Enhanced Handover Management For Wimax And Mobile Internet Using FINCH Protocol

[1].Venkatesulu Somapalli
Asst.Prof , Dept. of MCA

[2]Vedavyas. J
Asst.Prof , Dept. of MCA

Abstract—To improve Speed handovers in mobile WiMAX, this paper propose Fast Intra-Network and Cross-layer Handover (FINCH) for enhanced Handover management. FINCH is a correlative protocol to Mobile IP (MIP), which deals with interdomain mobility management in mobile Wimax. FINCH can reduce not only the handover intermission but also the end-to-end intermission for MIP. It enhances the energy efficiency for Paging extension. The proposed Cross-layer Handover is especially suitable for real-time services in frequent handover environment for mobile WiMAX networks. In addition A **cross-layer design approach in mobile worldwide interoperability for microwave access wireless communication.**

This is especially beneficial for the integration of Wimax and WiFi networks. Both mathematical analysis and simulation are developed to analyze and compare the performance of FINCH with other protocols. The results show that enhanced Cross-layer can support speed and efficient link layer and intradomain handovers. The numerical results can also be used to select proper network configurations

***Keywords*—FINCH, intradomain, Mobile IP, WiMAX, WiFi.**

1. INTRODUCTION

Mobile WIMAX is a new technology based on IEEE 802.16e standard. It brings broadband wireless access (BWA) to new challenges to support full mobility. Mobile WIMAX has the potential to replace, or at least enhance, cellular networks, including 3G networks. The major advantages of WIMAX include support of high data rate, covering large areas, supporting multiple services with different quality-of-service (QoS) policies, flexible and dynamic QoS support, good spectral efficiency, better support for Non-line-of-sight (NLOS) technologies, corporate-grade security, fast and inexpensive deployment of "last mile access" to public networking and being a cost-effective alternative to Wi-Fi and 3G/4G cellular networks [1]. Mobile WIMAX has been designed from the outset as a broadband technology capable of delivering triple-play services (voice, data and video). Voice in mobile WIMAX is packetized and treated as other types of IP packets except that it is prioritized. These applications consume significant bandwidth and, in some cases, require short end-to-end latency [2]. IEEE 802.16 standard develops the air interface medium access control (MAC) and physical (PHY) layers but does not define full end-to-end communication network architecture, while the scope of WIMAX Forum's Network Working Group covers higher-level network specifications above the radio interface specifications in the IEEE 802.16 air interface standard [3].

Handover (HO) mechanism is one of the critical - operations in mobile WIMAX. It can be defined as the maintaining of uninterrupted user communication session during movement from one location to another. HO mechanism handles mobile station (MS) switching from one serving base station (BS) to target BS. Furthermore, the mechanism can be used by BSs to trigger an HO in order to optimally balance the traffic load of cells within a network [4]. Many HO techniques have been developed. In general, they can be categorized into hard handover and soft handover techniques. In hard HO, a connection with a BS is ended first, before an MS switch to another BS. This is known as a break-before-make approach. On the contrary, soft HO uses a make-before-break approach, wherein a connection to the next BS is established before an MS leaves an ongoing connection to a BS. Although, hard HO is more bandwidth-efficient than soft HO, it causes longer delay and greater loss of packets [5]. Thus optimization of hard HO mechanism is one of the most important research areas for mobile WIMAX. The objective of this optimization is to reduce HO latency to be suitable for real-time show that, our proposed model provides a better decision for customers according to their available budgets.

Applications (e.g., less than 50 ms for VoIP). The IEEE 802.16e standard supports three methods of handover: Hard handover (HHO), fast base-station switching (FBSS) handover and macro-diversity handover (MDHO). The FBSS and MDHO are considered as soft HO mechanisms. Of these, the HHO is mandatory, while FBSS and MDHO are optional [5]. Soft HO such as MDHO or FBSS normally is more complex and adds significantly to the hardware costs in IEEE 802.16e.

