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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Generalized mobility

MPLS-based mobility capabilities in NGN

Recommendation ITU-T Y.2807

ITU-T

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Numbering, naming and addressing	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Security	Y.2700–Y.2799
Generalized mobility	**Y.2800–Y.2899**

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.2807

MPLS-based mobility capabilities in NGN

Summary

Recommendation ITU-T Y.2807 describes MPLS-based mobility capabilities in an NGN environment where the MPLS technology is deployed in the NGN core IP network. The MPLS-based mobility capabilities seek to provide QoS-enabled mobility support in NGN.

This Recommendation identifies service requirements, functional requirements, functional architecture and mobility scenarios for support of QoS-enabled terminal mobility in NGN using MPLS-based capabilities.

Source

Recommendation ITU-T Y.2807 was approved on 23 January 2009 by ITU-T Study Group 13 (2009-2012) under Recommendation ITU-T A.8 procedures.

Keywords

Handover, MMCF, MPLS, NGN, QoS, terminal mobility.

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CONTENTS

Introduction

In NGN, it is expected that a variety of the existing and new wired/wireless access network technologies are supported, such as WLAN, xDSL and 2G/3G mobile technologies, etc. Various services ranging from real-time multimedia services to data transfer services to a fixed or a mobile user are expected to be supported by the NGN, and such services may be provided with different QoS commitment levels, i.e., from best-effort up to more stringent QoS levels. Multiprotocol label switching (MPLS) is a key transport technology in NGN. Deployment of the MPLS technology in the NGN core IP network can provide significant assurance in the delivery of the desired QoS for a variety of services and applications.

Given the objective of fixed-mobile convergence in NGN, this Recommendation describes the MPLS-based capabilities required to provide QoS-enabled terminal mobility in NGN. This includes the support of terminal mobility across different fixed and mobile networks as well as in different mobility scenarios including intra-access network, inter-access network and inter-core network scenarios.

Recommendation ITU-T Y.2807

MPLS-based mobility capabilities in NGN

1 Scope

The objective of this Recommendation is to describe the MPLS-based capabilities required to provide QoS-enabled terminal mobility in NGN.

More specifically, this Recommendation identifies service requirements, functional requirements, functional architecture and mobility scenarios for support of QoS-enabled terminal mobility in NGN using MPLS-based capabilities.

This Recommendation builds on general mobility management functionalities described in [ITU-T Q.1707] for support of the NGN mobility related requirements described in [b-ITU-T Y.2201].

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.

[ITU-T Q.1706] Recommendation ITU-T Q.1706/Y.2801 (2006), *Mobility management requirements for NGN.*

[ITU-T Q.1707] Recommendation ITU-T Q.1707/Y.2804 (2008), *Generic framework of mobility management for next generation networks*.

[ITU-T Y.1541] Recommendation ITU-T Y.1541 (2006), *Network performance objectives for IP-based services*.

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2006), *Functional requirements and architecture of the NGN release* 1.

[ITU-T Y.2111] Recommendation ITU-T Y.2111 (2006), *Resource and admission control functions in Next Generation Networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 access network [ITU-T Q.1707]: A network that is characterized by a specific wired/wireless access technology.

3.1.2 core network [ITU-T Q.1707]: An architectural term related to the part of an NGN network, which is independent of a specific access technology.

3.1.3 handover [ITU-T Q.1706]: The ability to provide services with some impact on their service level agreements to a moving object during and after movement.

3.1.4 mobility [ITU-T Q.1706]: The ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment.

3.1.5 mobility management [ITU-T Q.1706]: The set of functions used to provide mobility. These functions include authentication, authorization, location updating, paging, download of user information and more.

3.1.6 session [b-ITU-T Y.2091]: A temporary telecommunications relationship among a group of objects in the service stratum that are assigned to collectively fulfil a task for a period of time. A session has a state that may change during its lifetime. Session-based telecommunications may, but need not be, assisted by intermediaries. Session-based telecommunications can be one-to-one, one-to-many, many-to-one, or many-to-many.

3.1.7 terminal mobility [ITU-T Q.1706]: This is the mobility for those scenarios where the same terminal equipment is moving or is used at different locations. The ability of a terminal to access telecommunication services from different locations and while in motion, and the capability of the network to identify and locate that terminal.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 end user : The actual user of the products or services.

NOTE – The end user consumes the product or service. Further, an end user may or may not be responsible for concluding contracts for the services subscribed to and for paying for these services (i.e., an end user may or may not be a subscriber).

3.2.2 roaming: This is the ability of the users to access services according their user profile while moving outside of their subscribed home network, i.e., by using an access point of a visited network. This requires the ability of the user to get access in the visited network, the existence of an interface between home network and visited network, as well as a roaming agreement between the respective network operators.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

2G	2nd Generation
3G	3rd Generation
A-HCF	Access Handover Control Function
A-LMF	Access Location Management Function
A-MMCF	Access Mobility Management Control Function
AN	Access Network
A-RACF	Access Resource and Admission Control Function
C-HCF	Central Handover Control Function
C-LMF	Central Location Management Function
C-MMCF	Central Mobility Management Control Function
CN	Core Network
C-RACF	Core Resource and Admission Control Function
CUE	Correspondent User Equipment
FTTH	Fibre-To-The Home
GMA	Global Mobility Agent

HCF	Handover Control Function
HDSF	Handover Decision Sub-Function
ID	Identifier
IP	Internet Protocol
IS	Information Server
L2	Layer 2
LER	Label Edge Router
LID	Location Identifier
LMA	Local Mobility Agent
LMF	Location Management Function
LSP	Label Switched Path
LSR	Label Switching Router
MM	Mobility Management
MMCF	Mobility Management Control Function
MPLS	Multiprotocol Label Switching
MSCS	Mobile Service Control System
NACF	Network Attachment Control Function
NGN	Next Generation Networks
P-CSC-FE	Proxy Call Session Control Functional Entity
PoA	Point of Attachment
QoS	Quality of Service
RACF	Resource and Admission Control Function
RAN	Radio Access Network
S-CSC-FE	Serving Call Session Control Functional Entity
SCF	Service Control Function
TCF	Transport Control Function
TF	Transport Function
UE	User Equipment
UID	User Identifier
WLAN	Wireless Local Area Network
W-LAN/MAN	Wireless Local Area Network/Metropolitan Area Network
xDSL	x Digital Subscriber Line

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

The terms "terminal" and "UE" are used interchangeably in this Recommendation.

6 Requirements for MPLS-based mobility capabilities

6.1 Service requirements

This clause identifies the service requirements for the MPLS-based mobility capabilities in NGN. The MPLS-based mobility capabilities are required to:

- Support terminal mobility [ITU-T Q.1706] in order to allow the UE to maintain its ongoing services while moving around.

  NOTE 1 – Mobility in NGN may impact the QoS delivered to the UE by NGN provisioning, since the various access networks connected to an NGN core may differ with respect to the QoS level they can provide to the UE. Therefore, NGN may be required to support QoS adaptation mechanisms.

- Support the IP QoS classes and associated performance requirements specified in [ITU-T Y.1541].

  NOTE 2 – [ITU-T Y.1541] recommends the selection of the specific QoS classes based on the application requirements.

- Provide the UE with pertinent network-related information, inclusive of, but not limited to, available access networks, related cost and related QoS level, that may enable the selection and utilization of access networks.

  NOTE 3 – It is recommended to achieve this via a request by the UE of information on accessible access networks so that one of the detected networks can be selected as appropriate, e.g., according to UE selection criteria or because of its movement into another access network.

- Monitor the temporal properties (e.g., available bandwidth, current packet loss rate) of the traffic stream against the agreed upon QoS level.

The MPLS-based mobility capabilities are recommended to:

- Provide support of network policies and user preferences for ongoing services.
- In case of QoS level degradation of the UE traffic stream and where possible, trigger UE handover to another access network in order to satisfy as much as possible the agreed upon QoS level.

6.2 Functional requirements

This clause identifies the functional requirements for the MPLS-based mobility capabilities in NGN.

- Interaction with location management
  - The MPLS-based mobility capabilities are required to recognize the UE movement and its location by interacting with the location management functions [ITU-T Q.1707].
  - The MPLS-based mobility capabilities are recommended to enable efficient resource allocation by activation of hierarchical location management [ITU-T Q.1707].

- Interaction with handover control
  - The MPLS-based mobility capabilities are required to interact with the handover control functions in order to minimize the impacts on ongoing services while the UE is moving into other access networks [ITU-T Q.1707].
- Interaction with service control
  - The session information related to required bandwidth, delay constraint and allowed packet loss rate of ongoing services is required to be delivered to the mobility management control functions in order to trigger the establishment of label switched paths (LSPs) as appropriate for handover support.
  - The MPLS-based mobility capabilities can optionally cooperate with the NGN service control functions (e.g., P-CSC-FE and S-CSC-FE [ITU-T Y.2012]) to receive the session information of ongoing services.
  - The provision of the collected network-related information (see the requirements for network resource control) to the service control functions is recommended to enable downgrading of the QoS level of ongoing services in case of lack of resources.
- Network resource control
  - The MPLS-based mobility capabilities are recommended to mediate resource allocation between SCF and RACF [ITU-T Y.2111].
  - In order to support as much as possible the agreed upon QoS level of ongoing services, as well as network providers' policies and user preferences, the MPLS-based mobility capabilities are recommended to collect and maintain the network-related information (network topology and QoS information (e.g., available bandwidth, packet loss rate)) from access networks via RACF.
  - The MPLS-based mobility capabilities are recommended to support network resource pre-provisioning in order to allow fast and reliable handovers.
  - The MPLS-based mobility capabilities are recommended to support network resource pre-provisioned in order to allow reliable and fast delivery of mobility signalling.

