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

Next Generation Networks – Generalized mobility

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# Framework of mobility management in the service stratum for next generation networks

Recommendation ITU-T Y.2809

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# Recommendation ITU-T Y.2809

## Framework of mobility management in the service stratum for next generation networks


**Summary**

Recommendation ITU-T Y.2809 describes the framework of mobility management (MM) in the service stratum for next generation networks (NGNs). This Recommendation identifies the functional architecture of MM in the NGN service stratum, and specifies the procedural information flows for location management and handover control based on the IP multimedia subsystem (IMS).



**History**

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**Keywords**

Framework, mobility management, NGN, service stratum.

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## Introduction

This Recommendation describes the framework of mobility management (MM) in the service stratum for NGNs. This work has been motivated by the observation that MM is an essential functionality to provide seamless mobility for NGN users and services. This Recommendation is a part of the MM framework for NGNs. Based on the generic framework of [ITU-T Q.1707], the two Recommendations [ITU-T Q.1708] and [ITU-T Q.1709] have addressed the MM schemes in the NGN transport stratum, whereas this Recommendation deals with the MM schemes in the NGN service stratum.

# Recommendation ITU-T Y.2809

## Framework of mobility management in the service stratum for next generation networks

## 1 Scope

This Recommendation describes the framework of mobility management (MM) in the service stratum for next generation networks (NGNs). This Recommendation addresses the issues on terminal mobility based on the IP multimedia subsystem (IMS). This Recommendation first identifies the functional architecture of MM in the NGN service stratum, and then specifies the procedural information flows for location management and handover control based on the identified functional architecture.

## 2 References

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


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

[ITU-T Q.1708] Recommendation ITU-T Q.1708/Y.2805 (2008), *Framework of location management for NGN*.

[ITU-T Q.1709] Recommendation ITU-T Q.1709/Y.2806 (2008), *Framework of handover control for NGN*.

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

[ITU-T Y.2091] Recommendation ITU-T Y.2091 (2007), *Terms and definitions for next generation networks*.

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


## 3 Definitions

This Recommendation uses the terms and definitions given in [ITU-T Y.2012], [ITU-T Y.2091], [ITU-T Q.1707], [ITU-T Q.1708], and [ITU-T Q.1709].

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ABG-FE Access Border Gateway Functional Entity

A-MMCF Access Mobility Management Control Function

BGF Border Gateway Function

CN Correspondent Node

| | |
|---|---|
| CSC-FE | Call Session Control Functional Entity |
| EN-FE | Edge Node Functional Entity |
| FE | Functional Entity |
| GGSN | GPRS Gateway Supporting Node |
| HC | Handover Control |
| HC-FE | Handover Control Functional Entity |
| HSS | Home Subscriber Subsystem |
| IBG-FE | Interconnection Border Gateway Functional Entity |
| I-CSC-FE | Interrogating Call Session Control Functional Entity |
| IMS | Internet Protocol Multimedia Subsystem |
| IP | Internet Protocol |
| LM | Location Management |
| MIH | Media Independent Handover |
| MM | Mobility Management |
| MMCF | Mobility Management Control Function |
| MN | Mobile Node |
| NGN | Next Generation Network |
| P-CSC-FE | Proxy Call Session Control Functional Entity |
| RACF | Resource Admission Control Function |
| SAA-FE | Service Authentication Authorization Functional Entity |
| SCF | Service Control Function |
| S-CSC-FE | Serving Call Session Control Functional Entity |
| SDP | Session Description Protocol |
| S-HC-FE | Handover Control Functional Entity in the Service Stratum |
| SIP | Session Initiation Protocol |
| SUP-FE | Service User Profile Functional Entity |
| UE | User Equipment |

# 5 Conventions

None.

# 6 Design considerations

This Recommendation considers mobility management (MM) in the service stratum of NGNs. In the network, a user or a user equipment (UE) may change its IP address by movement and thus the user may experience service disruption and session discontinuity. This Recommendation deals with the MM schemes or protocols that can be used to provide seamless services and session continuity against the movement of users. To provide seamless mobility, the link-layer information on the concerned access links might be used in the MM schemes, as shown in the IEEE 802.21 media independent handover (MIH). In this fashion, the so-called cross-layer optimization tasks may need to be taken to provide seamless mobility. However, the details of a specific link-layer technology are outside the scope of this Recommendation.

It is noted that the IP multimedia subsystem (IMS) platform can typically be used to support a variety of multimedia services. [b-ITU-T F.700] gives a generic model of multimedia service architecture. Multimedia services are built up by combining 'communication tasks' and organizing their interaction. A communication task is considered as a functional entity of a multimedia service, which performs its communication features. Each communication task handles a set of media components in a synchronized way, in order to convey and control information types such as audio or video. Media components are individual (mono-media) components, which handle functions related to each independent medium such as capture, coding and presentation. With regard to communication tasks, [b-ITU-T F.700] mentions 'conversing', 'conferencing', 'distributing', 'sending', 'receiving' and 'collecting'. It shall be noted that this list of communication tasks can be extended by new tasks or by the refinement of given tasks. Audio, video, text, graphics and data are identified on the level of media components.

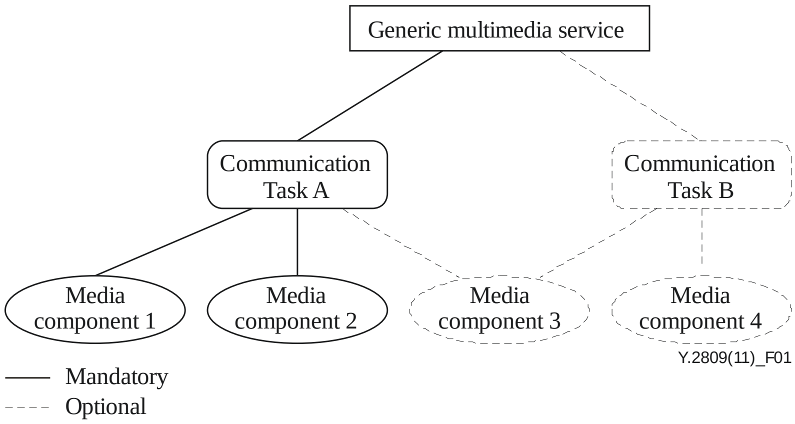


**Figure 1 – Reference model of generic multimedia services [b-ITU-T F.700]**

Figure 1 shows the relationship among multimedia services, communication tasks and media components. Communication tasks and media components will form the basic set of a specific multimedia service. For example, by the used media components, the multimedia conversational services can be further divided into:

- videophone service, with audio and moving pictures and optionally various types of data;
- voice and data services, with audio and various types of data;
- text telephony, with real time text, optionally combined with audio;
- total conversation service, with moving pictures, real time text and audio.

In general, the MM schemes for mobility support in NGNs can be classified into the network layer MM (in the transport stratum) and the application layer MM (in the service stratum). The MM issues in the network layer or in the transport stratum are addressed in [ITU-T Q.1708] and [ITU-T Q.1709]. This Recommendation focuses on the MM issues in the application layer or in the service stratum. In the application layer, the IP multimedia subsystem (IMS) platform will be considered and enhanced to provide seamless mobility.

This Recommendation describes the framework of MM in the NGN service stratum. For this purpose, the MM functional architecture based on the IMS platform is discussed, and the service control function (SCF) of the IMS will be investigated and further enhanced to support seamless mobility. Based on the functional architecture, the procedural information flows will be described for location management and handover control.

## 7 Functional architecture for MM in the service stratum

### 7.1 Generic architectural model

The generic architectural model for MM in the service stratum is described in Figure 2, in which the MM functionality is provided via collaborative interactions between the functional entities (FEs) in the SCF and transport function (TF).

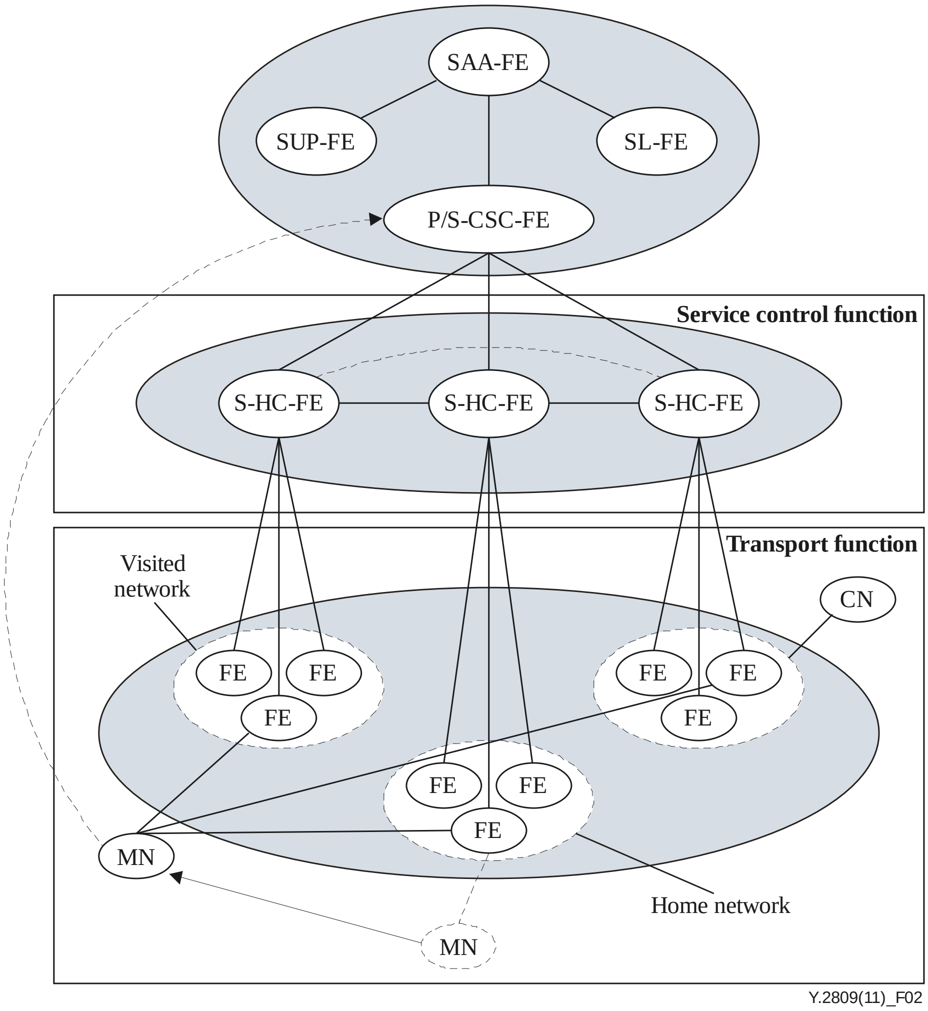


**Figure 2 – Generic architecture of mobility management (MM) in the service stratum**

The SCF may comprise the following components, which are described in the NGN architecture [ITU-T Y.2012]:

- call session control functional entity (CSC-FE);
- service authentication authorization functional entity (SAA-FE);
- service user profile functional entity (SUP-FE);
- subscription locator functional entity (SL-FE).

In addition, the handover control FE in the service stratum (S-HC-FE) is defined to support the handover of users in the service stratum. Such S-HC-FEs in the service stratum may be differently defined and implemented from the HC-FEs in the transport control function, which were described in [ITU-T Q.1708] and [ITU-T Q.1709].

In the service stratum, the MM functions are divided into the location management (LM) functionality and the handover control (HC) functionality. The CSC-FEs are used to provide the LM functionality (e.g., for location registration and/or update and location query from the UE or the network agent on behalf of the UE). On the other hand, the HC-FEs are defined and used to provide the seamless mobility for NGN users. For handover control, the HC-FEs may exchange the control messages with the FEs in the transport stratum, which may be used for management of handover tunnels or for optimization of data paths during handover.

In the transport stratum, some of the FEs may need to provide the handover enforcement at the network entities. Typical operations for handover control include the encapsulation, de-capsulation and forwarding of data packets based on the bearer path under the control of HC-FEs. It is noted that such HC-FEs may be instantiated by some of the NGN transport FEs, such as the edge node FE (EN-FE), access border gateway FE (ABG-FE) and interconnection border gateway FE (IBG-FE), which are described in the NGN architecture [ITU-T Y.2012].

In the MM model, a user moves from the home network to a visited network, which may belong to a different NGN provider (administration domain). The detailed MM scenarios will be described in the following clauses.

## 7.2 MM functional entities in the service control function

The FEs in the service control function in the IMS-based NGN can be used for MM, as described in Figure 3.

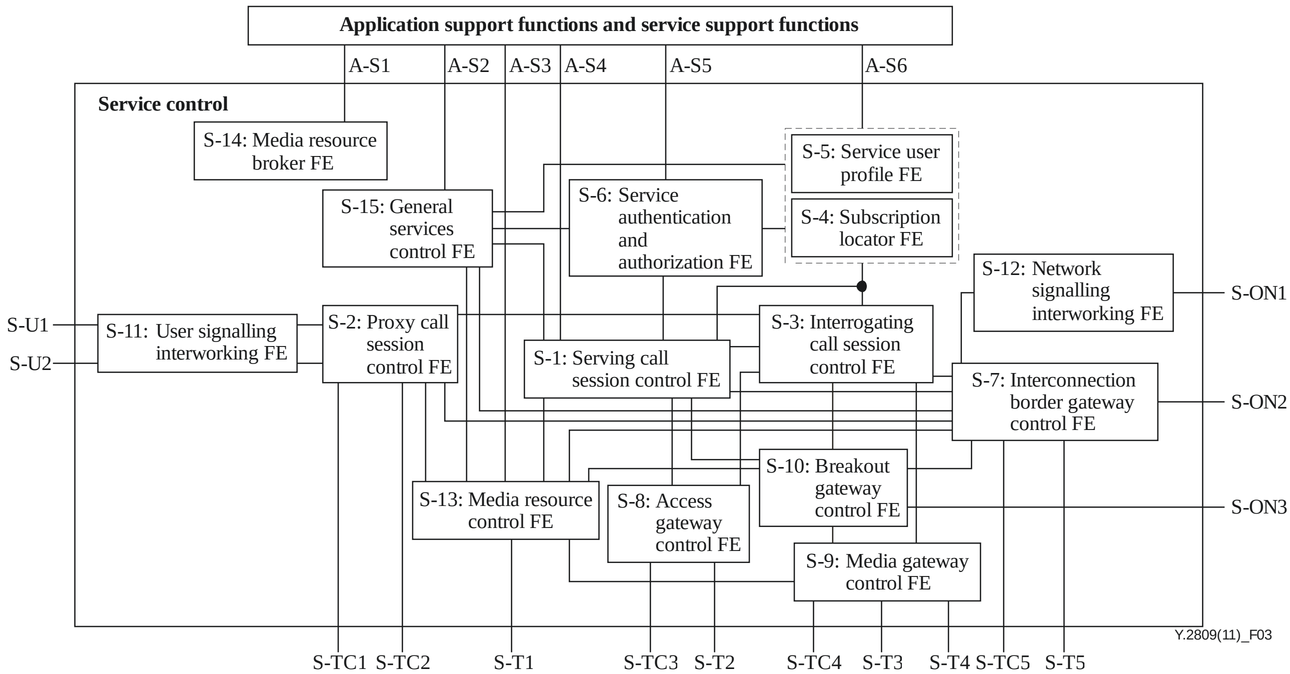


**Figure 3 – MM functional entities in an IMS-based NGN [Y.2012]**

The FEs in Figure 3, which are associated with MM, are described below.

### 7.2.1 S-CSC-FE (S-1)

The serving call session control FE (S-CSC-FE) handles the functionality related to session control, such as registration, session set-up/modification/teardown, and routing of session messages. In particular, the S-CSC-FE performs the registration functions for location management.

It can determine that a particular user and/or terminal identifier is currently in service and can interact with the SUP-FE (possibly via the SL-FE) to obtain the relevant service profile and address information which will act as an input to the service triggering and routing functions of the S-CSC-FE.

### 7.2.2 P-CSC-FE (S-2)

The proxy call session control FE (P-CSC-FE) acts as the contact point to a user for session-based services. Its IP address is discovered by the user's terminal using an address configuration mechanism such as static provisioning or dynamic address configuration in the NACF.

P-CSC-FE shall have the capability to forward the registration request from a user to an appropriate I-CSC-FE. The P-CSC-FE shall have the capability to forward the registration request messages received from the terminal to the S-CSC-FE.

### 7.2.3 I-CSC-FE (S-3)

The interrogating call session control FE (I-CSC-FE) is the contact point within an operator's network for all service connections destined to a user of that network operator. In the LM perspective, the I-CSC-FE performs the registration process by assigning an S-CSC-FE to a user.

### 7.2.4 Subscription locator FE (S-4)

The subscription locator FE (SL-FE) may be queried by the S-CSC-FE, I-CSC-FE, or application support FE, to obtain the address of the SUP-FE for the required subscriber. The SL-FE is used to find the address of the physical entity that keeps the subscriber's information for a given user identifier.

### 7.2.5 Service user profile FE (S-5)

The service user profile FE (SUP-FE) is responsible for storing user profiles, subscriber-related location information, and presence information, in the service stratum.

### 7.2.6 Service AA-FE (S-6)

The service authentication and authorization FE (SAA-FE) provides the authentication and authorization in the service stratum. The SAA-FE will perform the first step for the MM process via authentication, authorization, and accounting of users/terminals.

## 7.3 Mappings between IMS functions and MM control functions

It is noted that some of the IMS FEs could be used only for the LM functionality in the service stratum, without supporting the handover control. Some of the example usage or mapping scenarios between IMS functions and MM control functions (MMCF), defined in [ITU-T Q.1707] (MM framework), are described as follows:

- Use of P-CSCF as A-MMCF (or A-LMF) in the service stratum:

  P-CSCF is the first contact point in the IMS, so it could be used for A-MMCF in the service stratum which is defined in [ITU-T Q.1707]. Note that A-MMCF should support MM2 (Inter-AN MM) and MM3 (Intra-AN MM), but the conventional P-CSCF supports only the call-forwarding function. Therefore, in this case, a new function to support mobility management including MM2 and MM3 should be added to the conventional P-CSCF.

- Use of S-CSCF/HSS as C-MMCF in the service stratum:

  S-CSCF is likely to be located in the core network, which is responsible for accepting the registration request. Also, it makes the registration information available through the location server (i.e., HSS). Therefore S-CSCF could be mapped into C-MMCF in the service stratum along with HSS, which provides location information. Even though S-CSCF provides basic functions for mobility management, it may not be sufficient to support the full functions of C-MMCF in terms of MM types: MM1 (inter-CN MM), MM2, and MM3, described in [ITU-T Q.1707]. Therefore, in this case, some functions to support mobility management including MM2 and MM3 should be added to conventional P-CSCF, or should cooperate with other functions (or functional entities) in the transport/service stratum.

- Use of I-CSCF:

  I-CSCF is used only for the assignment of S-CSCF in IMS and does not maintain any information related to registration. Therefore, it does not seem to have a direct relationship with MMCF in the service stratum. However, the I-CSCF may be used for MM1 using its interworking supporting function.

