Latency Minimization Based Handover by using Floating Threshold Request

Thesis submitted towards
the partial fulfillment of the requirements for the degree of

MASTER OF ENGINEERING
in
Electronics and Communication Engineering

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DECLARATION

I, Gurwinder Singh hereby certify that the work which is being presented in the thesis entitled "Latency Minimization based handover by using floating threshold request" by me in fulfillment of requirement for the award of degree of Master of Engineering in Electronics and Communication Engineering submitted to the Department of Electronics and Communication Engineering, Thapar University, Patiala is an authentic record of my own work carried out under the supervision of Dr. Karamjit Singh Sandha,

The matter presented in this thesis has not been submitted in any other University/Institute for the award of any degree.

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ABSTRACT

Many research works carried out towards achieving faster and more reliable handover techniques in a Mobile WiMAX (Worldwide Interoperability for Microwave Access) network. Handover, also called handoff, is the critical mechanism that allows an ongoing session in a cellular mobile network like WiMAX to be seamlessly maintained without any call drop as the Mobile Station (MS) moves out of the coverage area of one base station (BS) to that of another. Mobile WiMAX supports three different types of handover mechanisms, namely, the hard handover, the Fast Base Station Switching (FBSS) and the Micro-Diversity Handover (MDHO). Out of these, the hard handover is the default handover mechanism whereas the other two are the optional schemes. Also, FBSS and MDHO provide better performance in comparison to hard handover, when it comes to dealing with the high-speed multimedia applications. However, they require a complex architecture and are very expensive to implement. So, hard handover is the commonly used technique accepted by the mobile broadband wireless user community including Mobile WiMAX users. Also call handover technique comes with some problem such as delay in response, loss of information, disturbance, insecure communication, and out of coverage area etc. creates inefficient communication and decreases QoS. The cause of problem can be due to overloaded BS, latency delay and inefficient handover decision. This produces poor end-to-end performance which future produces low throughput, less total packet received, high end-to-end delay etc. This level of QoS is not sufficient for good call handover in mobile WiMAX. In the Proposed scheme, the standby request based call or data handover mechanism has been proposed for the purpose of soft handover and to reduce the call drop rate during the process of changing the cell due to the movement of the user. The standby request mechanism has been designed to establish the semi-active connection with the non-active BTS within range. The semi-active connection is transferred to the active state once the connection is established between the cellular node and the in Range non-active base station. The intimation is given to the previous BTS to shift all active connections o the non-active base station, which minimizes the call drop rate. The experimental results have also revealed the efficiency of the proposed model in comparison with the existing model.

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ABBREVIATIONS

WiMAX	Worldwide Interoperability for Microwave Access
IEEE	Institute of Electrical and Electronics Engineering
WMAN	Wireless Metropolitan Area Network
NLOS	Non-line of sight
NWG	Network Working Group
BS	Base station
ASNWG	Access service network gateway
CSN	Connectivity Service Network
BST	Base Station Transceivers
BSC	Base Station Controllers
SGSN	Serving GPRS Support Node
FBSS	Fast Base Station Switching
HHO	hard handover
MDHO	macro diversity handover
TBS	target Base Station
SHO	Soft Handover
VoIP	Voice-over-IP
QoS	Quality of Signal
MAC	Medium Access Control
NTA	Network Topology Acquisition
MS	Mobile Stations

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

In the rising development world of communication, improvement is the main requirement of the mobility while communication. The idea of terminal mobility is a basic need of good significance which is supported with the procedure that is called handover. It is main element to maintain air link to the BS when the mobile station has moved by large changes of velocity and their geographical position. So, it includes the overall introduction to the WiMAX, WiMAX structure and their applications. The requirement of their handover in the WiMAX can be discussed. The problem definition can be offered and their objectives of carried out research can also be explained.

1.2 INTRODUCTION TO WIMAX

WiMAX known as World-wide Interoperability for the Microwave Access. “WiMAX” name invented from “WiMAX Forum” to promote interoperability with conformity of standard which is based on the IEEE 802.16 standard. This forum described in the WiMAX as “principles based innovation to enable to deliver later mile access of wireless broadband is an alternate to DSL or cable". Basically, WiMAX can be telecommunication technology which is aimed to offer the wireless data over their large distance in various methods, from one-to-one links for the full access of mobile cellular. WiMAX (IEEE802.16) technique is designed to offer the broadband access connectivity to mobile user and fixed in WMAN.

1.2.1 USES OF WiMAX

I. Offers telecommunication and data services.
II. Offer wireless communication in compare to DSL and Cable for long distance broadband access.
III. Single station may serve hundreds of the users.
IV. Gives a resource of connection of internet which is some portion of business congruity arrangement. In which, if a business can be affixed and especially Internet connection by un-related offers, since they are not likely to influence from comparable administration blackout.
V. In line-of-site, the Speed of 10 mbps to 10 kilometres

1.2.2 WiMAX TYPES

Several WiMAX types which is such as

- Mobile WiMAX and
- Fixed WiMAX

1.2.3 FIXED WIMAX IEEE 802.16d

- Developed to operate in 2-11 GHz frequency range.
- It supports to the Non-line of sight operation.
- It can be operates on both, un-licensed (5.8 GHz) & licensed (3.5 GHz).
- Its operation up to 50 km with data rate of the upto 75 Mbps.

1.2.4 MOBILE WIMAX IEEE 802.16e

- It operates in higher frequency range between the 2-6 GHz.
- It supports to standardize networking and mobility between the mobile devices and fixed base station.
- It enables higher-speed signal handoffs to the important for the communications with moving users on vehicular speed is bellow 100km/h.
- It delivers 70Mbps speed.

1.2.5 WIMAX ARCHITECTURE

WiMAX architecture, which is comprised of various components but in this basic 2 components are SS and BS. Another components are CSN, MS, ASN and CSN-GW etc.

[1, 2, 3].

The WiMAX Forum's Network Working Group can develop the reference model of network which is refer to IEEE 802.16e for point-to-point access for users to achieved WiMAX.

The WiMAX network design is based upon following main principles:

- Topology: It supports on the different RAN (Radio Access Network) topologies.
- Spectrum: In this, it is able to be work in both unlicensed and licensed spectra.
- Interworking: In this, Independent RAN architecture is able to interworking and seamless integration of network 3GPP, Wi-Fi, and 3GPP2 with their existed core operator IP networks.
- Mobility management: it is possible to provide access of broadband multimedia services and mobility delivery in compare to fixed receivers.

- IP connectivity: It supports to the mixed of both IP networks (IPv4, IPv6) which interconnects between the servers and clients.

To support nomadic, fixed and mobile WiMAX network, in this system reference model can be divided intelligently into these components are;

- **Mobile Station**

This is moveable station which transmit signal to huge areas for voice and data communication. It contains all important user equipment like as an amplifier, antenna, receiver, transmitter and software which is required to perform wireless communication. FDMA, GSM, CDMA, TDMA and W-CDMA devices are best examples of the Mobile station [3].

- **Access Service Network**

It's basically run by NAP which is integrated with ASN gateways (ASN-GW) and several or one base stations, which generates radio access network. It offers access to all services with the efficient scalability & full mobility. Their ASN-GW can control access of their network and coordinates between networking and data elements [3, 4]

- **Connectivity Service Network**

It offers IP connectivity to public and Internet or their corporate networks. It can apply per location management, address management, user policy management, between ensures Quality of Service, roaming, ASN and security [4].

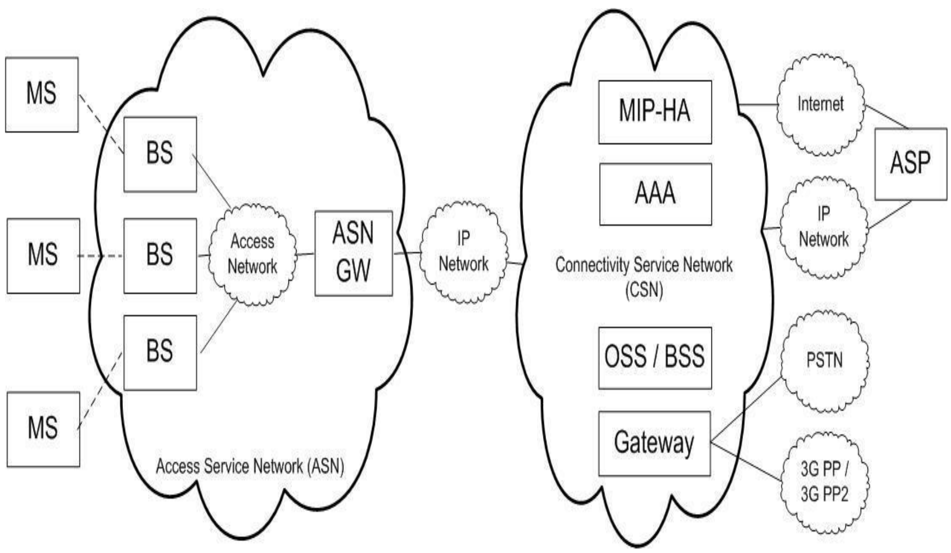

Figure 1.1: WiMAX Network Architecture based on IP

➢ Mechanism

WiMAX can be capable to work in distinct ranges of frequency but according to IEEE 802.16, frequency band can be 10 GHz - 66 GHz. It is typical architecture of the WiMAX which includes base station to build communicates on point to the multi-point basis and high rise building with subscriber stations that can be a home or business organization. The base station can be connected with their Customer Premise Equipment with customer, connection may be LOS or NLOS [9].

➢ Line of Sight (LOS)

In this type of connection, signal can travel in the straight line that is obstacles free, that means connection in direct path between transmitters to receiver. Line of sight needs their Fresnel zone, which is free from their most obstacles but if signal path can be blocked by the quality of sign which diminishes the significant result to the poor connectivity. There have a direct link between the WiMAX base station and receiver in Line of sight environment [1].

The features of Line of sight connections explained are,

- It can be used larger frequency between the 10 GHz to 66 GHz. Large coverage areas.
- It has less interference.
- In this, only threat came from atmosphere and their characteristic of frequency.
- Line of sight needs first Fresnel zone that should be free of obstacles.

