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

Next Generation Networks – Generalized mobility

Mobility management framework for IP multicast communications in next generation networks

Recommendation ITU-T Y.2810

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Recommendation ITU-T Y.2810

Mobility management framework for IP multicast communications in next generation networks

Summary

Recommendation ITU-T Y.2810 describes the mobility management framework for Internet Protocol (IP) multicast communications in next generation networks (NGNs). Specifically, this Recommendation pursues network-based mobile multicast support wherein multicast is handled without the involvement of the user equipment during handover.

This Recommendation identifies the design considerations, functional architecture, and information flows for supporting network-based mobile multicast services in NGNs.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.2810	2012-03-29	13

Keywords

Mobile, mobility management, multicast, NGN

FOREWORD

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Recommendation ITU-T Y.2810

Mobility management framework for IP multicast communications in next generation networks

1 Scope

The objective of this Recommendation is to describe the mobility management capabilities to support Internet Protocol (IP) multicast-based services in next generation networks (NGNs). Specifically, this Recommendation pursues network-based mobile multicast support wherein multicast is handled without the involvement of the user equipment during handover.

This Recommendation identifies design considerations, functional architecture, and information flows for supporting network-based mobile multicast services in NGNs.

This Recommendation builds on the general mobility management functionalities described in [ITU-T Q.1707] and multicast functionalities described in [ITU-T Y.2017].

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

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

[ITU-T Y.2017] Recommendation ITU-T Y.2017 (2009), *Multicast functions in next generation networks*.

[ITU-T Y.2111] Recommendation ITU-T Y.2111 (2011), *Resource and admission control functions in next generation networks*.

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 handover [b-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.

3.1.2 mobility [b-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.

3.1.3 mobility management [b-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.

3.1.4 multicast [b-ITU-T X.603]: A data delivery scheme where the same data unit is transmitted from a single source to multiple destinations in a single invocation of service.

3.1.5 network-based mobility management [ITU-T Q.1707]: A mobility management scheme in which the MM signalling is performed (or controlled) by the network entities, on behalf of the UE.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 mobile multicast: The ability to provide seamless multicast-based services to user equipment (UE) on the move.

3.2.2 multicast group: A set of service users that abide by appropriate group-membership criteria, or a set of rules belonging to a group that enables multicast-based services and applications.

3.2.3 multicast source mobility: A mobility scenario wherein the source equipment of a multicast session is moving.

3.2.4 multicast receiver mobility: A mobility scenario wherein the receiver equipment of a multicast session is moving.

3.2.5 separated transport model: Mobility transport architecture wherein unicast data and multicast data from/to a node are treated with different transport mechanisms.

3.2.6 unified transport model: Mobility transport architecture wherein unicast data and multicast data from/to a node are treated with the same transport mechanism.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA Authentication, Authorization, Accounting

ANI Application Network Interface

A-MMCF Access MMCF

C-MMCF Central MMCF

HCF Handover Control Function

IGMP Internet Group Management Protocol

IP Internet Protocol

IPTV Internet Protocol Television

LMF Location Management Function

MGMA Multicast Group Management Agent

MGMF Multicast Group Management Function

MLD Multicast Listener Discovery

MM Mobility Management

MMCF Mobility Management Control Functions

MR Multicast Router

MUE Mobile User Equipment

NACF Network Attachment Control Functions

NGN	Next Generation Network
NNI	Network Network Interface
PIM	Protocol-Independent Multicast
PIM-SM	Protocol-Independent Multicast – Sparse Mode
QoS	Quality of Service
RACF	Resource and Admission Control Functions
RP	Rendezvous Point
SSM	Source-Specific Multicast
TUP-FE	Transport User Profile Functional Entity
UE	User Equipment
UNI	User Network Interface
WiMAX	Worldwide Interoperability for Microwave Access

5 Conventions

None.

6 Design considerations

In a mobile environment, multimedia streaming services such as personal broadcasting, video conferencing, and IPTV are considered primary applications and are based on group communications and IP multicast. Multicast plays a particularly important role and possesses many distinct advantages in mobile environments because it enables scalable and global multimedia streaming services.

In NGNs, a wide variety of services and applications using multicast are expected to be used with user equipment (UE) operating over fixed and mobile access networks. Furthermore, it is desirable that new functionality for multicast-based services need not be installed on UE considering backward compatibility with legacy UE.

This Recommendation aims to develop a mobility management (MM) framework to support multicast communications in NGNs. To provide multicast-based services in NGNs, MM capabilities need to be combined and interoperated efficiently with multicast capabilities. These capabilities enable UE to receive multicast data continuously even while moving among different access networks. From these observations, it is noted that there is a crucial need to develop some promising MM schemes or protocols in order to provide seamless mobile multicast services under the mobility environments of NGNs.

6.1 Target applications and services

Generally, mobile multicast services mean that a service provider supports various multimedia services for the restricted user group in a mobile environment. A user has to join the multicast group for services offered by the multicast source. Once the user is a member of the multicast group, a multicast delivery path is constructed between the multicast source and user using multicast protocol such as protocol-independent multicast (PIM). Leaving a multicast group, a user cannot receive any multicast traffic from the source. When a user moves to another network, the corresponding procedures, unlike the unicast service, should be followed for seamless multicast service. To satisfy these requirements, some technical issues different from those applied to the fixed network should be considered.

This Recommendation supports IP-based multimedia multicast applications with the following characteristics:

a) Multicast applications and/or services with receiver mobility

Personal broadcasting is a service wherein the mobile multicast framework is applicable. The user can act as a multicast source, and other users who want to use the multicast service get source information, including group addresses, by online or offline advertisement. To provide the mobile multicast services, MM capabilities, including Access – Mobility Management Control Functions (A-MMCFs) and Central – Mobility Management Control Functions (C-MMCFs), interwork with multicast capabilities such as multicast routers (MRs). After users join the multicast group, they can receive multicast traffic from the source. The delivery path can be changeable dynamically as handover between access networks occurs (see Figure 6-1). The mobile multicast framework can be adopted not only for a given service but for any application with multiple mobile receivers.

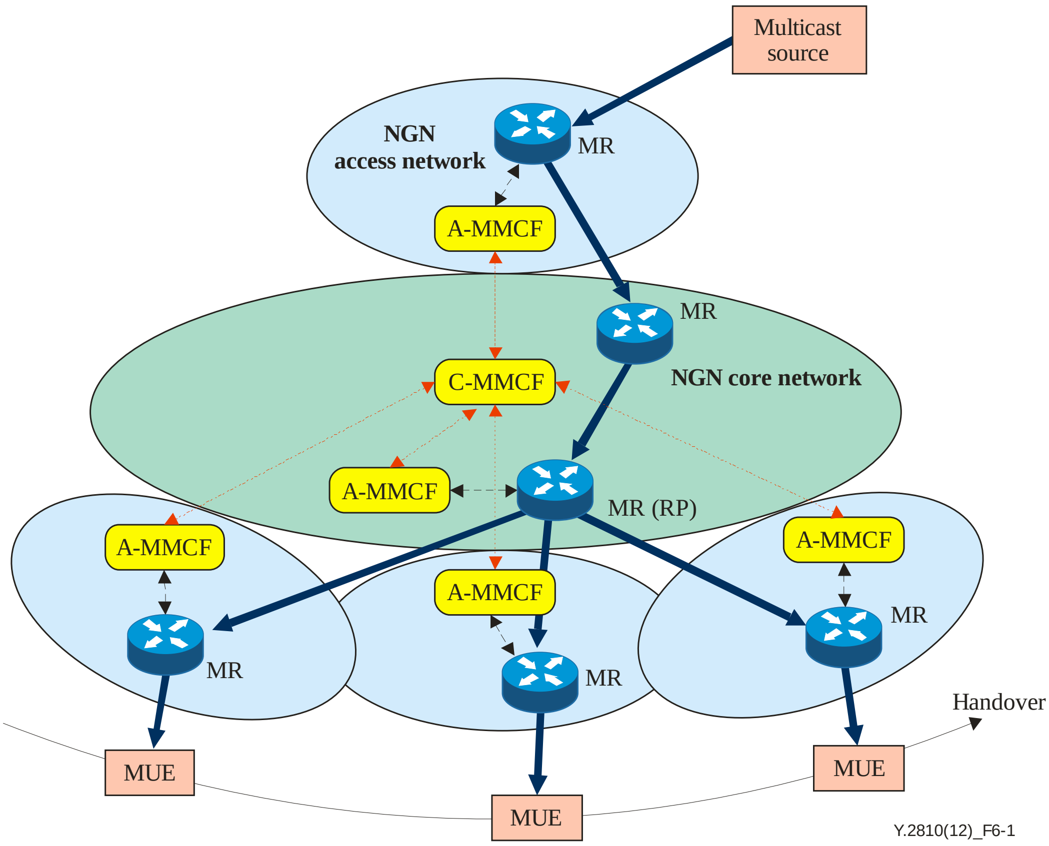

Figure 6-1 – Multicast applications and/or services for receiver mobility

b) Multicast applications and/or services with source mobility

Supporting the handover scenario is recommended in the aspect of multicast source (see Figure 6-2). In applications such as video conferencing and mobile broadcasting, a user participating in the service can be both the multicast data sender and receiver. Thus, the mobile source for multicast should also consider a framework different from what has been discussed by the mobile receiver side.

