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DESIGN AND PERFORMANCE ANALYZING OF WIMAX NETWORK IEEE 802.16 BASED ON OPNET MODELER

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Master's Thesis

Supervisor

Asst. Prof. Dr. Mesut ÇEVİK

Istanbul, 2022

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The thesis titled DESIGN AND PERFORMANCE ANALYZING OF WIMAX NETWORK IEEE 802.16 BASED ON OPNET MODELER prepared by AHMED ABDULSALAM ABDULRAZZAQ and submitted on 22/12/2022 has been **accepted unanimously** for the degree of Master of Science in Electrical and Computer Engineering.

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Ahmed Abdulsalam ABDULRAZZAQ

Signature

DEDICATION

According to dedicate partition, the journey will not accomplish without my parents, my brothers, my sisters, my advisor and who gave me his/her time and support to achieve this work.

PREFACE

According to the preface, this work submitted as a gift to my main advisor Asst. Prof. Dr. Mesut ÇEVİK for his time and advice.

ABSTRACT

DESIGN AND PERFORMANCE ANALYZING OF WIMAX NETWORK IEEE 802.16 BASED ON OPNET MODELER

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Because of the greatest coordination region, the unimportant expense of sending furthermore, and quick data rates, the WiMAX is a promising improvement for giving remote latest miles affiliation. Video Conferencing is one of the quickly making advances and ought to supplant the standard circuit exchanged video associations. Video Conferencing is in addition considered to be the first for these executioner apps of WiMAX that require a watchful plan for quality-of-service game plans. The important issue in this work for studying and examining this introduction of Video Conferencing in smaller WiMAX affiliations. The work had finished through the overview and assessment of several perspectives related to the WiMAX affiliation and Video Conferencing plans, for example, WiMAX association classes, adaptability, and the number of focuses. As far as possible coordinate throughput, and delay. The entertainment of various WiMAX network conditions utilizing OPNET Modeler.

According to the results, the video conferencing has been calculated for traffic sent regarding the raising time was initialized at 109 seconds when the settled time reached at 13990000 bytes rate, while the traffic received raising at 110 seconds and the time of settled around 290000 bytes rate and the overall WiMAX delay is arranged for 0.31 raising delay for the first 100 seconds while the settled time that arrived to 1.25 for the overall 300 times as the end of the simulation.

Keywords: WiMAX Networks, Quality of Service, Wireless Fidelity, Video Conferencing, OPNET Modeler.

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ABBREVIATIONS

WIMAX	:	Worldwide Interoperability for Microwave Access
SS	:	Subscriber Station
EN	:	Entire Network
Wi-Fi	:	Wireless Fidelity
VoIP	:	Voice over Internet Protocol
QoS	:	Quality of Service
ES	:	Ethernet Server
BAN	:	Backbone Area Network
OPNET	:	Optimized Network Engineering Tool
MAN	:	Metropolitan Area Network
LoS	:	Line of Sight
N-LoS	:	Non-Line-of Sight
IP	:	Internet Protocol
OFDMA	:	Orthogonal Frequency Division Multiplexing Access
IEEE	:	Institute of Electrical and Electronics Engineers
WLAN	:	Wireless Local Area Network
RF	:	Radio Frequency

PUSC	:	Partially Used Sub Channelization
DL	:	Down-Links
UL	:	Up-Links
HARR	:	Hybrid Automatic Repeat Request
TDMA	:	Time Division Multiple Access
CDMA	:	Code-Division Multiple Access
UFDM	:	Universal Factory Data Model
IFFT	:	Inverse Fast Fourier Transform
KP	:	Kinetic Potential
MAC	:	Media Access Control
DOCSIS	:	Data Over Cable Service Interface Specification
GHz	:	Giga Hertz
MHz	:	Mega Hertz
CSN	:	Customer Service Number
ASN	:	Access Server Network
CP	:	Cerebral Palsy

1. INTRODUCTION

The interest for giving advantageous clients broadband remote access has drawn in huge undertaking from the transmission correspondences industry in the turn of events and plan of versatile WiMAX networks. Video Conferencing shall be the first among applications to this fast arrangement for helpful WiMAX affiliations. The authentic of packaging video with information shall broaden this piece for video traffics on this application. In this manner, Video Conferencing, as the persistent improvement for using sound judgment through pack switch affiliations, will be an essential application in smaller WiMAX networks as in Figure 1.1 [1].

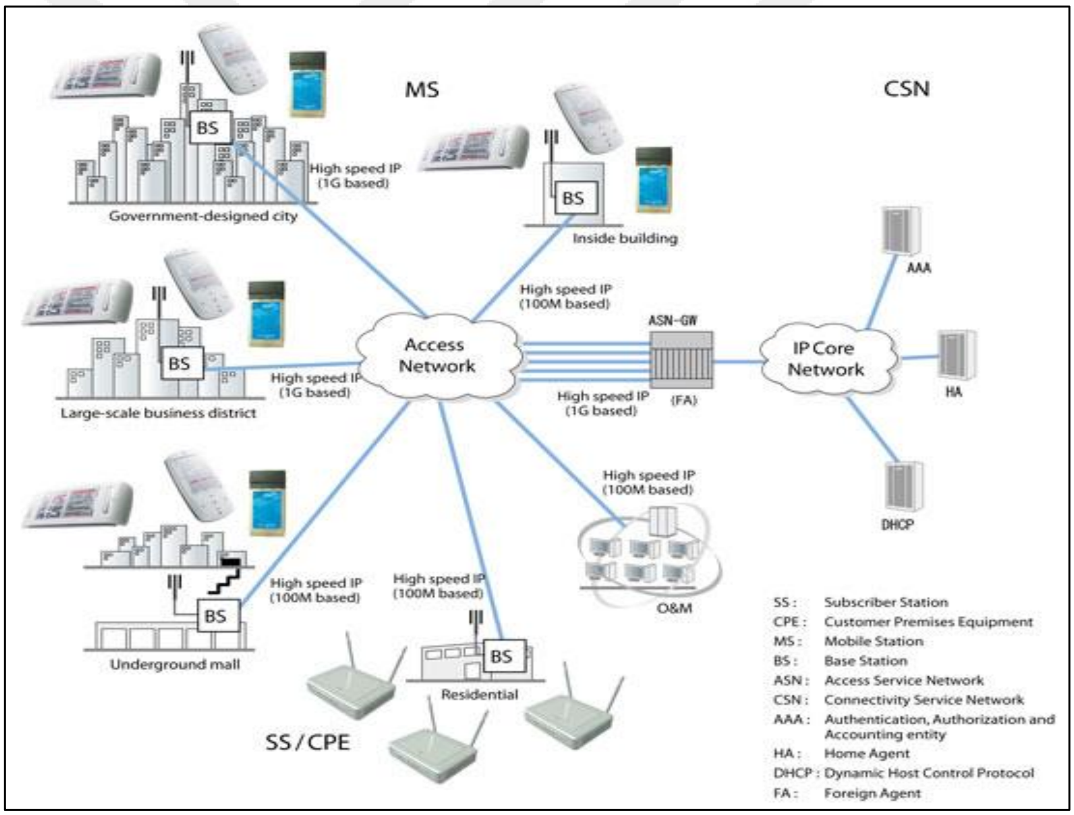

Figure 1.1: WiMAX with Access Network Categorize Example [1].

The expansion of Video Conferencing applications, for example, Skype, Google Talk, WhatsApp thus different others close by arising relationship of flexible WiMAX networks is making Video Conferencing over WiMAX a beguiling business region and a principal drive for the two transporters and gear providers in getting and pushing the going with flood of media correspondences improvement, yet challenges remain. In any case, the improvement for the equipment and application sides essentially emits an impression of being deficient. The choice of veritable affiliation climate is likewise vital to convey the voice correspondence and sight and sound get-together over the Internet. Improvement of the Video Conferencing bring limit on overall WiMAX networks is the first major test with stays an open examination issue. Thusly, on the speculation, the providing to a showcase evaluation for Video Conferencing on flexible WiMAX network. Because of the monster consolidation region, unimportant expense of sending and fast information rates, the WiMAX is a promise improvement to giving remote latest miles association. Video Conferencing is one of the quickly making advances and ought to supplant the standard circuit exchanged video associations. Video Conferencing is in addition considered to be first executioner app to WiMAX that requires an overall plan for quality-of-service game plans. The main goal of this study is to examine this service of Video Conferencing in smaller WiMAX networks. According to the overview and assessment for many perspectives from the literature with WiMAX network with Video Conferencing plans, for example, WiMAX association classes, adaptability, number of focuses. As far as possible coordinate throughput, and delay. The outcomes were defeating the game plan and entertainment of various WiMAX network conditions utilizing OPNET Modeler as described in Figure 1.2 [2].

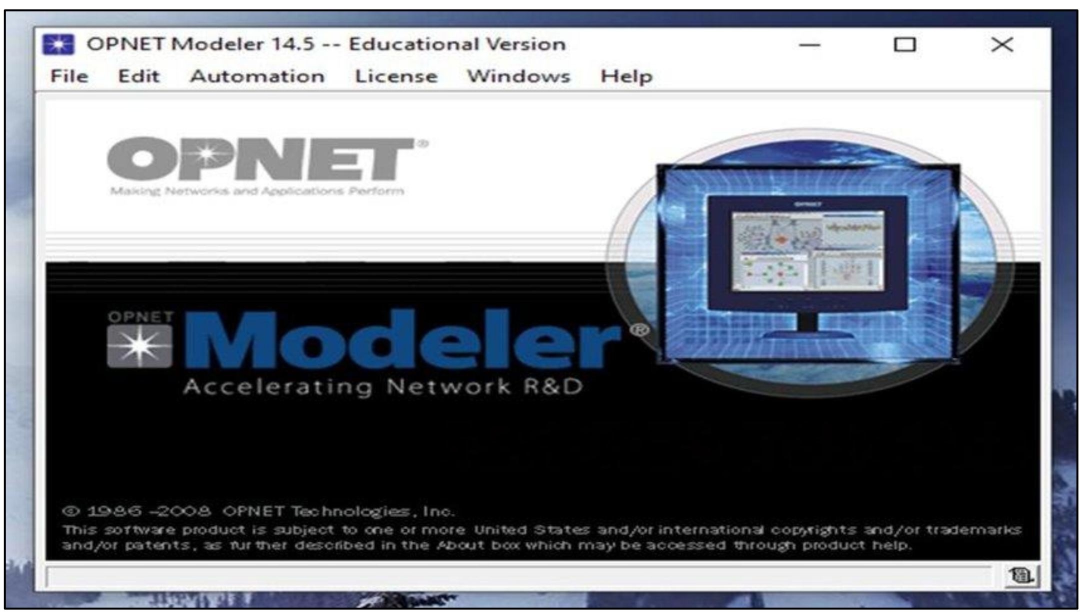

Figure 1.2: OPNET Modeler Program Version 14.5 [2].

Worldwide Inter-operability for Microwave Access, also known as WiMAX, is a set of rules for IEEE-802.16 that provides two different types of broad-banding accesses while still allowing for flexible access in the context of broadcast communications. In addition to the unlicensed 2-GHz and 11-GHz channels of action in Line-of-Sight (LOS) and Non-Line-of-Sight (NLOS) of every group, WiMAX operating in twice the bandwidth reached within 10-GHz and 66-GHz. Initially, Wireless interoperability for microwave access was allocated via a response for last kilometers broadband access, bypassing crucial system evaluations overseeing connections and digital subscriber line approaches. Moving forward, Mobile WiMAX passes the four-generation requirements for information adaptable associations testing required of supporters where higher bit per rate IP networking was achieved of proposed Quality of Service (QoS) [3].

The Wireless interoperability for microwave access is defined as the explanations of broad banding distance that support association for each broadband's association, flexible, fixing, on the common radios accessing wide-ranging broadband development, and designing for versatile associations. Orthogonal Frequency Division Multiplexing Access (OFDMA) of updated indicates for multiple-way situations, where scalability orthogonally frequencies division multiplex it is known as IEEE 802.16e Modification with sponsorship adaptable repetition bandwidths start via 1.25 up to 200-MHz [4].

1.1 MOTIVATION

Utilizing WiMAX throughout the network might lower throughput and error overall. Additionally, base stations were suggested to add to and improve the network's efficiency when linked through 1000BaseT cable with end users. As a result, we saw a significant increase in interest in the mobile WiMAX network during the transmission medium. These days, WiMAX equipment needs the right management, such as video conferencing, voice over internet protocol, file transfer protocol, and other management might demand greater transmission capabilities, such as Wi-Fi. Due to the facilities of the usage with a high emphasis on expenses, there may be more attention when considering the cost. The concept may be used with mobile WiMAX networks across long distances [5].

