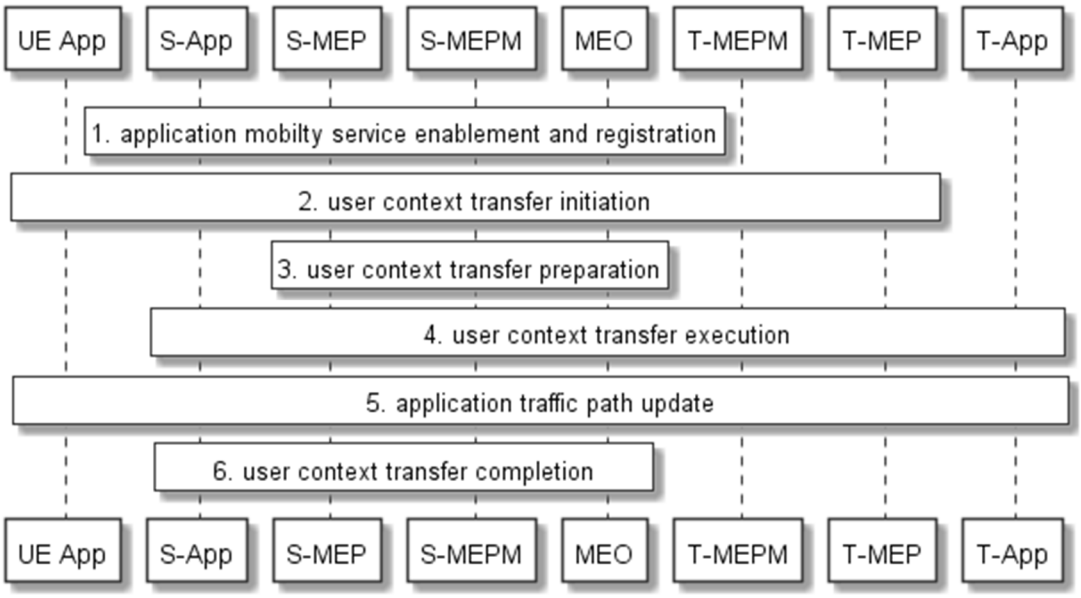

Figure 5.2-1: High level Application Mobility Service information flow

The information flow of intra MEC system Application Mobility Service may be divided into several sub-procedures that may or may not be present in the actual mobility scenario:

1) Application mobility enablement and registration: this sub-procedure illustrates the general procedure on enabling the Application Mobility Service and allowing the application instances to register to the required application mobility services.

2) User context transfer initiation: this sub-procedure illustrates various detecting and triggering mechanisms for transferring the user context to the target application instance.

3) User context transfer preparation: this is an optional sub-procedure for MEC assisted user context transfer, and used for MEC system to prepare for the transfer.

4) User context transfer execution: this sub-procedure illustrates how the user context is transferred to and synchronized on the application instance running on the target MEC host.

5) Application traffic path update: this sub-procedure illustrates how MEC system reconfigures the data plane to redirect the traffic to the application instance on the target MEC host.

6) User context transfer completion: this sub-procedure illustrates how MEC system to clean-up the user context and/or application instance at source MEC host after the user context has been transferred.

The services like RNIS on the source MEC host and the target MEC host may be involved in the application mobility procedures. The detailed involvement will be described in the individual sub-procedures.

5.3 Application mobility enablement

The application mobility capability (e.g. UserContextTrasnferCapability) information may be included in the application descriptor (AppD) to indicate the stateful/stateless characteristic, the support of user context transfer, and the Application Mobility Service dependency.

A suitable MEC host is selected based on the application requirements (including the application mobility support requirements) to instantiate the application. The application instance can register to the available AMS for application mobility support. The MEC system may also instantiate the same applications in other MEC host to assist the application mobility.

The information flow of Application Mobility Service enablement and registration is shown in figure 5.3-1.