7 Functional architecture for support of MPLS-based mobility capabilities

7.1 Network environment

Figure 7-1 shows an instantiation of network environment with support of MPLS-based mobility capabilities.

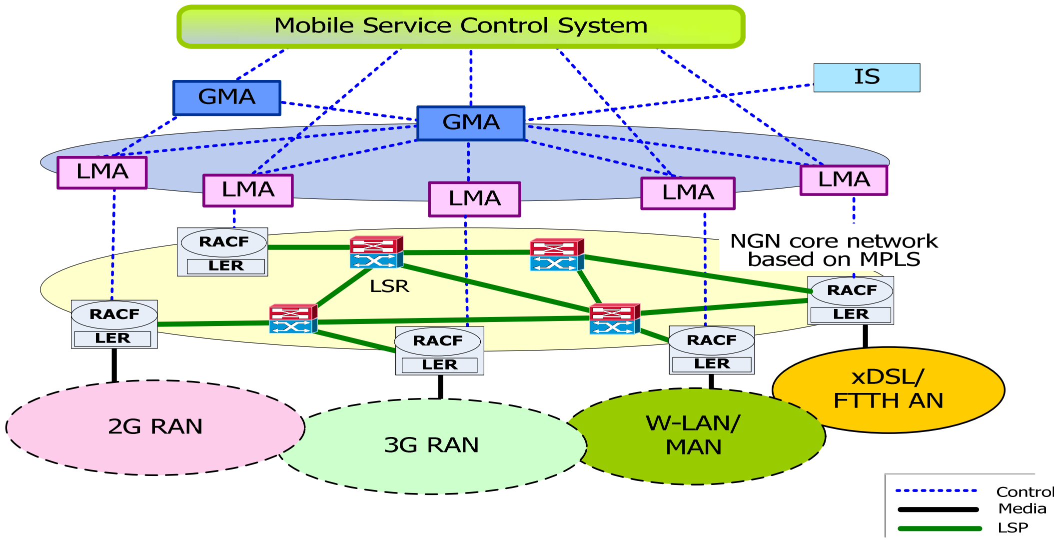

Figure 7-1 – Network environment with support of MPLS-based mobility capabilities

As indicated in the above figure, various types of access networks such as 2G RAN, 3G RAN, W-LAN/MAN and xDSL/FTTH based access networks may be connected to the MPLS-based NGN core network. The MPLS-based mobility capabilities in the NGN core network are responsible for UE mobility (e.g., the UE moving from a W-LAN/MAN access network to a 3G radio access network). The MPLS-based NGN core network has the control plane separated from the transport plane by using dedicated control LSPs. In the control plane, each global mobility agent (GMA) is connected to various local mobility a gents (LMAs), and each LMA is connected to a RACF instance (note that Figure 7-1 shows the case of distributed RACF) allowing the LMA to exchange information related to resource and admission control.

LMAs are located at the edge of the NGN core network and each LMA manages mobility within a given AN. In order to support mobility [ITU-T Q.1707], each LMA includes location management function (LMF) and handover control function (HCF), and maintains UE information (e.g., user ID, location ID, etc.). When moving to a new AN, in order to inform the LMA in that AN about its arrival and register its information, the UE performs registration to the LMA. Then the LMA interacts with the relevant GMA within the NGN core network in order to update UE location information. During the LMA registration to GMA, the LMA can exchange information with RACF for resource and admission control.

GMAs are located in the NGN core network and each GMA supports mobility between pairs of access networks (pairs of LMAs) connected to that NGN core network. In order to support mobility, each GMA includes LMF and HCF. During location management and handover control process, GMA interacts with the connected LMAs within the NGN core network. In case of mobility between different NGN core networks, the UE information (e.g., user ID, location ID, etc.) is exchanged with GMAs located in different NGN core networks.

RACF can be centralized [b-ITU-T Y.2175] or distributed [b-ITU-T Y.2174]. RACF manages resource and admission control.

Information servers (ISs) may store access network-related information of the various wired or wireless channels. When choosing to connect to one of the access networks or moving into another access network, a user may use this network-related information stored in ISs to make an appropriate selection.

Mobile service control systems (MSCSs) can be deployed in centralized or distributed form. MSCSs provide the service control functions described in clause 7.2.

7.2 Functional architecture

Figure 7-2 shows an overview of the functional architecture for support of MPLS-based mobility capabilities, which includes service control functions (SCF), mobility management control functions (MMCF), transport control functions (TCF) and transport functions (TF).

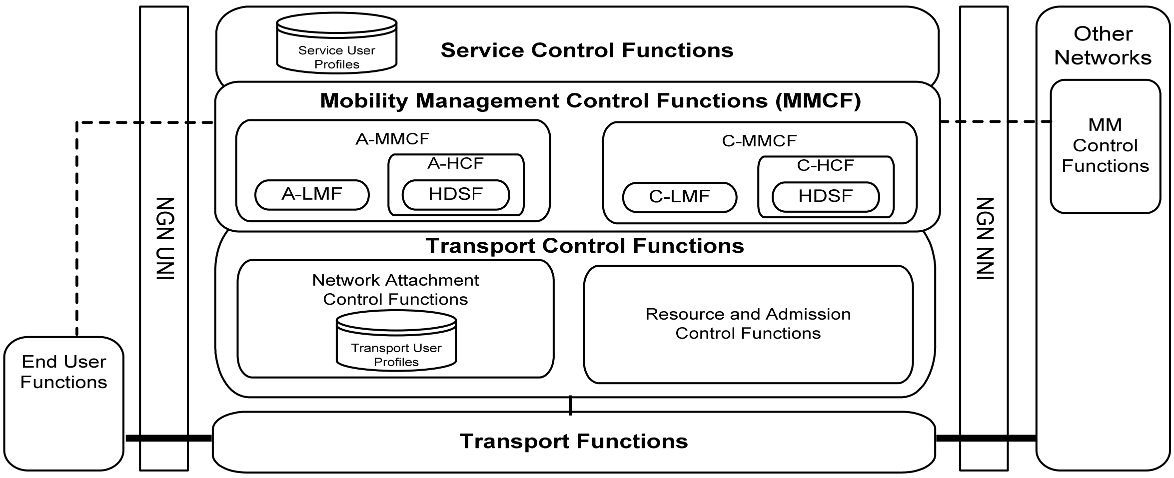

Figure 7-2 – Functional architecture for support of MPLS-based mobility capabilities

This functional architecture is aligned with the general mobility management functional architecture defined in [ITU-T Q.1707] and builds upon the NGN functional architecture [ITU-T Y.2012] with the addition of a new set of functions called MMCF for mediation between SCF and TCF. SCFs and TCFs interact with MMCF.

MMCF interacts with the UE as well as with other MMCFs (in other NGNs). MMCF includes a handover decision sub-function (HDSF), which is responsible for handover decisions.

For QoS management related to mobility, HDSF interacts with SCF to get information on the QoS level required by ongoing services. HDSF also interacts with RACF to get resource-related information and to compare post-handover QoS level with pre-handover QoS level. As described in clause I.3, the handover cases are classified into three: (1) case of having enough resources to provide the service continuously; (2) case of downgrading the QoS level, and; (3) case of no resources for handover. HDSF may also provide network-related information to the UE. The various functional groups shown in Figure 7-2 are described later in this clause.

NOTE – As far as the resource control mechanisms are concerned, these are specified in [b-ITU-T Y.2174] and [b-ITU-T Y.2175].

7.2.1 Service control function (SCF)

SCF includes resource control, registration, authentication and authorization functions at the service level for services as described in [ITU-T Y.2012]. It can also include functions for controlling media resources, specialized resources and gateways at the service signalling level. For authentication, mutual authentication between the end user and the service is performed. SCF accommodates service user profiles representing the combination of user information and other control data into a single user profile function [ITU-T Y.2012].

7.2.2 Mobility management control function (MMCF)

MMCF provides mobility management and control functions in order to support mobility in NGN as described in [ITU-T Q.1707]. MMCF includes LMF and HCF for, respectively, location management and handover control. These two functions include several functional entities as described in [ITU-T Q.1707]. Basically, MMCF in the functional architecture consists of access mobility management control functions (A-MMCFs) and central mobility management control functions (C-MMCFs). According to their functional role, C-MMCF can be classified into central LMF (C-LMF) and central HCF (C-HCF). Similarly, A-MMCF can be divided into access LMF (A-LMF) and access HCF (A-HCF).