1.2 PROBLEM DEFINITIONS

The problem of this thesis is regarding the performance of mobile WiMAX networks. The main issue of this research as follows:

i. To resolve the high coverage area in mobile WiMAX with decrease the overall delay during transmission process.

ii. To resolve the mechanisms of QoS in WiMAX which allocated for applications services like voice, video…etc.

iii. To resolve a low VoIP technology and implement its features while use a low frequency.

iv. To resolve the usage strategy for the mobile WiMAX network to avoid the problems regard QoS metrics and VoIP performance.

1.3 CONTRIBUTION OF THESIS

The purpose of this thesis is to investigate and analyze the performance of VoIP in WiMAX mobile networks. The main goals are as follows:

i. Proposed of the Mobile WiMAX (IEEE802.16e) standard, focusing on MAC layers and QoS features.

ii. Brief study of the WiMAX quality coefficients based on high coverage area 1000 *1000 km.

iii. Improvement of VoIP technology and key features.

iv. Measured the QoS metrics and determine the best way to design a mobile WiMAX network model for VoIP performance analysis.

v. We study and analyze VoIP performance by simulating WiMAX network models using different scenarios related to QoS type of service, mobility, number of users and audio codecs.

1.4 WIMAX NETWORK OVERVIEW

The Institute of Electrical and Electronics Engineers (IEEE) 802.16-2004 radio interface standard is the foundation of WiMAX technology. It became a leading technology for fixed broadband wireless communications quite fast. The CETECOM Laboratory established the first accredited laboratory. In Malaga, Spain, there are now around 150 WiMAX experiments running. America, Europe, Asia, and Africa. The IEEE 802.16-2004 radio interface standard-based stable WiMAX has replaced cable and Digital Subscriber Line (DSL) services as a cost-effective fixed wireless option. The IEEE adopted the 802.16e upgrade to the 802.16 standard in December 2005. The addition of these characteristics and functions to the Standard is necessary to enable the motion. The organization currently specifies WiMAX and IEEE-based certifications for computer performance profiles. Amendment to 802.16 relating to the WiMAX forum and the Mobile Over the Air interface Establishing the network infrastructure necessary for mobile apps Two-chain WiMAX the first iteration of the system profiles will be finished in early 2006 by a number of individuals from various WiMAX Forum groups with extensive knowledge of wireless technology as mentioned in Figure 1.3 [6].

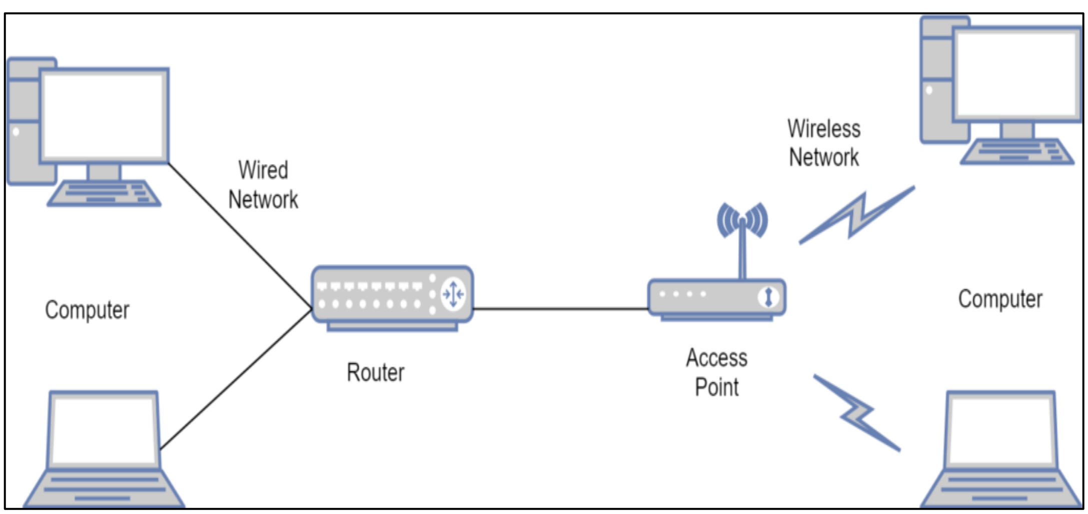

Figure 1.3: Wireless Networks Based on Access Points [6].

A wireless broadband option called mobile WiMAX makes it easier to integrate mobile and portable devices. Public broadband radio utilizing fixed bandwidth flexible network architecture and technologies the following is used by the WiMAX Air mobile interface: Orthogonal Frequency Division Multiplexing Access (OFDMA). Scalable OFDMA is known via SOFDMA to provide performance in the unseen media. Scalable channel bandwidth utilization was supported by the IEEE 802.16 amendment, according to Mobile Technology Group (MTG). Other elements of the IEEE standard must be implemented to build a Mobile WiMAX compliant wireless interface that has been authorized by the WiMAX connection. WiMAX Forum from 1.25 to 20 MHz while improving the obligatory and thorough requirements of the WiMAX mobile system [7].

The arrangement for the mobile settings according to common important operations using mobile WiMAX System profiles. An interpolation of various components from the original station specification is supplied as an appendix. It is intended to cover the fundamental functionalities of end terminals and base stations. This offers greater deployment flexibility based on certain deployment situations with various structures that are optimized for capacity or coverage that may be needed. There are profiles for the 5, 7, 8.75, and 10 MHz channels in WiMAX Mobile Release-1 that described in the Figure 1.4 [8].

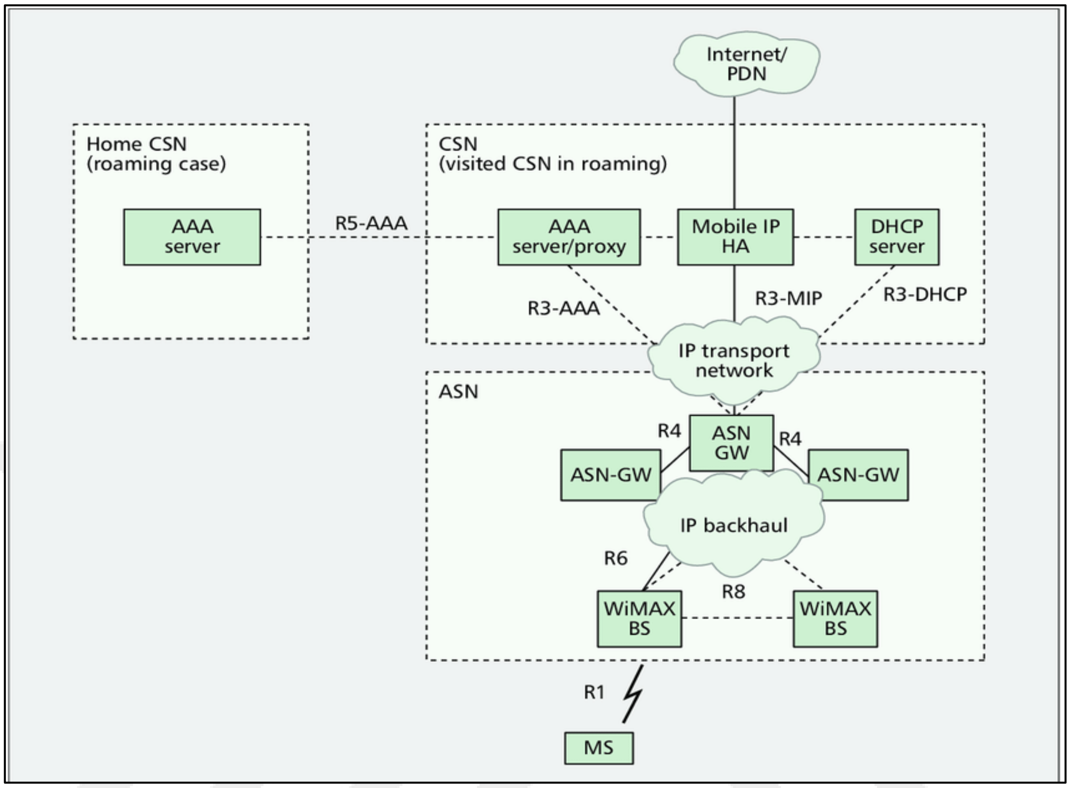

Figure 1.4: Architecture for Mobile WiMAX Network [8].

The Network Working Group is one of the WiMAX components (NWG). WiMAX cellular network parameters are more fully outlined in [9]. The IEEE 802.16 standard, which addresses radio interface standards, is this one. The joint efforts of the IEEE 802.16 and WiMAX groups are receiving more support. WiMAX mobile network system solutions. Scalability is a feature of mobile WiMAX systems for both networks and wireless technologies. More flexibility and network deployment possibilities are provided by this design as in Figure 1.5 [10].

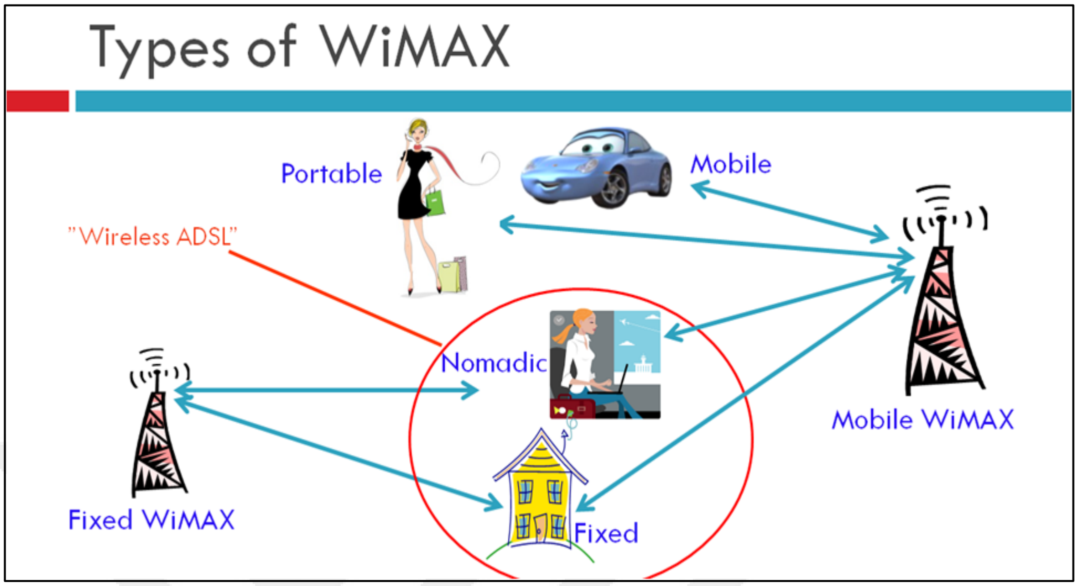

Figure 1.5: The Mobile WiMAX Network Types [10].

Low latency and an efficient transmission schedule are supported by WiMAX Mobile. For real-time applications like Voice over Internet Protocol (VoIP), more than 50 milliseconds are needed to avoid VoIP Degradation Utilize a flexible key management approach to ensure security. Keep on translating the market for WiMAX mobile devices is expanding, and equipment manufacturers are beginning to adopt it. aggressive machinery Participation in 802.16e-2005 and WiMAX mobile device trading; mobile WiMAX. explains WiMAX mobile technology in great depth. based on the anticipated WiMAX association's requirements and certification information Performance of mobile WiMAX in a mobile environment prediction analysis. Every reader seeking further details are directed to the whole bibliography with the work talks about one of WiMAX's characteristics as in the Figure 1.6 [11].

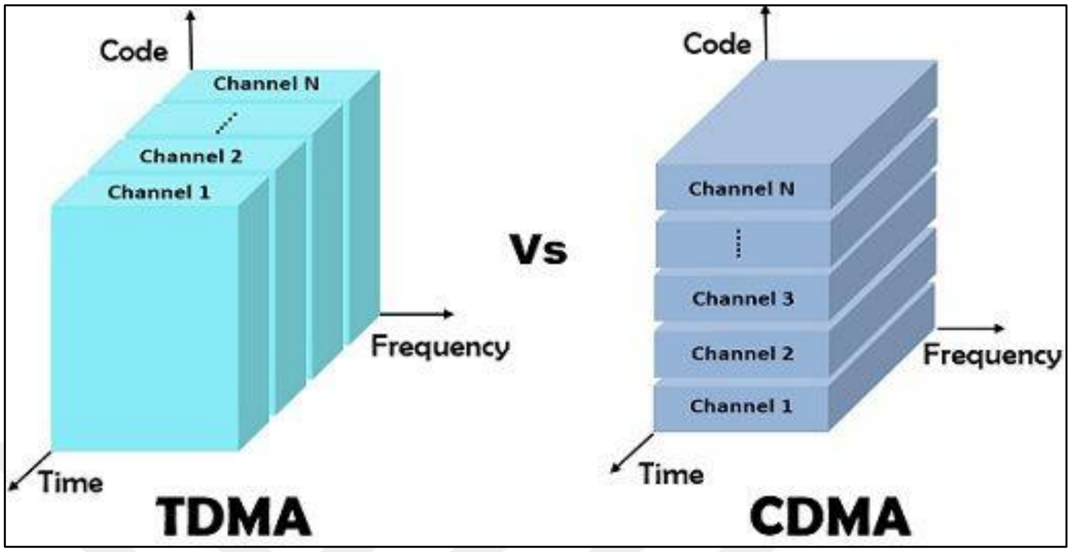

Figure 1.6: Types of Multiple Access [11].

