

Question(s): 2/19, 6/13

Seoul, Korea, 17-24 January 2008

TEMPORARY DOCUMENT

Source: Editors

Title: Draft Recommendation Q.MMF (version 1.7)

This is the output document of draft Recommendation MMF version 1.7, which was produced in the 2008 January NGN-GSI MM Group's meeting. This is submitted to the SG19 Plenary meeting and SG13 Plenary meeting for Consent.

MMF has so far been progressed as indicated by the following version history:

Version	Date	Meeting
0.1	November 2003	SSG Meeting
0.2	January 2004	Q.2/SSG Electronic Meeting
0.3	March 2004	Q.2/SSG Electronic Meeting
0.4	April 2004	SSG Meeting
0.5	December 2004	SSG Meeting
0.6	May 2005	SG19 Meeting
0.7	July 2005	Q.2/19 Electronic Meeting
0.8	September 2005	SG19 Meeting
0.9	January 2006	NGN-GSI Meeting
1.0	April 2006	NGN-GSI Meeting
1.1	July 2006	NGN-GSI Meeting
1.2	October 2006	NGN-GSI Meeting
1.3	April 2007	NGN-GSI Meeting
1.4	June 2007	Q.2/19 and Q.6/13 Electronic Meeting
1.5	September 2007	NGN-GSI Meeting
1.6	November 2007	Q.2/19 and Q.6/13 Electronic Meeting
1.7	January 2008	NGN-GSI Meeting

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ITU-T New Recommendation Q.1707/Y.2804

Generic Framework of Mobility Management for Next Generation Networks

Summary

This Recommendation describes a generic framework of mobility management for Next Generation Networks. This Recommendation describes the design considerations, conceptual framework, functional architecture, and high-level information flows for mobility management in the NGN.

Keywords

NGN, Mobility Management, Framework, Location Management, Handover Control

Introduction

This Recommendation describes a framework of mobility management (MM) for Next Generation Networks (NGN). This work has been motivated from the observation that NGN continues to evolve toward the convergence of fixed and wireless/mobile networks, and thus the MM is an essential functionality to provide seamless mobility for the NGN users and services.

This Recommendation is a part of the MM framework for NGN. The MM framework is designed with a couple of Recommendations, rather than a single Recommendation, as a suite of the framework of MM for NGN. This is because the design of the MM framework includes a variety of technical issues to be addressed. Furthermore, those design issues are associated with a wide variety of mobility scenarios and protocols. In this respect, the MM framework for NGN is described with a family of the following Recommendations:

- Recommendation Q.MMF: Generic Framework of Mobility Management for NGN;
- Recommendation Q.LMF: Framework of Location Management for NGN; and
- Recommendation Q.HCF: Framework of Handover Control for NGN.

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1 Scope

This Recommendation is purposed to describe a generic framework of mobility management (MM) for Next Generation Networks (NGN), which will include

- Design issues common to both location management and handover control;
- Functional architecture for mobility management in the NGN perspective;
- High-level information flows for mobility management.

It is noted that there are a variety of mobility types such as terminal mobility, network mobility, services mobility, etc. This Recommendation focuses on the terminal mobility in the IP or higher layer among those MM types. MM schemes associated with a specific link-layer or lower layer technology might be applied to the functions described in this Recommendation. However, the access technology specific details are outside the scope of this Recommendation.

This Recommendation describes a two-level architecture for MM functionality. For a scalability enhancement of MM in the NGN, the functional architecture can be extended to the architecture with more than two levels. This Recommendation also describes a high-level relationship between the MM control functions and the other functions defined in the NGN-FRA Release 1 so as to provide a guideline for further work on adding MM control functions to the NGN-FRA architecture.

2 References

The following ITU-T Recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [Q.1706/Y.2801] ITU-T Recommendation Q.1706/Y.2801 (2006), *Mobility management requirements for next generation networks*.
- [Y.2001] ITU-T Recommendation Y.2001 (2004), *General overview of NGN*.
- [Y.2012] ITU-T Recommendation Y.2012 (2006), *Functional requirements and architecture of the NGN*.
- [Y.2091] ITU-T Recommendation Y.2091 (2007), *Terms and definitions for Next Generation Networks*.
- [Q.1701] ITU-T Recommendation Q.1701 (1999), *Signalling requirements and protocols for IMT-2000*.
- [Q.1702] ITU-T Recommendation Q.1702 (2002), *Long-term vision of network aspects for systems beyond IMT-2000*.
- [Q.1711] ITU-T Recommendation Q.1711 (1999), *Network functional model for IMT-2000*.
- [Q.1761] ITU-T Recommendation Q.1761 (2004), *Principles and requirements for convergence of fixed and existing IMT-2000 systems*.

[M.1224] ITU-R Recommendation M.1224 (1997), *Vocabulary of terms for IMT-2000*.

3 Definitions

This Recommendation uses the definitions and terms that have been described in the ITU-T Recommendations Q.1706/Y.2801.

In addition, this Recommendation uses the following terms.

3.1 Access network

A network that is characterized by a specific wired/wireless access technology. Refer also to the Recommendation Q.1742.2.

3.2 Core network

An architectural term related to the part of an NGN network, which is independent of a specific access technology. Refer also to the Recommendation Q.1741.2.

3.3 Host-based mobility management

A mobility management scheme in which the MM signalling is performed based on (or controlled by) the User Equipment (UE).

3.4 Network-based mobility management

A mobility management scheme in which the MM signalling is performed (or controlled) by the network entities, on behalf of the UE.

3.5 Home network

The network (or service provider) to which a user has subscribed to. The user's subscription information is managed in the home network. Refer also to the Recommendation Q.1706.

3.6 Visited network

The network (or service provider) outside the home network. Refer also to the Recommendation Q.1706.

3.7 User identifier

A series of digits, characters and symbols or any other form of data that are used to identify a subscriber (user) or user equipment in the NGN. Refer also to the Recommendation Y.2091.

3.8 Location identifier

A topological location identifier of a UE. An IP address can be used as a location identifier. Refer also to the Recommendation Y.2091.

4 Abbreviations and acronyms

AAA Authentication, Authorization, and Accounting

A-HCF	Access HCF
A-LMF	Access LMF
A-MMCF	Access MMCF
AN	Access Network
AP	Access Point
AR	Access Router
BS	Base Station
BWA	Broadband Wireless Access
CDMA	Code Division Multiple Access
C-HCF	Central HCF
C-LMF	Central LMF
C-MMCF	Central MMCF
CN	Core Network
DHCP	Dynamic Host Configuration Protocol
FA	Foreign Agent
FE	Functional Entity
HA	Home Agent
HC	Handover Control
HCF	Handover Control Function
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IPSEC	IP Security Protocol
IMS	IP Multimedia Subsystem
IP	Internet Protocol
L2	Layer 2
LID	Location Identifier

LM	Location Management
LMA	Localized Mobility Agent
LMF	Location Management Function
LTE	Long Term Evolution
MAG	Mobile Access Gateway
MIH	Media Independent Handover
MIP	Mobile IP
MM	Mobility Management
MMCF	Mobility Management Control Function
NAI	Network Access Identifier
NACF	Network Attachment Control Function
NGN	Next Generation Networks
NGN-FRA	Functional Requirements and Architecture for NGN
PMIP	Proxy MIP
PoA	Point of Attachment
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RADIUS	Remote Authentication Dial-In User Services
SIP	Session Initiation Protocol
SSID	Service Set ID
UE	User Equipment
UID	User Identifier
URI	Uniform Resource Identifier
VoIP	Voice over Internet Protocol
W-CDMA	Wideband-Code Division Multiple Access
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network

5 Design considerations

5.1 Network environments

The network environments in NGN can be illustrated as the figure below. As shown in the figure, the MM framework will be designed to support the mobility for NGN users across a wide variety of heterogeneous access networks.

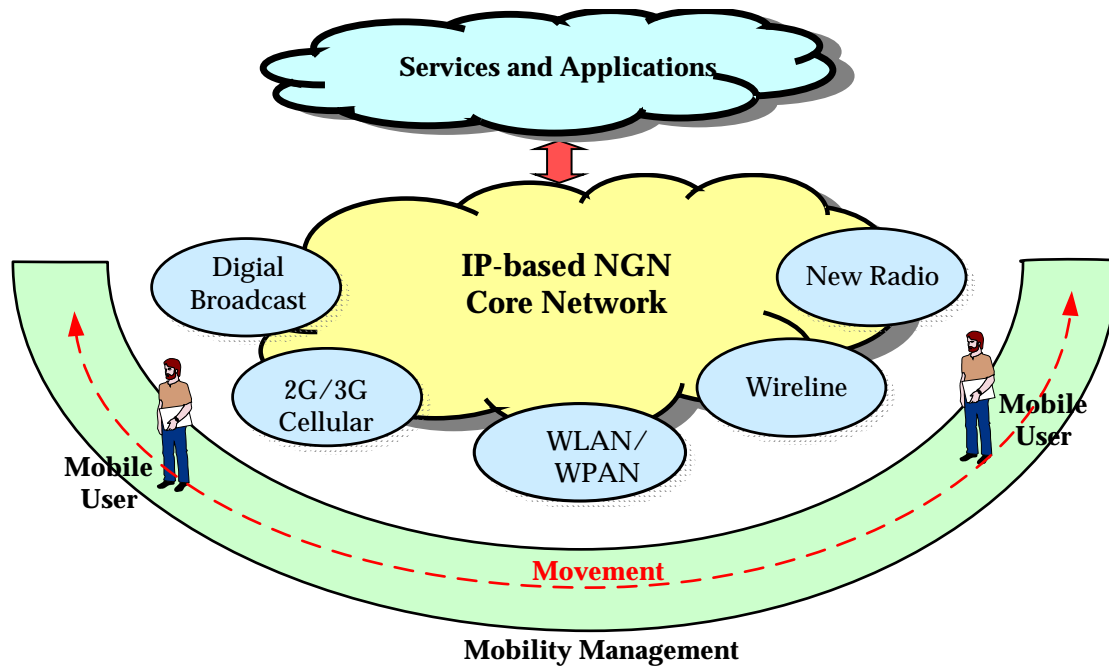


Figure 5.1 NGN environments

From the NGN point of view, the MM framework will be designed to provide a set of the signalling and control operations for MM. Those signalling and control operations will be performed among a variety of MM-related functional entities. In NGN, an operator may implement those MM-related functions in the Core Network (CN) and a variety of its Access Networks (ANs). With the help of the appropriate signalling operations for MM, an NGN user could benefit from the continuation of the services in the seamless manner, while it moves around the various access networks in NGN.