## 8 Information flows for IMS-based location management

### 8.1 Location registration and location re-registration

The IMS-based location registration and update (re-registration) procedures are described in Figure 4.

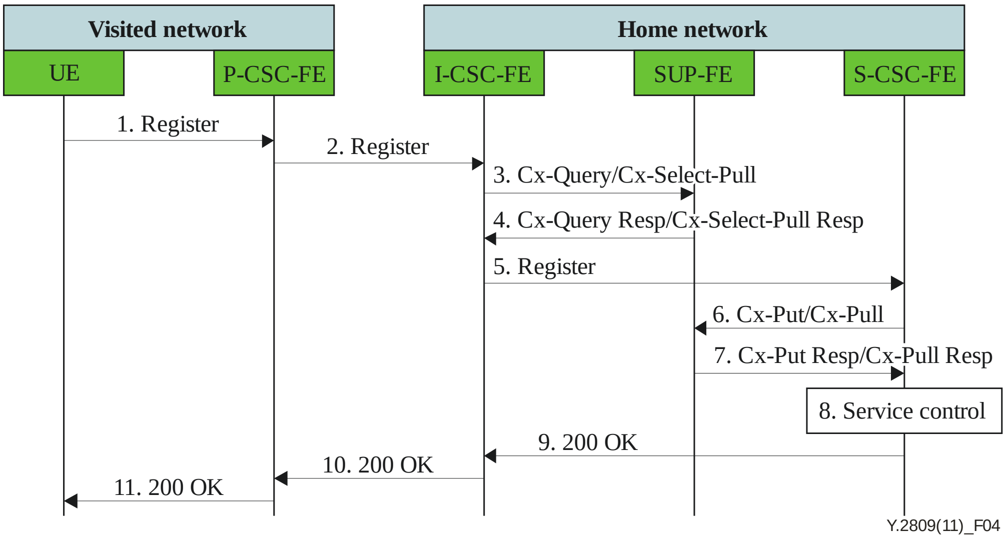


**Figure 4 – Location registration and location re-registration**

1) After the UE has obtained its IP connectivity, it can perform the IMS registration. To do so, the UE sends the register information to the P-CSC-FE.

2) Upon receipt of this register information, the P-CSC-FE shall examine the "home domain name" to discover the entry point to the home network (i.e., I-CSC-FE). The proxy shall send to the I-CSC-FE the register information, which includes the P-CSC-FE address/name, the public user identity, the private user identity, the P-CSC-FE network identifier and the UE IP address. A name-address resolution mechanism is utilized in order to determine the address of the home network from the home domain name. Note that the P-CSC-FE network identifier is a string that identifies the network where the P-CSC-FE is located (e.g., the P-CSC-FE network identifier may be the domain name of the P-CSC-FE network).

3) The I-CSC-FE shall send the Cx-Query/Cx-Select-Pull information to the SUP-FE, which may include the public user identity, the private user identity, and the P-CSC-FE network identifier. The SUP-FE shall then check whether the user is already registered. The SUP-FE shall indicate whether the user is allowed to register in that P-CSC-FE network (identified by the P-CSC-FE network identifier) according to the user subscription and operator limitations/restrictions, if any.

4) The Cx-Query Resp/Cx-Select-Pull Resp information is sent from the SUP-FE to the I-CSC-FE. It shall contain the S-CSC-FE name. When capabilities are returned, the I-CSC-FE may perform the new S-CSC-FE selection function. If the checking in SUP-FE was not successful, the Cx-Query Resp shall reject the registration attempt.

5) The I-CSC-FE, using the name of the S-CSC-FE, shall determine the address of the S-CSC-FE through a name-address resolution mechanism. The I-CSC-FE also determines the name of a suitable home network, possibly based on information received from the SUP-FE. The I-CSC-FE shall then send the register information (e.g., P-CSC-FE address/name, public user identity, private user identity, P-CSC-FE network identifier, and UE IP address to the selected S-CSC-FE). Then, the S-CSC-FE shall store the P-CSC-FE address/name, as supplied by the visited network. This represents the address/name that the home network forwards to the subsequent terminating session signalling to the UE. The S-CSC-FE shall store the P-CSC-FE network ID information.

6) The S-CSC-FE shall send Cx-Put/Cx-Pull (public user identity, private user identity, and S-CSC-FE name) to the SUP-FE.

7) The SUP-FE shall store the S-CSC-FE name for the user, and return the Cx-Put Resp/Cx-Pull Resp information to the S-CSC-FE. The information that was passed from the SUP-FE to the S-CSC-FE shall include one or more names/addresses, which can be used to access the platform(s) used for service control while the user is registered at this S-CSC-FE. The S-CSC-FE shall store the information for the indicated user.

8) Based on an appropriate filtering criterion, the S-CSC-FE shall send the register information to the service control platform and perform the service control procedures.

9) The S-CSC-FE shall return the 200 OK information (e.g., home-network contact information, and GRUU set) to the I-CSC-FE.

10) The I-CSC-FE shall send the 200 OK (home-network contact information, and GRUU set) information to the P-CSC-FE. Then, the I-CSC-FE shall release all registration information.

11) The P-CSC-FE shall store the home-network contact information, and shall send the 200 OK information to the UE.

## 8.2 Location query

The IMS-based location query procedures with the call set-up signalling operations are described in Figure 5.

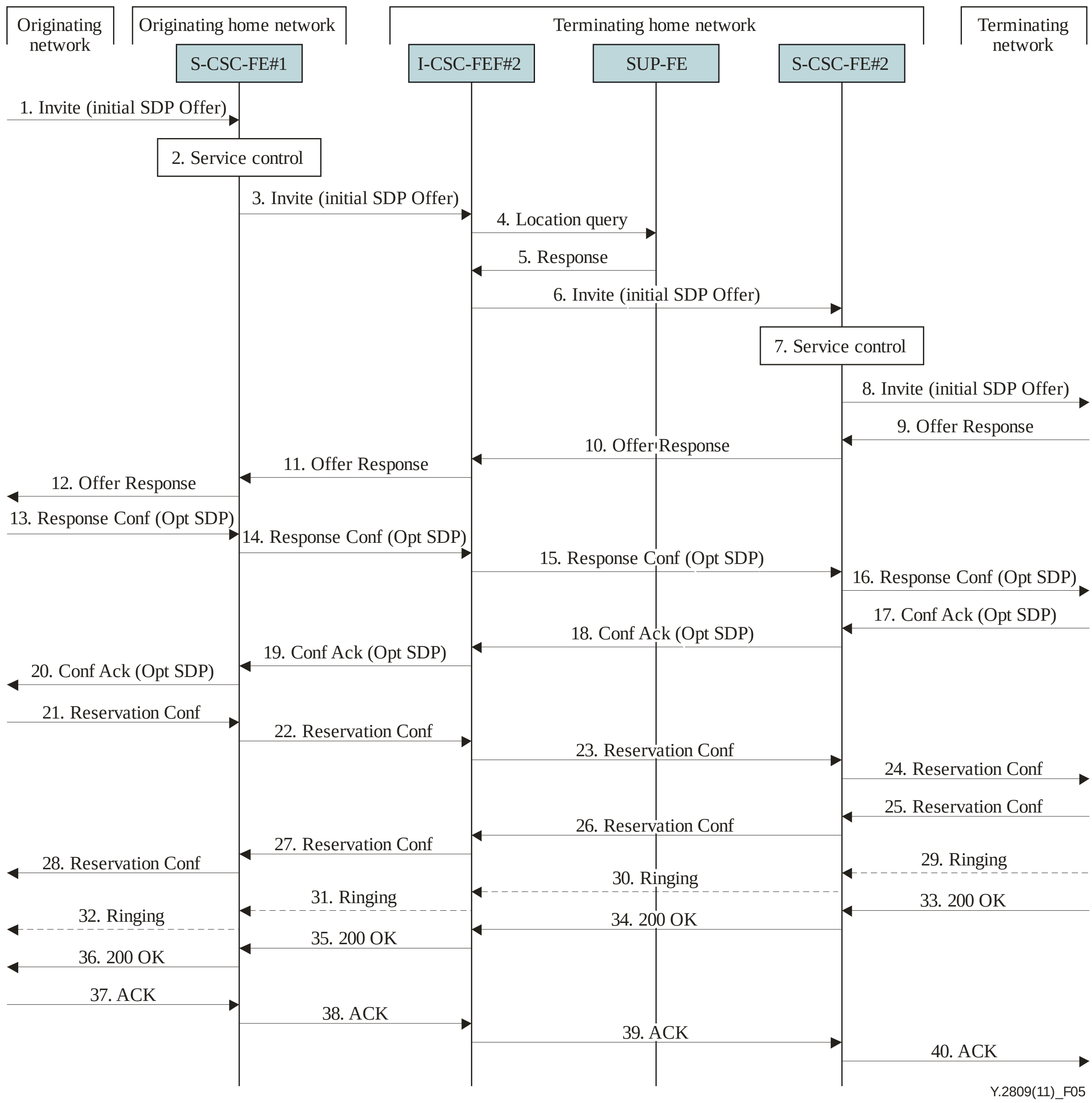


**Figure 5 – Location query with session set-up signalling**

1) The IMS INVITE request is sent from the UE to S-CSC-FE#1. This message should contain the initial media description in the session description protocol (SDP) offer.

2) S-CSC-FE#1 invokes the service logic that is appropriate for this session set-up attempt.

3) S-CSC-FE#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. Since it is local, the request is passed to a local I-CSC-FE.

4) I-CSC-FE shall query the SUP-FE for current location information.