1.5 WIMAX NETWORK ADVANTAGES

The MWN model has several benefits, and these benefits are explained with numerous applications that are connected to the characteristics and associated elements of such systems. to benefit from greater peak rates and enhanced throughput. Multiple streams are delivered through various antennas using spatial multiplexing.

i. The WiMAX station can simultaneously serve and cover hundreds of users while transmitting and receiving data at very fast rates and with full network security.

ii. Highest Speeds: In densely populated regions, high-speed connections and high-speed voice are necessary.

iii. Multipurpose: WiMAX technology can carry out several jobs concurrently, including voice and data transfer, high-speed Internet access, and telephone services.

iv. Infrastructures: WiMAX infrastructure is relatively straightforward and adaptable, delivering the highest level of network dependability and end-user accessibility.

v. WiMAX, based on the IEEE 802.16-2004 Air Interface Standard, offers a low-cost alternative network to Internet services supplied by Asymmetric Digital Subscriber Line (ADSL), modem, or Local Area Network (LAN) as in the Figure 1.7 [12].

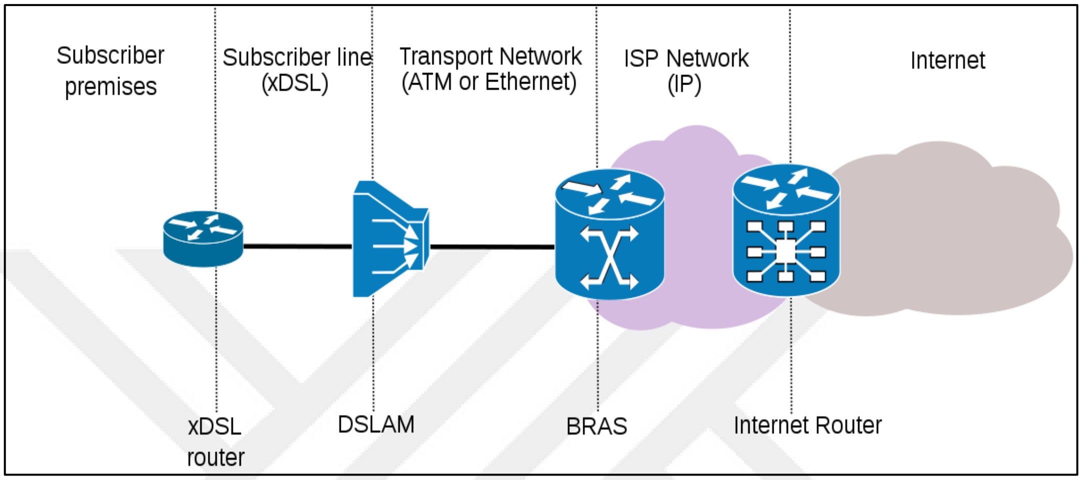

Figure 1.7: Broadband Remote Access Server [12].

1.6 MAC SCHEDULING FOR WIMAX NETWORK

The delivery method for MAC WiMAX Mobile programming service is efficient. Time-varying voice, data, and video services are all included in broadband data services. The MAC Scheduling Service works with the following broadband data transmission services to perform the following tasks:

Fastest data planning Data should be effectively distributed through MAC scheduling. resources that react to channel circumstances and time-varying data flow. Each base station has a scheduler that it uses to swiftly react to traffic packet data phrases that differ by service. The way packets are transmitted over the air interface is carefully defined by a flow scheduler with fully defined QoS criteria at the MAC level. Channel planning is made possible by the Channel Quality Indicator Channel (CQICH), which offers quick feedback on channel information. For each activity, pick the appropriate modulation and encoding. The modulation/coding technique guarantees steady transmission in time-varying channels, making it compatible with Hybrid Automatic Repeat Request (HARQ). Setting up download and upload times: There are scheduling services available for both Up-Link (UL) and Down-Link (DL) traffic. To effectively distribute resources and provide the necessary QoS in the UL, the MAC scheduler must deliver correct input to the UL. information in real-time on traffic conditions and QoS specifications. many uplinks bandwidth requests, including those for little bandwidth the upload bandwidth needs are met through channels, returns, and reconfigurations as in the Figure 1.8 [13].

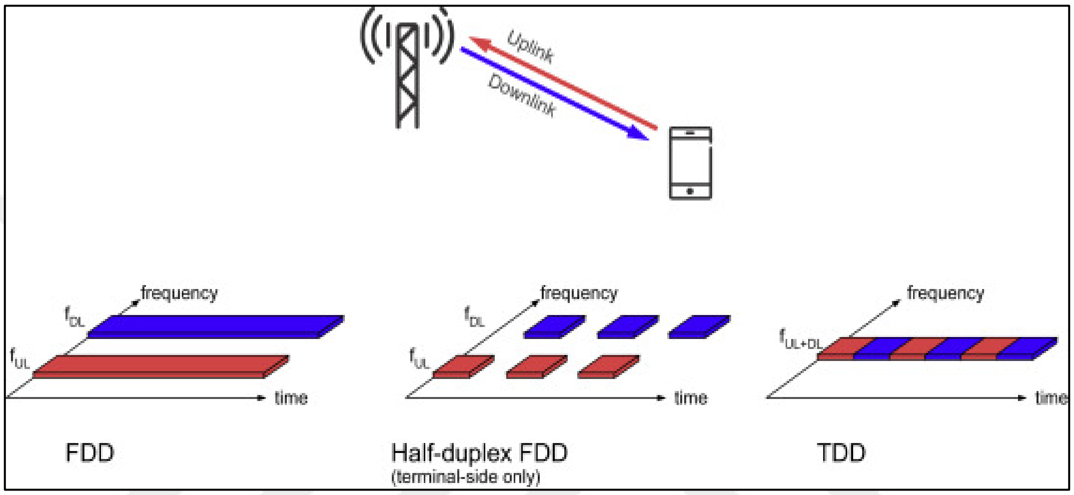

Figure 1.8: DL and UL Connection Example [13].

Resource allocation with periodicity is supported by MAC. allocation both in DL and UL by frame. Resource allocation entails: It is transmitted at the start of each frame as a MAP message. In response to traffic and channels, allocations can be modified frame by frame. Additionally, depending on the condition, the number of resources in each distribution may vary: For the whole frame, use one cell. This makes it possible for you to distribute resources thoroughly and promptly.

Data flow with high QoS. Data traffic on each channel is controlled by QoS, which is dependent on MAC scheduling. Each connection set has a set of data service QoS parameters attached to it that track different facets of its activity. The scheduler may provide High QoS for DL and UL traffic by having the option of dynamically allocating resources to DL and UL. Uplink plans benefit from more effective upstream resource allocation, predictable performance, and support for higher QoS as present in Figure 1.9 [14].

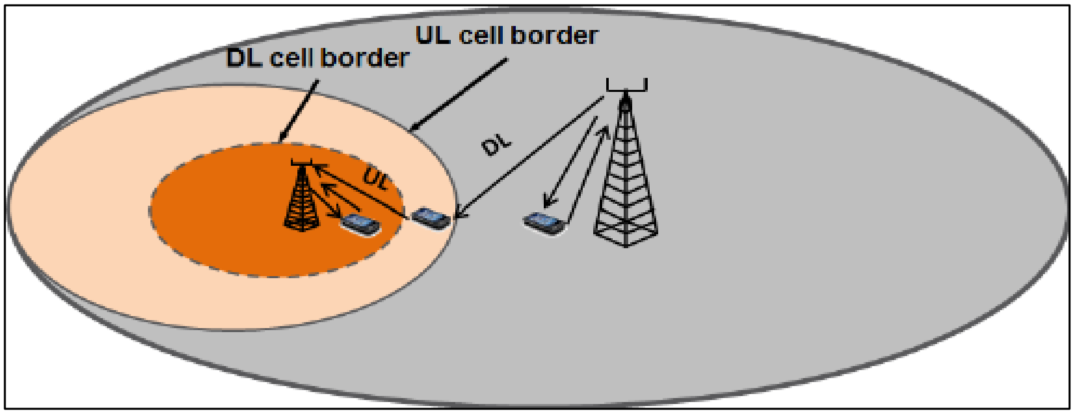

Figure 1.9: DL and UL Connection Example on Border [14].

Selective frequency programming with many operating modes for the programmer. Subchannel Switching with the subcarriers of the subchannels in subchannels with various frequencies, such as Partially Used Sub Channelization (PUSC), is distributed pseudo-randomly. Internal channel quality, bandwidth, and the frequency diversity plan: Support for QoS provided via careful and adaptable time-frequency resource allocation. AMC switching, for example, is a curious conundrum for adjacent switching subchannels. The extra frequency table may be broken down into the following categories:

Orient mobile users toward internal channels with more strength. In the university library, chosen frequency CQI scheduling can boost system performance while adding more overhead. A block of contiguous sub-carriers is grouped together to form a subchannel using the contiguous permutation. The DL AMC and UL AMC are two contiguous variations that share the same structure. A bin is made up of 9 adjacent sub-carriers in a symbol, 8 of which are designated for data and 1 for a pilot. Contiguous sub-carrier permutations are better suited for fixed, portable, or limited mobility situations while diverse sub-carrier permutations perform well in mobile applications as in the Figure 1.10 [15].

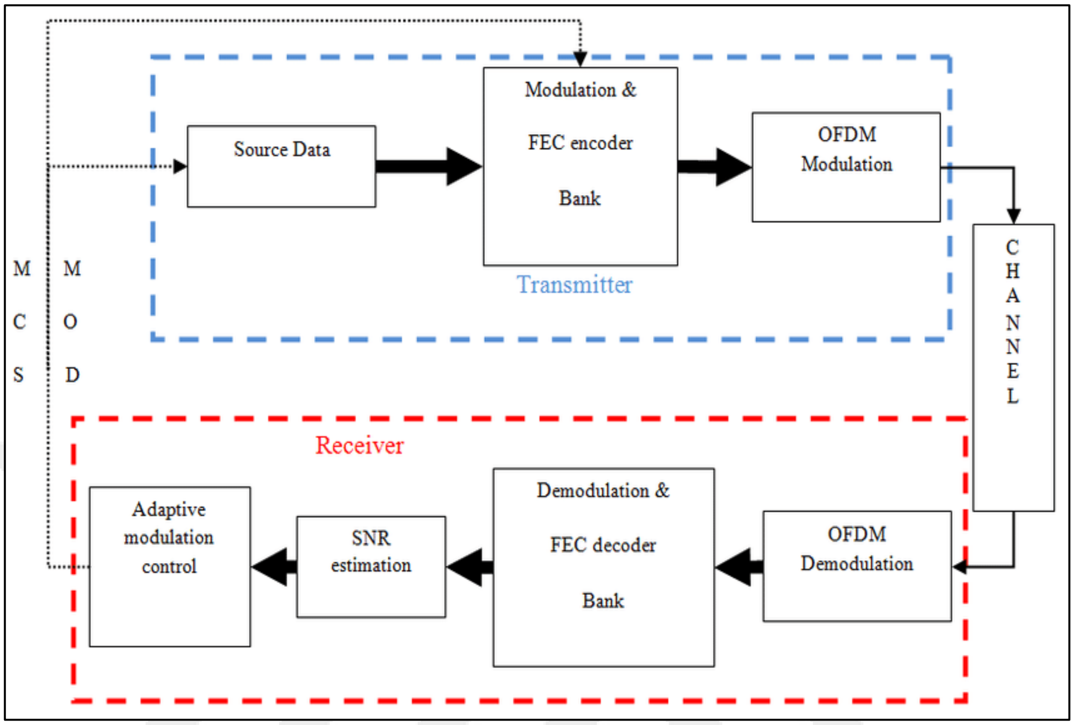

Figure 1.10: OFDM based on Modulation Process [15].

1.7 WIMAX NETWORK APPLICATIONS

The WiMAX networks, service providers may create fresh ideas for broadband services. WiMAX applications are more efficient than they are right now. This base improves the mobility of a wide range of consumers by offering services. WiMAX applications can be used by service providers to deliver data, video, phone, mobile, and Internet connection. WiMAX technology supports VoIP calls, mobile devices, video production, and high-speed data transfer in addition to providing straightforward cost savings and service efficiency [16].