5.2 Design principles

In this Recommendation, the MM framework will be designed with the following principles.

5.2.1 IP-based MM framework

One of the major requirements for MM in NGN is that the MM schemes can operate over the 'IP-based' networks, so as to support the mobility across a variety of heterogeneous access networks in NGN. The IP-based framework will ensure that the MM functionality could be commonly applied to the various networks or systems, independently of the underlying link-layer access technologies. The 'IP-based' MM framework will also facilitate that a variety of the well-defined existing IP-based protocols, such as AAA and DHCP, could be reused to support the MM.

5.2.2 Separation of MM control function from transport function

It is noted that MM functionality can be viewed as the transport control function, rather than the transport function. MM control function will be designed as a self-contained scheme, not depending on the specific data transport scheme. This feature will make it easier to implement and deploy the MM control functions to a variety of transport networks in NGN.

5.2.3 Location management and handover control functions

The MM framework is designed to provide the location management (LM) functionality. For this purpose, the latest information of the location of a mobile user will be registered and updated, each time it continues to move around in the network. The MM framework is also designed to provide the handover control (HC) functionality. With the help of this HC function, a mobile UE can seamlessly continue the data communication during the session, even though it changes the associated IP address in the network.

5.2.4 Separation of User ID and Location ID

In the MM framework, User ID (a.k.a., identifier) is separated from Location ID (a.k.a., locator). An NGN user has its own unique User IDs (UIDs) that may be associated with user's subscription or services. The NGN user may have one or more Location IDs (LIDs), depending on the specific MM scheme. A typical example of LID is an IP address. It is noted that a User ID is statically assigned to an NGN user by the services provider on the subscription basis. On the other hand, a Location ID is dynamically assigned to the UE in the network, and it may change in time.

5.2.5 Cross-layer interaction for optimized MM

To optimize the MM functionality, a cross-layer interaction may be required between different protocol layers. This cross-layer optimization will be taken to enhance the MM operations such as movement detection, network discovery, network selection, and proactive handover signalling. In particular, the MM between heterogeneous ANs may require an open interface for cross-layer interaction. For example, the open interface can be used for an IP-layer MM function to utilize the underlying link-layer services/functions for a wide variety of access technologies.

5.2.6 Harmonization of different MM protocols

It is expected that the MM control functionality such as LM and HC will be realized with a set of MM protocols, rather than a single MM protocol. In this respect, it is required to effectively harmonize different MM protocols so as to optimize the overall MM functionality.

5.2.7 Interworking with other protocols

The MM functionality could be accomplished with the help of protocols for authentication, security, call/session establishment, and so on. Accordingly, the MM framework is designed to ensure that the MM functions could effectively interwork with the relevant protocols to the extent possible. For example, a user should be able to be authenticated via the AAA protocols, such as RADIUS or Diameter, without any modification of those protocols. For security purpose, the MM signalling may be protected with the help of protocols such as IPSEC. For call/session establishment and maintenance, the SIP protocol might be used by MM functions..

5.2.8 Support of network-based MM

The MM framework needs to consider the network-based MM as well as the host-based MM. A host-based MM may not require any MM functionality in AN, if MM control functionality is located in CN. On the other hand, a network-based MM can minimize the functional overhead of UE such as the amount of MM signalling. A network-based MM can also support the legacy UE that does not have any MM capability.

5.2.9 Policy-based MM

A policy-based MM can be considered to enhance or optimize the MM functionality. For example, the handover decision might be made as per the pre-configured user/operator policies which may be possibly contained in the user profile or policy server.

6 Conceptual framework of MM

6.1 MM control function

The MM can be regarded as the control functionality. Accordingly, the MM control function will be separated from the transport function in NGN, as illustrated in the figure below.

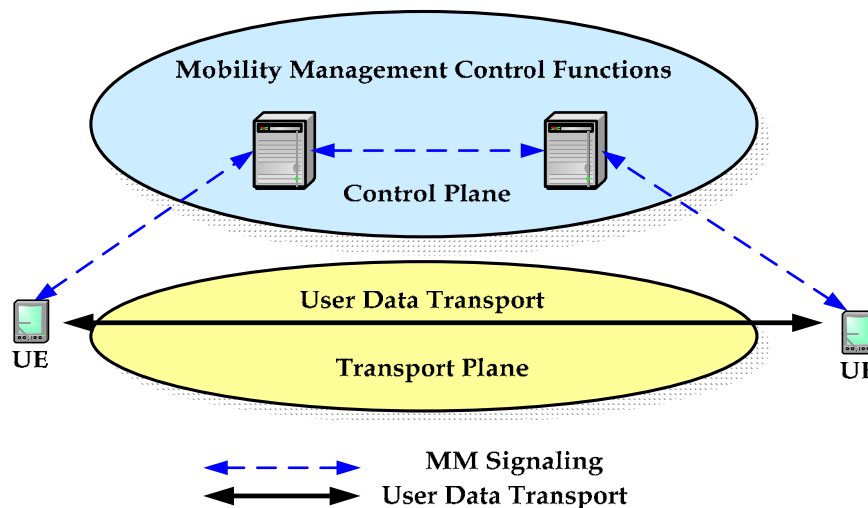


Figure 6.1 MM control functionality

The MM functionality will perform the signalling or control operations required for the mobility management through the MM control functions..

6.2 Types of MM in NGN

As described in the Recommendation Q.1706, the types of MM for NGN can be classified into the three cases: Inter-CN MM between different operators (MM1), Inter-AN MM between access networks (MM2) and Intra-AN MM within a same access network (MM3), as illustrated in the figure below.

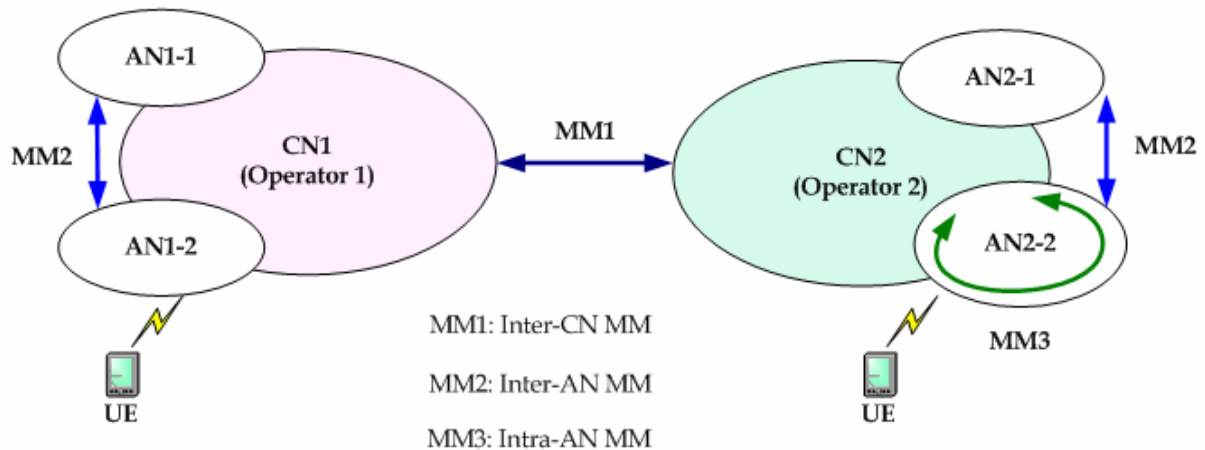


Figure 6.2 Types of MM in NGN networks

The MM3 considers the MM issues associated with the UE that moves within an AN. For MM2, the UE might change its AN, possibly with its underlying link-layer access technology. This MM2 can be further classified into homogeneous (horizontal) inter-AN MM and heterogeneous (vertical) inter-AN MM. For MM1, the UE may move into the network that is managed by a different NGN operator.

This Recommendation describes a framework of MM that could be commonly applied to all the types of MM. The more detailed issues on each of the three types of MM will be addressed in the other Recommendations: Q.LMF and Q.HCF.

6.3 MM identifiers

6.3.1 User ID

In the MM framework, a User ID (UID) represents an identifier, which is defined as a series of digits, characters, symbols or any other form of data that can be used to identify a user, as described in the ITU-T Y.2091. In this Recommendation, for terminal mobility, a UID can also be used to identify the UE of a user in a broad sense.

A UID shall be able to uniquely identify a specific user for MM. It is noted that an NGN user may have one or more UIDs, depending on the number of the equipments and services associated with the user. Typical examples of UIDs include International Mobile Subscriber Identifier (IMSI), E.164 number (for PSTN services), SIP URI (for IMS-based multimedia services), e-mail address, Network Access Identifier (NAI), and any identifier of a user or UE.

