

Fast Intra Network and Cross Layer Handover (FINCH) for WiMAX

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ABSTRACT

To support fast and efficient handovers in mobile WiMAX, we propose Fast Intra-Network and Cross-layer Handover (FINCH) for intradomain (intra-CSN) mobility management. FINCH is a complementary protocol to Mobile IP (MIP), which deals with interdomain (inter-CSN) mobility management in mobile WiMAX. FINCH can reduce not only the handover latency but also the end-to-end latency for MIP. Paging extension for FINCH is also proposed to enhance the energy efficiency. The proposed FINCH is especially suitable for real-time services in frequent handover environment, which is important for future mobile WiMAX networks. In addition, FINCH is a generic protocol for other IEEE 802-series standards. This is especially beneficial for the integration of heterogeneous networks, for instance, 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 FINCH can support fast and efficient link layer and intradomain handovers. The numerical results can also be used to select proper network configurations.

1. INTRODUCTION

Mobile WiMAX has been designed to support users moving at vehicular speeds. In addition, real-time services such as voice and multimedia applications are expected to be important services in future mobile WiMAX networks. Because MIP is adopted, mobile WiMAX is likely to inherit the MIP deficiencies. 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 intradomain 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 interdomain mobility management protocol. 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.

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. 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. HO mechanism handles mobile station (MS) switching from one serving base station (BS) to target BS. FINCH handles the HOs in both IP layer and link layer. As a generic protocol:

1. PROBLEM STATEMENT

Real-time communication in a mobile wireless Internet environment it is essential to minimize the transient packet loss when the mobile is moving between different cells (subnets) within a domain. Network layer mobility management schemes have been proposed to provide optimized fast-handoff for multimedia streams during a client's frequent movement within a domain. Application layer techniques to achieve fast hand off for real-time RTP/UDP based multimedia traffic in a SIP signaling environment. These techniques are based on standard SIP components such as user agent and proxy which usually participate to set up and tear down the multimedia sessions between the mobiles. Unlike network layer techniques, application layer techniques do not have to depend upon any additional components such as home agent and foreign agent. It thus provides a network access independent solution suitable for application service providers.

Many intra-domain mobility management protocols have been developed to take advantage of the hierarchy of tree network topology. However, suboptimal problem may happen in a non-tree network topology. Besides, most of the protocols operate on or above the IP layer. They do not address link-layer mobility. Interaction between the mobility management in IP and link layers is not considered either. Especially, IPv4 over the Ethernet-like networks mainly rely on ARP (IETF RFC 826) to associate IP address with link-layer address. The broadcast-and-reply nature of ARP wastes bandwidth and causes extra latency. Although cache memory can reduce the use of ARP, it is still inefficient when an MS moves frequently. ARP may seriously waste bandwidth in a highly mobile wireless environment. ARP must be used for address resolution in IPv4/Ethernet CS. The IPv4 address in the network layer must be associated with the Ethernet address in the link layer. An MS may need to perform two HO procedures in two different layers during each HO. For packet delivery, ARP may be executed in each wired and wireless link, which would significantly increase the packet delivery delay. We propose a cross-layer design, which considers the interactions between IP layer and link layer.

2. EXISTING SYSTEM

Real-time communication in a mobile wireless Internet environment it is essential to minimize the transient packet loss when the mobile is moving between different cells (subnets) within a domain. Network layer mobility management schemes have been proposed to provide optimized fast-handoff for multimedia streams during a client's frequent movement within a domain. Application layer techniques to achieve fast hand off for real-time RTP/UDP based multimedia traffic in a SIP signaling environment. These techniques are based on standard SIP components such as user agent and proxy which usually participate to set up and tear down the multimedia sessions between the mobiles. Unlike network layer techniques, application layer techniques do not have to depend upon any additional components such as home agent and foreign agent. It thus provides a network access independent solution suitable for application service providers.

3. PROPOSED SYSTEM

The proposed FINCH is especially suitable for real-time services in frequent handover environment, which is important for future mobile WiMAX networks. In addition, FINCH is a generic protocol for other IEEE 802-series standards. This is especially beneficial for the integration of heterogeneous networks, for instance, the integration of WiMAX and Wi-Fi networks. The proposed FINCH (Fast Intra-Network and Cross-Layer Handover), for intra-domain mobility (intra-CSN mobility), which can achieve fast Handover, especially suitable for real-time services such as VOIP and multimedia applications in frequent handover environment, which is important for future mobile WIMAX networks. It can also limits frequent handovers within connectivity service network (CSN). It cooperates with the MIP, which serves as an inter-domain mobility management protocol. FINCH intends to localize location update to reduce the Handover latency in MIP. In addition, FINCH is a generic protocol for other IEEE 802-series standards. This is especially beneficial for the integration of heterogeneous networks, for instance, the integration of WIMAX and Wi-Fi networks.

Objectives : To reduce Handover Latency, end to end latency for MIP, Paging extension to enhance the energy efficiency, reduce Packet Loss and Reduces Connection Drop.

