

A Multicast Service Scheme for Various Wireless Access Networks

Hyeonsik Yoon, Heasook Park

Omniflow System Research Team, Electronics and Telecommunications Research Institute, Daejeon, Korea

x7hyhs@etri.re.kr, parkhs@etri.re.kr

Abstract— A multicast technology has become a key component for the success of the IPTV service. Moreover as subscribers receive the data through various access networks, the necessity for the method that deals several wireless access networks equivalently for the multicast service is increasing. In this paper, we propose a multicast service scheme for the various wireless access networks and explain the operation scenario for the proposed scheme specifically. We believe that according to our proposal, it is possible that the multicast service is activated throughout all the wireless access networks.

Keywords— multicast, wireless, mobile, IGMP, VLAN, IPTV

I. INTRODUCTION

Recently, as the IPTV service spreads rapidly, a multicast technology is paid attention to. A multicast technology is a useful one that is able to transfer the same data to several receivers at the same time without an excessive load to a sender and networks.

Some of the reasons that have been contributing to the lack of wide scale multicast deployment are the complexity of the required protocol, the unstableness of the network as a result of the multicast protocol operation and the need for the upgrade of network components. Especially, though a huge investment is required for the multicast service, there are not profitable applications until now.

But, due to the development of the related technologies, the existing drawbacks of the multicast technology except the profitable applications are not a deployment bottleneck any more. And now, as the IPTV service which is the most profitable application has been commercialized successfully, the multicast service is required to transfer the same data to several subscribers efficiently.

On the one hand, subscribers receive the data through various access networks which include the wired networks like Ethernet, Asymmetric Digital Subscriber Line (ADSL), Cable Modem, etc. and the wireless networks like Wireless Local Area Network (WLAN), Wireless Broadband (WiBro)/World Interoperability for Microwave Access (WiMAX), Code Division Multiple Access (CDMA), Wideband Code Division Multiple Access (WCDMA), Long Term Evolution (LTE), etc. To receive the data through various access networks, the unified standardization for the multicast service is required.

Of course, each of the standardization bodies related to respective access networks is going on the standardization for the multicast technology. But regarding to interworking with other networks, it only considers the method to interwork with other networks subordinately. Therefore the necessity for the novel method that deals several wireless access networks equivalently for the multicast service is increasing. In order to resolve this issue, we will propose a multicast service scheme for various wireless networks and explain the operation of the proposed scheme specifically in the following sections.

The rest of the paper is organized as follows. In section 2, we explain the related work for the multicast mobility technology. In section 3, we present the network architecture for the paper and propose a multicast service scheme for various wireless access networks. And then we explain the operation scenario for the proposed scheme and finally present the vertical handover operation in the proposed scheme. This paper is concluded in section 4.

II. RELATED WORK

Recently, as the importance of the multicast mobility technologies related to IPTV is increasing, the multicast mobility (multimob) working group in the Internet Engineering Task Force (IETF) has been structured. The multimob working group provides guidance for supporting multicast in a mobile environment.

Specific goals for the group are:

- A solution to the tunnel convergence problem by separating multicast routing from a mobility anchor. Possible techniques are using native infrastructure, using a dedicated mobility anchor etc.
- Mechanisms to optimize multicast traffic during a handover. Such mechanisms may include context transfer functionality.
- Mechanisms needed to support multicast source mobility. Both any source multicast and source specific multicast mobility will be covered.
- Document the configuration of IGMPv3/MLDv2 in mobile environments.

Specifically, the study for the extensions of IGMPv3/MLDv2 to support better operation in mobile environments is performed [1][2][3]. It describes the ways of

IGMPv3 and MLDv2 optimization for mobility and aims to provide a guideline for query and other timers tuning.

And the mechanism to support multicast functionality in proxy mobile IPv6 (PMIPv6) is being developed [4][5]. It describes options for deploying multicast listener functions in proxy mobile IPv6 domains without modifying mobility and multicast protocol standards.

III. MULTICAST SERVICE SCHEME

A. Motivation

In this paper, we assume that a multicast IP address is used as a unique identifier that differentiates the several multicast services respectively. That is, the multicast IP address allocated to the related multicast service must be unique throughout all the wireless access networks.

