REPUPLIC OF IRAQ

MINISTRYOF HIGHER EDUCATION AND SCINTIFIC RESEARCH

AL-FURAT AL-AWSAT TECHNICAL UNIVERSITY

ENGINEERING TECHNICAL COLLEGE-NAJAF

DEPLOYMENT OF SEAMLESS HANDOVERS IN MOBILE WIMAX NETWORKS

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B. Sc. Communication Techniques Eng.

2021

بسم الله الرحمن الرحيم

فَتَعَالَى اللَّهُ الْمَلِكُ الْحَقُّ وَلَا تَعْجَلْ

بِالْقُرْآنِ مِنْ قَبْلِ أَنْ يُقْضَى إِلَيْكَ وَحْيُهُ

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سورة طه الآية 114

DEPLOYMENT OF SEAMLESS HANDOVERS IN

MOBILE WIMAX NETWORKS

THESIS

SUBMITTED TO COMMUNICATION DEPARTMENT

IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF M.Sc.

BY

HUDA HASSAN SAHEB

Supervised by

Asst. Prof. Dr. Bashar J. Hamza

Month /2021

Dedication

To whom our almighty Allah has bestowed with dignity and honor thee who taught me how to give and give awaiting nothing in return. To whom I carry his name with all the pride. Your words continue to show me the pathway today, tomorrow and forever like stars in the darkness of nights. My dear late father, may his soul rest in eternal peace and our Lord's mercy be upon him always.

And to my angel in life, to the meaning of love and compassion, the everlasting smile and the secret of existence, my beloved mother.

To those whom I spent with the sweetest days of my life and shared the best memories ever, those who feel happy for me and for my success, my siblings.

To my route companion, my soul mate, my partner and my support in life, my dear husband.

And finally, to my beloved and dear children Rukia, Mohammed and Azel .

Supervisor Certification

I certify that this thesis “ **Deployment of Seamless Handovers in Mobile WiMAX Networks**” which being submitted by **Huda Hassan Saheb** was prepared under our supervision at Communication Department, technical college/ Najaf, Al- Furat Al-Awset Technical University As a partial of fulfillment of the requirement for degree of M. Sc.

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Linguistic Certification

This is to certify that this thesis entitled **" Deployment of Seamless Handovers in Mobile WiMAX Networks**" was reviewed linguistically. Its language was amended to meet the style of the English language.

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Abstract

The IEEE 802.16e Mobile Worldwide Interoperability for Microwave Access (MWiMAX) standard allows Subscribers Stations (SS) to move, transforming them into Mobile Stations (MS). One among the most popular significant problems with IEEE 802.16e is that although the handover (HO) technology provides smooth high volume data services at a high speed scale, it only specifies a mechanism excluding precise methods or algorithms for handover that can be approved. However, the handover structure which regards the transition of mobile stations from one base station to another similar homogeneous network (horizontal handover) is a prime prestige for WiMAX to realize mobility. Reducing HO delay is critical for improving WiMAX service quality. This thesis proposes method to reduce HO delay by two steps. First, reducing scanning time by predicting Target Base Station (TBS) by an approach based on direction and genetic algorithm (GA). Serving Base Station (SBS) eliminates Neighboring Base Station (NBSs) that are not in the direction of the user's movement. GA optimizes the selection of TBS depending on speed of user so that it ensures a balance between reducing the scanning time and dropping call. Second, reducing the handover signaling during the re-entry process. The thesis proposes Pre-Authorization Algorithm (PAA) which facilitates the MS's re-entry when it moves to new BS by providing it with the information that needed in this process in advance. MATLAB 2018b was used to presents the results. The result indicates a decrease in the number of TBSs which reduced to one BS for users with high speeds and three TBSs as a maximum for another, it also showed a reduction in signaling time of up to 20% and thus a higher throughput during handover than the traditional approach.

Acknowledgment

First and foremost, Alhamdulillah for giving me the strength, patience, courage, and determination in completing this work. All grace and thanks belongs to **almighty Allah subhanah wataealaa .**

Many special thanks go to my supervisor **Asst. Prof**. **Dr. Bashar J. Hamza**, for his incredible guidance, continuous support, and encouragement. He always having time for me and readily providing his technical expertise throughout the period of my study. I owe more than I can ever repay. The completion of this work becomes possible due to his supervision. His high stance of diplomatic power and professionalism set a great model for me to follow.

I would also like to thank **Dr. Ahmed Fahem AL-Baghdadi** for his unlimited scientific support and continuous encouragement throughout my research. His helpful suggestions and advices on various aspects of my research work have certainly been very constructive. Without his kind cooperation and support, my graduate study would not have been accomplished.

DECLARATION

I hereby declare that the thesis is my original work except for quotations and citations which have been duly acknowledged.

/ / 2021 Huda H. Saheb

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List of Symbols

Symbol	Definition
T_{Con}	Time of conventional scheme
$T_{PAA/BV}$	Time of PAA/BV scheme
T_S	Time of synchronize with down link
T_C	Time of contention resolution
T_{Rng}	Time of ranging phase
T_{Auth}	Time of re-authorization
T_{Reg}	Time of registration
$T_{Scanning}$	Time of scanning process

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List of ABBREVIATIONS

Abbreviation	Definition
AHOP	Actual Handover Phase
BS	Base Station
BV	Base Station Visitor
BWA	Broadband Wireless Access
CAC	Call Admission Control
CDT	Call Disruption Time
CPE	Customer Premise Equipment
CRI	Chanel Report Indicator
DL	Down Link
DNA	Deoxyribonucleic Acid
DSL	Digital Subscriber Line

ETSI	European Telecommunications Standards Institute
FBSS	Fast Base Station Switching
GA	Genetic Algorithm
GPS	Global Position System
GSM	Global System for Mobile
HHO	Hard Handover
HO	Handover
LAN	Local Area Network
LTE	Long Term Evolution
LOS	Line of Sight
MSC	Modulation Coding Scheme
MDHO	Macro Diversity Handover
MS	Mobile Station
NBS	Neighboring Base Station
NGN	Next Generation Network
NLOS	Non Line of Sight
NTAP	Network Topology Acquisition Phase
OFDM	Orthogonal Frequency Division Multiplexing
PAA	Pre Authorization Algorithm
QoS	Quality of Service
RSS	Radio Signal Strength
RSU	Road Side Unit
RT	Real Time
SBS	Serving Base Station
SOFDMA	Scalable Orthogonal Frequency Division Multiple

	Access
TBS	Target Base Station
UL	Up Link
VOIP	Voice Over Internet Protocol
WAN	Wide Area Network
WiMAX	Worldwide Interoperability for Microwave Access
WMAN	Wireless Metropolitan Area Network

CHAPTER 1

1.1 Background

The ever-increasing demand for high data rate wireless networks led to the improvement of broadband wireless communication technologies for anytime and anywhere [1]. Since WLANs (Wireless Local Area Network) suffer from poor scalability and short range, 3G networks, on the other hand, have such drawbacks as limited capacity and high infrastructure costs. This void between Local Area Network (LAN) and Wide Area Network (WAN) technologies has been filled by the next-generation Wireless Metropolitan Area Network(WMAN) , which will integrate and introduce WiMAX as an option for the software platform use IEEE 802.16 [2].

WiMAX Fourth Generation (4G) technology is advancing as a new era dawns. In the IEEE 802.16e standard, with the new introduction of mobility management systems, WiMAX is now competing to offer ubiquitous computing solutions to current and future generations of wireless technologies [3]. As the demand for mobile services such as video conferencing, Internet TV, Voice over Internet Protocol (VoIP), video streaming and other similar services grow, The need for a strong and dependable mobile network capable of providing quick access to mobile services increase.

When it comes to WiMAX mobility and performance, the most critical aspect affecting WiMAX network performance is handover delay time [4]. However, when the mobile discovers a control channel where the signal is stronger than its current cell, the network will automatically change to the cell by transferring its mobile channel call to the new cell without the user noticing.

“ The main criterion used to take the decision to transfer the mobile is the measured signal power of the mobile node by the BS. In general, the station calculates an average over a time window to eliminate the rapid fluctuations resulting from multipath effects. Various techniques can be used to determine the moment of transfer of the mobile. In addition, this transfer can be controlled by either the network or the mobile. The simplest technique of handover decision is one that triggers the transfer as soon as the mobile detects a new signal stronger than the cell where it is connected. Mobility management is usually done using two databases: the HLR (Home Location Register) which maintains the data of the subscriber and the VLR (Visitor Location Register) which manages the customer in the visited cell. Using these two components, the network can manage the location of mobile node to be able to route its calls and also ensure the handover” [5]. Figure 1.1 explains the objective of handover.

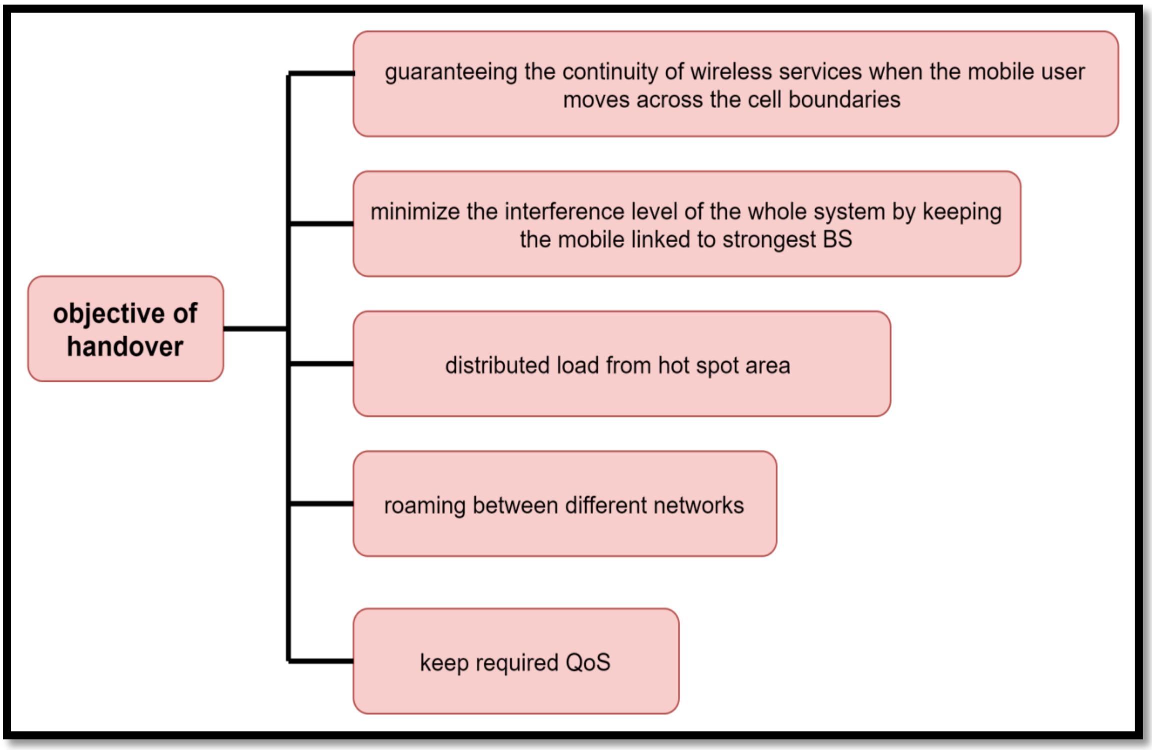

Figure 1.1 Objective of Handover [6]

The whole one, HHO method in IEEE 802.16e is generally split into the Network Topology of Acquisition phase (NTAP) and the Actual Handover Phase (AHOP) [7]. A superb summary of the whole process as following:

In NTAP, the MS and Serving BS (SBS) collect information about the underlying network topology, along with the assistance of the backhaul network, before the final handover decision is taken. It's done to choose lists of possible target BSs for handover operation, from which one unique TBS may be selected. The message sequence map for the phase is shown in Figure 1.2. In brief, the main tasks included in this stage are as follows:

1- Network Topology advertised by BS, using mobile neighboring advertisement message (MOB- NBR-ADV). The SBS regularly transmits information about the condition of the NBSs planning for future handover activities. With the support of the backbone network, the SBS continues to obtain such channel information from the NBSs.

2- Scanning by MS of adjacent advertisement BSs, the MS scans the announced BSs to pick acceptable nominee BSs for the handover within specific time frames. Thus, a list of prospective applicant TBSs is preserved. This procedure will be carried out with the assistance of the request for scanning interval allocation and reply messages, mobile scan request and mobile scan response (MOB-SCN-REQ and MOB- SCN-RSP) sent by MS and SBS respectively. Ultimately, the mobile scan report massage (MOB-SCN-REP) explains all the scanning operations.

3- Ranging and optional association tasks, scanning is performed at different stages in which the MS gathers additional knowledge from various sources about the physical channel associated with the chosen TBSs. For this function, originating ranging request or (RNG_REQ) message and originating ranging response (RNG_RSP) message. Optional association can be accompanied by ranging activities in which the mobile station is connected to the prospective BS target candidates. For this reason, association outcome reports message (MOB- ASC-REP) are used.

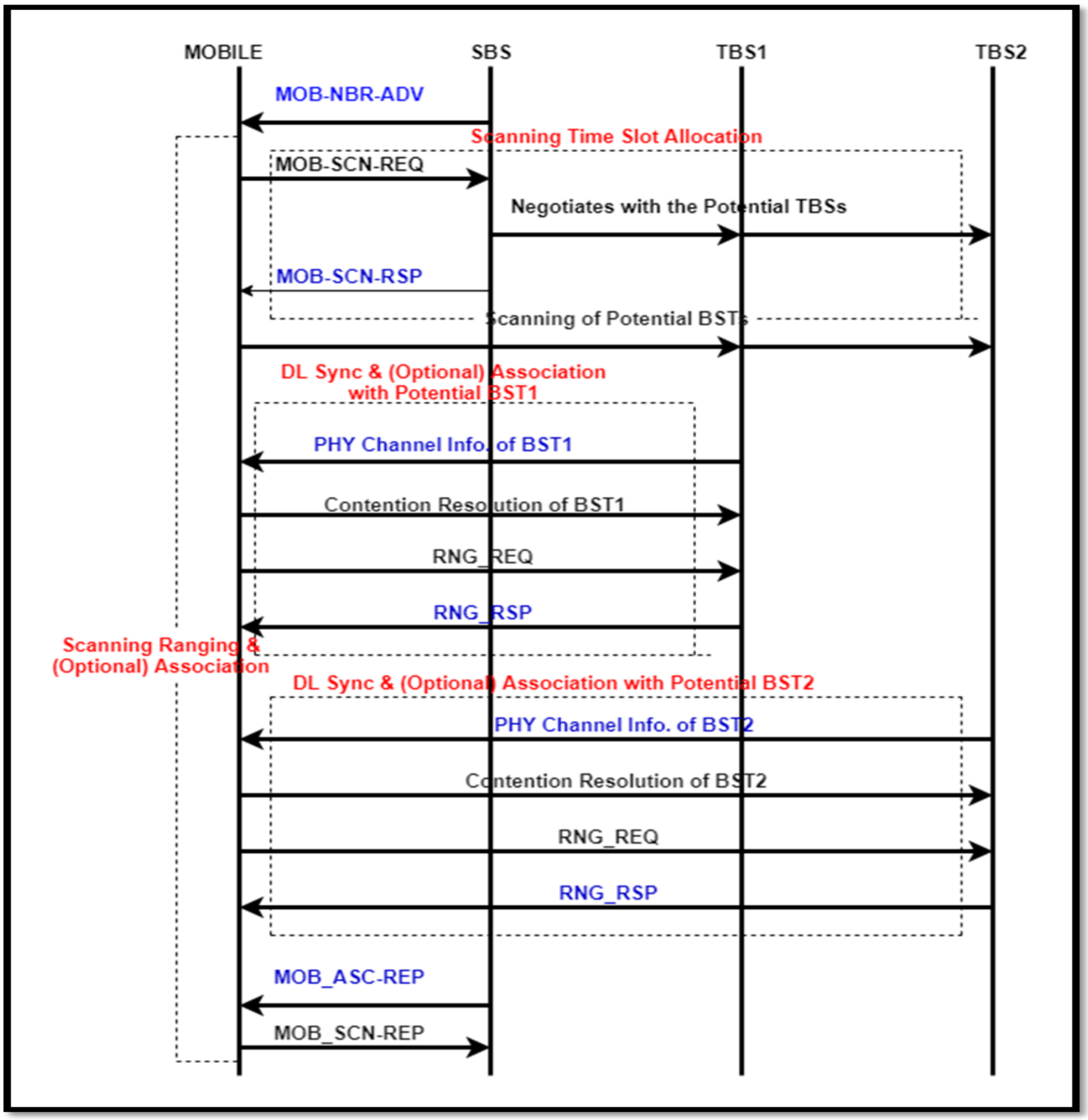

Figure 1.2 Network Topology Acquisition Phase [3]

In AHOP, the MS switches to the chosen TBS location from the SBS position. The key tasks included are briefly listed as follows:

1- Deciding on the target BS from many TBSs chosen from the scanning activities, the MS chooses the final target BS to be transferred to. At the MS, SBS or network, the decision or creation of a handover procedure can arise.