Research Methodology

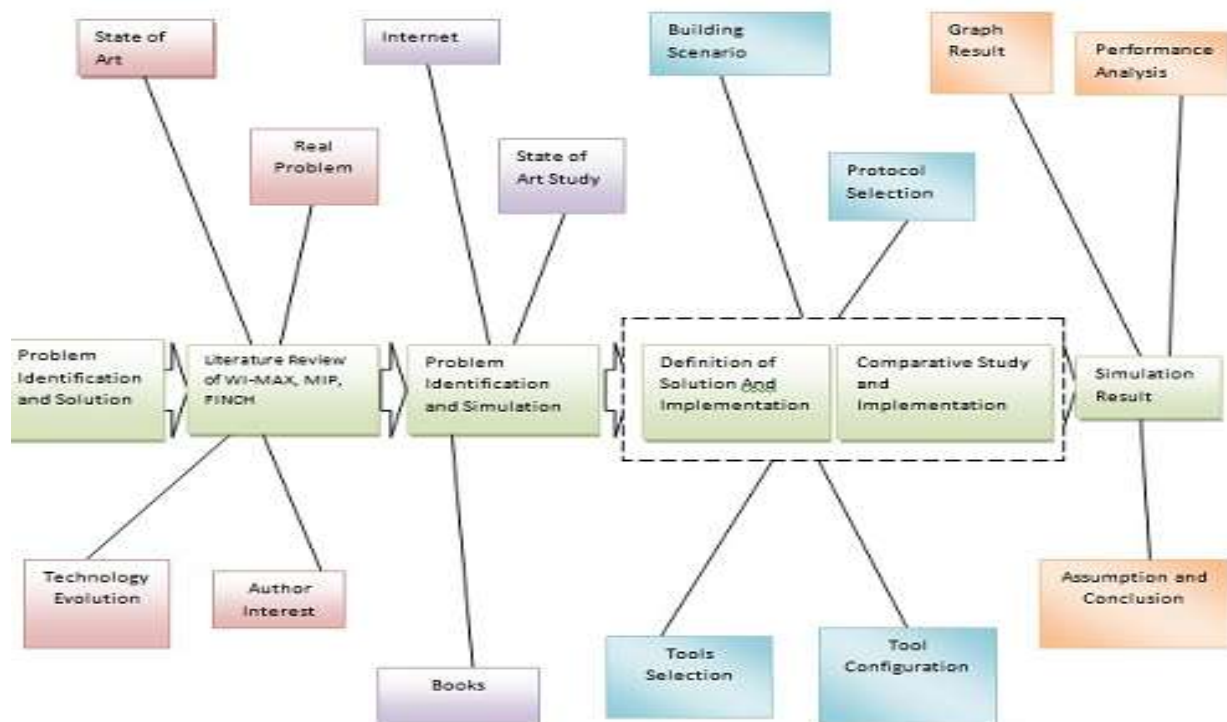


Figure 1: Research Methodology

Algorithm 1: Packet forwarding algorithm

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1: search column one/two of the FT for a matching address;
2: if (port != NULL) then
3: generate a MAC packet in which (destination
   address = MS MAC Address);
4: send this MAC packet through the wireless port;
5: else
6: generate a MAC packet in which (destination address = Forwarding MAC Address);
7: send this MAC packet through the wired/backbone network;
8: end if

```

Algorithm 2: Location update algorithm in the new BS

```

1: search column one of the FT for a matching address;
2: update the corresponding entry in the FT;
3: update forwarding MAC address to NULL;
4: update Wireless Port to the port number;
5: update Time Stamp;
6: send a packet to all directly connected device(s);

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Algorithm 3: Location update algorithm in other devices

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1: search column one of the FT for a matching address;
2: if (same Time Stamp) or (forwarding MAC address is the same as the source MAC address) then
3: destroy this packet;
4: else
5: update the Time Stamp;
6: /* comparing must be done before updating */
7: if (forwarding MAC address equals NULL) then
8: /* for old BS */
9: update the forwarding MAC address with the source MAC address;
10: update Wireless Port to NULL;
11: send a notice to mobile node

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12: else
13: /* for device(s) except the old BS */
14: update the Forwarding MAC address with the source MAC address;
15: end if
16: send a packet to all directly connected device(s) except the source;
17: end if

4. SYSTEM ARCHITECTURE

THE IEEE 802.16 standard is a promising standard for next-generation broadband wireless access networks. It provides last mile solution and supports high-speed multimedia services. The IEEE 802.16e amendment enhances IEEE 802.16 with mobility support for users moving at vehicular speeds. Like other IEEE 802-series standards, 802.16 standardize physical (PHY) layer and Media Access Control (MAC) layer only. To build a complete system, higher layers are still necessary. One of the major objectives of WiMAX Forum thus, is to promote conformance and interoperability of the IEEE 802.16 standards. The network reference model proposed by WiMAX Forum is depicted in below Figure 2. The Access Service Network (ASN) provides radio access to WiMAX subscribers. It consists of one or more ASN Gateways (ASN GWs) and Base Stations (BSs). ASNs are connected by Connectivity Service Network (CSN), which provides Internet Protocol (IP) connectivity services. To support IP mobility, Mobile IP (MIP, IETF RFC 3344) is adopted by WiMAX Forum. The Home Agent (HA) of a Mobile Station (MS) is located in the CSN of the MS's Home Network Service Provider (H-NSP). ASN GW supports the Foreign Agent (FA) functionality. For intra-ASN mobility, there is no need to update MS's care-of-address. MIP is a simple and effective way to deal with mobility management in the network layer. However, it also has some deficiencies, which include frequent location update, long handover (HO) delay, and long end-to-end latency. The registration of CoA with HA will cause many control messages if an MS moves frequently between subnets.