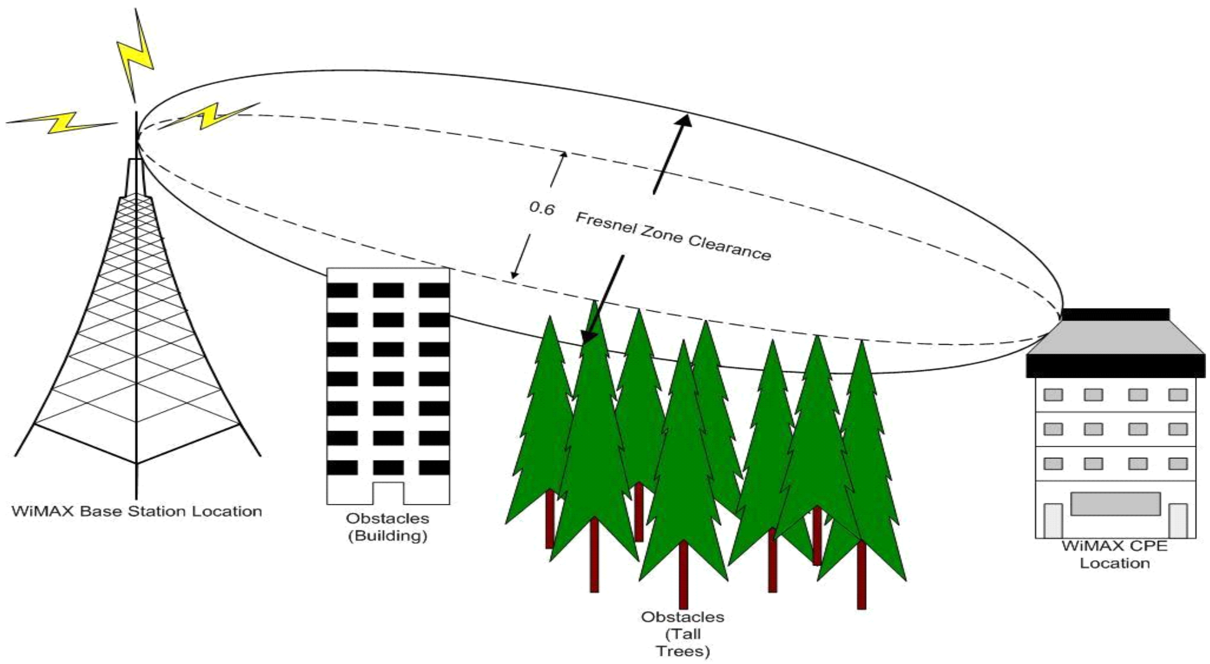

Figure1.2: WiMAX in LOS Condition

➢ **Non-Line of Sight (NLOS)**

The obstacles of signal experiences in path and arrives to receiver with various refractions, reflections, absorptions, scattering and diffractions etc. These signals are arrived to receiver in their distinct times, strength and attenuation that make hard to detect their real signal. WiMAX can display best performance in Non-Line of sight condition as it is based upon the OFDM that can handle to delay caused in the perfectly Non-Line of sight. WiMAX provides various benefits that work well in Non-Line of sight condition [1].

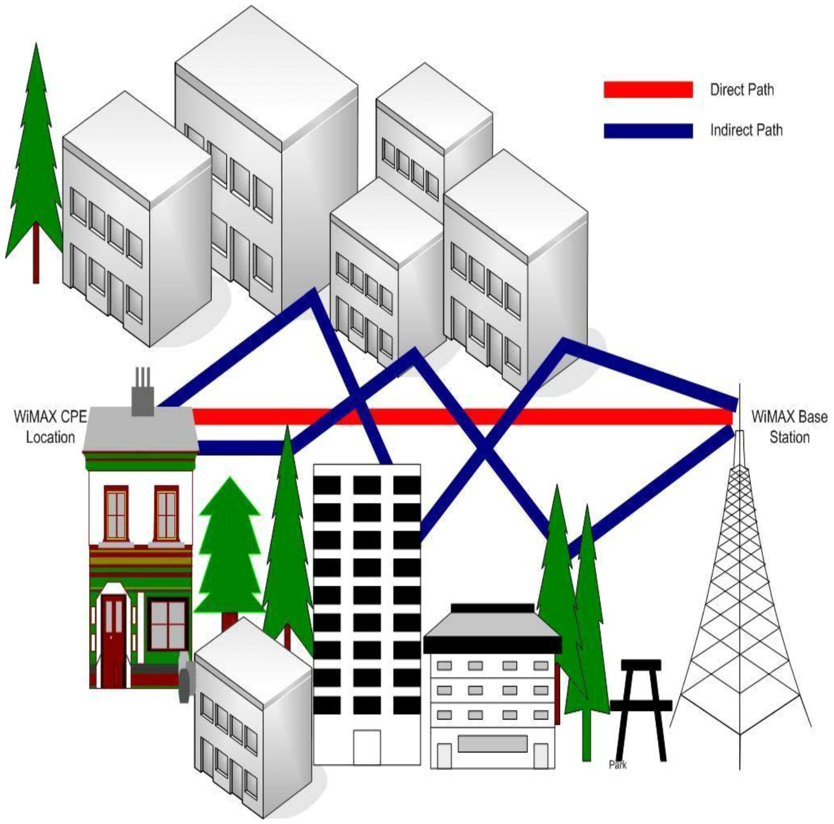

Figure 1.3: WiMAX in NLOS Condition

- AAS can direct WiMAX BS to a subscriber station.
- MIMO can be helped to prolong the signal strength and improve in both stations in Non-Line of sight condition, the speed is large but coverage area can be lesser than Line of sight condition.
- In this, fading of frequency selective can control by apply adaptive equalization.
- Adaptive Coding and Modulation (AMC), MIMO and AAS techniques can be helped WiMAX to worked with efficiently in Non-Line of sight condition.

- Sub-channelization can permit to send the appropriate power on the sub-channels.
- It is based upon channel condition and data rate, AMC can be offered to fix and correct code and modulation dynamically.

1.3 WiMAX COMPONENTS

WiMAX has two major parts:

- WiMAX base station
- WiMAX receiver

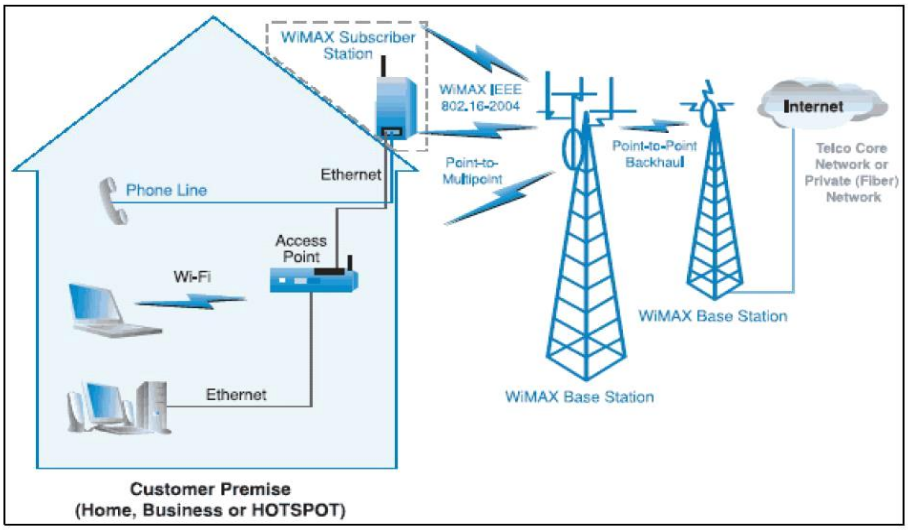

Figure 1.4: WiMAX technology

1.3.1 WIMAX BASE STATION

It's also known as WiMAX booster or tower. This BS can broadcast to the radio frequencies to receiver end. This station can consist of the WiMAX tower and electronic devices - that works such as GSM network. The WiMAX base station can be interconnected with base stations by large speed of microwave link that can be called backhaul [4].

- Responsible: It provides air link to MS which performs in the PHY and MAC.
- Additional functions: Hand off, reuse of Frequency, QoS, tunnel establishment and traffic classification etc.
- Management: Management to bandwidth, Session and multicast group for up and down links.
- Practical Face: Electronic appliances in indoor and Tower in the outdoor environments.

Figure 1.5: Mobile WiMAX BS

1.3.2 WiMAX receiver (CPE)

It receives radio frequency from base station of WiMAX, which provides a point to the availability for their WiMAX system in range. This WiMAX receiver and antenna can stand alone into PCMCIA slot card or small box. WiMAX tower can associate straightforwardly to internet while utilizing their high data transfer capacity and interface with the other tower while the use of non-line of their sight microwave link that is called as backhaul. The base station can allow the WiMAX users from one base station to another, which is similar as GSM networks [2, 4].

- Responsible: It offers connectivity between the subscriber equipment and a WiMAX base station.
- Connection: High speed microwave link, Backhaul that can be referred to connection between the WiMAX system and core network.
- Additional function: Network interoperability, Packet priority and QoS.
- Offers User: Multimedia and VoIP or access to internet with various mobile applications.
- Practical face: User Premises Equipment's for outdoor & indoor purposes.

Figure 1.6: Mobile WiMAX Indoor CPE Receiver

Figure 1.7: Mobile WiMAX Outdoor CPE Receiver

1.3.2 Backhaul

Backhaul can be referred to association from access point back association from offer to core network. The backhaul can work in any media offered and technology. It can connect backbone to the system. In the case of WiMAX scenario, there is possibility to interconnect various base stations to another one while using high-speed backhaul microwave links [4].

It's offer roaming by WiMAX subscriber from the one BS to another BS coverage, similar to roaming enable by the cell phones [4].

1.4 WIMAX WORKING

The WiMAX backhaul can be in view of average association with open remote systems with the use of microwave link, optical fiber, cable or higher speed connectivity. In some cases, Point-to-Multi-Point connectivity and mesh networks, can be works as backhaul. WiMAX can use it as backhaul to combine with subscriber sites from one to other and base stations with long distance. BS can serve to the user stations by using Point-to-Multi-Point connectivity; that connectivity can refer to last mile of communication. WiMAX offers Point-to-Multi-Point connectivity for connecting residential and business users to BS with NLOS.

