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Design of MBMS Client Functions in the Mobile

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***Abstract*—**MBMS is a unidirectional point-to-multipoint bearer service in which data are transmitted from a single source entity to multiple recipients. For a mobile to support the MBMS, MBMS client functions as well as MBMS radio protocols should be designed and implemented. In this paper, we analyze the MBMS client functions and describe the implementation of them in our mobile test-bed. User operations and signaling flows between protocol entities to control the MBMS functions are designed in detail. Service announcement utilizing the file download MBMS service and four MBMS user services are demonstrated in the test-bed to verify the MBMS client functions.

***Keywords*—**BM-SC, Broadcast, MBMS, Mobile, Multicast.

I. Introduction

POINT-to-multipoint services have become important today which allow data to be transmitted from a single source entity to multiple endpoints. Since these multicast services are expected to be used extensively over wireless networks, there is a need for a capability in the Public Land Mobile Network (PLMN) to efficiently support them. The 3rd Generation Partnership Project (3GPP) has standardized Multimedia Broadcast and Multicast Service (MBMS) to enable the efficient transport of these multicast traffic in its Release-6 specification [1-3].

The MBMS is a unidirectional point-to-multipoint bearer service in 3GPP cellular network in which data are transmitted from a single source entity to multiple mobiles. Various MBMS user services can be made up of these MBMS bearer services. To support the MBMS, Broadcast and Multicast-Service Center (BM-SC) is newly added to the network, and MBMS controlling functions are added to the existing network entities such as UMTS Terrestrial Radio Access Network (UTRAN), Serving GPRS Support Node (SGSN), and Gateway GPRS Support Node (GGSN) [4-6]. For user equipments (UEs) (or mobiles) to support the MBMS, much additional functionality are also required to be added. Some of them, for example, the interaction among protocol entities which is beyond of the standardization should be defined in detail. New protocols such as File Delivery over Unidirectional Transport (FLUTE) and media codecs are also needed to be implemented [6]. The detailed design of these MBMS client functions in the mobile is necessary for testing and implementing the MBMS.

In this paper, we describe our development of the MBMS client functions in the mobile test-bed. We analyze the MBMS client functionalities and implement them into our mobile test-bed. User operations and signaling flows among protocol entities to control the MBMS functionalities are designed in detail. Service announcement utilizing file download MBMS service and four MBMS user services are defined. We show the result of service announcement and MBMS user services.

The rest of this paper is organized as follows. Section II overviews the MBMS. Our 3G evolution network and mobile test-beds on which the MBMS functionalities are developed are described in Section III. The detailed design of MBMS client functions and several MBMS user services are described in Section IV. Conclusion is presented in Section V.

II. Overview of the MBMS

A. Service Definition

The MBMS is a unidirectional point-to-multipoint service in which data are transmitted from a single source entity to a group of users in a specific area. MBMS provides two modes of services – broadcast and multicast as in Fig. 1. The broadcast mode enables multimedia data (e.g. text, audio, picture, video) to be transmitted to all users within a specific service area. The broadcast mode needs neither service subscription nor charging. The multicast mode enables multimedia data to be transmitted from one source entity to a specific multicast group. For a user to receive a multicast mode service, it should be subscribed to the multicast group in advance. Multicast mode services are charged, and therefore should be protected from illegal users.

B. Network Architecture

Fig. 2 shows the 3GPP Release-6 network architecture for the MBMS [5]. BM-SC is newly added, and MBMS controlling functions are added in UE (mobile), UTRAN, SGSN, and GGSN. The BM-SC connects to the MBMS contents providers, and transmits and schedules MBMS services. G_{mb} and G_i reference points are defined between GGSN and BM-SC. MBMS data packets are transmitted over G_i interface, and MBMS control signaling is transmitted over G_{mb} interface.

