Design and Implementation for Seamless Multimedia Messaging Service over WLAN and CDMA2000

Su-Yong Kim, Yong-Bum Cho, Chang-Heon Oh and **Sung-Joon Cho**, *Member, KIMICS*

Abstract—MMS has been seen as the key application in its entry into the 3G mobile markets. Furthermore, the combination of WLAN and 3G wireless technologies will make MMS service more popular, bringing benefits to both service providers and their customers. To realize seamless MMS service over WLAN and CDMA2000 networks, we design and implement new platform architecture by reusing the existing standards and network elements at the same time. We employ loose coupling approach and Mobile IP approach to propose new platform architecture, interfacing MMSC with many existing components. Based on our platform architecture, we also present seamless MMS delivery implementations that can't be possible within the current MMS reference architecture. This paper will make a contribution for service providers to offer their customers with seamless MMS service over WLAN and CDMA2000 networks.

Index Terms—MMS, WLAN, CDMA2000, MMSC, SMSC, PI, PPG, PAP, HLR, HA, MSISDN, MIN, IMSI

I. INTRODUCTION

Multimedia Messaging Service (MMS) is a messaging service for the mobile environment that has been standardized by the WAP Forum [1], 3GPP [2], 3GPP2 [3], and OMA [4]. To the end user, MMS is very similar to the Short Message Service (SMS): it provides automatic and immediate delivery of user-created content. The used addressing is primarily the mobile number of the recipient and the bulk of the MMS traffic goes from mobile to mobile. MMS also provides support for E-mail addressing. Hence, messages can also be sent from mobile to E-mail and vice versa. In addition to the content type used for SMS text, MMS messages can contain still images, voice or audio clips, synthetic audio, video clips, and presentation information.

Furthermore, the combination of WLAN and 3G wireless technologies will make MMS more popular, bringing benefits to both service providers and their customers. Given the complementary characteristics of WLAN (faster short-distance access) and CDMA2000 (slower long-distance access), it is compelling to combine them to provide ubiquitous wireless access. It will allow CDMA2000 service providers to economically offload data traffic from wide-area wireless spectrum to WLAN indoor locations, hotspots, and other areas with high user density. For WLAN service providers, the integration will bring them a larger user base from CDMA2000, without having to win them through per-customer service contractors [5,6].

A network element called MMS Center (MMSC) implements the store-and-forward functionality in CDMA2000 network. In CDMA2000, with a Mobile Station ISDN Number (MSISDN), MMSC notifies the recipient Mobile Station (MS) of the new MMS message through Short Message Service (SMS) as the bearer protocol via SMS Center (SMSC). The notification contains the message size, the message reference (URL), the message subject, the originator address, etc. On the other hand, in WLAN, there is no specific method to send the notification about the incoming MMS message to the recipient MS which is identified with an IP address, not an MSISDN. This means that MMSC should inform the recipient MS of the new MMS message with an IP address in WLAN. As this functionality is not supported by the current MMSC, MMS service is not provided when the recipient MS is in WLAN, in spite of the integration of WLAN and CDMA2000.

In this paper, we design new platform architecture for supporting seamless MMS service over WLAN and CDMA2000 networks while considering the possibility of reusing the existing standards and network elements at the same time. We employ loose coupling approach and Mobile IP approach to propose new platform architecture, interfacing MMSC with many existing components. Based on our platform architecture, we also present seamless MMS delivery implementations that can't be possible within the current MMS reference architecture.

II. REFERENCE DESIGN ARCHITECTURE

A. Interworking Architecture

As shown in Fig. 1, several approaches such as loose coupling approach and tight coupling approach, have been proposed for interworking among heterogeneous networks [6-8].