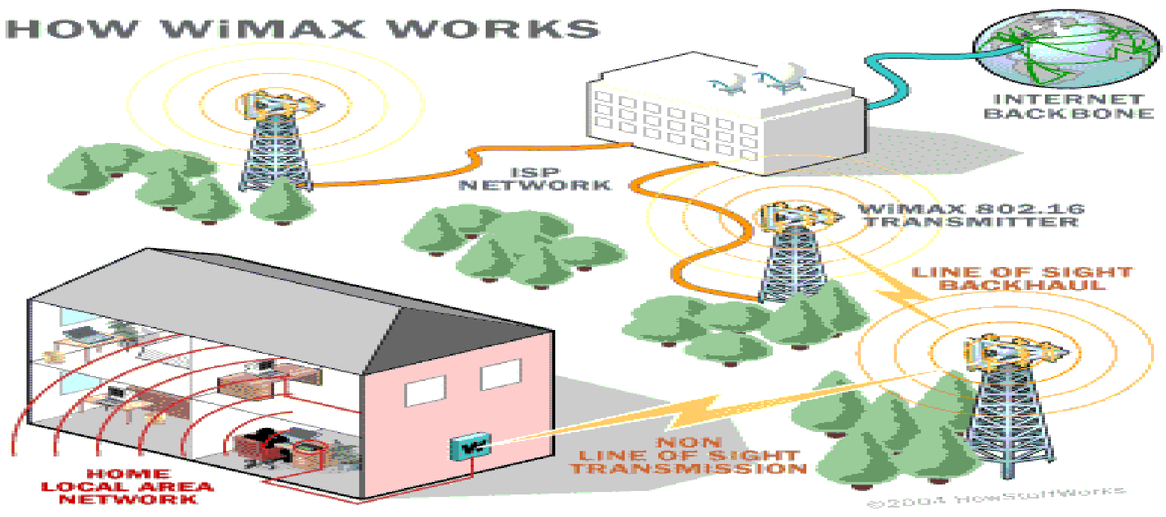

Figure 1.8: Working of WiMax

1.5 CALL HANDOVER IN WIMAX

When user will travel from one cell of coverage to another cell during call then call control transferred to base station of next cell. Otherwise, call should dropped because link between present base stations makes weak for mobile recedes. The ability to transfer call in their mobile cellular system without dropped called as handover. This action can complete when receiving controller can acknowledge the assumption of their control authority.

1.6 MOBILITY and HANDOVER MANAGEMENT

WiMAX can support 4 mobility scenarios.

- **Nomadic:** Subscriber is permitted to get fixed station (FS) and re-connect to distinct point of the attachment.
- **Portable:** In this, the portable device gets nomadic access through best-effort handover.
- **Simple mobility:** In this, speed of mobility is upto 60 kilo meter per hour with disturbance, lower than one second while hand-off is permitted to WiMAX users.
- **Full Mobility:** In the mobility, <1% packet loss can supports the WiMAX users, during handover with speed up to 120 Kmph. WiMAX can support to three different types of MAC-layer handover activities, HHO, MDHO and FBSS. HHO is default handover method and another two are the soft handover methods, MDHO and the FBSS are optional.

1.7 TYPES OF HANDOVER

Some handover types that are categorized as Structural, Initiation, Technology and Execution mechanisms aspects.

• **Technological Aspect:** Handovers may achieved with some different methods. Handover may occur between the wireless technologies and Mobile WiMAX, it is divided into two types that are vertical and horizontal handovers. First handover occurred within single technique, later handover within distinct technologies like as mobile WiMAX and WLAN.

• **Structural Aspect:** Handover is not mean to change Base Station, it likewise happen inside of same Base Station but several channels in similar BS, that called intra-cell handover, another one known as inter-cell handover in which transfer of call from one to another BS by MSS.

• **Initiation Aspect:**. In this handover, MS is responsible to conduct the handover, which is named as MS initiated handover. For this situation, handover trigger is because of uneven conveyance of the traffic which is generally BSS to recognize unbalance circumstance in system and BS starts handover, known as BS Initiated Handover.

• **Execution Mechanisms Aspect:** from the execution point of view basically WiMAX is classified into three types of the handover; hard handover (HHO) can be mandatory for FBSS. Macro diversity handover is optional.

1.7.1 HARD HANDOVER (HHO)

HHO is a procedure to modify the offering BS while using a "brake-before-make" connection to old BS can be broken before newest BS can be connected. This way to excess the signalling traffic to avoid while handover, but time before association in this typical operation may be large. During connected to BS, the MS can listen to messages of link-layer, a newest BS's occasionally can be shown neighbour notice message is gotten. These messages can be used to identify the networks and distribute the properties. The data can be received and give to the neighbouring BS. If better BS cannot found, the MS may save the information to provide handover.

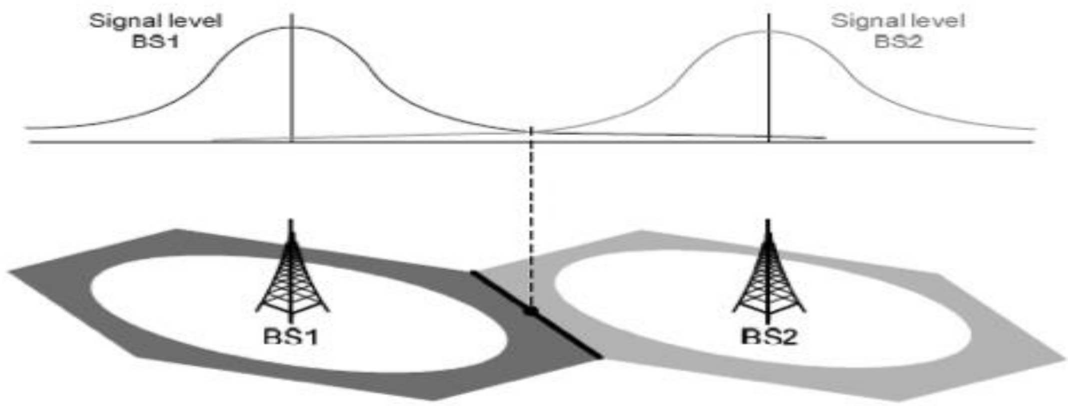

Figure 1.9: Structure of Hard Handover Network

1.7.2 FAST BASE STATION SWITCHING (FBSS)

In this technique, diversity set for every MS can be maintained. In this method monitoring of the neighbouring mobile stations and serving base stations is done by BS, which can be added into the set of diversity. The serving BS and MS maintained the set of Diversity. Diversity set can be collection of their base stations (BS) which is selected as target base station (TBS) for the handover. In fig. 1.10, MS can choose one base station as anchor base station from the set of diversity, which transfers its real location to the BS controller for making the decision of handover, if any requirement of handover the BS controller transmits message of handover initiation to the MS. Handover decision making is done by the MS or BS controller which depends upon the implementation.

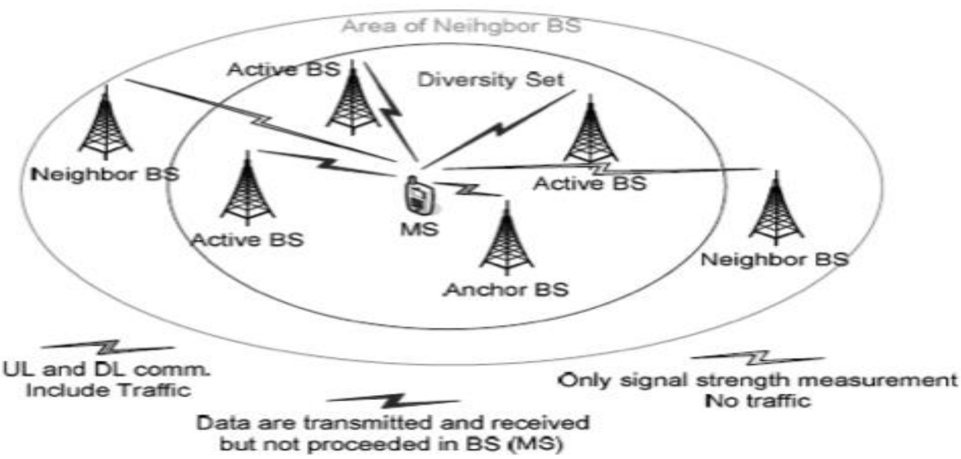

Figure 1.10: Fast Base Station Switching (FBSS) Network

1.7.3 MACRO DIVERSITY HANDOVER

MDHO can be intended to permit the full consistent portability with all the more high speeds. Moreover, it has advantages by using the same carrier frequency to perform the handovers within the sectors with universal frequency reuse concept.

Diversity set: It is selection of Base Stations by MS such which all Base Stations can operate on similar frequency channel or may be synchronized on frame level and time.

Update the Diversity set: It can be overhauled under their two circumstances: first when CISR level of the providing BS can fall underneath as pre-defined level called as H_Delete threshold, and during second case set of diversity of BS can be added if it is having CISR levels H_Add threshold.

Active BS: Provides data about MSS and MAC context to all the base stations in diversity set.

Serving BS: Base Station, which is recently registered with MS or handed over to MS.

Neighbor Base station: Base station which is not a part of the diversity set, data can't exchanged with Base Station, but MS performed signal quality estimation on that BS.

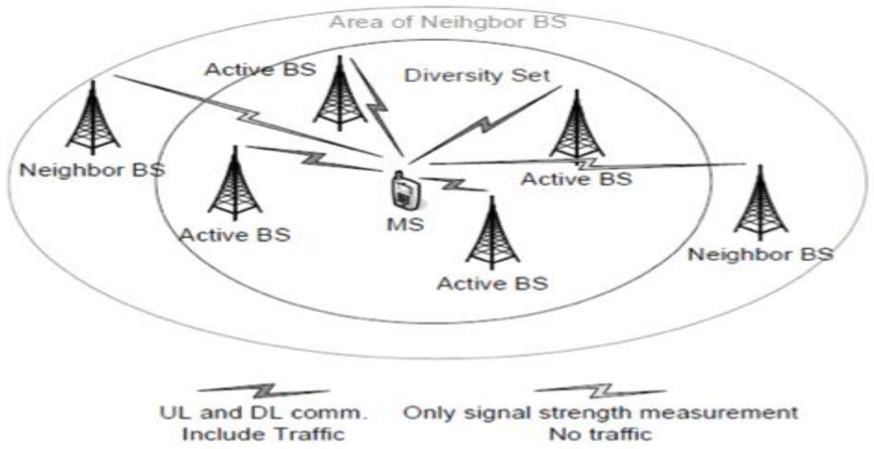

Figure 1.11: Macro Diversity Handover Network

1.8 HARD HANDOVER (HHO) VS. SOFT HANDOVER (SHO) IN WIMAX:

These three different handover method can be available in the network of WiMAX, are HHO, MDHO, and FBSS which has their own disadvantages and advantages. FBSS and MDHO can be often jointly known as Soft Handover (SHO).

The HHO scheme in the 802.16e can be fairly fast and largely bandwidth-efficient and seamless in nature. This Network can be Optimized HHO mechanism which can possibly diminish the handover delays, handover overheads, cell drops and resource wastages in case of full-mobility WiMAX. HHO is simple Mobile WiMAX method which ensures the efficient support to provision their diverse fast continuous applications without QoS degradation and significant interruptions. From commercial standpoint, main advantages of the HHO scheme in the Mobile WiMAX can less work cost and complexity, require few BSS spaced apart appropriately. Some of disadvantages of the HHO can be delay during the search and selection of the target BS, connection time increased, so non-negligible packet losses.

