QoS-aware Seamless Handover Schemes between Heterogeneous Networks in NGN

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***Abstract*—In this paper, we propose seamless handover scheme between heterogeneous networks by using a method which determines best target access network which can support required QoS in case of insufficient resource status of specific access network.**

***Keywords*— QoS, Mobility, VHO, NGN, Handover, RACF**

I. INTRODUCTION

ITU-T's definition of Next Generation Networks (NGN) is a packet-based network that able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service related functions are independent from underlying transport related technologies [1].

In NGN environment, ITU-T studies Mobility Management (MM) architecture for supporting user mobility. Q.1706 is the recommendation of mobility management requirements in NGN. In this recommendation, one of the requirements is that the mobility management must be supporting QoS [2].

QoS-aware mobility is able to ensure or provide higher QoS level provided in previous access network in case of handover between other networks.

In NGN architecture, the resource and admission control functions (RACF) acts as the arbitrator between service control functions and transport functions for QoS related transport resource control within access and core networks [7].

The resource of network is controlled and managed by using RACF based on policy which is managed by network administrator. In case of where the resource of network is insufficient for supporting required QoS by user and/or application, for providing required QoS, the PD-FE controls the resource reservation status of the session which is reserved by other user and/or application.

Such methods, however, it is difficult to ensure seamless handover within required QoS when the availability of network resources is insufficient status. Moreover, there are more serious problems for supporting seamless handover in insufficient resource status when the multimedia service user who requires plenty of resource.

The network environment in NGN is overlaid with various access technologies. And many kinds of the multimedia services are offered to user in NGN; like Internet Protocol Television, Video Conference, and Video on Demand. The multimedia services are required to high bandwidth and low latency time within network transport stratum. In this environment, the seamless handover cannot be provided to the UE when a user who is using multimedia service tries to access the new AN which has insufficient resource for supporting required QoS. Therefore, we propose seamless handover scheme between heterogeneous networks by using our proposal method which determines best target access network which can support required QoS in case of the insufficient resource status in specific access network.

The rest of the paper is organized as follows. The related works are discussed in Section II. And we provide an overview of NGN mobility management with QoS control in this section. Section III describes our proposal schemes and compares to each other. Finally, Section IV presents concluding remarks.

II. RELATED WORKS

A. ITU-T NGN Mobility Management

A study and standardization about mobility management in ITU-T are going by Next Generation Networks - Global Standards Initiative (NGN-GSI). Overview of recommendation related mobility management is briefly described.

Q.1706 describes the requirements for service user and mobility management for NGN [2]. Q.1707 describes a generic framework of mobility management for NGN. This Recommendation describes that the importance of mobility management are location management and handover control [3]. Q.1708 specifies detailed features of objects and message flows related to location management base on recommendation Q.1707 [4]. Q.1709 specifies detailed features of objects and message flows related to handover base on recommendation Q.1707 [5]. And Y.2808 describes architecture of Mobility Management and Control Functions (MMCFs) for the NGN transport stratum.

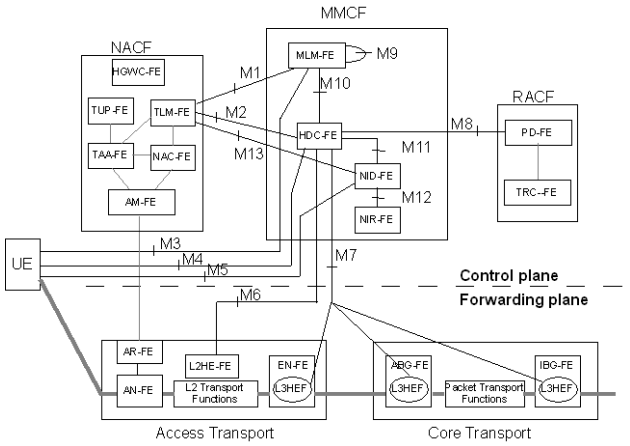

Figure 1. Reference points and information flows involved in mobility management and control [6]

This recommendation includes the definitions of the functional entities of MMCF and the scenarios for interactions with the other NGN functional components: NACF, RACF, SCF and the Access and Core Transport functional blocks within the forwarding plane [6]. Figure 1 shows the functions and functional entities described above along with the functional blocks and entities.