5) SUP-FE responds with the address of the current S-CSC-FE for the terminating user.

6) I-CSC-FE forwards the INVITE request to the S-CSC-FE (S-CSC-FE#2) that will handle the session termination.

7) S-CSC-FE#2 invokes the service logic that is appropriate for this session set-up attempt.

8) The sequence continues with the message flows determined by the termination procedure.

9-12) The terminating end point responds with an answer to the offered SDP and this message is passed along the established session path.

13-16) The originator decides on the offered set of media streams, confirms receipt of the Offer Response with a Response Confirmation, and forwards this information to S-CSC-FE#1 by the origination procedures. This message is forwarded via the established session path to the terminating end point. The Response Confirmation may also contain SDP. This may be the same SDP as in the Offer Response received in Step 12 or a subset.

17-20) Terminating end point responds to the offered SDP and the response, if forwarded to the originating end point via the established session path.

21-24) Originating end point sends successful resource reservation information towards the terminating end point via the established session path.

25-28) Terminating end point sends successful resource reservation acknowledgement towards the originating end point via the established session path.

29-32) Terminating end point sends a ringing message toward the originating end point via the established session path.

33-36) The SIP final response, 200-OK, is sent by the terminating endpoint over the signalling path. This is typically generated when the user has accepted the incoming session set-up attempt. The message is sent to S-CSC-FE#2 per the termination procedure.

37-40) The originating endpoint sends the final acknowledgement to S-CSC-FE#1 by the origination procedures, and it is then sent over the signalling path to the terminating end point.

# 9 Information flows for IMS-based handover control

## 9.1 Handover by interaction between P-CSCF and S-CSCF

As shown in Figure 6, in this handover control scheme, the UE is originating a voice call with the correspondent UE in the home network. When the UE is attached to the new visited network, it performs the location re-registration with the S-CSC-FE through a new P-CSC-FE in the visited network. The new P-CSC-FE and the S-CSC-FE will notify the new border gateway function (BGF) in the visited network and the BGF in the home network to install the new tunnel entry points through the new HC-FE in the visited network and the C-HC-FE, respectively. After that, the S-CSC-FE will interact with the old P-CSC-FE to notify the old BGF to release the tunnel resource through the A-HC-FE in the visited network and the C-HC-FE in the home network.

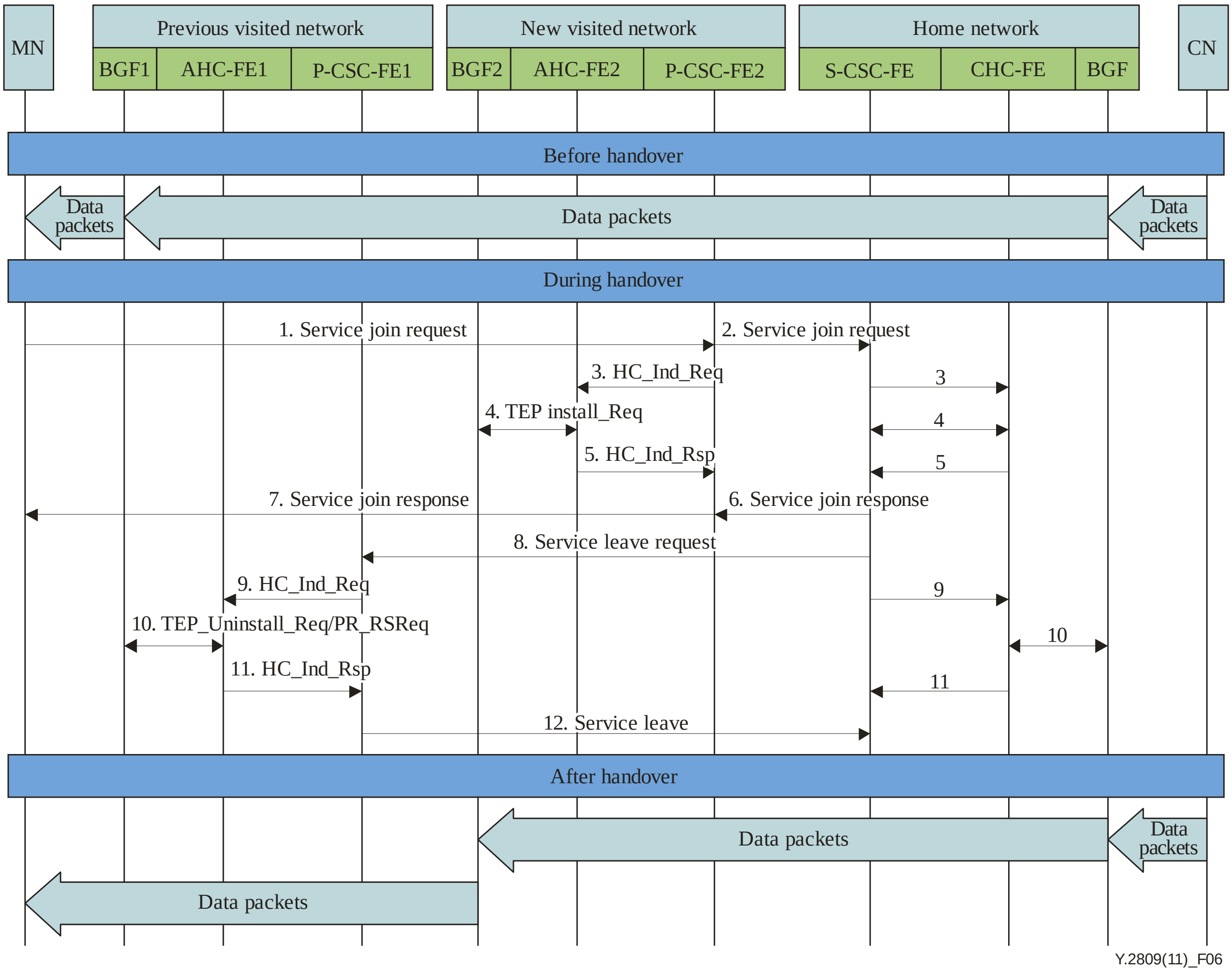


**Figure 6 – IMS-based handover using P-CSC-FE and S-CSC-FE**

The detailed signalling flows are described as follows:

a) Before handover

Before handover, the data packets from the correspondent node (CN) will be intercepted by the BGF in the home network and then encapsulated and tunnelled to the BGF in the previous visited network.

b) During handover

When the mobile node (MN) moves to the new visited network, it acquires a new address prior to receiving the data packet from the CN and performs the location re-registration (i.e., join service) with the S-CSC-FE in the home network via the P-CSC-FE in the new visited network (steps 1 and 2). Upon the request to join service from the MN, the proxy registrar and the home registrar will send a handover indication request so as to trigger the AHC-FE in the new visited network and the CHC-FE in the home network to perform the tunnel entry point installation on the BGF in the new visited network (steps 3 to 7). When a new tunnel is set up between the new BGF in the visited network and the BGF in the home network, the S-CSC-FE will interact with the old P-CSC-FE to make the old AHC-FE and the CHC-FE release the tunnel resource in the old BGF and in the BGF in the home network (steps 8 to 12).

c) After handover

After handover, the data packet from the CN will be intercepted by the BGF in the home network and then encapsulated and tunnelled to the BGF in the new visited network.

## 9.2 Handover control by interaction between two neighbouring proxy call session control functional entities (P-CSC-FEs)

In this handover control scheme, the UE is originating a voice call with the correspondent UE in the home network when the UE is attached to the new visited network, and performs the location re-registration with the S-CSC-FE through the P-CSC-FE in the new visited network. The S-CSC-FE will notify the new P-CSC-FE about the location of the old P-CSC-FE. Here, it is assumed that the two adjacent P-CSC-FEs in the visited network are allowed to communicate with each other. Then, the new P-CSCF will interact with the old P-CSC-FE to make the AHC-FE install a tunnel entry point between the old BGF and the new BGF in the two adjacent visited networks. When a voice-call session is terminated, the S-CSC-FE will request all the P-CSC-FEs along the path, from the first visited network to the last visited network, to release the tunnel resources.

Figure 7 describes the information flows of handover control by interaction between neighbouring P-CSCFs. The detailed signalling flows are described as follows:

a) Before handover

Before handover, the data packets from the CN will be intercepted by the BGF in the home network and then tunnelled to the BGF in the previous visited network.

b) During handover

When the MN moves to the new visited network, it acquires a new address prior to receiving a data packet from the CN and performs the location re-registration (i.e., joining service) with the S-CSC-FE in the home network via the P-CSC-FE in the visited network (steps 1 and 2). Upon receiving the service request from the MN, the S-CSC-FE will notify the new P-CSC-FE about the location of the old P-CSC-FE by sending the service response message (step 3). Then, the new P-CSC-FE will interact with the old P-CSC-FE to make the new AHC-FE and the old AHC-FE install a tunnel entry point between the old BGF and the new BGF in the visited network (steps 4 to 9).

c) After handover

After handover, the data packet from the CN will first be intercepted by the BGF in the home network and tunnelled to the BGF in the previous network. When the BGF in the previous visited network receives the datagram, it will forward the data packet to the UE through the BGF in the new visited network.