When an MS is far away from its HA, the registration will result in long delay. Thus, it causes long HO delay. The registration sent from an MS to its HA also results in extra delay. When an MS is far away from its HA, the redirection of user packets by HA will cause long end-to-end latency as well. Although route optimization has been proposed, it is designed as an optimization and can result in latency, which is highly variable. 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.

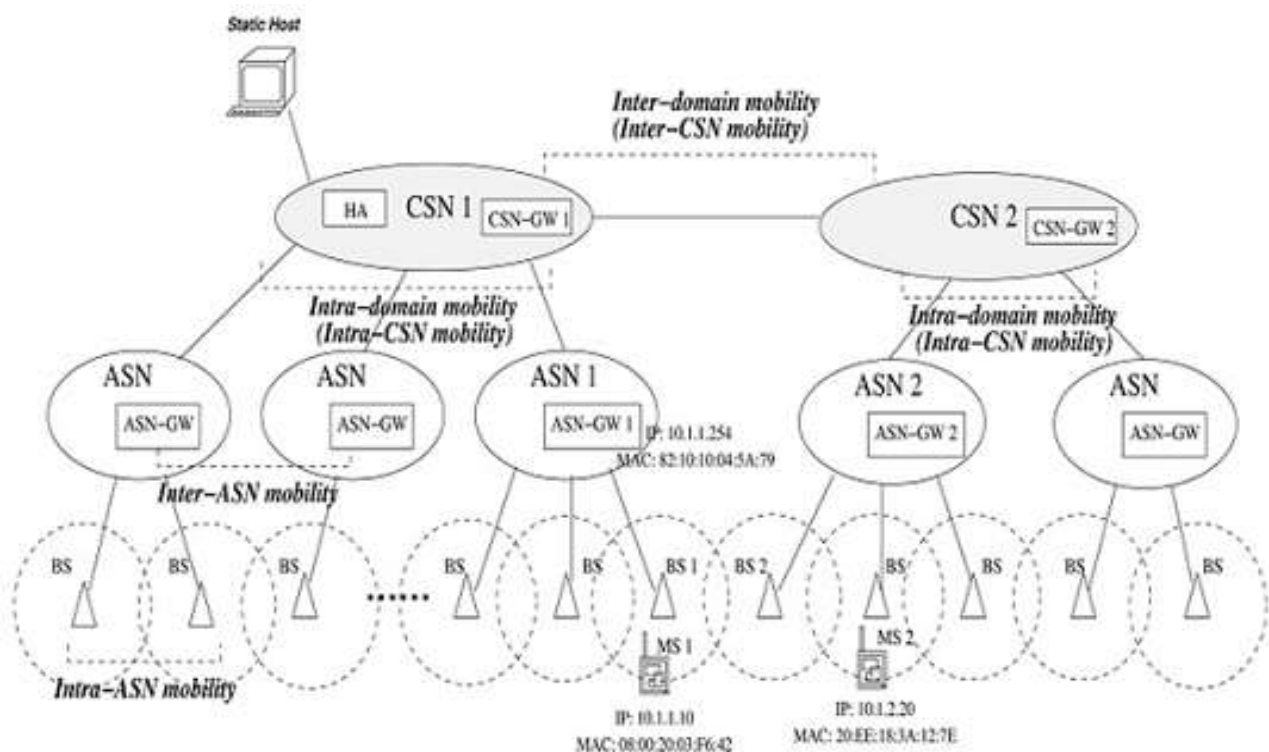


Figure 2: Generic WiMAX architecture

5. 802.16E HANDOVER

The 802.16e standard is the base for mobility in WIMAX. It supports handovers through procedures and functions at BS/MS level. The standard defines the means for gathering information and performing a handover but the decision whether to perform a handover or not is left out. Example situations on when to perform a handover is when the MS need to switch BS to receive higher signal quality or when the MS can obtain improved QoS from another BS. More detailed information about 802.16e handovers can be found in the IEEE Std. 802.16e.

5.1 HANDOVER PROCESS

The handover process consists of six different stages; cell reselection, handover decision and initiation, synchronization to target BS downlink, ranging, termination of service and handover cancellation. The cell reselection is the stage where the MS acquire information about BSs in the network. The information is used in evaluation of the possibility to perform a handover. This can be done by using the information in the network topology advertisements or require a scanning interval to obtain the needed information. The cell reselection phase does not need to occur in relation to a handover decision. The initiation of a handover is the decision to migrate the MS from the serving BS to a target BS.

5.2 INTRA ASN HANDOVER

The intra ASN handover is performed between BSs (or sectors within one BS) belonging to the same ASN, see below figure. The BSs can be connected to the same ASN GW or different ASN GWs (within the same ASN) it will still be an intra ASN handover. If there is only one BS within an ASN an intra ASN handover cannot be performed unless the BS has several antenna sectors. The purpose of the intra ASN handover is to minimize the delay and data loss during the MS's transition between BSs. If the MS are using services such as IP or MIP there will be no need for a change of IP-address after the handover since the movement of the MS is not visible from outside the ASN. The reference points involved in an intra ASN handover is R6, R8 and in some cases R4. R4 is only involved when the target BS is connected to another ASN GW than the serving BS.