B. ITU-T NGN QoS Control

Within the NGN architecture, the resource and admission control functions (RACF) act as the arbitrator between service controls functions (SCF) and transport functions for QoS related transport resource control within access and core networks. The policy decisions made by the RACF are based on transport subscription information, SLAs, network policy rules, service priority, and transport resource status and utilization information. Figure 2 depicts a schematic view of the RACF in the overall NGN architecture [7] [10].

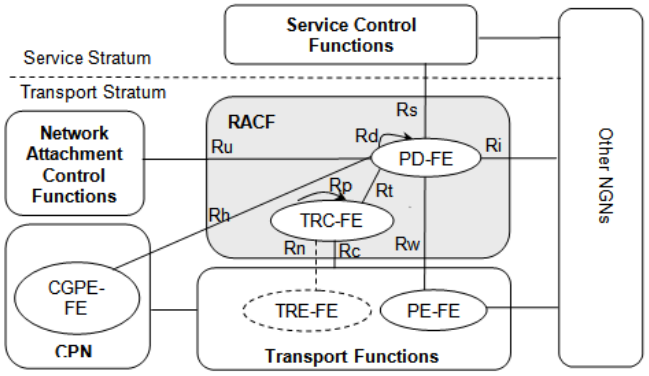

Figure 2. Generic resource and admission control functional architecture in NGN [7]

The RACF provides an abstract view of transport network infrastructure to the SCF and makes service providers agnostic to the details of transport facilities such as network topology, connectivity, resource utilization and QoS mechanisms /technology etc. The RACF interacts with the SCF and transport functions for a variety of applications that require the control of NGN transport resource, including QoS control [7][10].

The RACF executes policy-based transport resource control upon the request of the SCF, determines transport resource availability, makes admission decisions, and applies controls to transport functions for enforcing the policy decisions. The RACF interacts with transport functions for the purpose of controlling one or more of the following functions in the transport stratum: bandwidth reservation and allocation, packet filtering; traffic classification, marking, policing, and priority handling [7][10].

The RACF takes into account the capabilities of transport networks and associated transport subscription information for subscribers in support of the transport resource control. The RACF interacts with NACF (Network Attachment Control Functions), including network access registration, authentication and authorization, parameter configuration etc, for checking transport subscription information [7][10].

C. QoS-aware Mobility Management

ITU-T's recommendations [2]-[6], describe the requirements, architecture, and information flows for mobility management. And recommendation [7] specifies the functional architecture and requirements for the RACF in NGN, which provides real-time application-driven and policy-based transport resource management in support of end-to-end quality of service (QoS), gate control, network address translation, and traversal of remote network address translators. The article [9] presents an overview of NGN QoS control. And it explains in more detail the ITU-T QoS control architecture defined in RACF.

Figure 3 shows seamless mobility scenario which refers to ITU-T recommendation [1]-[8] and the article [9] for supporting QoS required by user.

First, the User's equipment (UE) has multi-interface, so UMTS, WiMAX and WLAN are available access network (AN) for user. However, WLAN and UMTS interfaces are only enabled by user. Under these circumstances, the UE connected to the WLAN#1 and uses the multimedia service through the WLAN#1. And then the UE's geographical location has been changed WLAN#2's arear from WLAN#1's coverage. In this case, the handover is required to UE. The explanation of each step in Figure 3 is as follows.

1 The UE sends the binding update to the mobile location management functional entity (MLM-FE) in mobility management control function (MMCF).

2 The UE sends the list of available AN to the handover decision and control functional entity (HDC-FE) in MMCF. In Figure 3, UE can connect the WLAN and UMTS.

