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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 applications with multiple devices

Recommendation ITU-T Y.2813

International Telecommunication Union

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Recommendation ITU-T Y.2813

Mobility management framework for applications with multiple devices

Summary

Recommendation ITU-T Y.2813 describes a mobility management framework that facilitates various seamless multimedia services using multiple devices.

This Recommendation identifies the design considerations, requirements, functional architecture and information flows for supporting various applications involving users with multiple devices.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.2813	2016-02-13	13	11.1002/1000/12710

Keywords

Mobility management, multiple devices, seamless service, switchover, NGN.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Mobility management framework for applications with multiple devices

1 Scope

The objective of this Recommendation is to develop a mobility management (MM) framework for applications involving users with multiple devices. To enable seamless services between those users, it is required to provide the functions of location management and handover control for a set of devices sharing a communication session. This Recommendation specifies design considerations, service scenarios, requirements, functional architecture and information flows for mobility support in applications with multiple devices.

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 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.2018] Recommendation ITU-T Y.2018 (2009), *Mobility management and control framework and architecture within the NGN transport stratum.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 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.

3.1.2 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.

3.1.3 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 handover: (Definition based on [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.

3.2.2 multiple devices: A set of individual user devices operated by and connected through the user. Bundling multiple devices belonging to the user together as a virtual set has the functionality as if there is only one device rather than multiple devices. One example of the usage using multiple devices is multi-screen environment. A user can have multiple devices such as TV, PC, mobile phone, digital album, etc. Each device belonging to the user can compose one logical set with the users. A user sometimes can have more than two sets of devices depending on the situation. However, in this Recommendation, one device set per user is considered.

3.2.3 switchover: The manual switch (or change) from one device to another device that belongs to the same user, to meet the needs of that user. It is assumed that, in a handover scenario, the user can move and roam between access networks using one single device within the mobility management framework. However, in this Recommendation it is assumed that the user can select and change devices, from among multiple devices, in a switchover scenario.

3.2.4 applications with multiple devices: When more than two user devices are used for a single application scenario such as one source multi use, etc. Three types of applications using multiple devices are taken in consideration in this Recommendation: One-to-multiple devices, multiple devices-to-one device and multiple devices-to-multiple devices applications.

- One-to-multiple devices application: It refers to application between a single entity (or sender) and a bundle of entities (or multiple receivers). Application with one source multi use is one example which consists of one content source on the sender side, and multiple devices on the receiver side.
- Multiple devices-to-one application: It refers to an application between a bundle of entities (or multiple senders) and a single entity (or receiver).
- Multiple devices-to-multiple devices application: It refers to an application between two bundles of entities comprising device sets. Both sender and receiver are made up of a bundle of devices that communicate with each other.

3.2.5 activated device: A user device that is selected by the user and is currently in use for on-going application.

3.2.6 deactivated device: A user device that is neither selected nor used by the user for application. Deactivated device can become an activated device based on user's selection.

3.2.7 seamless service: A service that is implemented in such way that it will ensure that users will not experience any service disruptions while changing the point of attachment or while changing devices.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA	Authentication, Authorization and Accounting
A-MMCF	Access MMCF
C-MMCF	Central MMCF
HCF	Handover Control Function
IMSI	International Mobile Subscriber Identifier
LMF	Location Management Function
MM	Mobility Management

MMCF	Mobility Management Control Function
NACF	Network Attachment Control Function
NAI	Network Access Identifier
NGN	Next Generation Network
OSMU	One- source Multi- use
RACF	Resource Admission and Control Function
SCF	Service Control Function
UE	User Equipment
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
Wi-Fi	Wireless Fidelity

5 Overview of Mobility Management (MM) for applications with multiple devices

The number of new services provided for smart devices is rapidly increasing. Connecting to the Internet with a smart phone while enjoying multimedia services on a smart TV has become common nowadays as we enter a "one person multi-devices era". One of the most widely used communication services using multiple devices is the multi-screen service. It provides multimedia contents for various devices such as TV, PC, tablet PC and mobile phone without interruption while switching between these devices. For example, a user can watch video with TV at home, with a smart phone in an outdoor area and with a PC in the office.

Cloud computing technology which distributes and stores contents using a local server system for sharing between devices is one of the approaches to realize multi-screen service. However it is only applicable to one source with multiple receivers and is generally implemented at session layer and application layer for sharing contents. Thus the management of application sessions and corresponding information to manage multiple devices can cause scalability problem as the number of devices increase.

There are similarities between applications involving users with multiple devices and mobility service in many ways. For instance, both services handle the identification of devices, managing the location of devices and controlling data transmission to devices in cases of device switchover and device movement. Therefore a mobility management framework including location management and handover control may be used for applications with sets of multiple devices. General mobility management framework is specified in [ITU-T Q.1707]. Frameworks for location management and handover control are described in [ITU-T Q.1708] and [ITU-T Q.1709], respectively. In this Recommendation, the framework for applications involving users with multiple devices will be addressed based on the existing mobility management architecture in next generation network (NGN). Figure 5-1 illustrates how mobility management framework can be harmonized with application involving users with multiple devices.