6.3.2 Location ID

To provide the location management, the MM framework needs to define a Location ID (LID) associated with the location of a UE. In general, the location information of a UE can be classified into the two categories: the physical/geographical location ID (e.g., Line ID, SSID of AP, or Base Station ID) and the logical location ID (e.g., routable IP address). The MM framework will in particular focus on the logical location of a UE (i.e., routable IP address) as an LID.

It is noted that an IP address as an LID may have the two different features: temporal and persistent. The temporal IP address can change when the UE moves into the other network, whereas the

persistent IP address may not change. In the example of the MIP, the Home Address (HoA) can be viewed as a persistent IP address, whereas the Care-of Address (CoA) corresponds to a temporal IP address.

In summary, the MM identifiers can be classified into UIDs and LIDs, as shown in Figure 6.3. A UID is used to identify an NGN user (possibly with the associated UE) whereas an LID represents the logical or physical location of the user in the network. The LIDs are further classified into persistent LIDs and temporal LIDs, depending on whether the LID can vary with the movement of the user in the network. In particular, an IP address can be used as either a persistent LID or a temporal LID.

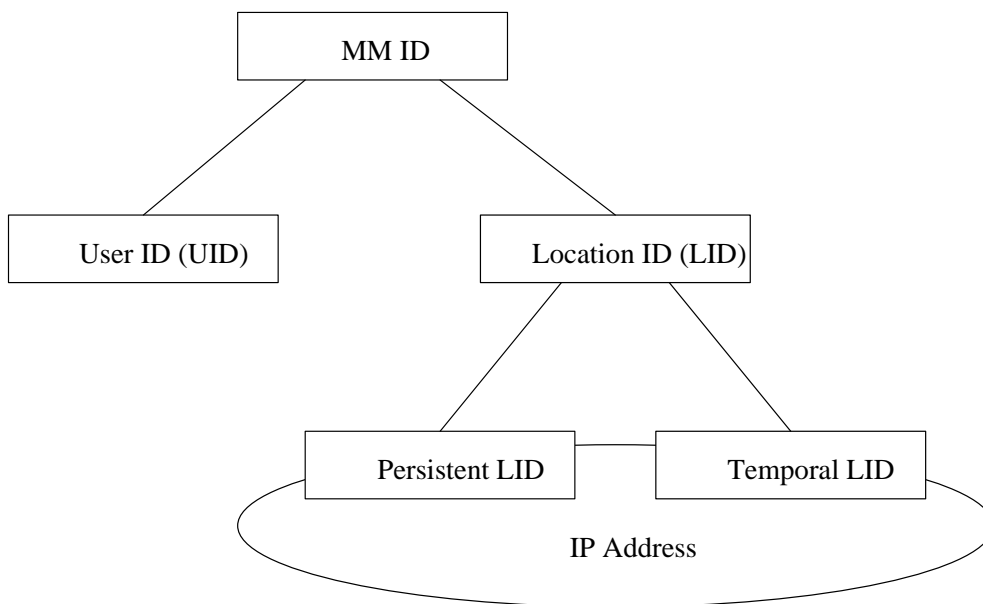


Figure 6.3 MM identifiers in NGN

6.4 Location management

The LM function is used to keep track of the movement of a UE in the network and to locate the UE for data delivery. The LM function is used for supporting the prospective ‘incoming’ session (or call) to the mobile user. The LM functionality includes the following subfunctions: location registration/update and location query/response (for user data transport) that may be performed with a service control function for call/session establishment.

The location registration and update functions are used to keep track of the current location of a UE. When a UE is attached to the network, it will register its current location with the location database for LM. When the UE moves into the other network, the corresponding LID will be updated. In the location registration and update function, the information of mapping between UID and LID for a specific UE will be managed and updated all the time.

The location query and response functions are used to locate the UE. The information of the current location of the UE will be identified through the suitable location query and response operations. It

is noted that the location query and response operations may be performed together with a relevant service control function.

6.5 Handover control

The HC function is used to provide the ‘session continuity’ for the ‘on-going’ session of the moving UE. To provide the seamless mobility or session continuity, the HC functions will be performed to minimize the data loss and handover latency during the handover of the UE.

In general, the handover control schemes can be divided by the protocol layer as follows.

- Handover control in the link layer;
- Handover control in the network layer; and
- Handover control in the transport/application layer

Each of the handover schemes will be performed using the corresponding signaling between the entities associated with handover. The handover signaling will be based on the movement detection (in the link-layer and/or in the network layer). A different HC protocol or scheme can be employed, depending on how to use the information on movement detection and/or how to perform the handover signaling. It is also noted that a different HC scheme can be used, as per the type of MM (e.g., inter-CN, inter-AN, and intra-AN handover).

7 MM functional architecture

7.1 Mobility Management Control Function (MMCF)

In this Recommendation, the Mobility Management Control Function (MMCF) is defined as a set of control functions that are used to provide the seamless mobility for NGN users.

Fig. 7.1 shows a conceptual model of MMCF in the network. As a control function, the MMCF operates independently of the data transport scheme used in the network. The MMCF can further be divided into Location Management Function (LMF) and Handover Control Function (HCF) for location management and handover control, respectively.

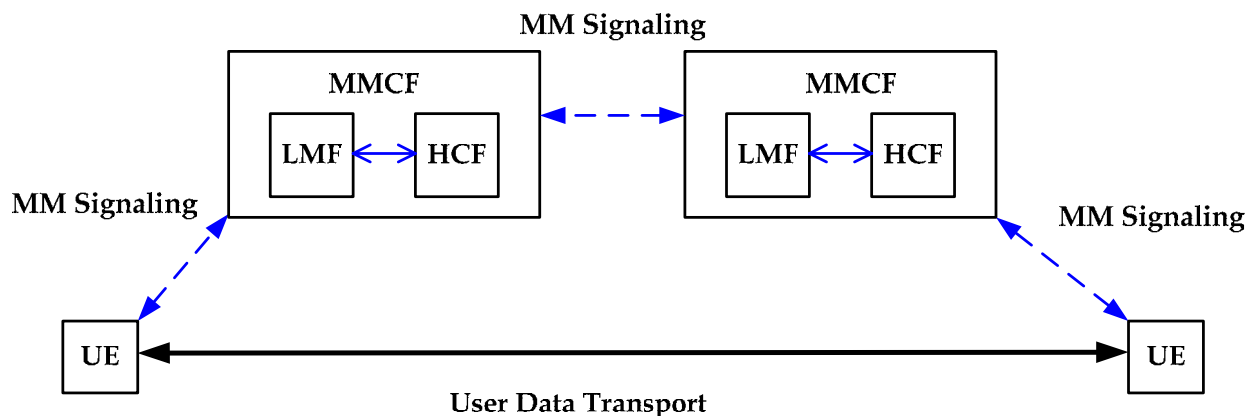


Figure 7.1 MMCF Model

The MM signalling operations will be performed between UE and MMCF, and between different MMCFs. In the host-based MM, the MM control operations will include the signalling procedures between UE and MMCF, whereas in the network-based MM, the MM control operations may be performed only between MMCFs.

The MMCF includes Location Management Function (LMF) and Handover Control Function (HCF). It is noted that the LMF and HCF functions represent the logical functions and thus those two functions can be implemented on either a single network component or different network components, which depends on implementation. The MM signalling operations may include interworking between LMF and HCF via an internal or external interface. MMCF shall be added to the existing NGN functional architecture.

Figure 7.2 shows the 2-level functional architecture of MMCFs in NGN with Central MMCF (C-MMCF) and Access MMCF (A-MMCF).

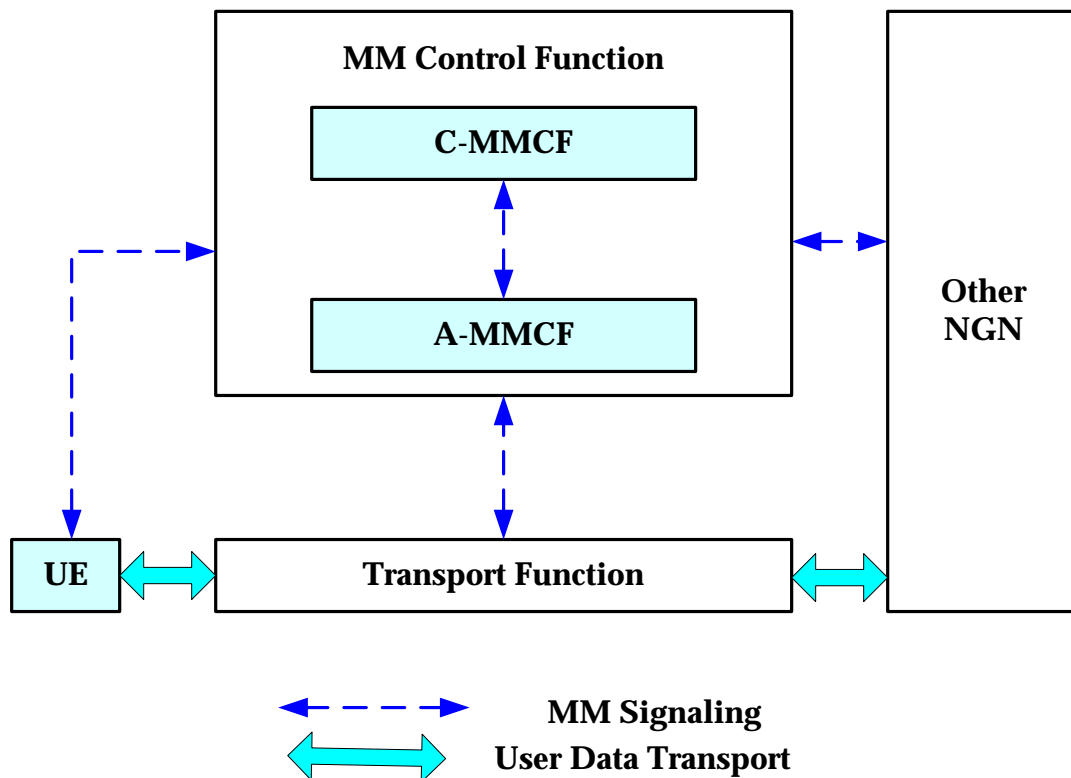


Figure 7.2 Functional architecture of MMCF in NGN

The C-MMCF function will be used to manage the user's roaming between different NGN operators (for MM1). The C-MMCF will also be used to manage the mobility within the NGN operator with the help of its downstream A-MMCFs in the network (for MM2 and MM3). The C-MMCF may be located in the CN of an NGN operator. The C-MMCF consists of C-LMF and C-HCF.