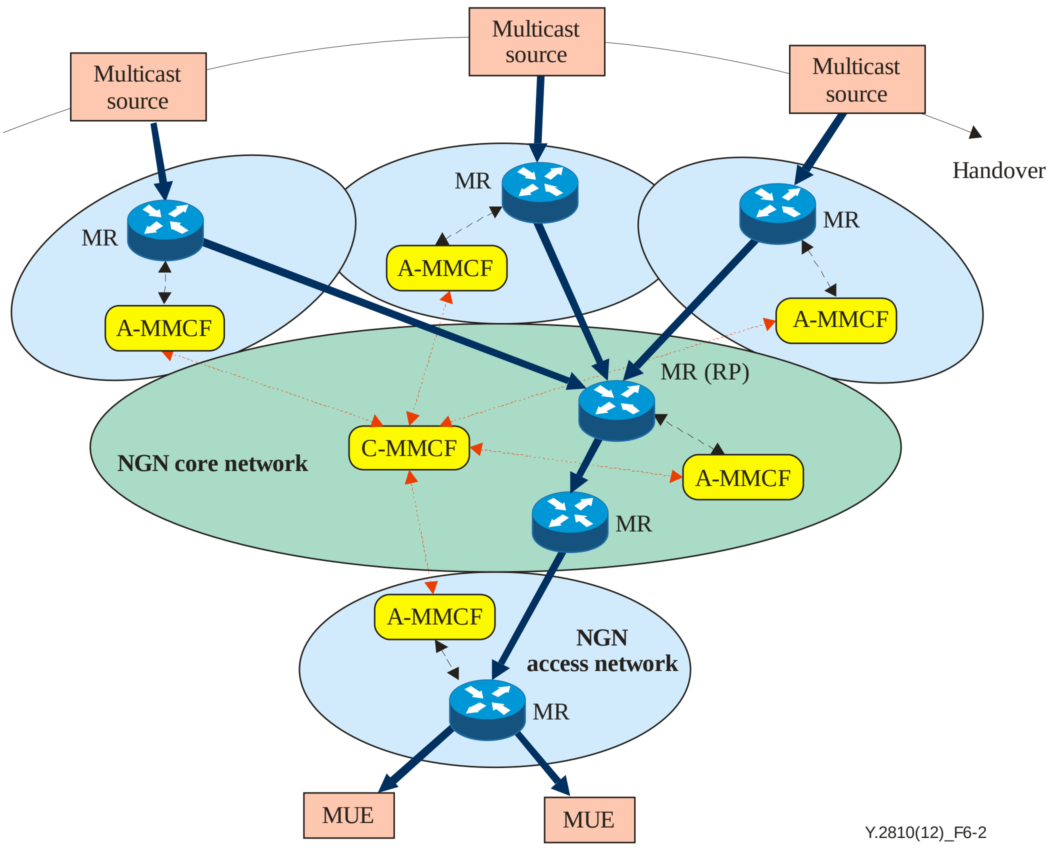

Figure 6-2 – Multicast applications and/or services for source mobility

6.2 Generic network models

6.2.1 Separated transport model for multicast and unicast flows

Figure 6-3 shows a separated transport model that delivers multicast and unicast flows to mobile user equipment (MUE). In this example of network topology, access networks are connected to a core network located at the centre, and all access and core networks are assumed to have the same mobility and multicast functionalities within a single administrative domain. In other words, one multicast function in an access network can interwork with the other multicast functions in different networks.

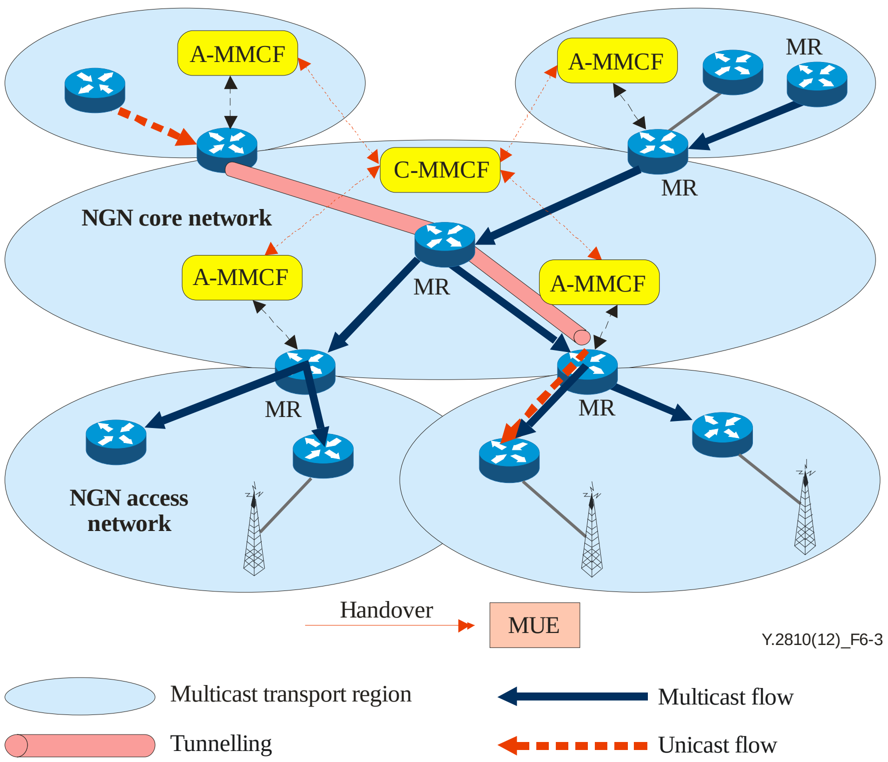

Figure 6-3 – Separated transport model for multicast and unicast flows

Under this network environment, unicast flows to and from MUE can be handled by mobility management control functions (MMCFs). Data packets transmitted to MUE in an access network are encapsulated and tunnelled via the core network to an access network where MUE is located. On the other hand, multicast flows to MUE can be handled by multicast transport functions and delivered to MUE according to the general multicast process. In case of MUE's handover, group join/leave operations will be executed with the aid of MMCFs, and multicast flows could reach MUE.

6.2.2 Unified transport model for multicast and unicast flows

Figure 6-4 shows a unified transport model for multicast and unicast flows. In NGNs, a variety of existing and new wired and/or wireless access network technologies are expected to be combined to provide various NGN services. Multicast functions in an access network may fail to interwork with the multicast functions in a different network for a variety of reasons. For example, administrative domains among networks may be different, or the network operator does not allow multicast flows to pass through their network.

In this network situation, MM functions can manipulate the multicast flows in an efficient manner. As shown in Figure 6-4, multicast packets arriving at the edge node of the NGN mobility network are encapsulated and tunnelled to the access network where MUE is located. MMCF functions with multicast extension can support the local distribution of multicast flow and seamless multicast handover within the NGN mobility domain.

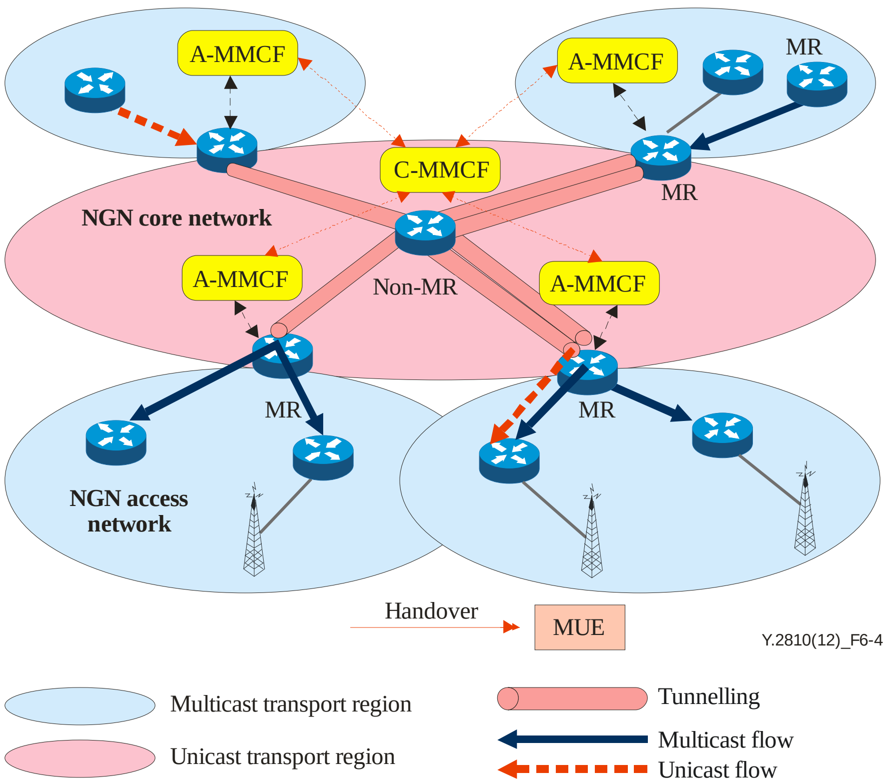

Figure 6-4 – Unified transport model for multicast and unicast flows

6.3 Functional requirements

This clause identifies the functional requirements for the MM capabilities for multicast communications in NGN.

a) Cooperation between MM functions and multicast capabilities

Multicast capabilities are required to recognize the movement of MUE by cooperating with the MM functions. If MUE performs handover, a multicast stream destined for MUE in the old access network could be redirected to the new access network where MUE exists.

b) Support for network-based mobile multicast

This Recommendation is relying on network-based mobile multicast schemes wherein multicast is handled without the involvement of MUE during handover. This network-based mobile multicast can minimize the functional overhead of MUE such as the amount of multicast signalling and support the legacy MUE that does not have additional multicast capabilities.

c) Alignment with [ITU-T Q.1707]

This Recommendation builds on the network-based MM functionalities described in [ITU-T Q.1707].

d) Support for proxy multicast signalling

MM or multicast capabilities located in access or core networks are recommended to provide proxy multicast signalling instead of MUEs to reduce the signalling overhead of MUEs and accelerate the signalling procedures related to multicast session control.

e) Control functionality for mobile multicast sessions

The mobile multicast capabilities are recommended to interwork with conventional IP multicast protocols such as IGMP/MLD and multicast routing protocols.

f) Support for membership monitoring

MM schemes are recommended to support the monitoring of active session membership of users for each multicast session.

g) Support for QoS monitoring in wireless environments

Note that wireless links generically have lower quality than wired links. Accordingly, mobile users may be affected by the quality of services in the case of mobile application services. In this context, the MM schemes can be optionally designed to provide the monitoring of QoS as perceived by end users. Such monitored QoS information may be used by content servers to adjust the data transmission rate.

h) Support for the handover of MUE

In NGN, each MUE tends to move into other networks; thus changing to a new access point in the newly attached network. The MM schemes are required to support such mobility or handover for MUE during the multicast session. With the help of this MM functionality, the mobile MUE could continue the multicast session seamlessly.

i) Support for the authentication and authorization of multicast users

The MM schemes are recommended to support the authentication, authorization and accounting (AAA) functionality for the multicast session. For this purpose, the MM schemes can optionally interwork with legacy AAA servers and/or user profile databases. These servers and databases may be used for the authentication and authorization of the newly joining multicast user.