Modern mobile society is enhanced by WiMAX technology. Besides, consumer communications, and backhaul are the main applications covered by WiMAX technology. Utilizing the capabilities of video, data, and voice transmission, WiMAX technology enhances communication and allows you to react to crises fast. Customers can employ WiMAX technology's transitory communication services to support events and conditions and speed up networks. The media, guests, and staff have access to WiMAX technology programs on a temporary basis. The company's event-related equipment is in the tower and is conveniently accessible. High bandwidth, high-quality service, security, ease of deployment, and low cost, including full duplex over DSL and cables, are the key advantages of WiMAX technology applications [17].

1.8 ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING OVERVIEW

A multiplexing technique is called OFDM (Orthogonal Frequency Division Multiplexing). The bandwidth should be split up into numerous frequency bands. The input data stream is split up into several simultaneous sub-streams in OFDM. The separate orthogonal media are any modulated underflow, any reduced data rate (due to higher code length), and below. The power of enhanced extended recording time OFDM is gradually increasing. Additionally, if a CP is present, include a Cerebral Palsy (CP) for Inter-symbol Interference (ISI). More time has passed than the channel delay. The last case of the data section of the related data block is typically repeated by CP [18].

The load is overflowing, which is a drawback of the Kinetic Potential (KP), and thus reduces the ability to process CP-wide band; nevertheless, the effect CP is increased since rotation is one carrier that is filtered by a cassette, which increases the effect System. Since the spectrum of OFDM is so crisp, it occupies more space. For data transmission, the available reserved channel bandwidth for performance decline brought on by the cyclic prefixes in Figure 1.11 [19].

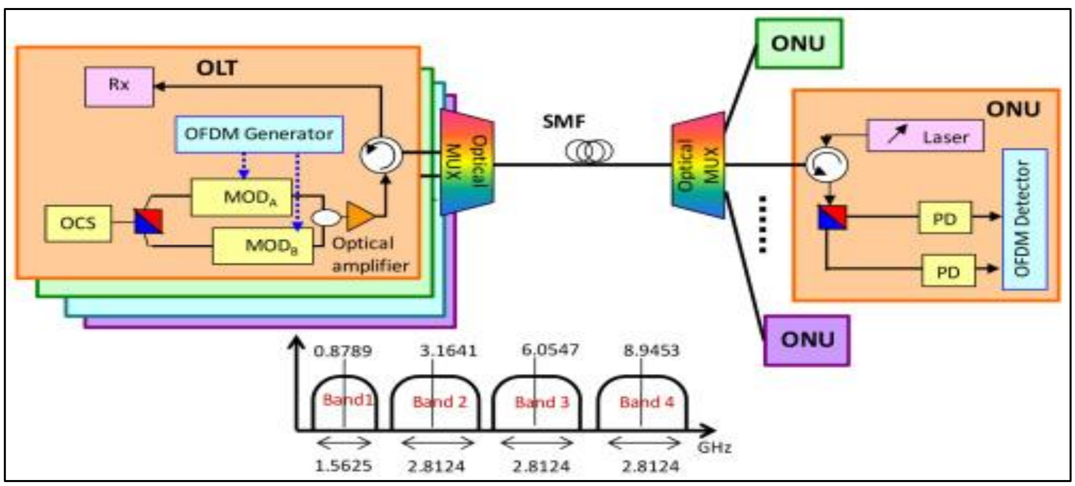

Figure 1.11: OFDM Architecture Components [19].

It makes use of OFDM coding and frequency diversity of multipath channels. before transmission, interprets information from internal media. An Inverse Fast Fourier Transform (IFFT) quick turn can start modulation. Low complexity enables a large underground population (by 2048). For OFDM systematic resources for the frequency range and the time domain through the internal media of the Universal Factory Data Model (UFDM). sources of frequency and time: This is categorized under users-only. opposite frequency for multiple access systems, some segments (OFDMA) have several channels. Serving several users in the downlink results in the activation of a data stream. With the use of additional channels and subchannels, multiple access is achieved [20].

1.9 THESIS ORGANIZATION

The WiMAX network and its claims were explained in this portion of the first chapter, which covers the entire organization about the linked concerns with the mobile WiMAX network model. WiMAX network modeling was provided for the mobile WiMAX equipment afterward, particularly at this stage. The benefits of using a WiMAX network and the OFDM structure were finally covered in the remaining paragraphs of this section.

Most of the scientists and authors that contributed to our literature study were included in the second chapter, where they were highlighted for their significant contributions and several highlights between each review. The written audit was marked as propositional for our subject, and numerous analysts added to it.

The third chapter emphasizes high coverage area and planning for our suggested system through experiments with the mobile WiMAX network connection applied with OPNET Modeler software. The primary components of the suggested system were also covered in this section. Additionally, this chapter demonstrates how multiple hypothetical perspectives might be created using various payment methods.

The proposed structure results from considering various base station insertion strategies and closure via various video conferencing services are described in the fourth chapter. Throughput and delay data could support the results as presented. Additionally, this chapter addressed the most recent links between our proposed system and earlier work put out by numerous researchers in order to achieve the foundation and efficacy of our suggested structures.

Discuss the flaws with the conclusion and your recommendations for further work in the fifth chapter.

2. LITERATURE SURVEY

In the investigation of WiMAX was covered by researchers [21]. In order to service the network, the base station is supplied with standard topologies. A combination of OFDM and heavy service performance is used. Additionally, the data rates had been evaluated for the model on 10 base stations with 100 base-T for data rates tested with a small coverage area because of the larger delay presented in the case of throughput. The model demonstrated efficacy over various distances, as indicated by the collected findings, for the lowest transmission up to 100 Mbps. As opposed to this, the WiMAX approach has proved to perform better overall when compared to other ways for data rate increases to 1000 Mbps, depending on the distance. In relation to the suggested model that was required, the bit rates achieved regarding the provided model, more improvement was required.

In [22], the authors suggested OPNET Modeler 14.5 software as an example of a WiMAX network model with the potential to support 1000 base-T concerning cabling use. The achieved data rate was 1000 Mbps, and the maximum transmission distance was 5 km. Common topologies are installed in the base station and are utilized to support the network. The mobile WiMAX network is integrated with the performance of light services. the reduced load that was demonstrated in the throughput instance. Additionally, the proposed efficacy was carried out using a WiMAX model based on three base stations, with throughput values of about 1500 Mbps provided and taken into consideration as the minimum threshold. Throughput and coverage area distance values need to be increased to improve this model.

In [23], authors suggested taking into account the WiMAX model, which uses the OPNET Modeler 14.5 software and has a potential for 1000 base-T with a new common base station insertion. The distances covered were 15 km, and the bit rate reached was 1000 Mbps. Common structures that might be used to reserve the entire network were installed in the base stations. For the model, the performance of heavy services is combined within the mobile WiMAX network. The situation of throughput presents the maximum load. Additionally, the WiMAX model-based recommended effectiveness was finished within 4 base stations, and the throughput results were approximately 2000 Mbps while being taken into consideration as the minimal threshold.

Researchers in [24] provided an illustration of a WiMAX model network with 1000 base-T capability and a shared backbone area network inserted using OPNET Modeler 14.5 software. The achieved bit rate was 2000 Mbps, while the coverage distance was 20 kilometers. The base stations were linked together within large buildings that were used to support the entire network. For the complete model, the fixed WiMAX network performance and QoS service performance are combined. In the circumstances of throughput, the highest load was displayed. Additionally, the WiMAX model-based recommended efficacy was completed within 5 base stations, with throughput results of about 3000 Mbps delivered while being taken into consideration as the minimum threshold. This model requires improvement.

The WiMAX model with four bridges was recommended by the authors in [25] as a consideration that has the potential for 1000 base-T with the addition of the backbone area network by OPNET Modeler 14.5 software. The coverage area was 25 km, and the data rate reached was 3000 Mbps. The head structures and base stations were integrated to reserve the complete network. For the finished model, the mobile WiMAX network performance and service quality are combined. The multi-cases for throughputs describe the increasing load. Furthermore, the proposed efficacy was carried out using 6 base stations in accordance with the WiMAX model, and the QoS results were around 4000 Mbps when presented as the threshold's minimal limits. This model needs to be improved more by raising the QoS and coverage area coefficients.

In [26], researchers suggested that the WiMAX network with five bridges be taken into consideration as having a 1 Gbps capacity with the BAN inserted using OPNET Modeler 14.5 version. The achieved bit rate was 4000 Mbps, while the coverage distance was 30 kilometers. The main buildings, which were used to reserve the entire network, were combined with the base stations. Within the mobile WiMAX network, the performance and quality of services are integrated for the primary model. The multi-cases for throughputs present the highest loader. Furthermore, the proposed efficacy was tested using 7 base stations in accordance with the

WiMAX model, and the QoS results showed that the minimum threshold requirement of 6000 Mbps was met. Through the issues addressed for service quality, this system has to be improved more.

The WiMAX network with 6 bridges was suggested by the authors in [27] as a consideration with a potential for 1.2 Gbps with the MAN network by OPNET Modeler 14.5 version. The coverage area was 35 km, and the data rate reached was 5000 Mbps. The primary buildings used to reserve the finished network integrated the key subscriber stations. With the mobile WiMAX network as the primary network, QoS performance is supported. The multi-cases for throughputs described the high stress on the model. Furthermore, the suggested method was developed using 8 WiMAX base stations and produced quality results at speeds close to 7000 Mbps, which was suggested as the threshold's minimum bounds. By increasing the QoS and coverage area coefficients, this model needed to be improved even further.

In [28] Researchers suggested the WiMAX model with seven bridges, which they claimed could support 1.4 Gbps with the MAN network using the OPNET Modeler 14.5 edition. The achieved bit rate was 6000 Mbps, and the coverage distance was 40 kilometers. The primary subscriber stations and the primary buildings used to reserve the finished network were combined. The mobile WiMAX networks' equipment for the primary networks' QoS performance. The multi-cases for throughputs presented the model's highest loader. Additionally, the suggested technique was tested with 9 base stations connected to the WiMAX network, and it produced good results at a speed of roughly 8000 Mbps when that speed was specified as the lowest acceptable threshold. Through the increased coefficients for QoS and coverage areas, this system model must improve.

3. METHODOLOGY

3.1 INTRODUCTION

This chapter will analyze in depth how the planned WiMAX network could lower overall error and performance across the entire network. Additionally, it was suggested that base stations would contribute to and improve network efficiency when linked by 1 Gbps cable with end users who used the more specialized OPNET Modeler software. The suggested model consists of two scenarios that depend on QoS. These scenarios are explained in detail, highlighting all the specified information. The OPNET Modeler utilized as the simulator for the studies may be explained in more detail, and this section might highlight the estimation of the parameters addressed for analyzing the model performance [29].

3.2 WIMAX DESIGN MODEL

For design, a WiMAX network has an Internet Protocol operator associated with 4 cells. All four of them have cellular communication of 15 km. A cell combines a base station and several mobile stations based on the development case. A typical network consists of a server backbone with 4 video servers per slot. Figure 3.1 conceptualizes a typical WiMAX congestion model. Table 3.1 shows the full range of active WiMAX network plans. The range of base station (PS) and mobile station (MS) shown the description from Figure 3.2, 3.3, 3.4, and 3.5. The range of WiMAX configuration nodes shows the design of the flexible model.

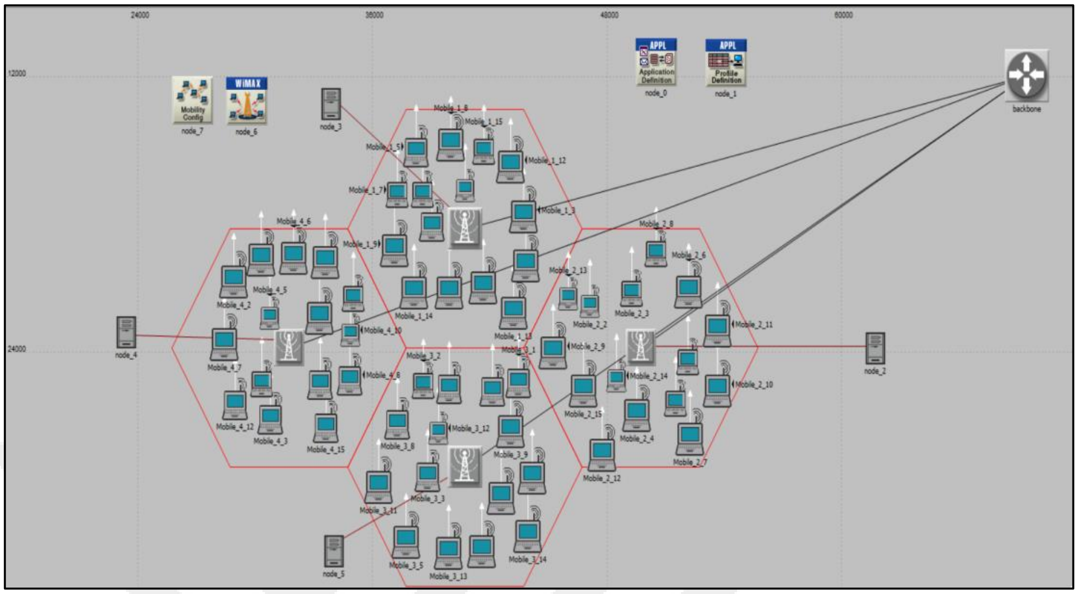

Figure 3.1: Overall WiMAX Model.