Although the mandatory HO technique in WIMAX is HHO [6], the study of spectral efficiency of downlink traffic in multi-hop relay system (802.16j) as simulated in [7] shows that MDHO has better spectral efficiency when compared with FBSS and HHO in a well-designed overlay cells system.

Many researchers introduced proposals to enhance HO mechanism to support real-time applications. Choi [8] propose an enhanced data link-layer HO algorithm where the serving BS forwards downstream data to the neighboring BS being ranged therefore, the MS can receive data downlink (from BS to MS) as soon as it becomes synchronized with the neighboring BS. It is efficient for downstream data such as video streaming. Chen [10] proposes a cross-layer solution to reduce scanning/ranging latency and eliminate the network re-entry latency through cross-layer in mobile WIMAX. It uses layer 3 to transmit MAC control messages between the MS and the BS during the HO to speed up the layer 2 HO. In addition, Chen et al [10] propose a pre-coordination mechanism (PCM) for BS-initialized predicted handover scheme (PHS) to simplify the process of the handover. Jiao et al. [11] propose a passport handover scheme to minimize the HO latency, also propose a connection channel Identification (CID) assignment strategy to avoid confliction of CIDs of handing over services with that of ongoing services in the target BS. For intra-domain (intra-CSN) mobility management, Yen et al. [12] propose fast intra-network and cross-layer handover (FINCH), which considers not only the L2 HO latency but also end-to-end HO latency for mobile IP (MIP).

In IPv4 over Ethernet, the Address Resolution Protocol (ARP) can incur significant delay for both packet delivery and HO. We propose to use MIP in mobile WIMAX for inter-domain mobility (inter-CSN mobility) only. We propose a new protocol, Fast Intra-Network and Cross-layer Handover (FINCH), for intra-domain mobility (intra-CSN mobility), which can achieve fast HO, especially for real-time services. FINCH limits frequent HOs within CSN. It cooperates with MIP, which serves as the inter-domain mobility management protocol [15].

FINCH intends to localize location update to reduce the HO latency in MIP. It also reduces end-to-end latency because packets are delivered in a shorter path than that in MIP. In addition, FINCH is a cross-layer protocol, which also considers link layer. The proposed FINCH is especially suitable for real-time services in frequent HO environment. Although FINCH considers both IP and link layers, we limit the link layer to those which are common in all IEEE 802-series standards only. Thus, FINCH is also a generic protocol for other IEEE 802-series standards. This project compares the performance of FINCH protocol with the MIP to support real-time applications in mobile WIMAX. Each of these mechanisms reduces the HO latency when compared with the conventional HO, especially during downlink traffic, but none of them reaches minimum level of HO latency for uplink traffic. It is noted that all the mechanisms do not consider the HO scenario between BSs that belong to different ASN-GWs, which cause extra HO latency.

Background

The IEEE 802.16 group was formed in 1998 to develop an air-interface standard for wireless broadband. The group's initial focus was the development of a Line Of Sight -based point-to-multipoint wireless broadband system for operation in the 10GHz–66GHz millimeter wave band. The resulting standard—the original 802.16 standard, completed in December 2001—was based on a single-carrier physical (PHY) layer with a burst time division multiplexed (TDM) MAC layer.

The IEEE 802.16 group subsequently produced 802.16a, an amendment to the standard, to include NLOS applications in the 2GHz–11GHz band, using an orthogonal frequency division multiplexing (OFDM)-based physical layer. Additions to the MAC layer, such as support for orthogonal frequency division multiple access (OFDMA), were also included. Further revisions resulted in a new standard in 2004, called IEEE 802.16-2004, which replaced all prior versions and formed the basis for the first WIMAX solution. These early WIMAX solutions based on IEEE 802.16-2004 targeted fixed applications, and we will refer to these as fixed WIMAX. In December 2005, the IEEE group completed and approved IEEE 802.16e-2005, an amendment to the IEEE 802.16-2004 standard that added mobility support.