2- Affiliated with the network. If the MS decision happens, the mobile station handover request (MOB-MSHO-REQ) message containing the set of chosen TBSs will be communicated to the SBS and the SBS will respond with base station response (MOB-BSHO-RSP) message. In the other side, if the decision is made at the SBS, it uses the base station handover request (MOB-BSHO-REQ) message. However, priority is often given to the handover decisions and creation messages from the user.

3- Initiating the handover, once a particular TBS is chosen from the list of appropriate nominee TBSs based on the above messages, the MS informs the current SBS by transmitting a Mobile Handover Indication (MOB- HO-IND) message about the beginning of the HO operation. The MS cuts its link to the current SBS at this point.

4- Synchronization of TBS and Ranging Process, when synchronization and ranging operations take place to restart Down Link/Up Link retransmissions again with TBS.

5- Phases of authorization and registration, lengthy authorization, the MS and TBS registration processes will follow next. It points the beginning of this MS's network re-entry process, after which it becomes completely operational with the new SBS.

The message sequence map for the phase is shown in Figure1.3.

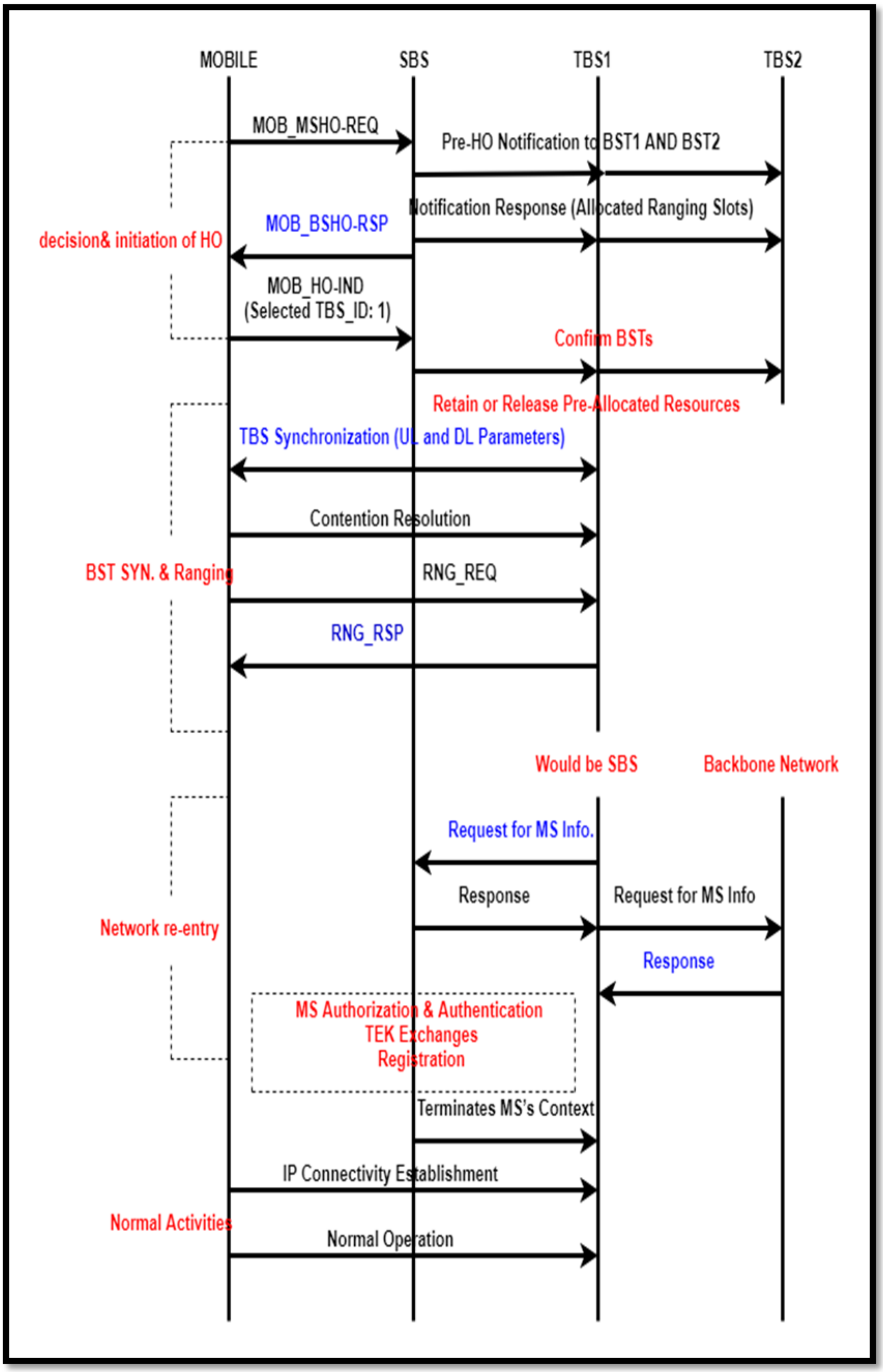

Figure 1.3 Actual Handover Phase [3]

The following is a breakdown of the chapter structure. The thesis problem statement is discussed first. This is followed by a list of the thesis objectives, scope and motivation of research, brief methodology, contributions and finally, the thesis structure is considered.

1.2 Problem Statement

WiMAX is growing more popular, however there are significant constraints that must be addressed if WiMAX is to achieve the efficiency that it promises. These restrictions present the important research issues, one of which is WiMAX Mobility management, which includes stages such as location management and handover management. The existing WiMAX handover mechanisms suffer from certain drawbacks, particularly related to wastage of channel resources, handover latencies and loss of data.

1.3 Aim and Objectives

The aim of this thesis is to design the most efficient homogeneous IEEE 802.16 WiMAX cellular networks possible by reducing handover delay to a bare minimum by characterizing the techniques and handover algorithms that will reduce handover delay while also ensuring the highest Quality of Service (QoS) and signal throughput. The goals of this study are to select the optimum handover algorithm for:

1- Improving decision-making during handovers.

2- Shortening the time it takes to make a decision at the handover.

3- Enhancing handover time and throughput.

1.4 Thesis Scope and Motivation

The mobile application business has evolved significantly, and many mobile applications now provide features that were not even available a few years ago. However, the increased demand and reliance on mobile services, there is a greater need to provide a stable and cost-effective data networks, making research in this scope both attractive and challenging.

The most important steps in beginning research in this sector were to understand and explore technologies, the standards and routing mechanisms in order to maintain track of any changes in these sectors. Many scholars are interested in wireless technology and mobility management in order to overcome frequent impairments caused by topographical effects and noise constraints.

WiMAX infrastructure resolutions provide high mobility, wideband and high QoS. Once WiMAX mobility problem is handled, it will be able to offer a complete package with a low-cost wireless network that can be utilized for not only services of Internet but also applications of streaming multimedia. This period of time is known as handover delay; having short period of handover delay results in a more efficient WiMAX transmission. Figure 1.4 illustrates the flow of our research.

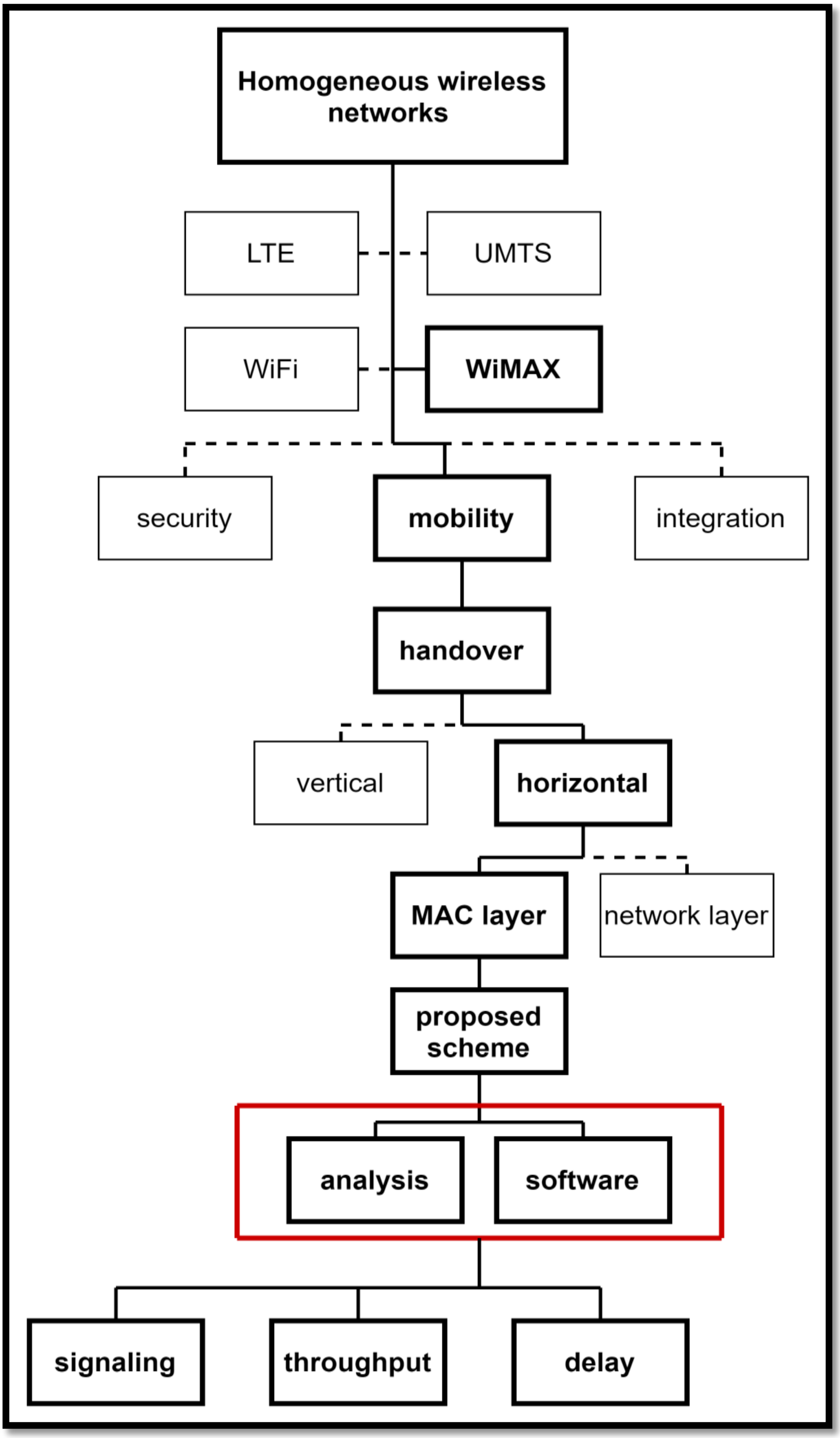

Figure 1.4 Study Module

1.5 Brief Methodology

The first part of this research presents our efficient handoff scheme by suggesting BV to reduce the signaling time during handover process. Pre-authorization process is facilitating the subscriber's entry to new BS. BV provides information to TBS in advance that MS requires during visiting these base stations to perform pre-authorization and reduce signaling, thereby improving overall efficiency.

The second part is eliminating unnecessary scan by excluding the NBSs that are not in the direction of the users movement from the scanning process. The GA works to reduce further in a way that ensuring a balance between the scanning time with the possibility of dropped calls, this is achieved by using a fitness function that perform this purpose. The main idea is to avoid superfluous scans during the handover procedure in order to reduce latency. In the standard scheme, the MS needs to scan NBSs when the Radio Signal Strength (RSS) reaches to threshold. At that time, BS gives time interval for MS to scan NBSs. MS will scan all BSs in the neighboring to determine which one is the best to be targeted. In this scheme, the mobile station determines its own location using the Global Positioning System (GPS) and delivers it to the present BS. As a result, the SBS influences the direction of MS migration. While the MS sends a mobile scan request (MOB-SCN-REQ) message to demand the scanning time interval, SBS will filter only the BSs located in the direction of the user's movement. This process takes long time [8] therefore, the researchers worked to predict the target to reduce the number of constellations that are being scanned.

1.6 Research Contributions

The contributions of this thesis are as follows:

1. Reducing the number of target candidate BS by up to half for users with relatively low speeds and up to a quarter for users with relatively speeds compared to the traditional scheme.
2. An optimization in the selection of TBS as a result of using a GA.
3. Reducing the signaling time (the time for exchanging messages among network devices) by 20 % compared to traditional scheme.

1.7 Thesis Organization

Chapter 1 provides general introduction to the research with regards to the background as well as the objectives and scope of the research topic.

Chapter 2 provides information about WiMAX network, handover and some proposed solutions for handover problem.

Chapter 3 discussed the proposed base station visitor and genetic algorithm to reduce scan time and authorization signaling respectively.

Chapter 4 results of this research and discussion

Chapter 5 summary, conclusion and recommendations for future research

CHAPTER 2

LITERATURE REVIEW

In this chapter, a background review of the WiMAX networks, such as WiMAX system, WiMAX and common standard, Handover and MWiMAX Hard Handover Scenario will be explained.

The chapter discusses some proposed solutions for handover process (horizontal handover).

2.1 WiMAX System

Based on an Radio Frequency (RF) technology called Orthogonal Frequency Division Multiplexing (OFDM) and designed for Broadband Wireless Access (BWA) and operating above 2 GHz, WiMAX is an efficient means of transmitting high-velocity data, mainly when the bandwidth used 5 MHz or greater. A WiMAX BS and Customer Premise Equipment (CPE) for indoor service and a mobile unit or modem for outdoor service are included in WiMAX wireless connectivity. A range of up to 30 miles is technically covered by WiMAX BS but it is only restricted to a more realistic range of 6 miles. Ranges of up to 70 Mbps were supported by data rates. A line-of-sight (LOS) service is WiMAX backhaul, interconnecting BSs, whereas a SS and BS may just be a LOS or a Non-Line-of-Sight (NLOS) service. The SS may also be in motion in mobile WiMAX [9].

The fundamental applications and services provided by WiMAX are as shown in Figure 2.1:

1. Fixed: in lieu of or supplement to cable or Digital Subscriber Line (DSL) for the home Internet customer.

2. Phone: Voice-over-Internet Protocol (VoIP) for home telephone service; including video calls.

3. Nomadic: For Internet users of laptops in different locations where service may be accessible, such as in cafés or libraries.

4. Mobility: For Internet data connectivity for laptop/handset users or only for a VoIP service for handset users (Pedestrian or vehicular use is indicated by mobility).