So far as SHO can be concerned, both FBSS and MDHO have their different features such as fast switching and low packet loss, which provides <50 milli-sec handover latency, having potential to allows real time voice-centric applications such as VoIP. To get aforementioned components can be truly troublesome which the outline can be to a great degree expensive, intricate and inefficient of the assets such as power. Synchronization of BSS in a active Diversity sets by using carrier frequency reuse and network entry-related information. Either FBSS or MDHO in WiMAX network are not fully developed yet.

Parameters	**HHO**	**FBSS**	**MDHO**
Latency	Higher	Medium	Lower
Implementation Complexity	Lower	Medium	Higher
Reliability	Lower	Medium	Higher
Packet Loss	Higher	Lower	Lower
Cost of Implementation	Lower	Higher	Higher
Support for Delay Sensitive Applications	Lower	Higher	Higher
Speed	Lower	Medium	Higher
Hardware Complexity	Lower	Medium	Higher
Hardware Cost	Lower	Medium	Higher
Link Quality	Lower	Medium	Higher
Commercial Usability	Higher	Medium	Lower

Table 1.1: comparison of Handover technique

1.9 PROBLEM STATEMENT

In the topic of wireless, mobility makes key place for the regular communication. When subscriber can move from one base station to other station then they need continuity communication. So, there have a method of call handover. This call handover method comes with few problem like as delay in loss of data, response, insecure communication, disturbance, and out of coverage area etc. This loss of data can be delay in response which decreases QoS and generates inefficient communication. This cause of problem can be due to the latency delay, overloaded BS and inefficient handover decision. It produces the poor end-to-end performance in call handover into mobile WiMAX. The end-to-end performance can be produced with less throughput, high end-to-end delay, low total packet received, etc. This level of QoS is not sufficient for best call handover in the mobile WiMAX. There is requirement to take an improvement in handover procedure for good performance of the call handover in their mobile WiMAX for application.

1.10 OBJECTIVES

- To study existing systems to improve and Fast the Handover in WiMAX.
- To develop the newest system while using several Handover improvement methods in WiMAX.
- To create the fundamental scenario in NS2 or Opnet for implementation of proposed system.
- Analyse the proposed system and obtain key results to compare the existing methods and proposed technique.

CHAPTER 2

LITERATURE REVIEW

2.1 DETAILED STUDY OF HANDOVER METHOD

Medium Access Control (MAC) layer, HO process of the Mobile WiMAX can consist of two phases. The first phase is Network Topology Acquisition that can be carried out with actual HO process. The actual HO process can be included HO initiation, decision, ranging and network re-entry process can be performed.

NTA before HO

- scanning of neighbour BSs by MS

- Network Topology Advertisement

-Association Process

HO Process during HO

-Cell reselection

-Close all connection (break- before make)

-HO decision and Initiation

-Obtain up-link parameters

-Synchronize with new down-link and obtain parameters

-Re-register

-Ranging and up-link parameter adjustment -Termination with serving BS -MS re-authorization

2.1.1 NETWORK TOPOLOGY ADVERTISEMENT

The Base Stations can broadcast with Mobile Neighbor Advertisement controlling messages. Those messages includes information of link and physical layer. MS may become aware of neighboring BSs.

2.1.2 SCANNING/RANNGING PROCEDURE

MS synchronizes and scans with neighbour Base Stations which is based on the channel data from neighbour advertisement. If synchronization can success, then it can be started range procedure. Firstly, MS transfer Mobile Scanning Request to their neighbour base stations with potential target and their base station list. The provided BS can reply to the Mobile Scanning Response information to the MS for allocation scanning duration. Base station can negotiate specifically with recorded BSs, designation of unicast running open door. In the event that it is fruitful, running system can be non-conflict based.

MS can start hand-shake range process with neighbour BS for the parameter adjustment and OFDMA uplink synchronization. This process can contain the several message Range Response and Range Request transmission, it is also having information about parameter adjustment transactions. This process completed after MS can be set range with their neighbouring. MS can be switch to newest channel, therefore no connection loss with serving base station.

2.1.3 DECISION AND INITIATION OF HANDOVER

Handover triggers, initiation as well as decision may be originated with BS and MS by use of Request message (MOB_BSHO-REQ) and MS Request message (MOB_MSHO-REQ) respectively. MS can be made the decision about that will be target base station. Handover starts by MS transmits a MOB_MSHO-REQ messages to their providing base station indicator, there may be more than one target BS's. The providing BS can be attained direct from the TBS can be expected performance of MS at TBS with interchange response and indication messages of HO. After receiving the messages from the TBS (MOB_BSHORSP), MS can be notified as providing BS about their performing decision to the handover process with meaning of handover Indication (MOB_HO-IND) messages. MS is asked for providing base station to compensate with their TBS for allocation of range opportunity. It is important, MS starts with the range after initiation of handover. The initiation as well as decision process of handover cannot call to the connectivity break-up which add their latency.

2.1.4 RE-ENTRY OF NETWORK

The adjustments of physical parameters can be completed successfully; system re-entry procedure is started to build up connection between MS and TBS, defined by IEEE 802.16e, the process can be included the capacity authentication, negotiation and registration transactions. Because MS may be in waiting condition until re-entry process can be successfully completed with restored the communication.

2.2 LITERATURE SURVEY

In this thesis, we can represent completed work which is done by several researchers on the improvement mobility handover scheme in WiMAX.

Khosla et al.[5] can be proposed handover methods to improve mobility with their low implementation scan time in WiMAX technique. The compulsory handoff method can be Hard Handoff for other two optional and Mobile WiMAX soft handoff methods can be FBSS and MDHO method. Handover delay can be generated while data transmission but the handover makes delay that should be lower than 50milli second for the real time high speed data applications as VoIP. Improvement of mobility handover method depends upon velocity factor which can be taken into the consideration in paper. The proposed method can skip few unimportant handover stages, and can be reduced the handover delay to adjust handover RSS trigger viz. handover parameters and threshold handover RSS trigger value can be improved the speed of MS. The presented scenario is implemented to use QualNet network simulator that can lead to low handover time. Hence, the mobility improvement HO method can be proposed, in that HO threshold can be varied with velocity of MS. The conclusion can display the HO delay less than 50ms limit when the speed can be changed from the 20-29 m/s, Delay of handover may be decreased when speed exceeds 29 m/s which equal to 105km/h. This method is more useful in real time and high velocity applications can offered for Mobile WiMAX.

Yadav and Mehandia [6] described some soft handovers which is avoided data loss while HO. The two types of the HO in WiMAX: Soft and Hard handover. To avoid this data losing while the handover can be proposed a method to opt a BS for potential SHO in the WiMAX. We can develop the base station selection procedure which is optimized to soft handover like as zero data losses, HO decisions can takes place fastly, therefore HO performance get improved. The comparison of QOS with soft handover and hard handover can be done through it. We can analyse the proposed method with existed method for soft handover in the WiMAX. The relationship between velocity and handover latency of mobile station is find out by this simulation. The handover mechanism can be displayed by using MATLAB and completes the need of HO in WiMAX, when MS may travels at speed of 20 meter per sec. Therefore, while using link going down method can decreases latency of HO, its challenge to get mobility upto 120 km/hr, HO latency of lower than 50ms with a loss of packet, <1.

Khan et al.[7] in the past few years, Mobile WiMAX become most important methods which has an ability to offer the users with higher speed of wireless network . While the user moves from one cell to another, mobility can bring with need of handover, and is considered as essential in WiMAX. Conventional handover methods with few techniques which deals to reduce latency as well as handover. These can be included with cross layer latency reduction and handover technique in handover while using MAC layer handover and mobility pattern algorithms. Provide the mobility in the WiMAX networks can be via seamless HO mechanisms gets to be noteworthy range of the exploration in wireless communication. Various handoff methods for the WiMAX networks can be compared and studied on handover initiation and latency. It is displayed thorough analysis which can be reduced latency of HO by half, in comparison to basic HO mechanism refer to WiMAX standard.

Ashoka et al.[8] presented WiMAX providing a huge number of MS in the practical needs an desirable handover technique. Presently, WiMAX can be long time delay in handover process which can be contributed to delay in communication. Most researches are focuses on the increases efficiency of handover methods. It is analysed with performance of two standardized handover methods, which is namely the ASN-based Network Mobility and Mobile IP. The conclusion can indicate which ABNM more efficient for the handover throughput and delay. The results of research can be promised for applicability of network-based HO technique, encouraging for network-based HO researches. Mobile WiMAX network offers satisfied with ASN anchored protocol because of fact own protocol, and also changed to protocol cannot influence the mobile devices of clients. Most conventions for the portability administration can be tent to need alterations to MS programming stack. MS being free of the mobility management, merchants designed for the mobile phones for mobile WiMAX without requiring providing for frequent software updates, manufacturer makes the mobile devices which is irrelevant of handover protocol can be uses in network. Overall, we can demonstrate the ABNM handover method improves the capability of the mobile WiMAX network control their networks and operators to manage effectively.

Ray et al.[9] proposed the effective backing of the consistent handover administration movement which is key requirement for the correspondence advancements can be proposed to generally acknowledged in the cutting edge correspondence frameworks. The paper can be identified and different MAC layer and network layer of handover which is issued in WiMAX, and enlighten these in the cross-layer challenges. MAC-layer HHO are related to optimization and loss of the scan processes and inter-handover CDT, taken as broad open, as WiMAX Forum cannot be reached with definite results regarding to change the existed standard to incorporate the modified suggested date. The issues can be considered on network optimization load distributions, re-entry processes with MDHO and FBSS, not attractive for research. Moving up, cross-layer challenges can got with more attention than only Layer 3 ones. This is possible with performance of macro-mobility handover, can be dependent on performance of both L2 & L3 handovers with L3 handover. Hence, cross-layer issues, such as undisturbed integration of L2 and L3 efficient bidirectional flow and handover management message, can be lower than other issues and requiring more attention in order to devise a best WiMAX CLHM framework. A standardization of WiMAX L3 framework will be helped to get this. Attention should be provided to select the good option for MIPv6 to provide seamless handover performance for the high-speed real-time multimedia applications. However, it is appeared when the PMIPv6 is most promised option, being mechanism can be closely aligned with architectural direction of the WiMAX, since there is nothing can be decided yet, this is broad open area for the investigation.