Table 3.1: Our simulation parameters.

Parameter	Value
Terrain Size	1000 x 1000 km
Number of cells	4
Cell Radius	15 km
Number of BSs	4
Number of MSs	45
Operating Frequency	5.8 GHz
System Bandwidth	20 MHz
PHY Scheme	OFDMA
Duplex scheme	TDD
Modulation Technique	Adaptive
Mobility Model	Random Way Point

Table 3.1: Our simulation parameters "tables continued".

Fading Model	Rayleigh Fading Model
Multipath Channel Model	ITU Vehicular A
BS transmit power	1 W
MS transmit power	0.5 W
QoS Service Class	UGS, rtPS & BE
Application Video Type	Video Conferencing
Simulation time	5 Minutes

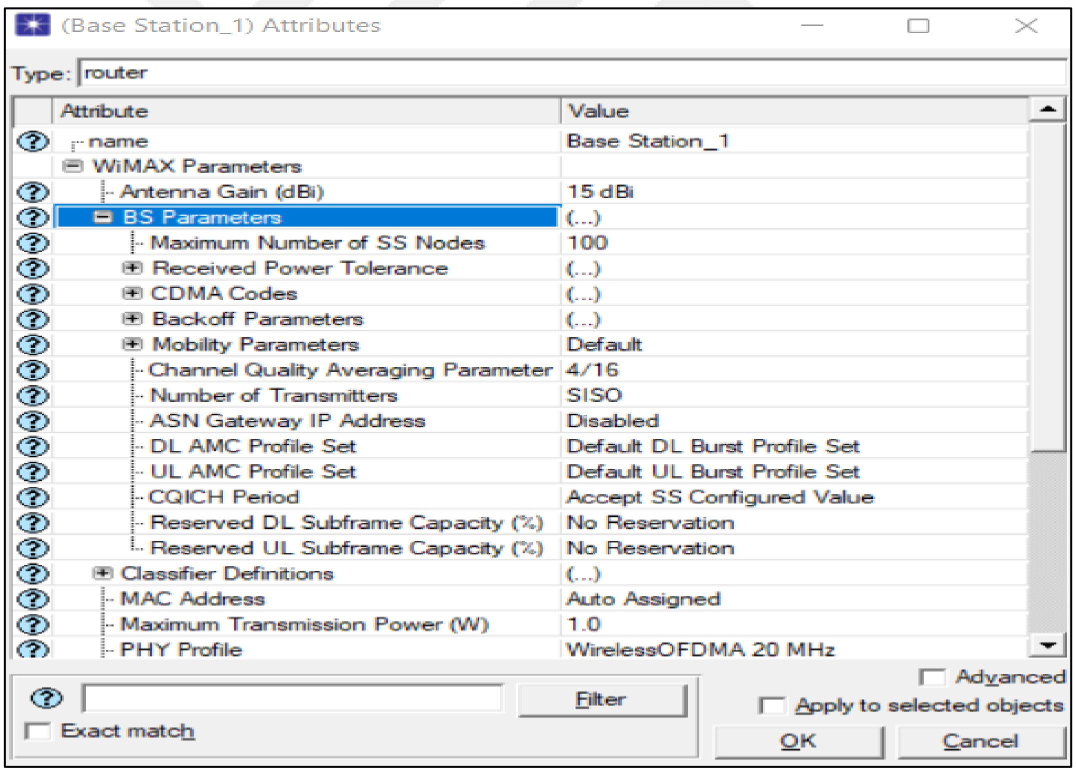

Figure 3.2: Base Station Configuration.

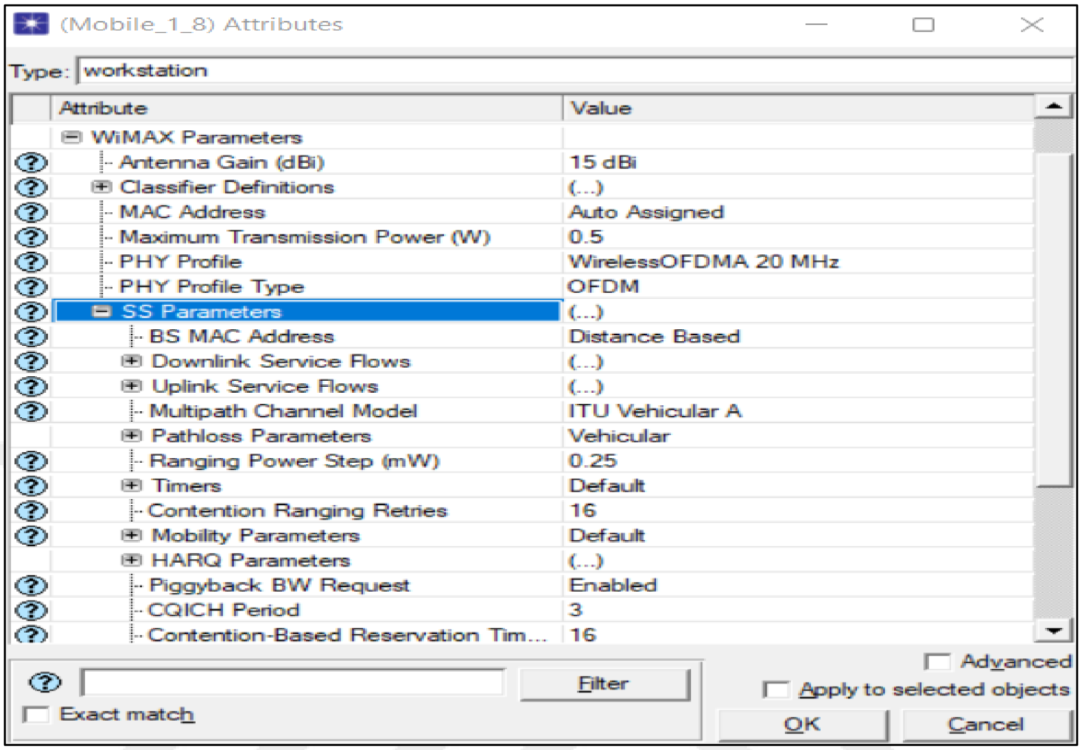

Figure 3.3: Mobile Station Configuration.

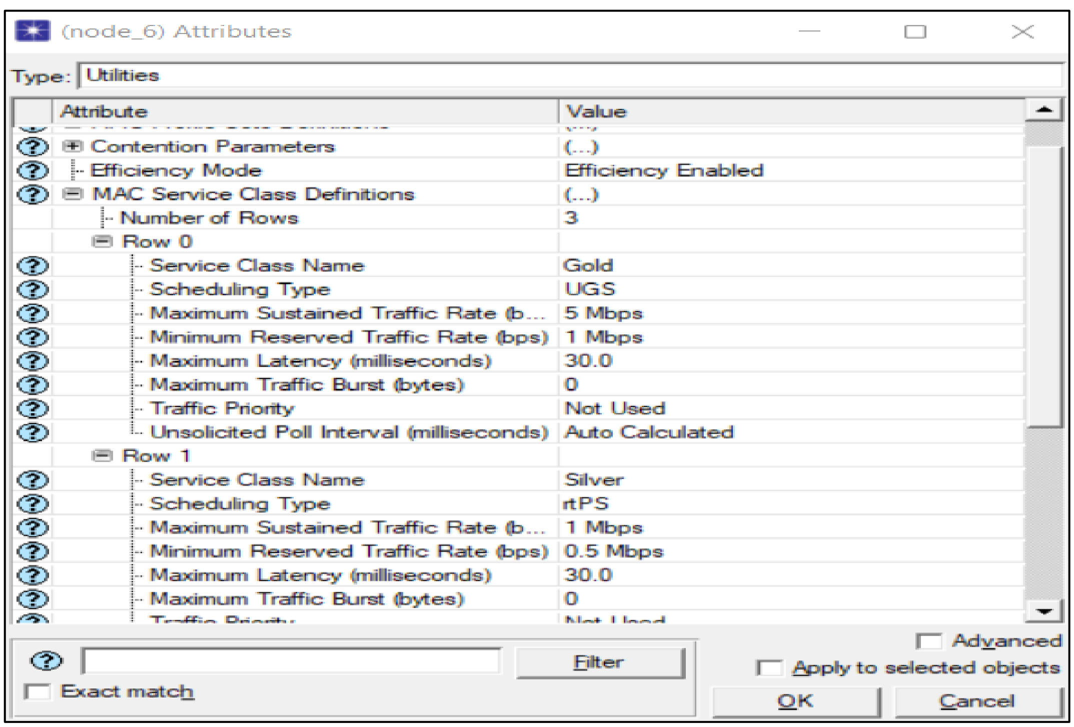

Figure 3.4: WiMAX Configuration.

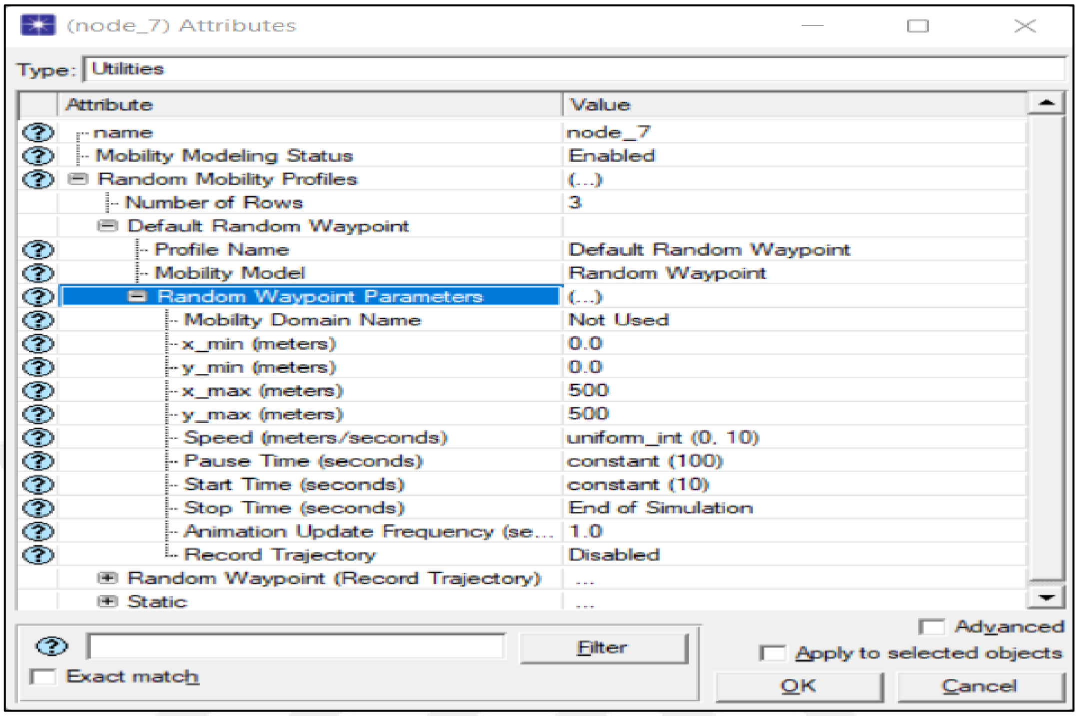

Figure 3.5: Mobility Configuration.

3.3 INTERNAL COMPONENTS OF MOBILE WIMAX NETWORK

Reduced WiMAX headway offers flexibility for the most important factors, Radio Frequency (RF) access information and affiliation plan, so to provide a significant reduction of flexibility goes with proper network design decisions and association matters. The following are the fundamental components that Mobile WiMAX kept in mind.

The presence of Multiple Input and Multiple Output (MIMO) radio wires indicates that day coding, flexible subchannel constructions, and modulators are close to being introduced. This development has helped Mobile WiMAX reach its peak maximum weight information periods of around 280 Mega Bites per second in a 10 MHz channel and the most significant downloading information periods of around 630 Mega Bites per second for all areas. The quality of service could be viewed as the main pillar supporting the media access control scheme for this IEEE802.16 as it enables services to run while providing planning for diffuser programming step stream step were empowered from start to finish IP Show as in the Figure 3.6 [30].