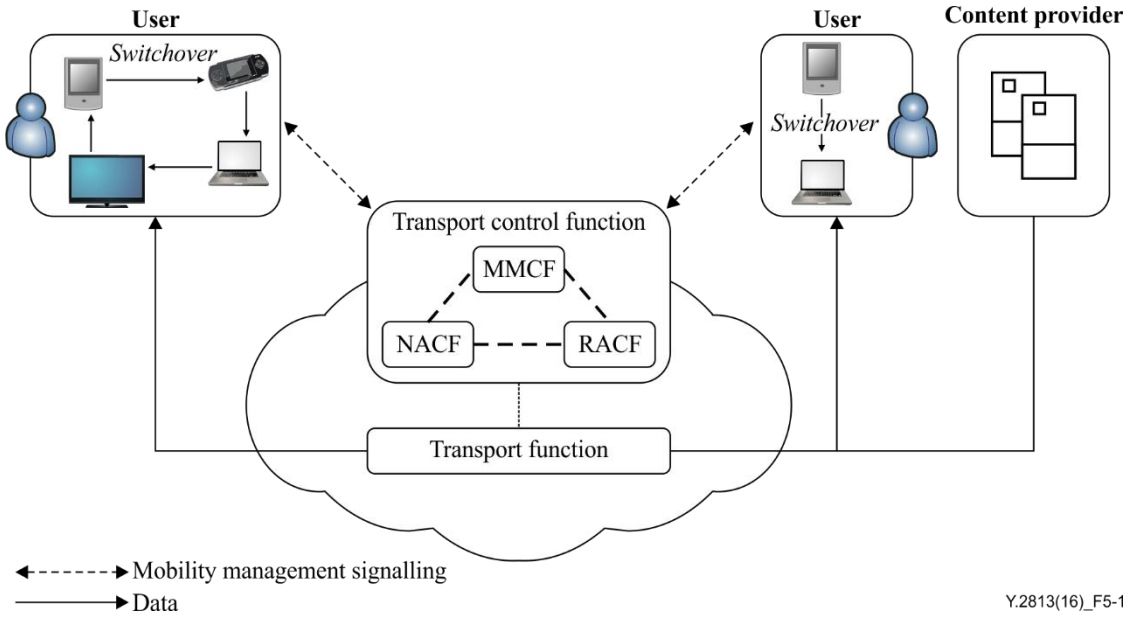

Figure 5-1 – Mobility management for application using multiple devices

For the realization of applications using multiple devices, service model can be classified depending on the types of sender and receiver as described in Table 5-1.

One-source multi-use (OSMU) service is an example of case I and OSMU service system consists of one fixed content source (or user with single device) on the sender's side and multiple devices on the receiver's side. It provides service continuity with multiple devices belonging to a user without any restriction in case of device switchover.

Possible scenarios of case I according to the changes of location, device and network are illustrated in Figure 5-2 and described as follows:

- Scenario ①: This is a scenario where the device is switched and the access network changes, while user's location remains unchanged. An example is when the user moves from a laptop connected to Wi-Fi to a mobile phone connected to WiMAX at home.
- Scenario ②: This is a scenario of switching device and changing user's location while access network is unchanged. An example is changing a laptop connected to WiMAX to a mobile phone connected to same WiMAX in an outdoor area.
- Scenario ③: This is a scenario of switching device, changing user's location and access network. An example is changing a mobile phone connected to WiMAX to laptop connected to Wi-Fi in office.
- Scenario ④: This is a scenario of switching device, while user's location and access network are unchanged.

Table 5-1 – Possible service models using multiple devices

			Sender		
			Content provider	User	
				Single device	Multiple devices
Receiver	User	Single device	–	–	Case II
		Multiple devices	Case I	Case I	Case III

Another example is switchover of devices on the sender's side, as identified in case II. In this case, a content provider with multiple sources provides contents to a user with a single device at the receiver side. Possible scenarios according to changes in location, device and network are illustrated in Figure 5-3 and described as follows:

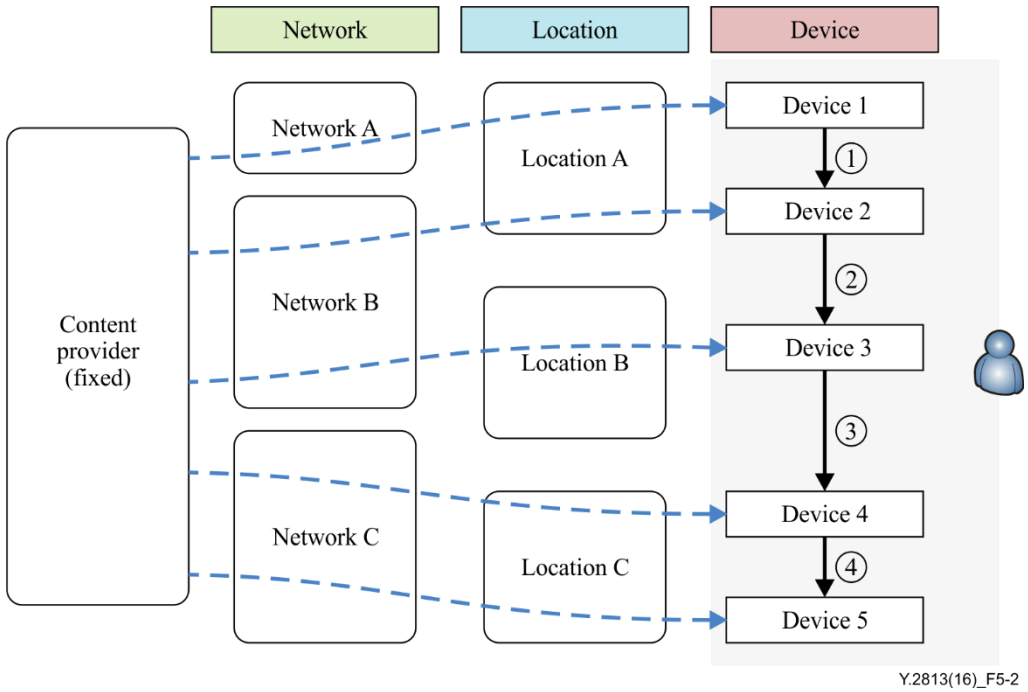

Figure 5-2 – Scenario model of application with one-to-multiple devices (Case I)