A-MMCF is used to support intra-AN mobility (see clause 8.1). A-MMCF is used to support inter-AN mobility (see clause 8.2) through interaction with C-MMCF. C-MMCF is used to manage inter-CN mobility (see clause 8.3).

7.2.3 Transport control function (TCF)

TCF includes NACF and RACF. NACF provides registration at the access level and initialization of end user functions for accessing NGN services as described in [ITU-T Y.2012]. These functions provide transport stratum-level identification/authentication, manage the IP address space of the access network, and authenticate access sessions. NACF provides the following functionalities:

– Dynamic provisioning of IP addresses and other user equipment configuration parameters.
– By endorsement of user, auto-discovery of user equipment capabilities and other parameters.
– Authentication of end user and network at the IP layer (and possibly other layers); for authentication, mutual authentication between the end user and the network attachment is performed.
– Authorization of network access, based on user profiles.
– Access network configuration, based on user profiles.
– Location management at the IP layer.

NACF includes the transport user profile representing the combination of a user's information and other control data into a single "user profile" function in the transport stratum.

RACF provides the resource and admission control functions for QoS-related transport resource control within access and core networks as described in [ITU-T Y.2111]. RACF can make use of information such as transport subscription information, network policy rules, service priority and transport resource status and utilization information.

RACF interacts with SCF and TFs for services requiring NGN transport resource control. RACF performs policy-based transport resource control at the request of SCF, determines the transport resource availability and admission, and applies controls to TFs to enforce the policy decision. RACF interacts with TFs for the purpose of controlling functions such as bandwidth reservation and allocation, traffic classification and policing in the transport layer. RACF takes into account the capabilities of transport networks and associated transport subscription information for subscribers in support of transport resource control.

7.2.4 Transport function (TF)

TFs provide the connectivity for all components and physically separated functions within NGN as described in [ITU-T Y.2012]. These functions are responsible for the transfer of media information, as well as control and management information.

7.2.5 End user functions

These functions request access network-related information allowing the UE to make the appropriate selection among the detected access networks. These functions allow dynamic change of QoS level upon UE request.

8 Mobility scenarios using MPLS-based mobility capabilities

In NGN, various types of access networks (ANs) may be connected to a core IP/MPLS network through ingress label edge routers (LERs). These access networks may use MPLS or IP-based technologies to transport traffic from/to the UE.

Three types of mobility are considered: intra-AN mobility, inter-AN mobility, and inter-CN mobility. As shown in the example configuration in Figure 8-1, TF1 and TF2 exist in AN1, and TF3 in AN2. AN1 and AN2 are controlled by A-RACF1 and A-RACF2, respectively, and are connected to the same core network 1 (CN1). C-RACF may be centralized in the NGN core network (as in Figure 8-1) or distributed. C-RACF monitors the resource status of the core network and triggers the establishment of new LSPs or resizing of existing LSPs by interacting with TFs.

The following clauses provide a functional overview of the mobility scenarios related to the above mentioned three types of mobility. Appendix II describes information flows to support these mobility scenarios using MPLS-based mobility capabilities.

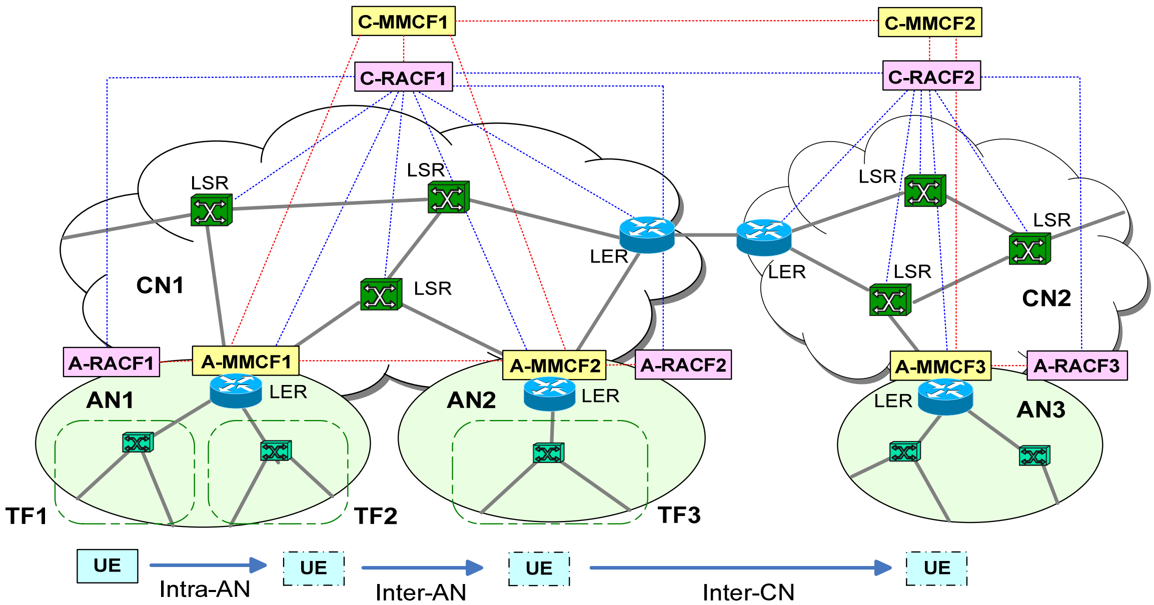

Figure 8-1 – Mobility scenarios across access networks connected to MPLS-based NGN core networks

8.1 Case of intra-AN mobility

This case is the mobility scenario associated with UE movement within a single AN. In this scenario, the UE can continue to use its ongoing services. No location update to C-MMCF is needed because the UE movement is within the same AN.

SCF provides application level signalling for session handling. It also provides information to MMCF to allow identification of media sessions and their required QoS characteristics.

MMCF requests transport resources to RACF1 and receives notifications from RACF1 when these resources are reserved or released. A-MMCF is used to manage the intra-AN mobility and may be located within the LER interconnecting that AN with the NGN core network.

In this scenario, the UE moves under control of the same RACF. Depending on the UE movement, RACF1 supports the establishment of a new connection on TF2 and releases the resources allocated on TF1.

8.2 Case of inter-AN mobility

In this case, the UE moves to another AN (AN2) connected to the same NGN core network. This scenario requires handover control and LSP re-direction since the UE moves between ANs. According to its movement, the UE executes a location update to C-MMCF. Afterwards, traffic to/from the UE can be sent through AN2. In this process, HDSF makes use of the network-related information provided by RACFs, and subsequently verifies resource availability in AN2.

Moving between ANs, the UE may change its location ID (LID) and its corresponding A-MMCF. The UE executes a location update to the new A-MMCF (A-MMCF2). A-MMCF1 and A-MMCF2 interact with C-MMCF to support the inter-AN handover.

By interacting with MMCFs, C-RACF requests the establishment of a new LSP or resizing of an existing LSP in the NGN core network, and A-RACF2 performs the establishment of a new connection on TF3 in AN2. The existing connection in AN1 is then released by A-RACF1. At the AN2-related ingress LER of the NGN core network, the session in AN2 is mapped into the relevant LSP in the core network. For scalability purposes, the session-to-LSP mapping may be controlled by C-RACF.

8.3 Case of inter-CN mobility

In this case, the UE moves to an access network connected only to a different NGN core network. The UE performs roaming signalling via the C-MMCFs located in the old and new NGN core networks through an LSP established between the old and new NGN core networks.

C-MMCF is used to manage UE roaming. According to the UE movement, C-MMCF requests C-RACF to establish a new LSP or resize an existing LSP to transport traffic from/to the UE through the two NGN core networks.

C-RACF collects the network-related information in the new NGN core network and verifies availability of its resources.

9 Security considerations

In the MPLS-based NGN core network (and in those access networks where the MPLS technology is deployed), it is recommended to maintain secure LSPs (this being particularly important during the handover process).

The following are requirements related to the establishment of security associations in scenarios related to the three types of the mobility described in clause 8:

- Intra-AN mobility:

  UE movement does not require the establishment of any new security association.

- Inter-AN mobility:

  UE movement is controlled by the same GMA. The UE requires re-registration to GMA with information related to the new LMA. A new security association between the UE and the new LMA needs to be established.

- Inter-CN mobility:

  When moving from the old NGN core network to the new NGN core network, the UE requires new security associations with the relevant LMA and GMA in the new NGN core network.

Appendix I

Functional procedures using MPLS-based mobility capabilities

(This appendix does not form an integral part of this Recommendation)

This appendix describes functional procedures using MPLS-based mobility capabilities related to location registration, service registration and handover.

I.1 Location registration

This clause describes the location registration procedures for the UE.