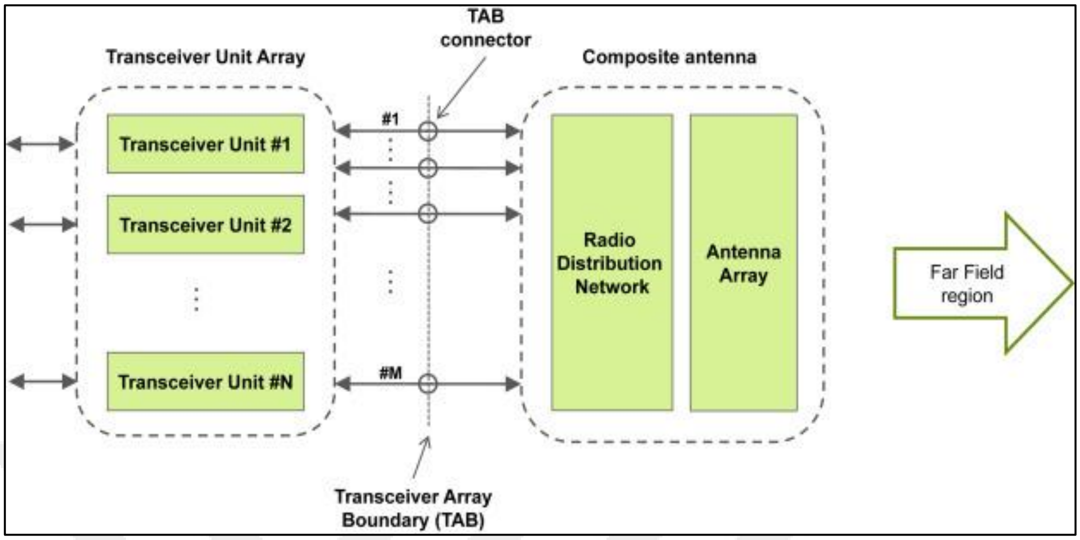

Figure 3.6: Transceiver with Antenna Components via Radio Distribution Network [30].

These resources for the overall reach of remote broadbands are now very rare with their parts even with a constantly globalized budget, so advancement of Versatile WiMAX is seen as prepared to act in different channelization in the range of 1.25 to 20 MHz to satisfy the various generally necessary requirements like forwarding efforts to arrive at range synchronization and allows coordinated economies for understanding the benefits that described in the Figure 3.7 [31].

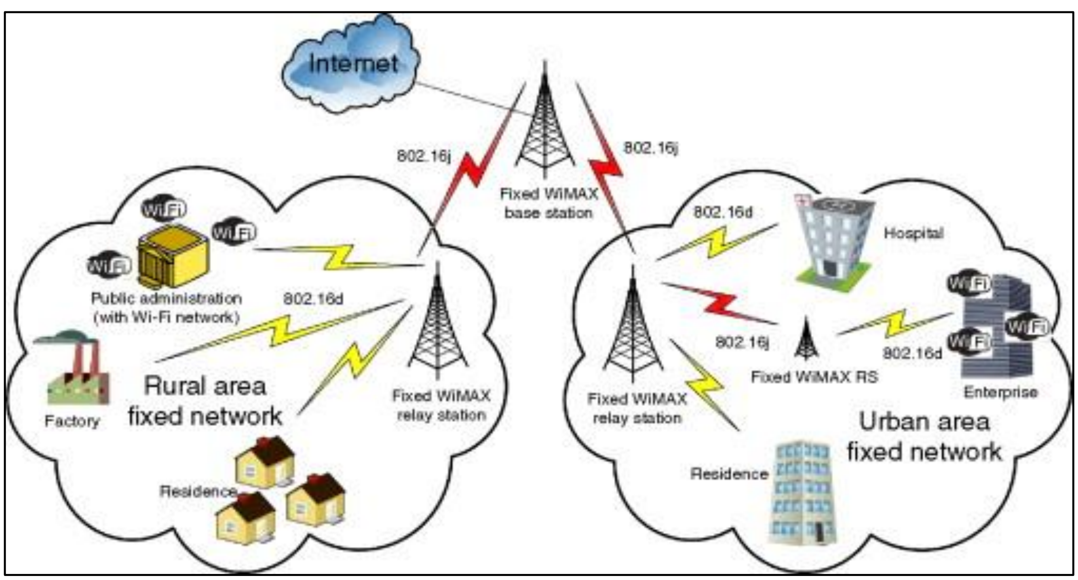

Figure 3.7: Services of WiMAX BS [31].

The Mobile WiMAX security components had been given the most unquestionable features in messages look at code, sponsorships updated task structures inside subtlety's not more than 500 msec, and so on. This was done to ensure that real-time introductions like Voice over IP execution would not suffer from association rot. Flexible key management procedures ensure that security is maintained during transfer. The WiMAX regulations' delayed effects will undeniably affect fixed-band mobile office settings. The rules for keeping an eye out for all applications of adaptability were revised. When necessary, Mobiles WiMAX sponsors steady progress for wandering as an alternative to set plans. WiMAX can take care of the moving parts by providing the greatest information rates, sponsoring fixed, mobile, and adaptable applications, combining mobile and fixed affiliations, and having flexible orchestration models in addition to being moderate with basic for transmitting. Additionally, the continuous support of components includes multipoint connection, IP-focused setup, and job simplification that helps everyone with voice over IP (VoIP) applications. Currently, a power-saving device that extends a battery lifespan off restricted devices is shown in Figure 3.8 [32].

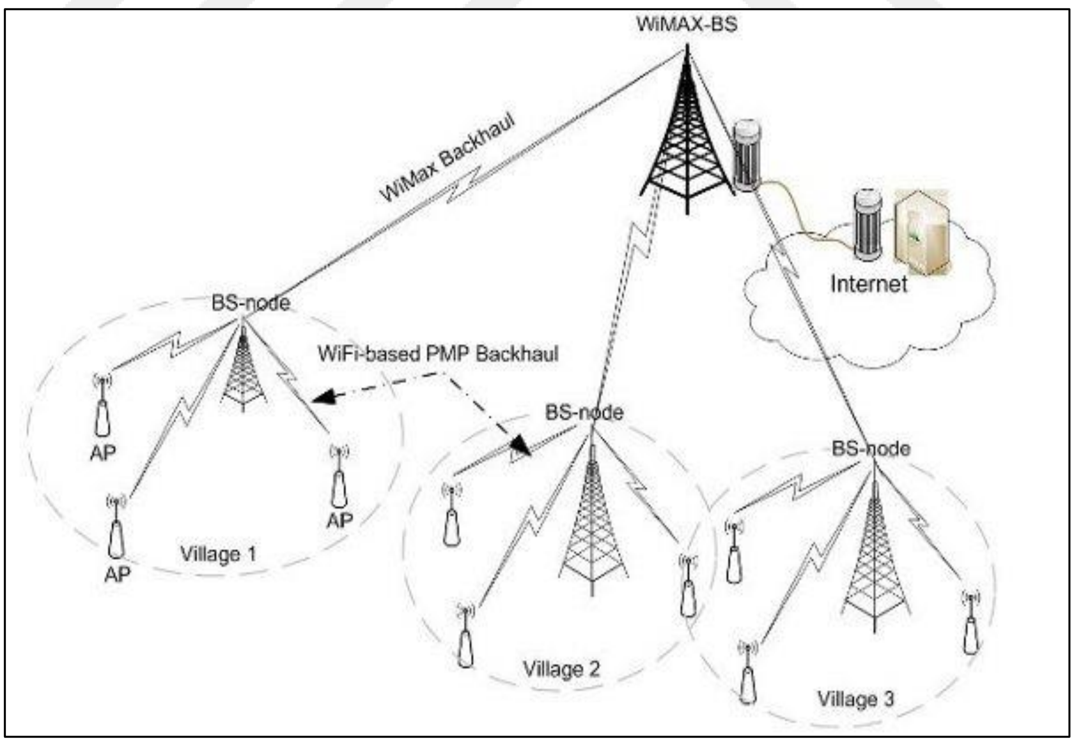

Figure 3.8: Scenarios of WiMAX [32].

3.4 MEDIA ACCESS CONTROL DESCRIPTION ON LAYERS

Standard bandwidth is intended to be provided via 802.16 land. Information, data, and sound are all types of services. The MAC evaluated DOCSIS (Data Over Cable Service Interface Specification) standards and assistance for high-speed data traffic with high demand. Support for delayed audio traffic and video playback concurrently Different channel resources may be assigned to the MAC scheduler. A wide dynamic range is offered from slow motion to full frame. a particular user terminal's bandwidth at a certain moment. The MAP message at the start of each frame contains all the source Map data. The scheduler has the following effective options for modifying resource allocation for a frame [33].

Mobile WiMAX may satisfy QoS requirements for a variety of services and programs for data transfer because to its rapid air connection, asymmetric lowering/lifting, modest flares, and flexible resource allocation method. The service flow at the MAC layer provides Mobile WiMAX QoS. packets with defined QoS settings that are sent only in one direction. A unidirectional logical link between MAC peers is first established between the base station and the user terminal before any data services are offered.

Through the MAC interface, packets are connected by outgoing MACs. Set the link's relative QoS for the service flow. In the flow of services and radio interfaces, it establishes the timing and order of the exchange. Tuned sky management can be offered through connection oriented QoS. Since connection air interfaces are frequently small, seamless QoS management can be carried out effectively. The parameters of service flow include MAC messages with dynamic control for dynamic service deployment For DL and UL, QoS techniques based on request flow are utilized. bi-directional QoS improvement A variety of data transmission services are supported by WiMAX Mobile. Applications with various QoS specifications are shown in Figure 3.9 [34].

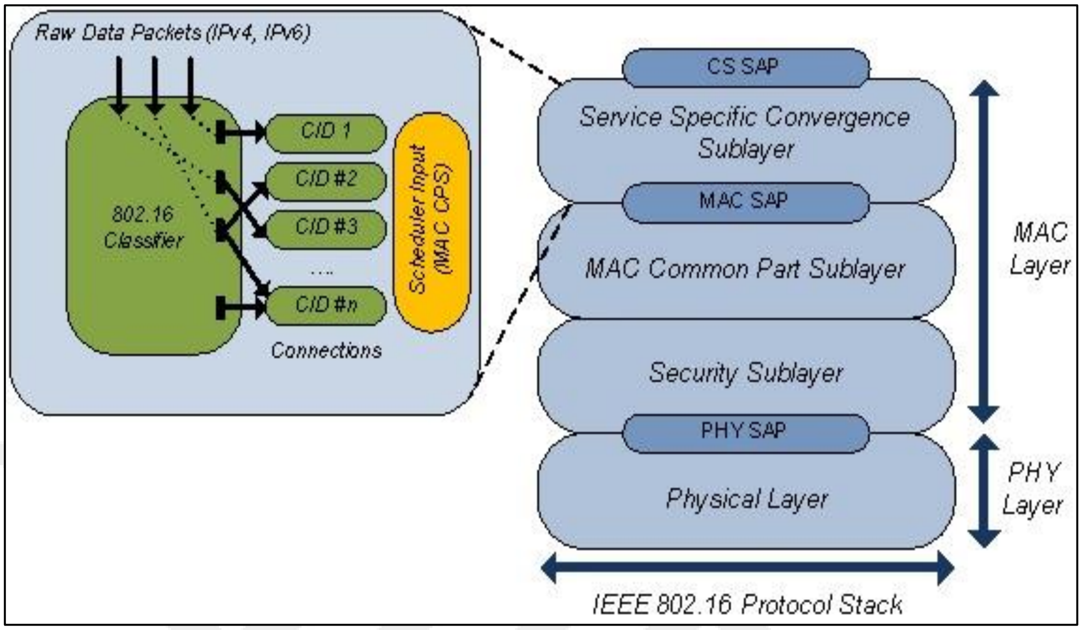

Figure 3.9: Mobile WiMAX on QoS Layers Structure [34].

WiMAX moving networks have been developed under the guidance of some shared policies. Structures and logical units are included to ensure IP management practices, connectivity, and connection control. ASN Protocol that utilizes the National Adaptation Plan and permanent architectural policy (NAPs) Accept the sole Network Service Provider (NSP) offered by the price that supports ASN and includes several NSPs or choose an already-existing NSP. Additionally, have access to the ASN topology which maintains cumulative operating services If online processing actions are required, Declarative language and infrastructure description additional network groups' signals Many providers communicate between ASN, ASN, and Connectivity Service Network (CSN), particularly Microsoft, ASN, and CSN. development assistance Among other models, highways are one that makes use of intelligent technical hypotheses. adding additional providers for various uses. When such a race is combined with present order protocol and actions for real network companies Documents and specifications for networks CSN restricted the number of operator packages that could be used in ASN Operations for operators to offer basic online access services. Think about or dial nearly. IP and Ethernet services can be used on conventional mobile phones to the WiMAX architecture [35].

3.5 WIMAX ARCHITECTURE

Only the physical and medium access control (MAC) levels were defined by IEEE. For technologies like Ethernet and Wi-Fi, this strategy has been successful. Additionally, it establishes new groups, like the Internet Engineering Task Force (IETF).