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S. Y. Kim is with the Dept. of Inform. & Telecomm. Eng., Graduate School of Hankuk Aviation Univ., Koyang-City, Kyounggi-Do, 412-791, Korea (Tel : +82-2-3158-1518, Fax : +82-2-3158-1935, E-mail : sykim@hau.ac.kr)

Y. B. Cho is with the Dept. of Inform. & Telecomm. Eng., Graduate School of Hankuk Aviation Univ., Koyang-City, Kyounggi-Do, 412-791, Korea (Tel : +82-2-3158-1518, Fax : +82-2-3158-1935, E-mail : athome@hau.ac.kr)

C. H. Oh is with the School of Information and Technology, Korea University of Technology and Education, P.O. Box 55, Cheonan, 330-600, Korea (Tel : +82-41-560-1187, Fax : +82-41-564-3261, E-mail : choh@kut.ac.kr)

S. J. Cho is with the Dept. of Inform. & Telecomm. Eng., Graduate School of Hankuk Aviation Univ., Koyang-City, Kyounggi-Do, 412-791, Korea (Tel : +82-2-3158-1518, Fax : +82-2-3158-1935, E-mail : sjcho@hau.ac.kr)

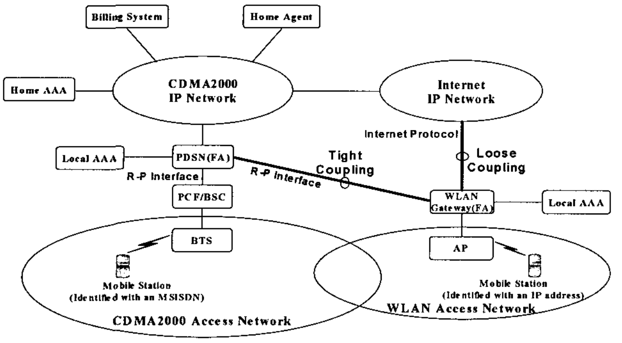

Fig. 1 Interworking architectures between WLAN and CDMA2000 networks

In loose coupling approach, it completely separates the data path in WLAN and CDMA2000 networks. As there are no data interfaces to the CDMA2000 IP network, the WLAN data traffic is never injected into the CDMA2000 IP network and directly accessed to the Internet IP network. They can differently handle the authentication, billing, and mobility management with their own mechanisms and protocols. They have to interoperate for seamless roaming. In tight coupling approach, the WLAN is connected to the CDMA2000 IP network in the same manner as just another Radio Access Network (RAN) technology like the CDMA2000 access network. The WLAN data traffic is flowed into the CDMA2000 IP network by using the CDMA2000 network protocols. They can share the same authentication, billing, and mobility management, regardless of the protocols used at the physical layer on the radio interfaces.

There are several advantages to loose coupling approach over tight coupling approach. First, it guarantees independence between WLAN and CDMA2000 access technology. Second, it is consistent and interoperable with existing WLAN environments. At last, it requires little standardization work and is cost effective. Therefore, loose coupling approach is the next step toward the interworking evolution. To support seamless MMS service over WLAN and CDMA2000 networks, we will use loose coupling approach as a reference model in this paper.

B. MMS Architecture

As illustrated in Fig. 2, MMS reference architecture contains several key elements that interwork with one another to provide MMS service. The key elements defined by the WAP Forum [1], 3GPP [2], 3GPP2 [3], and OMA [4] are described as followings.

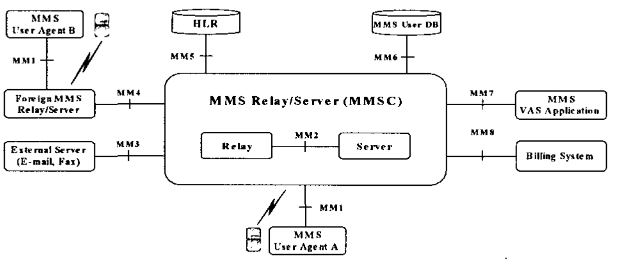

Fig. 2 Current MMS reference architecture

MMS User Agent: MMS User Agent (UA) is responsible for composing and rendering multimedia messages. Message rendering is performed by using the appropriate content rendering service. MMS User Agent also sends and receives multimedia messages to/from MMSC with the appropriate network protocols.

MMS Relay/Server (MMSC): MMS Relay, which is the key element in MMS Environment (MMSE), takes the responsibility for transferring multimedia messages across different messaging systems, transcoding multimedia message format, interworking with other platforms, and enabling access to various servers residing in other networks. MMS Server does store and handle the incoming and outgoing multimedia messages.

