

Mobile Multicast Mechanism based MIH for Efficient Network Resource Usage in Heterogeneous Networks

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Abstract— In this paper, mobile multicast mechanism based on IEEE 802.21 MIH (Media Independent Handover) for efficient network resource usage is proposed. Proposed mechanism supports the efficiency of network resource usage and fast multicast handover. The proposed architecture adopts multicast manager concept to MIH framework in order to efficiently perform mobile multicast handover, and adds the new MIH messages dedicated for mobile multicast. Multicast network selection algorithm is designed by means of terminal speed and fair selection algorithm named AHP/GRA. Finally we compare the performance of the proposed mechanism with the legacy mobile multicast mechanism.

Keywords— Mobile Multicast, Handover, Mobility, MIH, Network Resource

I. INTRODUCTION

The desire for mobility among mobile user and the rapid progress in hardware technologies have developed new wireless mobile network technologies. In this network environment, advances of technologies have increased the requirement for various service that use various radio access technologies such as 3GPP/GPP2, Wibro, WLAN in wireless mobile networks – for example, internet broadcasting, multiple video/audio conferencing. The increase of usage of multimedia services causes more usage of network resource.

Multicasting has naturally been considered the ideal technique to be used with multimedia communications, mainly because its inherent nature is to minimize the network resource needed to support this type of communication. And supportable speed of Mobile Nodes (MN), bandwidth, number of channel and QoS (Quality of Service) are different in accordance with access technologies. Therefore, access technologies are needed for integrated management.

Since wireless mobile networks have limited network resources compared with fixed networks, the issue is very critical and essential to achieve high network performance. Recently some mobile operators and device manufacturers introduced multi-mode MNs to provide seamless network connectivity to their subscribers by using multiple wireless access technologies.

In order to optimize vertical handover between various wireless networks, IEEE 802.21 WG has been developing

MIH standardization from 2004. It defines the link-layer handover framework supporting network transparency and fast triggering on handover events [4]. Most of fast handover protocols such as FMIPv6 assume L2 triggering events on handover. Therefore, MIH can effectively work with network-layer fast handover protocols and many researches are ongoing. But there are not many research of multicast.

Nowadays, the research of mobile multicast for fast handover is that the mechanism is fast Mobile IPv6 added multicast option to join the multicast group before handover. But, it is not optimized to heterogeneous networks and cannot be the integrated management of many MNs and various networks.

We propose the mobile multicast mechanism for efficient network resource usage and fast handover to select the adequate network by using network characteristics, Dedicated CHannel (DCH) and Common CHannel (CCH), QoS, and so on.

In this paper, we will suggest a mobile multicast mechanism based MIH for efficient network resource usage and fast handover in heterogeneous networks. The rest of this paper, chapter 2 presents related work on fast mobile IPv6 handover for multicast service and IEEE 802.21 MIH. Chapter 3 introduces the architecture of mobile multicast based MIH and protocol procedure. Chapter 4 analyzes the new scheme. Conclusion is detailed in chapter 5.

II. RELATED WORK

A. Fast Mobile IPv6 Handover for Multicast Service (FMIPv6-M)

This protocol describes a fast multicast protocol to reduce a multicast data loss and delay in Mobile IPv6 environments.

A MN sends the information about a multicast group to which MN subscribes, to the current access router before a MN handovers to another network. After receiving this information, the current access router sends this information to the nearby access router to which the MN will handover in order to subscribe to a multicast group. When the MN handovers to another network, the access router of the network can deliver multicast data packets to the MN, because it already subscribes to a multicast group. Therefore the MN can receive multicast data with reduced loss and delay after handovers. [8]