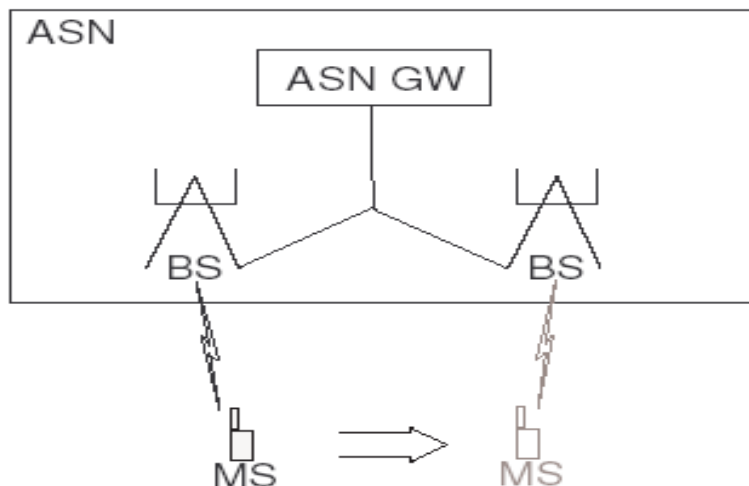


Figure 3: Intra ASN Handover

5.3 INTER ASN HANDOVER

An inter ASN handover is a handover between BSs not part of the same ASN, see figure 4. During an inter ASN handover ASN GWs in separate ASNs need to coordinate their actions to make the handover smooth to the MS. There are two possible ways of dealing with the data flow during an inter ASN handover, anchoring and re-anchoring. The purpose of anchoring is to avoid a path update and hence a redirection of the data path, where in the re-anchoring case an update will be performed. The decision to anchor or re-anchor the data path is made by the target or anchor ASN GW and there are three different decision procedures with two possible outcomes. Either both parties can decide that a re-anchoring is not needed or one of the ASN GW decides that it wants a re-anchoring. If the target ASN GW wants a re-anchoring the anchor ASN GW will follow that decision and vice versa. It is always the target ASN GW who will make its decision first. What this decision is based upon is Implementation dependent and not included in the scope of the WIMAX document.

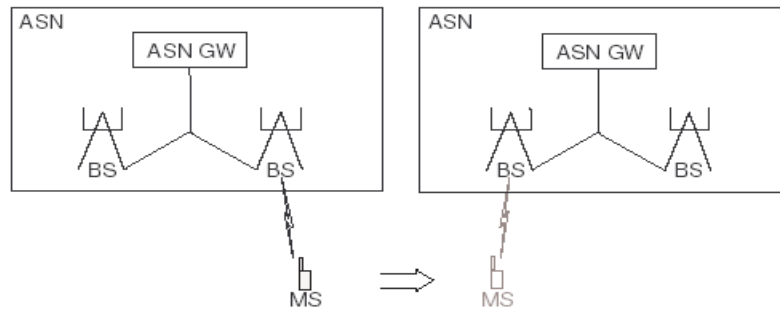


Figure 4: Inter ASN Handover

6. IMPLEMENTATION

Implementation is the stage of the research paper, when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective. The implementation stage involves careful planning, investigation of the existing system and its constraints on implementation, designing of methods to achieve changeover and evaluation of changeover methods. The following modules are implemented.

1. Networking module.
2. Intradomain mobility management module
3. Cross-layer design module.
4. Packet forwarding module.
5. Location update module

Networking module: Client-server computing or networking is a distributed application architecture that partitions tasks or workloads 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 client-server characteristic describes the relationship of cooperating programs in an application. The server component provides a function or service to one or many clients, which initiate requests for such services.

Intradomain mobility management module: Network architecture for inter-domain mobility and intradomain mobility, in which a domain may be configured in many different ways, such as a bus network, a ring network, a star network, a tree network, and so forth. There are different network components including routers, and bridges. 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.

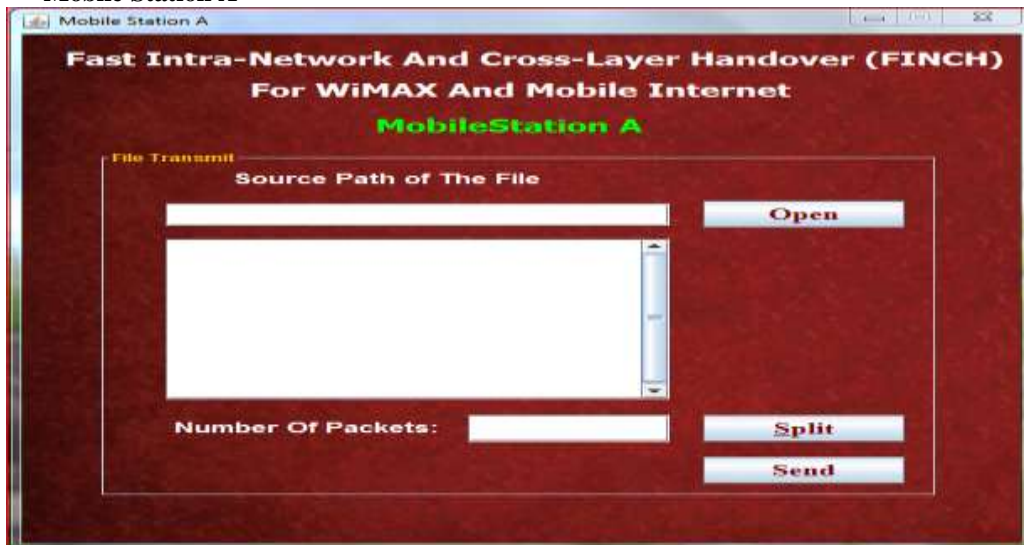
Cross-layer design module : Fast Intra-Network and Cross-layer Handover (FINCH), for intradomain mobility, which can achieve fast HO, especially for real-time services. FINCH limits frequent HOs within CSN. It cooperates with MIP, which serves as the inter-domain mobility management protocol. FINCH intends 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. Thus, FINCH can further improve the performance. The proposed FINCH is especially suitable for real-time services in frequent HO environment. In addition, paging extension is designed to conserve the energy of MS and reduce the signaling overhead for location update.