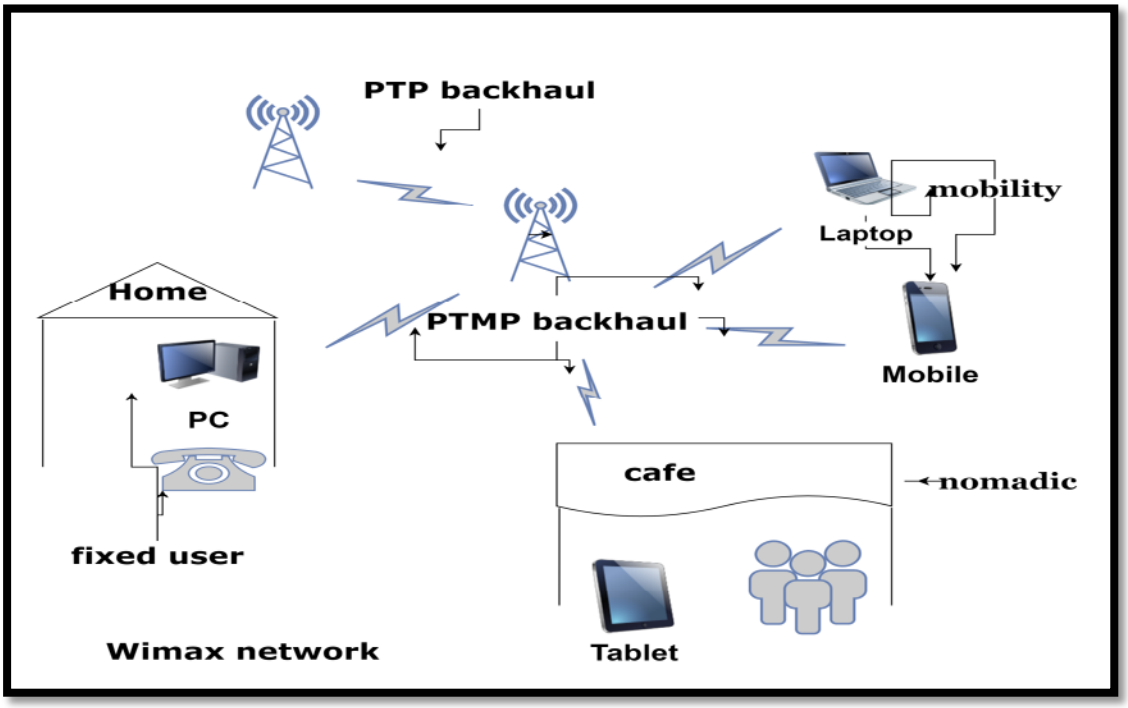

Figure 2.1 The Fundamental Applications and Services Provided by WiMAX [9]

WiMAX's outstanding benefits include:

* An all-IP techniques, all-packet.

* Low costs.

*IP packet-based system that benefits from the advancement of computer equipment.

* WiMAX concerns layers 1 and 2 (physical and MAC layers) do not identify network layer (layer 3) connectivity, leaving third parties to invent and standardize higher layer connectivity.

* Link to legacy networks of IP cores of wireline carriers or IP cores of wireless operators.

* Internet-working roaming IP Multimedia Subsystem (IMS).

* Cellular 3G compatibility.

* QoS and general application, IP-based.

* Exploiting the already made investment in the current core network.

* An alternative to DSL/cable operators laying copper lines by using their current IP core network.

* Service for difficult-to-reach rural areas.

2.2 WiMAX and Common Standards

The WiMAX standard, also referred to as wireless area metropolitan networks, was developed by the IEEE 802.16 working group (WMANs) [9]. The WiMAX-based IEEE 802.16 protocol also addresses an integrated high-performance radio and/or cellular telephone network (Hiper MAN) standard of the European Telecommunications Standards Institute (ETSI); making it a globally compatible standard-network .

* The original standard 802.16 stipulated transmissions in the 10-66 GHz range.

* Lower frequencies in the 2–11 GHz range were included in 802.16d.

* Frequencies generally used are 3.5 and 5.8 GHz for 802.16d.

* Depending on the region, the frequencies typically used for 802.16e are 2.3, 2.5

and 3.5 GHz.

Three modes, an obligatory hard handover , Macro Diversity Handover (MDHO) and a Fast Base Station Switching (FBSS) are included in IEEE 802.16e's link layer handover, alternatively called a layer 2 handover. The last two are selectable soft handovers in which a MS can simultaneously register with different BSs in order to achieve minimal handover latency. Anyhow, under these two modes there are quite a few constraints on the BS such as synchronization in a shared timing source, the same frequency of the carrier and sharing of all data. Therefore, the IEEE 802.16e essentially utilizes the hard handover. Cell reselection, handover decisions and initiation, synchronization to destination BS, ranging and network re-entry and cancellation of relation with previous BS are a part of the IEEE 802.16e connection layer handover process. The efficiency of a network depends on how secure handovers are performed regardless of the type of architecture installed [8]. Table 2.1 explains comparisons between the WiMAX standards [9].

Table 2.1 Comparisons between the WiMAX standards

	802.16	802.16d/Hiper MAN	802.16e
Completed	December 2001	June 2004	2005
Spectrum	10-66 GHz	<11GHz	<6GHz
Channel	LOS	NLOS	NLOS
Bit rate	32-134Mbps in 28 MHz channel bandwidth	Up to 75 Mbps in 20 MHz channel bandwidth	Up to 15 Mbps in 5MHz channel bandwidth

Modulation	QPSK,16QAM,64 QAM	OFDM 256 FFT ,QPSK,16QAM,64QAM	Scalable OFDM 128-2,048 FFT/BPSK, QPSK,16QAM,64QAM
Mobility	Fixed	Fixed	Nomadic/Mobile
Channel bandwidth	20-25 &28MHz	1.75-20 MHz	1.75-20 MHz

2.3 Handover

Handover is a process which helps in maintaining a link between the MS and the BS while it is moving from one BS to another [10]. While the BS that provides connection to MS is called to serving base station; that is modified when the MS is crossing from BS to another base station. The new BS will supply facilities to MS after the handover is done and the BS that's being replaced is called the TBS. Depending on the underlying technology, the handover can be roughly divided into two separate forms: horizontal handover and vertical handover.

Horizontal handovers are inter-cellular homogeneous intra-network while the vertical ones are inter-cellular heterogeneous inter-network. For instance, handovers are horizontal between multiple WiMAX networks, while those are vertical between WiMAX and UMTS or LTE networks [11,12]. Figure 2.2 illustrates this form of handover.

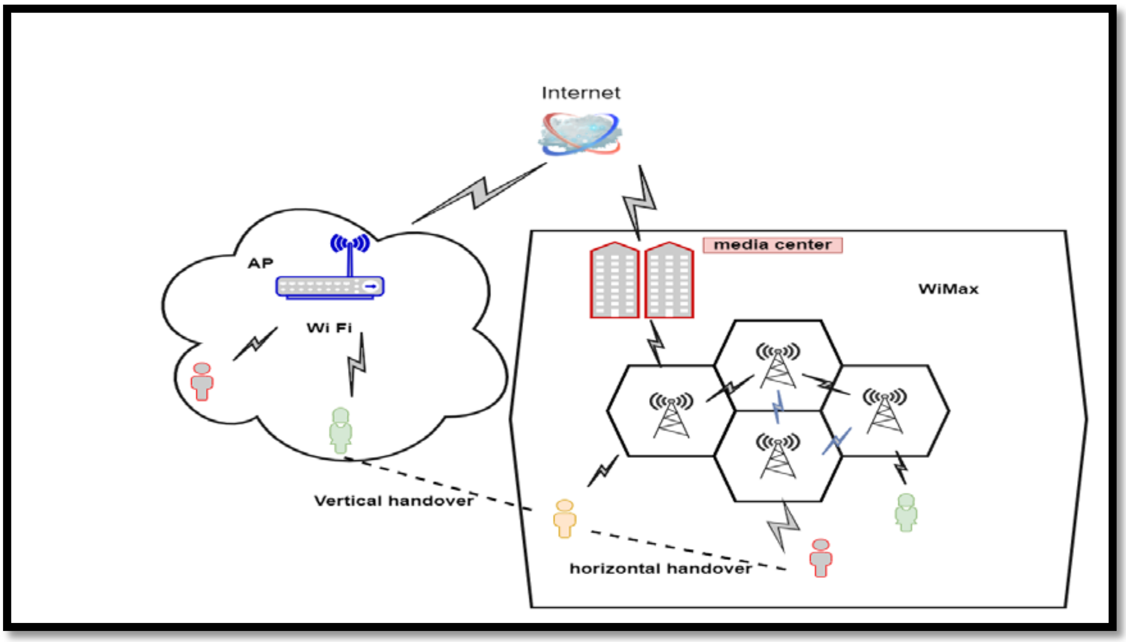

Figure 2.2 Horizontal and Vertical Handover [13]

There are other classifications to handoff process in WiMAX networks depending on whether there is a disconnect during handover or not and these are : HHO , MDHO and FBSS [14].

Though both MDHO and FBSS offer significantly better handover performance in comparison to HHO, there is still a long way to go before adequate support measures for these two techniques can be developed and deployed in MWiMAX networks. accurately sharing the same carrier frequency among the multiple BSs in the Active Set (AS), perfectly synchronizing the active set BSs and handling the increased deployment expenses, seem to be the major challenges so far[3].

2.3.1 Hard Handover (HHO)

The MS interacts with only one BS at any time during the hard handover. Until the new link is formed, the connection with the old BS is disrupted. Handover is implemented after the strength of signal exceeds the strength of signal of the current cell from the neighbor's cell, Figure 2.3 illustrates this condition. The thick black line at the cell boundary indicates the location where the hard handover is realized[15].

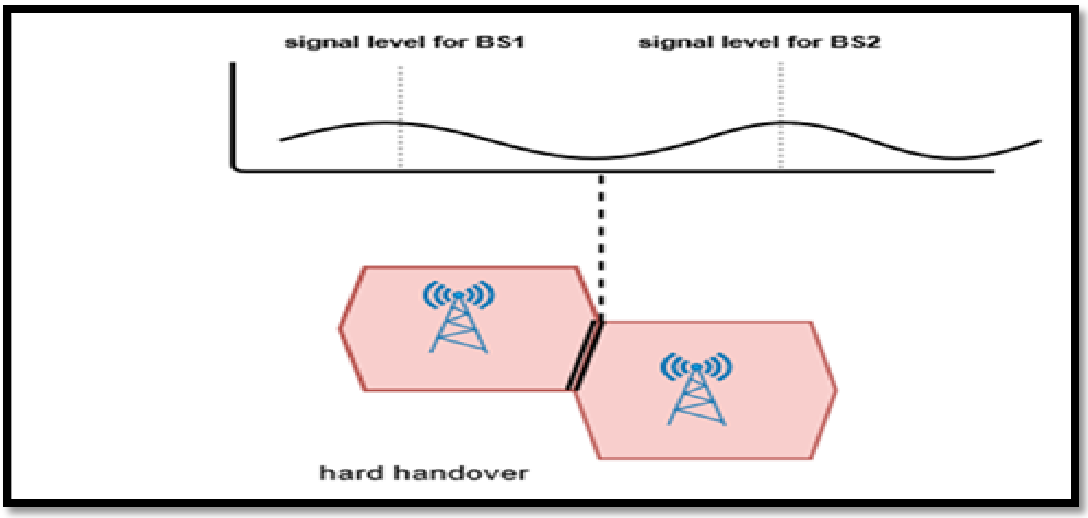

Figure 2.3 Hard Handover [15]

2.3.2 Macro Diversity Handover (MDHO)

When MDHO is sponsored by MS and BS, MS and BS retain the "Diversity Set". The diversity collection is several BS's that are included in the process of handover[16]. The diversity set for all MS's in the network is established. MS interacts in the diversity collection with all BS's, see Figure 2.4. Transmitting data to MS by two or more BS so that combining diversity can be achieved at the MS for downlink in MDHO. MS communication is obtained by several BS for uplink in MDHO where diversity in selection is performed of the information received. The BS is known as neighbor BS, that receives communication between MS's and other BS's, but the strength level of the signal is not adequate.

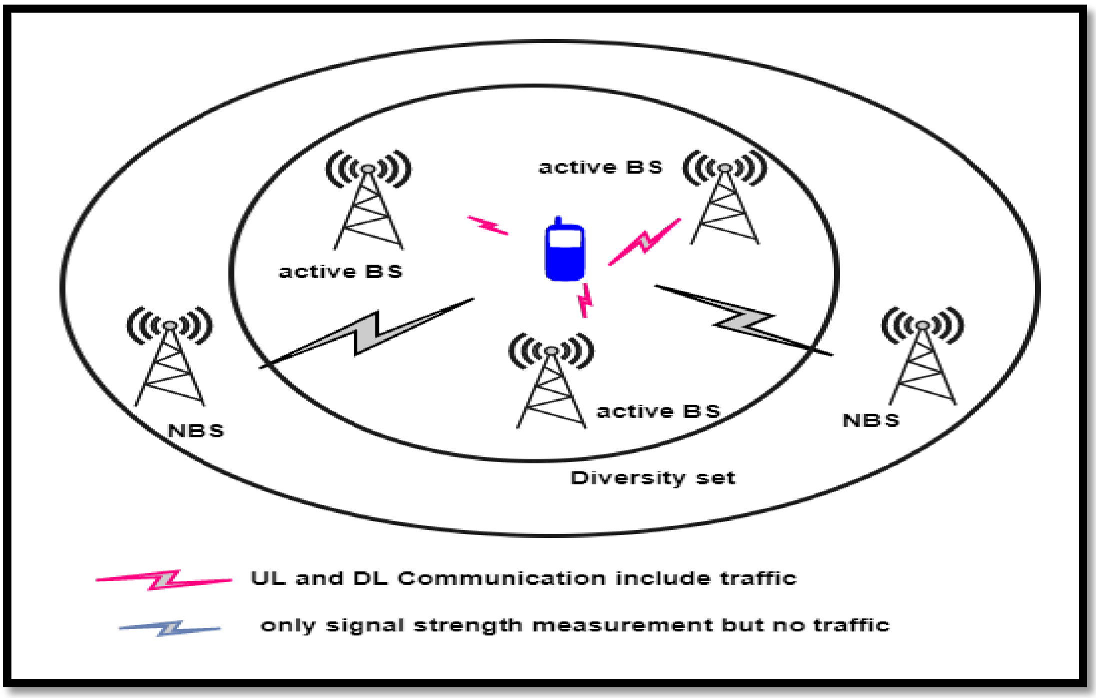

Figure 2.4 Macro Diversity Handover

2.3.3 Fast Base Station Switching

In FBSS, the diversity collection of MS and BS is retained as close as in MDHO. MS continually monitors the BSs and identifies an "Anchor BS" in the diversity collection. Anchor BS is just one BS of the diversity collection in which MS interacts with all uplink and downlink traffic, containing management messages[17]. Figure 2.5 illustrate that there is BS where MS is recorded, synchronized, ranging output and downlink channel for control messages are monitored. Depending on the BS selection scheme, the BS anchor may be changed from frame to frame. This implies that each frame can be sent in the diversity set through different BS.