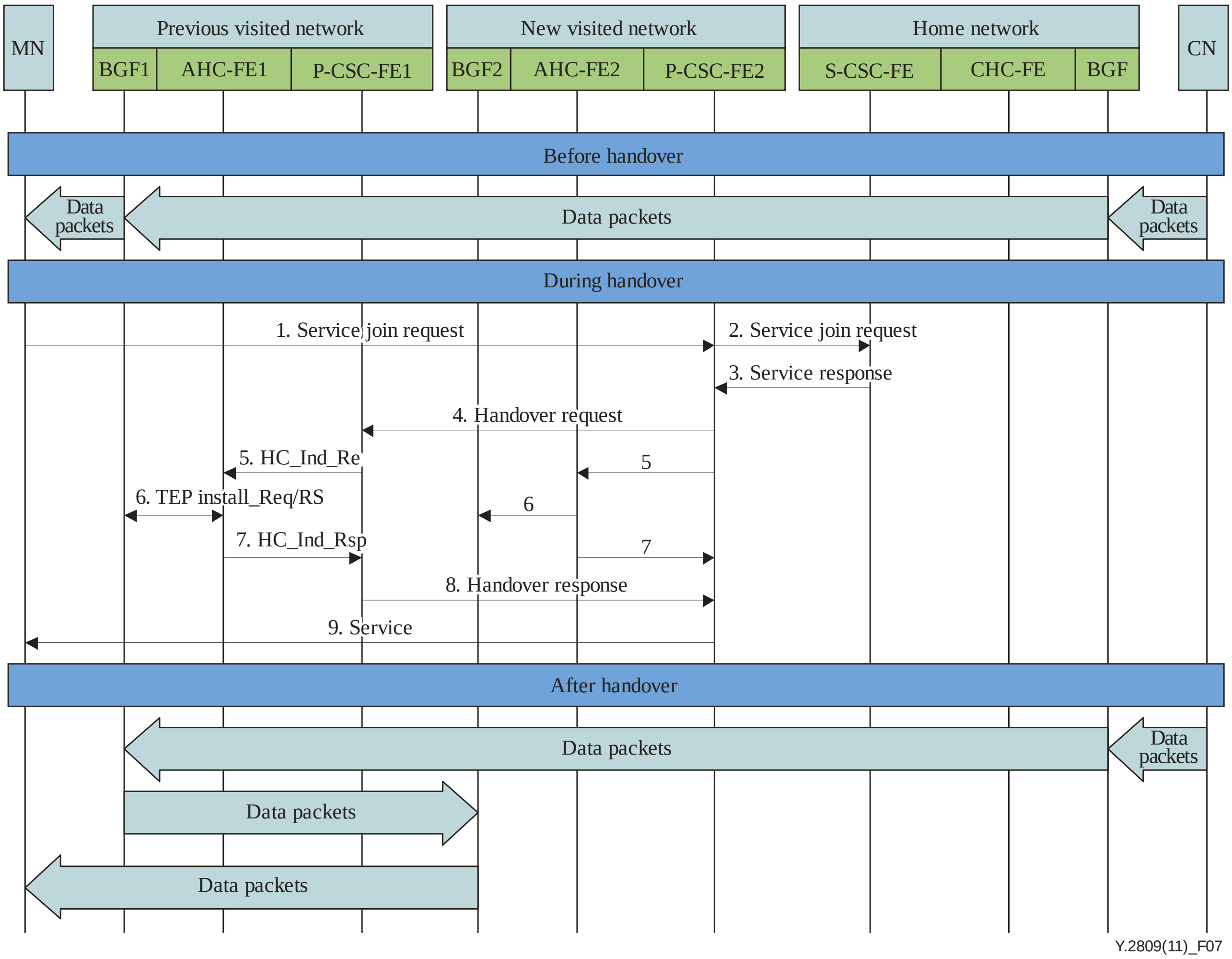


**Figure 7 – IMS-based handover using two neighbouring P-CSC-FEs**

## 10 Security considerations

This Recommendation does not require any specific security considerations and aligns with the security requirements in [ITU-T Y.2701].

# Appendix I

## Use cases of IMS-based MM with IEEE 802.21

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

This appendix provides some scenarios of IMS-based MM schemes using [b-IEEE 802.21] (MIH). Figure I.1 depicts a simplified IMS network, while Figure I.2 shows the migration of 802.21 as an application server (AS) in the context of IMS.

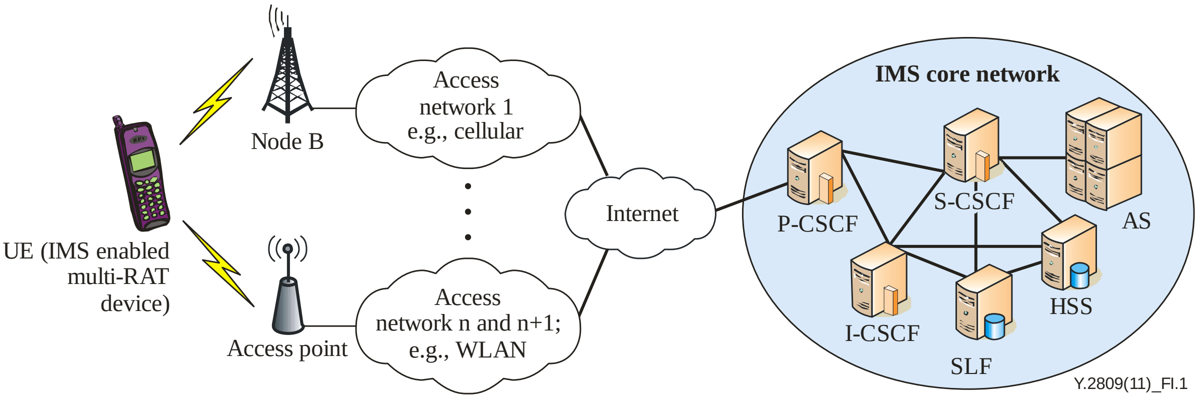


**Figure I.1 – Simplified IMS network**

The IMS network relies on high-level security, reliable QoS, and a standardized framework for easy application server (AS) service deployment.

The migration of 802.21 to an IMS platform requires that the 801.21 MIH be an IMS client application in the UE (IMS-enabled multi-RAT device) and the inclusion of 802.21 as an IMS-application server. This solution also brings the advantages of having minimal HO interruption time, and there is no user involvement in the HO process, thus providing an enhanced user experience.