7 Functional architecture for mobile multicast in next generation networks

This clause describes the functional entities that support mobile multicast service in NGNs. Figure 7-1 presents an overview of the functional architecture for supporting mobile multicast capabilities, which includes service stratum, transport stratum, management functions, and end-user functions.

This functional architecture is aligned with the NGN multicast framework architecture defined in [ITU-T Y.2017], building upon the NGN functional architecture [ITU-T Y.2012] with the addition of a new set of functions for mediation between mobility functions and multicast functions. Some NGN functional entities are extended with functions to support mobile multicast services.

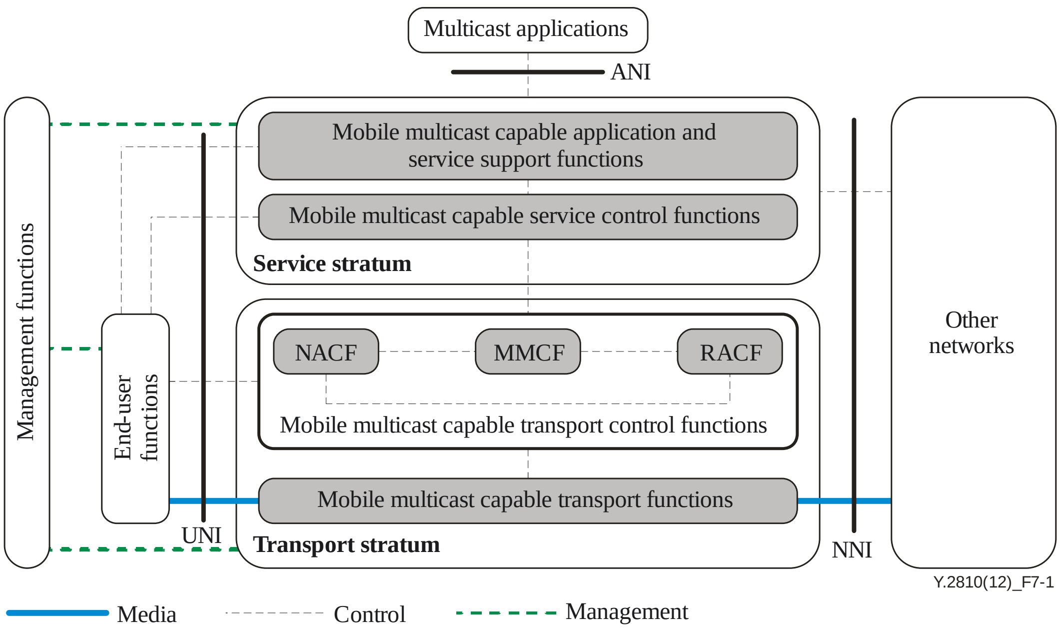

Figure 7-1 – Functional architecture for supporting mobile multicast services

7.1 Service stratum

The service stratum provides mobile multicast capable functions at the service level. These functions are described in the following sub-clauses.

7.1.1 Mobile multicast capable service control functions

The mobile multicast capable service control functions provide control functions such as session control functions, service authentication and authorization functions for mobile multicast. It also accommodates media quality control functions and service user profiles representing the combination of user information and other control data into a single user profile function.

Many people currently use several MUEs. In this case, the capability information of all MUE that a user has is associated with the service user profile.

7.1.2 Mobile multicast capable application support and service support functions

Mobile multicast capable application support and service support functions support the transcoding, conversion, and relay of different types of multimedia. These functions are implemented by application servers or by application gateways with control elements recognizing the need to do the transformation in relation to the type of multimedia being sent and capabilities of MUE to which it is being sent.

These functions also include functions such as registration, authentication, and authorization functions at the application level. Application interactions with the mobile multicast capable application support and service support functions are handled through the ANI reference point.

7.2 Transport stratum

The transport stratum provides mobile multicast capable functions at the transport level. These functions are described in the following sub-clauses.

7.2.1 Mobile multicast capable transport control functions

In the case of multicast communication, the scenario of handover is particularly challenging, and several issues emerge with most solutions due to the handover impacts. Unfortunately, when a multicast receiver is mobile, it will experience additional delay in receiving multicast packets due to handover delay, join latency, and increased propagation delay to the new location. These impacts depend on the way IP multicast is combined with mobility capabilities.

Mobile multicast capable transport control functions include resource and admission control functions (RACFs), mobility management control functions (MMCFs), and network attachment control functions (NACFs).

a) Mobility management control function (MMCF)

The MMCF provides mobility management and control functions to support mobility in NGNs as described in [ITU-T Q.1707]. The MMCF includes location management functions (LMFs) and handover control functions (HCFs) for location management and handover control, respectively. These two functions include several functional entities as described in [ITU-T Q.1707].

In addition, the MMCF includes multicast group management functions (MGMFs) for the network-based mobile multicast scheme. The MGMF keeps the information of the multicast group for each MUE. The MGMF cooperates with other functional entities in the MMCF to support minimizing the latency for joining and leaving a multicast group in support of handover.

For example, the MGMF keeps and manages the following data if the multicast routing protocol is Protocol-independent multicast – sparse mode (PIM-SM):

– IP address of a multicast group;
– IP address of multicast source;

– IP address of rendezvous point (RP);

– Existence of receiver for a multicast group.

The MMCF interacts with the RACF to support mobile multicast services requiring NGN transport resource control.

b) Resource and admission control function (RACF)

Multicast transmission for multimedia streaming may suffer from unreliable connection and heterogeneous bandwidth for different receivers. In particular, additional signalling for multicast service mobility in air interface is more significant.

The 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]. The RACF can make use of information such as transport subscription information, network policy rules, service priority, and transport resource status and utilization information.

c) Network attachment control function (NACF)

The NACF provides registration at the access level and initialization of end-user functions for accessing mobile multicast services.

Multicast group and source information is added to the NACF, and the transport user profile functional entity (TUP-FE) is extended to support multicast announcement identification information.

7.2.2 Mobile multicast capable transport functions

These transport functions perform the delivery of multicast-based services to users in the mobility environment. These functions can cooperate with the MMCF for maintaining session continuity during the movement. It will support fast handover to cater to seamless non-real-time and real-time services' requirements.

For the inclusion of multicast delivery, multicast functions in the access network play a role in the multicast-enabled router in the access network.

7.3 Management functions

The management functions provide abilities to manage the mobile multicast functions in NGNs to provide mobility services supported by multicast with QoS, security, and reliability in the service stratum and transport stratum.

Multicast sessions may be established either on demand or by management procedures. Session parameters (e.g., bandwidth availability, time delay or packet loss ratio) for the multicast session could be applicable to establish the transport session.

7.4 End-user functions

End-user functions can optionally request multicast-based service information and/or solicit and receive multicast transport information to join a mobile multicast service.

Different types of devices can be used in NGNs, and these devices have various screen sizes and different resolutions from small to big considering heterogeneous networks such as IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), and IEEE 802.3 (Ethernet) as well as 3GPP/3GPP2 networks. Then, if the multimedia content is simply transferred from a widescreen device to a small-sized device without considering the resolution and ratios aspect, the viewing experience of the user may be very uncomfortable.

End-user functions can provide hardware capabilities and service preferences to the multicast capable service control function in the service stratum. Depending on the intervention of service control functions, down-sampling, up-sampling or en(de)coding can occur in the delivery channel for mobile multicast services.

8 Information flows for mobile multicast management

8.1 Information flows for the separated transport model

8.1.1 Multicast receiver mobility

This clause describes the multicast receiver mobility procedures for the separated transport model.

8.1.1.1 Multicast receiver joining procedure

Figure 8-1 describes the information flows for handling multicast receiver joining procedures for the separated transport model.

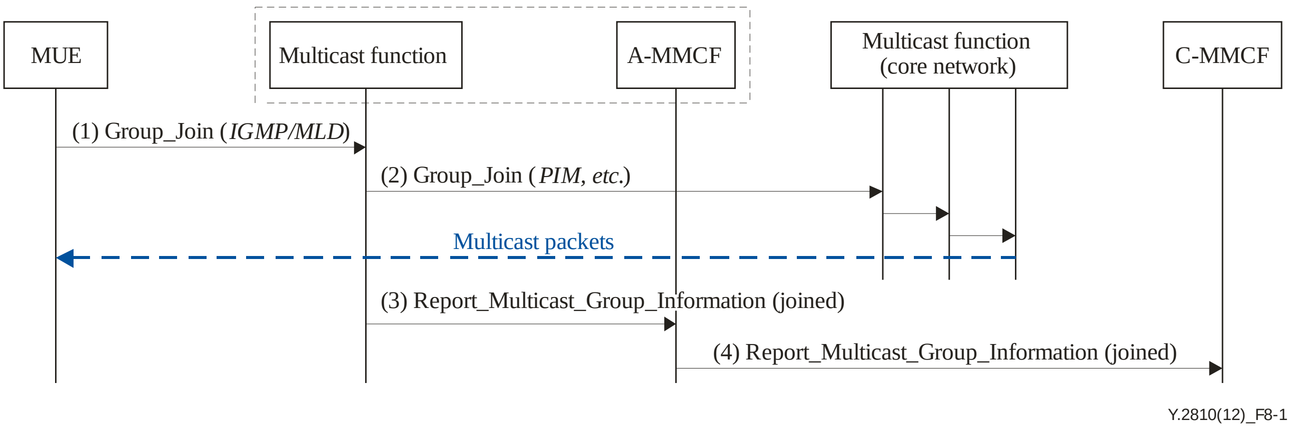

Figure 8-1 – Multicast receiver joining procedure

The interactions shown in Figure 8-1 are as follows:

1) MUE requests to join a multicast group by sending a Group_Join message of the multicast group membership protocol (such as the Internet Group Management Protocol (IGMP)/Multicast Listener Discovery (MLD)) to the multicast function;

2) Upon receiving the Group_Join message, the multicast function joins the multicast group by sending a Group_Join message to the multicast functions in the core network using the multicast routing protocol such as PIM-SM. Then, multicast packets can be transmitted to MUE;

3) The multicast function sends a Report_Multicast_Group_Information message to inform A-MMCF of the joined multicast group information of MUE. The multicast group information includes the IP address of the multicast group and the IP address of MUE;

4) MGMF of A-MMCF stores the joined multicast group information and delivers it to C-MMCF by sending a Report_Multicast_Group_Information message;

5) MGMF of C-MMCF stores the joined multicast group information, which will be used when MUE moves to another network.