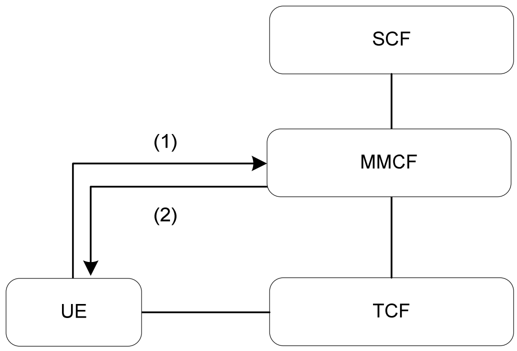

Figure I.1 – Location registration procedure

(1) The UE performs location registration to MMCF. After receiving the request via flow (1), the MMCF creates an association between the address of the UE and the address of its point of attachment (PoA) and stores the association in its local lookup table.

(2) A location registration confirmation is sent from MMCF to the UE.

I.2 Service registration

This clause describes registration procedures for the UE to use a service.

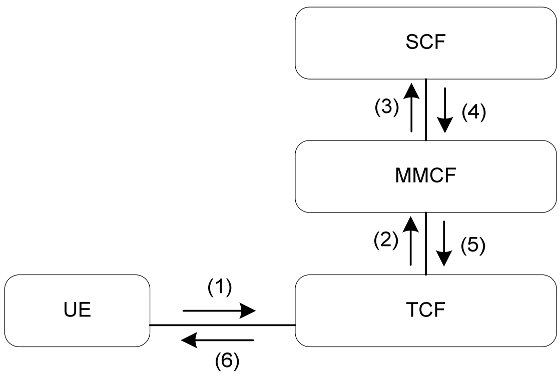

Figure I.2 – Service registration procedure

(1) The UE performs service registration to the TCF. This service registration request contains QoS information for the service.

(2) Upon receipt of the service registration request, the TCF sends this message to MMCF together with information on the resource usage status.

(3) The MMCF stores the information on the resource usage status and requests service registration to SCF.

(4) After receiving the information on the requested QoS level for the service from the SCF via the service registration response, the MMCF decides whether the QoS parameters (e.g., bandwidth, delay, jitter, loss, etc.) of the requested QoS level are accepted or not.

(5) If the requested QoS level is accepted, the MMCF informs the TCF that the requested QoS parameters are accepted.

(6) The TCF replies to the UE, i.e., the requested registration with the QoS parameters is accepted.

I.3 Handover

Handover cases are classified into three: (1) case of having enough resources to provide the service continuously; (2) case of downgrading the QoS level, and; (3) case of no resources for handover.

- Case of having enough resources to provide the service continuously

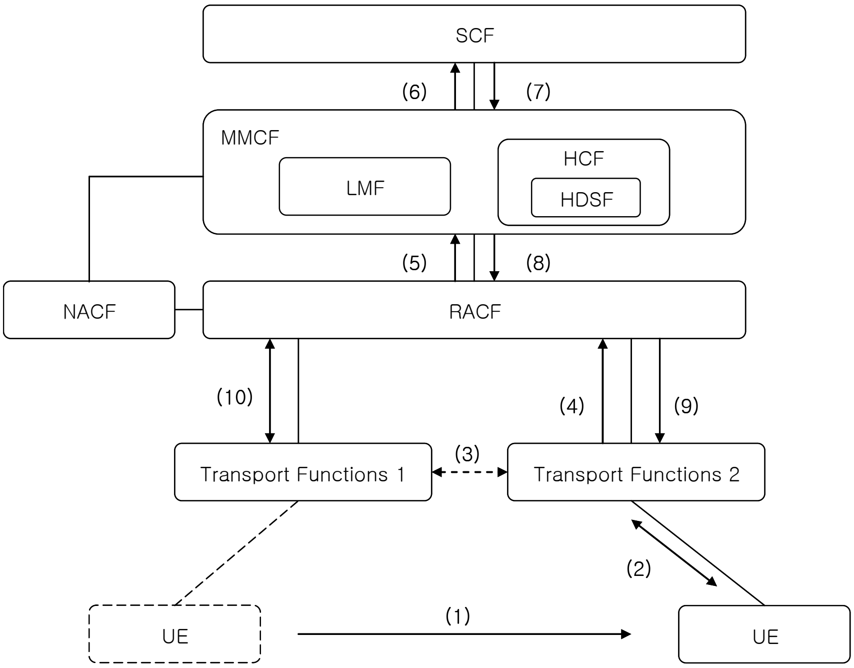

Figure I.3 – Handover functional procedure in the case of having enough resources

(1) The UE moves to TF2.

(2) The UE executes the network re-entry procedure. This step includes the interactions with NACF to perform authentication, authorization, etc.

(3) Optionally, TF2 performs a context retrieval procedure to get some information from the previous TF1 (for example, in WLAN, the inter-access point protocol (IAPP) and other proprietary methods are used to support roaming between different access points; the details of this step are not covered by the scope of this Recommendation).

(4) TF2 sends a handover request to RACF with information on the current resource usage status.

(5) RACF requests for handover from HDSF and sends information on the resource usage status.

(6) HDSF stores information on the resource usage status and asks SCF for information on the QoS level required by the service. At this time, the SCF can decide if the service level should change or not with the current resource usage status because it knows which service level is allowed for the service.

(7) After receiving information on the QoS level required by the service from SCF, the HDSF decides whether the UE should execute handover or not based on service level information received from the SCF.

(8) If it decides handover execution because of enough resources, the HDSF informs RACF that the current resource usage status satisfies the QoS level required by the service.

(9) RACF performs the resource reservation procedure and applies policy decisions to TF2.

(10) RACF notifies TF1 of the handover status and requests for the release of the previously allocated resources on TF1. After receiving the release indication from RACF, TF1 releases the correlated resources and subsequently gives a response to RACF.

• Case of downgrading the QoS level

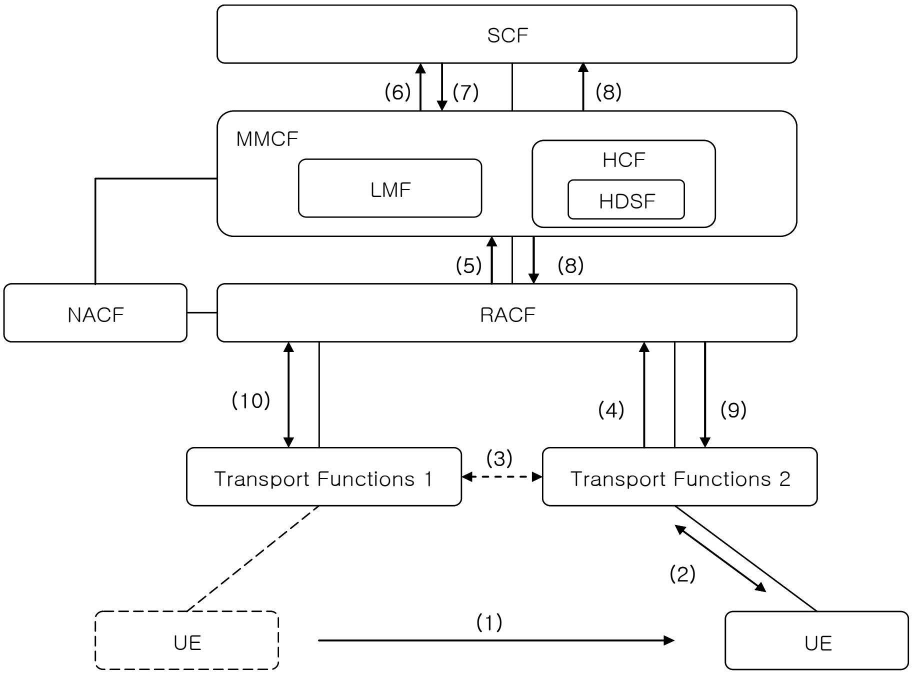

Figure I.4 – Handover functional procedure in the case of downgraded service

Steps (1) ~ (7) are similar to the procedure described above.

(8) In case it decides that keeping the service is possible by downgrading the QoS level even as it confirms that TF does not have enough resources to provide the service, HDSF adjusts the QoS level of the service and informs SCF and RACF of the revised QoS level.

(9) RACF performs the resource reservation procedure and applies the policy decisions to TF2 according to the revised QoS level of the service.

(10) RACF notifies TF1 of the handover status and requests for the release of the previously allocated resources on TF1. After receiving the release indication from RACF, TF1 releases the correlated resource and subsequently gives a response to RACF.