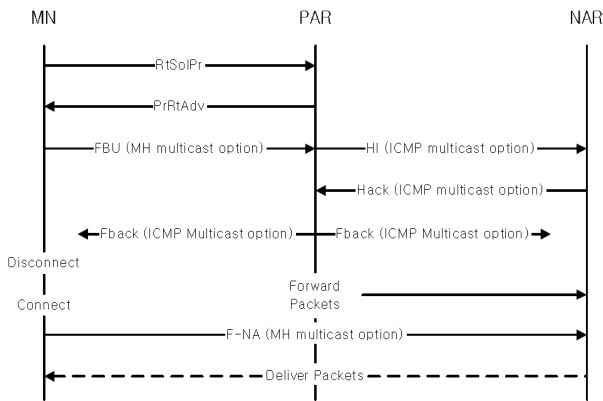


Fig.1.Fast Handover with Multicast Option

B. IEEE 802.21 Media Independent Handover Service

The IEEE 802.21 Media Independent Handover Function (MIHF) managing the mobility between the heterogeneous networks is positioned between the link layer (L2) and upper layers in the MNs and network element. And it provides the function of supporting the fast handover between L2 and L3. MIHF has three kinds of services. These services provision the information such as link status, neighboring access networks information, and operation policies. And, they support both network-initiated and mobile-initiated handovers. The above three services are Media Independent Event Service (MIES), Media Independent Command Service (MICS), and Media Independent Information Service (MIIS). [4]

1) *MIES*: MIES provides event classification, event filtering and event reporting services corresponding to dynamic changes in link characteristics, links status, and link qualities.

2) *MICS*: MICS allows MIHF to query neighboring link resources, and so helps them manage and control link behavior relevant to handovers by using a set of primitives and commands.

3) *MIIS*: MIIS offers a mechanism for an MIHF entity to access the fundamental information about heterogeneous neighboring access networks, network topology, properties, and available services in order to facilitate the handover process.

III. MOBILE MULTICAST HANDOVER BASED MIH

In this chapter, we propose the design that support the fast handovers and guarantee QoS when providing the multicast service in the heterogeneous networks.

A. MIH-Multicast (MIH-M) Architecture

In figure 1, It introduce system architecture for mobile multicast handover based MIH

1) *Multicast Manager (MM)*: In the heterogeneous networks, MM performs the function which selecting the network which is adequate to the requirement of the multicast application, the state of MN, and the efficient use of network resource.

2) *Multicast Channel Controller (MCC)*: Since MN change the channels and networks, MCC reports to MM about

information of monitoring continuously multicast channel and supporting networks.

3) *Handover Controller (HC)*: The function of HC which charges the direct interface with MIHF maintains and controls the flow between many components.

4) *Handover Policy Manager (HPM)*: It decides a policy of performing multicast handover. There are two type policy decision; manual, automatic

5) *Connection Manager (CM)*: It is a module which has control of the connectivity to the heterogeneous networks.

6) *MIH-IS(Information-Server)*: It provides the information of networks, multicast group for MM to decide the multicast networks.

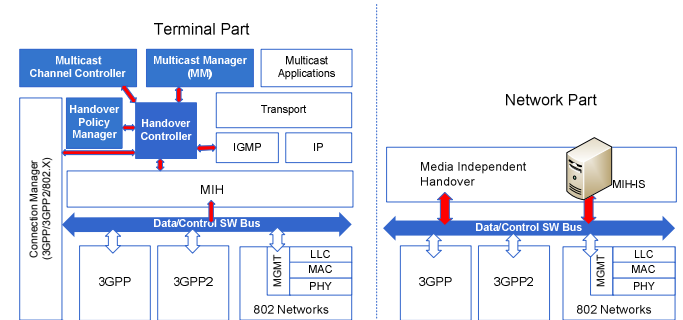


Fig. 1 The proposed MIH-Multicast System Architectures

B. MIH-Multicast Procedure

In this section, we will illustrate by using a flowchart.

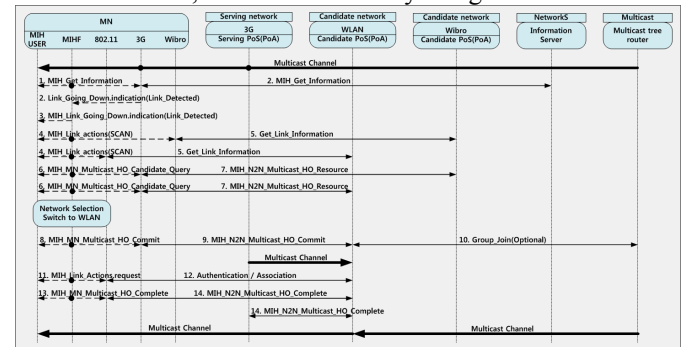


Fig. 2 New MIH Message Flow on Handover

The figure 2 shows the procedure of MIH-M message flow during handover. MN receives the multicast data, and periodically updates the information of neighbor networks by using MIH-IE message and MN check link status.