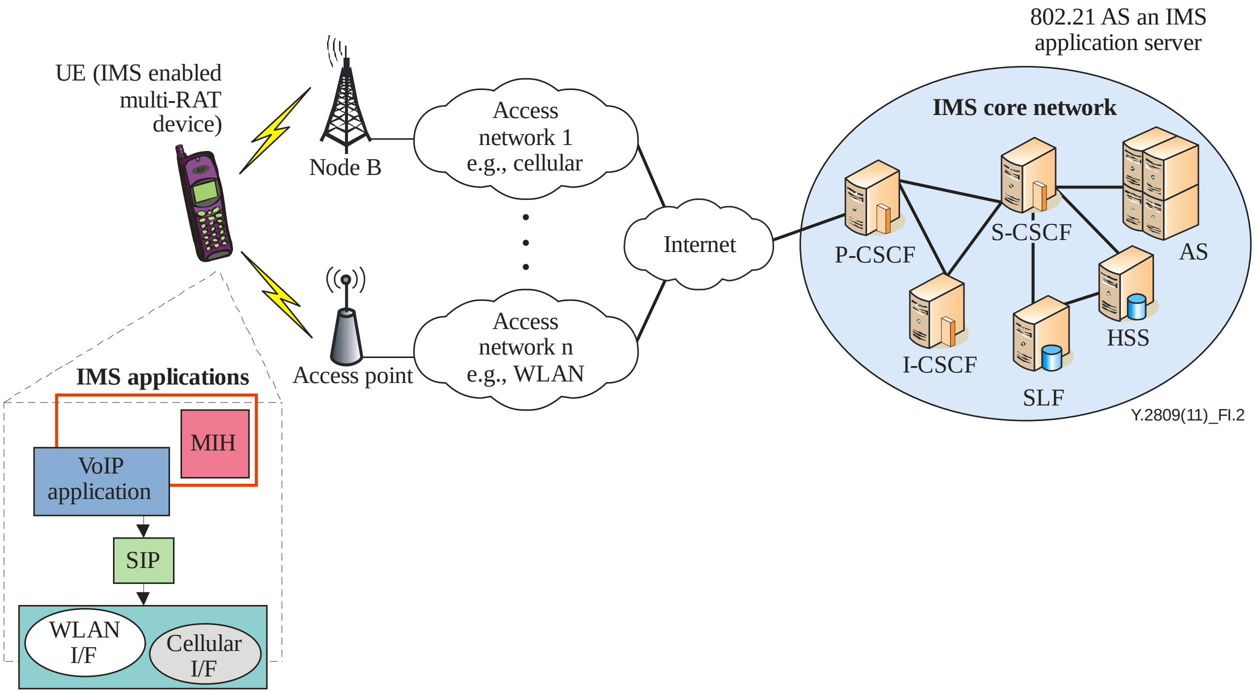


**Figure I.2 – Migration of IEEE 802.21 to an IMS Platform**

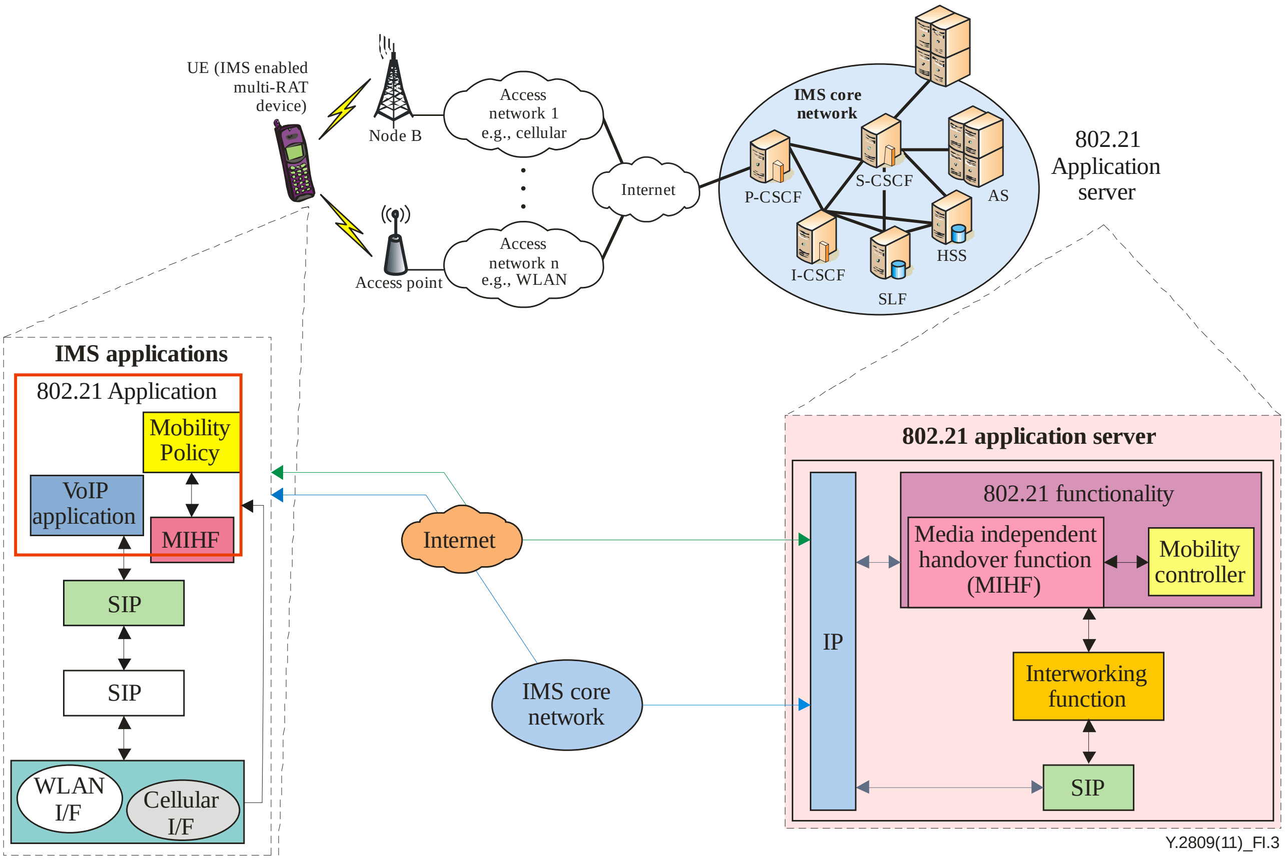


**Figure I.3 – High-level description of IEEE 802.21 for IMS Model**

Figure I.3 shows a high-level description of the IEEE 802.21-IMS model. The left box describes the related components within the terminal, while the right box shows the 802.21 AS functionality. The bi-directional flow arrows through the IMS core platform and the IP network illustrate the message exchange, as described below.

In the IEEE 802.21-IMS model, the UE (IMS-enabled multi-RAT device) triggers the SIP functionality. The SIP messages are used to set up an 802.21 session, as shown in the lowest flow between the terminal, the IMS core network, and the 802.21 AS's SIP function. Directly after session set-up, 802.21 messages are exchanged over IP between the terminal's MIH function (MIHF) and the 802.21 AS's functionality, as shown in the upper flow. The 802.21 functionality in the AS will trigger the SIP module to send the requests during the HO process.

In Figure I.3, the home subscriber system (HSS) in the IMS core network provides the 802.21 AS with the user preferences and subscription information to perform intersystem handover optimized decisions.

Figures I.4, I.5 and I.6 describe these interactions in more detail, showing the detailed message flows for IMS registration, session set-up in the control/signalling plane, MIH registration, VoIP session set-up, VoIP session data exchange, handover initiation, inter-system handover and standardized 802.21 commands to control links, handover execution, and handover completion to resume the ongoing VoIP session.