A standard for cutting-edge protocols used on phones in the wireless world, including VoIP, IP security, and Transmission Control Protocol/Internet Protocol (TCP/IP). Different interfaces and protocols necessitate roaming for multi-operator access, operator interaction, payments made online, and across businesses, in addition to wireless compatibility. Operators and Internet service providers were aware of this issue that shown in the Figure 3.10 [36].

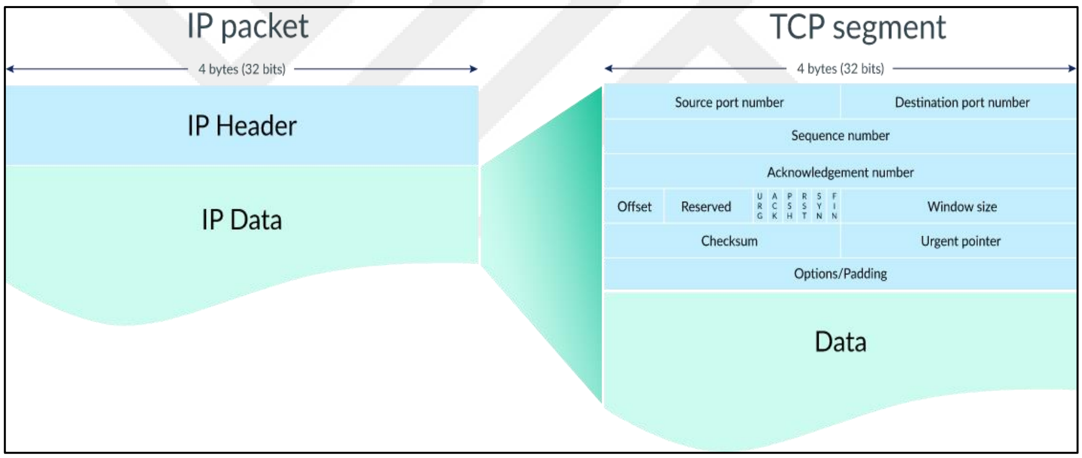

Figure 3.10: TCP/IP Segment Elements [36].

To build common network definitions, further working groups were formed. Launch the web interface design. WiMAX forums make up two of them. a network that concentrated on developing advanced networks and technical standards-violating aspects of portable, mobile, and WiMAX systems The service group for IEEE 802.16 determines the standard and supports it. For the sake of the workgroup network, prioritized requirements must be in writing. All-Internet Protocol is the foundation for WiMAX Mobile Network Setup, which is built on all handheld technologies without reading a plan [37].

It has less advantages. the overall cost of ownership for the deployment of a WiMAX network. as a use All IP allows for the usage of a single network core without the need to save both. Core networks and closed circuits were previously introduced. Another benefit To achieve the whole performance curve, All-IP utilizes the network. Moore's Law is a term used frequently to describe target CPUs and computing hardware.

Computer Processing improvements happen far more quickly than communication device improvements. since general purpose hardware is not just used in communications equipment primarily for long, difficult cycles A network is the outcome. enhanced capital and operational efficiencies to support ongoing adoption The online community makes use of third-party innovations. This causes a decrease. Cost-effective, highly scalable, and quick implementation for all network functions mainly computer software services. An element of a communication network in the Topology's IP connection service is not in accordance with the IEEE 802.16 wireless specification [38].

Architecture offers adaptability and adaptability for broad acceptance. final capacity and activation as a little fugitive with a wireless lid The WiMAX network the city, suburbs, and national radio stations are all present there. approval and/or regularity, Mild, friendly, or online alternatives, Accept a stable routine, nomads, infrequent users, and cellphone models, programs, and services for It is the ultimate structure for the emergency control services, multimedia service, and supporting sound, Application Service Providers (ASP) roughly connect mobile devices that have been ported for display by translating IP over Heritage Services, for instance, messages utilizing internet protocol networks with access to WiMAX and providing multilateral IPs and distributing services via WiMAX.

Routes are still another powerful force in the final network, which includes many active scenes from architecture. specifically to Free calls supported by wireless networks Global wandering to avoid support and information on the WiMAX network phone calls that have been introduced by standard use, current wire connections such as DSL, and standard interface ethics Coordination over the whole account and agreement for accounting and investors A logical representation of a network structure can be seen in the various authentication user settings, such as user and password, to identify certificates, (SIM), Universal Subscriber Identity Module (USIM), and WiMAX Network certificates specified by WiMAX Forum [39].

The operating system as well as the OS version are identified by these businesses. It was created between the architecture's functional units with the following goals in mind. Internal support is provided for features needed for network implementation. Use situations and models (static - mobile - portable - simple mobile - for all mobile subscribers). 17 ASN, MS, and a clear point of reference for connecting logical objects and CSNs to the major regulatory principles R1-R5. anything, MS, ASN CSN stands for a collection of active businesses. Each of these attributes consists of It can be set up on a single physical device or spread across several of them as in the Figure 3.11 [40].

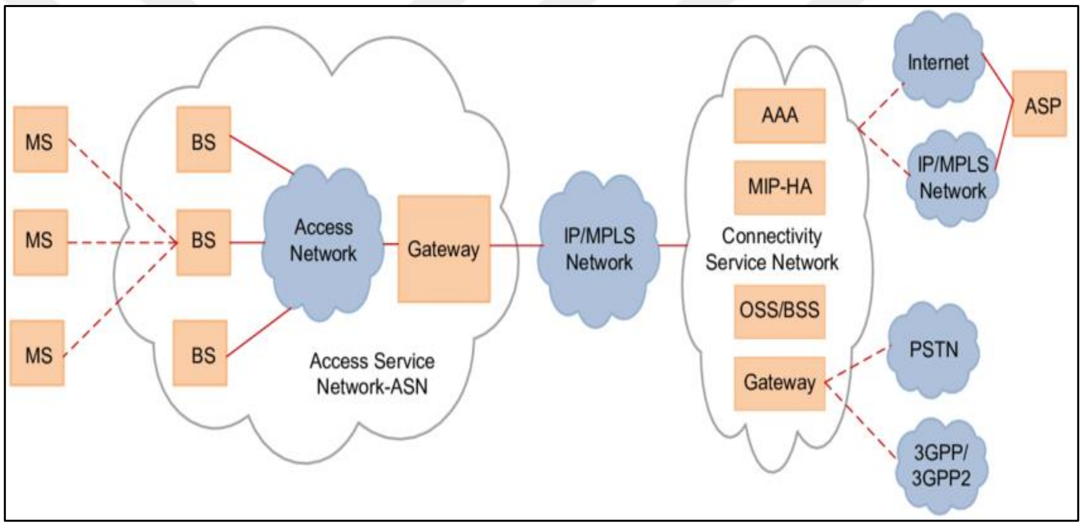

Figure 3.11: Mobile WiMAX Network Model Structure [40].

The logical boundaries that connect the pertinent functional objects and the pertinent message flow can be defined and simply described to ASN. services are available. ASN alludes to the following operating system's restrictions: Functions of the WiMAX Connection Service, the WiMAX Customer, and synchronization with other providers ASNs can be implemented in a variety of methods, as indicated in the NRM's comparison of logical and practical objects. WiMAX forum for various online profile management options that mentioned in the Figure 3.12 [41].

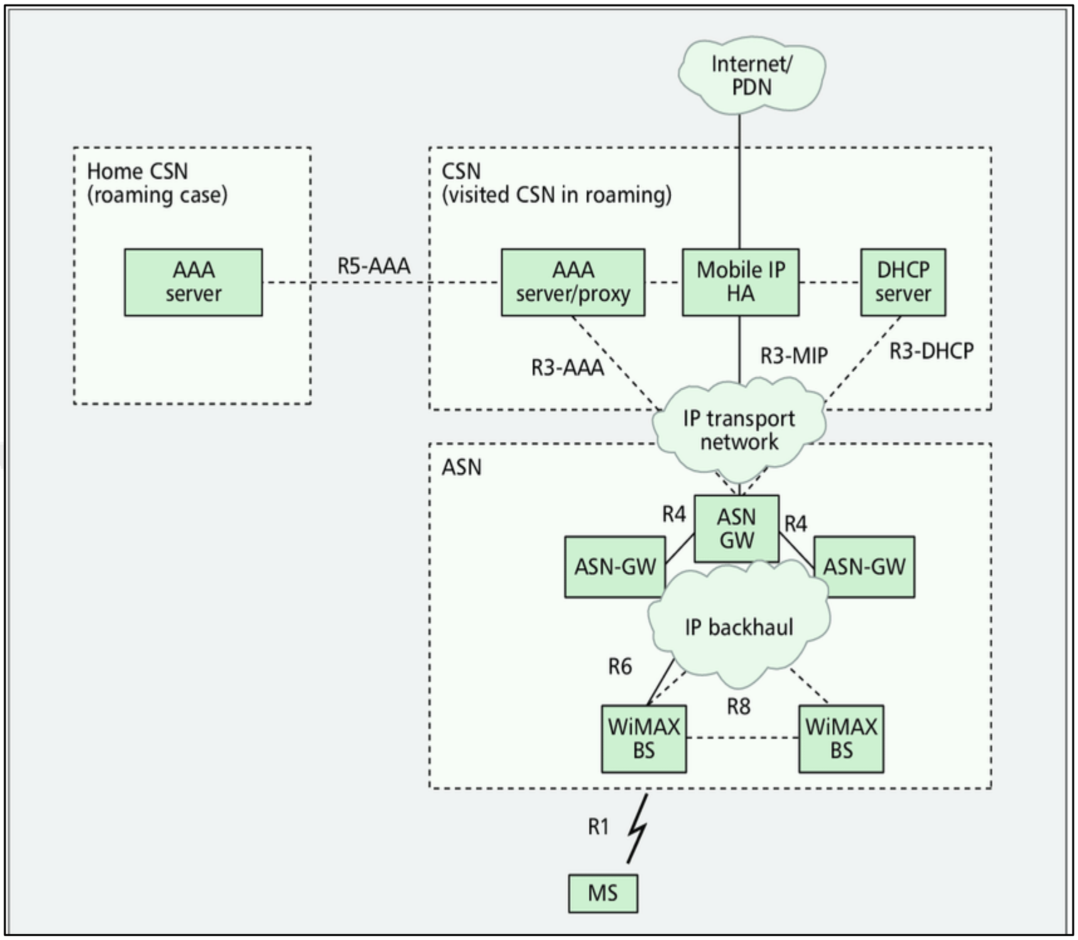

Figure 3.12: Mobile WiMAX Network Internal Architecture Based ASN and CSN [41].

Some general tenets have guided the development of Mobile WiMAX Network Architecture and include the following: a) Provision of logical separation between such procedures and IP addressing, routing and connectivity management procedures and protocols to enable use of the access architecture primitives in standalone and interworking deployment scenarios, b) Support for sharing of ASN(s) of a Network Access Provider (NAP) among multiple NSPs, c) Support of a single NSP providing service over multiple ASN(s) – managed by one or more NAPs, d) Support for the discovery and selection of accessible NSPs by an MS or SS, e) Support of NAPs that employ one or more ASN topologies, f) Support of access to incumbent operator services through internetworking functions as needed, g) Specification of open and well-defined reference points between various groups of network functional entities (within an ASN, between ASNs, between an ASN and a CSN, and between CSNs), and in particular between an MS, ASN, and CSN to enable multi-vendor interoperability, h) Support for evolution paths between the various usage models subject to reasonable technical assumptions and constraints, Enabling different vendor implementations based on different combinations of functional entities on physical network.

4. RESULTS AND ANALYSIS

In the part, the study of WiMAX performance has been investigated to measure the application service which is belong to the video conferencing for traffics sent and received in addition to that, delay, throughput, utilization had measured for improve WiMAX network packets and bitrates between overall and over nodes were are provides high traffic and low delay to enable the better video conferencing performance additionally WiMAX QoS behavior study is so important due to its throughput importance to send huge data between base stations and mobile stations to achieve high bandwidths were allocated via base stations up to mobile stations as mentioned in Figure 4.1.