As an example, when the Cable News Network (CNN) broadcasting is transferred as an IPTV service, it must be sent using the multicast IP address as a destination IP address. If we assign 224.1.1.10 to the multicast IP address of the CNN broadcasting, the IP address of the CNN broadcasting must be 224.1.1.10 in all the wireless access networks.

Each wireless access network guarantees different bandwidth and Quality of Service (QoS) against another wireless access networks especially in a wireless region. Hence, a multimedia stream must be offered to an access network considering the characteristics of the wireless region of the corresponding access network.

In more detail, because the mobile network like CDMA, WCDMA and LTE generally provides relatively low bandwidth, the multimedia server must offer a multimedia stream with low bandwidth. On the other hand, because the WLAN is relatively fragile to a packet loss, the multimedia server must provide a multimedia stream with an error correcting functionality.

As an example, in case of the CNN broadcasting as an IPTV service, the multimedia stream for a mobile network like CDMA and the multimedia stream for WLAN must be made separately and sent in a multimedia server. But in this method, we have a serious issue, that is, how the different multimedia streams for the CNN broadcasting with the same IP address (e.g. 224.1.1.10) could be requested and sent differently.

In this paper, we propose a multicast service scheme that identifies the different multimedia streams with the same IP address using the Virtual Local Area Network Identifier (VLAN ID) and therefore supports the multicast service through various wireless access networks.

B. Network Architecture

The network architecture for this paper is shown in Fig. 1. The network for offering multicast service through various wireless access networks includes a server farm, a public network and several wireless access networks.

The server farm includes one or multiple multimedia servers.

The public network is composed of a Convergence Gateway (C-GW), an edge router and several core routers.

The edge router is located at the network boundary and connected to the multimedia server. When the multimedia server sends a multimedia stream to the public network, the edge router transfers the multimedia stream to the C-GW through tunneling. Of course, in case that the multimedia server is connected to the C-GW directly, the tunneling is not required.

The C-GW interworks with various wireless access networks. And it differentiates the multimedia service required by the respective wireless access networks and transfers the multimedia stream, which is sent from the multimedia server through the edge router by tunneling, to the corresponding wireless access network. Finally the core router operates as an ordinary router.

The wireless access network could be the WLAN, WiMAX/WiBro, CDMA, WCDMA or LTE. And each access network includes an access network termination device which is located at the boundary of the access network and interworking with the C-GW. The access network termination device sends the IGMP report message to the C-GW for requesting the multicast service and receives a multimedia stream from the C-GW. In case of CDMA and WCDMA, a Gateway GPRS Support Node (GGSN) operates as an access network termination device and in case of LTE, a Public Data Network Gateway (PDN GW) is used. And in case of WiMAX/WiBro, Access Service Network Gateway (ASN GW) operates as an access network termination device and in case of WLAN, an Access Router (AR) is used as that device.

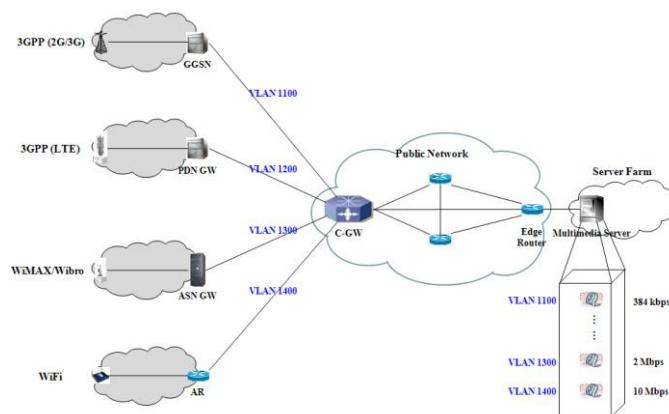


Figure 1. The network architecture

C. Proposed Multicast Service Scheme

In this section, we will explain the proposed multicast service scheme for various wireless access networks. The operation procedure for the proposed scheme is presented in Fig. 2.

At first, we must configure the VLAN between the C-GW and the wireless access networks, exactly the access network termination device in each access network. And the VLAN configuration information between the C-GW and the wireless access networks also must be stored in the multimedia server.

In Fig. 1, the VLAN ID for CDMA access network is assigned the VLAN ID 1,100 region (e.g. VLAN ID 1,100 ~

1,199) and the VLAN ID for WiMAX/WiBro access network is assigned the VLAN ID 1,300 region (e.g. VLAN ID 1,300 ~ 1,399). And this information must be shared among the multimedia server, the C-GW and the wireless access networks.