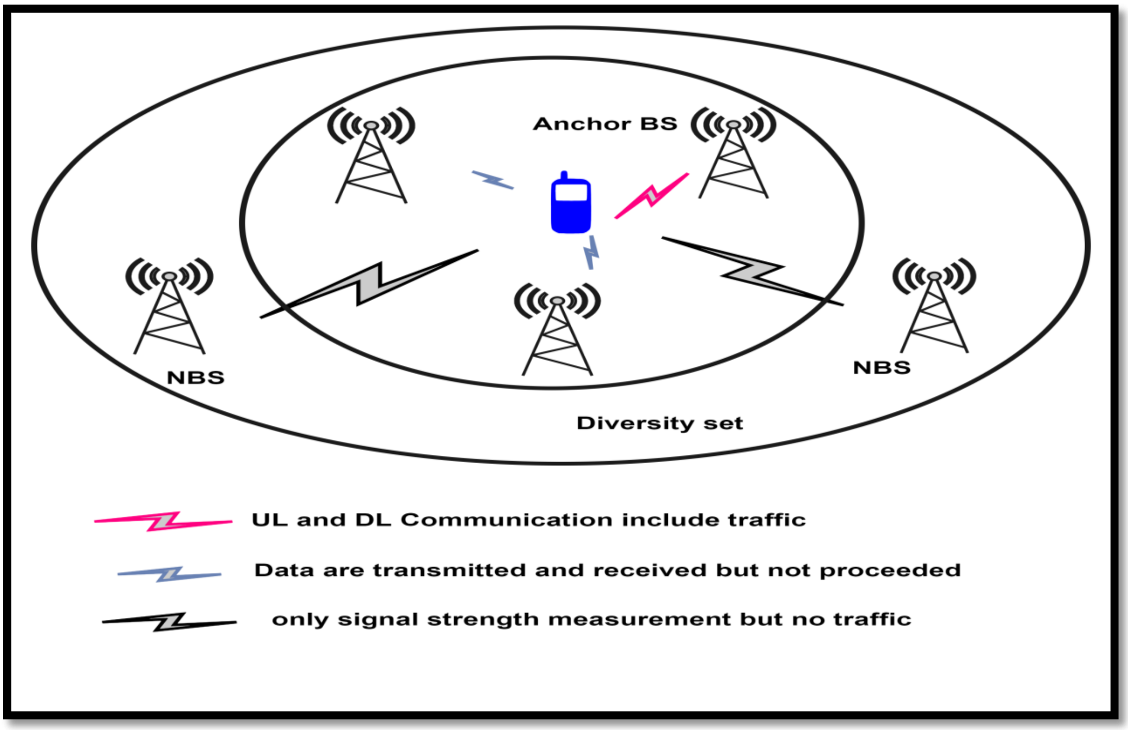

Figure 2.5 Fast Base Station Switching

2.3.4 Horizontal Handover and Some Proposed Solutions.

Horizontal handover takes place between the two cells with the same access technologies or between the homogeneous BSs [18,19]. There is no link split between the two cells in this process. Generally, the scanning process is the key part of the handover delay [20].

Caiyong et al. [21] Suggests the Velocity Adaptive Handover Scheme. This scheme modifies threshold of HO (Th_{HO}) by changing its value dynamically based on velocity (v). This can be explained in the following way: th_{HO} = thdrop + ΔH Based on the analysis above, ΔH should grow as MS velocity increases. To reduce excessive network loss, the Th_{HO} should be adjust as low as feasible in the static state (v = 0), where the topological information for the network channels is constant with the shortest HO delay. In the maximum speed case (v goes to 1), The topological information on the network channel changes so fast that improving the Th_{HO} has almost no influence on delay of HO.

Zhang, Z., Pazzi, R. W., Boukerche, A., & Landfeldt, B. [22] suggests a method of mobility patterns used to decrease HO delays. Skipping needless scans in HO are the basic principle of this scheme. This work used four kinds of scan operation to test its proposal,(scan without association, scan with association but without coordination, association with coordination and assisted association reporting). All scenario explained that estimation of the TBS also contributed to a reduction in the scanning process as part of the transfer reduction.

Becvar, Z., Mach, P., & Simak, B. [23] suggested a prediction approach focused on monitoring the signal strength between the mobile station and all NBSs. This procedure uses two thresholds for selecting the most likely BS. First threshold is related to the signal level received by the MS from the serving BS while the second threshold is related to the signal level measured by the MS from the potential target BS. The proposed solution requires exchange of no additional information except information sent conventionally among MSs and BSs during the normal operation of a WiMAX network. Additionally, no inputs from users or special knowledge or capabilities of networks are required. Hence no modifications to the conventional WiMAX MAC layer or hardware are required.

Ahmed, S. H., Bouk, S. H., & Kim, D.[24] proposing an effective network-assisted handover scheme that decrease the scanning latency suffered by vehicles while the handover procedure by offering a network-assisted handover in such a way that the service RSU (road side unit) selects the required target RSU. Additionally , the MS will obtain correct channel/frequency information from the target RSU and the estimated time to start the dedicated scanning phase based on its speed. Data contact between the MS and the RSU service will also not be interrupted during the transfer process and the MS will also be approved with the upcoming RSU before its arrival.

Talreja, R., Jethani, V., Marathe, N., & Saxena, K. [25] suggests a system where the intersection between the (SBS) coverage area and the NBS coverage area is considered to be one set of NBSs (Set A). Another group of NBSs shapes the NBS in the direction in which MS travels (Set B). MS will then search the NBS that exists in Set A as well as Set B to find a suitable TBS.

Lakshmi, L. R., Ribeiro, V. J., & Jain, B. N. [26], the BS transition management solution is suggested to provide quality service for the transfer of nodes. In addition, a delay reduction approach is suggested to decrease the delay in transmission of the packets during the HO. To treat calls from various service groups equally, according to their preferences, a Call Admission Control (CAC) algorithm is suggested. It is proposed to minimize handoff errors by minimizing the various service classes' probabilities while not wasting the continuing calls of lesser priority service kind.

Bi, Y., Tian, L., Liu, M., Liu, Z., & Chen, W. [27] introduces a novel algorithm that not only supports horizontal handover in the same network, but can also distinguish RSS , optimize speed and data rate under various channel conditions in order to select an appropriate network to handover. For low computational complexity, RSS is utilized to provide handoff among cells and the fuzzy logic decision algorithm is utilized to provide handoff between floors(vertical handover).

Oroskar, S., Singh, J., Malhotra, R., & Manchanda, N. [28], a relay node is allowed to transmit to an end-user wireless system, any data packets remaining in the end-user wireless device buffer prior to the end-user wireless device switch. Upon beginning the switch, the relay node changes the scheduling operation to use the lowest possible modulating coding scheme (MCS) in order to transmit the remaining buffered data to the end-user wireless computer. In addition, the scheduling operation is modified to disregard any subsequent channel quality indicator (CRI) reports from the end-user wireless system, thus ensuring that the end-user wireless device has a higher chance of receiving the data. The handover is executed when the buffer is zero.

Basloom, S., Akkari, N., & Aldabbagh, G. [29] suggests a hybrid clustering strategy using the k-mean and genetic algorithm Cluster. The purpose of clustering is minimizing the scanning process of the mobile node by reducing a number of access points which require to be scanned for handover. The clustering technique increases the classification model's accuracy [30].

Kavitha, V., Manimala, G., & Kannan, R. G. [31] developed a triangular method of predicting the next likely base station. This approach eliminates hexa-directional uncertainty and predicts the following one completely in advance, greatly enhancing efficiency. This study assumes that the network is completely divided into hexagons, which are not the case in fact. Additionally, calls are prone to failure if the user is traveling at a fast speed and abruptly changes direction. Table 2.2 contains some related work.

Table 2.2 Related works in homogeneous WiMAX

	proposed idea	advantage	limitation
[22]	proposed Mobility patterns scheme by making a table contain pervious BSs ID, target BSs ID and handover times for each user.	Skipping needless scans in HO is the basic principle of this scheme by estimation of the target base station.	This proposal makes a table for all users which may increase computational load during HO.
[24]	This research introduce a notion of the network supported handover.	decreases the scanning latency faced by vehicles during HO process by chooses an suitable target RSU among neighbors and achieves pre-authorization for MS.	In this research, the decision of HO is made by serving RSU(road side unit) by using backbone server i. e. (it is need more signaling).

[25]	BSs with greater overlap with the serving BS have a greater chance of being chosen as TBS and which exists in the zone where MS is moving.	Reducing handover latency by lowering the number of NBS that an MS must scan to find the TBS.	This research didn't take into account the users moving towards the cells less overlapping with current BS.
[31]	propose triangular way of determining the next potential base station in advance.	This approach eliminates hexa-directional uncertainty and predicts the following one completely in advance, greatly enhancing efficiency.	This study assumes that the network is completely divided into perfect hexagons, which is not the case in fact.

CHAPTER 3

Methodology

3.1 Introduction

IEEE 802.16e is a platform eligible of meeting those standards in modern wireless networks that demand broad bandwidth and high-speed mobility [51]. One of the most significant problems with IEEE 802.16e is that although the handover technology provides smooth high volume data services at a high speed scale, it only specifies a mechanism without including precise methods or algorithms for handover that can be delegated [33]. Up till now, systems are still using simple mechanisms to make handover decision, based on the evaluation of the Received Signal Strength (RSS). In some cases these mechanisms are not efficient, for example we can find a system with a good RSS and a worse data rate [34].

One of the most critical challenges with IEEE 802.16e is the ability of the handover technology to supply smooth high-capacity data services at a high speed rate. Some of the NBSs can be scanned by the MS as prospective TBS candidates [35]. However, the HO approach makes no mention of the amount of NBSs which an MS may require to scan before deciding. This could result in excessive scanning of NBSs [36], wasting channel resources and compromising overall performance. Furthermore, scanning, synchronization, range and association actions are carried out sequentially (i.e. not at the same time) during the NTAP.

As a result, copious scanning, accompanied by extended synchronization, range, and association activities relative to the number of NBSs scanned, adds to the total handover latency. Furthermore, while scanning the NBSs excessively may impact the SBS's scheduler implementation, especially for delay-sensitive downlink traffic, superfluous contention-based ranging outcome in undesirable consuming of Contention slots has an impact on total throughput [37]. While scanning for the handover procedure, data transfer to the terminal device is paused. Prolonged scanning, of course, degrades network performance.

This chapter presents the proposed work which is divided into two phase, the first A Pre-authorization Algorithm (PAA) which accepts incoming requests quickly because it already has the incoming request information saved in BV. The objective reduces handover signaling during scan process as well as during the re-entry process when a mobile station requests access to the next possible base station.

The second phase based on direction and genetic algorithm. The goal is to predict TBS consequently minimize the number of BSs that are scanned by the MS and thus decreases the scan time during NTAP which constitute the longest time through handover process [38]. Also this chapter explains the mechanism of genetic algorithm and Voronoi diagram which is used in network model.

3.2 Pre-authorization Algorithm /base station visitor (PAA/BV)

As a MS tries to connect to a new BS in MWiMAX HHO, it must finish network re-entry procedure, which requires a set of protection and link reestablishment procedures. This takes a long time. As MS is passed from one cell to another but quickly returned to the original cell, a ping-pong effect occurs, as does when high-speed users pass the cell's edge. Ping-pong effects cause unnecessary network re-entry procedures, which cause delays, call disturbances and handover overheads, which can impair overall system performance. To avoid this impact, the SBS informs the MS of the length of time that MS traffic will be buffered in the SBS [39].

The PAA is based on the fact that the authorization process occurs in AHOP when the MS disconnects from the former BS and connects to the present BS. According to IEEE 802.16e, the current BS requests information about the MS from the previous BS [47], as shown in Figure 3.1 and the last one gathers this information with the aid of the backbone network. The network re-entry can be seen here. Since transmitting the stocked authorization messages from the SBS to the TBS can sometimes boost the total load in the backhaul network [40] .

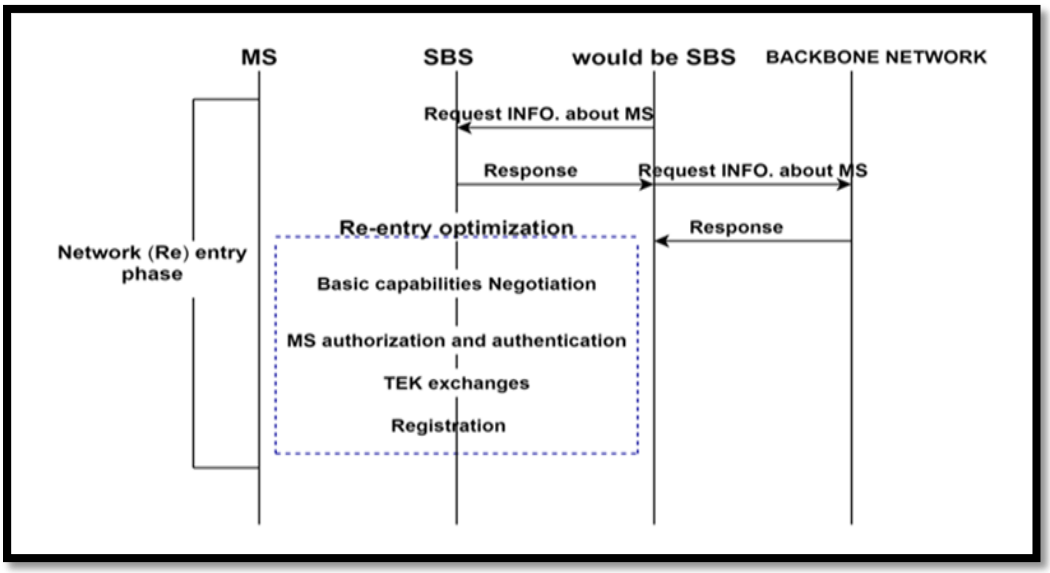

Figure 3.1 Re-entry Phase in HHO [3]

The proposed PAA/BV that provides information to TBS in advance that MS requires during visiting these base stations to perform pre-authorization and reduce signaling, thereby improving overall efficiency. Figure 3.2 describes re- entry phase in PAA/BV.

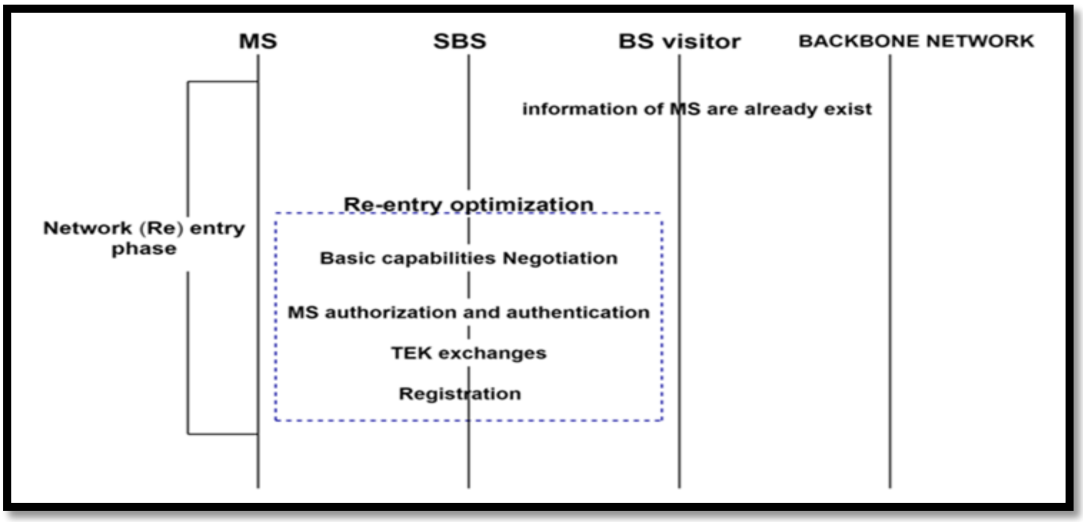

Figure 3.2 Re-entry phase in PAA/BV

The service interruption time of conventional scheme:

$$T_{CON} = Ts + Tc + T_{RNG} + T_{auth} + T_{reg} \quad (3.1)$$ [41]

While the service interruption time of PAA/BV is:

$$T_{PAA/BV} = Ts + Tc + T_{RNG} \quad (3.2)$$

Where Ts : average time is taken to synchronize with new downlink.

Tc : the average time needed for the contention resolution procedure during the contention based ranging phase.

T_{RNG} : the average amount of time needed for ranging phase during HO.

T_{auth} : the average time needed for re-authorization during HO.

T_{reg} : the average time needed for registration process during HO.

3.2.1 Base station visitor

BV is a server in a cellular network that assists roaming tasks for users outside the coverage zone of their own home location register (HLR).

The method of adding user information to BSs is influenced by two major factors: the capacity of the base station and the rate at which users visit these sites. Figure 3.3 describes the flowchart of adding user to BV.