The A-MMCF function will be used to manage the intra-AN mobility of a UE within an AN of NGN (for MM3). This function can also be used to support the inter-AN mobility by interaction with the C-MMCF (for MM2). The A-MMCF may be co-located with access router (AR) which provides an IP connectivity for the UE. The A-MMCF consists of A-LMF and A-HCF.

Figure 7.3 illustrates the MMCFs in the NGN. The MMCFs can be classified into A-MMCF and C-MMCF, and each MMCF will contain the LMF and HCF. The MM framework will focus on the functionality and information flows associated with the MMCFs which will also interact with the other NGN functions or functional entities for MM.

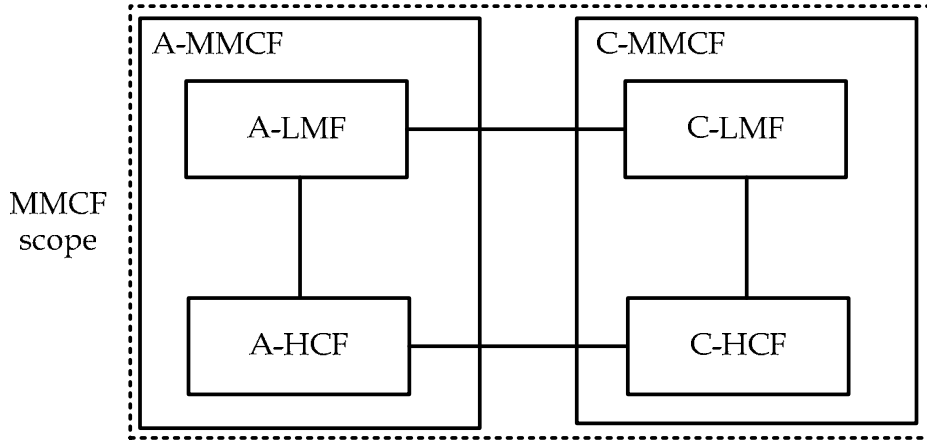


Figure 7.3 Structure of MMCFs

Figure 7.4 shows an example of network configuration of the MMCFs in the NGN, in which the C-MMCFs and A-MMCFs are logically configured in the NGN network. It is noted that there can be a variety of other possible configurations of the MMCFs in the network. Furthermore, there can also be so many possible mapping of the MM-related functional entities onto the equipments and devices in the real networks or systems.

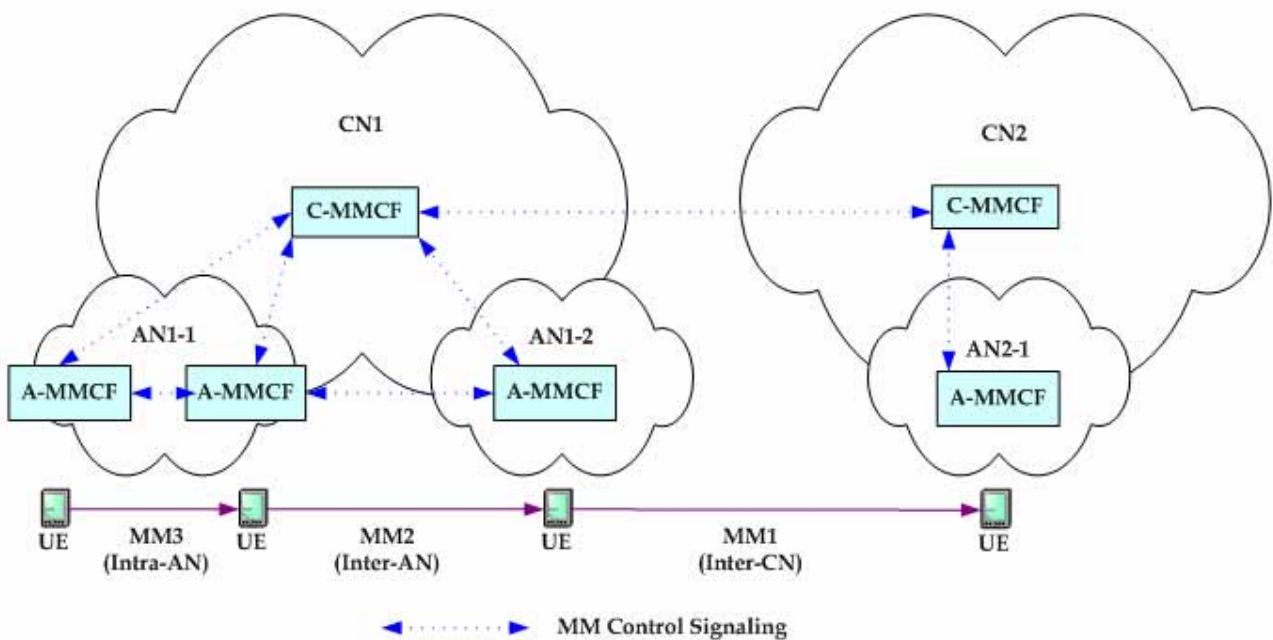


Figure 7.4 An example of network configuration of MMCFs in NGN

On the other hand, a hierarchical MM functional architecture could be considered to enhance the scalability of the MM signalling (e.g., for reducing the signalling load and latency) as well as to support the local mobility for the UEs within a local network region, as seen in the example of the IETF Hierarchical MIP. For this purpose, a new MMCF, Local MMCF (L-MMCF) can be considered in the MM architecture, which results in the 3-level functional architecture with C-MMCF, L-MMCF, and A-MMCF. In the 3-level architecture, the L-MMCF will be used to locally manage the mobility of the UEs in the network. The L-MMCF may be located at the access gateway of the concerned AN. The primary goal of the L-MMCF is to provide the scalability of the MM control operations for a large-scale network and a large number of users in the AN. The 3-level MMCF architecture will be described in the Recommendations Q.LMF and Q.HCF, wherever applicable.

7.2 Location Management Function (LMF)

The LMF can be classified into Access LMF (A-LMF) and Central LMF (C-LMF) according to its functional role. The A-LMF is expected to be located in the AN. This function will cooperate with the UEs, C-LMF and the other A-LMFs to provide the LM functionality. The C-LMF is expected to be located in the CN. This function will interact with the C-LMFs of the other NGN operator as well as the downstream A-LMFs in the same NGN operator.

7.2.1 C-LMF

The C-LMF supports the location management of UEs moving between different NGNs (MM1). In this respect, the C-LMF can be classified into Home C-LMF and Visited C-LMF. The C-LMF is also used to support the location management of UEs within an NGN network (for MM2 and MM3) by cooperation with its downstream A-LMFs.

7.2.2 A-LMF

The A-LMF supports the location management of UEs moving within an NGN (for MM2 and MM3) with the help of C-LMF. It is noted that there are many different LM schemes. For example, in the host-based MM, the signalling messages for LM can be exchanged between UE and A-LMF. On the other hand, in the network-based MM, an A-LMF may initiate the LM signalling operations instead of the UE.

7.2.3 Reference points of LMF

Fig. 7.5 shows the reference points of LMF.

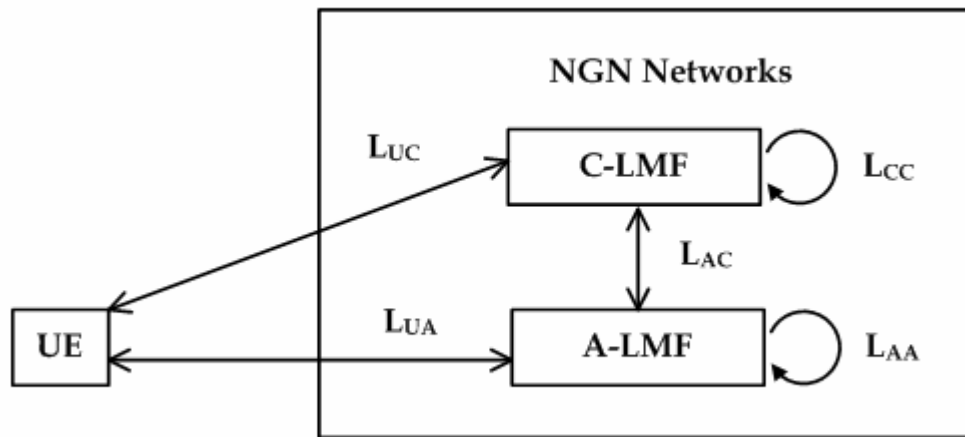


Figure 7.5 LMF Reference Points

In the figure, the L_{UA} reference point is used to support the LM signalling between UE and A-LMF. An example of L_{UA} is the MIPv4 protocol used between Foreign Agent (FA) and UE.