Kumar et al. [10] proposed the updated handover method for WiMAX networks. The handover mechanism can be guaranteed improvisation of delay time of handover process. The delay time of handover mechanism can be reduced with place of mobile nodes in the WiMAX networks. A set of simulation scenarios can be illustrated handover between 3G and WiMAX networks are evaluated. The conclusion is indicated with the mechanism can be reduced than 98% handover delay in the WiMAX networks. The handover mechanism can be guaranteed improvisation of delay time of handover process. The delay time of handover mechanism can be reduced with location of their mobile nodes in the WiMAX networks. A set of their simulation scenarios illustrated handover between 3G and WiMAX networks can be evaluated. And conclusion indicates mechanism can be reduced more than 98% of the handover delay in their WiMAX networks.

Shinde[11] described major issue in WiMAX network can handoff latency and it is occurred when MS can be unable to predict TBS based on quality signal. In proposed paper a solution which improved handover latency. This paper can be introduced with implementable enhanced handover target cell selection algorithm for WiMAX network which is based upon effective capacity estimation and neighbour advertisement. Qualnet 5.0 simulation can be provided to display the enhancement performance of enhanced algorithm compared with traditional algorithm which is based upon signal power. The proposed work improves the handoff latency. The paper introduced an optimized handover scheme for WiMAX network. The technique depends on successful limit estimation of a BS and publicizing unmoving limit data through neighbor ad messages as per the IEEE 802.16 specifications

Sawant and Vernekar[12] can be proposed two newest methods, one for minimization of excessive scan involved in opting of TBS and secondly to reduce handover delay involved for the real handover initiation. The minimization can be done to predict the Target base station from data offered by GPS system. This prediction can be helped in minimum number of the channel frequencies to be scanned by MS thereby decreased the delay involved in handover. Since MS can be remain disconnected with SBS till scan can be done with delay can be introduced which can be reduced to minimize the number of frequencies required to scan and however reduce the delay. For minimization of the handover delay can be dynamic distance handover scheme can be proposed. According to existed draft version of 802.16e standard, HO initiation can be performed if RSSI of served BS is lesser than RSSI of TBS. Hence, it does not consider distance between MS and BS in HO process, so there is a handover delay can be included. To cope with problem proposed scheme can be made use of the dynamic distance threshold that can be allowed with handover between two BSs depends upon velocity of MS and established connection before MS can overruns boundary of the NBS to much extent in their terms of distance to decrease handover delay can be involved.

Gupta[13] centered upon relative investigation of a few situations of the handover procedure to offer the mobility to WiMAX system alongside progressed QoS. Today the wireless network field can be Worldwide Interoperability for the Microwave Access or WiMAX can be emerged out most promised networking technologies. But in order to compete the recent existed other wireless technologies such as 3GPP/UMTS, Wi-Fi, Bluetooth; WiMAX has to promise cost efficiency and better QoS. Along with QoS today's greatest network can demand mobility can be supported by the handover mechanism. With this paper several scenarios and methods of handover. Obviously, for each specific network environment particular handover method is suitable and still there is concern for the researchers to provide stable and broad acceptable handover algorithm. Out of the relevant for low speed portable WiMAX organizes however it is less expensive and easier. Then again need of fast versatility requests delicate being mind boggling and costly. But, by minimizing the cost can be minimized and being more reliable and compatibility incorporated that significantly handover component is not building design autonomous, and both the basic types of handoffs, i.e. soft and hard both can incur at the level of layer 2 or layer 3 of the OSI network model.

Becvar and Zelenka [14] focused on description of the full mobile WiMAX and proposes the overview of handover types and procedures can be used while movement of users. In this paper they analyse present handover situation in their WiMAX networks. In first version of the WiMAX standards, the mobility cannot supported at all. By time became a need of user mobility. Because of reason various types of handover in WiMAX technology have been introduced. Hard handover can allow only less speed mobility. For higher speed mobility can be MDHO and FBSS implemented. FBSS and MDHO belong to group of the soft handovers. In booth handover types the diversity set is maintained. The main difference between MDHO and FBSS is, that in MDHO is applied the selection diversity and diversity combining in uplink and downlink, respectively. In FBSS all data traffic is processed only in the anchor base station.

Dong-ho cho [15] proposed the velocity-adaptive handover method. This method can be adopted with dynamic handover threshold according to the distinct velocity to skip handover stages**,** diminishes handover postpone and increments system asset use. The simulation performance and result can be analysis to validate efficiency of proposed scheme. According to existing draft of 802.16e standard, Handover initiation could be perform, the RSSI of providing Base Station is less than threshold value. It don't take velocity's influence on Handover processes and threshold value of handover, set as constant. Therefore, velocity decreases performance of handovers. Threshold value of handover can be set as per MS mobility. Simulation conclusion can display delay in handover process less than 50 mili-sec, If velocity can be varied from the 20 m/s to 28 m/s. Delay in handover can be decreases if velocity exceeds 28 m/s. Thus, the velocity adaptive HO method provides undisturbed communication in WiMAX for high velocity data applications.

Joon et al.[16] proposed a method to opt a BS for the potential SHO in the WiMAX, which is developed BS selection method which can be optimized soft handover , with no loss of data; handover decision of handover can be quickly takes place and therefore improves performance of handover process. The main aim of simulation is to find, relationship among latency of handover and MS velocity. It is displayed the present handover methods by using NS-2 simulator, completes need of undisturbed handover in mobile WiMAX, where MS dramatically reduce latency of handover, it is still difficult to achieve mobility upto 120 km/hr, with latency of handover less than 50 mili-sec, related packet loss is less load factors of TBS.

CHAPTER 3

EXPERIMENTAL DESIGN

3.1 SIMULATION SCENARIO

The design of simulation scenario has been made with eight WiMAX base stations and one user node. The simulation results have been obtained from the user node to calculate its performance with new handoff method, proposed model is based upon the standby request mechanism, which is sent to multiple bts before leaving the connected cell. Once the connection request is approved from the other base stations, the node leaves the connected cell and updates the running connections through the next connected base stations. The important topological parameters have been defined in the following table:

Property	**Value**
Radius of Transmission	2500 cm
Initial Coordinates	Random
Queue Length	50 packets
Wire-less Channel	Standard WiMax
Type of Link Layer	LL
Routing Protocol	AODV
Nodes	9
Connecting Model	MAC 802.16
Antenna Model	Omni Antenna
Simulation Area	[1800 x 800] [2439 x 1000]

Table 3.1: Table of node configuration

NS-2 simulator is used for preparation of simulation scenario. The NS-2 simulator abbreviated for Network Simulator version 2, commands are required in C/C++ language. This simulator Required Ubuntu Linux version 12.04 for installation for experimentation in thesis work.

Various simulation aspects performed during experimentation. The Tcl/tk language used for the simulation programming in NS-2 Simulator. With the help of simulation programming we make the nodes, its connection and behaviour based initiators. The specifications of NS-2 are given below;

Property	**Value**
Operating System	Ubuntu Linux version 12.04
Requirements of Memory	2.5 Giga Bytes or more
Processor	Dual Core or Any two core CPU
HD Space required	25 Giga Bytes or more
Requirements of packages in Linux	Build-essentials Automake Autoconf Libxt-dev Libxmu-dev Libx11-dev Perl Tcl-debug Dmalloc Tcl release 8.5.10 (essential component) Tk release 8.5.10 (essential component) Otcl release 1.14 (essential component) TclCL release 1.20 (essential component) Ns release 2.35 (essential component) Nam release 1.15 (optional component)

	X-graph version 12 (optional component) C-Web version 3.4g (optional component) SGB version 1.0 (?) (optional component, builds for all UNIX type platforms) Gt-itm gt-itm and sgb2ns 1.1 (optional component) Zlib version 1.2.3 (optional, but required should Nam be used) Y-graph/Gamma Graph (X-graph alternatives)

Table 3.2: NS-2 simulation environment specifications

The NS-2 simulator has installed from Debian repository for Ubuntu systems. The debian repository is online free access Ubuntu repository, which is used to install packages online using the apt-get or aptitude modules of the Linux systems. The installation procedure for the NS-2 simulator has been completed by following the instructions given below:

- Update the apt-get repository information on the newly installed Ubuntu System

  sudo apt-get update

  sudo apt-get dist-upgrade

  sudo apt-get update

- Install the essential packages (dependencies):

  sudo apt-get install build-essential autoconf automake libxmu-dev gcc-4.3

  sudo apt-get install tcl8.5-dev tk8.5-dev

  sudo apt-get install perl xgraph libxt-dev libx11-dev libxmu-dev

  sudo apt-get install ns2

  sudo apt-get install nam

3.2 DESIGN AND IMPLEMENTATION OF PROPSOED ALGORITHM

The proposed model has totally based upon newest and effective model for efficient handoff mechanism. The proposed model can be entirely based on the newest designed mechanism of standby request for the efficient use of handoff between the different WiMAX network cells. The WiMAX networks are designed to offer the high bandwidth connectivity to the users in the long-range connectivity.

Algorithm 1: Stand-by Request based Super Soft Handoff (SRBSSF)

1. Load the cell information.
2. Enable the cell Base Transceiver Station (BTS).
3. Enable the mobile nodes
4. Prepare the connectivity model.
5. Join the node in the network and assign a global id to the network.

   The N_j is the network node N_j, which equals of equips the connectivity with the node W_c and it is not connected to zero nodes, which means it is not out of the range:

   $$Nj = Wc \sim 0$$

   The $N_j(i)$ is the node in the Wi-Max network, where the $N_j(i)$ node becomes the member of W_c base station and keeps itself connected with the W_c node.

   $$Nj(i) = Nj(i) \in Wc$$

   When the node $N_j(i)$ comes in the range of another BTS $W_{ci}(j)$, it calculates the probability of the connectivity with that node and with the existing base stations node.

$$Nj(i) = Nj(i) \in \{Wc(j), Wci(j)\}$$

Where N_j = Node join the WiMAX Network

W_c = BTS with which the node is connected

W_{ci} = Cell ID

0 = denotes the unavailability

1 = denotes the availability

6 Compute the user distance from the BTS according to given Threshold.

The radius has been set to 250 meters in the whole simulation network.

R=250

The threshold TH has been set at {240,230} meters of distance, which describes the distance of the connectivity between the active base station and the other base stations in range. The 240 meters range of nearby will be preferred over the range of 230 meters, as there is a high probability with the node on the 240 nodes, while changing the cell. The

TH={240,230}

The D is the distance and uses the following Pythagorean equation to calculate the distance between the two network points.