It should be noted that maximum capacity varies from BS to BS depending on the nature of the coverage area, whether it has a high or low population density. Whereas in the first case, the capacity of the visitor list is high and in the second case, it is smaller. The method for adding a consumer to the main list of BV as follows :

Algorithm 1 adding user information to BV:

The PAA algorithm has been designed to add the information that the user needs in the handover process to BVs. It depend on two primary factors, the BV's storage capacity and the number of visits to BS per user.

The algorithm uses two values, zero threshold and case threshold, it uses them to meet additional expectations in case the capacity was high or low.

In the case that the load in BV is high (80% or more of the capacity) it only adds the user if the average amount of visits to BV exceeds the average amount of visits of previous users, to that BV. But if the load was low (lower than 80%) it adds the users information if the average amount of visits during the month exceeds the load percentage to the total capacity, otherwise it will not add the information. Note that

PPA/BV prioritizes users who visit the BS often, regardless of the available capacity of the BS.

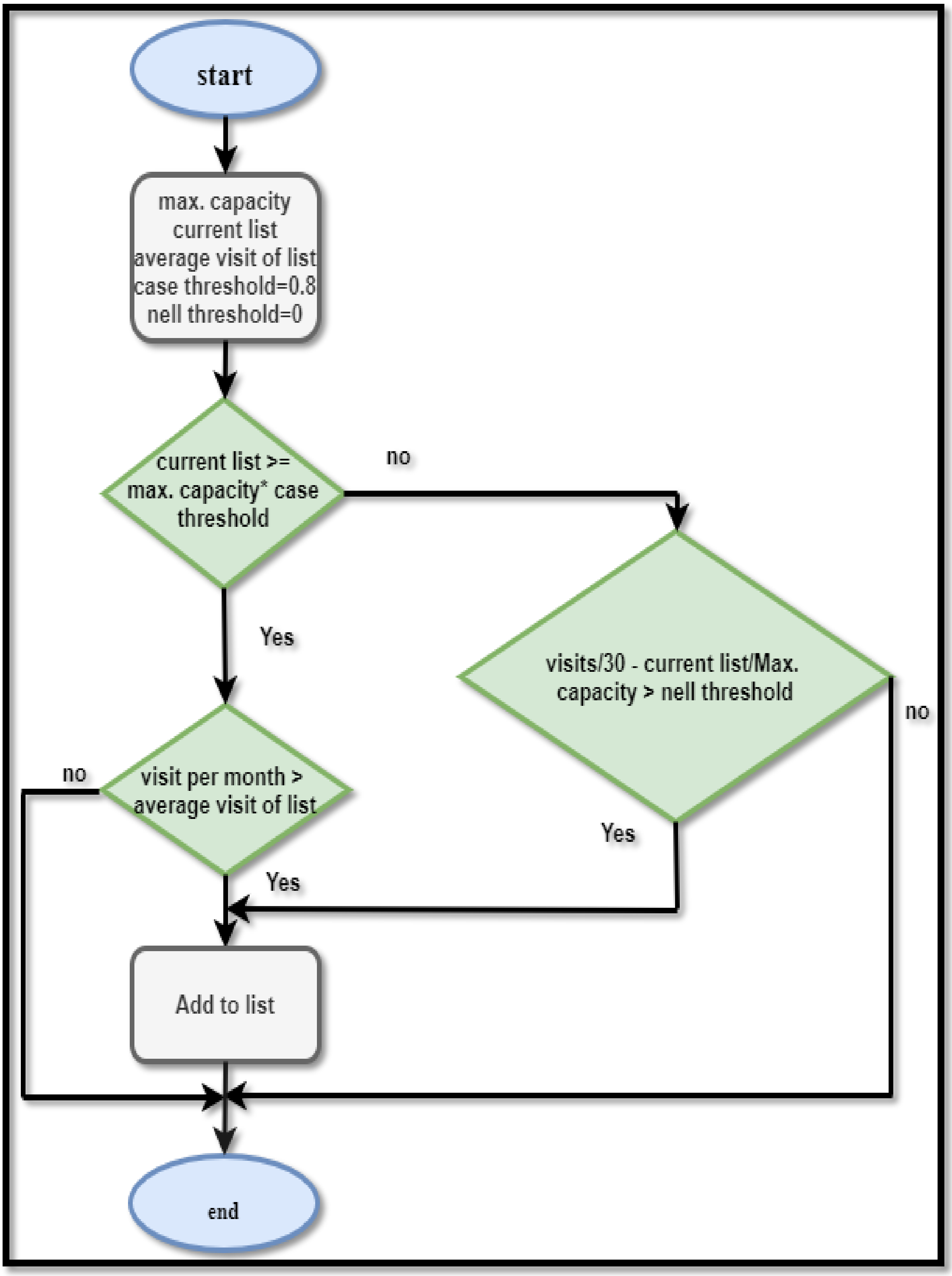

Figure 3.3 Flowchart of Adding User to BV

3.2.2 Mechanism of updating visitor list of BV

Since the rate of visits per user changes on a regular basis, the visitor list in BV is continuously updated. The mechanism of updating is designed depending on the network model. The mechanism for updating is depicted in Figure 3.4 below.

Algorithm 2 updating visitors list;

The servers located in BSs (BV) constantly update the main lists of visitors, which contain their information.

It relies on the information stored in matrix that is programmed for the purpose of recording visitor numbers and the number of their visits within a month.

When calling each user's information, aforementioned (adding user to BV) to make decision.

Depending on the currently available capacity and the current average of visits, a decision is made to add the user or not .

If the decision is to add the user, then the current list is updated and the average of visit is calculated (the total number of visits divided by the number of users). Finally, the user is added to the main list of BV.

In the event that decision is not to add the user, the information of another user is called and so on.

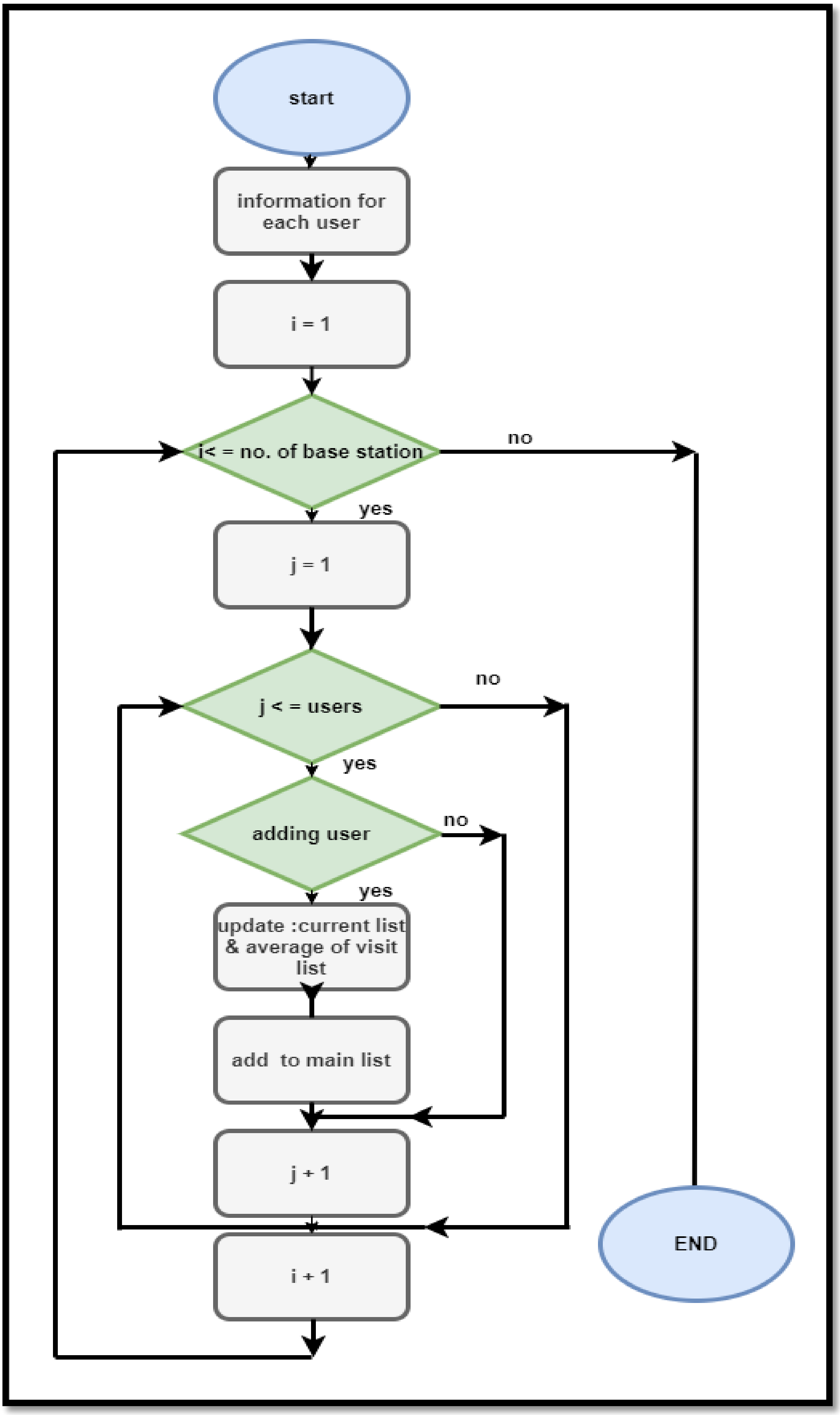

Figure 3.4 Flowchart of Updating Visitor List

3.3 Predicting Target Base Station

According to the suggested system, BSs in the direction of the user's movement have a higher possibility of being a target candidate. Because MS is most likely to have a link with one of these BSs, the purpose of the genetic algorithm is to nominate a rate of these TBSs to be a target based on the user's speed, in a way that ensures a balance between reducing scanning time with the loss in calls.

In IEEE 802.16e, the entire HHO procedure is divided into two phases: NTAP and AHOP. The thorough description of the entire process was found in [7]. The main responsibilities involved in NTAP are the following :

BS advertises the network topology, MS scans of announced nearby BSs, ranging, and optional association activities.

For each handover, the MS searches through all NBS to identify a TBS and then initiates the handover [42]. However, this intrinsic scanning time can be mitigated to some extent by lowering the number of NBS that an MS must scan in order to choose the TBS. Taking into account the network area divided by Voronoi diagram which is the practical layout.

3.3.1 Network Model and Voronoi Diagram

The supposed network consists of seven base stations distributed in an area that is supposed to contain a set of street, intersection, residential area and some buildings. Voronoi diagram is used to partition area into cells as in Figure 3.5. A Voronoi diagram is a mathematical diagram that divides a plane into regions that are similar to each of a given set of objects. In the most basic case, these objects are simply a finite number of points in the plane known as seeds, sites, or generators. For each site, there is a corresponding region known as a Voronoi cell, which consists of all points in the plane that are closer to that site than to any other [43]. This diagram helps us to know the closer BS with respect to user and the boundaries of Voronoi cells represent the handover regions.

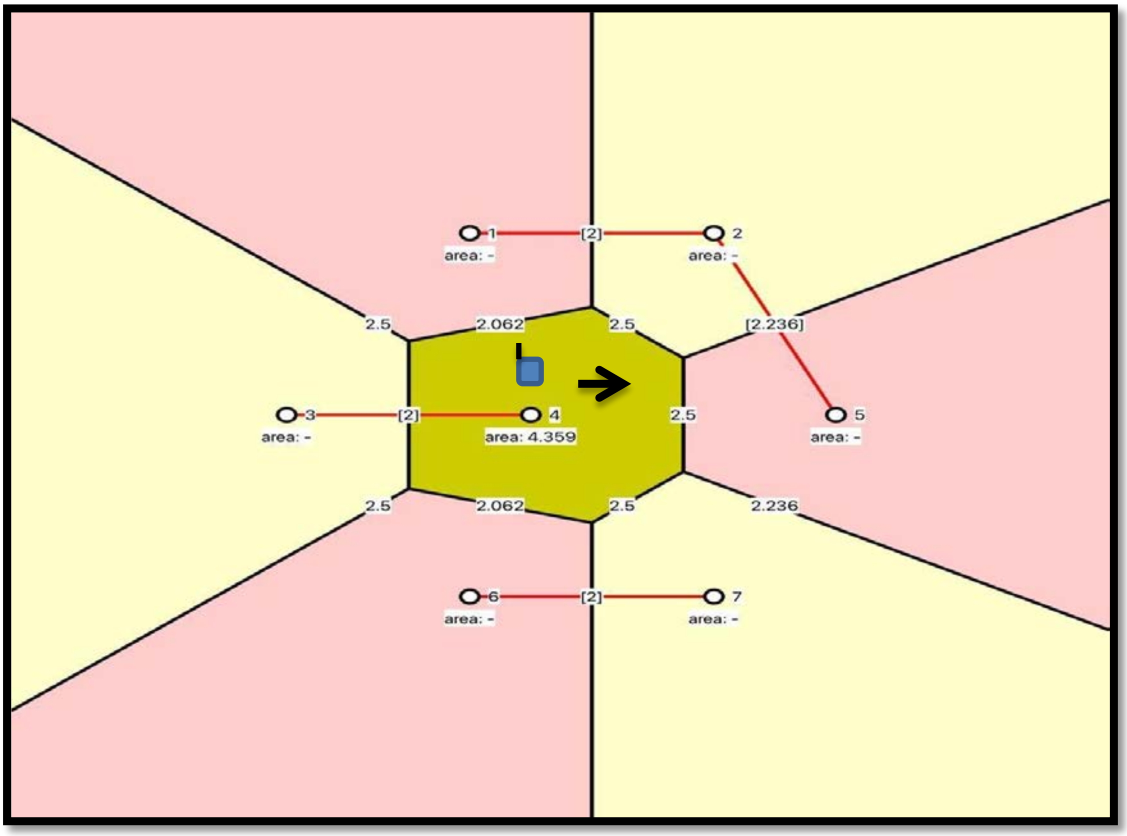

Figure 3.5 Supposed Network Model and Partition According to Voronoi Diagram

The network model was drawn using Voronoi plotter program. The diagram works in the following way:

1- Find the midpoint between any two point (BS).

2- Find slope between these BS.

3- Use the midpoint and perpendicular slope to write the equation of the line that represent edge of cell.

4- Voronoi diagram will repeat the former steps to all points (BSs) in network model.

5- It will use dashed line, then it will remove the parts of the edges that are closer to the third site than the two sites in its name.

Table 3.1 shows some details of network calculating in Voronoi plotter program.

Table 3.1 Voronoi details for network model

Point (BS)	Nearest point	Shortest point	Longest distance	Mean distance	Voronoi cell area
1	2	2	2.5Km	2.187Km	_
2	1	2	2.5Km	2.245Km	_
3	4	2	2.5Km	2.333Km	_
4	3	2	2.5Km	2.271Km	4.359Km
5	2	2.236	2.5Km	2.324Km	_
6	7	2	2.5Km	2.187Km	_
7	6	2	2.5Km	2.245Km	_

3.3.2 Genetic Algorithm (GA)

GA is a natural selection-based search heuristic developed by Charles Darwin. The fittest individuals are selected for reproduction in order to generate children for the following generation, and this algorithm is modeled after that process [44].

Natural selection begins with the choice of the fittest people from a population. They have offspring who inherit the characteristics of their parents and are passed down to the next generation. If parents are more fit, their children will be fitter than their parents and have a better chance of survival. This procedure is repeated indefinitely and finally, a generation of the fittest people will be revealed. Figure 3.6 explains the concept of GA. This concept can be used to solve a search challenge. It analyze a set of solutions to the problem and choose the finest ones from among them. A genetic algorithm considers six steps will explained later.