The L_{UC} reference point is used to support the signalling between UE and C-LMF. An example of L_{UC} is the MIPv6 protocol used between Home Agent (HA) and UE.

The L_{AC} reference point is used to support the signalling between A-LMF and C-LMF. An example of L_{AC} is the MIPv4 protocol used between FA and HA.

On the other hand, L_{AA} represents the reference points between the two different A-LMFs. For example, in the location update operations, the new A-LMF may request de-registration of the old information to the old A-LMF, which is implementation-specific.

The L_{CC} represents the reference points between the two different C-LMFs, which will be used to support the roaming case of UE by using Home LMF and Visited LMF.

The specific use of these reference points will be discussed in the Recommendation Q.LMF.

7.3 Handover Control Function (HCF)

Handover Control Function (HCF) is used to provide the seamless mobility for a UE who moves around in the NGN networks. The HCF can be classified into Access HCF (A-HCF) and Central HCF (C-HCF) as per its functional role and physical location. The A-HCF is the HCF that is closest to a UE, which is generally located with the access router. The A-HCF will detect the handover event and perform the relevant handover control procedures. The C-HCF is generally located in the core network. The C-HCF will interact with the A-HCF to support the inter-AN handover of a UE.

7.3.1 C-HCF

The C-HCF is used to support the handover of UEs which move around in the NGN operator's network together with the A-HCFs. The specific functional procedure of C-HCF depends on the handover scheme used in the network.

The use of C-HCF for inter-CN (MM1) handover is for further study.

7.3.2 A-HCF

The A-HCF is used for handover control of UEs which move across/within an access network (MM2 or MM3). There are many different HC schemes. For example, in the host-based MM, the

UE will initiate the signalling operations for handover control with the relevant A-HCF, and the A-HCF may relay the associated information to the C-HCFs and/or other relevant A-HCFs as well. On the other hand, in the network-based MM, an A-HCF initiates the handover signalling operations instead of the UE.

7.3.3 Reference points of HCF

Fig. 7.6 shows the reference points of HCF.

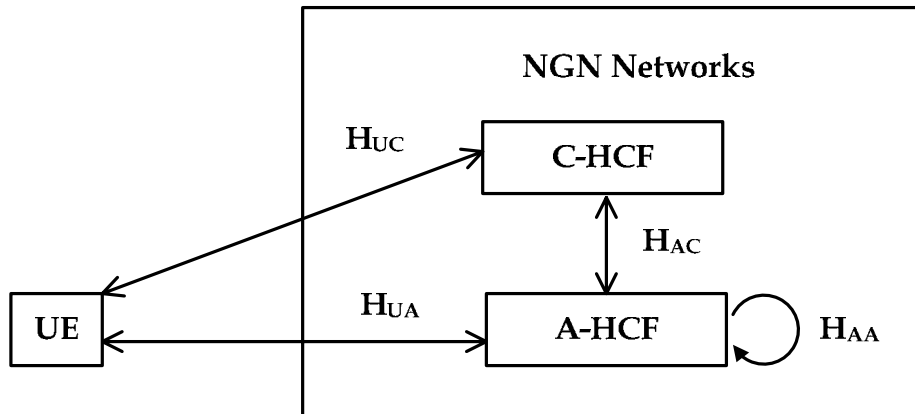


Figure 7.6 HCF Reference Points

The H_{UA} reference point is used to support the signalling between UE and A-HCF. An example of H_{UA} in the host-based handover control scheme is the MIPv4 protocol used between Foreign Agent (FA) and UE (e.g., ICMP extension for MIPv4). On the other hand, an example of H_{UA} in the network-based handover control scheme can be the Media Independent Handover (MIH) protocol used between Point of Attachment (PoA) and UE (e.g., handover trigger).

The H_{UC} reference point is used to support the direct signalling between UE and C-HCF. In terms of the host-based handover control scheme, an example of H_{UC} is the MIPv6 protocol used between Home Agent (HA) and UE (e.g., for MIPv6 Route Optimization).

The H_{AC} reference point is used to support the handover signalling between A-HCF and C-HCF. An example of H_{AC} for the host-based handover control is the MIPv4 protocol used between FA and HA. On the contrary, an example of H_{AC} for the network-based handover control can be the Proxy MIP (PMIP) protocol used between Mobile Access Gateway (MAG) and Localized Mobility Agent (LMA).

The H_{AA} is the reference point between the two different A-HCFs. This can be used for interaction between neighbouring A-HCFs. For example, the new HCF for a UE may request the old HCF to temporarily store the data packets destined to the UE and to forward the packets after the handover is completed.

The specific use of these reference points will be discussed in the Recommendation Q.HCF.

7.4 Relationship between MMCF and NGN-FRA functions

This clause describes a high-level relationship between MMCFs and the NGN-FRA described in the Y.2012. It is noted that the MM framework describes the MM-related functions only. The

functional entities required for realizing these functions will be addressed in the Recommendations Q.LMF and Q.HMF.

The following figure shows the generic relationship between MMCFs and NGN-FRA functions.

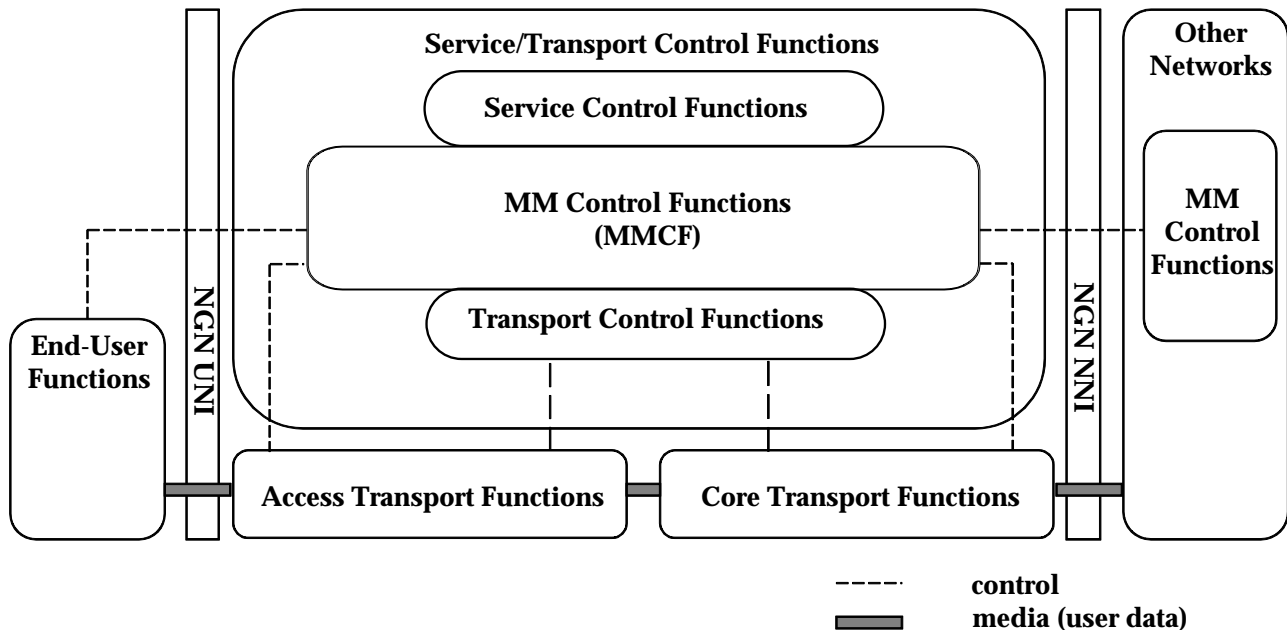


Figure 7.7 Relationship between MMCF and NGN-FRA functions

As shown in this figure, the Service/Transport Control Functions are associated with the MMCF. The MMCF is associated with the UE as well as the network entities. Furthermore, the overall MM functionality will be achieved through interworking with the other NGN networks, when necessary. It is noted in the figure that the MMCF may interwork with the Service and Transport Control Functions as an integral part of NGN. The MMCF will also interact directly or indirectly with the Transport Function, wherever applicable.

The detailed mapping between MMCF functions and NGN-FRA functions such as NACF and RACF is for further study.

8 High-level information flows

This clause describes the high-level information flows for MM in NGN, which include the network attachment, location management, user data transport, and handover support. The high-level information flows will be described based on the MMCFs and UEs.

It is noted that the more detailed procedural information flows between MMCFs and the other NGN 'functional entities' (e.g., AAA, DHCP, policy servers) will be given in the Recommendations, Q.LMF and Q.HCF. Those procedural information flows may be given as per the following categories:

- 1) Roaming and non-roaming cases in the location management;

- 2) Hierarchical and non-hierarchical location and handover management;
- 3) Host-based and network-based location and handover management; and
- 4) Horizontal and vertical handover management.

8.1 Network attachment

8.1.1 Link establishment

The MM control operations will begin when a UE attempts to establish a connection to the network link. The network link will be a wired or wireless link that depends on a specific link-layer access technology such as Ethernet, cdma2000, W-CDMA, WLAN, BWA, etc.

8.1.2 User authentication and authorization

When a UE has established a connection to the network, the user authentication and authorization will be performed, typically through interaction with the AAA-related servers. In this user authentication/authorization process, a User ID (UID) associated with the UE will be referred to.