3 The MLM-FE accepts the UE's binding update and it sends a handover request to the HDC-FE.

4 The HDC-FE requests QoS requirement of the user to the transport location management functional entity (TLM-FE) in network attachment control functions (NACF).
The TLM-FE holds a number of records representing active access sessions. These records contain information received from the NAC-FE and the TAA-FE, information on the list of SCFs having subscribed to particular events and

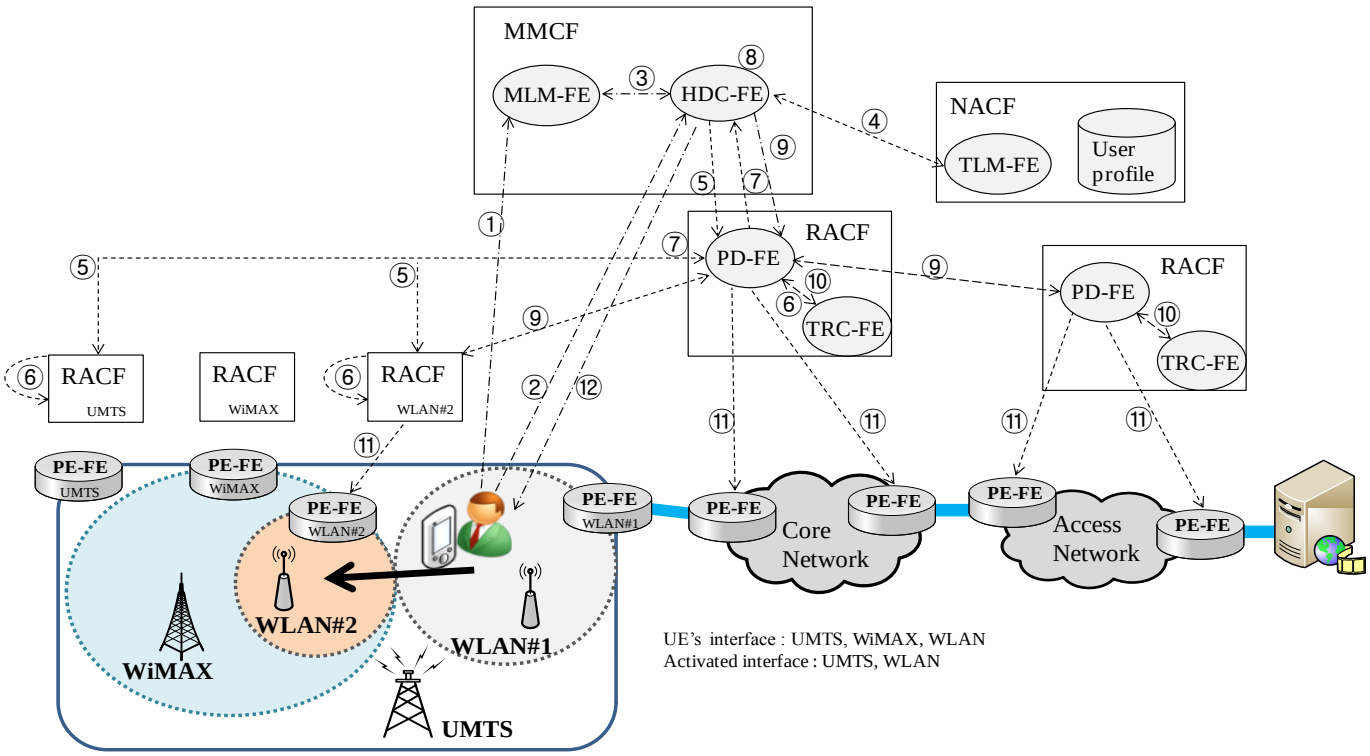

Figure 3. ITU-T QoS-aware Mobility Management message flows

additional statically configured data. In these records, bandwidth among QoS information is included [8].

5 The HDC-FE sends a resource statues request to the policy decision functional entity (PD-FE) of the core network (CN), UMTS, and WLAN#2. The resource statues request contains the QoS requirement.

6 The PD-FE of the CN, WLAN#2 and UMTS checks the resource availability from the transport resource control functional entity (TRC-FE). TRC-FE is monitoring the resource status of the network region and responds to the resource check request.

7 The RACF sends the response of the resource statues request.

8 The HDC-FE receives the resource statues information of WLAN#2 and UMTS from the PD-FE. The HDC-FE decides handover comparing the resource statues between WLAN#2 and UMTS. In Figure 3, WLAN#2's resource is better then UMTS, so HDC-FE decides handover from WLAN#1 to WLAN#2.