• Case of no resources for handover

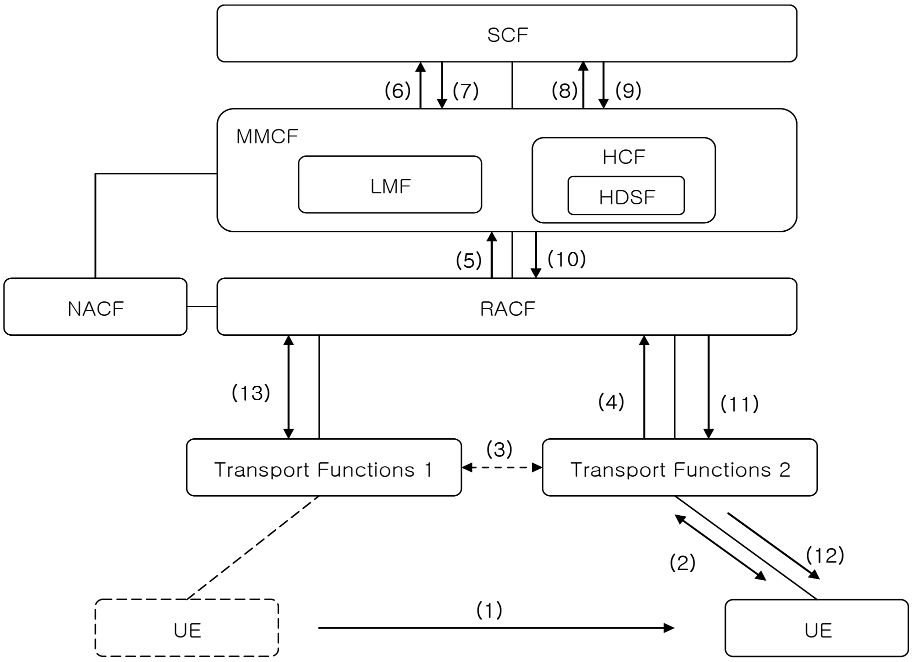

Figure I.5 – Handover functional procedure in the case of no resources

Steps (1) ~ (7) are similar to the procedure described above.

(8) In case it decides that keeping the service is impossible because of lack of resources, the HDSF informs the SCF that the resources in TF2 are not enough to support the service.

(9) The SCF decides that providing the service continuously is impossible. HDSF is then informed by SCF that it cannot provide the service because of lack of resources.

(10) HDSF informs RACF that SCF cannot provide the service because of lack of resources.

(11) RACF informs TF2 that SCF cannot provide the service because of lack of resources.

(12) TF2 informs the UE that SCF cannot provide the service because of lack of resources.

(13) RACF notifies TF1 of the handover status and requests for the release of previously allocated resources on TF1. After receiving the release indication from RACF, TF1 releases the correlated resource and subsequently gives a response to RACF.

Appendix II

Information flows using MPLS-based mobility capabilities

(This appendix does not form an integral part of this Recommendation)

This appendix describes information flows using MPLS-based mobility capabilities for the mobility scenarios described in clause 8.

NOTE – In this appendix, H_GMA is the GMA located in the home network of the UE [ITU-T Q.1707].

II.1 Location registration

This clause describes information flows for the location registration in two cases: (1) initial location registration of the UE, and (2) location registration of the UE in the new GMA.

- Initial location registration

Figure II.1 shows the information flow for the initial location registration.

– When the UE enters a new PoA_1 area, an L2 association is made between the UE and the PoA_1. During the L2 association, PoA_1 gets UE L2 ID (e.g., MAC address).

– PoA_1 sends to LMA_1 a Link_Up_Notification message together with UE L2 ID. Upon receiving this message, LMA_1 allocates the temporal IP address for the UE and creates a record for the UE in its local address table.

– LMA_1 sends to H_GMA a Location_Registration message together with UE L2 ID and temporal IP address and LMA_1 IP address through the previously established LSP between LMA_1 and H_GMA.

– Upon receiving this Location_Registration message, H_GMA, which does not have UE L2 ID, sends the GMA_Information_Request message to the UE to confirm whether the UE has information on any other GMA related to the UE.

– The UE sends the GMA_Information_Response message to H_GMA to let H_GMA know that the UE has no information on other GMAs related to itself. Upon receiving this message, H_GMA stores information on UE L2 ID, UE temporal IP address, and LMA_1 IP address and subsequently sends the Location_Registration_Response message to LMA_1.

– After receiving the Location_Registration_Response message from H_GMA, LMA_1 sends to the UE the Address_Inform message including the UE temporal IP address, LMA_1 IP address, and H_GMA IP address and receives the Address_Inform_Response message as a response.

– In the initial location registration, the UE temporal IP address is considered a persistent IP address.

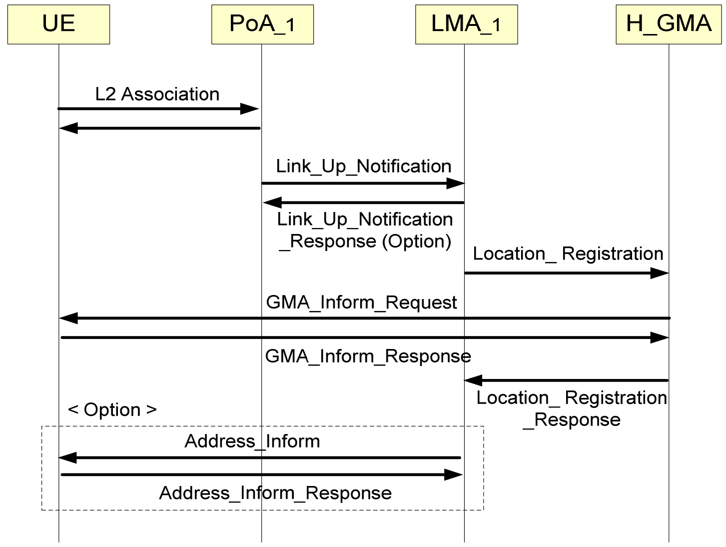

Figure II.1 – Information flow for initial location registration

- Location registration in the new GMA

Figure II.2 shows the information flow for location registration in the new GMA.

– When the UE enters a new PoA_1 area, an L2 association is made between the UE and the PoA_1. During the L2 association, PoA_1 gets UE L2 ID (i.e., MAC address).

– PoA_1 sends to LMA_1 a Link_Up_Notification message together with UE L2 ID. Upon receiving this message, LMA_1 allocates the temporal IP address for the UE and creates a record for the UE in its local address table.

– LMA_1 sends to GMA_1 a Location_Registration message together with UE L2 ID and temporal IP address for UE and LMA_1 IP address through the previously established LSP between LMA_1 and GMA_1.

– Upon receiving this Location_Registration message, GMA_1 sends the GMA_Information_Request message to the UE to confirm whether the UE has information on any other GMA related to the UE.

– The UE sends the GMA_Information_Response message to GMA_1 to let GMA_1 know that the UE has information on H_GMA related to itself. This message includes the UE persistent IP address as well as the information of H_GMA. Upon receiving this GMA_Information_Response message, GMA_1 stores information on UE L2 ID, UE temporal IP address and persistent IP address, and LMA_1 IP address.

– GMA_1 sends the Location_Registration message to H_GMA to register UE location information including LMA_1 IP address and GMA_1 IP address as well as UE L2 ID, persistent IP address, and temporal IP address.

– H_GMA updates UE location information together with UE temporal IP address and LMA_1 IP address and subsequently sends the Location_Registration_Response message to GMA_1.

– After receiving the Location_Registration_Response message from GMA_1, LMA_1 sends to the UE the Address_Inform message including UE temporal IP and LMA_1 IP address UE and receives the Address_Inform_Response message as a response.

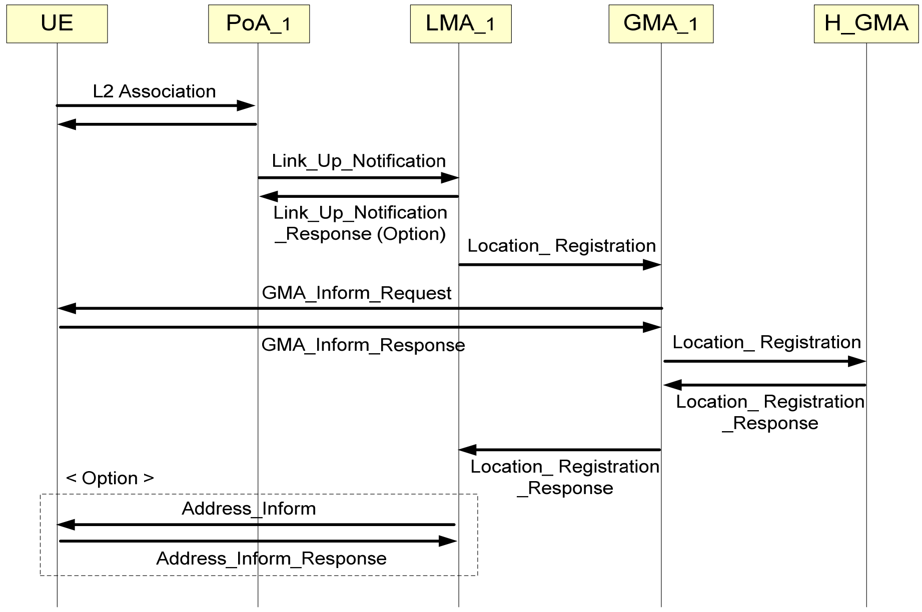

Figure II.2 – Information flow for location registration in new GMA

II.2 Location update

This clause describes the information flow for location update in three cases: (1) the UE moves between different LMAs within the home core network; (2) the UE moves into a foreign core network, and correspondent UE (CUE) is located in the home core network; and (3) the UE moves into a foreign core network, and CUE is located in another foreign core network.