8.1.3 Location ID configuration

When or after a UE is authenticated and authorized by the network (or service provider), it will be given one or more Location IDs, which must include a routable IP address. As an LID, an IP address will be configured using a DHCP server or using an appropriate auto-configuration scheme.

When a UE is connected to the network, it will send the information of UID to the A-LMF for authentication and authorization. For this purpose, the A-LMF may interact with the NGN-NACF (Network Attachment Control Function), and it may also contact with an appropriate User Profile Server. When the authentication/authorization is completed, an LID will be assigned to the UE.

8.2 Location registration and update

After the UE has completed the network attachment, it will perform the location registration and update procedures. By this, the information on mapping between UID and LID will be recorded and managed by the associated LM functions with the help of the relevant location database. When a

UE is first attached to the network, it will perform the location 'registration,' whereas it will perform the location 'update' whenever it moves into the other network and thus changes its LID.

8.2.1 Location registration

For the location registration in the host-based LM, when a UE gets its LID, it registers its LID and UID with the associated LM functional entities. The following figure shows an abstract flow of the location registration for the non-roaming case.

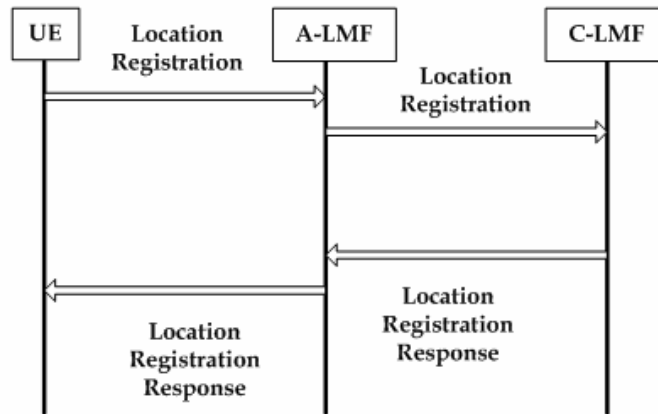


Figure 8.1 Location registration for the non-roaming cases

In the figure, an UE registers its LID and UID with the A-LMF by sending a location registration message. Based on the location registration message received from the UE, the A-LMF may add a new entry of the location information associated with the UE and keep the information of mapping between UID and LID. The A-LMF then relays the message to the C-LMF.

When the C-LMF receives the location registration message from the A-LMF, it will also add the associated location information into the location database (or user profile server) for the UE. On the successful processing of the location database, the C-LMF will respond with a location registration response message to the A-LMF. In turn, the A-LMF will respond to the UE.

In the host-based LM, the UE will itself perform the location registration, whereas in the network-based LM, a network agent concerned with A-LMF may be responsible for location registration. The more detailed procedures for the location registration will be described in the Recommendation Q.LMF.

In the roaming case, in which a UE moves into a different NGN operator's network, the location registration will be done with the help of the Visited C-LMF and Home C-LMF. The following figure describes a high-level information flow for the location registration in the roaming case.

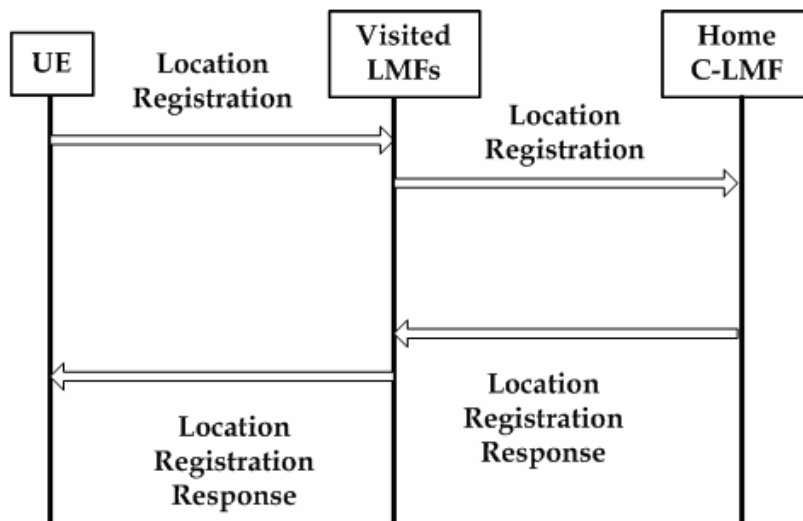


Figure 8.2 Location registration for the roaming case

In the figure, Visited LMFs represent a set of A-LMF and/or C-LMF in the network of the NGN operator that is being visited by the UE. There may be a variety of location registration schemes in the roaming case, which will be described in the Recommendation Q.LMF.

8.2.2 Location update

After the initial location registration, the UE may move around in the network. When the UE moves into the other network and changes its LID, it will perform the location update operations.

By movement in the network, the UE may change its LID and its corresponding A-LMF. In this case, the UE will update its location information by sending the location update message to the new A-LMF, as shown in the figure below.

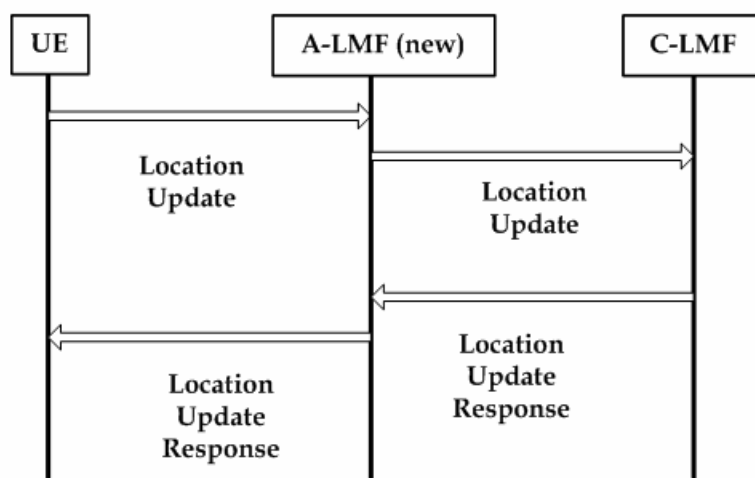


Figure 8.3 Location update information flow

In the figure it is assumed that the UE enters a new A-LMF. The location update message will indicate that this is for re-registration of the location information. In the host-based LM, the UE will itself perform the location update procedures, whereas in the network-based LM, the A-LMF will be responsible for location update procedures.

In the roaming case, the UE may change its corresponding NGN operator with C-LMF. In this case, the location update messages will be exchanged between the Visited LMF and Home LMF, as the location registration flows for the roaming case. The detailed procedures for the location update will be described in the Recommendation Q.LMF.

8.3 Location query for user data transport

For user data transport, the correspondent UE will perform the 'location query' operations to identify the location of the mobile UE. In the location query operation, a corresponding (internal or external) UE will try to locate a concerned UE by sending the location query message to the LMFs. The LMFs will then respond with the location query response message to the corresponding UE.

The location query operations can be differently performed for the following two cases: location query without session setup signalling and location query with session setup signalling.

8.3.1 Location query without session setup signalling

According to the application/session type, the location query and response operations may be done together with the session setup signalling (e.g., SIP-based VoIP application), or without the session setup signalling (e.g., E-mail).

For an application that does not require any session setup signalling, the caller UE will get the location information of the concerned callee UE using the location query and response operations.

The following figure gives a high-level information flows for the location query and response operations without the session setup signalling operation in the non-roaming case.

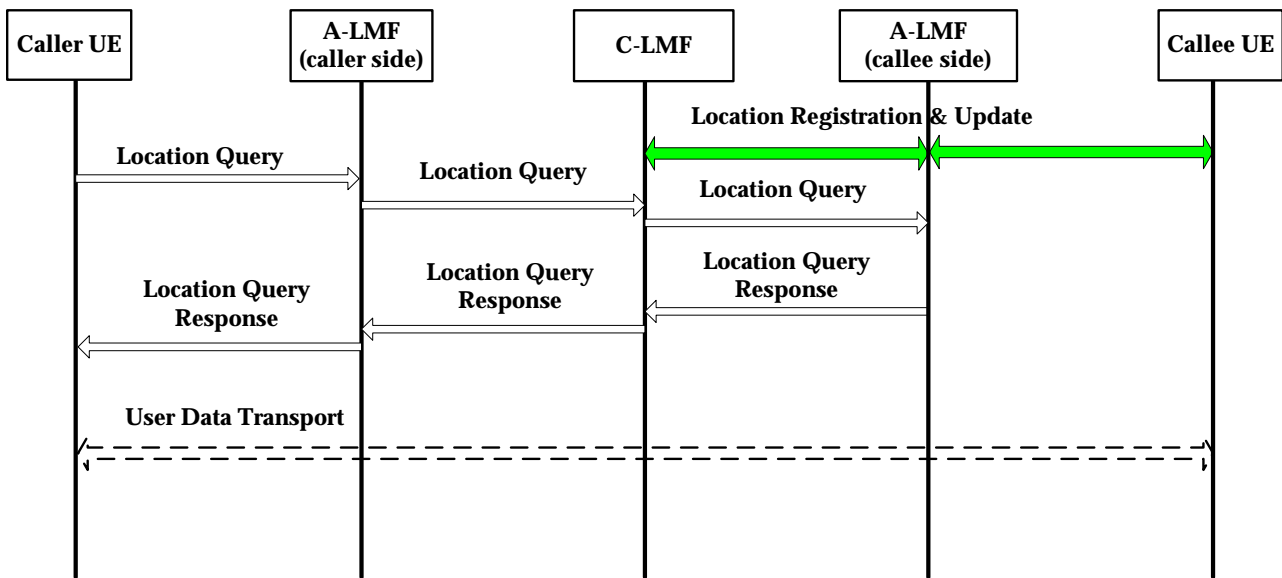


Figure 8.4 Location query without session setup signalling in the non-roaming case

In the figure, it is assumed that the callee UE has already registered its current location information with the associated A-LMF as well as C-LMF. It is also assumed that the caller UE and the callee UE are registered with different A-LMFs, in which the A-LMF in the caller side manages the location information of the caller UE, whereas the A-LMF in the callee side manages the location information of the callee UE. Depending on the specific LM scheme, some of the flows may be omitted in the figure.