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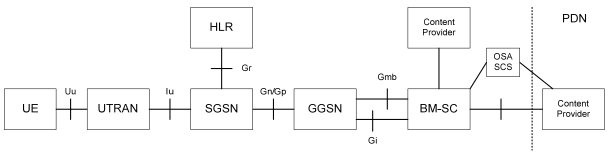

Fig. 2 Network reference model for the MBMS

III. System Environments for Developing the MBMS

A. 3G Evolution Test-Bed

3G evolution (3GE) system has been studied in 3GPP since 2004, which is defined as a packet-optimized system with higher user data rates, reduced latency, improved system capacity and coverage, and reduced costs for operators as compared to the 3G system. The evolution includes the radio access network architecture as well as the radio interface. However, the 3GE system architecture and specification has not been agreed yet, and needs more time to be standardized. For developing and testing 3GE system technologies, ETRI has prepared a 3GE system test-bed which consists of UEs, Evolved NodeB (E-NodeB), and Evolved Serving Node (E-SN) as shown in Fig. 3. BM-SC is connected to the E-SN via IP router. IPv6 is used as a transport between network entities.

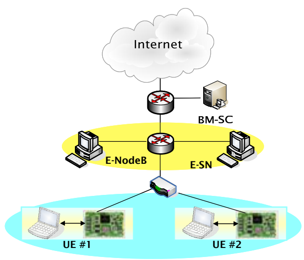

Fig. 3 3GE system test-bed

3GE Mobile (or UE) test-bed consists of terminal equipment (TE) and mobile terminal (MT). The TE is a portable notebook PC with x86 and Windows XP. The MT is an embedded system with StrongARM and VxWorks. The 3GPP radio interface protocols run on the MT, whereas MBMS applications and 3GE user interface programs run on the TE. USB interface is used between the MT and the TE. Ethernet interface is used between UEs and E-NodeB as the 3GE radio interface has not been standardized yet.

B. UE Protocols and MBMS Client

Fig. 4 shows UE protocol stack for the MBMS. MBMS-Session Management (MBMS-SM) controls the activation and deactivation of MBMS contexts, and Radio Resource Control (RRC) controls availability of MBMS services and manages MBMS radio resources. Transport channels for the MBMS such as MBMS Control Channel (MCCH), MBMS Scheduling Channel (MSCH), and MBMS Traffic Channel (MTCH) are defined newly [4-6]. Since the MBMS is unidirectional service (downlink only), Radio Link Control (RLC) Unacknowledged Mode (UM) is used to transfer MBMS data packets. The MBMS mandates H.264 for video streaming [7-9], and FLUTE for file download service. We use VideoLan Client (VLC) and MAD Flute free softwares to support these two kinds of MBMS services.

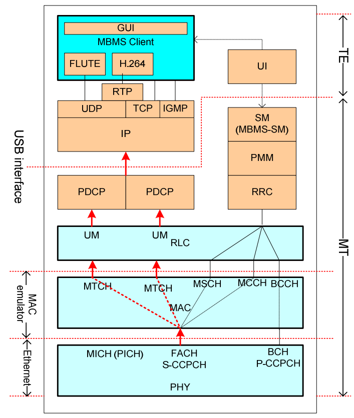

Fig. 4 UE protocol stack for MBMS

MBMS client is a kind of user application program which includes graphic user interface (GUI), media transport protocols such as FLUTE and H.264, media players, and other MBMS service control functions. The MBMS client application interacts with 3GPP user interface (UI) module and IP layers to control MBMS services. The MBMS client functions include not only the MBMS client program but also other MBMS-related functions in the mobile.

IV. Implementation of MBMS Client Functions in the Mobile

A. User Operations

The user's actions to control MBMS services are defined as following operations.

- *UE Power on (1)*
- *MBMS client on*
- *MBMS service on (3)*
  - *. Broadcast service on (3-1)*
  - *. Multicast service on (3-2)*
- *MBMS service off (4)*
  - *.Broadcast service off (4-1)*
  - *. Multicast service off (4-2)*
- *MBMS client off (5)*
- *UE Power off (6)*

Each operation initiates specific protocol procedures such as radio channel establishment and service activation as in Fig. 5. Using the GUI of the MBMS client program, a user selects or de-selects a specific MBMS service. The multicast service activation and deactivation requires UE-Network signaling, whereas the broadcast service activation and deactivation needs intra-UE signaling only.