9 The HDC-FE sends a resource request to the PD-FE of the CN and WLAN#2.

10 The PD-FE of the CN, AN and WLAN#2 checks again the resource status from the TRC-FE.

11 The PD-FE controls the policy enforcement functional entity (PE-FE) at the boundary of the regional network.

12 The HDC-FE sends handover acknowledgement to the UE.

With these procedures, the HDC-FE selects the AN which has available resource. And it can be possible to provide handover within required QoS.

In NGN, the resource of network is controlled and managed using RACF based on policy which is managed by network administrator. In case of where the resource of network is insufficient for support required QoS, for providing required QoS, the PD-FE control the resource reservation status of the session which was reserved by other user.

Such methods, however, it is difficult to ensure seamless handover within required QoS when the availability of network resources is insufficient situation.

Additional problem that may occurs in the following cases; where only specific interface is activated. In this case, the HDC-FE decides the specific network which is only activated interface of UE. For example, WLAN interface of UE is only activated. However, WLAN has no more resource. Nevertheless, UE always try to access WLAN. So, the UE is not provided required QoS from the WLAN.

In order for the network to provide seamless mobility to the UE from like example situation, we proposal seamless handover schemes between heterogeneous networks when the shortage of resource of specific AN.

III. Proposed Schemes

The network environment in NGN is overlaid with various access technologies. In this environment, various services are offered to user; like Internet Protocol Television, Video Conference, and Video on Demand. The multimedia services

are required to high bandwidth and low latency time within network transport stratum. The seamless handover cannot be provided to UE when a user who is using multimedia service tries to access the new AN area which has insufficient network resource.

We explained the method of seamless mobility within required QoS in related work of this paper. Such methods, however, it is difficult to ensure seamless handover within required QoS when the availability of network resources is insufficient situation. In NGN, the resource of network is managed by RACF based on policy. To provide required QoS, the PD-FE controls the resource reservation status of the session which is reserved by other user when the resource of network is insufficient for supporting required QoS.

But this NGN method cannot provide seamless handover when the multimedia service user who require plenty of resource. Therefore, we propose seamless handover schemes between heterogeneous networks and we present a solution for insufficient resource status of the network. One is the terminal-based scheme, and the other is the network-based scheme.

A. Terminal-based scheme

Terminal-based seamless handover scheme within required QoS is a simple idea that HDC-FE informs the UE of the information about insufficient resource status. After receiving the information about insufficient resource status, the UE activates all its interfaces. And then the UE searches the AN which can be accessible.

The 'NGN massage' in Figure 4 is equal to the message of Figure 3. In terminal-based scheme like Figure 4, the UE only WLAN interface is activated in spite of the multi-mode interface; WLAN, WiMAX, and UMTS. Under these circumstances, the UE is connected to the WLAN#1 and it is provided with multimedia service through the WLAN#1. And then geographical location of the UE is changed from WLAN#1's coverage to WLAN#2's coverage. Therefore, the handover is required to UE. However, the resource availability of WLAN#2 is an insufficient status.

The explanation of each step in Figure 4 is as follows.

1~5 To provide handover for the UE from WLAN#1 to WLAN#2, the HDC-FE sends a resource request to the PD-FE of the CN and WLAN#2.

6 The TRC-FE in WLAN#2 measures a resource status insufficiently.

7 The PD-FE sends a resource status insufficiently to the HDC-FE.

8 The HDC-FE informs the UE of the information about insufficient resource status in WLAN#2 for supporting QoS which is required in multimedia service.

9 After receiving the information about insufficient resource status, the UE activates all its interfaces. And then the UE searches the AN which can be accessible.

10 The UE sends the list of available AN to HDC-FE. After step 9, UE can access the WiMAX and UMTS

11~13 The HDC-FE requests the resource status request to PD-FE of the UMTS and WiMAX.