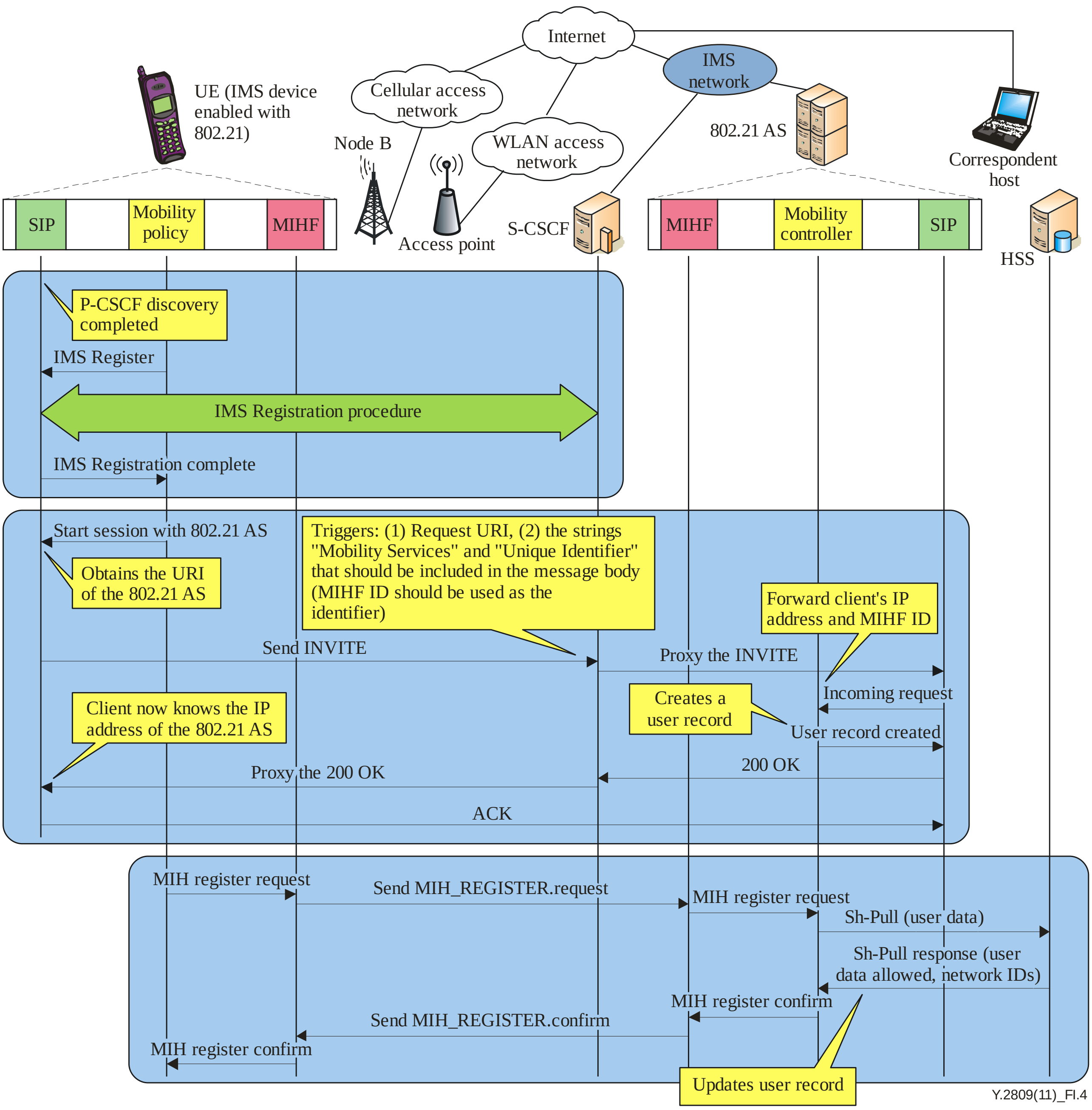


**Figure I.4 – VoIP session set-up with IEEE 802.21 application server**

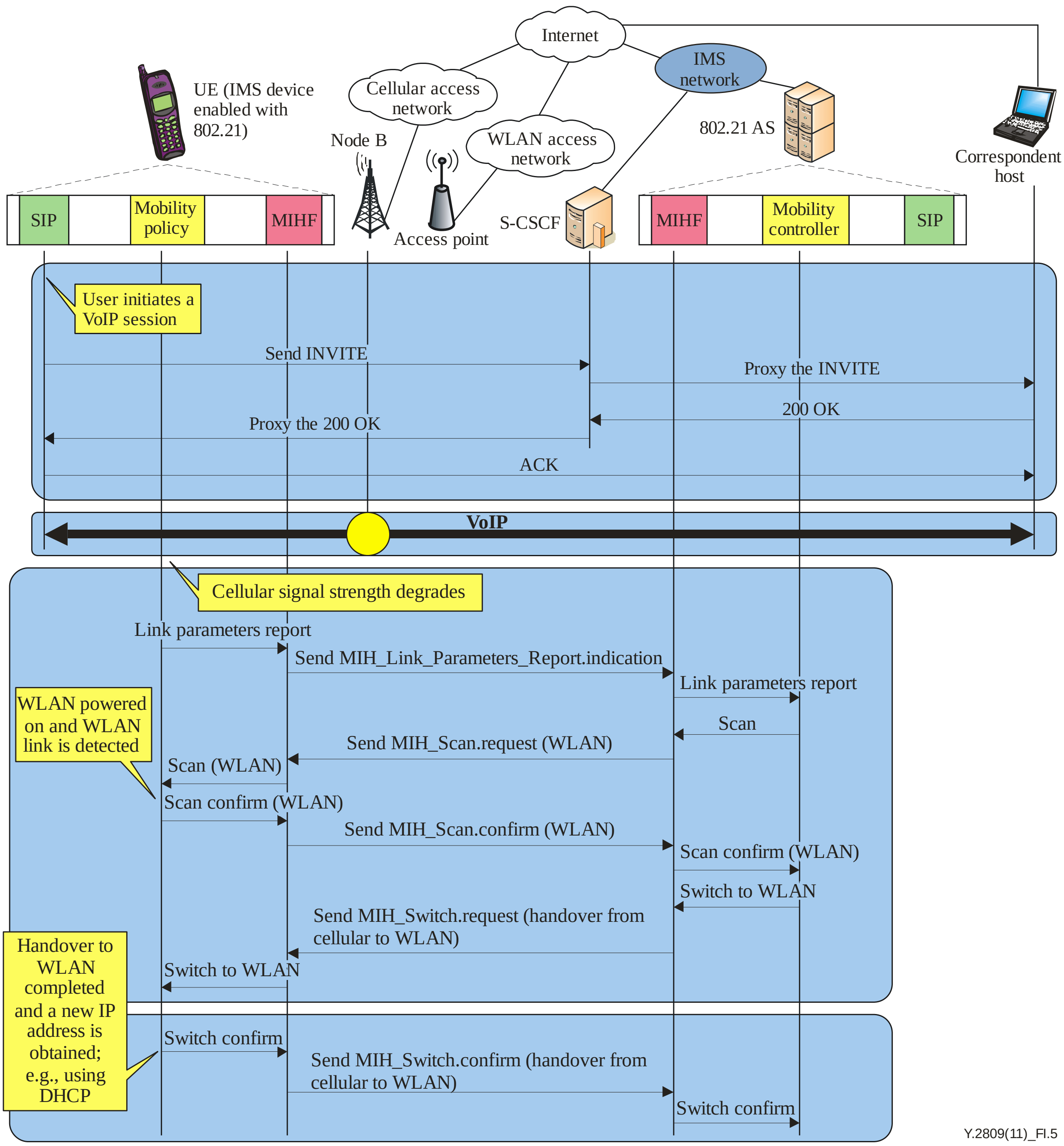


**Figure I.5 – Handover initiation by IEEE 802.21 application server**

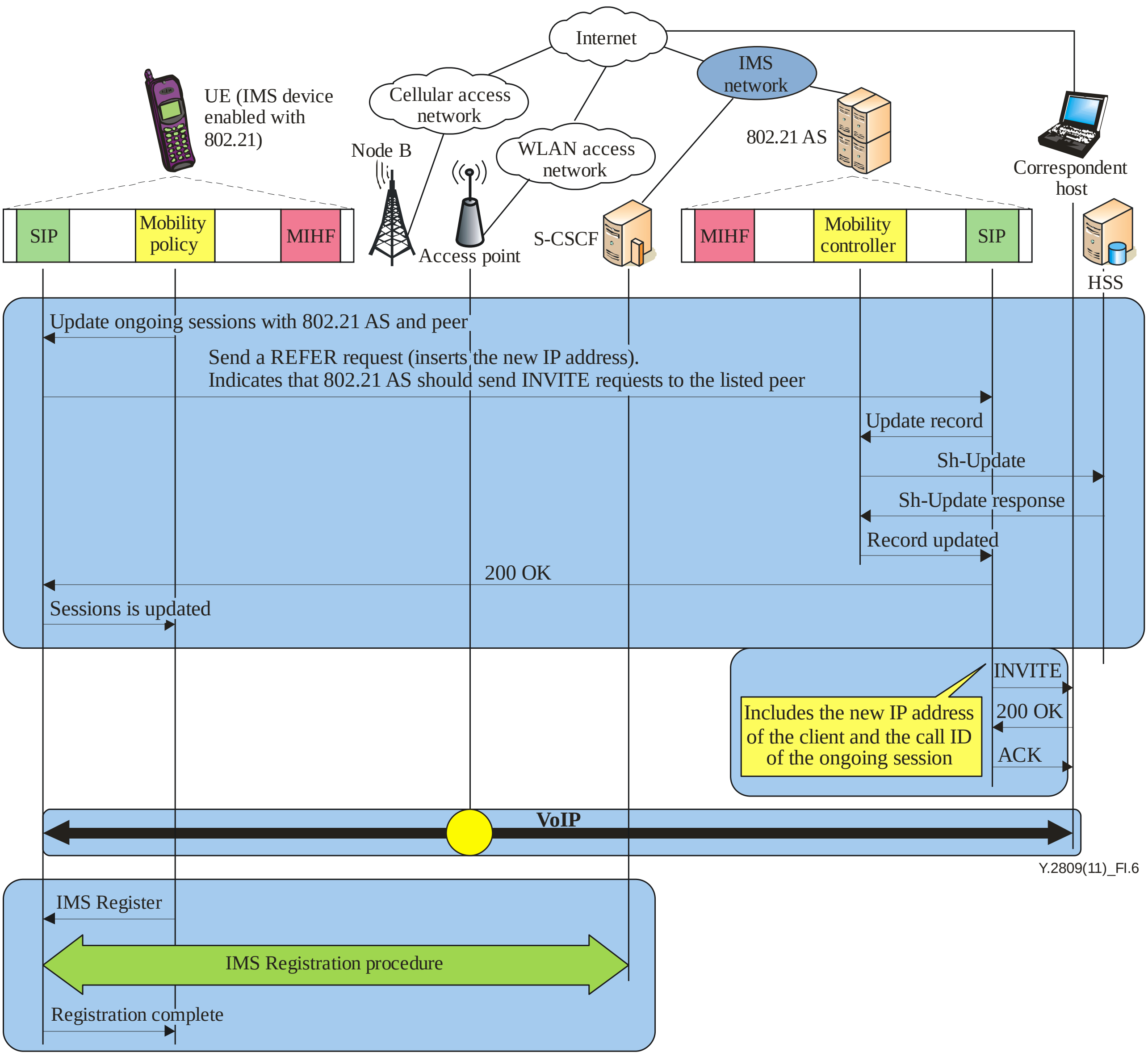


**Figure I.6 – Handover completion: IEEE 802.21 triggers SIP messaging**

The mobility controller, depicted in the flow diagrams, decides whether to switch the subscriber to WLAN, or any other radio access technology (RAT). It requires the user subscription profile and user preferences stored in the HSS. The IMS $S_h$ interface is used to transfer information between the 802.21 AS, using the mobility controller, and the HSS.

In Figure I.4, after receiving the MIH_Register Request message from the IMS-device-enabled UE, the mobility controller starts the standardized Sh-Pull procedure with the HSS. It sends the user identity and requests data related to the specific user. The HSS answers to the mobility controller with the Sh-Pull Response message containing user data; including networks IDs – with which the home network has agreements, and/or to which the user has subscribed, and therefore roaming is allowed. The network IDs may provide the 802.21 AS user with preferences to decide upon handover execution based on current characteristics, such as network connection costs or network speed.

Figure I.5 shows the VoIP session set-up procedure with related messages. The VoIP media exchanges are continued until the UE detects the radio signal degradation and decides to prepare a notification to the network for an inter-system handover.

In Figure I.6, the UE sends the REFER request to the 802.21 AS to trigger the SIP functionality. In turn, the mobility controller starts the Sh-Update procedure to which the HSS responds with a Sh-Update Response message. The 802.21 AS thus informs the HSS about the IP address change, and the VoIP session resumes.

## Appendix II

## Examples of IMS handover using network agents

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

This appendix gives the two examples of IMS handover using network agents, the resource admission control function (RACF) and the GPRS gateway supporting node (GGSN), as possible examples of IMS-based handover.

### II.1 RACF applicability in the IMS handover

The handover control scheme can be performed with the support of agents in the network. The following figure shows the overview of the handover control scheme in the session or application layer. Within this handover control scheme, the P-CSCF and the C-CSCF play the role of location management and handover control. The RACF acts as arbitrator between the IMS component (e.g., CSCF) and the transport function (e.g., BGF).