- In case the UE moves between different LMAs within the home core network

Figure II.3 shows the information flow for fast handover when the UE moves to the new PoA area in the home core network.

– When the UE enters a new PoA_2 area, an L2 association is made between the UE and the PoA_2. During the L2 association, PoA gets UE L2 ID.

– PoA_2 sends to LMA_2 a Link_Up_Notification message together with UE L2 ID. Upon receiving this message, LMA_2 allocates the temporal IP address for the UE and creates a record for the UE in its local address table.

– LMA_2 sends to H_GMA a Location_Registration message together with UE L2 ID and temporal IP address and LMA_2 IP address through the previously established LSP between LMA_2 and H_GMA.

– Upon receiving this Location_Registration message, H_GMA, which has UE L2 ID, updates the information in the global address table and sends a Location_Registration_Response message to LMA_2.

– H_GMA sends to LMA_CUE a Binding_Update_Notification message together with the UE persistent IP address and temporal IP address and LMA_2 IP address. If LMA_1, where UE was connected before handover or LMA_2 where UE is currently connected, is able to know the location information of CUE, LMA_1 or LMA_2 can optionally send the Binding_Update_Notification message to LMA_CUE.

– After receiving the Binding_Update_Notification_Response message from H_GMA, LMA_2 sends to the UE the Address_Inform message including UE temporal IP and LMA_2 IP address and receives the Address_Inform_Response message as a response.

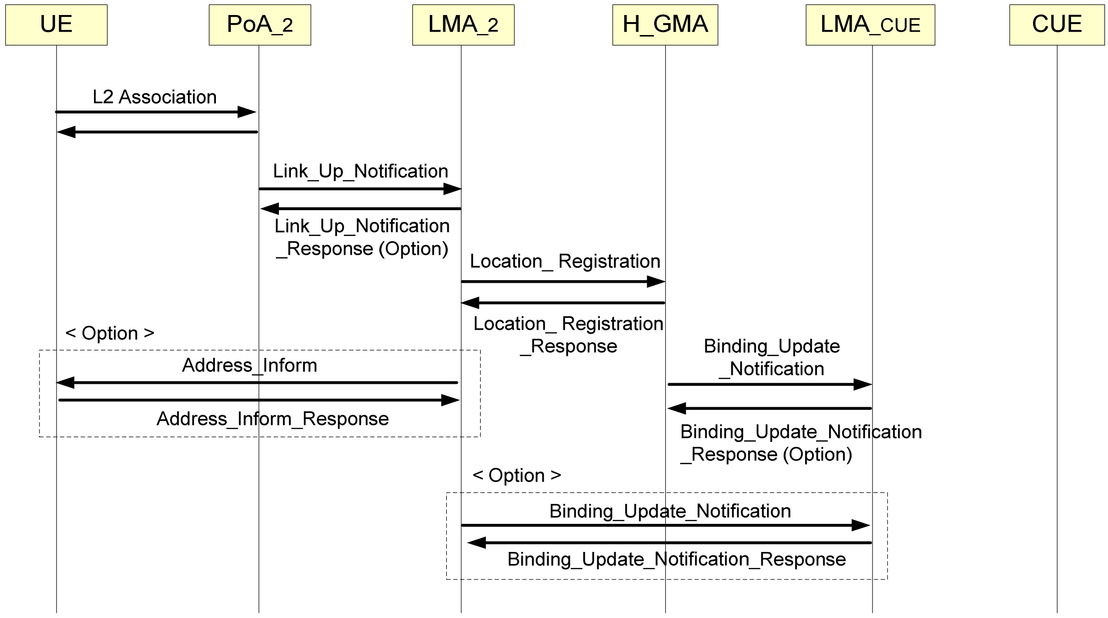

Figure II.3 – Information flow for location update in case UE moves between different LMAs within the home core network

- In case the UE moves into a foreign core network (CUE exists within the home core network)

Figure II.4 shows the information flow for fast handover when the UE moves to the area of the new PoA located in the foreign core network.

– When the UE moves from the area of the old PoA to the new PoA area, the L2 association is performed between the UE and the new PoA. During the L2 association process, the new PoA gets UE L2 ID.

– PoA sends to LMA_UE a Link_Up_Notification message together with UE L2 ID.

– LMA_UE sends to GMA_UE a Location_Registration message together with UE L2 ID and temporal IP address via the previously established LSP between LMA_UE and GMA_UE.

– Upon receiving this Location_Registration message, GMA_UE searches for UE L2 ID in its global address table.

– If its global address table does not have UE L2 ID, GMA_UE requests for the other GMA information from the UE.

– The UE responds to GMA_UE with the UE the persistent IP address as well as the information of H_GMA.

– GMA_UE registers the location information of the UE based on the received GMA_Information_Response message to H_GMA.

– By using the registration message of GMA_UE, H_GMA updates its global address table related to the location information of the UE and sends the Location_Registration_Response message to GMA_UE. In addition, GMA_UE sends the Location_Registration_Response message to LMA_UE.

– H_GMA sends to LMA_CUE a Binding_Update_Notification message together with UE temporal IP address, UE persistent IP address, and LMA_UE IP address. If LMA, where the UE was connected before handover or LMA_UE where UE is currently connected, is able to know the location information of CUE, the LMA or LMA_UE can optionally send the Binding_Update_Notification message to LMA_CUE.

– LMA_UE informs the UE of LMA IP address and UE temporary IP address; the UE sends the Address_Inform_Response message to LMA_UE.

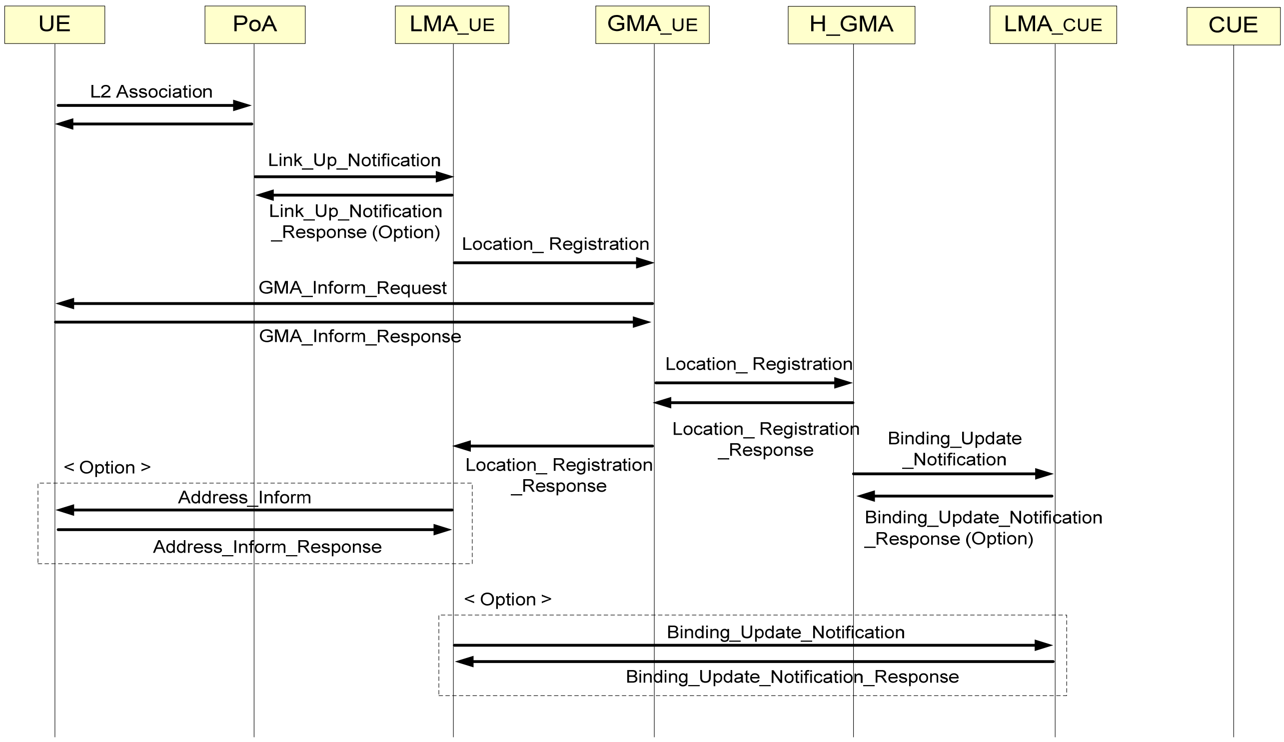

Figure II.4 – Information flow for location update in case UE is located in a foreign core network, and CUE in the home core network

• In case the UE moves into the foreign core network (CUE exists within the home core network)

Figure II.5 shows the information flow for fast handover when the UE and CUE move to the areas of the new PoAs located in different foreign core networks.

– When the UE enters a new PoA area, an L2 association is made between the UE and the PoA. During the L2 association, PoA gets UE L2 ID.

– PoA sends to LMA_UE a Link_Up_Notification message together with UE L2 ID. Upon receiving this message, LMA_UE allocates the temporal IP address for the UE and creates a record for the UE in its local address table.