14 The HDC-FE decides handover by comparing the resource statuses between UMTS and WiMAX. In Figure 4, WiMAX's resource is better than UMTS, so HDC-FE

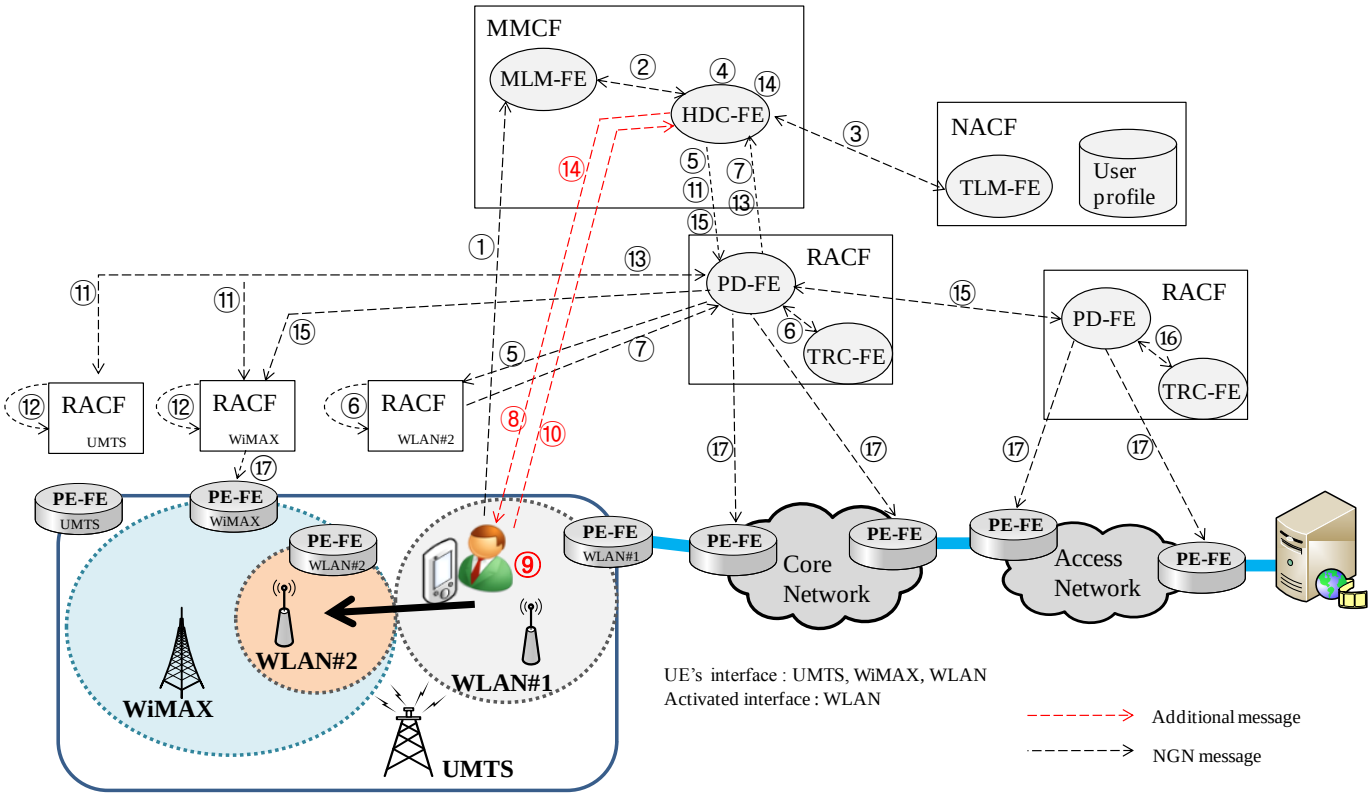

Figure 4. Terminal-based QoS-aware MM message flows

decides handover from WLAN#1 to WiMAX. And then, the HDC-FE sends information of the handover to the UE.

15 ~17 The HDC-FE sends a resource request to the PD-FE of the core, AN, and WiMAX for UE's handover.

The terminal-based scheme, it has an advantage that additional components of the network are not required. This method needs only two kinds of procedures. One is the message flow that is 'Access network is not available network to support QoS' messages sent and received between the UE and the HDC-FE; the other is UE's ability of activating its interface and searching the AN.