8.1.1.2 Multicast receiver prune procedure

Figure 8-2 describes the information flow for handling multicast receiver prune procedures for the separated transport model.

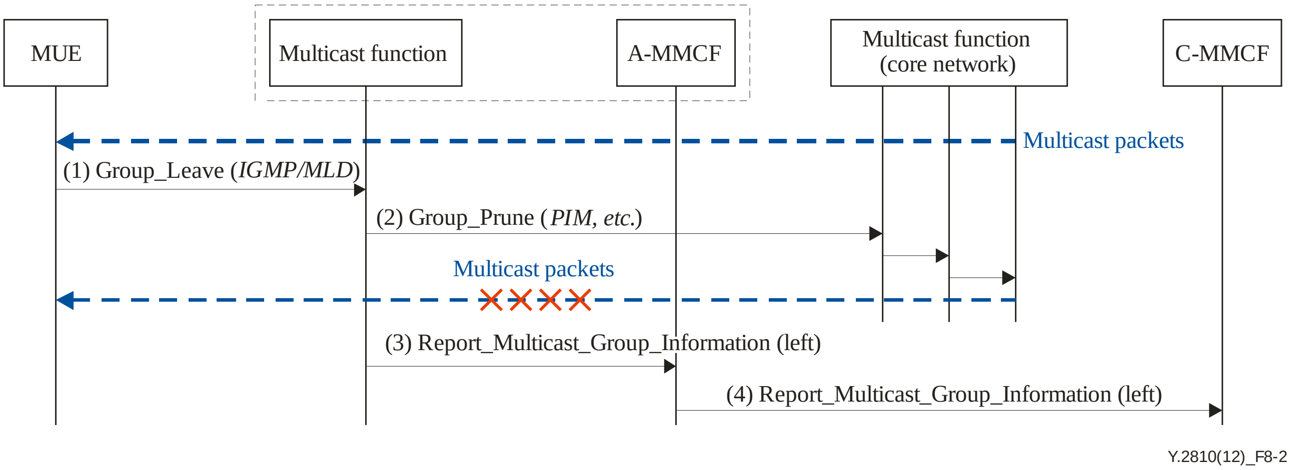

Figure 8-2 – Multicast receiver prune procedure

The interactions shown in Figure 8-2 are as follows:

1) MUE sends a Group_Leave message (using the existing multicast group membership protocol such as IGMP/MLD) to stop receiving the multicast service;

2) After receiving the Group_Leave message, the multicast function sends a Group_Prune message by using the multicast routing protocol such as PIM-SM to leave the multicast group. In that case, the multicast packets are no longer delivered to MUE;

3) The multicast function sends a Report_Multicast_Group_Information message to A-MMCF to relay the leaving of the multicast group by MUE. The message includes multicast group information, i.e., the IP address of the multicast group and the IP address of MUE.

4) MGMF of A-MMCF deletes the information corresponding to the multicast group left by MUE and sends a Report_Multicast_Group_Information message to C-MMCF.

5) Upon receiving this message, MGMF of C-MMCF deletes the information of the multicast group left by MUE.

8.1.1.3 Multicast receiver handover procedure

Figure 8-3 describes the information flow for handling multicast handover procedures for the separated transport model.

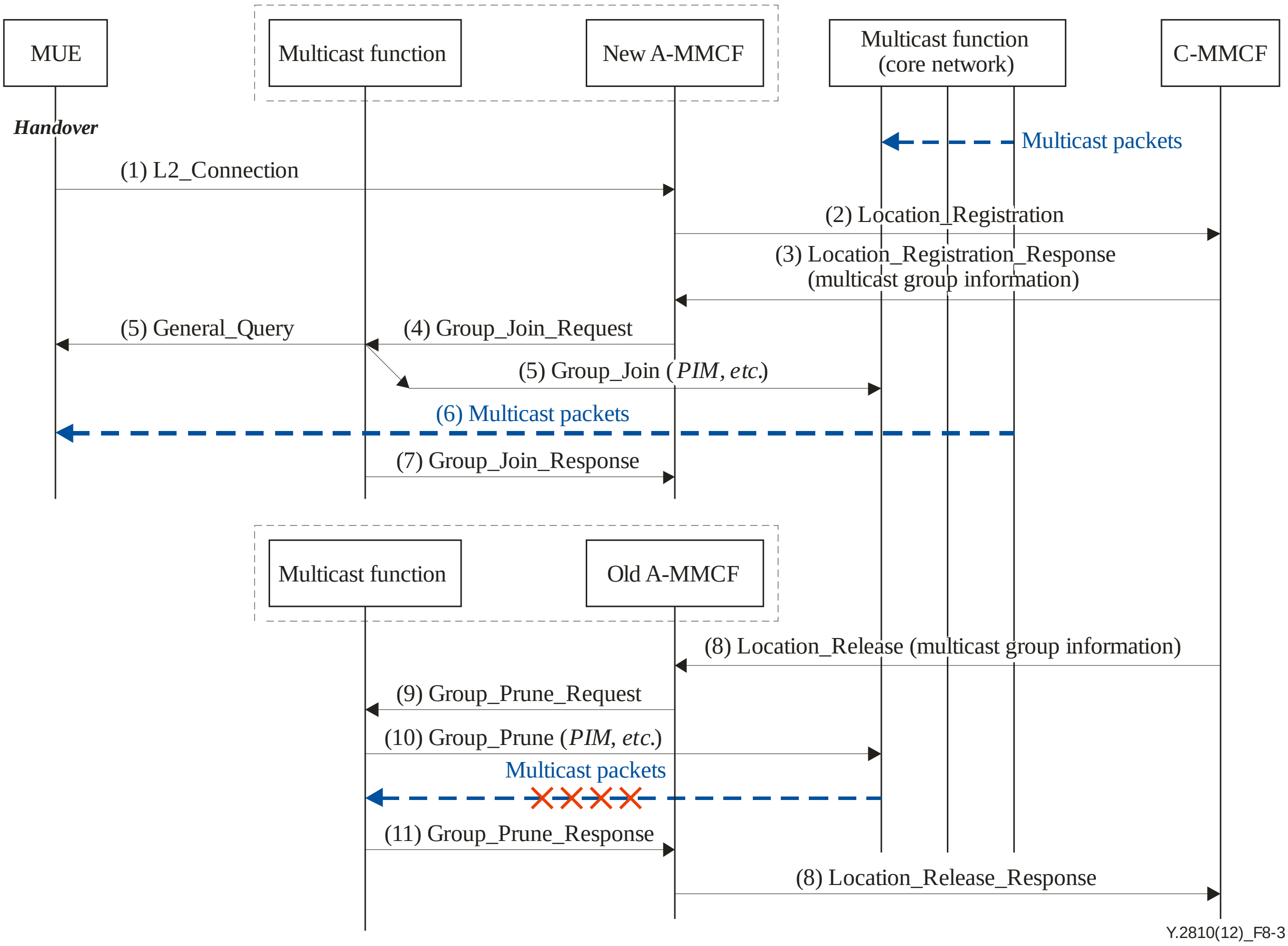

Figure 8-3 – Multicast receiver handover procedure

The interactions shown in Figure 8-3 are as follows:

1) When MUE moves to another network, the new A-MMCF detects MUE by using L2 association procedures.

2) The new A-MMCF sends a Location_Registration message to C-MMCF for the location registration of MUE;

3) C-MMCF checks information on MUE and recognizes that MUE belongs to a multicast group. Then, C-MMCF informs the multicast group information of the MUE to the new A-MMCF by sending a Location_Registration_Response message;

4) Upon receiving the multicast group information of MUE, the new A-MMCF requests to join the multicast group to the multicast function by sending a Group_Join_Request message;

5) According to the multicast group information of MUE, the multicast function joins the multicast group by sending a Group_Join message and sends a General_Query message to MUE;

6) The multicast packets are transmitted to MUE;

7) The multicast function sends a Group_Join_Response message to the new MMCF in response to the Group_Join_Request message;

8) After step 3), C-MMCF sends a Location_Release message to the old A-MMCF to release the location information of MUE;

9) Upon receiving the Location_Release message, which includes the multicast group information of MUE, the old A-MMCF checks whether or not there are other MUEs in the multicast group. If there is no MUE left in the multicast group, the old A-MMCF requests to prune the multicast group to the multicast function by sending a Group_Prune_Request message. If any MUE still remains in the multicast group, A-MMCF deletes only MUE's information;

10) According to the multicast information of MUE, the multicast function prunes the multicast group by sending a Group_Prune message of the multicast routing protocol such as PIM-SM;

11) When the old A-MMCF receives a Group_Prune_Response message, it deletes MUE's information.

12) The old A-MMCF sends a Location_Release_Message to C-MMCF.

8.1.2 Multicast source mobility

This clause describes the multicast source mobility procedures for the separated transport model.

8.1.2.1 Multicast source registration procedure

Figure 8-4 describes the information flow for handling multicast source registration procedures for the separated transport model.