Implementation of MIP versus FINCH:

In general, on the Internet, IP packets are transported from their source to their destination by allowing routers to forward data packets from incoming network interfaces to outbound network interfaces according to information obtained via routing protocols. The routing information is stored in routing tables. Typically the routing tables maintain the next-hop (outbound interface) information for each destination IP network. The IP address of a packet normally specifies the IP client's point of attachment to the network. Correct delivery of IP packets to a client's point of network attachment depends on the network identifier portion contained in the client's IP address. Unfortunately, the IP address has to change at a new point of attachment.

Altering the routing of the IP packets intended for a mobile client to a new point of attachment requires a new client IP address associated with that new point of network attachment. On the other hand, to maintain existing transport protocol layer connections as the mobile client moves, the mobile client's IP address must remain the same.In order to solve this problem, Mobile IP introduces two new functional entities within IP networks. Those are the Foreign Agent, FA and the Home Agent, HA.

These two new entities together with enhancements in the mobile node (the client) are the basic building blocks for a Mobile IP enabled network. The last entity for providing a full reference for a basic Mobile IP enabled network is the Correspondent Node, CN. The Correspondent Node is another IP entity e.g. an Internet Server with which the mobile node communicates. In the basic Mobile IP scenarios the Corresponding Node does not need to have any Mobile IP knowledge at all. This is an important distinction. To require that new devices that are introduced on the Internet to have new functionality is one thing – to require that all Internet servers and fixed clients should be upgraded is completely different. A Mobile IP enabled network requires the mobile nodes to be upgraded, it also requires new functions in the visiting and home networks; however it does not require upgrading of core Internet services.

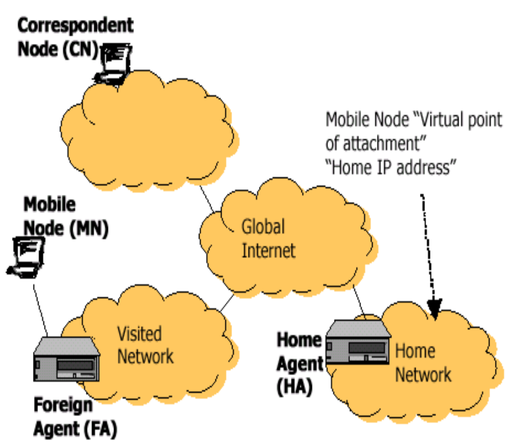

Fig: Mobile IP.

The basic entities constituting a MIP aware network are:

- The Mobile Node comprising the Terminal Equipment and the Mobile Termination
- The Foreign Agent
- The Home Agent
- The Corresponding Node

FINCH implementation:

1. Networking module
2. cross-layer design module
3. Packet forwarding module
4. Location update module

1. Networking Module

Fig 1 Client-Server

Client-server computing or networking is a distributed application architecture that partitions tasks or work load between service providers (servers) and service requesters, called clients. Often clients and servers operate over a computer network on separate hardware. A server machine is a high-performance host that is running one or more server programs which share its resources with clients. A client does not share any of its resources, but requests a server's content or service function. Clients therefore initiate communication sessions with servers which await (listen to) incoming requests. The server component provides a function or service to one or many clients, which initiate requests for such services.

2. Cross-Layer Design Module

MS MAC Address	MS IP Address	Forwarding MAC Address	Wirelessport	Time Stamp
08:00:20:03:F6:42	10.1.1.10	NULL	1	2007.02.03.16.21.32.18
20:EE:18:3A:12:7E	10.1.2.20	82:10:10:04:5A:79	NULL	2007.02.03.16.21.52.08
....	....	... ...		

2 Forwarding Table

Explanation: In existing system two-level mobility management technique for fast HO. MIP is used for inter-domain (inter-CSN) mobility management. The proposed FINCH is used for intra-domain (intra-CSN) mobility management. Also, FINCH handles the HOs in both IP layer and link layer. As a generic protocol, FINCH deals with location update in the link layer and cooperates with the L2 HO procedure. FINCH uses a special table-lookup technique for both link layer and IP layer to update the location. Based on the table, location updates in the link layer and IP layer are coupled together. Consequently, ARP is no longer necessary.