If these requirements add-ins in the NGN environment, it can be possible to support seamless handover within required QoS in insufficient resource status of specific AN.

However, terminal-based scheme has a weakness which is the long time of delay and unnecessary battery consumption with activating the UE's interface and searching the AN. Delay is one of the issues during handover; it is required to study about reducing delay by searching AN in terminal-based scheme.

B. Network-based scheme

Terminal-based scheme has the weakness which is the long time of delay with activating the UE's interface ad searching the AN in spite of more advantages.

The network-based scheme There is another scheme to support seamless handover within required QoS. For network-based scheme, it is required that the network can be check the UE's interface information without the UE, and needed to known the network topology information. By using this information, the HDC-FE decides the target AN which is the best one for supporting required QoS level. For the decision of AN by the HDC-FE, the HDC-FE can be recognized a list of UE's interface information. The UE's interface information is a possibility of knowing from authentication server (e.g. HSS and AAA of the GSM).

And the HDC-FE can be recognized a list of AN which can be connected at the UE's geographically location by the UE.

For this, following two information are assumed; Topology Server and User location information.

Topology server is the server which keeps information about AN from NGN. This server manages information about available AN which are located at around specific AN. And geographical location information of UE is also offered to the HDC-FE.

After assuming the HDC-FE knows this information, explanation of each step in Figure 5 is as follows.

1~7 These procedures are same or identical as Figure 4.

8 The HDC-FE sends a UE's identifier to the User Profile Server for getting a UE's interface information. After receiving the UE's identifier, User Profile Server searches UE's interface information using UE's identifier. After the searching, User Profile Server sends the list of UE's interface information to the HDC-FE. Identifier of UE uses the information used when UE requests a Binging Update to MLM-FE.