MMS User DB: MMS User Database (DB) may consist of lots of different data, such as user profile database, subscription database, and Home Location Register (HLR) information for mobility management.

MMS VAS Application: MMS Value Added Service (VAS) Application could be included in or connected to MMSE. The MMS VAS Application offers a value added service to MMS users and then may be able to generate charging data.

External Servers: Several external servers, such as E-mail server, Fax server, and SMSC, can be included in MMS reference architecture. Convergence functionality between external servers and MMS UA is provided by MMSC, which enables the integration of different server types across different networks.

III. PROPOSED MMS PLATFORM ARCHITECTURE

MMS delivery between two mobile stations can be divided in two parts. In the first part, referred to Mobile Originated (MO) message delivery, the originator MS submits the message to MMSC. In the second part, after completely receiving the message from the originator MS, MMSC delivers the message to the recipient MS. This part is referred to Mobile Terminated (MT) message delivery. An MS is identified with an MSISDN in CDMA2000 and with an IP address in WLAN. Currently in CDMA2000, with an MSISDN, MMSC informs the recipient MS of the new MMS message through SMS via SMSC. In WLAN, however, there is no specific method to send the notification about the incoming MMS message to the recipient MS which is identified with an IP address, not an MSISDN. Therefore, MMS service can't be supported to the recipient MS in WLAN, in spite of the integration of WLAN and CDMA2000.

As illustrated in Fig. 3, we employ loose coupling [7,8] approach and Mobile IP [9] approach to propose new platform architecture for supporting seamless MMS service over WLAN and CDMA2000 networks. We interface MMSC with many existing network elements such as SMSC, Push Proxy Gateway (PPG), HLR, Home Agent (HA), Authentication Authorization Accounting (AAA), Packet Data Service Node (PDSN), WLAN Gateway, and so on.

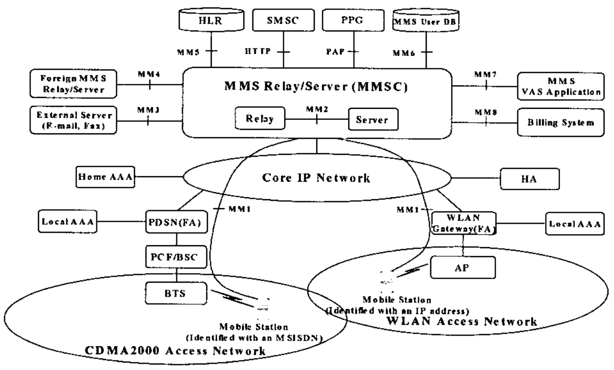

Fig. 3 Proposed MMS platform architecture over WLAN and CDMA2000 networks

The new and enhanced elements defined in our proposed architecture are described as followings.

MMSC: MMSC, as a Push Initiator (PI), is the entity that originates push content and submits it in the form of a push request using Push Access Protocol (PAP) to PPG for delivery to the recipient MS. Each submission has a unique identifier. MMSC can request the outcome of a push submission.

PPG: PPG is responsible for delivering the push content to the recipient MS. In doing so, it potentially may need to translate the recipient address provided by MMSC into a format understood by the mobile network, to transform the push content to adopt it to the recipient MS's capabilities, to store the content if the recipient is currently unavailable, etc. In addition to push delivery, PPG may notify MMSC about the result of a push submission.

PAP: PAP is based on standard Internet protocols. XML is used to express the delivery instructions and the push content can be any MIME media type. These standards help make WAP Push flexible and extensible [10].