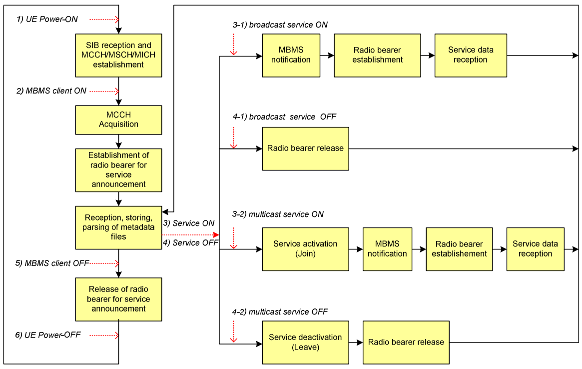

Fig. 5 User operations and procedures for the MBMS

B. *MBMS Control Signaling*

The 3GPP MBMS specifications do not include interactions between protocol entities in the UE. We design the inter-protocol interactions in the UE as in Fig. 6. The interactions are implemented with service primitives. The MBMS service primitives between protocol entities have several parameters – 'op-type', 'tmgi' and 'rab-id', which have values as following. The 'op-type' indicates an MBMS operation, the 'tmgi (temporary mobile group identity)' indicates the corresponding MBMS service, and the 'rab-id' indicates the MBMS bearer identifier.

- *Op-type = {mbms_on, mbms_off, broadcast_act, broadcast_deact, multicast_act, multicast_deact}*
- *Tmgi = service_id + plmn_id*
- *Rab-type = {pdp,mbms}*

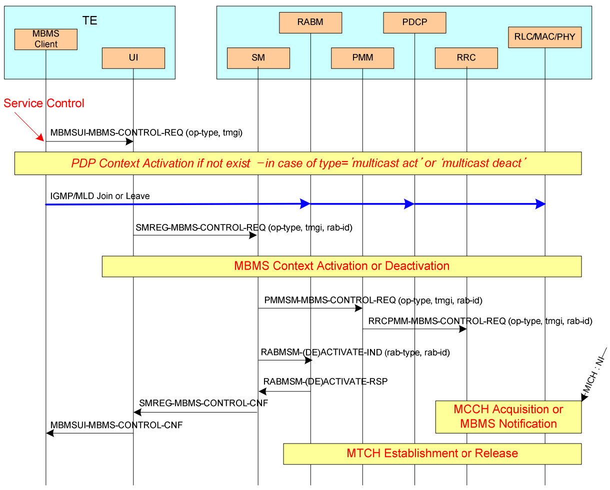

Fig. 6 MBMS control signaling between protocol entities

C. *Service Announcement*

For a user to receive MBMS services, it needs to know in advance which MBMS services are provided by the network, and how to receive them. This kind of information named as metadata structured as Fig. 7 is provided with service announcement procedure. The service announcement can be realized with several ways such as MBMS, cell broadcast service (CBS), or HTTP [6]. We use MBMS file download service for the service announcement. Using the MBMS download service, the metadata is broadcast over the entire network periodically. The multicast IP address and UDP port number for the service announcement should be predefined and may be broadcast over the network contained in RRC System Information Block (SIB) message. IP address '*ff1e::ff*' and UDP port '*5000*' are used in the service announcement.

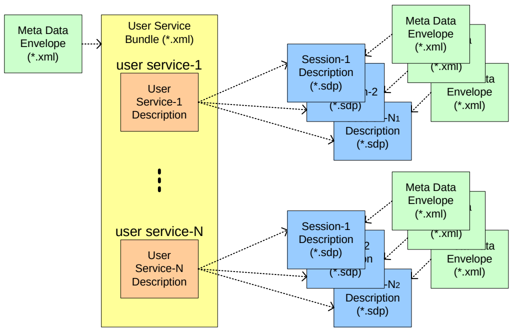

Fig. 7 File structure of the metadata

When a user initiates the MBMS client program, a FLUTE process is created for receiving the service announcement (metadata files). Fig. 8 shows the metadata files downloaded with the service announcement, and downlink packet rate during the service announcement. On receiving the metadata files, the FLUTE process stores them on the specified directory. The MBMS client program parses the stored metadata files, and extracts service information such as channel name, contents name, and service starting time, and then displays them to the user.