Then the C-GW creates the IP-in-IP tunnel with the edge router which is connected to the multimedia server. Of course, in case that the multimedia server is connected to the C-GW directly, the IP-in-IP tunnel is not needed.

After the above configuration is completed, the wireless access network that intends to receive a multicast service sends the C-GW an IGMP report message to request the join for a particular multicast group. At this time, the VLAN ID assigned to the access network is included in the option field of IP header in the IGMP message. And the C-GW can differentiate the sender of the IGMP message by investigating the option field.

The C-GW builds the multicast information database using a received IGMP message and transfers the IGMP message to the edge router. At this time, the C-GW transfers the IGMP message through tunneling. So the IGMP message is encapsulated with a tunnel IP header.

The edge router which receives the IGMP message removes a tunnel IP header and transfers to the multimedia server.

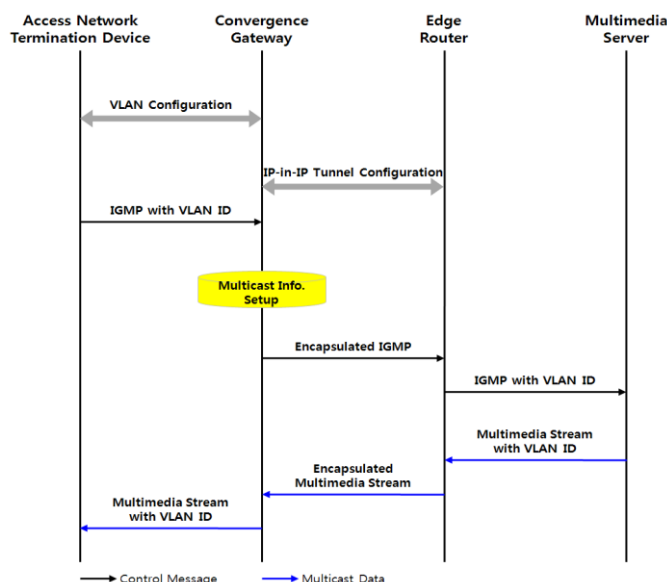


Figure 2. The proposed operation scenario for the multicast service

The multimedia server identifies the wireless access network, which requests the join for a particular multicast group, by the VLAN ID in the option field of the received IGMP message and sends the suitable multimedia stream for the corresponding access network with the related VLAN ID in a VLAN tag.

The format of the IP packet for the multimedia stream is constructed as follows: {VLAN tag, IP header, IP Payload}. The source IP address of the above IP packet is the IP address of the multimedia server and the destination IP address of the

above IP packet is the IP address of the requested multicast group.

The edge router, which receives a multimedia stream with a VLAN tag from the multimedia server, encapsulates the multimedia stream using the tunnel IP header and transfers it to the C-GW.

The format of an encapsulated multimedia stream forwarded from the edge router is shown as follows: {Outer IP header, VLAN Tag, Inner IP header, IP Payload}. The outer IP header is a tunnel IP header. The source IP address of the outer IP header is the IP address of the edge router and the destination IP address of the outer IP header is the IP address of the C-GW.

When the C-GW receives an encapsulated multimedia stream by tunneling, it removes the outer IP header of the received multimedia stream and obtains the VLAN ID and the multicast IP address included in the multimedia stream. If more than one access network are identified by the acquired VLAN ID and multicast IP address, the C-GW must transfer the multimedia stream to the corresponding access networks simultaneously.

We show the ordinary IP header format used in the Internet in Fig. 3. In our proposal, we will use the option field in an IGMP report message to deliver the VLAN ID related to an access network. And we think that it's better to be delivered in the TLV format. The proposed TLV format is shown in Fig. 4.

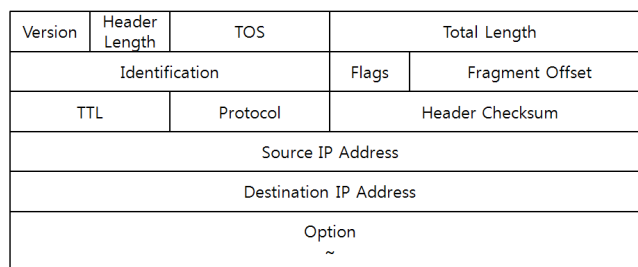


Figure 3. IP header format

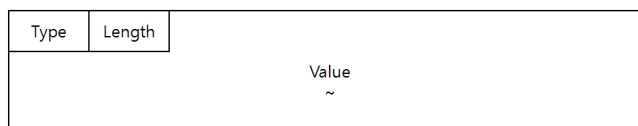


Figure 4. TLV format

D. Vertical Handover Operation

In this section, we will explain the vertical handover operation between various wireless access networks in the proposed multicast service scheme. The operation scenario of the vertical handover is presented in Fig. 5.