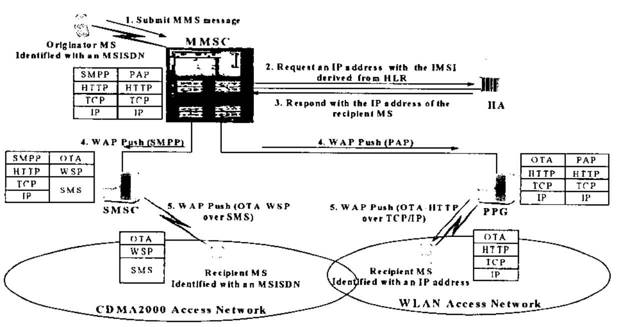

Fig. 4 Protocol stack for MMS push notification over WLAN and CDMA2000 networks

In our proposed architecture, before sending the notification about an incoming MMS message to the recipient MS in WLAN, MMSC needs to find out an IP address of the recipient MS with the MSISDN provided by the originator MS. As shown in Fig. 4, MMSC first asks for the International Mobile Subscriber Identity (IMSI) to HLR with the MSISDN. MMSC requests an IP address of the recipient MS to HA with the IMSI derived from HLR. With the IP address, MMSC sends the notification by using PAP to PPG over the wired network and then PPG sends the notification by using the push OTA protocol over the wireless network. MMSC originally creates the notification message. PPG examines the message and performs the required encoding and transformation. In the process, it generally should not remove any headers or the body of the message, although it may perform encoding or transforming. PPG, however, may add additional headers to the message to enable the needed OTA services. The notification message is delivered using HTTP POST method, implying that PPG acts as HTTP client and the recipient as HTTP server.

There are two methods for establishing an active TCP connection, such as PPG Originated TCP (PO-TCP) and Terminal Originated TCP (TO-TCP) [10]. PO-TCP allows an active TCP connection to be established when the bearer is active or the terminal's IP address is known by PPG. TO-TCP addresses other cases and is usually used in combination with Session Initiation Request (SIR) mechanism. In our new architecture, we use PO-TCP method.

IV. SEAMLESS MMS DELIVERY IMPLEMENTATION

To implement our new architecture, let us consider MMS push notification procedures that are not possible within the current MMS reference architecture.

1. To deliver a new MMS message, an originator MS submits MM1_submit.req message to MMSC using HTTP Post method in WLAN and CDMA2000.
2. MMSC sends MM1_submit.res message back to the originator MS indicating whether the new message is successfully accepted or not.
3. As the notification mechanism is dependent on the location of the recipient MS, MMSC needs to check which network the recipient MS is connected to before notifying the recipient MS of the incoming MMS message. MM1_notification.req message can be sent to the recipient MS with the MSISDN through SMS via SMSC in CDMA2000 like Fig. 5. On the other hand, in WLAN, MMSC needs to find out an IP address of the recipient MS from HA with the MSISDN provided by the originator MS. In WLAN like Fig. 6, MM1_notification.req message can be delivered to the recipient MS with the IP address through HTTP via PPG.
4. The recipient MS responds with MM1_notification.res message using HTTP Post method in WLAN and CDMA2000.
5. To download the new MMS message, the recipient MS transmits MM1_retrieve.req message to MMSC using HTTP Get method with the URL provided by MM1_notification.req message in WLAN and CDMA2000.
6. According to the terminal capabilities described in MM1_retrieve.req message, MMSC adapts the multimedia contents of the new MMS message. After encapsulating the new MMS message into MM1_retrieve.res message, MMSC sends it to the recipient MS using HTTP Post method in WLAN and CDMA2000.

7. On receiving MM1_retrieve.res message, the recipient MS sends MM1_acknowledge.req back to MMSC in WLAN and CDMA2000.
8. Before forwarding the delivery report to the originator MS, MMSC also needs to check the location of the originator MS. If the originator MS is in CDMA2000 like Fig. 6, MM1_delivery_report.req message can be sent to the originator MS with the MSISDN through SMS via SMSC. However, when the originator MS is connected to WLAN, MMSC first has to obtain an IP address of the originator MS from HA. And then, as shown in Fig. 5, MM1_delivery_report.req message can be submitted to the originator MS with the IP address through HTTP via PPG.