A generic network architecture for inter-domain mobility and intra-domain mobility, in which a domain (or a CSN) may be configured in many different ways, such as a bus network, a ring network, a star network, a tree network. The functionality of the network components can be either like an L3 router or an L2 bridge. The mobility management and packet routing within the domain are done by replacing the necessary routing table and bridging table with a Forwarding Table (FT).In table, there are five fields in each FT:

1. The MAC address of an MS,
2. The IP address (HoA or permanent address) of the MS,
3. The forwarding MAC address to which the IP packets destined to the MS should be forwarded
4. The wireless port if the FT is maintained by a BS, which the MS can communicate directly by a wireless port (otherwise, the field is NULL).
5. The time stamp copied from the original packet sent by the MS.

3. Packet Forwarding Module:
They are capable of processing IP packets. If a BS does not support IP routing, we assume that there is an Access Router (AR) behind the BS to handle IP packet routing. Remember that Table 1 represents the FT in BS 1 depicts that any IP packet arriving at BS 1 and bound for MS 1, as identified by its IP address is not forwarded to any other node. The IP packet is transmitted directly over a port.

4. Location Update Module
We derive the location update cost of the proposed FINCH. When an MS enters a new CSN, it should perform intra-domain registration, which is combined with the MIP registration. Therefore, when traversing i cells from the ith cell, the MS will perform registrations. Moreover, the location update of intra-domain mobility traverses from the new BS to the original BS.

Architecture:

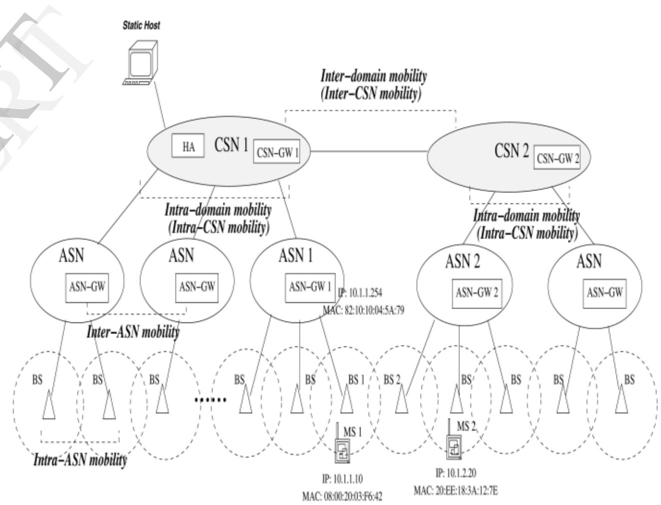

Fig: FINCH

Conclusion
Mobile WIMAX has been designed at the outset as a broadband access technology capable of delivering triple play services (voice, data and video). However, the HO operation is one of the critical operations in mobile WIMAX, which can influence the continuity of real-time applications over WIMAX. The HO mechanism is one of the most important research areas in the field of mobile WIMAX, and the goal of reducing the HO latency to support real-time applications should be pursued.

Mobile WIMAX has been designed to support mobile users moving at vehicular speeds. MIP is adopted as the mobility management protocol by WIMAX Forum. However, it is generally realized that MIP cannot support HOs well when mobile nodes move frequently and/or when the coverage area of a subnet is small. The problem is even exaggerated for real-time services, which require very fast HOs in mobile WIMAX networks. In this project, we propose to use MIP in mobile WIMAX for inter-domain (inter-CSN) mobility management only. We propose a fast HO protocol, FINCH, for intra-domain (intra-CSN) mobility management.

This paper proves that the proposed FINCH can support fast and efficient link layer and intra-domain Handovers. Because of the cross-layered design, comparing with other intra-domain mobility management protocols, the proposed FINCH reduces location update cost. Comparing with MIP, the proposed FINCH does not need IP encapsulation and does not have triangular routing problem. It also reduces the overhead caused by registering CoA with the HA. By unifying the mobility management in layer 2 and layer 3, the overhead and latency in interfacing conventional mobility management protocols in the two layers are eliminated.

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