When the subscriber, which is receiving a multicast service in a wireless access network, moves to another wireless access network, the new wireless access network identifies the movement of the subscriber. And the termination device of the new wireless access network sends the C-GW an IGMP report message with VLAN ID B.

At this time, the subscriber ID must be sent with the VLAN ID in the option field of the IGMP message. The subscriber ID

is the identifier which discriminates the subscriber node and could be the MAC address, the serial number of the mobile node or the Universal Subscriber Identity Module (USIM) card information.

The C-GW, which receives the above IGMP message, can confirm the movement of the subscriber node by searching the multicast database with the subscriber ID and the VLAN ID. In case of new subscriber regarding the related multicast group, the C-GW creates new multicast database. On the other hand, in case of the vertical handover the C-GW requests the subscriber profile information to the old access network for the confirmation of user authority and access rights. And using the response information, the C-GW updates the multicast database.

Then the C-GW transfers the IGMP message to the edge router through tunneling and the edge router which receives the IGMP message removes a tunnel IP header and transfers to the multimedia server.

The multimedia server identifies the new wireless access network, which requests the join for a particular multicast group, by the VLAN ID in the option field of the received IGMP message and sends the suitable multimedia stream for the corresponding access network with the related VLAN ID in a VLAN tag.

The forwarding procedure and the format of the multimedia stream are identical to the initial operation of the proposed multicast scheme mentioned before.

the wireless access networks and the multicast service will be activated.

IV. CONCLUSIONS

We have proposed a multicast service scheme for various wireless access networks. In the proposed scheme, we assume that a multicast IP address is used as a unique identifier that differentiates several multicast services respectively. We presented the network architecture for the deployment of the proposed scheme. We must configure the VLAN between the C-GW and the wireless access networks. And then this information must be shared among the multimedia server, the C-GW and the wireless access networks.

When the wireless access network that intends to receive a multicast service sends the C-GW an IGMP message with a VLAN ID, the C-GW can discriminate the sender of the IGMP message by investigating the option field of the received packet and transfers the message by tunneling to the edge router connected to a multimedia server. The multimedia server identifies the wireless access network which requests the join for a particular multicast group by the VLAN ID included in the option field of the received IGMP message and sends the suitable multimedia stream for the corresponding access network with the related VLAN ID in a VLAN tag.

Further studies are required to use the PIM-SM protocol instead of tunneling for transferring the IGMP message with a VLAN ID and to present the simulation results that evaluate the effectiveness of our proposal.

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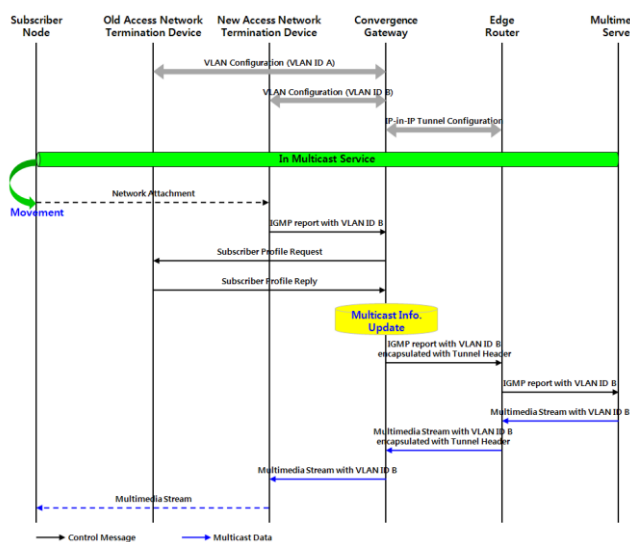


Figure 5. The vertical handover operation in the proposed scheme

We are sure that according to our proposal, it is possible that the multicast service is operated effectively throughout all