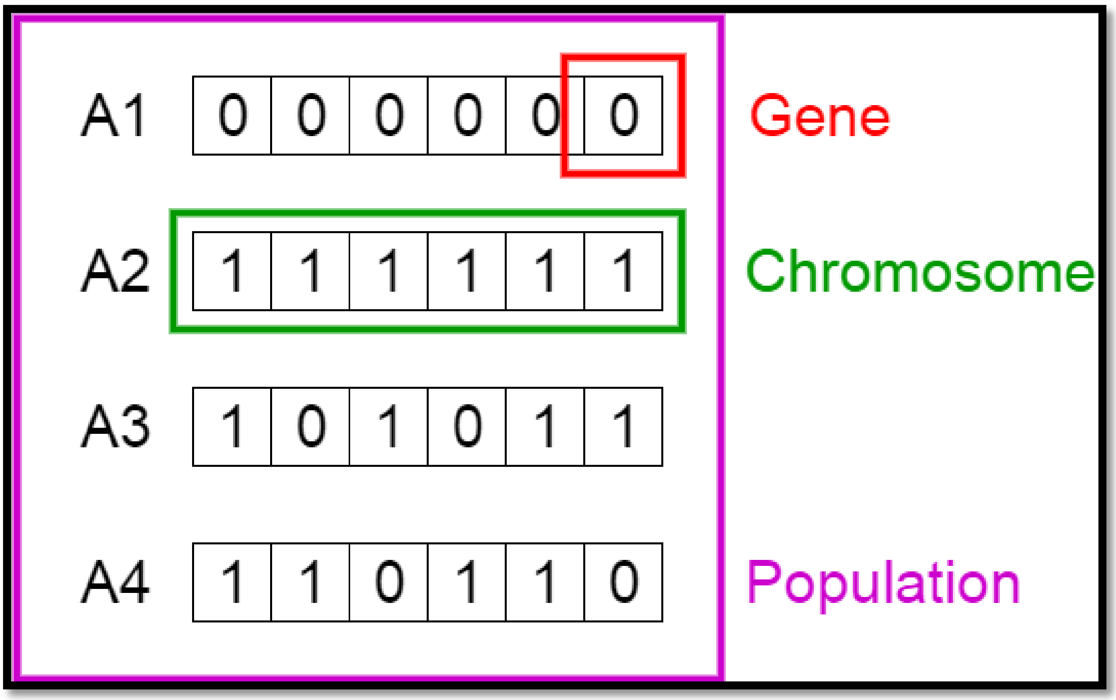

Figure 3.6 Concept of Genetic Algorithm [44]

3.3.2.1 Initial Population

The process begins with a group of people described as a population. Each person is a solution to the problem we wish to solve. A person is defined by a set of factors (variables) called as genes. To constitute a chromosome, genes are attached together in a string (solution). A GA represents an individual's set of genes as a chain in alphabet terms. Binary values are commonly utilized (series of 1s and 0s). this is called encoding the genes on a chromosome.

3.3.2.2 Fitness Function

The fitness function calculates a person's level of fitness (a person's ability to compete with other people). It gives each individual a fitness score. The fitness score of an individual determines the likelihood that it will be selected for reproduction.

3.3.2.3 Selection

The aim is to identify the most suitable individuals and let them pass their genes to the generations to come. Two pairs of people (parents) are chosen based on their fitness scores. Persons are fit physically are more likely to be selected for reproduction.

3.3.2.4 Crossover

Crossover is a major phase of a genetic algorithm. For each pair of parents to be mated, as indicated in Figure 3.7, a cross over site is randomly selected from inside the Deoxyribo Nucleic Acid (DNA).Until the crossover point is reached, the parent genes will be exchanged to produce children. As a result of the new generation, the population rises. Figure 3.8 explains the generating offspring.

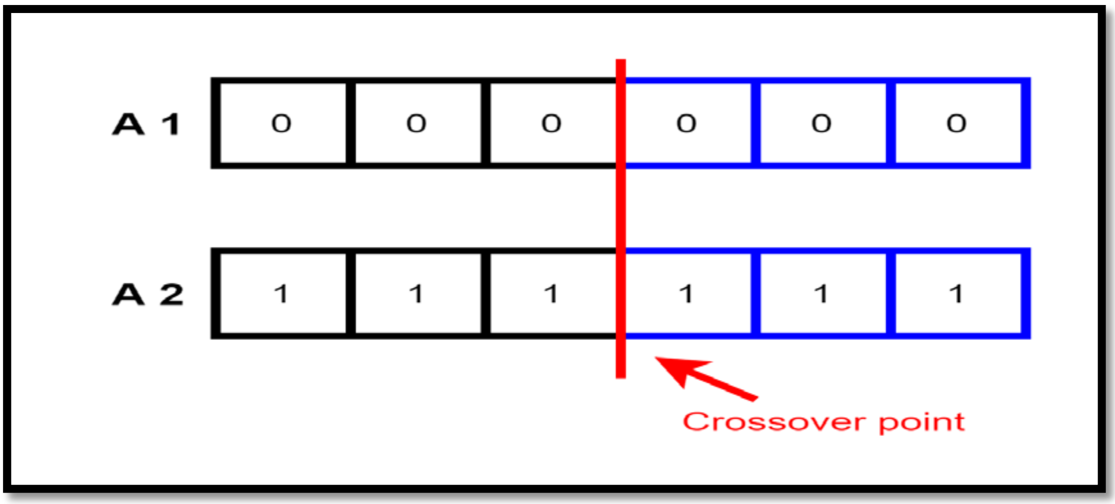

Figure 3.7 Crossover [45]

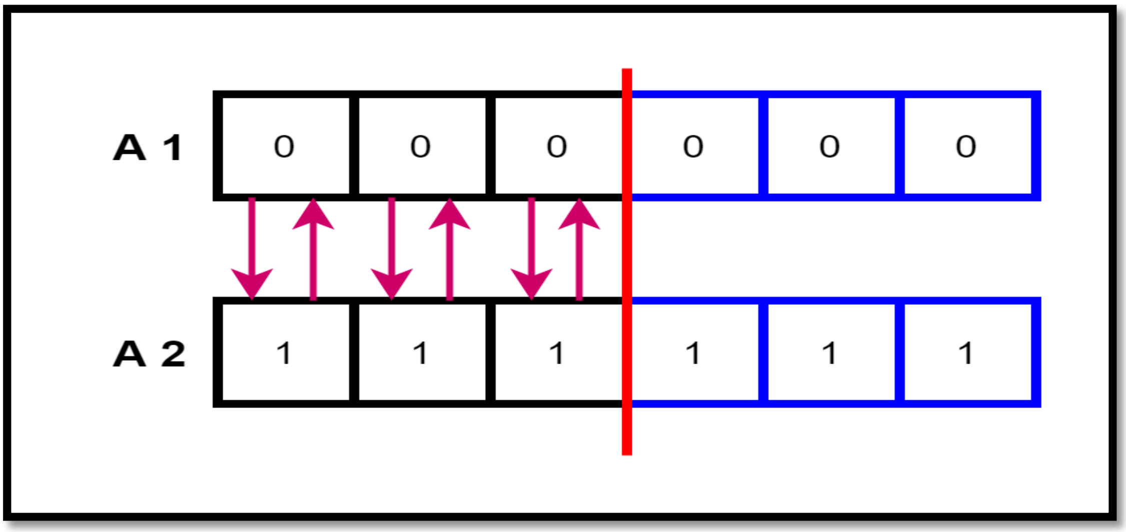

Figure 3.8 Generating Offspring [45]

3.3.2.5 Mutation

Some new children's genes may be susceptible to a mutation with a low random frequency. This indicates that some of the bits in the bit string can be rearranged. Mutation happens to preserve population variety and avoid precocious convergence. Figure 3.9 explains mutation.

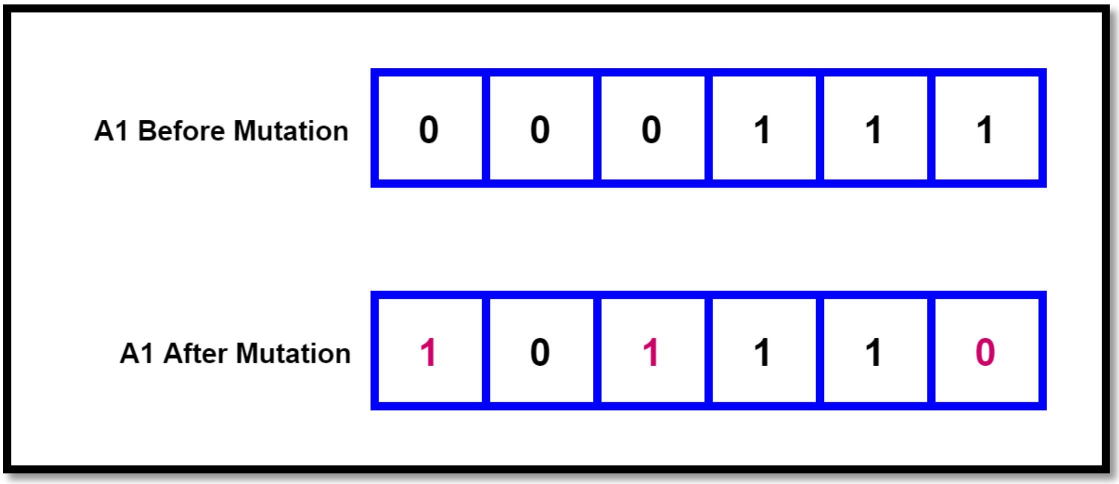

Figure 3.9 Mutation [45]

3.3.2.6 Termination

If the population has converged, the algorithm will end (does not produce the progeny which is significantly different from the former generation). The GA is thus deemed to have generated a set of solutions to our issue.

The population size is fixed. Individuals with the least fitness die when new generations emerge, making room for future progeny. The phases are repeated in order to develop individuals who are better than the former generation in each new generation. Figure 3.10, flowchart explains the mechanism of GA.

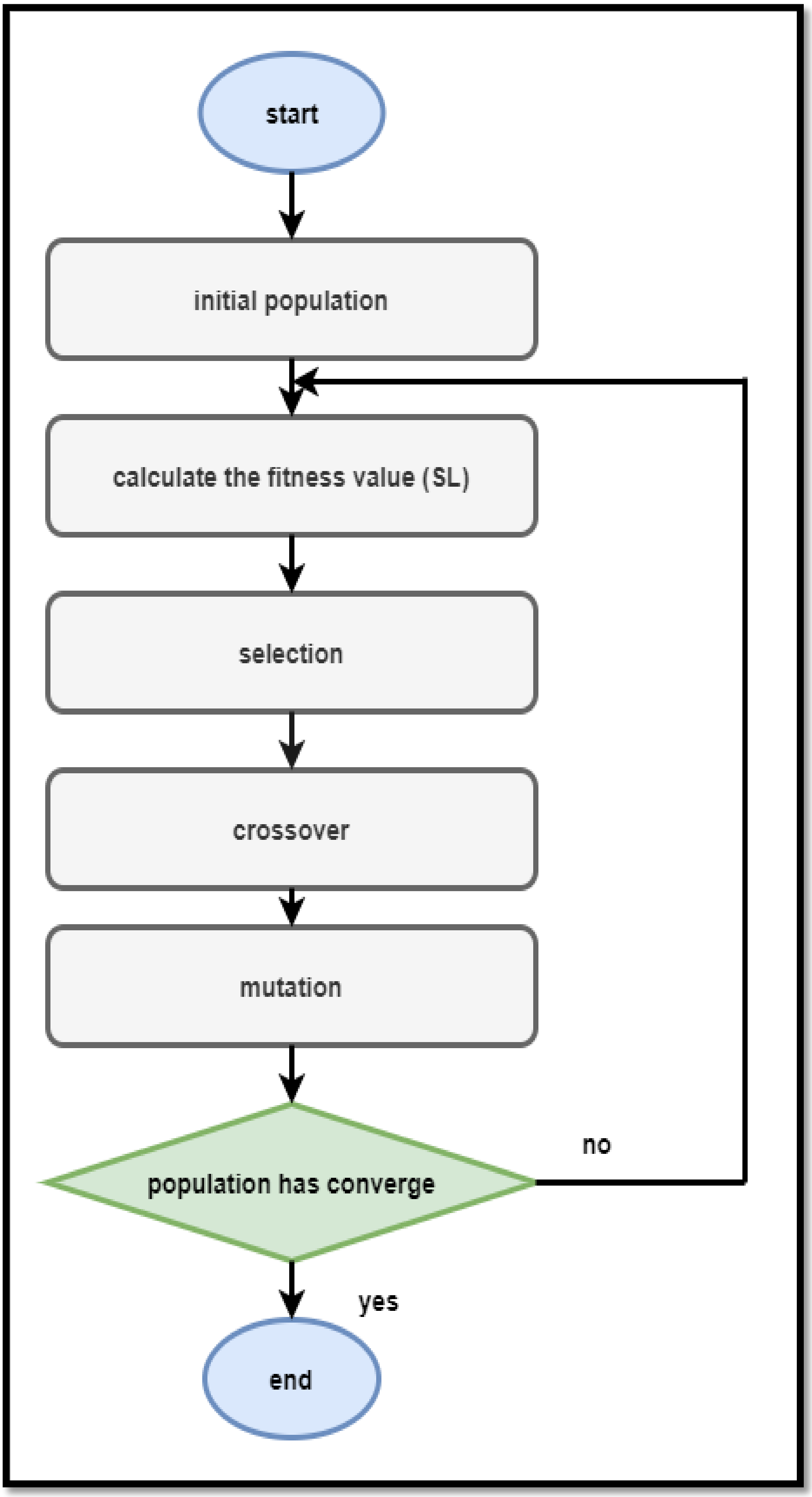

Figure 3.10 Flowchart of Genetic Algorithm [46]

3.3.3 Predict TBS based on direction and GA

Determining the target BS that best meets the mobility path and application requirements is far from straightforward in most mobility cases. In most cases, the mobile device must scan numerous channels in order to locate surrounding BSs and select an acceptable target [47].

This selection might be depended on a variety of variables. In this thesis the mobile station determines its own location using the Global Positioning System (GPS) and delivers it to the current base station. As a result, the SBS influences the direction of MS migration. When the MS sends a MOB-SCN-REQ message to request the scanning time interval, the serving BS will filter only the BSs located in the direction of the user's movement. As illustrated in Figure 3.5, the MS is moving towards the TBSs 2, 5, and 7. As a result, the MS will just scan these BSs rather than all 6BSs. This reduces the amount of time required to complete the scanning procedure.

$$\text{Standard}_{\text{time to scan}} = T_{\text{scanning}} * 6 \qquad (3.3)\ [25]$$

$$\text{Proposed}_{\text{time to scan}} = T_{\text{scanning}} * (\text{TBS in the collection}) \qquad (3.4)$$

In this case, TBS in the collection represents the BSs placed in the zone where MS is moving (2, 5, and 7).

This approach was not fully satisfied with this decrease, but instead depended on the MS's speed to improve TBS selection in a way that ensures minimizing the number of scans while not missing calls. This is where the role of GA in the selection optimization process comes into play. GA is a way for resolving limited and unconstrained optimization issues that are based on the natural selection procedure, which resembles biological evolution [48]. The following equations (3.5,3.6) represent the fitness function.

$$\text{Rate of qualified BSs} = e\hat{}(-speed/SL) \quad (3.5)$$

$$\text{Objective} = 0.5*\text{mean}_{(\text{Normalized calls dropping})} + 0.5*\text{mean}_{(\text{Normalized scan Time})} \quad (3.6)$$

Where SL = 111.08 (optimal value from GA)

Parameters was used for Genetic Algorithm in this thesis

Np = 10; % Population Size

Increasing the number of population members leads to faster access to the optimal value, but it leads to complication in the calculation.

T = 100; % No. of iterations

The number of iterations depends on the experience to reach the optimal value.

etac = 20; % Distribution index for crossover

represent the point of exchange of genes.

etam = 20; % Distribution index for mutation

represent the point where mutation takes place.

Pc = 0.8; % Probability of Crossover

Increasing the probability of crossover allows the transit of good traits of individuals through generations.

Pm = 0.2; % Probability of Mutation

Absence of mutations causes falls in local minima. The increase in probability of mutation also has a negative effect.