– LMA_UE sends to GMA_UE a Location_Registration message together with UE L2 ID and temporal IP address for UE and LMA_UE IP address through the previously established LSP between LMA_UE and GMA_UE.

– Upon receiving this Location_Registration message, GMA_UE sends the GMA_Information_Request message to the UE to confirm whether the UE has information on any other GMA related to the UE.

– The UE sends the GMA_Information_Response message to GMA_UE to let GMA_UE know that the UE has the information on H_GMA related to itself. This message includes UE persistent IP address as well as the information of H_GMA. Upon receiving this message, GMA_1 stores information on UE L2 ID, UE temporal IP address and persistent IP address, and LMA_1 IP address.

– GMA_UE sends the Location_Registration message to H_GMA to register UE location information including LMA_UE IP address and GMA_UE IP address as well as UE L2 ID, persistent IP address, and temporal IP address.

– H_GMA updates UE location information and then sends the Location_Registration_Response message to GMA_UE.

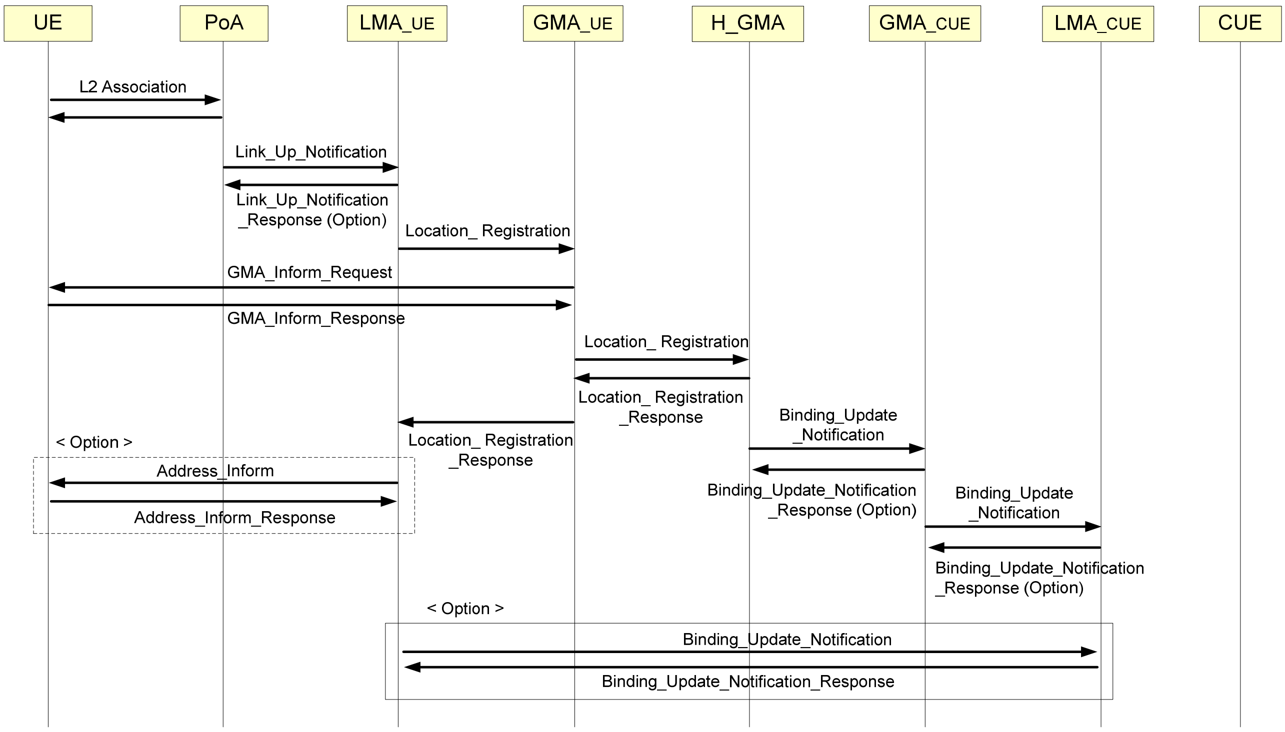

Figure II.5 – Information flow for location update in case UE and CUE are located in a foreign core network

– H_GMA sends to GMA_CUE and LMA_CUE a Binding_Update_Notification message together with UE persistent IP address and temporal IP address and LMA_2 IP address. If LMA, where the UE was connected before handover or LMA_UE where the UE is currently connected, is able to know the location information of CUE, the LMA_UE or LMA can optionally send the Binding_Update_Notification message to LMA_CUE.

– After receiving the Location_Registration_Response message from GMA_CUE, LMA_UE sends to the UE the Address_Inform message including UE temporal IP and LMA_UE IP address and receives the Address_Inform_Response message as a response.

II.3 Location query/response for user data transmission

This clause describes the information flows for the location query/response for user data transmission in three cases: (1) both the UE and the CUE are located within the home core network; (2) the UE is located in a foreign core network, and the CUE in the home core network; and (3) both the UE and the CUE are located within different foreign core networks.

• In case the UE and the CUE are located within the home core network

Figure II.6 shows the information flow for data packet transmission between the UE and the CUE when H_GMA has UE temporal IP address.

– When the CUE sends data packets, the UE persistent IP address is used for the destination IP address; the CUE persistent IP address is used for the source IP address.

– Upon receiving the first packet toward the UE, LER_2 searches for UE temporal IP address in its local address table. If it does not have UE temporal IP address, LER_2 sends a Packet_Arrival_Event to LMA_2.

– When receiving this message, the LMA_2 sends a Location_Query message to H_GMA to determine UE temporal IP address.

– Upon receiving this message, H_GMA searches for UE temporal IP address in its global address table. If it has UE temporal IP address in its global address table, H_GMA sends a Location_Query_Response message to LMA_2.

– On the other hand, upon receiving a Location_Query message from the LMA_2, H_GMA sends a Binding_Update_Notification message to LMA_1 to set up another endpoint of LSP tunnel. This message contains the CUE temporal IP address (i.e., LSP endpoint controlled by LMA_2).

– Tunnel_Request/Response messages are exchanged between LMA_1 and LER_1 and between LMA_2 and LER_2 to set up LSP for user data transmission.

– During this process, the received packets from CUE may be buffered in LER_2.

– Finally, data packets from the CUE to UE can be transmitted through the LSP tunnel established between LER_2 and LER_1.

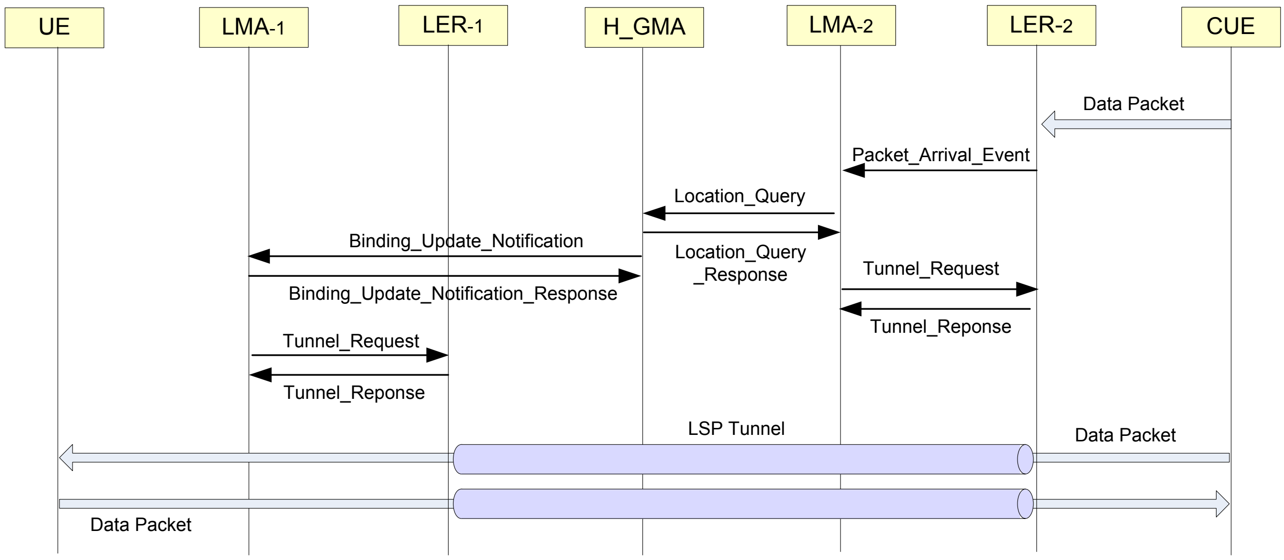

Figure II.6 – Information flow for location query/response in case UE and CUE are located within the home core network

• In case the UE is located in the foreign core network (CUE exists within the home core network)

Figure II.7 shows the information flow for data packet transmission between the UE and the CUE in case the UE moves into the foreign core network and the CUE is located within the home core network.

– Upon receiving the first packet toward the UE, H_LER searches for UE temporal IP address in its local address table. If it does not have UE temporal IP address, H_LER sends a Packet_Arrival_Event to H_LMA.