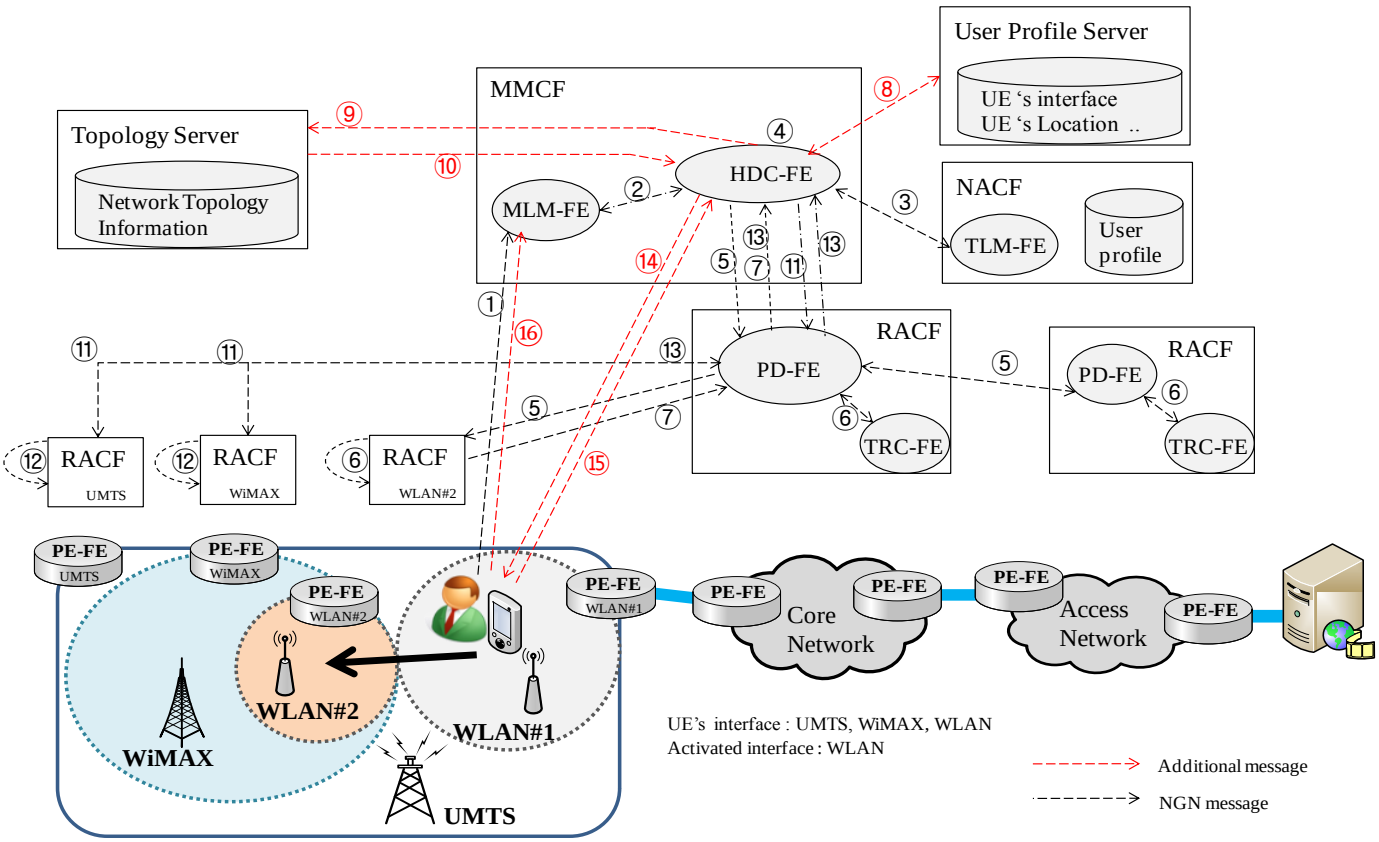

Figure 5. Network-based QoS-aware MM message flows

9 Topology Server is requested the information from the HDC-FE. This information is the geographical location information of UE and AN information which has connectivity with UE for getting available AN information. In Figure 5, the AN which has connectivity with UE is WLAN#1, and available AN is WiMAX and UMTS.

10 Topology Server sends a list of available AN to the HDC-FE. In this, we assume that Topology Server can be known this information.

11~13 Using the list of available AN, the HDC-FE requests the resource status request to PD-FE of the WiMAX and UMTS.

14 After resource measurement, HDC-FE decides the target AN which is the best one for supporting required QoS level. And then the HDC-FE sends the information of target AN to the UE.

15 The UE activates interface of target AN and sends binding update message to MLM-FE.

After these steps, UE can be received seamless handover within supporting required QoS.

Network-based scheme is needed assuming Topology Server and knowing the geographical location information of UE. However, network-based scheme has non-delay and low battery consumption by searching the AN based on terminal-based scheme.

C. Comparison between Network-based and Terminal-based scheme

We proposed terminal-based scheme and network-based scheme in chapter III. Both are also support to seamless handover within supporting required QoS when the shortage of resource of specific AN.

Terminal-based scheme has advantages that any components of the network are required. But, terminal-based scheme has a weakness which is the long time of delay and unnecessary battery consumption with activating the UE's interface and searching the AN. Delay is one of the issues during handover.

Network-based scheme is needed assuming Topology Server and knowing the geographical location information of UE. However, network-based scheme has non-delay and low battery consumption by searching the AN based on terminal-based scheme.

Therefore, it is required to study about reducing delay by searching AN in terminal-based scheme. In network-based network, it is required to study about architecture of Topology Server and management the UE's geographical location.

IV. CONCLUSIONS

This paper proposes seamless handover schemes between heterogeneous networks. For this, the HDC-FE decides the target AN which is the best one for supporting required QoS level when the shortage of resource of specific AN. Network resource control mechanism based on policy which is serviced at present is difficult to ensure user's QoS requirement which increases gradually. Existing mechanism does not support QoS provided in previous AN in case of handover toward new AN which has insufficient resource status. Network resource (bandwidth) affects the QoS for providing seamless multimedia service. Blur and blocky will be prevented by perform handover towards the closest heterogeneous network which supports QoS in that AN lacks resource. This paper focuses on the mechanism which ensures QoS provided in previous AN in case of handover between heterogeneous networks. Standardization, is progressed in ITU-T, has to solve the problem which was presented in this paper. And our proposed mechanism is a solution to solve the problems mentioned above.

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