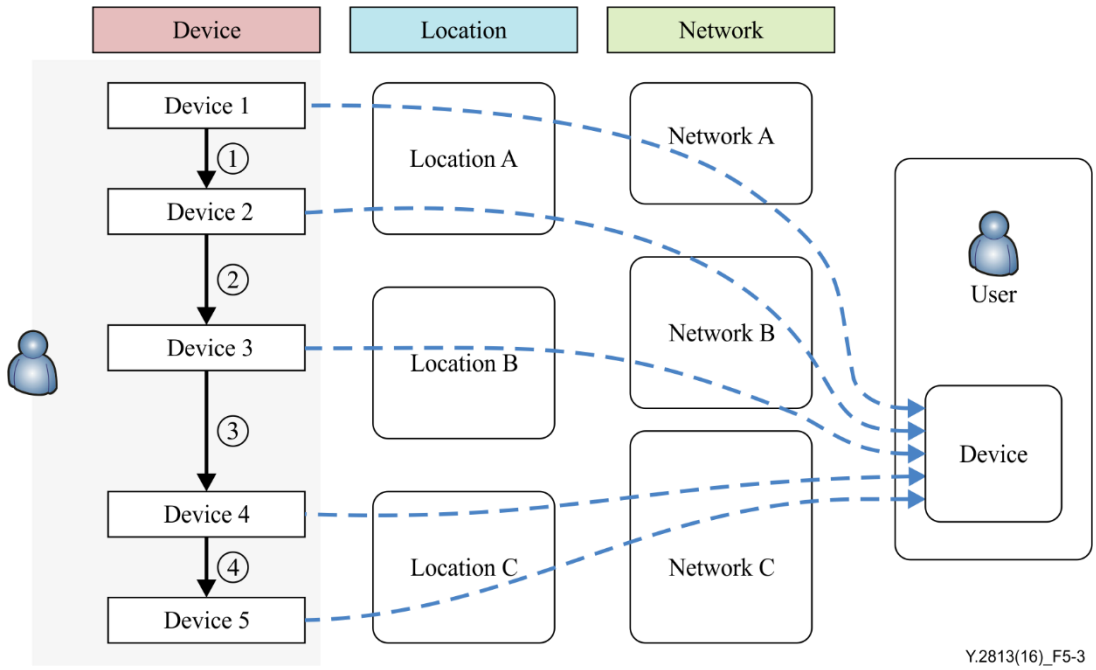

Figure 5-3 – Scenario model of application with multiple device-to-one (Case II)

– Scenario ①: This is a scenario of switching device of the sender and changing access network to another while the user's location is unchanged. An example is changing a laptop connected to Wi-Fi to a mobile phone connected to WiMAX at home.

– Scenario ②: This is a scenario of switching device and changing sender's location while access network is unchanged. An example is changing a laptop connected to WiMAX to a mobile phone connected to same WiMAX in an outdoor area.

– Scenario ③: This is a scenario of switching device, changing sender's location and access network. An example is changing a mobile phone connected to WiMAX to laptop connected to Wi-Fi in office.

– Scenario ④: This is a scenario of switching device, while sender's location and access network are unchanged.

It is also applicable to support multiple devices on both the sender's and the receiver's sides as case III. In this service model, two users can communicate without any restriction while changing their devices continuously. Possible scenario model of case III can be combined with case I on the sender's aspect and case II on the receiver's aspect.

This Recommendation describes a framework for mobility management with multiple devices that can be commonly applied to aforementioned service models.

6 Requirements of MM for applications with multiple devices

This clause identifies the functional requirements for MM capabilities to support communications involving users with multiple devices in NGN.

6.1 Cooperation between MM functions and capabilities to handle multiple devices

Some capabilities can additionally be required to support applications with multiple devices such as one-to-multiple devices, multiple devices-to-one and multiple devices-to-multiple devices by cooperating with the existing MM functions.

6.2 Support of network-based control scheme

This Recommendation designs a network-based control scheme for multiple devices where device switchover is handled without the involvement of the devices. This network-based scheme should support the legacy device while requiring no additional functions to control mobility management on the device.

6.3 Alignment with [ITU-T Y.2018] and [ITU-T Q.1707]

This Recommendation builds on general mobility management and control framework described in [ITU-T Y.2018] and network-based mobility management functionalities described in [ITU-T Q.1707].

6.4 Identification of user and multiple devices

It is required to manage identification capabilities in a network for handling multiple devices, logical set of devices belonging to a user, and their relationship.

6.5 Support of the device switchover

In the general MM framework, each device tends to move across various access networks in NGN. Similarly, this Recommendation can include location management and handover control functionalities in the MM scheme to consider switchover among multiple devices for seamless service. For this purpose, the latest information of the location of a device should be registered and updated while the device continues to switchover around the network.

6.6 Support for authentication and authorization of user and devices

The MM schemes are recommended to support the authentication, authorization and accounting (AAA) functionality to handle device switchover. For this purpose, the MM schemes can optionally interwork with legacy AAA servers and/or user, device profile databases. These servers and databases may be used for the authentication and authorization of the devices in case of switchover.

7 Functional architecture for applications with multiple devices

This clause describes a high level architecture and the related functional entities for MM architecture over multiple device environments supporting device switchover. This architecture is aligned with the existing MM framework defined in [ITU-T Q.1707] and built on the NGN functional architecture [b-ITU-T Y.2012] with addition of a new set of capabilities to harmonize mobility management functions. To provide applications with one-to-multiple devices, multiple devices-to-one and multiple devices-to-multiple devices, several capabilities in both the service stratum and the transport stratum would be required to extend (and/or to define new capabilities) as illustrated in Figure 7-1.

7.1 Transport stratum

7.1.1 Transport functions

The transport functions provide the connectivity for all components and physically separated functions within the NGN. These functions provide support for the transfer of media information as well as control information. These functions also perform the delivery of services to user and cooperate with the mobility management control function (MMCF) for maintaining service continuity during the device switchover. It also can support fast switchover to cater to seamless non real-time and real-time service's requirements.