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.

Location update module : we derive the location update cost of the proposed FINCH. When an MS enters a new CSN, it should perform intradomain registration, which is combined with the MIP registration. Therefore, when traversing i cells from the j th cell, the MS will perform registrations. Moreover, the location update of intradomain mobility traverses from the new BS to the original BS.

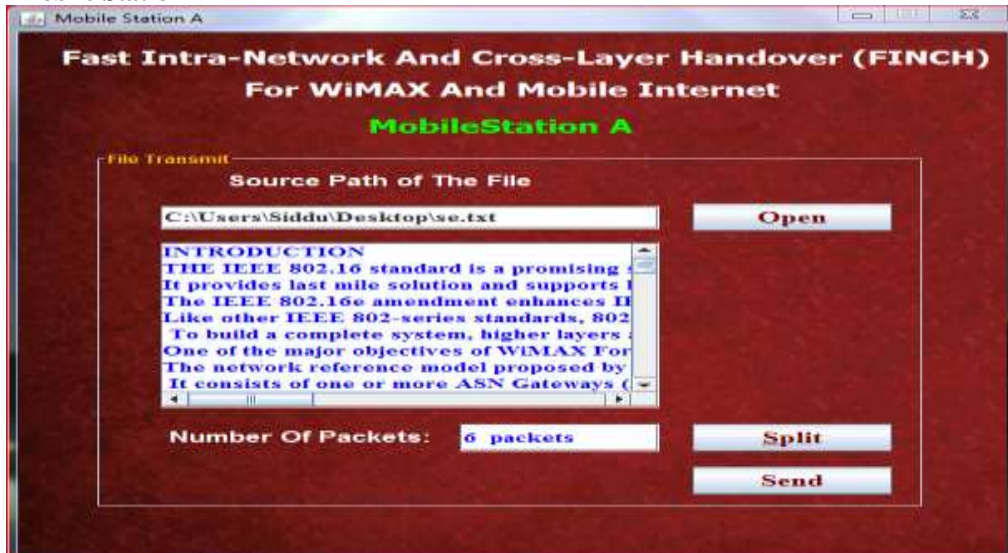
7. RESULTS

Mobile Station A



The screenshot shows the 'Mobile Station A' window. The title bar reads 'Mobile Station A'. The main title is 'Fast Intra-Network And Cross-Layer Handover (FINCH) For WiMAX And Mobile Internet'. Below this, it says 'MobileStation A' in green. The 'File Transmit' section has a 'Source Path of The File' label above a text input field. To the right of the input field is an 'Open' button. Below the input field is a large text area containing a document preview. At the bottom left, there is a 'Number Of Packets:' label followed by a text input field. To the right of this field are 'Split' and 'Send' buttons.

Mobile Station A



This screenshot shows the 'Mobile Station A' window with the same layout as the previous one, but with content in the text fields. The 'Source Path of The File' input field now contains 'C:\Users\Siddu\Desktop\se.txt'. The document preview area shows the following text:

INTRODUCTION

THE IEEE 802.16 standard is a promising

It provides last mile solution and supports

The IEEE 802.16e amendment enhances

Like other IEEE 802-series standards, 802

To build a complete system, higher layers

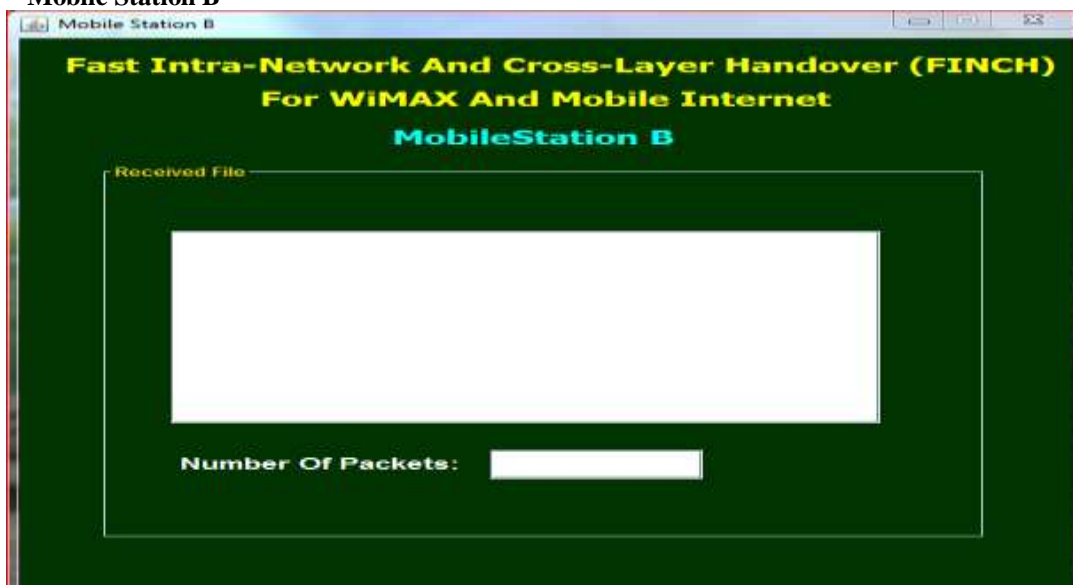
One of the major objectives of WiMAX For