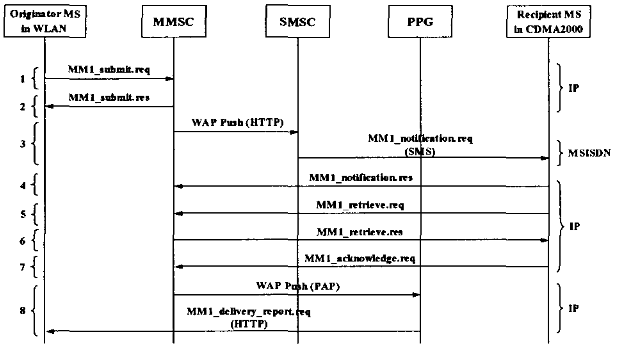

Fig. 5 Push notification procedure for seamless MMS service from WLAN to CDMA2000

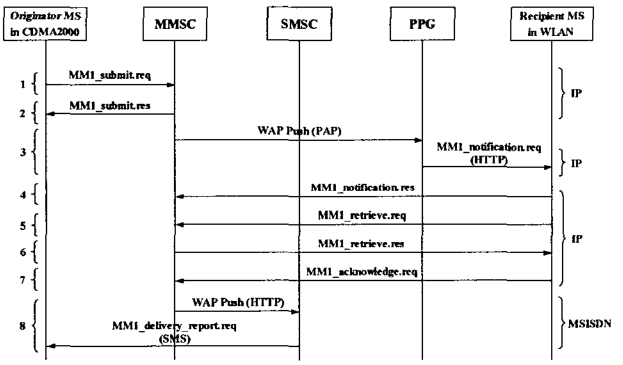

Fig. 6 Push notification procedure for seamless MMS service from CDMA2000 to WLAN

If WLAN doesn't support MMS service, MMSC has to delay the notification about the incoming MMS message or the delivery report until the recipient MS or the originator MS moves into CDMA2000 from WLAN.

V. CONCLUSIONS

In this paper, we designed new platform architecture for supporting seamless MMS service over WLAN and CDMA2000 networks while considering the possibility of reusing the existing standards and network elements at the same time. We employed loose coupling approach and Mobile IP approach to propose new platform architecture, interfacing MMSC with many existing components such as SMSC, PPG, HLR, HA, AAA, PDSN, WLAN Gateway, and so on. Based on our proposed platform architecture, we also presented seamless MMS delivery implementations that can't be possible within the current MMS reference architecture. This paper will make a contribution for service providers to offer their customers with seamless MMS service over WLAN and CDMA2000 networks. For secure MMS service, we need more investigations in the area of common authentication and mobility management.

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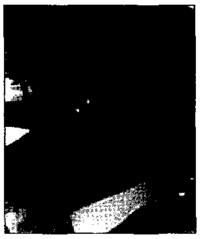

Su-Yong Kim
Received the B.S. and M.S. degrees in telecommunication and information engineering from Hankuk Aviation University, Kyounggi-Do, Korea in 1997 and 1999, respectively. He is currently completing the Ph.D. degree in information and telecommunication engineering at the same university. His research interests are in the areas of wireless Internet platform, wireless security and WLAN-Cellular integration.

Chang-Heon Oh
Received the B.S.(*magna cum laude*) and M.S.E. degrees in telecommunication and information engineering from Hankuk Aviation University, Kyounggi-Do, Korea in 1988 and 1990, respectively. He received the Ph.D. degree in avionics engineering at the same university. Since 1999, he has been a professor in the department of information and communication engineering, Korea University of Technology and Education, Chonan, Korea. His research interests are in the areas of communication theory, radio communications, and mobile communication systems design with particular emphasis on CDMA cellular system.

Yong-Bum Cho
Received the B.S. and M.S. degrees in telecommunication and information engineering from Hankuk Aviation University, Kyounggi-Do, Korea in 1996 and 1998, respectively. He is currently completing the Ph.D. degree in information and telecommunication engineer-ing at the same university. His research interests are in the areas of wireless TCP, Ad-hoc Network, WPAN, WLAN, and multimedia messaging service.

Sung-Joon Cho
Received the B.S. degree in telecommunication engineering from Hankuk Aviation University, Kyounggi-Do, Korea in 1969, the M.S. degree in the telecommunication engineering from Hanyang University, Seoul, Korea in 1975 and the Ph.D. degree in telecommunication engineering from Osaka University, Osaka, Japan in 1981. Since 1972, he has been a professor in the School of Electronics, Telecommunication and Computer Engineering, Hankuk Aviation University, Kyounggi-Do, Korea. His research interests are in the areas of wireless communication, mobile communication, and electromagnetic interference.