– When receiving this message, the H_LMA sends a Location_Query message to H_GMA to determine UE temporal IP address.

– Upon receiving this message, H_GMA searches for UE temporal IP address in its global address table. If it has UE temporal IP address, GMA sends a Location_Query_Response message to H_LMA.

– On the other hand, upon receiving a Location_Query message from the H_LMA, H_GMA sends a Binding_Update_Notification message to LMA_UE to set up another endpoint of LSP tunnel. This message contains the CUE temporal IP address (i.e., LSP endpoint controlled by H_LMA).

– Tunnel_Request/Response messages are exchanged between LMA_UE and LER_UE and between H_LMA and H_LER to set up LSP for user data transmission.

– During this process, the received packets from the CUE may be buffered in H_LER.

– Finally, data packets from the CUE to the UE can be transmitted through the LSP tunnel established between H_LER and LER_UE.

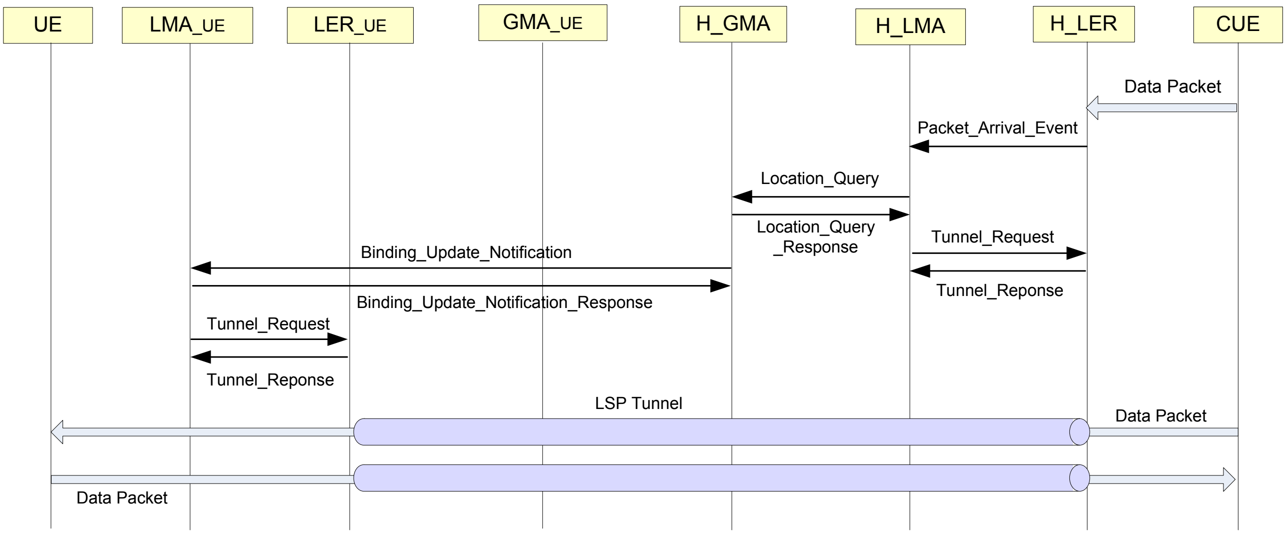

Figure II.7 – Information flow for location query/response in case UE is located in a foreign core network (CUE exists within the home core network)

• In case the UE and CUE are located within different foreign core networks

Figure II.8 shows the information flow for data packet transmission between the UE and CUE when GMA_CUE does not have UE temporal IP address.

– Upon receiving the first packet toward the UE, LER_CUE searches for UE temporal IP address in its local address table. If it does not have UE temporal IP address, LER_CUE sends a Packet_Arrival_Event to LMA_CUE.

– When receiving this message, the LMA_CUE sends a Location_Query message to GMA_CUE to determine UE temporal IP address.

– Upon receiving a Location_Query message from LMA_CUE, GMA_CUE searches for UE temporal IP address in its global address table. If GMA_CUE does not have UE temporal IP address, it sends a Location_Query message to H_GMA.

– When H_GMA responds with UE temporal address, GMA_CUE updates its global address table and sends a Location_Query_Response message to LMA_CUE via GMA_CUE.

– On the other hand, upon receiving a Location_Query message from the GMA_CUE, H_GMA sends a Binding_Update_Notification message to LMA_UE to set up another endpoint of LSP tunnel. This message contains the CUE temporal IP address (i.e., LSP endpoint controlled by LMA_CUE).

– Tunnel_Request/Response messages are exchanged between LMA_UE and LER_UE and between LMA_CUE and LER_CUE to set up LSP for user data transmission.

– During this process, the received packets from CUE may be buffered in LER_CUE.

– Finally, data packets from the CUE to UE can be transmitted through the LSP tunnel established between LER_CUE and LER_UE.

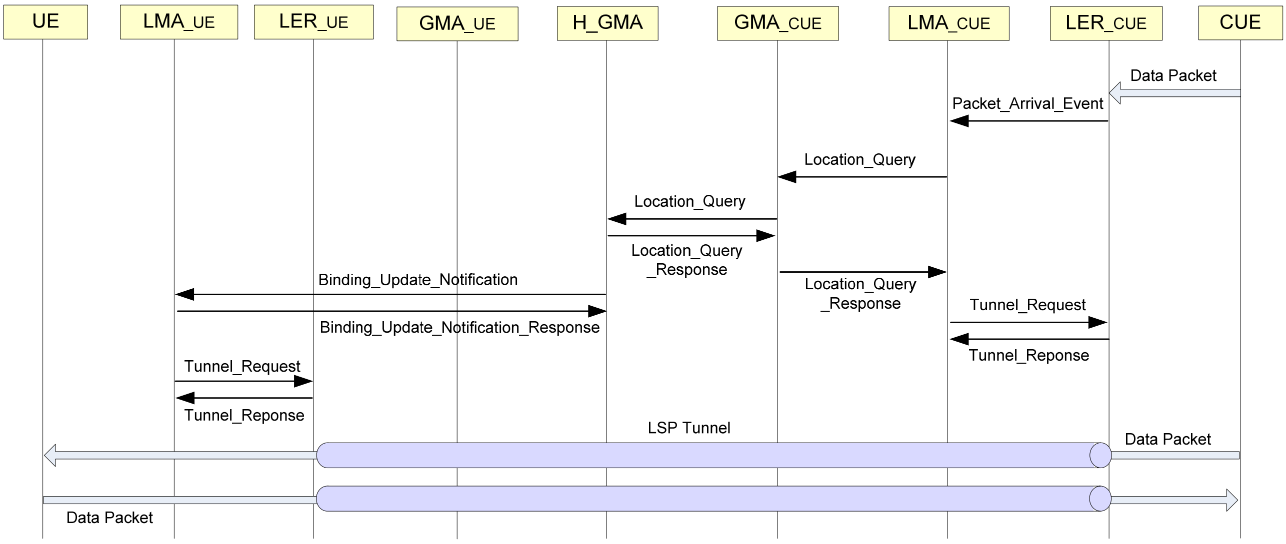

Figure II.8 – Information flow for location query/response in case UE and CUE are located within different foreign core networks

Bibliography

The following references are useful to understand this Recommendation:

[b-ITU-T Y.1281] Recommendation ITU-T Y.1281 (2003), *Mobile IP services over MPLS*.

[b-ITU-T Y.2001] Recommendation ITU-T Y.2001 (2004), *General overview of NGN*.

[b-ITU-T Y.2091] Recommendation ITU-T Y.2091 (2007), *Terms and definitions for Next Generation Networks*.

[b-ITU-T Y.2174] Recommendation ITU-T Y.2174 (2008), *Distributed RACF architecture for MPLS networks*.

[b-ITU-T Y.2175] Recommendation ITU-T Y.2175 (2008), *Centralized RACF architecture for MPLS core networks*.

[b-ITU-T Y.2201] Recommendation ITU-T Y.2201 (2007), *NGN Release 1 requirements*.

[b-ITU-T Y-Sup.1] ITU-T Y-series Recommendations – Supplement 1 (2006), *ITU-T Y.2000 series – Supplement on NGN Release 1 scope*.

[b-IEEE 802.21] IEEE 802.21 (2008), *Standard for Local and metropolitan area networks: Media Independent Handover*.

[b-IETF RFC 2475] IETF RFC 2475 (1998), *An Architecture for Differentiated Services*.

[b-IETF RFC 3031] IETF RFC 3031 (2001), *Multiprotocol Label Switching Architecture*.

[b-IETF RFC 3036] IETF RFC 3036 (2001), *LDP Specification*.

[b-IETF RFC 3209] IETF RFC 3209 (2001), *RSVP-TE: Extensions to RSVP for LSP Tunnels*.

[b-IETF RFC 3212] IETF RFC 3212 (2002), *Constraint-Based LSP Setup using LDP*.

[b-IETF RFC 3344] IETF RFC 3344 (2002), *IP Mobility Support for IPv4*.

[b-IETF RFC 3775] IETF RFC 3775 (2004), *Mobility Support in IPv6*.

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