The network reference model proposed by

It consists of one or more ASN Gateways (

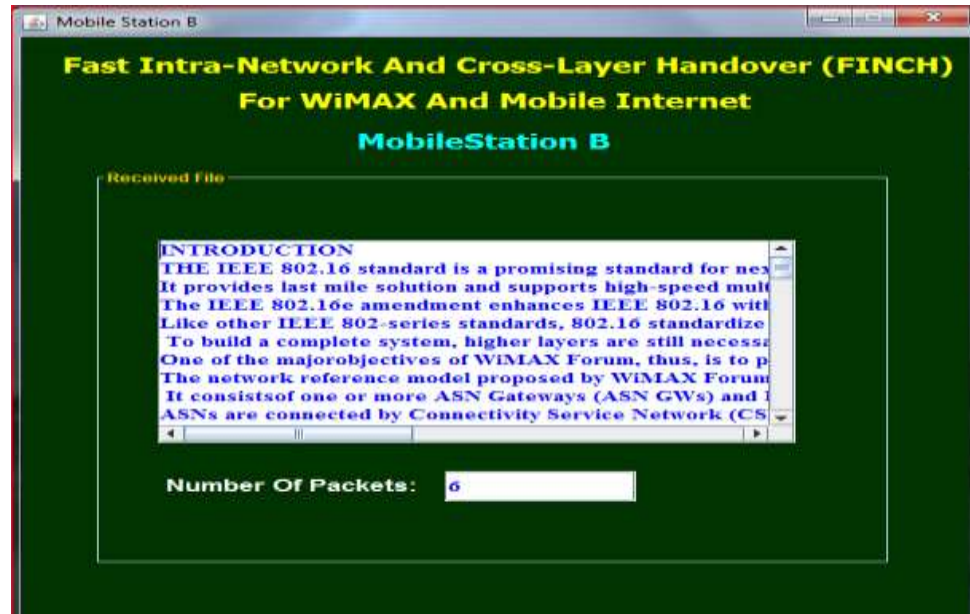
The 'Number Of Packets:' input field now contains '6 packets'.

Mobile Station B

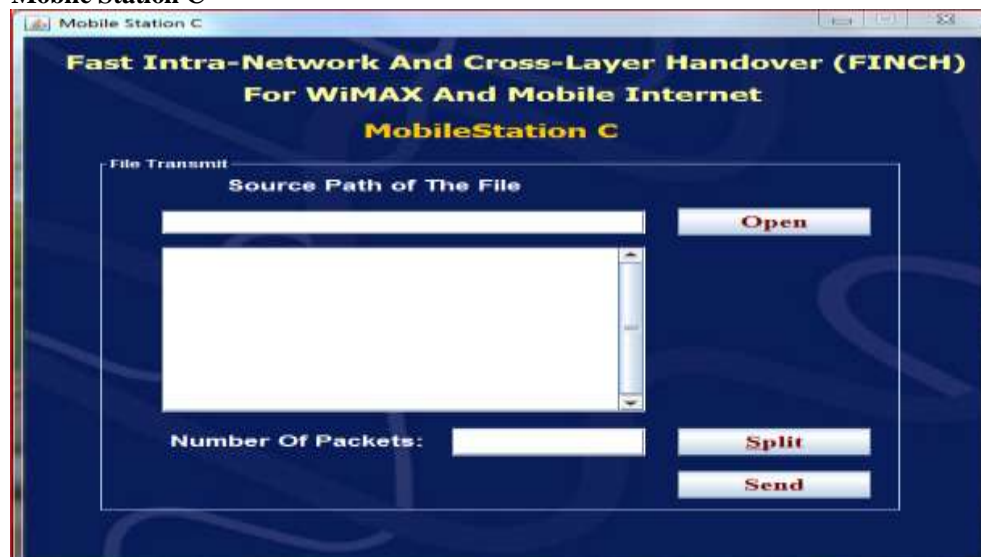


The screenshot shows the 'Mobile Station B' window. The title bar reads 'Mobile Station B'. The main title is 'Fast Intra-Network And Cross-Layer Handover (FINCH) For WiMAX And Mobile Internet'. Below this, it says 'MobileStation B' in green. The 'Received File' section has a large empty text area. At the bottom left, there is a 'Number Of Packets:' label followed by an empty text input field.