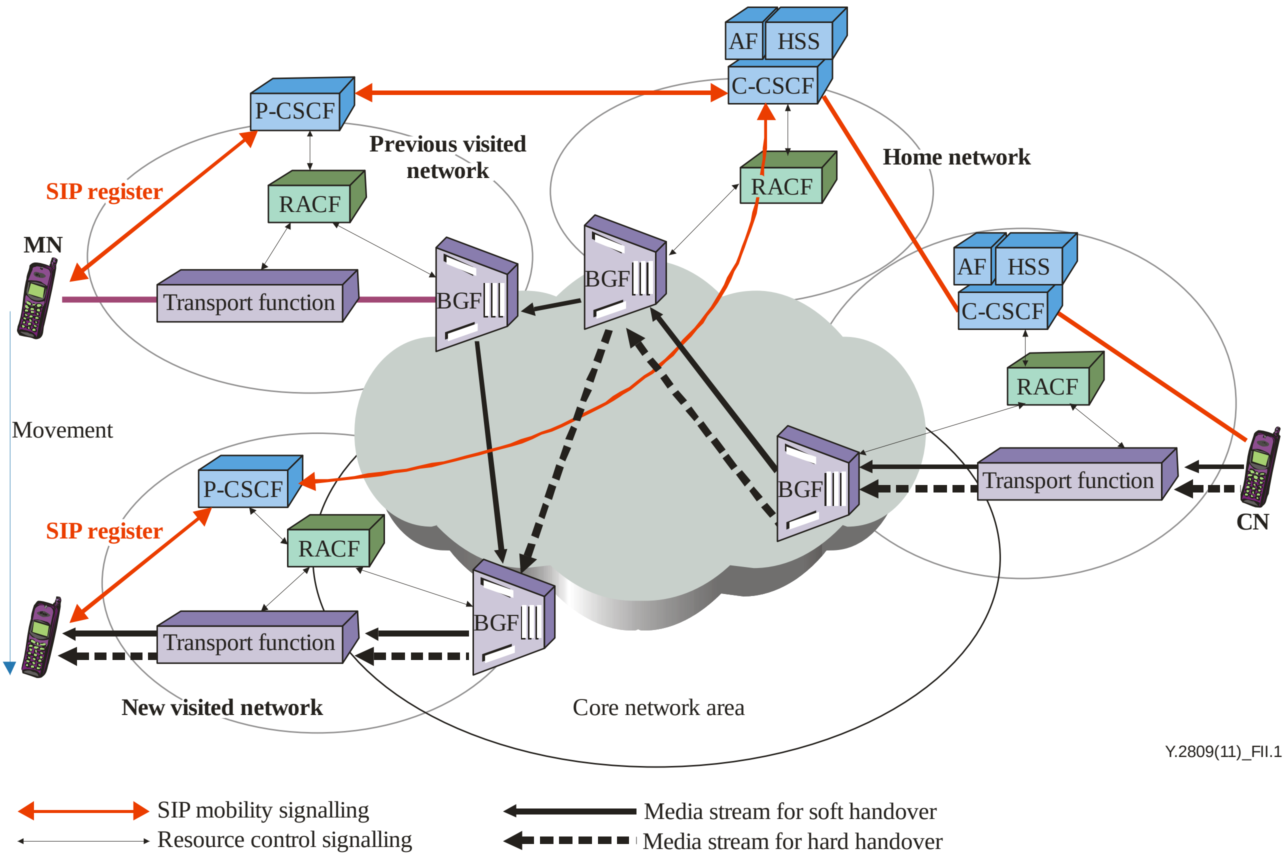


**Figure II.1 – Application-layer handover control with mobile agent support**

On the service join request from the mobile host, the proxy registrar (i.e., P-CSCF) will send a service request to trigger RACF to perform resource admission control on the corresponding transport functions in the visited network. Also, the BGFs in the visited network and home network interact with the proxy registrar and home registrar to establish a relationship between BGFs. Thereby, the datagram from the corresponding host could be redirected to the BGF in the current visited network from the BGF in the previous visited network, or from the BGF in the home network. In this way, continuity of mobility, and transport independent from handover control, can be achieved. The only difficult part is the detection ability that is required at the application layer to identify when the IP address has changed. The ability to notify application subscribers of such changes would be preferable.

## II.2 GGSN applicability in the IMS handover

The existing IMS handover scheme operates at the application layer, and thus the overall handover latency can be significantly increased during handover, depending on the network conditions such as movement detection, IP address configuration, and new signalling of INVITE messages. The IMS handover latency could be reduced by using the fast handover with the support of the link-layer triggers and the network agents such as GGSN nodes.

The following figure shows the overall procedures of the IMS fast handover with the support of the network agent, in which the 3GPP network system is considered as an example.

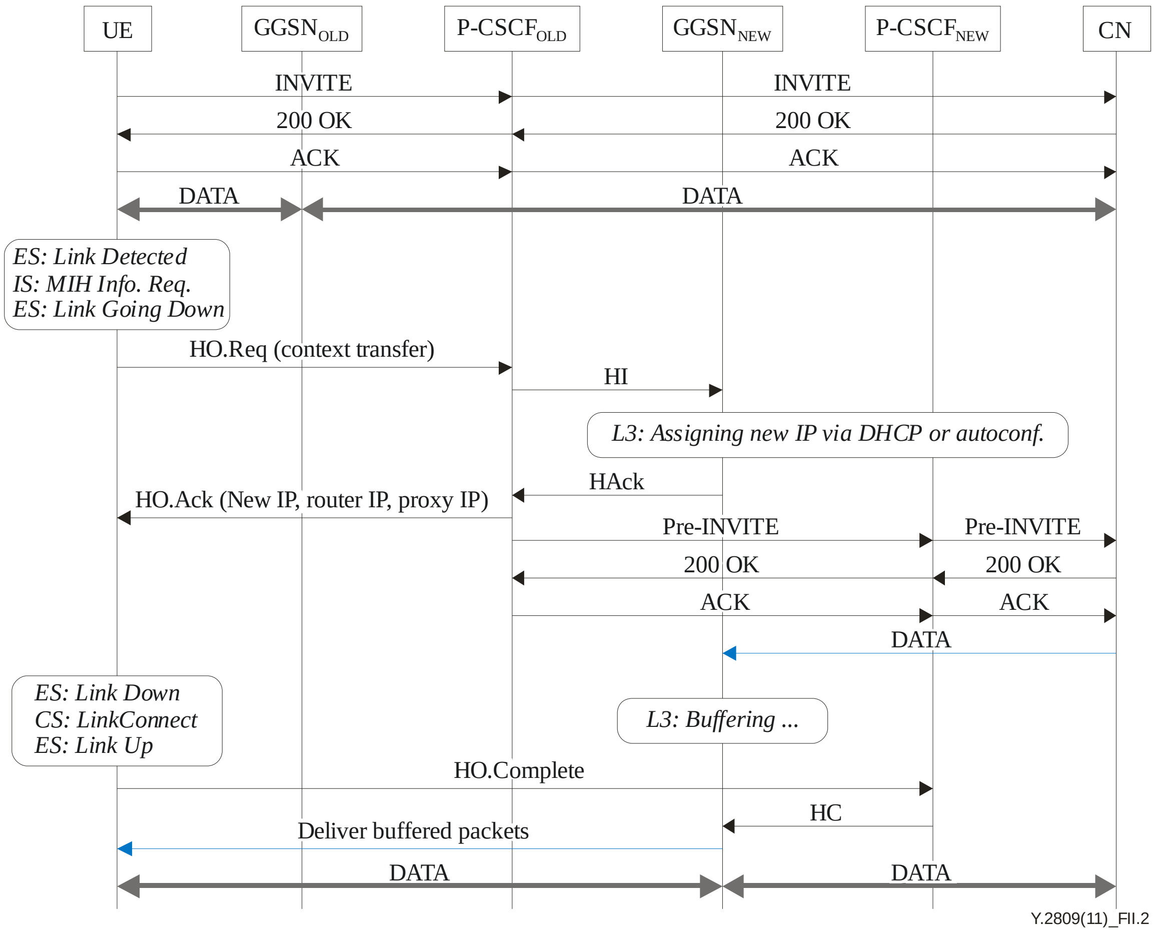


**Figure II.2 – IMS fast handover with network agent support**

The overall handover steps can be classified into four steps: (1) detecting a new network and preparing required information using MIH, (2) triggering the handover procedure and acquiring a new IP address, (3) making a new session and buffering application data, and (4) completing the procedure and receiving the buffered data.

In the figure, the UE has connected to the old network and communicates with the CN. When it receives Link Detected event from the MIH layer, it can retrieve information about available neighbouring networks using the MIH information service. Although the MIH specification defines many elements in this neighbour information, the minimum functionalities, like an IP address of the candidate next router ($GGSN_{NEW}$), are used. The information server and the detailed procedures for an information query are not presented in the figure.

When the signal strength of the old link gets weaker than the predefined threshold, the UE detects a Link Going Down event from the MIH layer and triggers the handover procedure by sending HO.Req message to the old SIP proxy server (P-CSCF$_{OLD}$). The context information of the UE must be included in HO.Req such as the identifier, MAC address, IP address of GGSNNEW, or security information like a session key.

After receiving HO.Req, P-CSCF$_{OLD}$ sends HI message to the GGSN$_{NEW}$ with the received context information. Then GGSN$_{NEW}$, instead of the UE, configures the new IP address for the UE by DHCP or the auto-configuration mechanism. It is assumed that P-CSCF$_{OLD}$ can configure the UE's address. It is also assumed that GGSNNEW knows the IP address of the next SIP proxy server (P-CSCF$_{NEW}$). The configured IP address and IP address of P-CSCF$_{NEW}$ are delivered to the UE through HAck and HO.Ack message.

When the UE gets its new address and P-CSCF$_{NEW}$ address, it attaches the new address into its network interface. It is noted that most operating systems allow attaching multiple IP addresses to one network interface card. After successful address attachment, the UE can switch the underlying network. At the same time, GGSN$_{NEW}$ makes a new session for the UE using Pre-INVITE message. If the UE requested handover with the data buffering option, GGSN$_{NEW}$ should keep application data from the CN until it receives the HC message from P-CSCF$_{NEW}$.

Now, the UE can associate to the new network link by using the MIH LinkConnect command when it detects a Link Down event. As soon as possible after the UE detects Link Up event, it has to send HO.Complete message to P-CSCF$_{NEW}$. Finally, it can receive all the buffered data and new application data from the CN through the new network.

The protocol messages required for IMS fast handover are for further study.

# Bibliography

The following documents are useful to understand this Recommendation:


[b-ITU-T F.700] Recommendation ITU-T F.700 (2000), *Framework Recommendation for multimedia services.*

[b-ITU-T F.702] Recommendation ITU-T F.702 (1996), *Multimedia conference services.*

[b-ITU-T F.703] Recommendation ITU-T F.703 (2000), *Multimedia conversational services.*

[b-IEEE 802.21 ] IEEE 802.21-2008, *IEEE Standard for Local and metropolitan area networks – Part 21: Media Independent Handover Services.*

[b-IETF RFC 3261] IETF RFC 3261 (2002), *Session Initiation Protocol.*

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