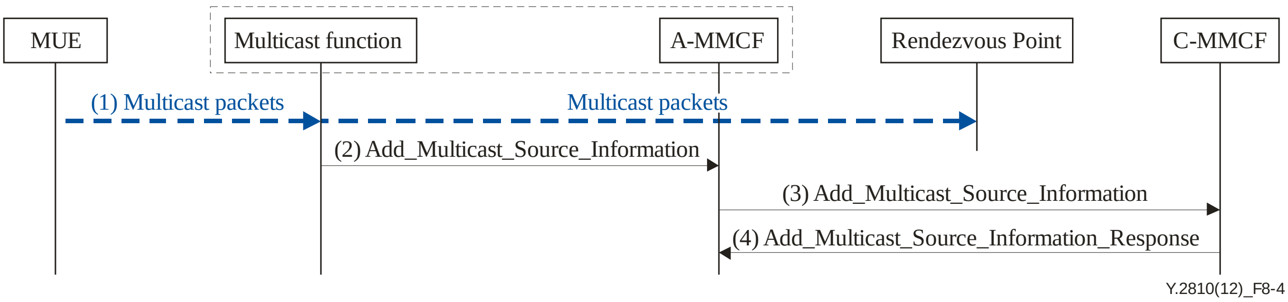

Figure 8-4 – Multicast source registration procedure

The interactions shown in Figure 8-4 are as follows:

1) Upon receiving the multicast packets sent from MUE, the multicast function such as the enhanced PIM-SM block sends the multicast packets to Rendezvous Point. After that, the multicast function and Rendezvous Point exchange several signalling messages for the proper transmission of the multicast packets. Through this process, the multicast function gets multicast source information including the IP address of the multicast source, IP address of Rendezvous Point, IP address of the multicast group;

2) The multicast function informs A-MMCF of the multicast source information by sending an Add_Multicast_Source_Information message;

3) Upon receiving the multicast source information, MGMF of A-MMCF stores the information and sends an Add_Multicast_Source_Information message to C-MMCF;

4) MGMF of C-MMCF stores the multicast source information, which will be used when MUE moves to another network. C-MMCF sends an Add_Multicast_Source_Information_Response message in response to the Add_Multicast_Source_Information message.

8.1.2.2 Multicast receiver joining procedure

Figure 8-5 describes the information flow for handling multicast receiver joining procedures for the separated transport model.

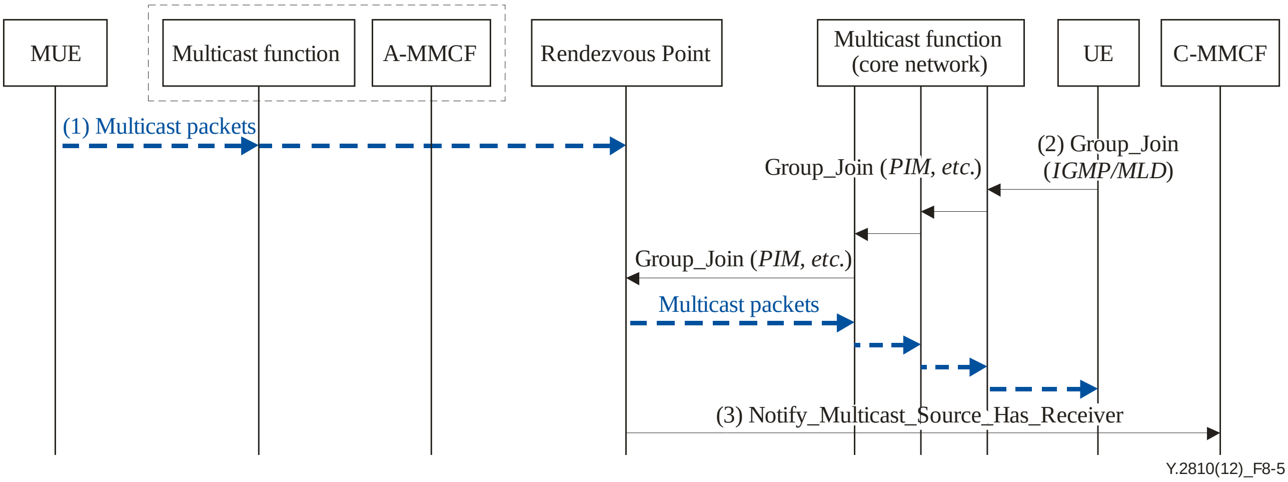

Figure 8-5 – Multicast receiver joining procedure

The interactions shown in Figure 8-5 are as follows:

1) MUE is transmitting multicast packets through NGN.

2) When UE requests to join the multicast group, a multicast delivery path to UE is established, and the multicast packets are transmitted to UE. Through this process, Rendezvous Point knows that the multicast group has a receiver.

3) A-MMCF of Rendezvous Point sends a Notify_Multicast_Source_Has_Receiver message, which means that the multicast group has a receiver to C-MMCF. The information may be used for path establishment to deliver multicast packets when MUE moves to another network.

8.1.2.3 Multicast source handover procedure

Figure 8-6 describes the information flow for handling multicast source handover procedures for the separated transport model.

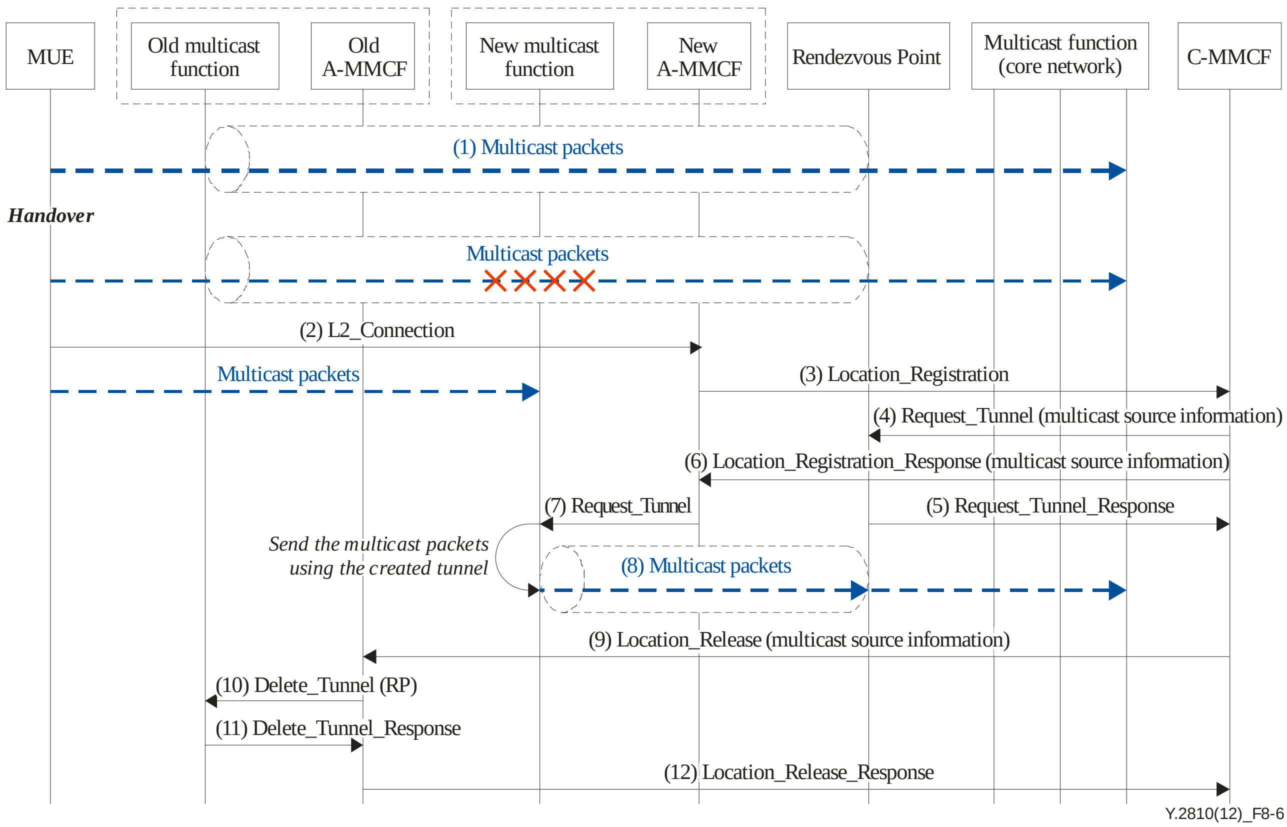

Figure 8-6 – Multicast source handover procedure

The interactions shown in Figure 8-6 are as follows:

1) MUE is transmitting multicast packets to a network;

2) When moving to another network, MUE establishes a new L2_connection to the new A-MMCF;

3) The new A-MMCF sends a Location_Registration message to C-MMCF for the location registration of MUE;

4) C-MMCF checks the information of MUE and recognizes that MUE is the multicast source and that its multicast group has one or more receivers. Thus, C-MMCF sends a Request_Tunnel message with the multicast source information to Rendezvous Point, which is sending the multicast packets;

5) Upon receiving the multicast source information of MUE, Rendezvous Point creates a tunnel to the multicast router where MUE is located. A-MMCF of Rendezvous Point sends a Request_Tunnel_Response message for the result;

6) Meanwhile, after step 4), C-MMCF sends the multicast source information of MUE to the new A-MMCF by using a Location_Registration_Response message;

7) Upon receiving the multicast source information of MUE, the new A-MMCF sends a Request_Tunnel message with multicast source information to the new multicast function;

8) The new multicast function creates a tunnel to Rendezvous Point and sends the multicast packets through the created tunnel. Upon receiving the multicast packets, the multicast function of Rendezvous Point forwards the multicast packets to a network. Finally, the multicast packets are delivered to one or more receivers;

9) After step 5), C-MMCF sends a Location_Release message to the old A-MMCF for the location release of MUE. The message includes the multicast source information of MUE;

10) Upon receiving the Location_Release message, the old A-MMCF sends a Delete_Tunnel message with multicast source information to the old multicast function. The multicast function checks whether or not there is a tunnel for MUE. If there is a tunnel, the multicast function deletes it;

11) The multicast function sends a Delete_Tunnel_Response message to the old A-MMCF in response to the Delete_Tunnel message. The old A-MMCF deletes MUE's information;

12) The old A-MMCF sends a Location_Release_Response message to C-MMCF in response to the Location_Release message.

8.1.2.4 Multicast source prune procedure

Figure 8-7 describes the information flow for handling multicast source prune procedures for the separated transport model.