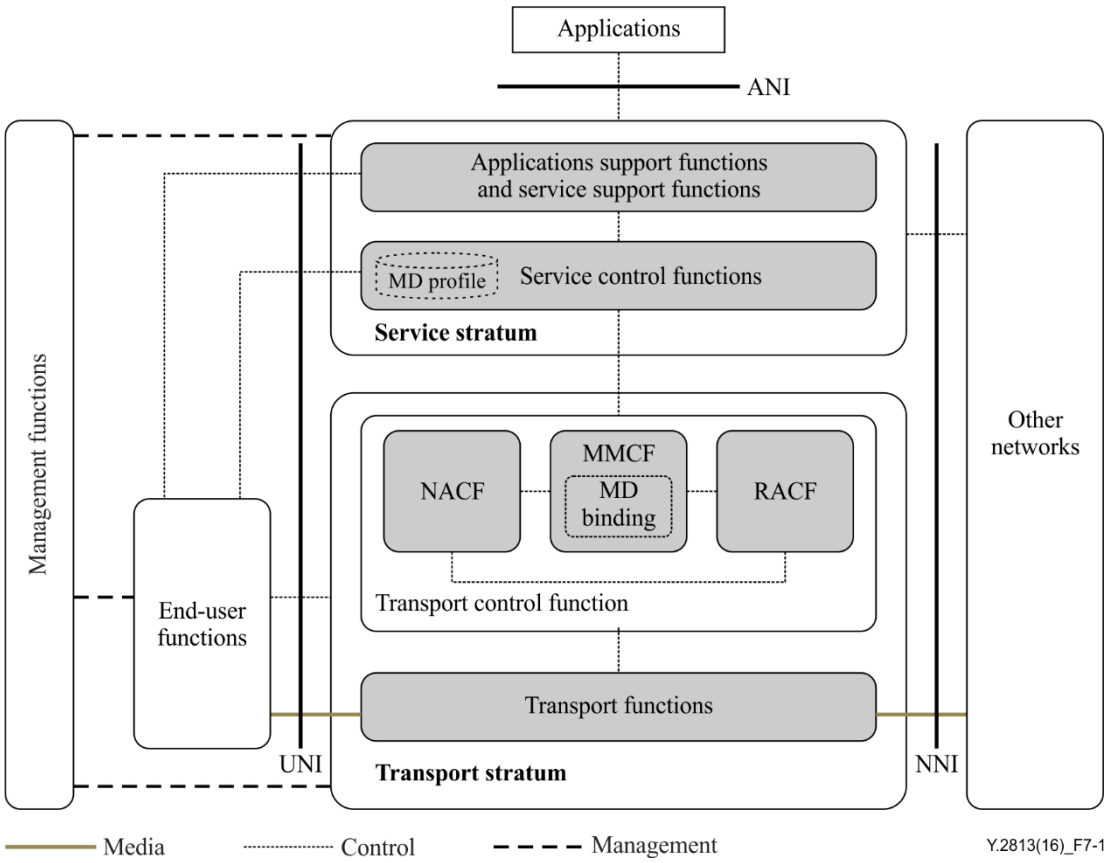

Figure 7-1 – High level architecture for application with multiple devices based on [b-ITU-T Y.2012]

7.1.2 Transport control functions

The transport stratum provides connectivity to NGN users under the control of transport control functions including network attachment control function (NACF), resource admission and control function (RACF) and MMCF. More detailed information on NACF and RACF in NGN can be founded in [b-ITU-T Y.2014], [b-ITU-T Y.2111] respectively.

According to [b-ITU-T Y.2012], NGN transport control functions are able to support different types of NGN services in a common way. Application with multiple devices is expected to be supported by those functions as well.

7.1.2.1 Network attachment control function (NACF)

The NACF provides the registration function to allow registration of NGN users at the access level and provides the initialization of end-user functions so that the users can access NGN services including applications with multiple devices. More detailed information on NACF in NGN can be found in [b-ITU-T Y.2014].

7.1.2.2 Resource admission and control function (RACF)

The RACF manages NGN resources to support resource reservation for traffic flows. The function provides admission control and gate control for traffic flows based on criteria such as user profiles, SLA, operator specific policy, etc. More detailed information on RACF in NGN can be found in [b-ITU-T Y.2111].

7.1.2.3 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 function (LMF) and

handover control function (HCF) 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 may include capability for controlling the relationship between users and their devices in network based mobility scheme. This capability keeps the binding information per users and cooperates with other functional entities in the MMCF to support switchover. It also keeps and manages the following data which is not supported in handover scenarios in MM framework:

- The current location of devices belonging to user;
- The binding information between user and devices belonging to user;
- The current status of devices (such as activated or deactivated).

The MMCF interacts with the RACF to support multiple devices requiring NGN transport control.

7.2 Service stratum

The service stratum is required to provide functions for supporting multiple devices at service level.

7.2.1 Application support functions and service support functions

The application support functions and service support functions include functions such as the gateway, registration, authentication and authorization functions at the application level. These functions may also support the transcoding, conversion and relay of different types of multimedia depending on device profile. However, these functions are out of scope in this Recommendation.

7.2.2 Service control functions

The delivery of applications with multiple devices is provided by utilizing the application support functions and service support functions as well as related service control function in the NGN service stratum.

To support and handle multiple devices, some capabilities in service control function can be defined as follows:

- management of membership including authentication and authorization for a user and devices belonging to users;
- request of resource and admission control to RACF for application with multiple devices;
- management of device status according to the user's selection.

8 MM procedure for applications with multiple devices

This clause describes high level mobility management procedure for three types of applications with multiple devices. For support application with multiple devices, two kinds of identification is necessary. One is used for the identification of the user, and the other is to identify devices belonging to the user. Various types of identification schemes (such as uniform resource identifier (URI), uniform resource locator (URL), international mobile subscriber identifier (IMSI), network access identifier (NAI), etc.) can be used to realize applications with multiple devices. For the description of MM procedure in this clause, it is assumed that well known IP address is used to identify both a user and the user's devices.

8.1 Procedure for registration

Figure 8-1 describes an initial registration procedure of user and user devices in the aspect of mobility management. Each device can perform the registration procedure independently.