As shown in the figure, the caller UE will first try to find the location information of the callee UE by contacting with to the A-LMF in the caller side.. If the callee UE has not registered with the A-LMF of the caller UE, the A-LMF in the caller side will consult with the C-LMF. The C-LMF may then find the location of the callee UE by contacting with the A-LMF in the callee side. The location information of the callee UE will be delivered to the caller UE with the location query response message. Then the user data transport begins.

On the other hand, the following figure shows an abstract information flows for the location query and response operations in the roaming case.

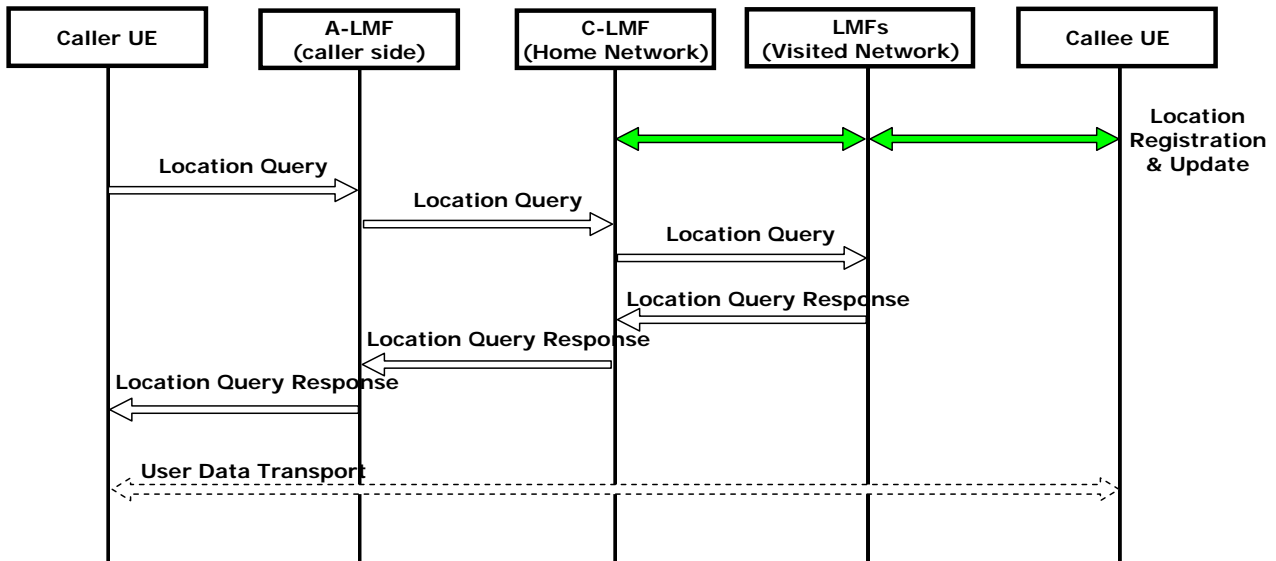


Figure 8.5 Location query without session setup signalling in the roaming case

In the figure, it is assumed that the callee UE is now in the visited network and has already registered its current location information with the associated Home C-LMF, possibly via the Visited LMFs.

In this case, the caller UE gets the location information of the callee UE by sending a location query to A-LMF in the caller side. In turn, the A-LMF of the caller UE sends a location query to Home C-LMF of the callee UE. The Home C-LMF will then consult with Visited LMFs of the callee UE.

8.3.2 Location query with session setup signalling

For an application that requires a session setup signalling operation (e.g., SIP-based application), the location query and response operations may be performed together with the session setup signalling operations. In this case, the messages for session setup signalling may contain the location query/response information, as shown in the SIP INVITE and OK messages.

The following figure gives an example of information flows for the location query/response operation with the session setup signalling for the non-roaming case.

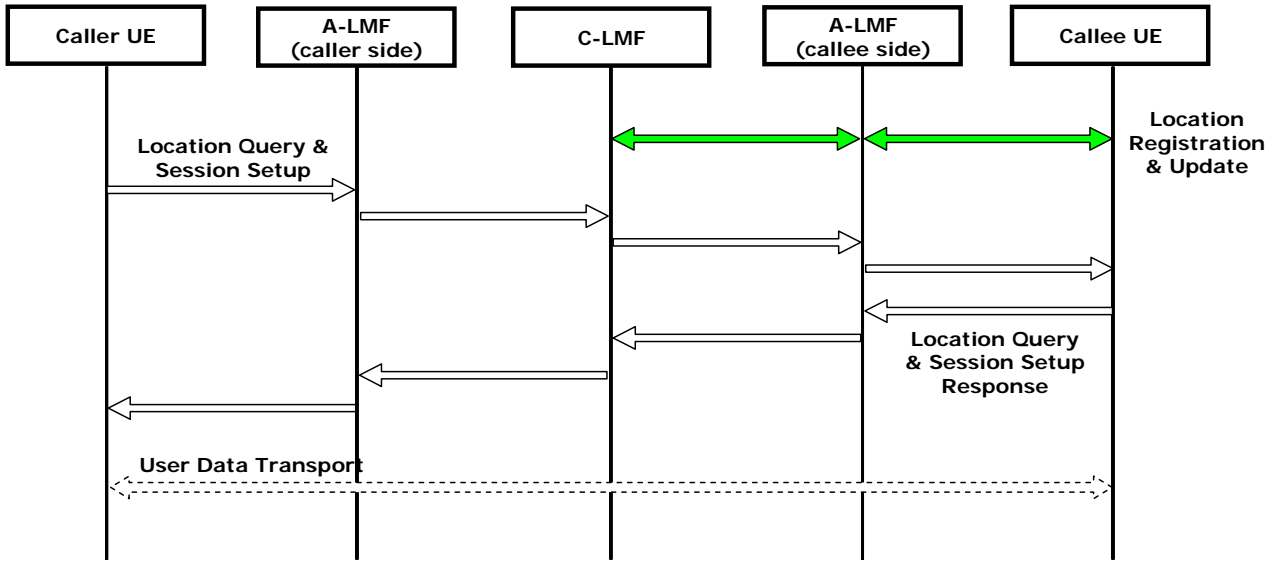


Figure 8.6 Location query with session setup signalling in the non-roaming case

In the figure, it is assumed that the callee UE has already registered its current location information with the associated A-LMF (callee side) as well as C-LMF. In case of IMS-based applications, the A-LMF may be working with the Proxy CSCF (Call/Session Control Function), and the C-LMF may be with the S-CSCF (Serving CSCF).

On the other hand, the following figure shows an abstract information flows for the location query and response operations with session setup signalling operations in the roaming case. The more detailed information flows will be described in the Recommendation Q.LMF.

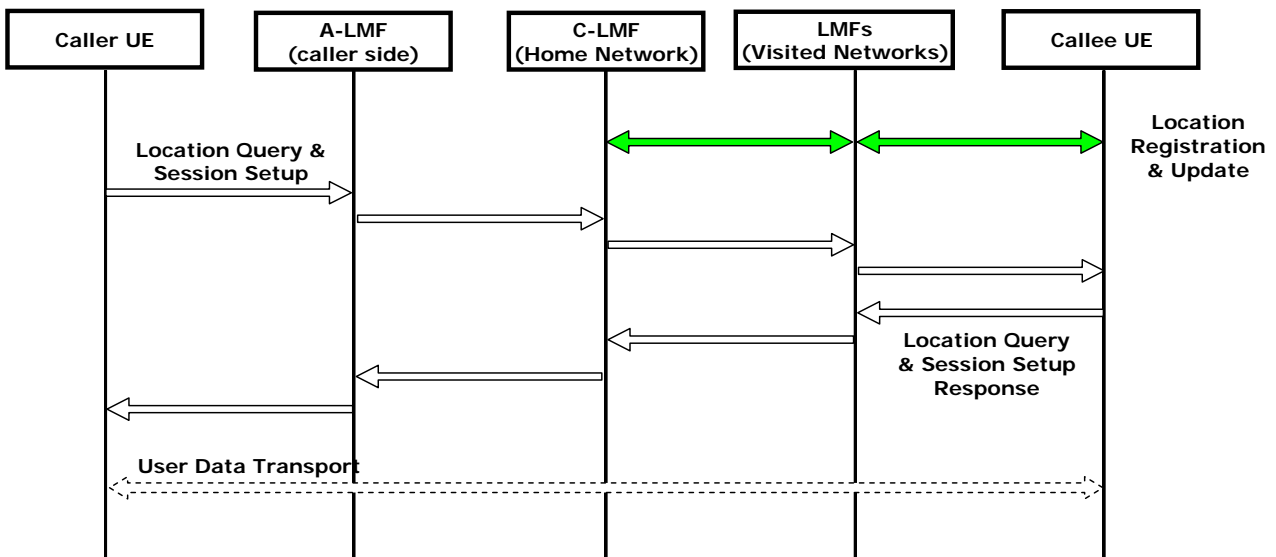


Figure 8.7 Location query with session setup signalling for roaming case

8.4 Handover support

After the location query and response operations, the user data transport operations will begin. The data packets would be exchanged between the two concerned UEs using the standard IP routing scheme.