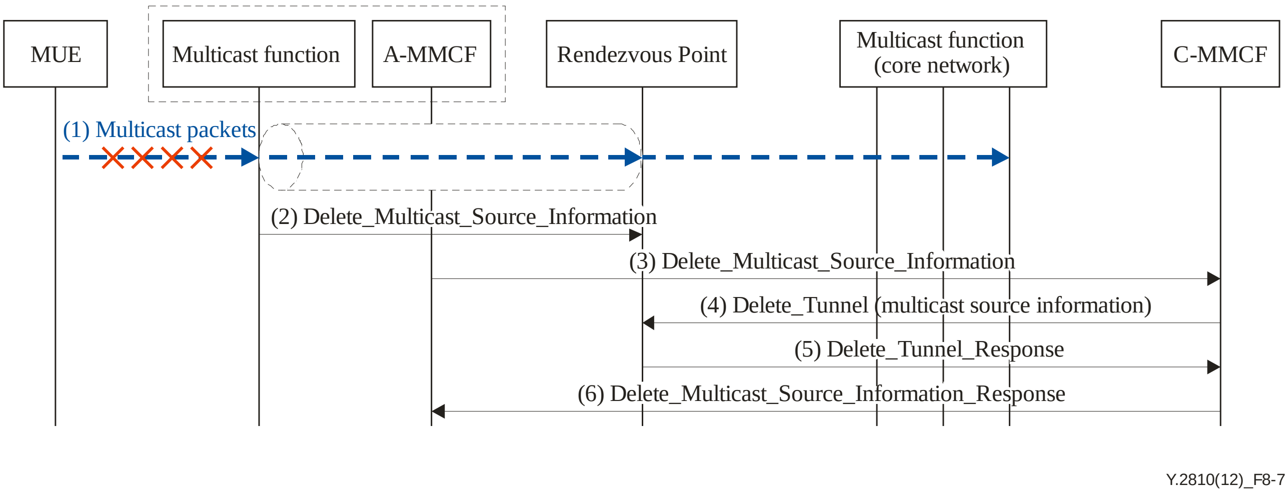

Figure 8-7 – Multicast source prune procedure

The interactions shown in Figure 8-7 are as follows:

1) MUE stops to send multicast packets to the network;

2) The multicast function detects that MUE stops to send the multicast packets. The multicast function checks whether or not there is a tunnel for MUE. If there is, the multicast function deletes the tunnel and sends a Delete_Multicast_Source_Information message to A-MMCF;

3) Upon receiving the message, A-MMCF deletes the multicast source information of MUE and reports it to C-MMCF by sending a Delete_Multicast_Source_Information message;

4) C-MMCF deletes the multicast source information of MUE and sends a Delete_Tunnel message to Rendezvous Point. Upon receiving the message, the multicast function of Rendezvous Point checks whether or not there is a tunnel for MUE. If there is, the multicast function deletes it;

5) Rendezvous Point sends a Delete_Tunnel_Response message to C-MMCF in response to the Delete_Tunnel message;

6) C-MMCF sends a Delete_Tunnel_Source_Information_Response message to A-MMCF for the result.

8.2 Information flows for the unified transport model

8.2.1 Multicast receiver mobility

8.2.1.1 Multicast receiver joining procedure

Figure 8-8 describes the information flow for handling multicast receiver joining procedures for the unified transport model.

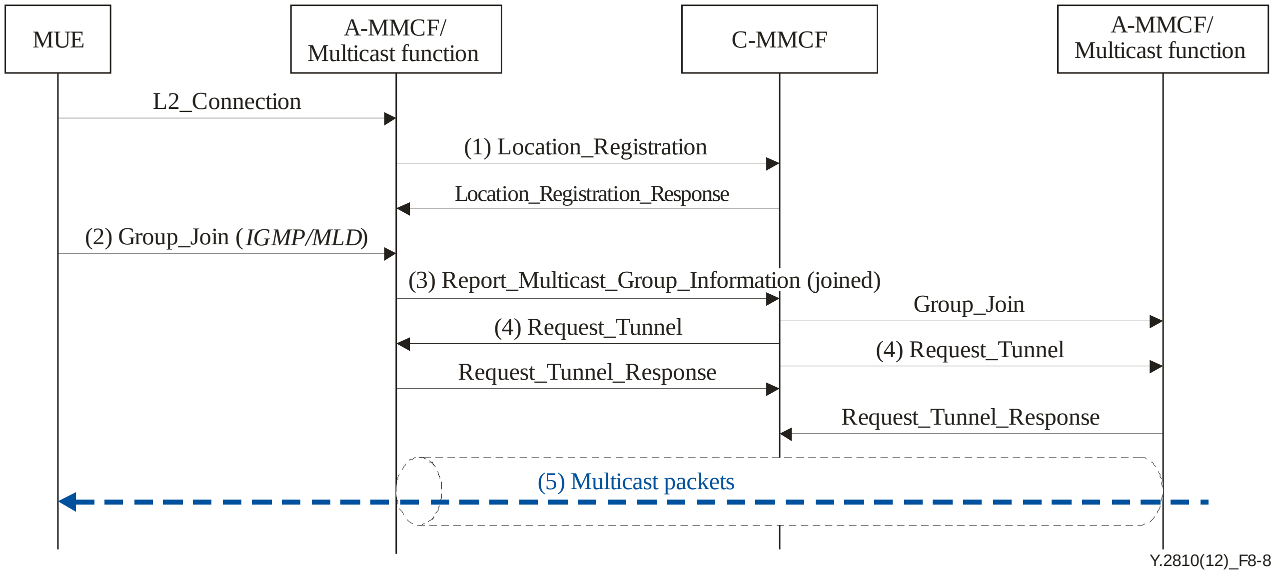

Figure 8-8 – Multicast receiver joining procedure

The interactions shown in Figure 8-8 are as follows:

1) When MUE is first attached to NGN, it will trigger the sending of a Location_Registration message by A-MMCF to C-MMCF;

2) MUE requests to join the multicast service group by sending a Group_Join message to A-MMCF;

3) Upon receiving this message, A-MMCF sends a Report_Multicast_Group_Information message to C-MMCF, and C-MMCF sends a Group_Join message to the corresponding A-MMCF;

4) C-MMCF requests to establish a tunnel between A-MMCF where MUE is located and a corresponding A-MMCF. Moreover, the multicast group information of MUE is recorded in C-MMCF;

5) Thereafter, multicast packets are delivered to MUE through the tunnel between A-MMCFs.

Figure 8-9 describes the information flow for handling an additional multicast receiver joining request for the unified transport model. While one or more MUEs are receiving a multicast stream, the MUE that has been involved in the multicast group could migrate to the same subnet, or the MUE staying in the subnet could join the multicast group wherein some MUEs in the same subnet are already involved. In these cases, the following procedures can be applied:

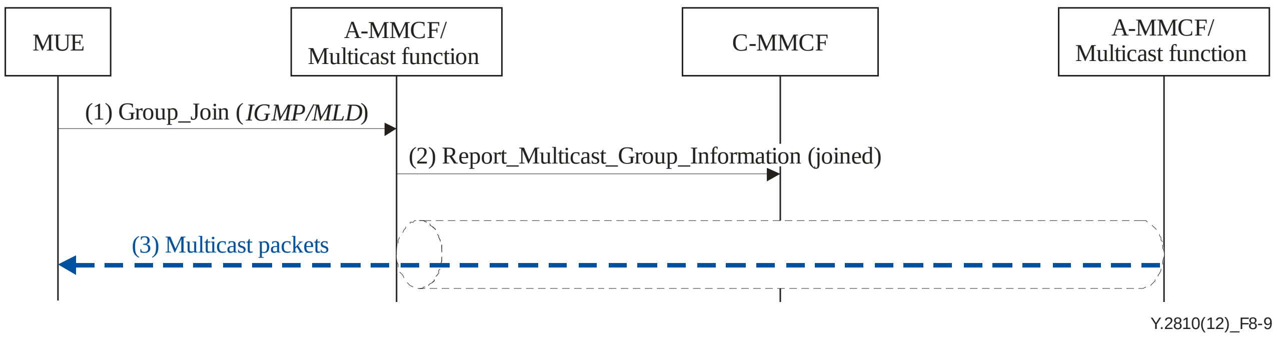

Figure 8-9 – Additional multicast receiver joining procedure

The interactions shown in Figure 8-9 are as follows:

1) MUE requests to join the multicast group by sending a Group_Join message using the multicast group membership protocol such as IGMP/MLD;

2) When A-MMCF receives the join message, it sends a Report_Multicast_Group_Information message to C-MMCF. Upon receiving this message, C-MMCF creates an entry in its MGMF to indicate a mapping relation among the IP address of MUE, the IP address of the multicast group, and the tunnel information. The information may be used when MUE moves to another network;

3) The multicast function of A-MMCF enables multicast packets to be copied and forwarded to MUE. Thereafter, multicast packets are delivered to the newly joined MUE.

   NOTE – Because there is a tunnel between the multicast functions of A-MMCFs for the existing MUEs, A-MMCF does not need to establish a new tunnel for the newly joined MUE.

8.2.1.2 Multicast receiver handover procedure

Figure 8-10 depicts the information flow for handling the multicast receiver handover procedures between two A-MMCFs' regions for the unified transport model. It is similar to that of the initial connection establishment, but the Tunnel_Request message is replaced with a Tunnel_Update message. The Tunnel_Update message contains information to enable the multicast function controlled by A-MMCF to distinguish the initial connection establishment and handover situations of MUE.