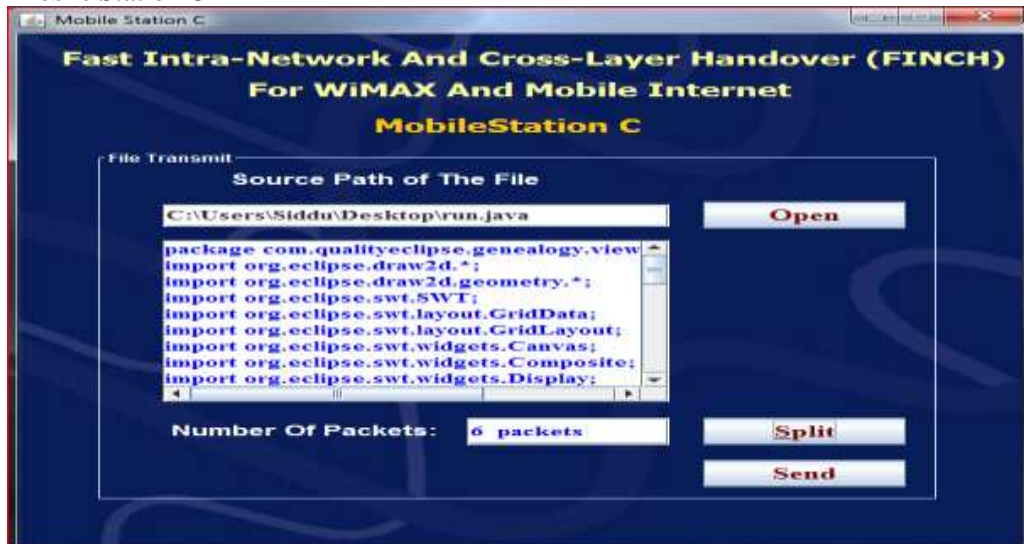
Mobile Station B

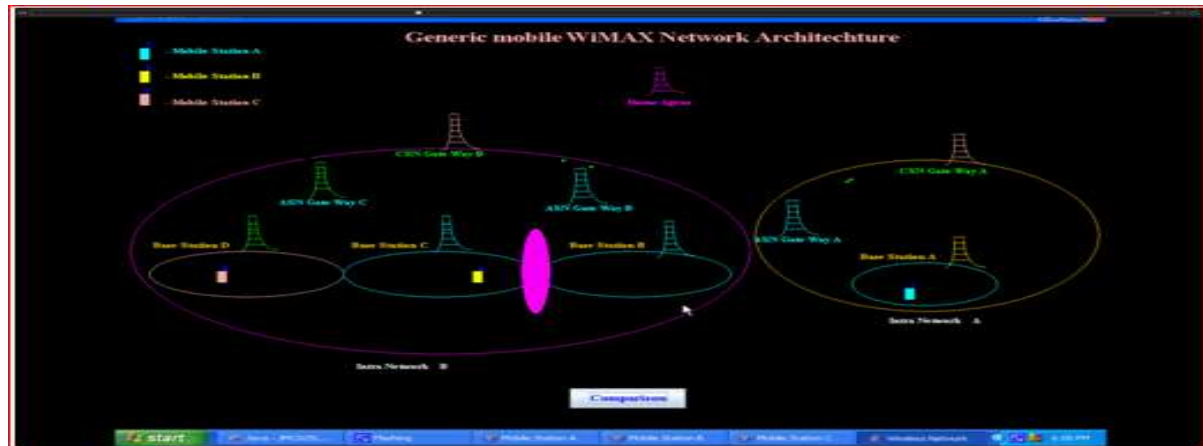


Mobile Station C



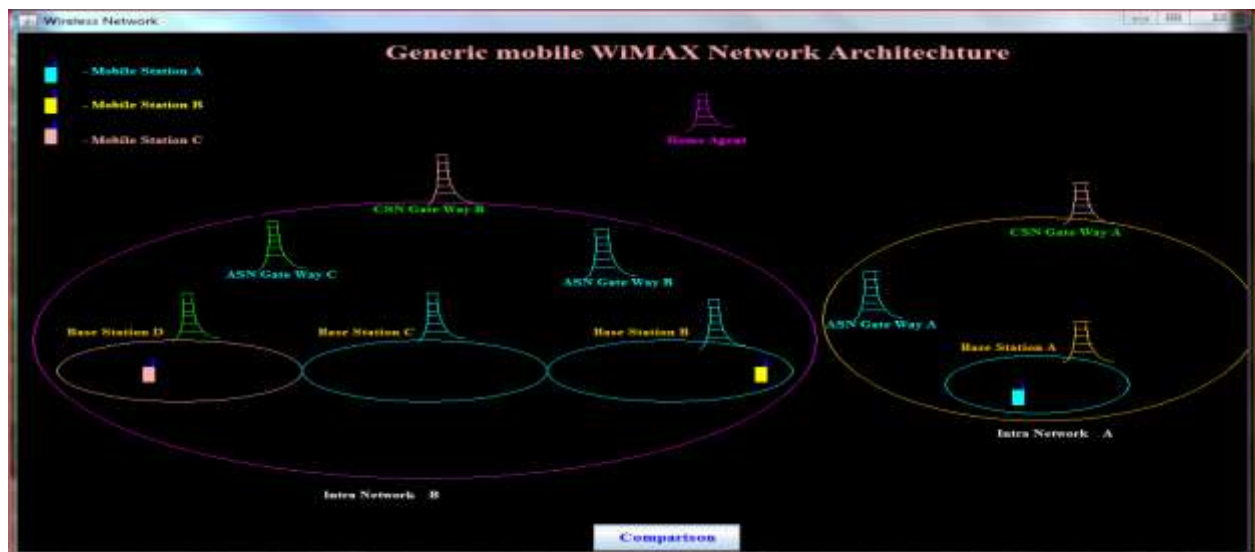
Mobile Station C





WiMAX Network Architecture: In this internetwork, we have taken two networks. Network A and Network B. Network A consists of Mobile Station A and Network B consists of Mobile Station B, Mobile Station C. These two networks consist of Base stations (BS), Access service networks (ASN), connectivity service network (CSN), ASNGW and CSNGWS. The registration of CARE-OF-ADDRESS takes place at HOME AGENT.