If MN gets the MIH event service message such as Link_Going_Down (LGD) and Link_Detected (LD) message, MN predicts the handover, and prepares handover execution. MN commands link-layer to scan the candidate networks by using link-action message for handover, and get the information of link-layer connection of candidate networks.

MN gets the information of candidate networks including multicast information, and MN decides a top candidate network to do handover by using network selection algorithm including AHP/GRA (Analytical Hierarchy Process / Grey Relational Analysis). MN sends the information of the handover execution including MN's multicast group membership to a selected network by using MN_Multicast

_HO_Commit, and N2N_Multicast_HO_Commit. If a selected network does not have MN's multicast group membership, it sends the multicast join message to the upstream multicast routers before handover.

In FMIP-M protocol, MN sends FBU message including multicast group membership, and join the multicast group. But, in MIH-M protocol, Mobile IPv6 specification is not need to be revised. And proposed protocol which be used MIHF efficiently can manage the mobile multicast handover in heterogeneous wireless networks.

After multicast handover, MN sends MN_Multicast_HO_Complete which means the handover execution is finished. And MN receives the multicast data. Simultaneously, MN informs the finish of handover execution to previous network.

Table 1 is the revised MIH message for multicast handover.

TABLE I
MIH MESSAGES ADDED IN THIS PAPER

Primitives	Service	Parameter
MIH_MN_Multicast_HO_Candidate_Query	MICS	.Destination_ID .Source_ID .Candidate_Link_List .Qos_Requirement .IP_Configuration .Candidate_Prefix .MN_Multicast_Group .Network_Multicast_Group
MIH_N2N_Multicast_HO_Query_Resource	MICS	.Destination_ID .Candidate_Link_List .Qos_Requirement .IP_Configuration .AR_Address .Candidate_Prefix .MN_Multicast_Group .Network_Multicast_Group
MIH_MN_Multicast_HO_Commit	MICS	.Destination_ID .Link_Type .Target_Network_Info .MN_Multicast_Group
MIH_N2N_Multicast_HO_Commit	MICS	.Source_ID .MN_ID .Target_MN_Link_ID .Target_PoA .Request_Resource_Set .MN_Multicast_Group
MIH_MN_Multicast_HO_Complete	MICS	.Destination_ID .Source_ID .Target_Link_ID .HandoverResult

C. Network Decision Algorithm of MIH-Multicast

In this section, we explain the network decision algorithm.

MN periodically checks MN's link status and neighbor networks. While this process, there are two way for MN to do handover. First way is that MN receives LGD message. Second way is that MN receives LD message. First way means that MN predicts the handover soon. Second way means that MN detects some networks which have better QoS factors.

Figure 3 shows the procedure of the first way. The wireless network techniques have the limit speed supporting the mobility. For example, MNs in high-speed train (300km/h) is possible to have a connection to 3G network but cannot connect the WiBro supporting the speed of 90km/h. In the case of WLAN, it is another wireless network technique which is possible in very small range, so is difficult to support the mobility.

The priority of selection network is a MN speed in order to prevent the unnecessary performance of determining whether the networks support the desired QoS or not. In case the speed of the MN can be supported, next procedure is performed.

```
# Handover is generated by MIH Event

# MN periodically get the information of neighbor networks and MN status.

# When MN get two kinds of MIH_Messages
(Link_going_out or Link_detected),
Multicast Manager works.

switch(MIH_Message) {
case Link_going_out :
if(Supportable Speed of detected network >= MN_Speed)
{
register networks which can support MN in Det_Network_List(m);
delete the unsupportable networks;
if(Det_Network_List(m)  $\ni$  Det_Common_Channel(m))
{
compare Det_Network_List(m_C) using AHP/GRA;
decide the best network for handover;
send the group_join message;
}
else
{
if(Det_Network_List(m)  $\ni$  Det_Dedicated_Channel(m))
{
compare Det_Network_List(m) using AHP/GRA;
decide the best network for handover;
send the group_join message;
}
else {
restart the procedure;
}
}
}
else {
restart the procedure;
}
}
```