Because the problem of calls dropping during handover accompanies users with high speed [49], GA limits the number of candidate BSs for scanning as the MS speed increases so that it can complete the scanning process before the call drops. For a user moving at high speed, the GA filters one third of the number of pre-selected BSs by SBS so:

$$Proposed_{\text{time to scan}} = T_{\text{scanning}} * (\text{TBS in the collection} * rate_{\text{qualified BS}}) \quad (3.7)$$

$$Proposed_{\text{time to scan}} = T_{\text{scanning}} * (3 * 1/3)$$

$$Proposed_{\text{time to scan}} = T\ scanning$$

With the pre- authorization algorithm that reduces the signaling time, the scanning time will be reduced even more.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter will discuss the most important results obtained from the PAA and its impact on reducing signaling time, as well as, the factors affecting the process of adding users' information to BV. Also it shows the results of reducing scanning time as a result of using direction of MS and GA. Moreover, it will show the impact of reducing handover time on throughput during this process. MATLAB 2018b was used to calculate and draw the results.

4.2 PAA (pre-Authorization Algorithm)

In Figure 4.1 the curve shows the effect of the number of user visits during a month to BS on the probability of adding his information to BV. It explains that the relationship between the number of user visits and the probability of adding users information to BV is direct proportionality. i. e. increases the first factor (number of visit) leads to increase the probability of adding user. As we mentioned earlier, the algorithm sets a strict condition for adding users in the event that the available BV storage capacity is only 20% or less of its full capacity, which is that the number of users visits is greater than the average of visits of users who are currently in the main list of BV. Other than that, it adds users on a mitigating condition. Therefore, users with high visits are added even if the available storage capacity of the BV is low.

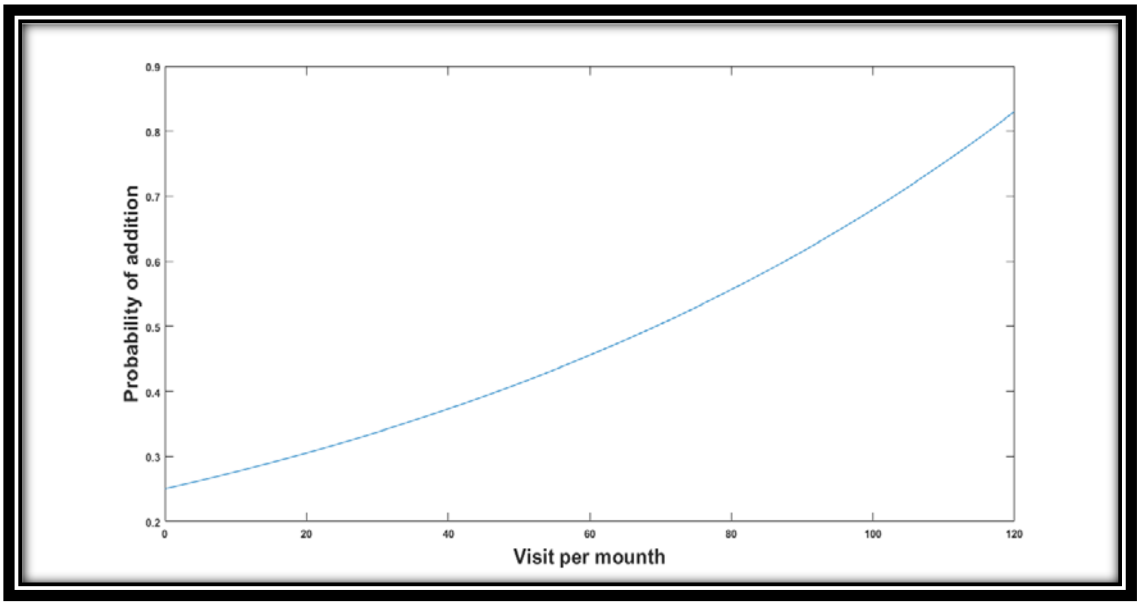

Figure 4.1 Probability of Addition Versus Visit per Month

While Figure 4.2 shows the relationship of the probability of addition versus the storage capacity of the BV. It is natural that the probability of adding users information is large when the storage capacity of BV is large compared to the existing load. This applies to BV located in remote areas, where users are added regardless of the number of their visits as a result of high capacity and few user.

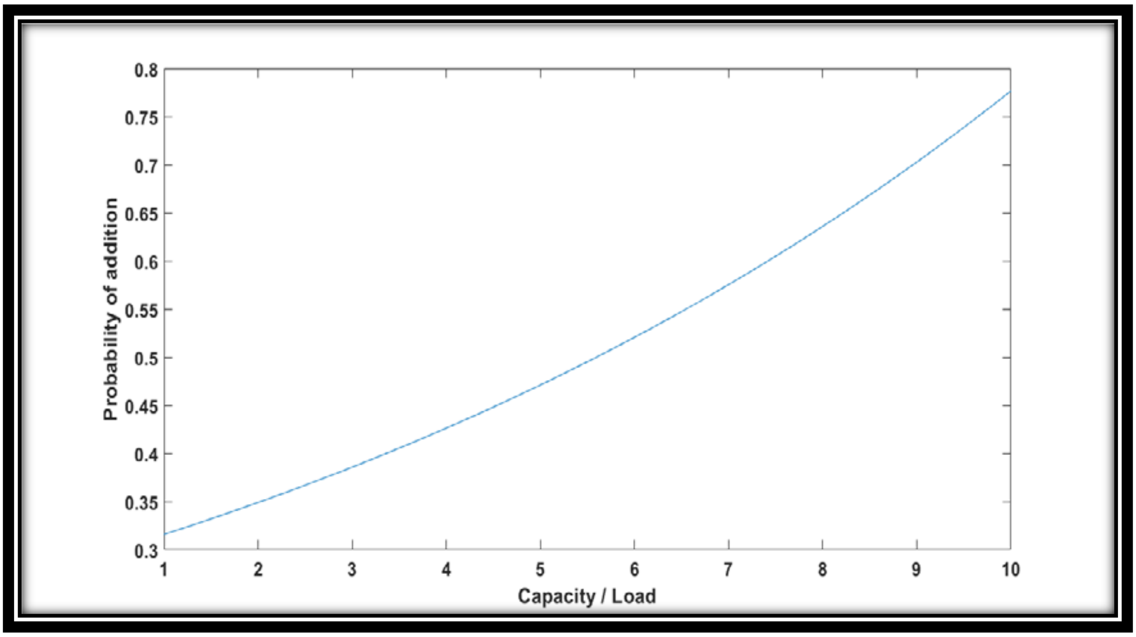

Figure 4.2 Probability of Addition Versus Capacity/Load

Figure 4.3 shows the effect of the capacity factor and the number of visits factor together on the probability of adding users to main list of BV. The Figure shows that maximum probability of addition corresponds to the maximum value for both factors (number of visits and capacity) and vice versa.

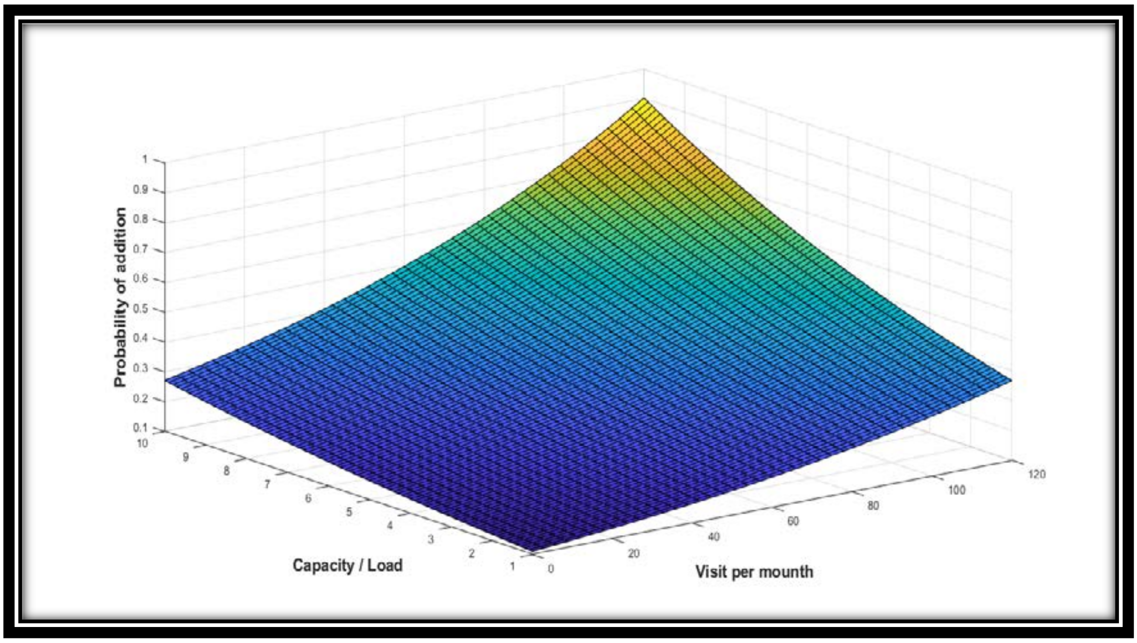

Figure 4.3 Probability of Addition Versus Capacity/Load and Visit per Month

At the end of this section Figure 4.4 shows the value of shorthand at the time of signaling as a result of the availability of the MS information that needed during the transition to a new BS in advance and this is what PAA algorithm does. The results indicate that signaling has been substantially decreased by about 20%. As a result, overall handover time and efficiency are improved.

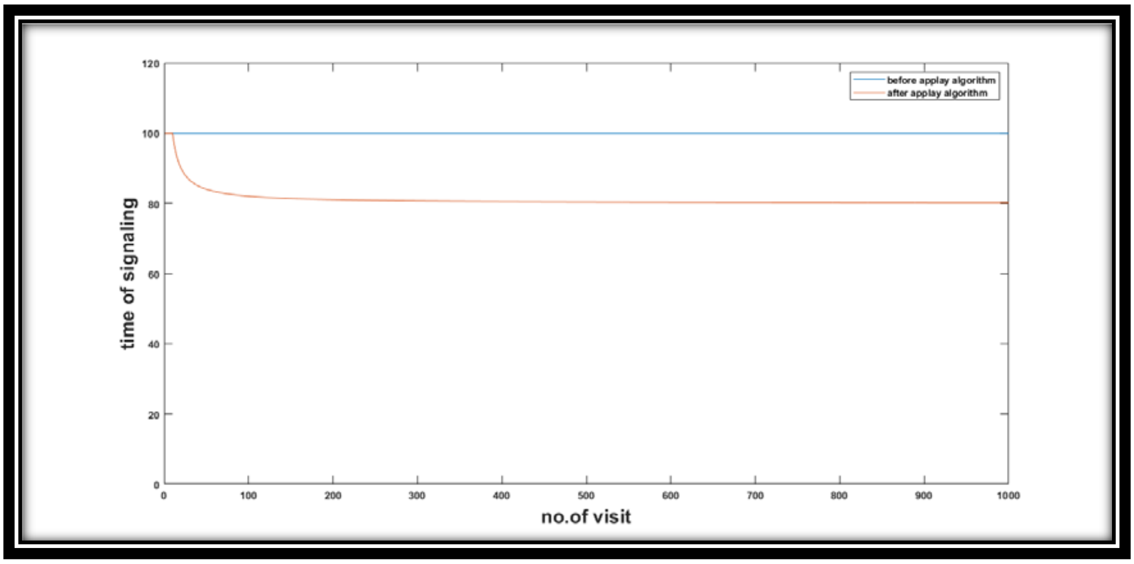

Figure 4.4 Reducing of Signaling Time

4.3 predicting TBS

Figure 4.5 shows the optimal curve obtained from GA, which shows the relationship between the number of qualified BS as a target and speed of the user. GA limits the number of candidate BSs for scanning as the MS speed increases so that it can complete the scanning process before the call drops. For a user moving at high speed, the GA filters one third of the number of pre-selected BSs by SBS.

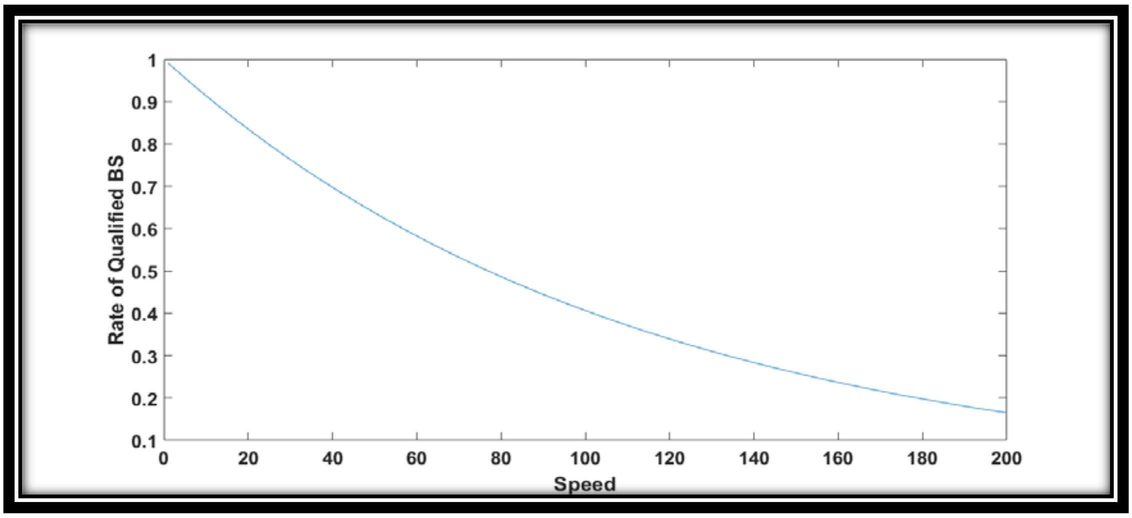

Figure 4.5 Qualified BS Versus Speed of MS

Figure 4.6 includes a comparison of the conventional scheme [50] with the suggested scheme in terms of the relationship of the number of qualified BS as a target with the speed of the mobile station. Where the number of qualified BSs in the first scheme ranges from six at slow speeds to four at relatively high speeds. In this proposal, the number of qualified BSs ranges from three to one which means that it has reduced the number of TBS by half at slow speed and by a quarter at high speed compared to the conventional scheme.

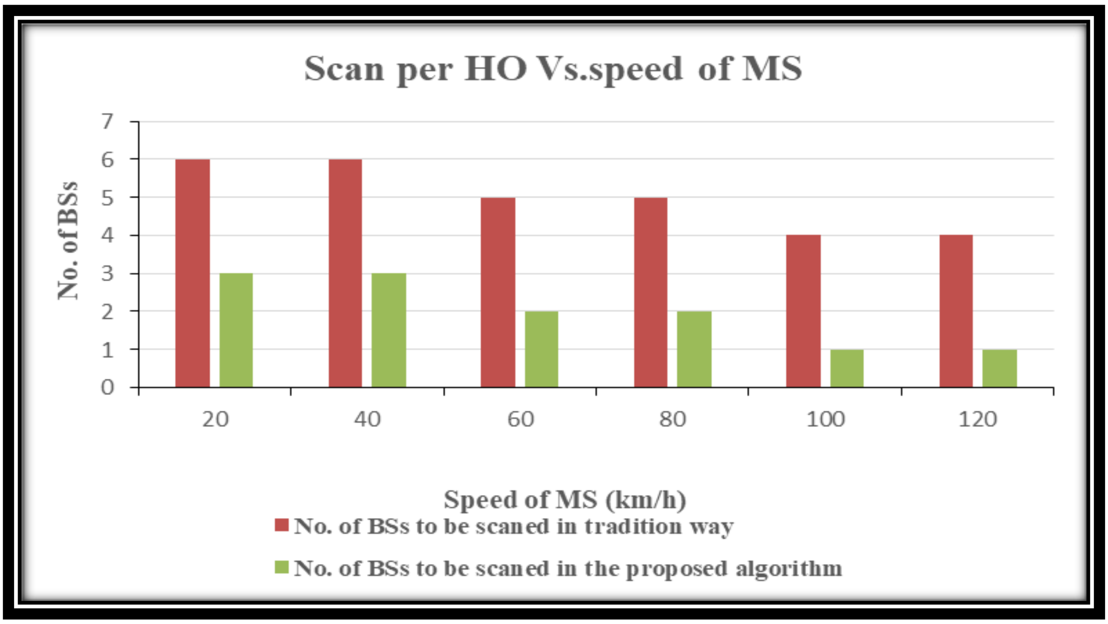

Figure 4.6 Number of BS Versus MS speed

Figure 4.7 clarifies the relation of scanning time with mobile speed. Since the scanning time, which accounts for about 90% of overall handover latency [8]. Therefore, reducing it significantly will reduce the overall handover delay. It is noted that the scanning time decreases with the increase in the mobile speed so that users with high speeds can complete the scanning process before transition to the target cell and losing its call. Although users with low speeds need a longer scanning time, they are less in need of the handover process due to the large cell size in WiMAX networks compared to their low speed.