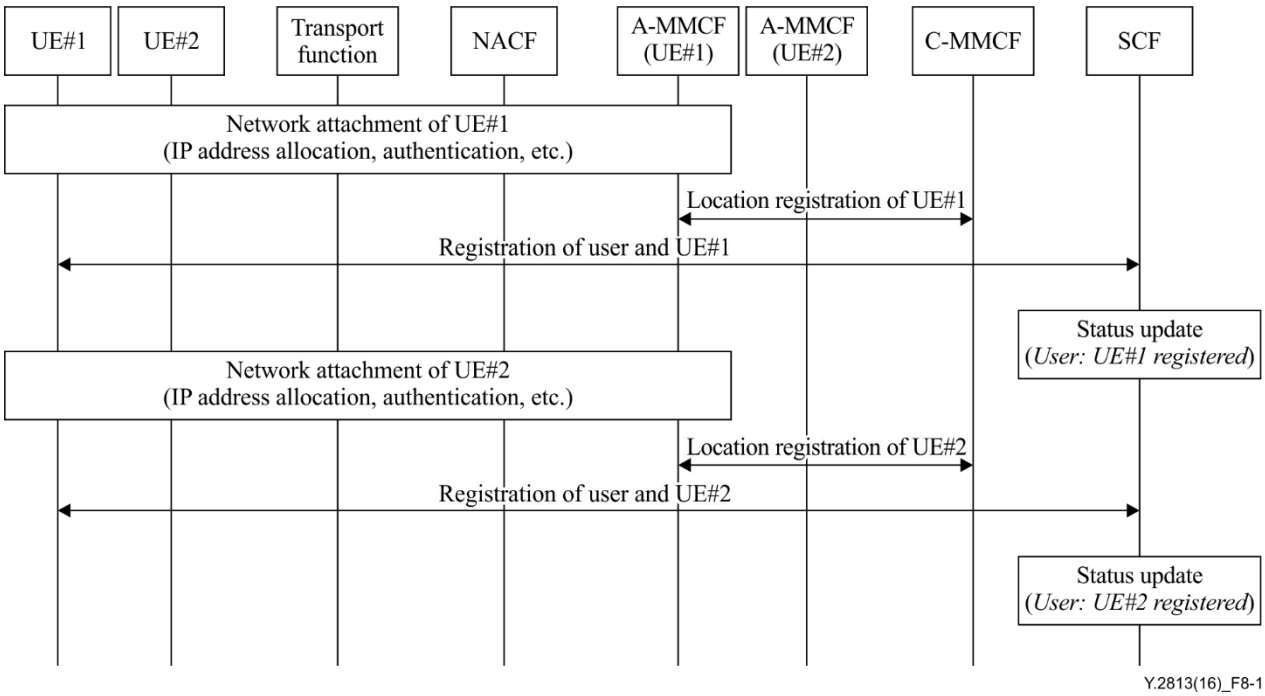

Figure 8-1 – Procedure for registration of user and devices

The interaction shown in Figure 8-1 is as follows:

1) After the user equipment (UE) UE#1 has completed the network attachment, the access MMCF (A-MMCF) performs the location registration to the central MMCF (C-MMCF). In this step, user ID (*U_addr*) and device ID (*UE#1_addr*, *UE#2_addr*, etc.) are registered in A-MMCF and C-MMCF in transport control function.

2) UE#1 also registers to SCF for application service, and SCF updates information including user and device.

8.2 Procedure for applications with one-to-multiple devices

Figure 8-2 describes the mobility management procedure for one-to-multiple devices with one content source on the sender side, and multiple devices on the receiver side.

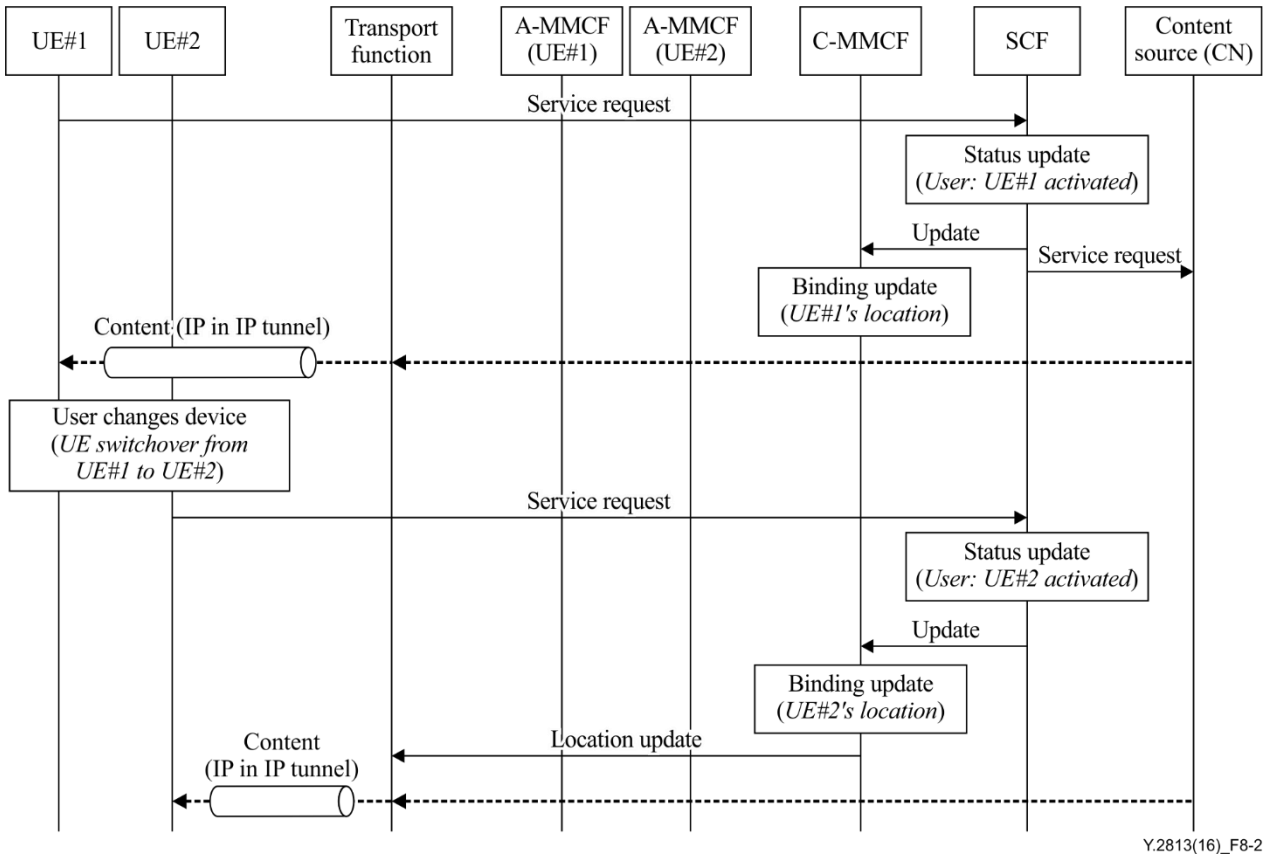

Figure 8-2 – Procedure for application with one-to-multiple devices

The interaction shown in Figure 8-2 is as follows:

1) UE#1 requests service (or content) to SCF and SCF updates activation status.
2) On receiving the service request, SCF sends an update message to C-MMCF to inform that UE#1 has been activated by the user.
3) On receiving service request, the content source sends content with the source field set to the address of content source, and the destination set to the user's address (*U_addr*).
4) On receiving packet from content source, transport function relays content with the change of destination information. The destination is changed from user's address (*U_addr*) to activated device address (*UE#1_addr*).
5) User changes device from UE#1 to UE#2 and UE#1 requests service (or content) to SCF and SCF updates activation status. Now active device of user is UE#2.
6) On receiving service request, SCF sends update message to C-MMCF to inform that UE #2 has just been just activated by the user.
7) C-MMCF updates UE#2's location information and send information to transport function.
8) On receiving packet, transport function relays packet with the change of destination information sent to the address of activated device of user (*UE#2_addr*).