Fig.3 Network Decision Algorithm for Link_Going_Down message

After MN receives LGD message, MN scans the candidate networks and get the information of networks. And then, MN compares MN's speed with supportable speed of detected network. MN checks DCH and CCH of networks among networks with supportable speed. If CCH is in detected networks, MN compares detected networks which have CCH by using AHP/GRA. According to the result, MN decides an adequate network, and executes handover procedure. CCH is higher priority than DCH, so CCH is considered first. If CCH

is not in networks, MN compare with detected networks which have DCH by using AHP/GRA. The AHP Factors are Quality of Service element (Delay, Bandwidth, BER, Cost), Network usability, and available lifetime.[14]

We can configure AHP map based these values of information and set the weight values on various situations. By using GRA, the values of the quality of service information of each mobile network are standardized and it reflects the weight value of AHP. If the group join is needed, the multicast handover is performed. [6]

```

Case(Link_detected)
if(Supportable Speed of detected network >= Speed(m))
{
    register networks which can support MN in Det_Network_List(m);
    delete the unsupportable networks;
    if(MN_Connected_Net = Common_Channel(m))
    {
        if(Det_Network_List(m)  $\ni$  Common_Channel(m))
        {
            compare Det_Network_List(m) with present connected network using
            AHP/GRA;
            decide the best network for handover;
        }
        else
        {
            maintain the connection with connected network;
        }
    }
    else
    {
        if(Det_Network_List(m)  $\ni$  Common_Channel(m))
        {
            compare Det_Network_List(m) with present connected network using
            AHP/GRA;
            decide the best network for handover;
        }
        else
        {
            maintain the connection with connected network;
        }
    }
}

```

Fig. 4 Multicast Network Selection Algorithm for Link_Detected

Figure 4 shows the second way. MN received LD message which means MN detect the new neighbor networks. First, MN selects the networks which can support MN's speed. If MN connects the CCH of current network, and detected networks have CCH and MN's multicast membership, MN compares current network with detected networks by using AHP/GRA. MN decides the handover depending on computed value. If MN connects the DCH of current network and detected networks have CCH, MN compares current network with detected networks. MN decides the handover depending on computed value.

IV. PERFORMANCE EVALUATION

In this chapter, we compare MIH-M with the FMIPv6-M in heterogeneous networks.

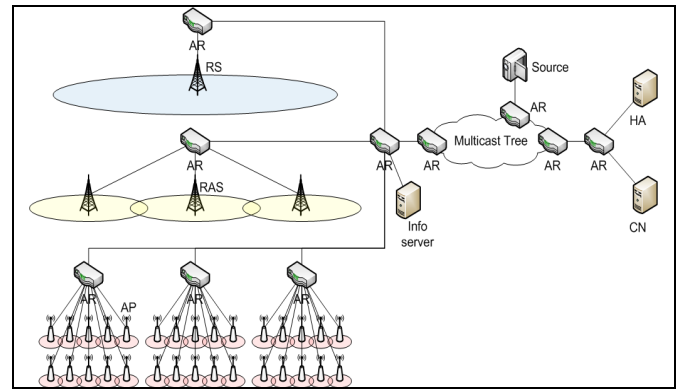


Fig. 5 Network Simulation Environment

Each network has characteristics defined as shown on table 2, and be overlaid as shown on figure 5. All MN know the information of current speed and direction. We compare FMIPv6-M with MIH-M for channel and bandwidth utilization. Simulation uses NS-2 simulator, and parameter as shown on table 3.

TABLE II
NETWORK MODEL

	WLAN	Wibro	3G
Bandwidth	50Mbps	10Mbps	2Mbps
Maximum Supportable Speed	< 8.3m/s	25m/s	> 25m/s
Cell Coverage	100m	1km	2km

FMIPv6-M is not optimized to heterogeneous networks, so network selection algorithm uses RSSI (Received Signal Strength Indicator) and network selection algorithm of MIH-M uses previous defined policy.

TABLE III
SIMULATION PARAMETER

Area Size	2000m $\times$ 2000m
Simulation Time	30s
Number of Node	1000
Speed Rang	1m/s ~ 35m/s
Multicast channel	10
Mobility Model	. Random way point . Manhattan

Next, we compare the performance evaluation of each algorithm. In a simulation scenario, we use two mobility model which MNs has various speed (1~35m/s). and we evaluate the channel and bandwidth usage.