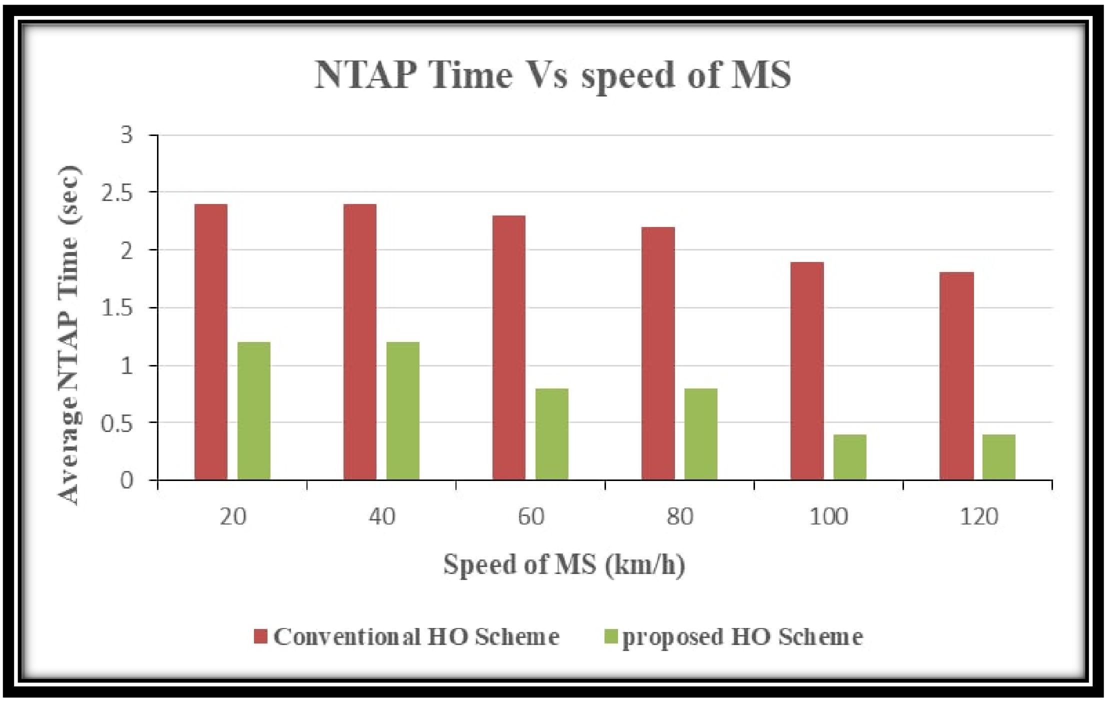

Figure 4.7 Average NTAP Time Versus MS speed

4.4 Throughput

As it is known, throughput is defined as the total amount of data that arrives at its destination divided by the time it takes to transfer the data from the source to the destination so, it is affected by the delay in the handover process. Where the time that MS takes to transit from the SBS to the TBS in the route is described as delay.

Throughput = (total received data *8 bit) /(End time (s) –Start time (s)) (4.1) [51]

Since the relationship between throughput and delay is inverse, the reduction of handover time will improve throughput during HO. Figure 4.8 depicts the variability in throughput for MS versus time during conventional handover [52] due to the delay associated with the handover process.

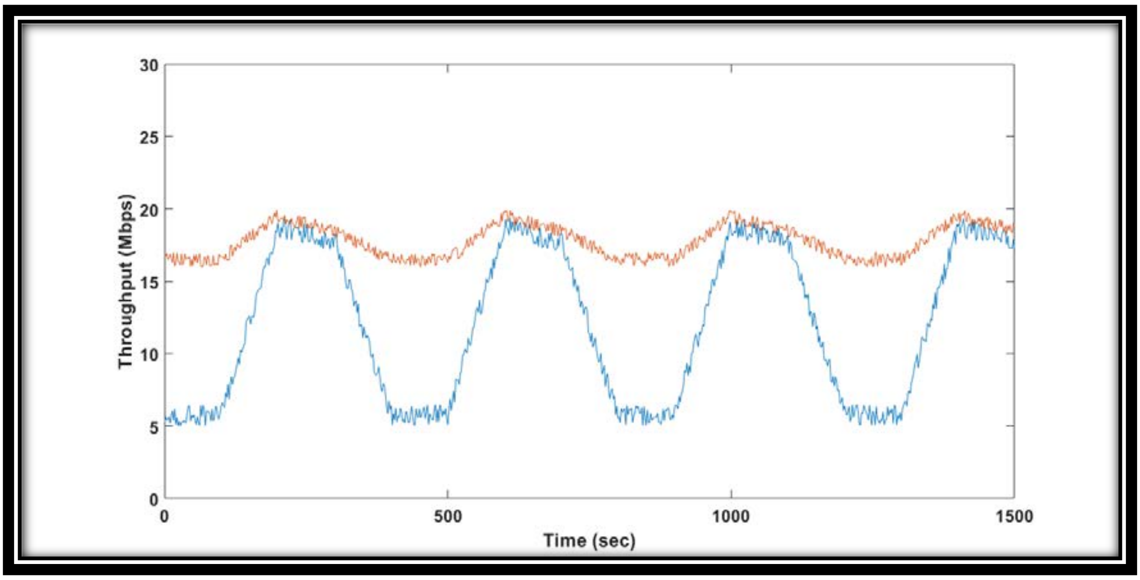

Figure (4.8) Throughput Versus Time

The red line shows the improvement in throughput versus time in proposed scheme as a result of reducing the handover time in NTAP and AHOP represented by reducing scanning time and reducing signaling time respectively.

Figure 4.9 depict the relation of the throughput to distance. If the user moves from cell number four towards cell number five, throughput decreases as the user moves away from the BS4 to reach the lowest value at the edge of the cell at 5Km where the handover area is. Then throughput increases gradually to reach the higher value again at 7.5 Km where the BS5 was located. The red line shows a significant decrease in the level of throughput due to the delay in the traditional handover scheme. While the blue line shows a higher level of throughput as a result of the reduction in the delay time in the proposed scheme.

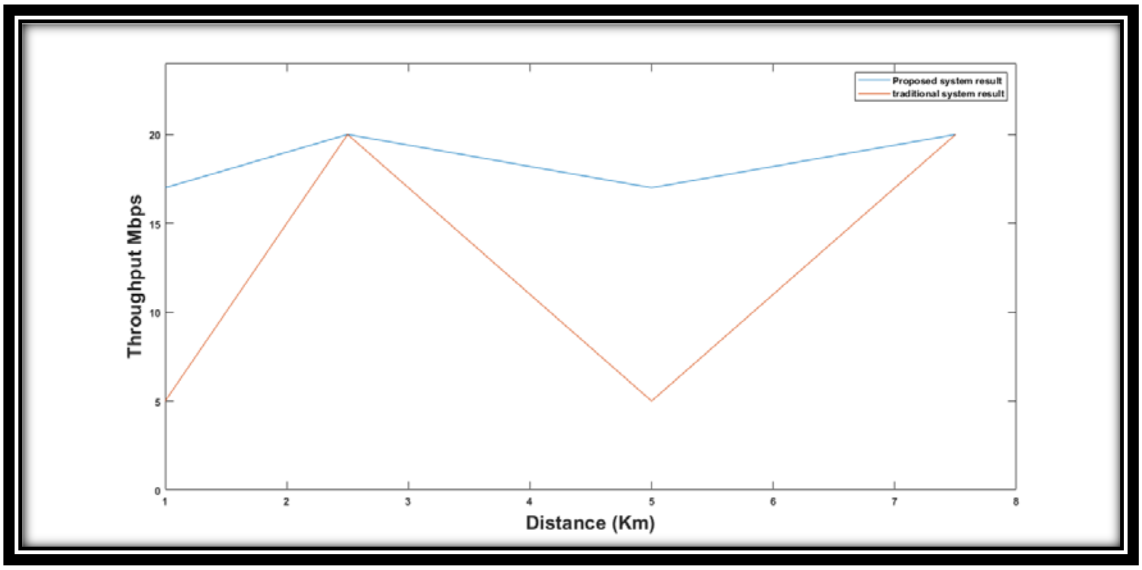

Figure 4.9 Throughput Versus Distance

4.5 Comparison with some related work

To evaluate proposed scheme, we need to discuss the cons and pros of some related works also show the features of this proposal compared to these works as in table 4.1

Table 4.1 Comparison with some related work

	Basic idea	Pros and cons	Results
[44] 2010	Estimation the target BS using mobility pattern.	No. of candidate TBS may reach one but, there may be an increase in the delay as a result of the increased computational load caused by a large memory.	$T_{delay} = T_{scan} + T_{CDT}$
[46] 2016	Lowering the number of NBS that an MS must scan depending on overlapping area and direction.	No. of candidate TBS depends on the number of cells with greatest overlap and within direction of user movement. This work don't take speed of users into account.	$T_{delay} = T_{scan}$ * (no. of TBS in the set) + T_{CDT}

[47] 2019	Eliminating hexa-directional uncertainty and predicts one TBS by dividing coverage area to triangles area each one correspond one BS.	No. of candidate TBS is one. This work don't take call dropping into account for high speed user.	$T = T_{scan} + T_{CDT}$
This work	Predicting TBS using GA and direction + reducing signaling using PAA	No. of candidate TBS ranges from three to one depending on speed of user. GA filters TBS in a way that ensures the success of the calls.	$T = T_{scan}$ * (TBS in the collection * rate $_{qualified\ BS}$) + 0.20 * T_{CDT}

CHAPTER 5

CONCLUSION AND FUTURE WORK

This thesis investigates the deployment of seamless handovers in mobile WiMAX networks and provides concluding remark. Also, it presents some future works.

5.1 Conclusion

This thesis showed that the prediction approach based on direction and GA algorithm contributed to decrease the number of TBS depending on speed of MS as well as optimize in selection process of TBS. Also, reducing the number of TBS will contribute to reduce time of ranging, synchronizing and optional association process accompanying the scan operation. Since the data transmission stops during the scanning time, throughput will decrease. we conclude from the foregoing that using prediction approach not only reduces the scanning time, but also contributes to improving throughput.

This thesis also introduced the PAA algorithm, which contributed to reducing the time of signaling (exchanging of messages) during re-entry process by 20%. PAA algorithm enhances network performance by reducing signaling overhead consequently decrease the load in network.

Finally, we conclude that the use of both algorithm and the direction of motion gives better performance in terms of reducing overall HO delay and improving throughput.

5.2 Future work

1- Using the users' information added to BV as a parameter to aid predict the TBS.

2- Make a simulation to study and evaluate the impact of PAA and GA together on the QoS.

3- PAA algorithm can be used in heterogeneous network to facilitate the user's login process when moving from one network to another.

4- In GA, several parameters can be employed, such as the city traffic flow, RSS, data flow index etc. to expand the model in order to improve it further by choosing the best network for the user to move to.

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BIODATA OF STUDENT

The author was born on the twenty-first of March 1984, she completed school in the city of Kufa / Najaf / Iraq, she joined the Technical College of Engineering / Najaf in 2002 and obtained her bachelor's degree in communications technology engineering in 2006. She work now in the field of telecommunications. On 15/9/2019 she started studying master’s in Communications Engineering from the same college. Her main research interests are wired and wireless networks especially mobile networks.

List of Publications

1- Saheb, H. H., Hamza, B. J., AL-Baghdadi, A. F., Saad, W., & Abdulwahed, S. H. (2021). An Overview For WiMAX Networks Covering Some Handover Algorithms. *Turkish Journal of Computer and Mathematics Education (TURCOMAT),* 12(14), 1260-1268.

2- Saheb, H. H., Hamza, B. J., & Al-Baghdadi, A. F. (2021, August). A Pre-authorization Algorithm for WiMAX Network to Reduce Handover Signaling. *In Journal of Physics: Conference Series* (Vol. 1973, No. 1, p. 012072). IOP Publishing.

3- Saheb, H. H., Hamza, B. J., & AL-Baghdadi, A. F. (2021). New approach based on direction and genetic algorithm to predict target base station in mobile WiMAX. *Materials Today: Proceedings.*

Certificate of Participation

الخلاصة

يسمح معيارIEEE 802.16e MWiMAX لمحطات المشتركين (SS) بالتحرك وتحويلها الى محطات متنقلة (MS) . تتمثل إحدى أهم المشكلات في هذا المعيار في أنه على الرغم من أن تقنية التسليم توفر خدمات بيانات عالية الحجم سلسة بمقياس عالي ، الا انها تحدد آلية فقط دون تضمين طرق او خوارزميات دقيقة للتسليم يمكن اعتمادها. ومع ذلك فان بنية التسليم (HO) التي تتعلق بانتقال المحطات المتنقلة ضمن نطاق الشبكة (التسليم الافقي) هي امرا رئيسا ل WiMAX لتحقيق التنقل. يعد تقليل تأخير التسليم أمرًا بالغ الاهمية لتحسين جودة الشبكة . تقترح هذه الاطروحة طريقة لتقليل تأخير التسليم بمرحلتين . الاولى تقليل وقت المسح من خلال التنبؤ بالمحطة الهدف TBS من خلال نهج يعتمد على الاتجاه والخوارزمية الجينية GA . حيث تقوم المحطة الخادمة باستبعاد المحطات المجاورة التي ليست ضمن اتجاه حركة المستخدم . تقوم الخوارزمية الجينية بتحسين اختيار المحطة الهدف وفقا لسرعة المستخدم بطريقة تضمن التوازن بين تقليص الوقت واسقاط المكالمات . الثانية تقليل إشارات التسليم أثناء عملية إعادة الدخول تقترح الأطروحة خوارزمية التفويض المسبق (PAA) التي تسهل إعادة دخول MS عندما تنتقل إلى TBS من خلال تزويدها بالمعلومات التي تحتاجها في هذه العملية مسبقًا. تم استخدام برنامج MATLAB 2018b لعرض النتائج. تشير النتائج إلى انخفاض في عدد TBSs حيث يصل إلى TBS واحد للمستخدمين ذوي السرعات العالية وثلاثة TBS كحد أقصى للمستخدمين الاخرين ، كما أظهرت أيضًا تقليصا في اشارات التسليم بنسبة تصل إلى 20٪ وبالتالي إنتاجية أعلى أثناء التسليم مقارنة بالطريقة التقليدية.

نشـر تسـليم سلس في شبكات البينية التشغيليـة العالميـة للولوج بالموجـات الدقيقـة

الاطروحـــة

مقدمـة الى قسم هندسـة تقنيـات الاتصـالات كجزء من متطلبـات نيل درجة

المـاجستير

تقدمت بها

هـدى حسن صـاحب

اشـراف

الاستاذ المساعد الدكتـور بشـار جبـار حمـزة

2021

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وزارة التعليم العالي والبحث العلمي

جامعة الفرات الاوسط التقنية

الكلية التقنية الهندسية- نجف

نشر تسليم سلس في شبكات البينية التشغيلية العالمية للولوج بالموجات الدقيقة WiMAX

هدى حسن صاحب

بكالوريوس في هندسة تقنيات الاتصالات

2021