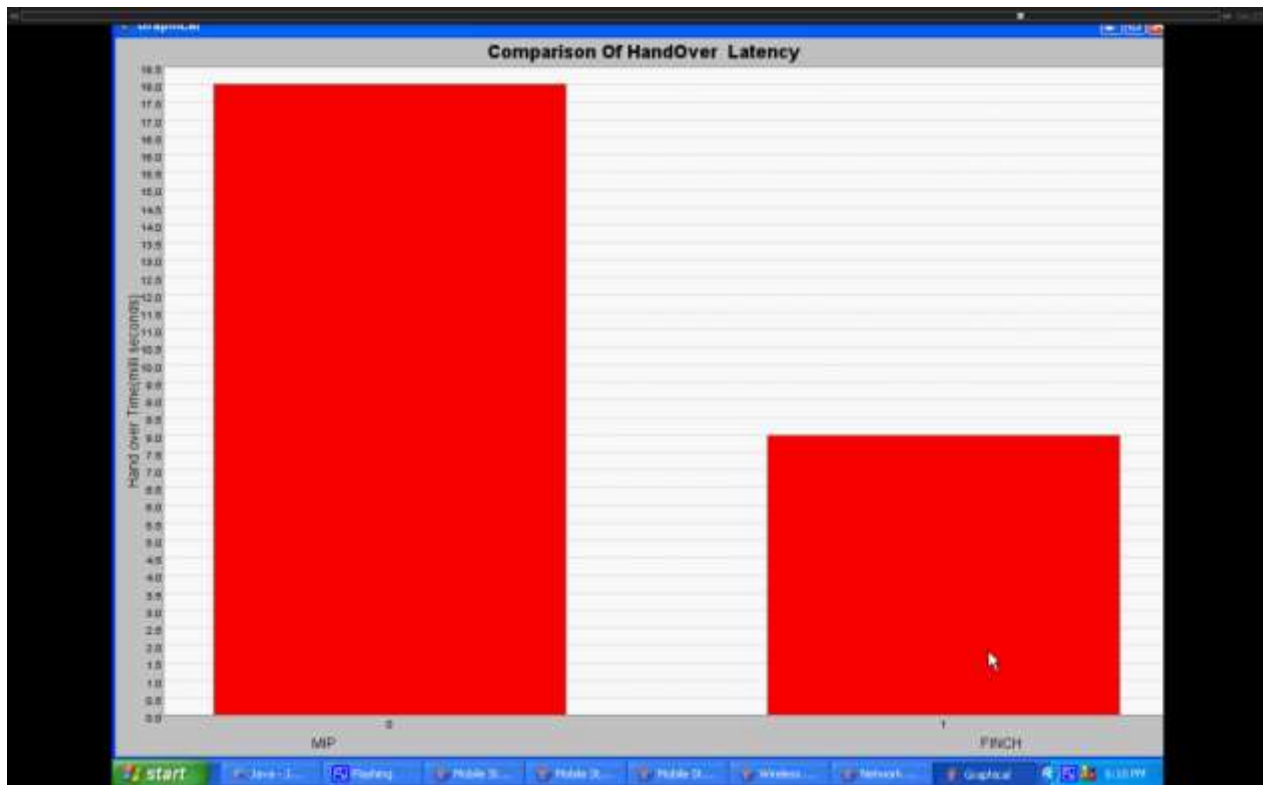
Intra Network Packet Transmission: In intra-network mobile wimax, we propose a FINCH protocol. It's a complementary protocol to Mobile IP. In FINCH protocol select data file from Mobile station C to Mobile station B. In this research paper, we overcome the ARP problem and Triangular routing as well as encapsulation. FINCH can support HO, reduced number of packets, long HO delay and end to end latency.



Handover Approximation in MIP And FINCH

| HandOver Approximation in MIP and FINCH | | | |
|---|-----------------------|---|-----------------------|
| Mobile Internet protocol | | Fast Intra-Network And Cross-layer Handover | |
| NEW COA | DATA TRANSMITTED TIME | RECEIVER CURRENT PATH | DATA TRANSMITTED TIME |
| NULL | 5ms | B/ASN B/BS C/MIS B | 3ms |
| NULL | 5ms | B/ASN B/BS C/MIS B | 3ms |
| NULL | 5ms | B/ASN B/BS C/MIS B | 3ms |
| CSN B/ASN B/BS C/MIS B | 5ms | B/ASN B/BS B/MIS B | 3ms |
| CSN B/ASN B/BS C/MIS B | 6ms | B/ASN B/BS B/MIS B | 3ms |
| CSN B/ASN B/BS C/MIS B | 6ms | B/ASN B/BS B/MIS B | 3ms |

Graph of MIP and FINCH



8. FUTURE ENHANCEMENT

Finch Protocol has some drawbacks we will implement in Future Enhancement.

- Integrating the entire network in to a single network.
- Paging energy conservation.
- Seamless network implementation.
- Signaling Load Control.
- 3G, 4G Implantation
- When we send a video and audio files Finch protocol will convert it into machine code.
- When we select image files pdf files Finch protocol convert it into machine code.
- Set the maximum and minimum limit for sending packets.

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. We propose to use MIP in mobile WIMAX for inter-domain (inter-CSN) mobility management only and fast HO protocol, FINCH, for intra-domain (intra-CSN) mobility management. 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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