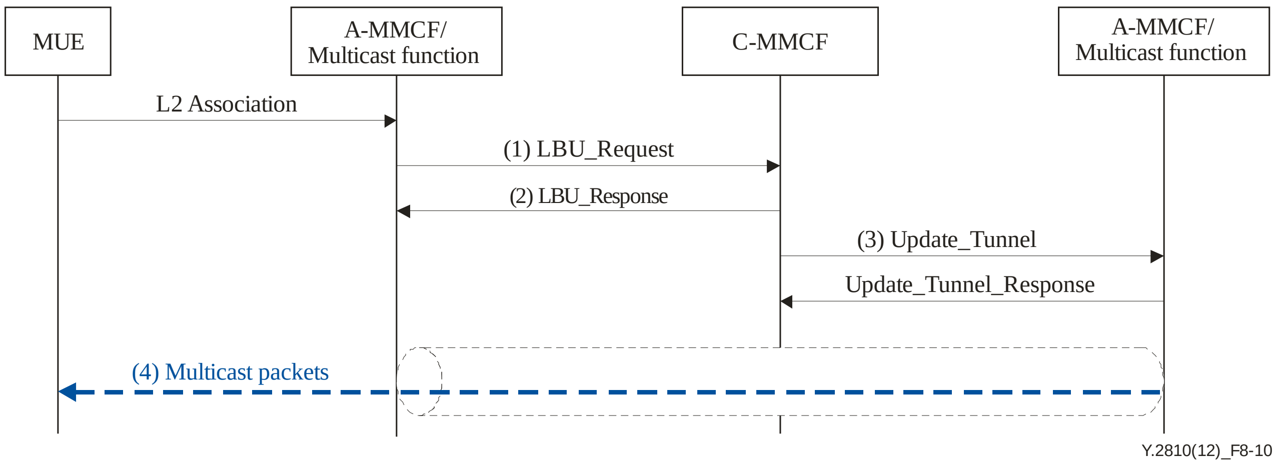

Figure 8-10 – Multicast receiver handover procedure

The interactions shown in Figure 8-10 are as follows:

1) When an LBU_Request message from the new A-MMCF is received, C-MMCF updates the LID binding information of MUE with a newly assigned TLID;
2) C-MMCF then replies to the previous LBU_Request message by sending an LBU_Response message;
3) Subsequently, C-MMCF sends a Update_Tunnel message to the multicast function controlled by A-MMCF. Upon receiving the message, the multicast function searches and updates the data tunnel binding information of MUE so that a new multicast tunnel (toward the new A-MMCF) is bound by MUE;
4) Finally, multicast packets are delivered to MUE through the tunnel.

8.2.1.3 Multicast receiver prune procedure

Figure 8-11 depicts the information flow for handling the multicast receiver prune of MUEs.

When MUE#1 and MUE#2, which have been joining the same multicast group, leave the multicast group, the prune procedures of MUE#1 and MUE#2 are differently performed whether or not there is any MUE left in the multicast group.

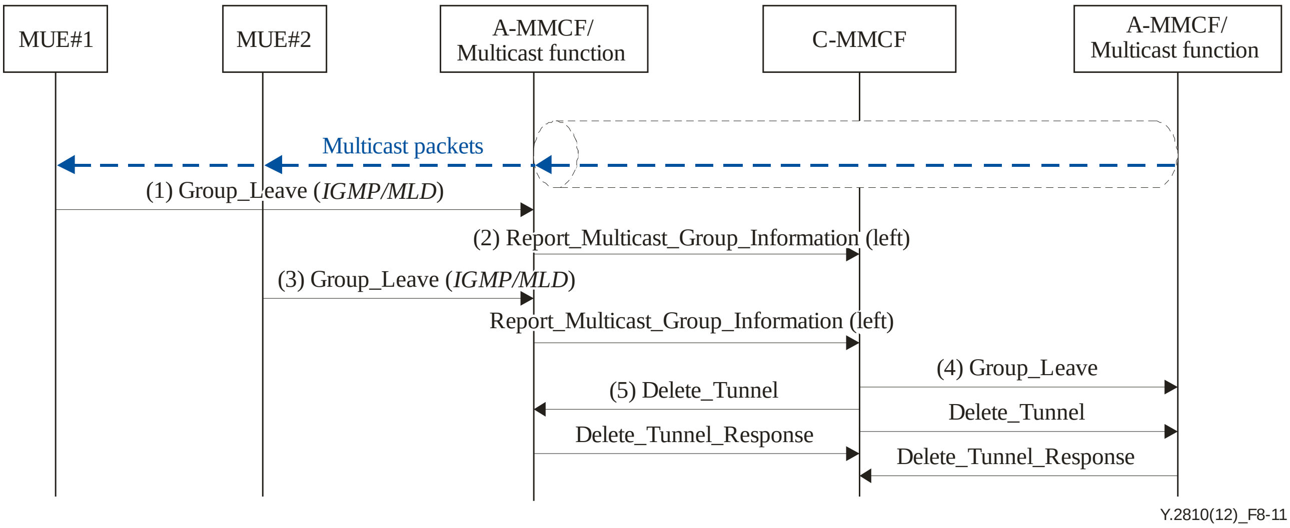

Figure 8-11 – Multicast receiver prune procedure

The interactions shown in Figure 8-11 are as follows:

1) To leave a multicast group, MUE#1 sends a Group_Leave message by using the multicast group membership protocol such as IGMP/MLD;
2) Upon receiving this message, the multicast function (administering MUE#1) sends the left multicast group information of MUE#1 to A-MMCF. The multicast group information includes an IP address of the multicast group and an IP address of MUE. The MGMF of A-MMCF deletes the left multicast group information of MUE#1 and sends it to C-MMCF. When C-MMCF receives this message from A-MMCF, it also deletes the left multicast group information and checks whether or not there is any MUE receiving the multicast service in the same subnet. If there is MUE left in the multicast group, C-MMCF maintains the established tunnel for the multicast stream;
3) When MUE#2 leaves the multicast group, the left multicast group information is delivered to C-MMCF via A-MMCF;

4) C-MMCF deletes the left multicast group information of MUE#2 and sends a Group_Leave message to the correspondent A-MMCF to inform it that there is no MUE left in the multicast group;

5) Finally, C-MMCF sends Delete_Tunnel messages to A-MMCFs to release the tunnel if it is no longer used between the multicast functions of A-MMCFs.

8.2.2 Multicast sender mobility

8.2.2.1 Multicast source registration procedure

Figure 8-12 describes the information flow for handling multicast source registration procedures for the unified transport model.

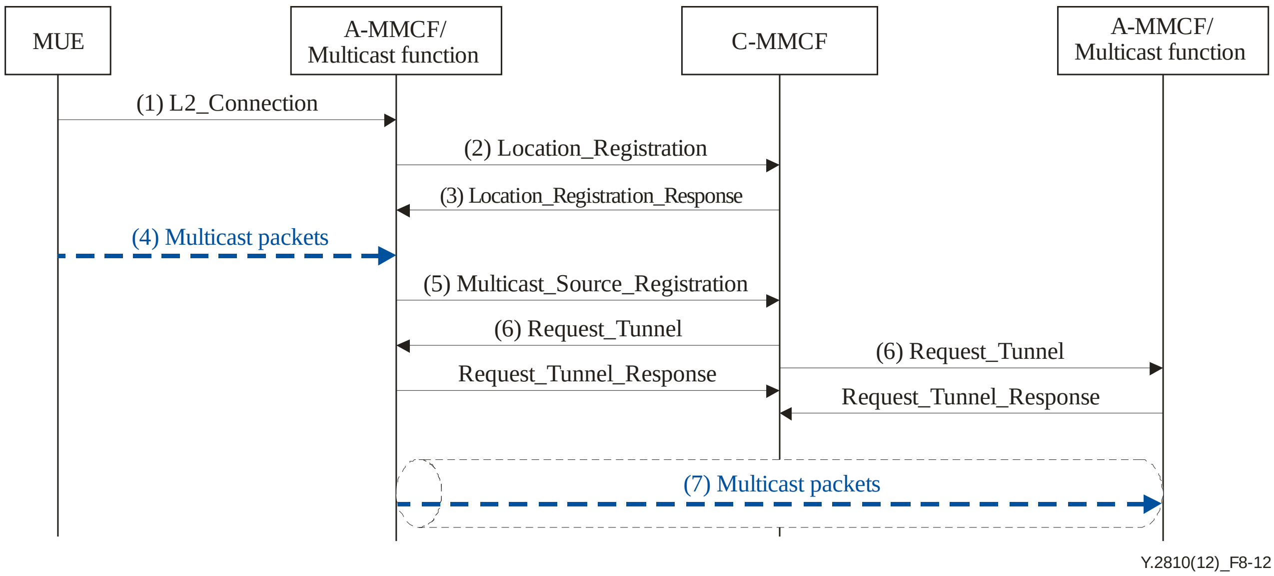

Figure 8-12 – Multicast source registration procedure

The interactions shown in Figure 8-12 are as follows:

1) MUE establishes a new connection to the new A-MMCF with L2 association;

2) A-MMCF sends a Location_Registration message to C-MMCF to request the location registration of MUE;

3) C-MMCF sends a Location_Registration_Response message to MUE in response to the Location_Registration message;

4) MUE sends multicast packets to NGN;

5) A-MMCF detects the multicast packets and sends a Multicast_Source_Registration message including multicast source information. Upon receiving this message, C-MMCF stores the multicast source information, which will be used when MUE moves to another network;

6) C-MMCF sends Request_Tunnel messages to establish a tunnel to A-MMCF and the multicast function;

7) A-MMCF sends the multicast packets through the created tunnel.

8.2.2.2 Multicast source handover procedure

Figure 8-13 describes the information flow for handling multicast source handover procedures for the unified transport model.