During the session, whenever a UE moves into another network region, the handover support operations will be activated to provide the seamless session continuity with the help of Handover Control Functions (HCFs). Those handover support operations can be classified into the two phases: handover preparation and handover execution.

8.4.1 Handover preparation

The first step of handover preparation is the handover (or movement) detection to recognize that a link-layer handover of a mobile UE is imminent. This can be achieved with the help of an associated link-layer notification. For example, a link trigger such as Link-Going-Down may be used for notification of an imminent link-layer handover. It is noted that the link-layer triggers provided by different access technologies need to be integrated into an open service interface between the link-layer protocols and the upper-layer MM schemes, as shown in the Media Independent Handover (MIH) services.

The next step would be the network discovery operation to search access networks to which the UE is able to connect. This step may be performed by scanning all accessible links from the UE. In a certain case, the neighboring network information may be periodically announced from the access network to the UE.

The network discovery can be followed by the network selection to choose the target access network (or PoA) for handover. A UE may select one of the accessible links found in the network discovery according to the predefined handover policy.

If sufficient network information is provided for network selection, the UE and/or HCF may choose a target network which is the most profitable one as per the predefined policy. The policies or factors to be considered for network selection may include the available resources, estimated handover latency, QoS support, types of MM protocols, wireless cell coverage, etc. The HCF may interact with the other NGN functions (i.e., RACF, NACF, etc.) to negotiate the QoS-related parameters or to perform the proactive operations for fast handover.

The handover procedure can be enhanced by proactively performing some of network-layer handover operations before a link-layer handover is completed. While the target network for handover is selected, a UE may obtain the information to perform the proactive handover toward the target network. Proactive operations may reduce the handover latency required for allocation of a new LID, authentication/authorization, and handover signaling between UE and HCFs. The issues on proactive handover operation would be further described in the Q.HCF.

The following figure shows an example of the high-level information flows for the handover preparation.

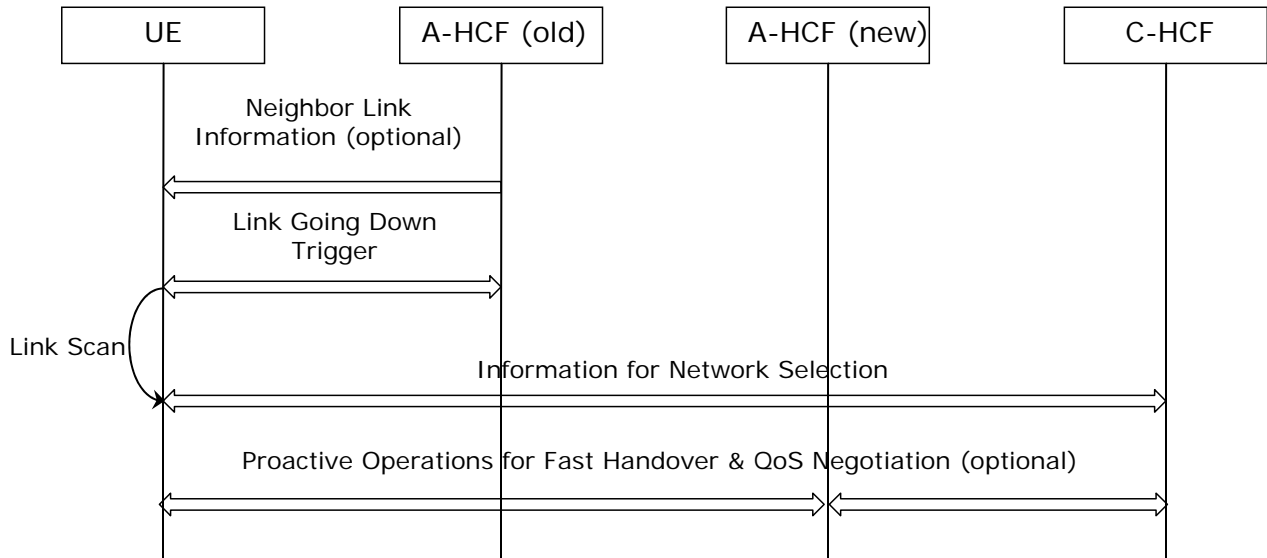


Figure 8.8 An example of information flows for handover preparation

When a UE perceives an imminent disconnection from the currently attached link, it scans all the accessible links (or networks) and selects one of those detected links as the target of a handover. Optionally, the information of adjacent links can be delivered from the A-HCF to the UE to reduce the scanning latency, as shown in the figure. With the help of a link-layer trigger, the link scanning process will be performed. For selection of the target network, the necessary information may be exchanged between UE and C-HCF, possibly with A-HCFs. This network selection may be done either in the UE-controlled manner or in the network-controlled manner. When the target network is selected, some proactive operations for fast handover and QoS negotiation may be performed, which depends on the specific handover scheme.

It is noted that the figure illustrates the case of host-based handover control. In the network-based handover control, an A-HCF may play the role of UE.

8.4.2 Handover execution

The handover execution phase starts by determining the need of L3 handover control. A UE (or HCF) checks whether a handover should be handled at L2 or higher layer, and then initiates corresponding handover control procedures. When a UE moves within the same A-MMCF domain, it requires only the L2 handover control that is generally provided by each access technology. However, when the UE moves between different A-MMCF domains (or different networks), it is further required to configure a new Location ID (LID) and to invoke the subsequent location management procedure.

The configuration of a new Location ID may be done using the stateful (using the DHCP server) or stateless (auto- or manual configuration) schemes. It is noted that the Location ID configuration operations may be associated with a specific handover scheme. That is, a specific handover scheme may use a different scheme for configuration of the Location ID.

During the handover, the HCF may trigger the L3 location management procedure by interworking with the associated LMFs. This is done for reducing the handover detection latency since HCFs may usually detect the L3 handover event of the UE earlier than the LMFs.

A handover typically changes the data delivery path between a UE and its correspondent UE. The HCF adjusts the routing path from/to a UE according to the change of location by interworking with the Core/Access Transport Functions in NGN.

The network access authentication and authorization will be required to mitigate the threats associated with unauthorized access. When the UE turns on the power and it connects to an access network, an authentication is performed. Moreover, even when the UE performs the handover and it connects to the new access network, an authentication shall be performed. Accordingly, a key issue of the handover control for the seamless service will be to reduce the delay time associated with the authentication during handover.

The following figure gives an example of the high-level information flow for handover execution.

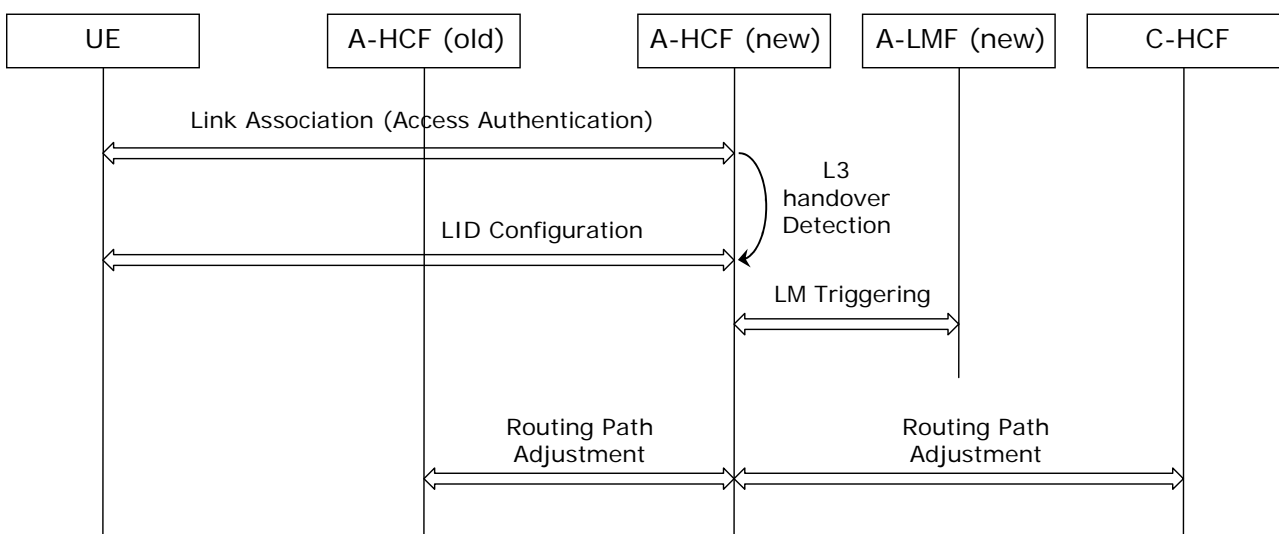


Figure 8.9 An example of information flows for handover execution

It is noted that the handover execution operations such as handover detection, configuration of a new LID, routing path adjustment and authentication may be performed before the L2 handover is completed in order to improve the handover performance. The handover signaling for routing path adjustment can be performed to establish the handover tunnel or to perform bicasting between the concerned network entities, so as to minimize the data loss and latency associated with the handover. In the host-based handover control, the UE will be involved into the handover signalling operations, whereas in the network-based handover, a network agent concerned with A-HCF may perform and complete the handover signalling operations. There are many types of handover in the network, such as vertical handover and horizontal handover, and handover for the hierarchical and non-hierarchical network. The detailed information flows for those types of handover will be described in the Recommendation Q.HCF.

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