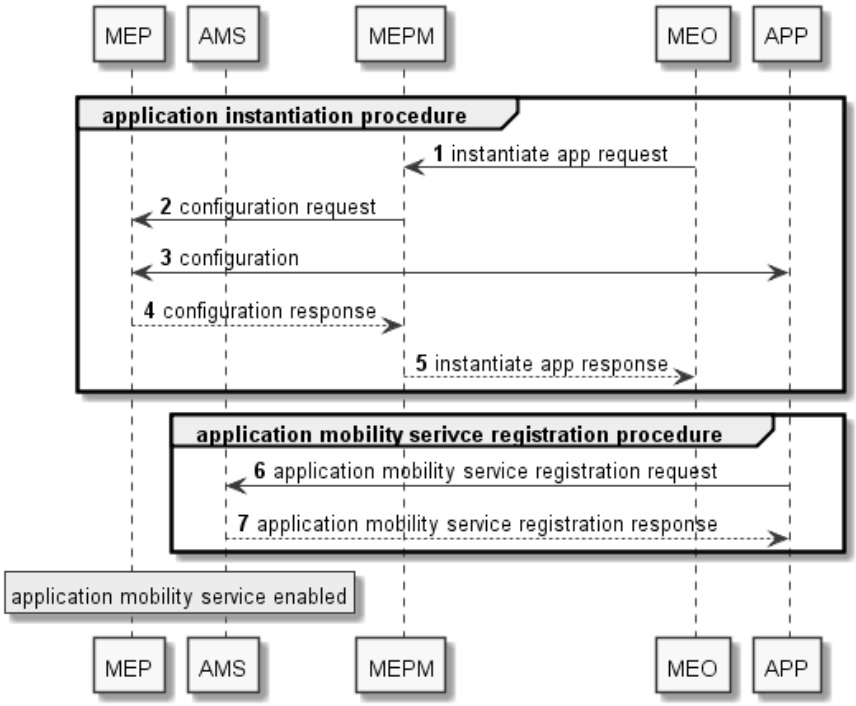

Figure 5.3-1: Application Mobility Service enablement and registration

The steps 1 to 5 are existing procedures specified in ETSI GS MEC 010-2 [7] and ETSI GS MEC 011 [5]:

6) The application instance sends the Application Mobility Service registration request to the AMS running on the MEC host.

7) The AMS sends the Application Mobility Service registration response to the application instance with the application mobility service ID to confirm the service registration success. The Application Mobility Service is then enabled to serve to this application instance.

5.4 Application relocation initiation

5.4.1 Overview

Application Mobility Service support may rely on many factors, and may be initiated by different functional entities in the MEC system, including:

1) A combination of source and target MEPs and their associated services. Specific combinations include S-MEP & S-RNIS, S-MEP & S-DP, T-MEP & T-RNIS, T-MEP & T-DP and the MEO.

2) A MEC application instance.

3) A UE application client.

A service of particular relevance to application mobility is RNIS which provides the services of radio network information to AMS. The information used to trigger Application Mobility Services may include:

- information about UEs connected to the radio node(s) associated with the MEC host, and the related radio access bearers;

- changes in information related to UEs connected to the radio node(s) associated with the MEC host and the information related radio access bearers.

Using RNIS, the AMS is able to query for radio information or subscribe to notifications related to special events, a particular UE, or to radio node(s) attached to the MEC host.

RNIS uses a service consumer specified associateId to identify a particular UE or UE(s). The identifiers of the associateId by RNIS are:

- UE IPv4 address;
- UE IPv6 address;
- NATed IP address; or
- GTP TEID.

5.4.2 MEC assisted application mobility information flow

5.4.2.1 S-MEP triggered application mobility using RNIS

The first step in this flow is the AMS in the serving MEP (S-MEP) subscribing to cell change notifications for a UE or UEs in the cell(s) (radio nodes) associated to the MEC host. When a tracked UE moves across cells' boundary of the underlying network, the RNIS of serving MEC host (i.e. S-RNIS) will send event notifications about cell changes to the AMS in S-MEP. This may trigger application mobility procedures. Based on the received cell change notifications, the AMS in S-MEP verifies whether the UE has moved out of the coverage area of the source MEC host. If it does, the AMS in S-MEP will initiate application mobility procedures toward the T-MEH. The AMS in S-MEP uses the associateId in the notification to identify the target UE.

The S-MEP (i.e. AMS) initiated application mobility information flow regarding to UE cell change (handover) is depicted in figure 5.4.2.1-1.

Figure 5.4.2.1-1: The information flow of S-MEP initiated application mobility

The information flow of S-MEP (i.e. AMS) initiated application mobility consists of following steps:

0) The AMS in S-MEP, registered by the application instance, subscribes the cell change notification associated with a UE or UEs in the cells under the MEC host. The AMS in S-MEP maps the appInstanceId with the associateId(s) after subscription. When a specified UE moves within the underlying network and triggers a cell change event, the S-RNIS sends a RNI cell change notification that indicates the handover status of the UE.