D= (x-x1)2 + (y-y1)2

Where *R* = Radius of the BTS

TH = Threshold value

D = Distance

x = x co-ordinate of WiMAX BTS

y = y co-ordinate of WiMAX BTS

x1 = x co-ordinate of node

y1 = y co-ordinate of node

TH={TH if TH<R R if TH>R

If D<TH

Ac = Wci(J)

Nr = 0

Ab= W(j)

Nl= 1nw(1),w(2),w(3)……w(n)

Where A_c = is the activated cell

N_r = Neighbor cell updation requirement

A_b = Active BTS

N_l = initiated BTS list

Otherwise

Ac= Wci(j)

Ab=W(j)

D(j)= (x1-x(j))2+ (y1-y(j))2

D(j)={ D(1),D(2),D(3)……..D(4)}

THj=R+(R-TH)*2

D(js)=D(j) ifD(j)<R+((R-TH)*2)

Where *D(j)* = Distance of node from other BTS

D(js)= Distance under threshold

Nr=1

Nls= 1nW(js)

Rnj= 1nW(js)<THj

Where N_{ls} = shortlisted node

7 If the user reaches within the limit R of N_{ls} cell, N_{ls} cell will update its membership all from previous to itself.

3.3 WORKFLOW DIAGRAM

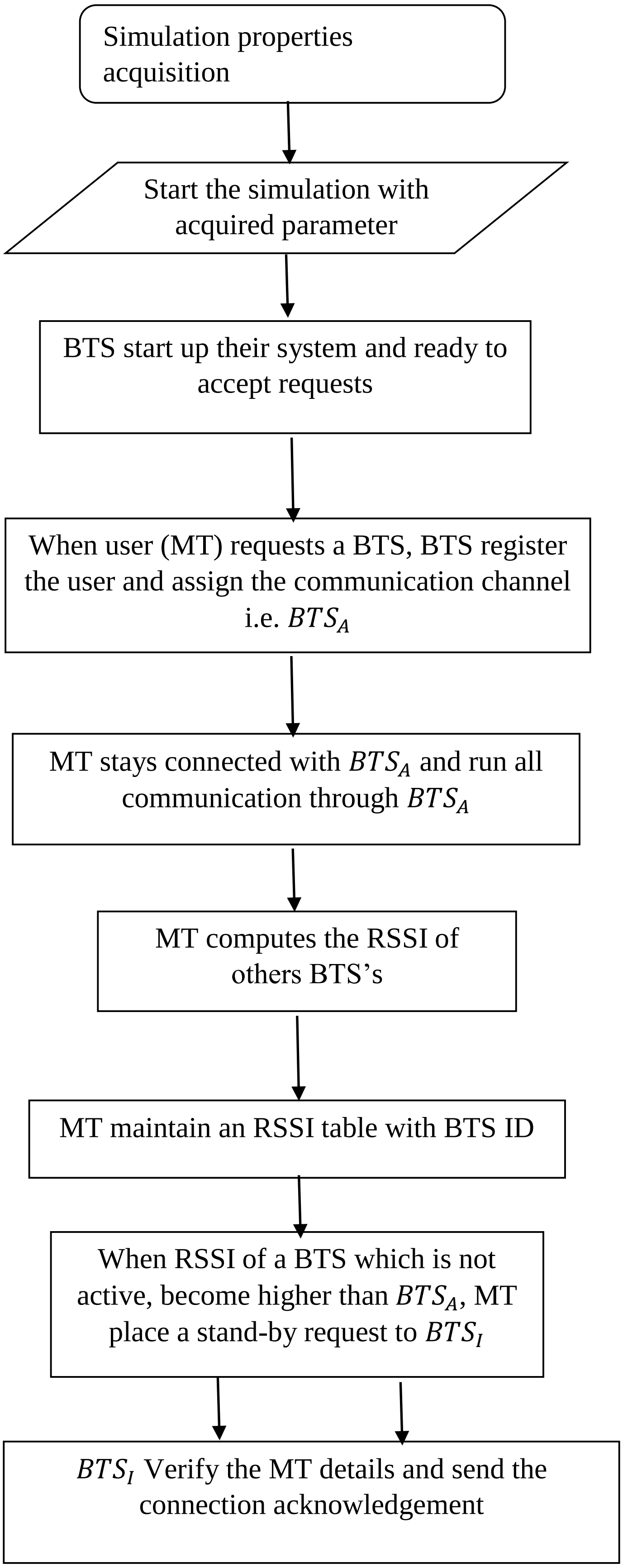

Figure 3.1 workflow diagram

CHAPTER 4

RESULT ANALYSIS

4.1 SIMULATION SCENARIO

The simulation scenario has been designed with eight WiMAX base stations and one user node. The simulation results have been obtained from the user node for evaluation its performance with the new handoff algorithm. Proposed model is based upon the standby request mechanism, which is sent before leaving the connected cell. Once the connection request is approved from the other base stations, the node leaves the connected cell and updates the running connections through the next connected base stations. The important topological parameters have been defined in the following table:

Input/output Parameter	**Value**
Number of base stations	8
Number of user nodes	1
Connectivity Mechanisms	Wi-Max
Wireless Standard	802.16
Request Threshold	80/20 (Connected Cell/In-Range Cell)
Connectivity Distance (BTS and Node)	250 meters
Request type	Standby Request

Table 4.1: Topological Parameters

4.2 SIMULATION PARAMETERS

The performance metrics chosen for the evaluation of the proposed model are transmission delay, throughput, packet loss, packet delivery ratio and network load.

- ### Transmission Delay (End-to-End Delay)

The transmission delay is defined as the time taken by a packet reaches to the receiver end from the generation of a packet by the source, so it is the time that a packet takes to go across the network, it represented in seconds (sec).

- **Throughput**

Network throughput or simply throughput can be calculated as ratio of total amount of data which successfully reaches receiver end from sender to the time it takes for the receiver to receive the last packet. It is expressed in bytes per second or packets per seconds.

- **Network Load**

Network Load can be defined as traffic or amount of data carried out by a network at a particular time. The network load may be different at different time. It is calculated in bytes per second or packets per seconds**.**

- **Packet Dropped (Packet Loss)**

Packet Dropped is data packets which may lost during the transmission not reaches to the destination.

- **Packet Delivery Ratio**

It can be calculated by ratio of number of packets at received end by number of packets send from source end, describes by loss rate. For better Performance the high value of packet delivery ratio is required.

4.3 SIMULATION RESULTS

4.3.1 Transmission Delay: The transmission delay has been obtained as the parameter from the proposed and existing models. Once the traffic gets stable, the transmission delay remains at the 0.03 seconds for the proposed mode and 0.09 seconds for the existing model. This shows the effectiveness of the proposed model against to existing model. The proposed model results for transmission delay have been displayed below:

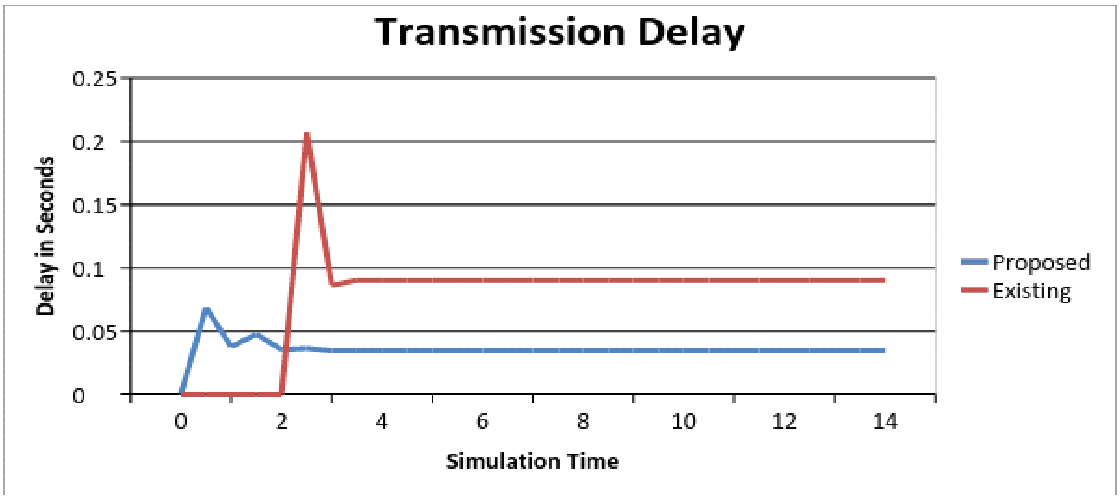

Figure 4.1: The transmission delay between the proposed model and existing model

Simulation Time	**Proposed**	**Existing**
0	0	0
0.5	0.068644665	0
1	0.037673199	0
1.5	0.047423531	0
2	0.035342592	0
2.5	0.036441307	0.207509381
3	0.034304296	0.08627308
3.5	0.034304296	0.090207093
4	0.034304296	0.090207093
4.5	0.034304296	0.090207093
5	0.034304296	0.090207093
5.5	0.034304296	0.090207093
6	0.034304296	0.090207093
6.5	0.034304296	0.090207093
7	0.034304296	0.090207093
7.5	0.034304296	0.090207093
8	0.034304296	0.090207093
8.5	0.034304296	0.090207093
9	0.034304296	0.090207093
9.5	0.034304296	0.090207093
10	0.034304296	0.090207093
10.5	0.034304296	0.090207093

11	0.034304296	0.090207093
11.5	0.034304296	0.090207093
12	0.034304296	0.090207093
12.5	0.034304296	0.090207093
13	0.034304296	0.090207093
13.5	0.034304296	0.090207093
14	0.034304296	0.090207093
14.5	0.034304296	0.090207093

Table 4.2: The transmission delay of the proposed v/s existing models

4.3.2 Packet Delivery Ratio: It is the ratio of total percentage data delivered successfully on the other end. Packet delivery ratio graphs have been shown between the proposed and existing models. The graphical representation of the packet delivery ratio clearly shows the effectiveness of proposed model against the existing model. Proposed model has been recorded with the maximum packet delivery ratio at 82 percent and 30 percent for the existing model.

The consistent line of the packet delivery ratio in the graph shows the stability in the data transmission, which is produced due to the use of constant bit rate (CBR) traffic module in the simulation. The CBR module increases the traffic volume step by step and finally gets stable at a point.