8.3 Procedure for applications with multiple devices-to-one

Figure 8-3 describes mobility management procedure in multiple devices-to-one application with multiple devices on the sender's side and single receiver.

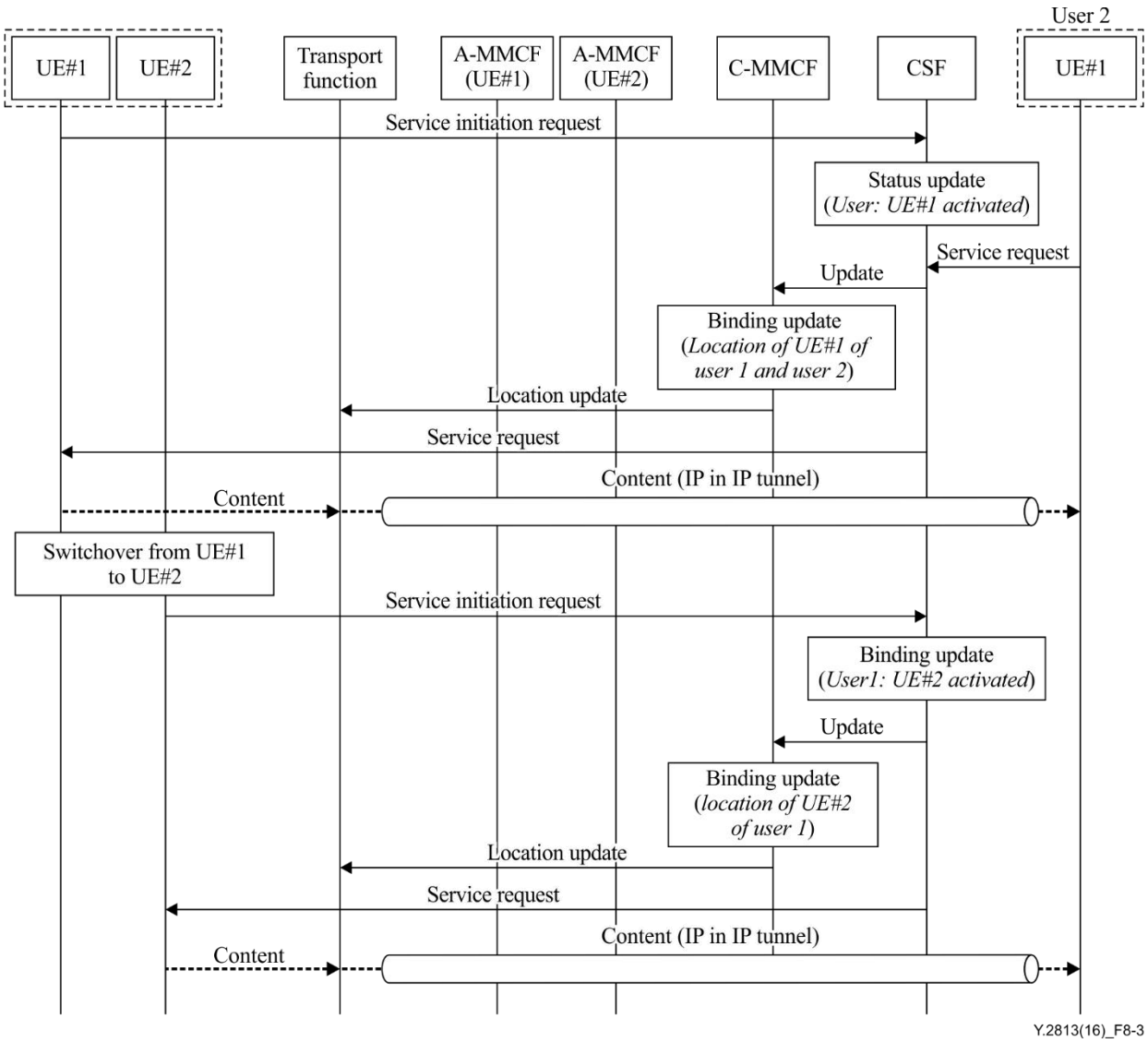

Figure 8-3 – Procedure for application with multiple devices-to-one

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

1) UE#1 of user 1 request service initiation as a sender to CSF and CSF updates activation status.

2) On receiving service initiation request, CSF sends update message to C-MMCF to inform that UE#1 of user 1 has just been activated by user.

3) UE#1 of user 2 requests service to CSF and CSF updates activation status.

4) On receiving service request, CSF sends updated message to C-MMCF to inform that UE#1 of user 2 has just been activated by user.

5) CSF requests service to UE#1 of user 1.

6) On receiving service request, UE#1 of user 1 sends content with the source set to user address *U1_addr* and the destination set to user address *U2_addr*.

7) On receiving packet from UE#1 of user 1, transport function relays content with the change of destination information. The destination is changed from user's address (*U2_addr*) to activated device address (*U2_UE#1_addr*).

8) User 1 changes device from UE#1 to UE#2 and UE #2 requests service initiation to CSF and CSF updates activation status. Now active device of user 1 is UE#2.

9) On receiving service initiation request, CSF sends updated message to C-MMCF to inform that UE #2 of user 2 has just been activated by user.

10) C-MMCF updates UE #2's location information and send information to transport function.

8.4 Procedure for applications with multiple devices-to-multiple devices

For the procedure for multiple devices-to-multiple devices application, it can be applicable based on Figure 8-2 on the receiver's aspect and Figure 8-3 on the sender's side.

9 Security considerations

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

Appendix I

Use case of application based on MIP

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

For the realization of application services with multiple devices, this appendix provides an additional use case of application with one-to-multiple devices using well known mobility protocols.