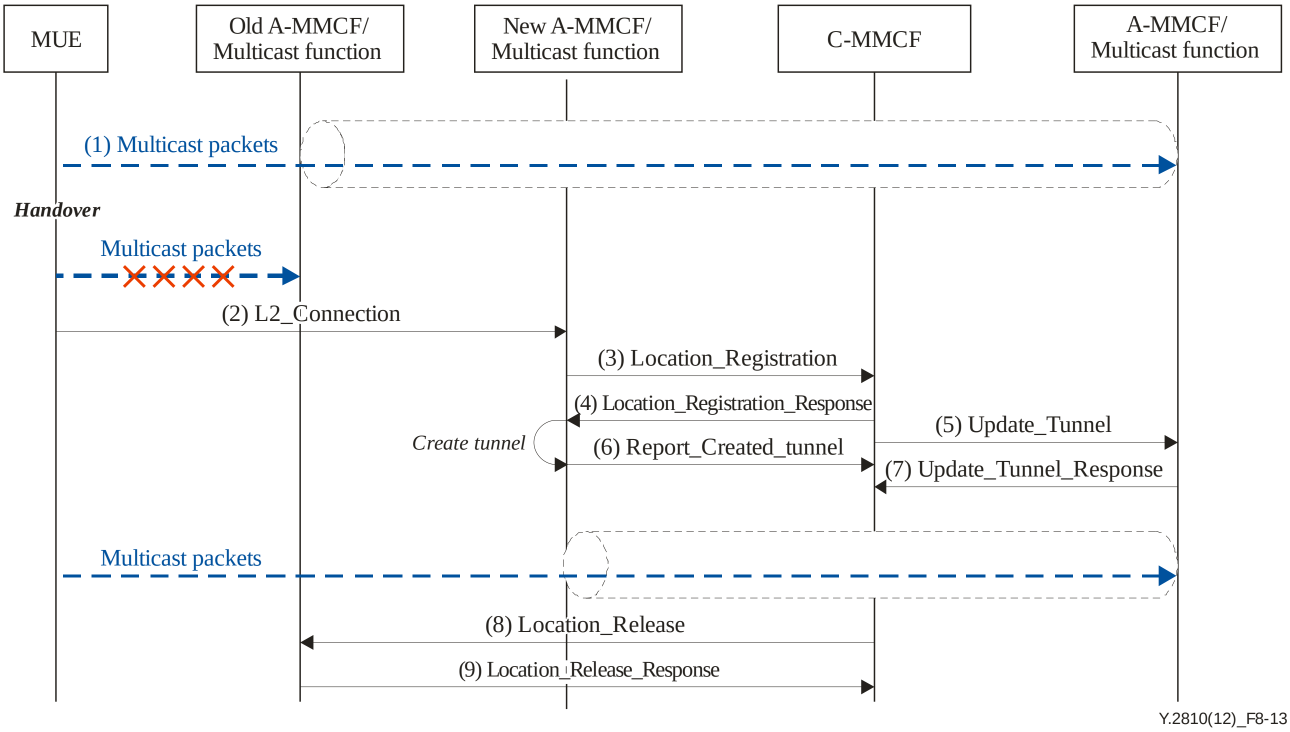

Figure 8-13 – Multicast source handover procedure

The interactions shown in Figure 8-13 are as follows:

1) MUE is transmitting multicast packets to an NGN;

2) When MUE moves to another network, MUE establishes L2_connection to the new A-MMCF;

3) The new A-MMCF sends a Location_Registration message to C-MMCF to request the location registration of MUE;

4) C-MMCF checks the information of MUE and recognizes that MUE is a multicast source, and that the multicast group has a receiver. Thus, C-MMCF sends a Location_Registration_Response message including the multicast source information to the new A-MMCF;

5) Likewise, C-MMCF sends a Update_Tunnel message including the multicast source information to the multicast function;

6) Upon receiving the Location_Registration_Response message, the new A-MMCF establishes a tunnel to the multicast function and sends the multicast packets through the created tunnel. After that, the new A-MMCF reports it to C-MMCF by sending a Report_Created_Tunnel message;

7) Meanwhile, the multicast function establishes a tunnel to the new A-MMCF and sends a Update_Tunnel_Response message to C-MMCF;

8) C-MMCF sends a Location_Release message to the old A-MMCF for the location release of MUE. Upon receiving this message including the multicast source information of MUE, the old A-MMCF deletes the tunnel used for the multicast packet transmission of MUE;

9) The old A-MMCF sends a Location_Release_Response message to C-MMCF in response to the Location_Release message.

NOTE – The multicast receiver joining procedures in the multicast source mobility situation based on the unified transport model is the same as the multicast group joining procedures in clause 8.2.1.1 because the A-MMCF/MRouter plays a role for Rendezvous Point.

8.2.2.3 Multicast source prune procedure

Figure 8-14 describes the information flow for handling multicast source prune procedures for the unified transport model.

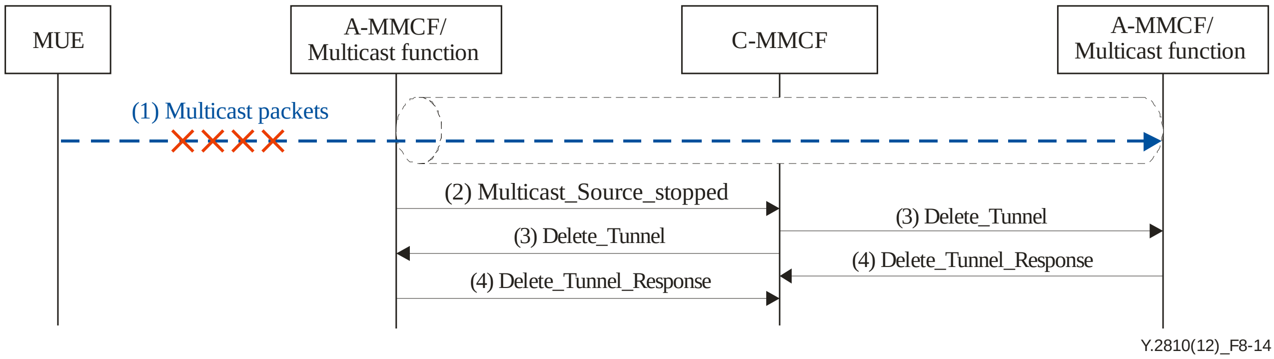

Figure 8-14 – Multicast source prune procedure

The interactions shown in Figure 8-14 are as follows:

1) MUE stops to send multicast packets to NGN;

2) A-MMCF detects that MUE stops to send multicast packets and reports it to C-MMCF by sending a Multicast_Source_Stopped message;

3) Upon receiving this message, C-MMCF sends Delete_Tunnel messages to both A-MMCFs;

4) When the multicast function receives this message, it checks whether there is a tunnel for MUE. If there is, the multicast function deletes the tunnel and sends a Delete_Tunnel_Response message to C-MMCF for the result. The A-MMCF also checks whether there is a tunnel for MUE. If there is, A-MMCF deletes the tunnel and sends a Delete_Tunnel_Response message to C-MMCF.

9 Security considerations

This Recommendation requires no specific security considerations and aligns with the security requirements in [ITU-T Y.2701].

Appendix I

Example of transport stratum for the separated transport model

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

This appendix describes an example of mobile multicast capable transport functions in the transport stratum for the separated transport model.

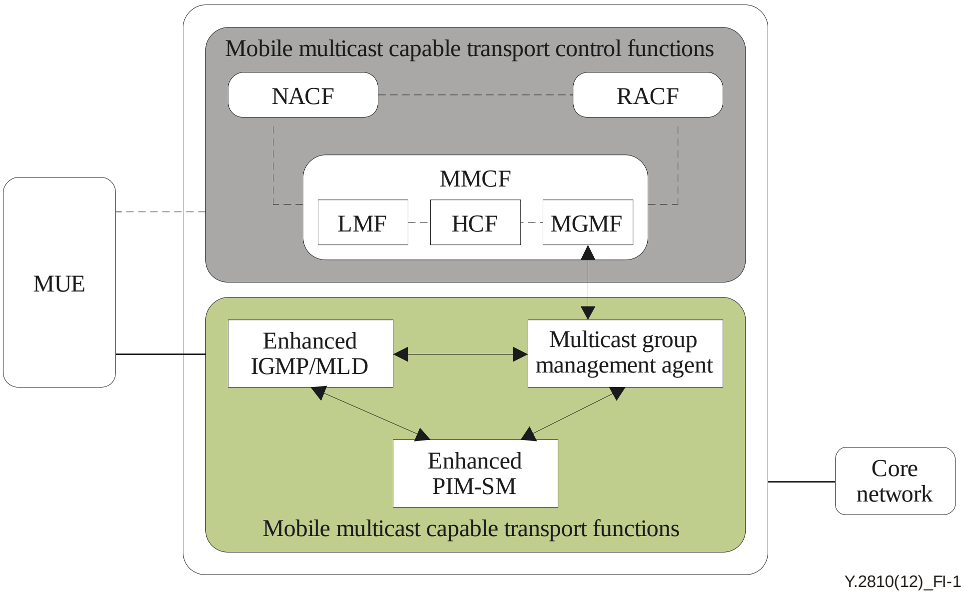

Figure I.1 – Example of mobile multicast capable transport functions architecture

Figure I.1 describes an example of mobile multicast capable transport functions architecture. Mobile multicast capable transport functions include enhanced IGMP/MLD block, enhanced PIM-SM block, and multicast group management agent (MGMA) with the following characteristics:

- Enhanced IGMP/MLD

  The following new functions are added to the existing IGMP/MLD function:

  – To report the joined/left multicast group information to MGMA when MUE joins/leaves a multicast group

  – To update the multicast group table at MGMA's request and to request the enhanced PIM-SM block to join/leave the multicast group

- Enhanced PIM-SM

  The following new functions are added to the existing PIM-SM function:

  – To report multicast source information to MGMA when MUE sends multicast traffic to a network

  – To update the multicast routing table at MGMA's request and to create/delete the tunnel used for multicast source traffic transmission

  – To send multicast source traffic using tunnel

  – To report the existence of multicast traffic receiver on Rendezvous Point to MGMA

- Multicast group management agent (MGMA)

MGMA interworks with the MGMF of MMCF, the enhanced IGMP/MLD block, and the enhanced PIM-SM block. For multicast receiver mobility, it collects MUE's joined/left multicast group information from the enhanced IGMP/MLD block and reports the information to MGMF. For multicast source mobility, it collects multicast source information from the enhanced PIM-SM block and reports the information to MGMF.

In case of multicast receiver mobility, when the MUE that interests a multicast group moves to another network, the MGMA located at the multicast router in the visited network receives MUE's multicast information from the new A-MMCF. According to the multicast information, MGMA requests re-joining the multicast group to the enhanced IGMP/MLD block. Furthermore, after MUE's handover, the old A-MMCF reports MUE's absence to MGMA, which then requests pruning the multicast group to the enhanced IGMP/MLD.

In case of multicast source mobility, when MUE sends multicast packets to a network, the enhanced PIM-SM block reports the multicast source information to MGMA, which then reports it to A-MMCF. Multicast source information includes the IP address of the multicast group, IP address of the source and IP address of Rendezvous Point. After that, if a multicast receiver joins the multicast group, then the enhanced PIM-SM as the role of Rendezvous Point reports to MGMA that there is a receiver for the multicast group. MGMA then reports it to C-MMCF. When MUE performs handover, the new A-MMCF requests the location registration of MUE to C-MMCF, which then checks MUE's information. As a result, C-MMCF knows that MUE is a multicast source, and that there is a multicast receiver that interests the multicast group. Thus, C-MMCF requests the creation of a tunnel between the new A-MMCF and Rendezvous Point that has been serving the multicast group. After creating the tunnel, the multicast function of the new A-MMCF sends multicast source traffic to Rendezvous Point using the tunnel.

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