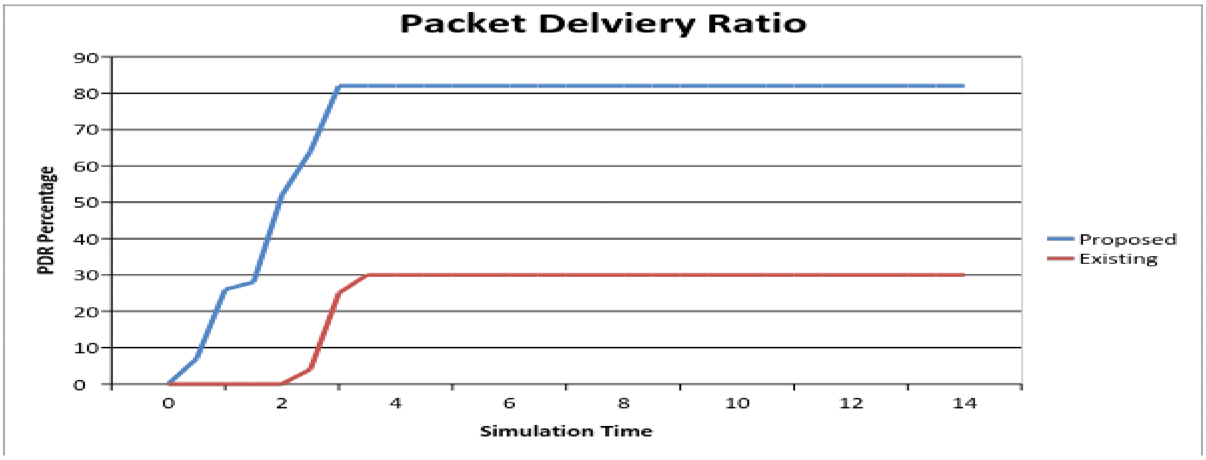

Figure 4.2: Packet delivery ratio between the proposed model and existing model

Simulation Time	Proposed	Existing
0	0	0
0.5	7	0
1	26	0
1.5	28	0
2	52	0
2.5	64	4
3	82	25
3.5	82	30
4	82	30
4.5	82	30
5	82	30
5.5	82	30
6	82	30
6.5	82	30
7	82	30
7.5	82	30
8	82	30
8.5	82	30
9	82	30
9.5	82	30
10	82	30
10.5	82	30

11	82	30
11.5	82	30
12	82	30
12.5	82	30
13	82	30
13.5	82	30
14	82	30
14.5	82	30

Table 4.3: The simulation time against the packet delivery ratio for existing and proposed models

4.3.3 Packet Loss (Data Loss): The packet loss is the parameters which indicate the loss of packets during the transmission between the network nodes. The existing model has been found way higher than the proposed model. The loss of packet occurs because the transmission outage during the handoff. During the handoff the data packets gets lost between MS and BS. The proposed model has been proposed to be effective than the proposed model as per shown in the following graph and table:

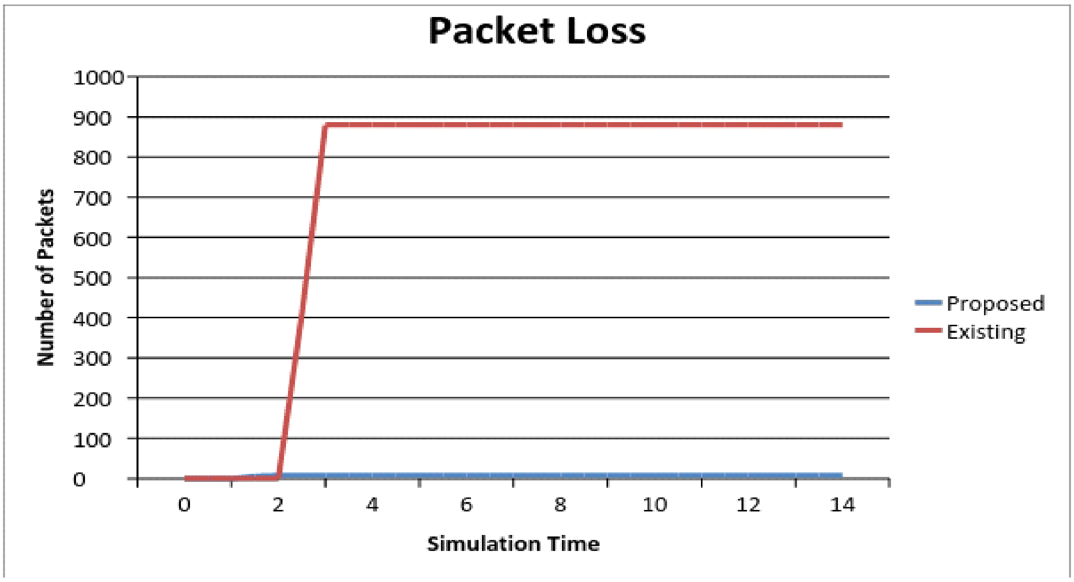

Figure 4.3: The packet loss recorded between the proposed model and existing model

Simulation Time	**Proposed**	**Existing**
0	0	0
0.5	0	0
1	0	0
1.5	6	0
2	8	0
2.5	8	410
3	8	880
3.5	8	880
4	8	880
4.5	8	880
5	8	880
5.5	8	880
6	8	880
6.5	8	880
7	8	880
7.5	8	880
8	8	880
8.5	8	880
9	8	880
9.5	8	880
10	8	880
10.5	8	880

11	8	880
11.5	8	880
12	8	880
12.5	8	880
13	8	880
13.5	8	880
14	8	880
14.5	8	880

Table 4.4: The comparison table for packet loss between proposed and existing model

4.3.4 Network Load: The network load is the parameter to find the data per time interval on each node for processing. The low amount of easily process able data indicates the robust performance of the proposed model according to the following graph and table:

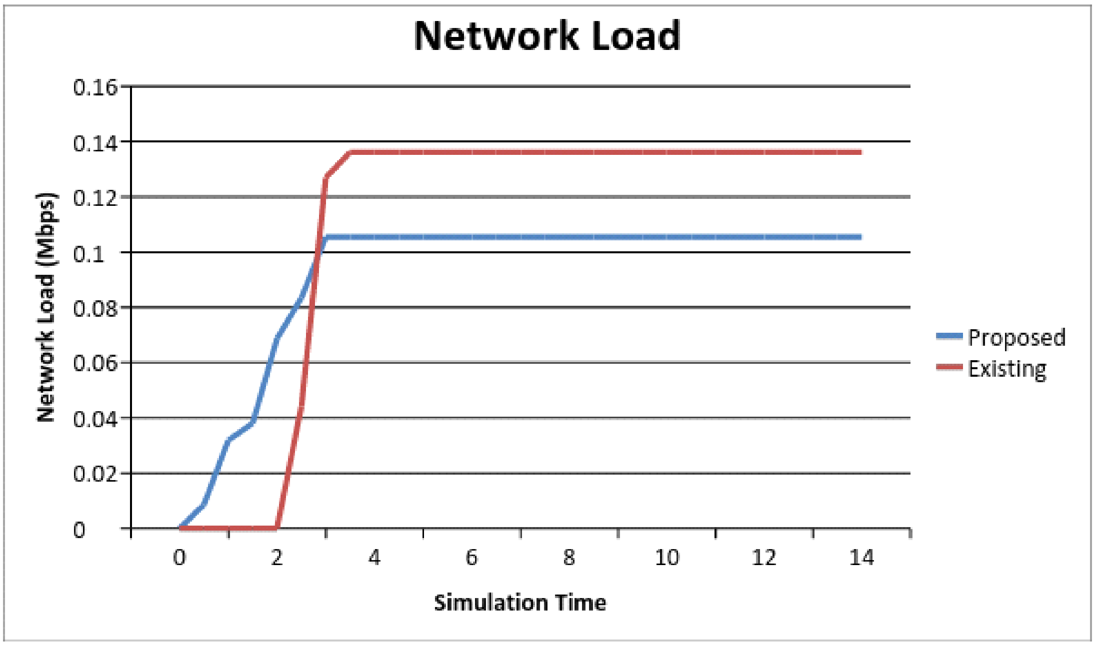

Figure 4.4 : The network load recorded between the proposed model and existing model

Simulation Time	Proposed	Existing
0	0	0
0.5	0.008586667	0
1	0.031893333	0
1.5	0.038026667	0
2	0.068693333	0
2.5	0.083413333	0.04416
3	0.105493333	0.12696
3.5	0.105493333	0.13616
4	0.105493333	0.13616
4.5	0.105493333	0.13616
5	0.105493333	0.13616
5.5	0.105493333	0.13616
6	0.105493333	0.13616
6.5	0.105493333	0.13616
7	0.105493333	0.13616
7.5	0.105493333	0.13616
8	0.105493333	0.13616
8.5	0.105493333	0.13616
9	0.105493333	0.13616
9.5	0.105493333	0.13616
10	0.105493333	0.13616

10.5	0.105493333	0.13616
11	0.105493333	0.13616
11.5	0.105493333	0.13616
12	0.105493333	0.13616
12.5	0.105493333	0.13616
13	0.105493333	0.13616
13.5	0.105493333	0.13616
14	0.105493333	0.13616
14.5	0.105493333	0.13616

Table 4.5: The comparison table for network load between proposed and existing model

4.3.5 Throughput: Throughput is the parameters indicate the successfully processed or transferred data between all of the nodes within the network. The higher throughput adds the robustness to proposed model over existing model after analysis of the handoff models simulation:

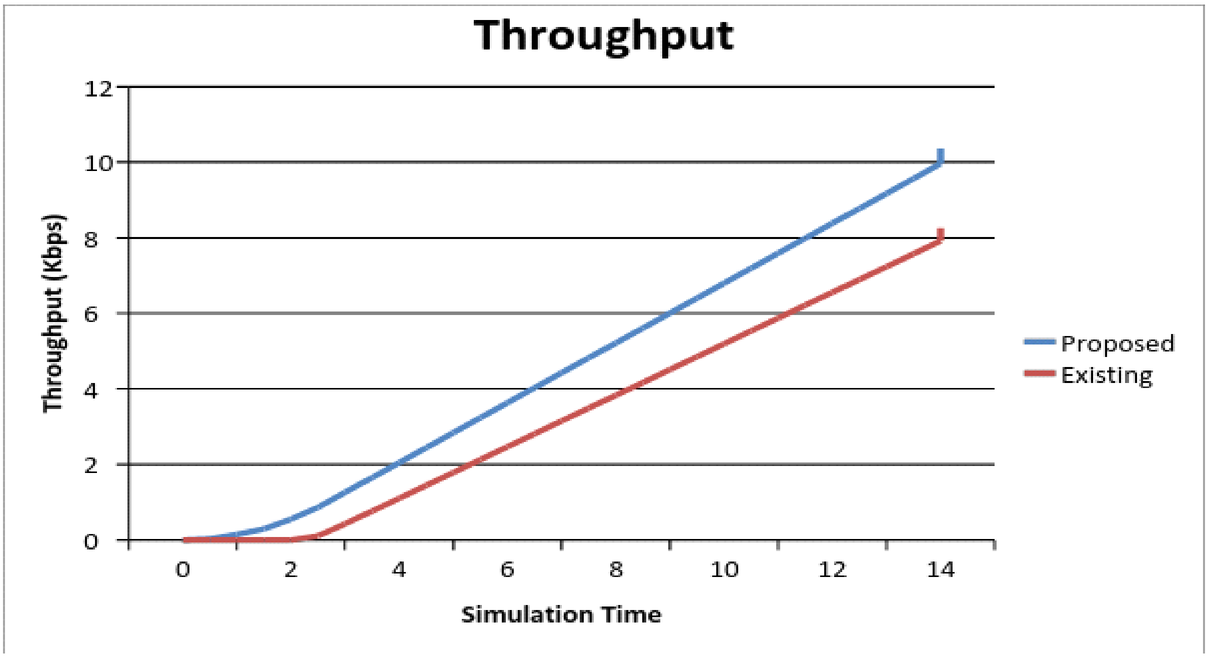

Figure 4.5: The throughput recorded between the proposed model and existing model