1) The associateId in the cell change notification can identify the UE that is performing the handover. The AMS in S-MEP processes the received cell change notification, mapping the notification to the application instance(s) serving the UE. The AMS in S-MEP may correlate different notifications to determine whether the UE has moved out of the coverage area of the S-MEH. If it does, the AMS in S-MEP sends to the MEO through the S-MEPM the MobilityProcedureNotification including the UE ID (associateId), the application instance IDs (appInstanceId), the source radio node ID (srcEcgi) and the target radio node ID (trgEcgi) which are all reported in the RNI cell change notification.

2) The S-MEPM relays the MobilityProcedureNotification to the MEO.

5.5 Application relocation verification and validation

When a UE moves to the service area of another MEC host, the MEC may instantiate on that MEC host the same application as the one serving to the UE, if an instance of the same application does not exist. The application relocation verification and validation are not addressed in the present document.

5.6 User context transfer

5.6.1 Introduction

For service continuity of a stateful application service, it is necessary to import the user context from the source application instance into the target application instance in the target MEC host. The user context includes user specific runtime data. The user context can be associated with a specific user or a group of users.

As specified in clause 5.1, there are three high level implementation approaches for user context transfer where the MEC system is the decision maker and selects appropriate MEC application instance:

1) Device application assisted state transfer

2) MEC assisted state transfer

3) Application self-controlled state transfer

The user context transfer is dependent on the capabilities of the application itself and of the underlying operating system of the MEC host. Both of these aspects are outside the scope of MEC specifications.

5.6.2 Application self-controlled user context transfer

The application self-controlled user context transfer assumes the application (server side, client side, centralized cloud component) to be able to detect the need for the user context transfer by its own means. Furthermore, it assumes the application is able to execute the context transfer without assistance from the MEC system. The role of the MEC system is to fulfil the applicable service and session continuity commitments for the application traffic and to enable the required application communication. The MEC application communication requirements and session and service continuity requirements may be brought into the MEC system at the time of on-boarding or deployment of the application.

An example scenario for the application self-controlled user context transfer is described below:

1) The MEC application instance serving the end user client is changed from one MEC host to another MEC host.

2) The session and service continuity requirement for the MEC application is to maintain the IP address.

3) The underlying access network and MEC reconfigure the routing of the application traffic so it reaches the new serving MEC application instance.

4) When the client connects with the server, the two have means to determine the need for the user context synchronization and have means to have the user context synchronized into the new serving MEC application instance, e.g. from the application client itself or from the central cloud instance.

5.6.3 Device application assisted user context transfer

The device application assisted user context transfer assumes that the application client is assisted by the device application associated with the corresponding MEC application (i.e. user application) in the MEC system.

NOTE: A device application is logically separate from the client application, irrespective of the way how the two have been implemented in the device. The device application session is with the user application LCM proxy which is a MEC system level functional entity.

The present Mx2 API [i.1] supports notifying the device application of the user application address change. Consequently the device application can receive the up to date information of the MEC application address and may pass this information to the client side application. A client application designed to be assisted by the device application does not require the underlying access network and MEC to maintain the IP address of the application. In addition, the client application may use the new MEC application instance address for the user context synchronization in the new user application instance.

5.6.4 MEC assisted user context transfer

The MEC assisted user context transfer relies on the Application Mobility Service (AMS) of MEC to trigger the user context transfer and to inform the MEC application of the target end point of the user context.

The MEC application is a consumer of the AMS. The AMS is kept updated of the devices served by the MEC application. The AMS notifies the MEC application of the user context target end point when there is the need for a user context transfer. MEC application then sends the user context to the target end point. The user context is application specific and it is exchanged between MEC application peers in the source and target MEC hosts.

5.7 Application traffic path update

The application traffic path update is to switch the delivery of user traffic from the source to the target application instance. The AMS triggers the switch of traffic path after the application completes the user context transfer to the target application instance.

5.8 Application relocation completion

The application relocation completion is a process to clean-up the resource allocated to the application instance served to the application client in the source MEC host, if necessary.

The present document specifies the AMS API in clauses 6 and 7.

6 Sequence diagrams

6.1 Introduction

The following clauses describe how service consumers, i.e. application instances or MEC platform, interact with AMS to obtain application mobility related information.

The service consumers register to AMS with device information if AMS service is used, and deregister such information from AMS if AMS service is not needed no longer.

The service consumers could query the information from AMS, and subscribe to AMS on particular events in order to receive notifications when the events occur.

The Application Mobility Service will provide the following application mobility related information to the registered consumers:

- endpoint information of adjacent application instances with communication links;
- identification of application instance running on the target MEC host;
- communication link information between the source and target instances of the same application;
- notification of application mobility status;
- assistance to clean up the user information at the source application instance and MEC platform when the user context has been transferred to the target application instance.