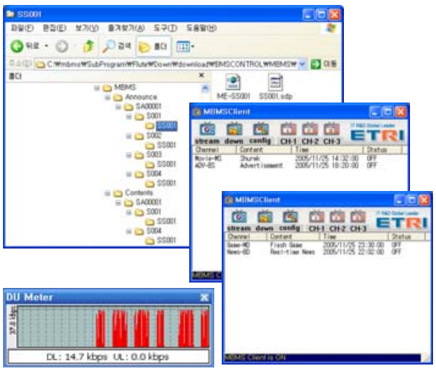

Fig. 8 Example of service announcement

D. *MBMS User Services*

An MBMS user service is provided with one or more than one MBMS bearer services. For simplicity, we only consider MBMS user service composed of one MBMS bearer service.

As the MBMS supports two service modes (multicast and broadcast) and two delivery types (streaming and file download), we compose four MBMS user services. Table I shows the parameters of the MBMS user services.

TABLE I
PARAMETERS OF MBMS USER SERVICES

Service ID	Channel Name	Multicast IP Address	Port#
1	Game-MD	ff1e::1	4001
2	Movie-MS	ff1e::2	4002
3	News-BD	ff1e::3	4003
4	Adv-BS	ff1e::4	4004

MS=Multicast-Streaming, BS=Broadcast-Streaming
MD=Multicast-Download, BD=Broadcast-Download

1) Video Streaming Service

When a user selects a video streaming service (channel named as *Movie-MS*), a VLC process is created with a multicast IP address and UDP ports specified in the corresponding metadata file. Fig. 9 shows the demonstration of the video streaming service. In 3GPP specification, maximum of 384 Kbps data rates are possible for the MBMS. In our test-bed, the video streaming service shows data rate about 1 Mbps due to using Ethernet instead of radio between UE and E-NodeB.

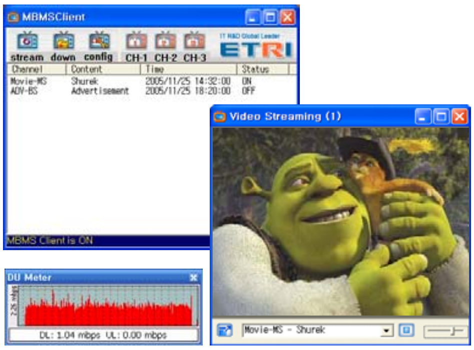

Fig. 9 Service examples - video streaming

2) File Download Service

When a user selects a file download service (channel named as *News-BD*), a FLUTE process is created with a multicast IP address and UDP ports specified in the corresponding metadata file. Fig. 10 shows the demonstration of the file download service. The downloaded file *(news.txt*) contains real-time news written in text, which is displayed on the MBMS client program GUI. The file download service which periodically broadcast same text files periodically to the service area shows periodical peak in the packet data rate graph.

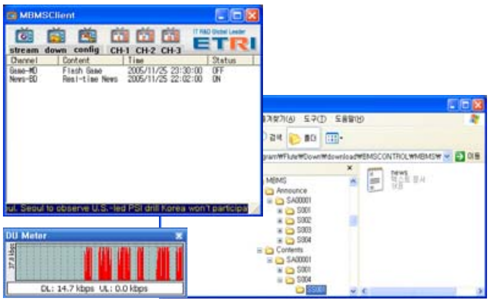

Fig. 10 Service examples - file download

V. CONCLUSION

In this paper, we analyze the MBMS client functions in the mobile and describe the implementation of them in our mobile test-bed. User operations and signaling flows among MBMS user, MBMS client program, and radio protocol entities to control MBMS functions are analyzed and designed in detail. Service announcement utilizing file download MBMS service and four MBMS user services are defined and demonstrated in our 3Ge system test-bed to verify the MBMS client functions. The demonstration shows that the MBMS services can be controlled efficiently with the MBMS client functions.

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