Simulation Time	**Proposed**	**Existing**
0	0	0
0.5	0.0322	0
1	0.1518	0
1.5	0.2944	0
2	0.552	0
2.5	0.8648	0.1104
3	1.2604	0.4278
3.5	1.656	0.7682
4	2.0516	1.1086
4.5	2.4472	1.449
5	2.8428	1.7894
5.5	3.2384	2.1298
6	3.634	2.4702
6.5	4.0296	2.8106
7	4.4252	3.151
7.5	4.8208	3.4914
8	5.2164	3.8318
8.5	5.612	4.1722
9	6.0076	4.5126
9.5	6.4032	4.853
10	6.7988	5.1934
10.5	7.1944	5.5338

11	7.59	5.8742
11.5	7.9856	6.2146
12	8.3812	6.555
12.5	8.7768	6.8954
13	9.1724	7.2358
13.5	9.568	7.5762
14	9.9636	7.9166
14.5	10.3592	8.257

Table 4.6: The throughput table of proposed model compared to existing model

CHAPTER 5
CONCLUSION

Proposed model simulation is designed for the purpose of soft handoff in the WiMAX networks. The WiMAX networks are the alternatives to the Wi-Fi networks and are popular for the high-speed network connectivity in many forms of networks. The latest popular use of the WiMAX model is its application in the 4G/LTE network, where the networks are used in the high-speed connectivity. The proposed model has been designed for the purpose of soft handoff with minimizing the probability of the connection loss while changing the coverage cell. The proposed work has been equipped with the stand-by request based mechanism. The proposed mechanism enables the WiMAX users to stay connected while changing the cells in the WiMAX network. The WiMAX network nodes connect themselves with the other base station in the vital reach in order to keep itself connected while keeping all of the data or voice connections intact in the given WiMAX network while changing its positions from one cell to another cell. The proposed model proposes the use of standby request for the purpose of improvement in the handoff procedure in the existing schemes. The simulation results have been obtained in the form of network performance parameters of network load, packet delivery ratio, packet loss, throughput and transmission delay. The effectiveness of the proposed model and the existing models are shown in experimental results.

FUTURE WORK

In the future, the proposed model can be improved for the more balanced and accurate handoff methods for better connectivity. The performances of proposed model can be evaluated and compared with the existing models of handoff for the WiMAX networks.

[1] W.H. Yu, et al. "Interference-aware IEEE 802.16 WiMax mesh networks." *Vehicular Technology Conference, 2005. VTC 2005-Spring. 2005 IEEE 61st*. Vol. 5. IEEE, 2005.

[2] Deb, Sujay, Shradha Jaiswal, and Kanthi Nagaraj. "Real-time video multicast in WiMAX networks." *INFOCOM 2008. The 27th Conference on Computer Communications. IEEE*. IEEE, 2008.

[3] Pentikousis, Kostas, et al. "An experimental investigation of VoIP and video streaming over fixed WiMAX." *Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks and Workshops, 2008. WiOPT 2008. 6th International Symposium on*. IEEE, 2008.

[4] S. Chakchai, Raj Jain, and Abdel-Karim Tamimi. "Scheduling in IEEE 802.16 e mobile WiMAX networks: key issues and a survey." *Selected Areas in Communications, IEEE Journal on* 27.2 (2009): 156-171.

[5] A. Khosla, N. Sood and M. Anwar, “A Mobility Improvement Handover Scheme for Mobile-WiMAX”, *International Journal of Computer Applications (0975 – 8887)* Vol.11, Issue 3, pp. 28-31, December 2010.

[6] J. Yadav and B. Mehandia, “Handover performance in mobile WiMAX networks”, *International Journal of Advanced Research in Computer and Communication Engineering* Vol. 3, Issue 8, pp. 7696-7699, August 2014.

[7] A. Khan, W. Anwer and E. Munir, “Handover Techniques in Mobile WiMAX Networks: Analysis and Comparison”, *Middle East Journal of Scientific Research* Vol.15, Issue 11, pp.1599-1605, 2013.

[8] B. Ashoka, D. Eyers and Z. Huang, “Handover Delay in Mobile WiMAX: A Simulation study”, *12th International Conference on Parallel and Distributed Computing, Applications and Technologies,* pp. 305-312, October2011.

[9] S. Ray, K. Pawlikowski and H. Sirisena, “Handover in Mobile WiMAX Networks: The State of Art and Research Issues”, *IEEE Communications Surveys and Tutorials Magazine,* No. 3, pp. 376-399, August 2010.

[10] P. Kumar, “Effective Handover Mechanism for WiMAX Networks”, *Indian Journal Of Applied Research* Vol.3, Issue 10, pp. 1-4, October 2013.

[11] P. Shinde, “Algorithm for the selection of Target Base station during handover in Mobile WiMAX 802.16e”, *International Journal of Emerging Technology and Advanced Engineering* Vol.2, Issue 9, pp 218-221, September2012.

[12] S. Sawant and N. Vernekar , “Dual Triggering for Improvement of Handover in Mobile WiMAX”, *International Journal of Computer Applications* Vol. 67, Issue 23, pp. 33-39, April 2013.

[13] K. Priya and R. Gunasekaran "QoS enhancement in future generation network by handoff delay minimization", 2012 International Conference on Recent Trends in Information Technology, 2012.

[14] Becvar, Zdenek, and Jan Zelenka. "Handovers in the mobile WiMAX."*Research in Telecommunication technology* 1 (2006): 147-50.

[15] D.H. Cho. "Fast Handover Scheme for Real-Time Downlink Services in IEEE 802.16e BWA System", 2005 IEEE 61st Vehicular Technology Conference, 2005

[16] J. Rambir, Manveen Singh, Chadha Sandeep. "Analysis of WIMAX Handover." *International Journal of Soft Computing and Engineering (IJSCE)*2.

[17] B. Mubarak, A. Mohammed, B. M. Ali, Nor Kamariah Noordin, Alyani Ismail, and Chee Kyun Ng. "Fuzzy Logic Based Self-Adaptive Handover Algorithm for Mobile WiMAX", Wireless Personal Communications, 2013.

[18] S. M. Aleynikov† "Static Analysis of Contact Problems for an Elastic Half-Space", Foundations of Engineering Mechanics, 2011.

[19] Mansour, Asmae Ait, Nourddine Enneya, Mouhammed Ouadou, and Driss Aboutajdine. "Handoff between WiMax and WiFi networks", Second International Conference on the Innovative Computing Technology (INTECH 2012), 2012.

[20] Ray, S. Kumar, Harsha Sirisena, and Devatanu Deka. "Fast and reliable target base station selection scheme for Mobile WiMAX handover."*Telecommunication Networks and Applications Conference (ATNAC), 2012 Australasian*. IEEE, 2012.

[21] E. Kacerginskis, and L. Narbutaite. "Capacity and handover analysis in mobile WiMAX." *Elektronika ir Elektrotechnika* 119.3 (2012): 23-28.

[22] P. P. Winston, and K. S. Shaji. "Multiple trigger initiated handover execution in WiMAX networks." *Circuits, Power and Computing Technologies (ICCPCT), 2013 International Conference on*. IEEE, 2013.

[23] H. Kuei-Li, et al. "A Fast Authentication Scheme for WiMAX–WLAN Vertical Handover." *Wireless personal communications* 71.1 (2013): 555-575.

[24] B. Ammar, Mohd Dani Baba, and Mohammad Ibrahim. "IEEE 802.21 based vertical handover in WiFi and WiMAX networks." *Computers & Informatics (ISCI), 2012 IEEE Symposium on*. IEEE, 2012.

[25] F. Anmin, et al. "A novel group-based handover authentication scheme with privacy preservation for mobile WiMAX networks." *Communications Letters, IEEE* 16.11 (2012): 1744-1747.

[26] Nguyen, Thuy Ngoc, and Maode Ma. "Enhanced EAP-based pre-authentication for fast and secure inter-ASN handovers in mobile WiMAX networks." *Wireless Communications, IEEE Transactions on* 11.6 (2012): 2173-2181.

[27] P. Shinde. "Algorithm for the selection of Target Base station during handover in Mobile WiMax 802.16 e." *International Journal of Emerging Technology and Advanced Engineering* 2.9 (2012): 218-221.

[28] J. Kire, and T. Janevski. "Vertical Handover Decision Algorithm from WiMAX to WLAN based on the Mobile Node's Speed and the Session's Priority." *International Journal of Advanced Science and Technology* 49.1 (2012): 1-14.

[29] Nguyen, Thuy Ngoc, and Maode Ma. "An pre-authentication protocol with symmetric keys for secure handover in mobile WiMAX networks."*Communications (ICC), 2012 IEEE International Conference on*. IEEE, 2012.

[30] N. M. Alamri, and Nadine Adra. "Integrated MIP-SIP for IMS-based WiMAX-UMTS vertical handover." *Telecommunications (ICT), 2012 19th International Conference on*. IEEE, 2012.

[31] M. Grine, A. Najid, and R. Messoussi. "Performance Optimization of WiMAX Mobile Networks with a Predictive Handover Process." *International Journal of Distributed and Parallel Systems* 3.3 (2012): 9-19.

[32] H.Y. Teng, C.C. Kuo, and R. H. Hwang. "Downlink packet scheduling and resource allocation in EPON WiMAX hybrid access networks." *EURASIP Journal on Wireless Communications and Networking*2012.1 (2012): 1-13.

[33] A. Saedi, F. A. Thweny, and W. A. Maddallah. "Evaluation of Handover Process in WIMAX Networks." (2012).

[34] A. Mahdi, et al. "A formally verified AKA protocol for vertical handover in heterogeneous environments using Casper/FDR."*EURASIP Journal on Wireless Communications and Networking* 2012.1 (2012): 1-23.

[35] A. Alessandro, S. Rizzuto, and R. Zambon. "A WiMAX simulation module for investigating QoS during horizontal handovers."*Simulation Modelling Practice and Theory* 29 (2012): 52-65.