I.1 Use case overview

In this case, the sender, content provider in Figure I.1, provides contents like video streaming to user having multiple devices with the following procedures.

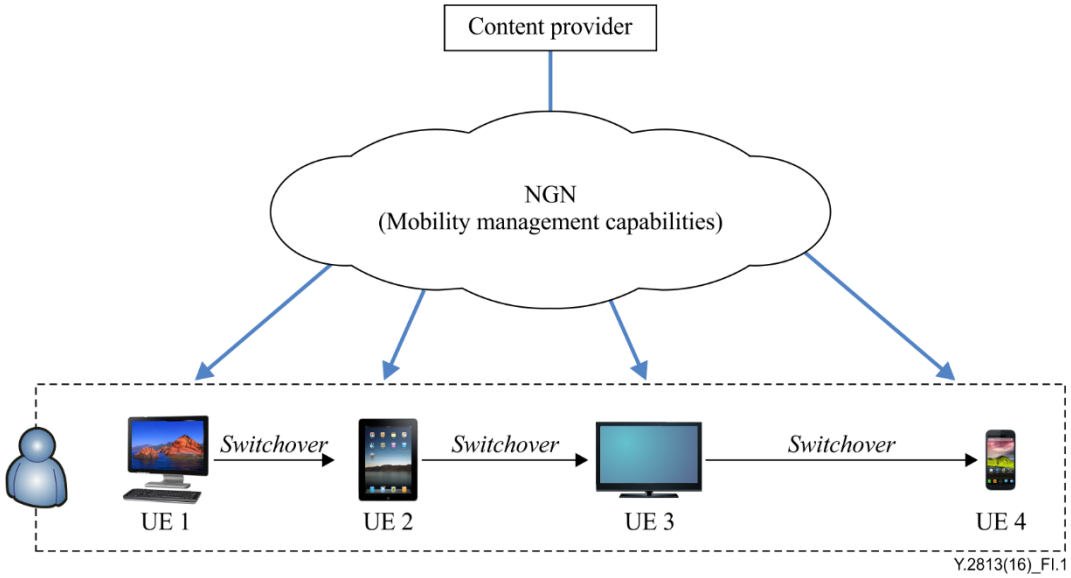

Figure I.1 – Example of application with one-to-multiple devices

1) The user has four devices including a PC and a smart phone at the office, and a TV and a tablet PC at home, all of which have network connectivity.
2) User first starts to enjoy streaming service like VoD, live TV at his office using device #1 (PC).
3) When user leaves office, he changes his device to device #2 (tablet PC) and moves to home.
4) When user arrives at home, he turns on his device #3 (TV) and continues to watch streaming service.
5) User changes his device to device #4 (smart phone) when he goes out.

I.2 Deployment scenario of application with multiple devices using MIP

Also, applications can be deployed using existing mobility management protocols. Figure I.2 shows a deployment scenario using Mobile Internet Protocol (MIP). It consists of content provider as correspondence node, user with multiple devices, mobility binding information management module, IP-in-IP tunnelling module as transport control function and transport function respectively.

The use of home address (HoA) and care of address (CoA) specified in MIP enable mobile devices to be assigned IP addresses respectively and upload/update IP binding information (between user IP and active device) with ease. The content provider (the source) in this example can be regarded as correspondent node (CN), which is defined in MIPv4. As seen in figure, MIP home agent (HA) is able to play roles in IP binding information management and conversion, which means, the necessary

functions in recommended mobility management framework can be completely implemented with MIP. To be more specific, two core functions IP address binding and IP conversion are implemented by registration request/reply functions between HoA and CoA, and by IP-in-IP tunnelling method respectively.

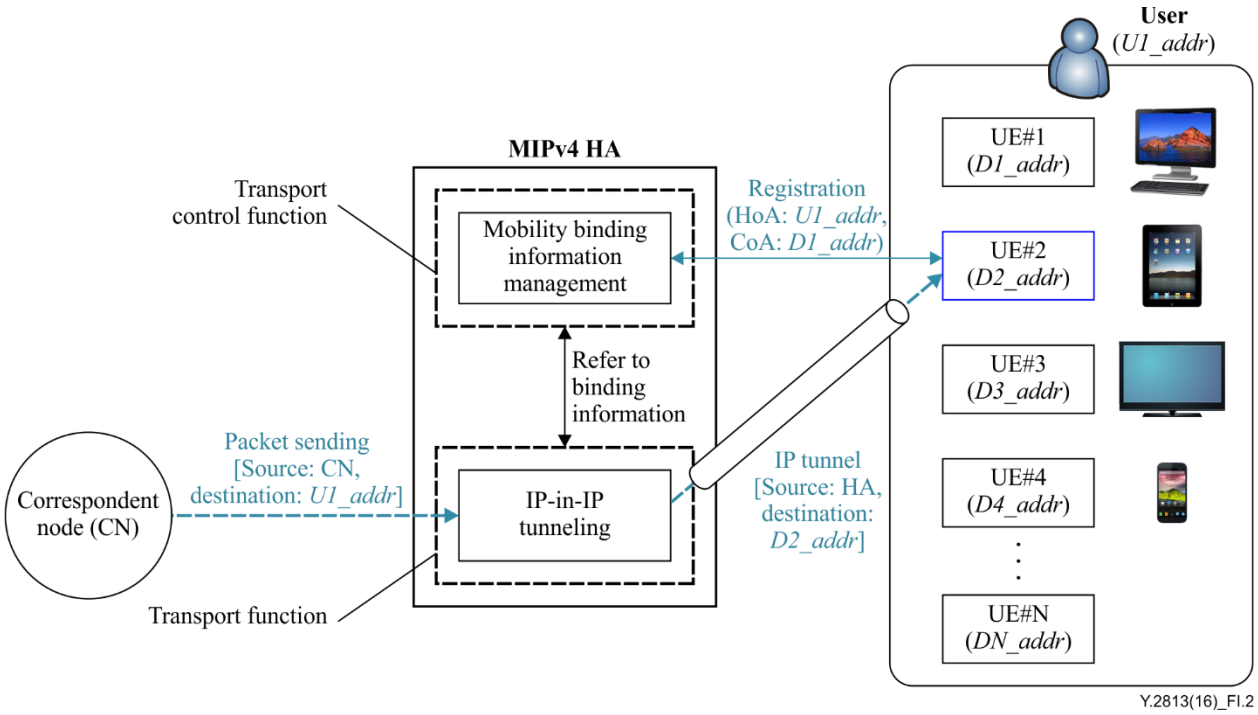

Figure I.2 – Deployment of applications using MIPv4 (in case of one-to-multiple devices)

The Figure shows the overall picture of the content transmission between content provider and user having multiple devices. Each device is required to have its own IP address (T1_1, T1_2, …, T1_N) along with IP of user (S1) that represents all the devices owned by the IP user. The user IP has to be assigned prior to or at the first connection.