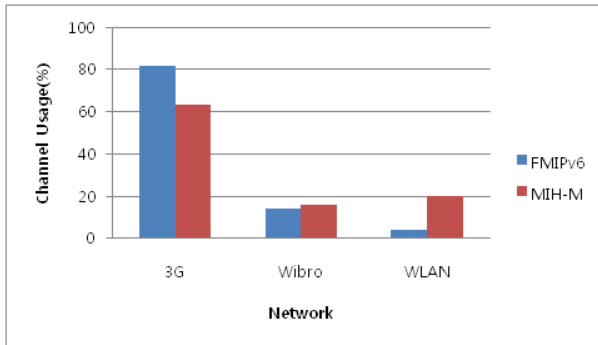
Figure 6 shows network channel usage. Channel usage of 3G is decreased, but the others are increased. MIH-M selects the efficient network because it checks CCH in network, and considers MN's speed, QoS support. Many MNs execute handover to Wibro, WLAN except MNs which have high speed and be in area where MN cannot connect Wibro and WLAN.

V. CONCLUSIONS

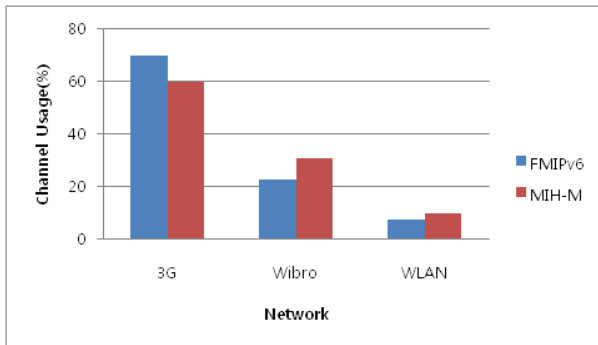
In this paper, we proposed a multicast handover mechanism based on MIH which supports efficient network resource usage and fast handover and QoS for mobile multicast channels by using DCH/CCH, network information, MN's mobility. It includes a network selection algorithm which first performs network filtering based on terminal speed and processes AHP/GRA algorithm in order to choose the optimum network satisfying QoS requirements of a multicast service. In addition, we propose the extended protocol to standard MIH to effectively collect the network information and multicast group information. Finally, a simulation was carried out in order to evaluate the effectiveness of the multicast handover mechanism. The simulation results showed that MIH-M has efficiency of network usage than other approach.

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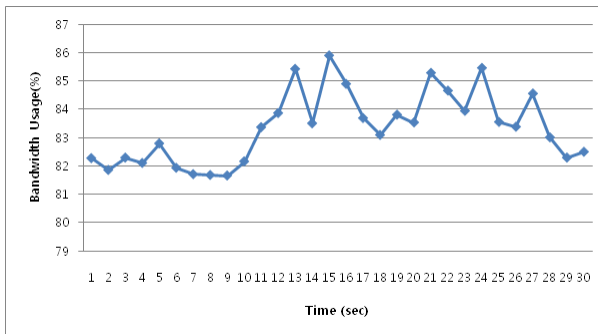
(a)



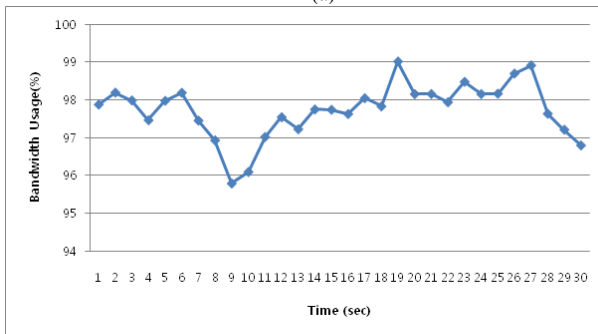
(b)

Fig.6 Network Usage with two Mobility Models. (a) Manhattan Model, (b) Random WayPoint

Figure 7 shows bandwidth usage. MNs which connect CCH are increased so that total network resource is decreased. In result MIH-M uses network resource 2~20% less than FMIPv6-M



(a)



(b)

Fig.7 Bandwidth Usage with two Mobility Models. (a) Manhattan Model, (b) Random WayPoint