The first step of the recommended mobility management is to update binding information between user IP(S1) and IP of the device that the user is currently using (active device) by requesting Mobility Binding Information Management module. The binding information should be updated whenever the user switches over from the current device being used to one of the other devices.

Once the update of IP binding is completed, the contents are ready to be transmitted. In the figure, for example, the content provider provides contents for the device group of user. Without reference to the IP of active device, the content provider only needs to know the user IP (S1) for the transmission as long as Mobility Binding Information Management module has the binding map between S1 and T1_2, [S1:T1_2]. In virtue of the recommendation, the content provider does not need to know every device of user A, and thereby the transmission does not need to go through the customary way which contains processes of terminating/modifying/recreating session or data socket when switching over the device. While transmitting contents over IP network, IP-in-IP encapsulates the packets, and converts destination IP from user IP to device IP, source IP from CN to HA. In this case, the destination IP S1 is converted to T1_2, and therefore the active device can receive the contents. The tunnelling module refers to Mobility Binding information to convert the IP addresses

Figure I.3 presents an information flow demonstrating how mobility management based on MIPv4 works. In addition to simple delivery, the figure covers a switch over scenario (from device#2 to device#3).

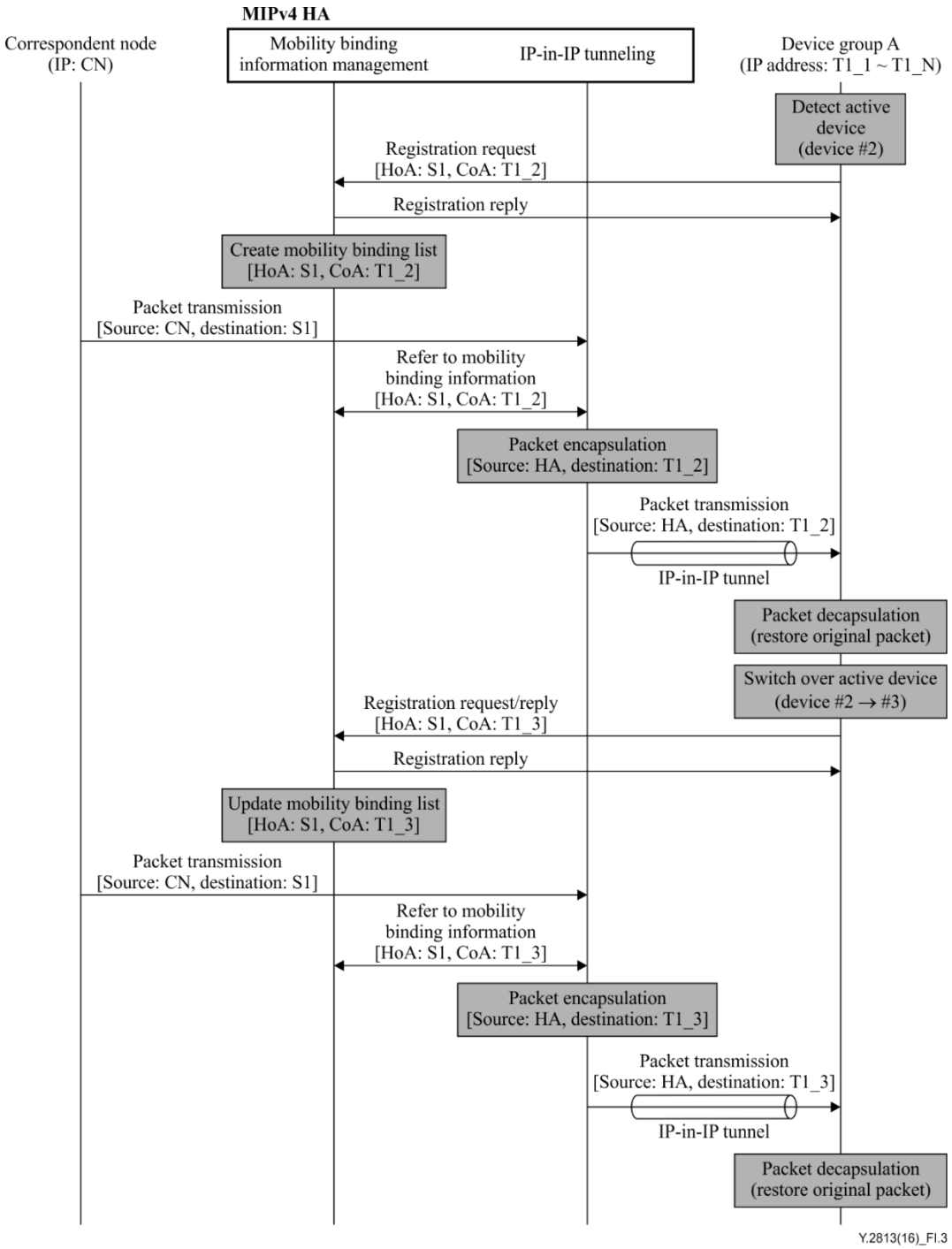

Figure I.3 – Mobility management procedure based on MIP

1) After detecting active device, the device group (S1) is requested to register its HoA and CoA (S1, T1_2 respectively).
2) Mobility Binding Information Management module creates the mobility binding list according to the request.
3) When CN transmits packets, IP-in-IP Tunnelling module refers to Mobility binding information, and then the packets are encapsulated.
4) Packets are delivered to the device via IP-in-IP tunnel, and decapsulated.
5) If the user switch over active devices, process of 2) ~ 4) are to be repeated.

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