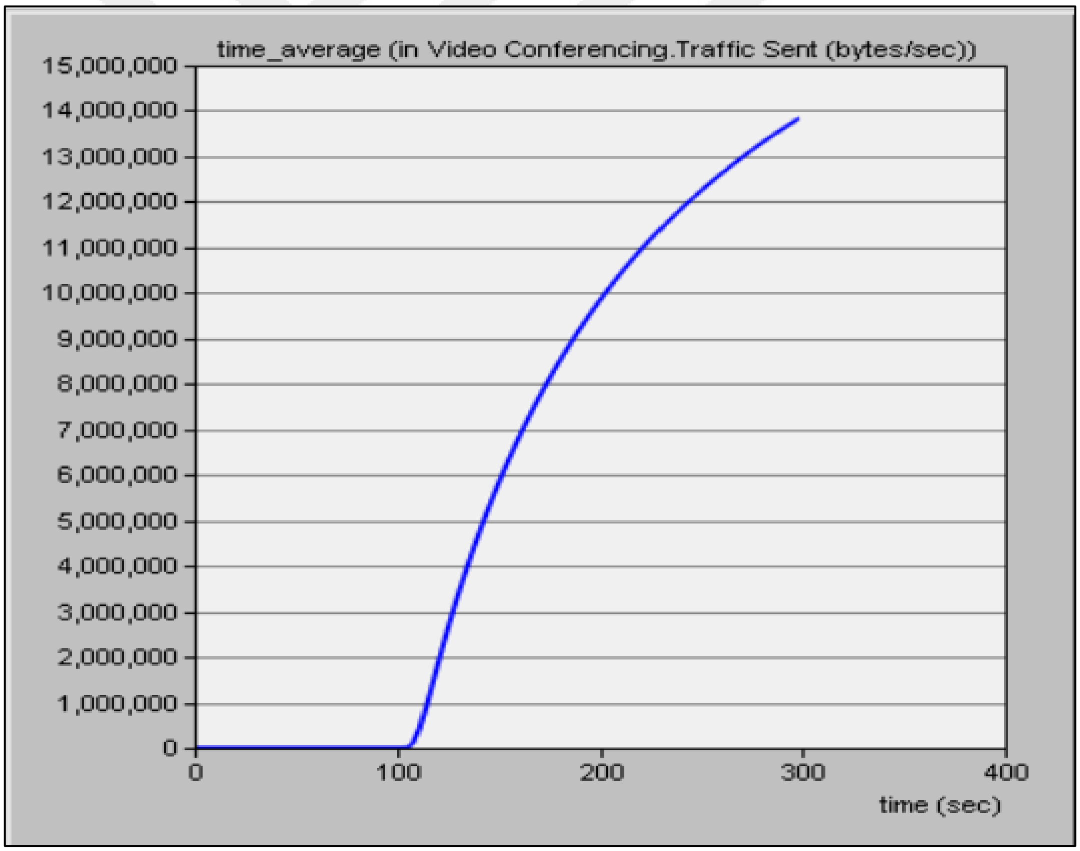

Figure 4.1: Video Conferencing Traffic Sent for bytes/sec.

In Figure 4.2, which describe the video conferencing rely up on traffic received that executed over bytes rate when raising around 101 seconds and settled in 290000 bytes over seconds.

In Figure 4.3, which describe the Packet End-to-End delay while set for seconds and according to the raising issue that occurred for 0.50 in the first 100 seconds from the execution of simulation and settled at 0.10 in the end of 300 seconds.

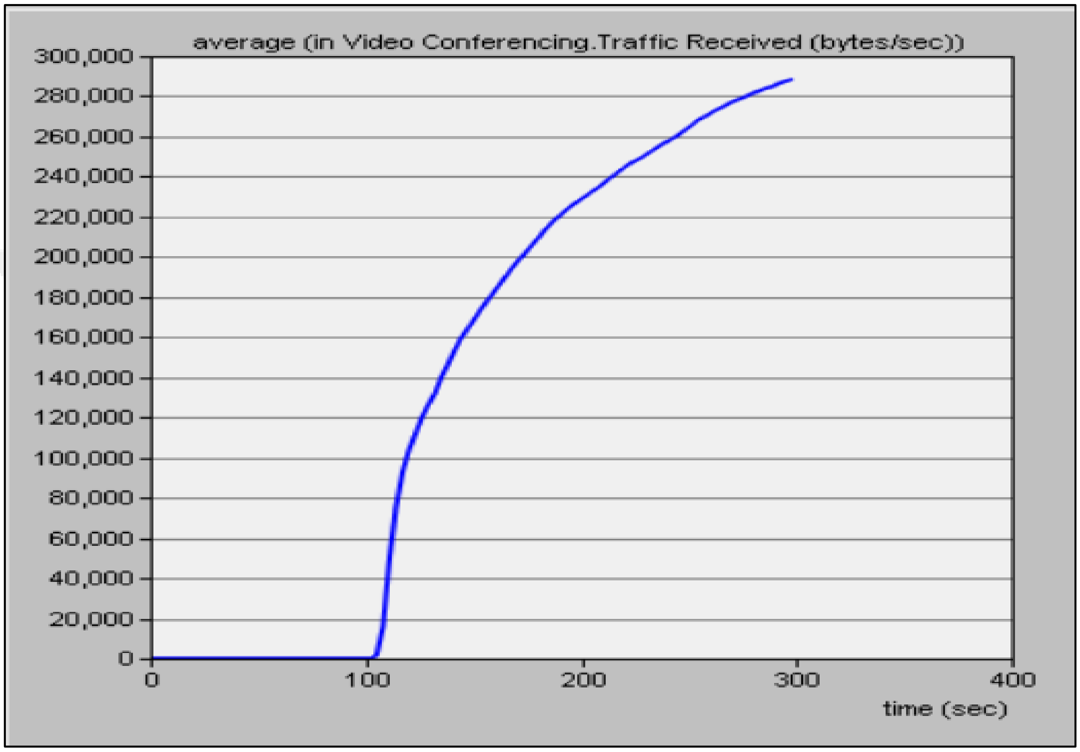

Figure 4.2: Video Conferencing Traffic Received for bytes/sec.

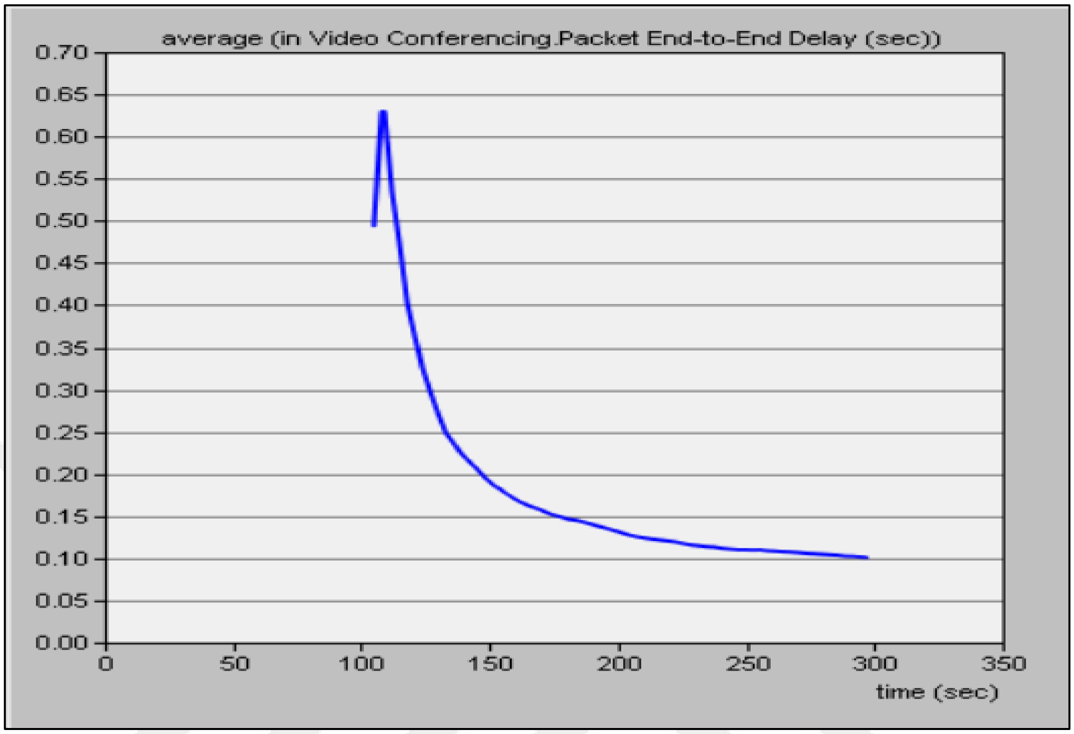

Figure 4.3: Video Conferencing Packet End-to-End Delay in Seconds.

In Figure 4.4, which present the traffic sent for the packets rate issue, while the raising made from the initialized 110 seconds the settled time that occurred during 800 packets for a second in the 300 seconds time of simulation.

In Figure 4.5, 4.6, 4.7, and 4.8 which describe the raising at 105 seconds and settled for 17 packets over seconds that occurred for traffic received at the end of execution.

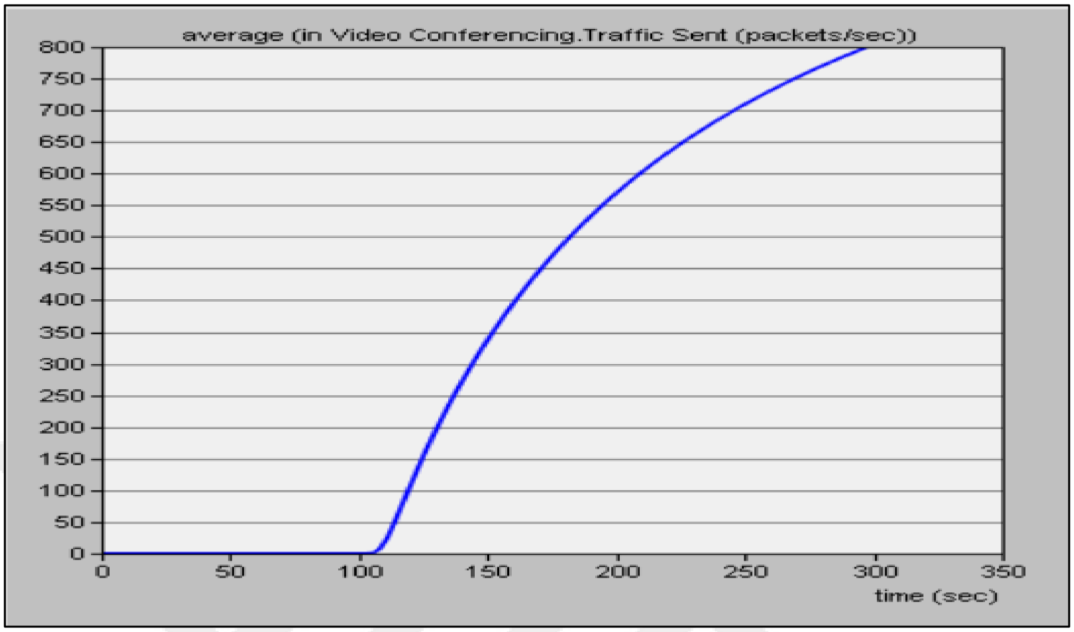

Figure 4.4: Video Conferencing Traffic Sent in Packets/sec.

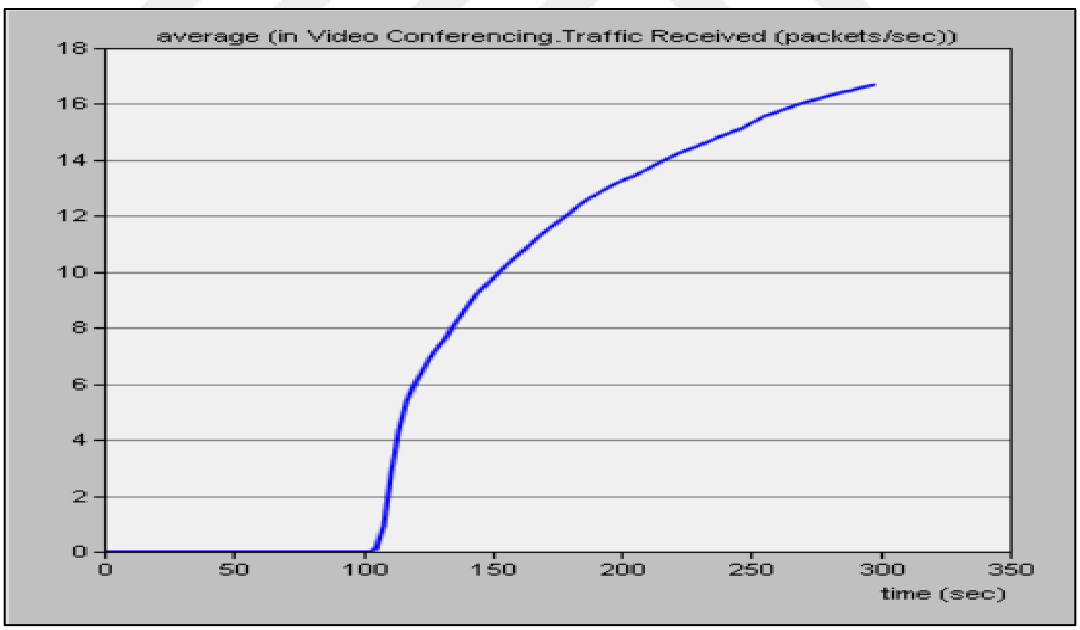

Figure 4.5: Video Conferencing Traffic Received in Packets/sec.

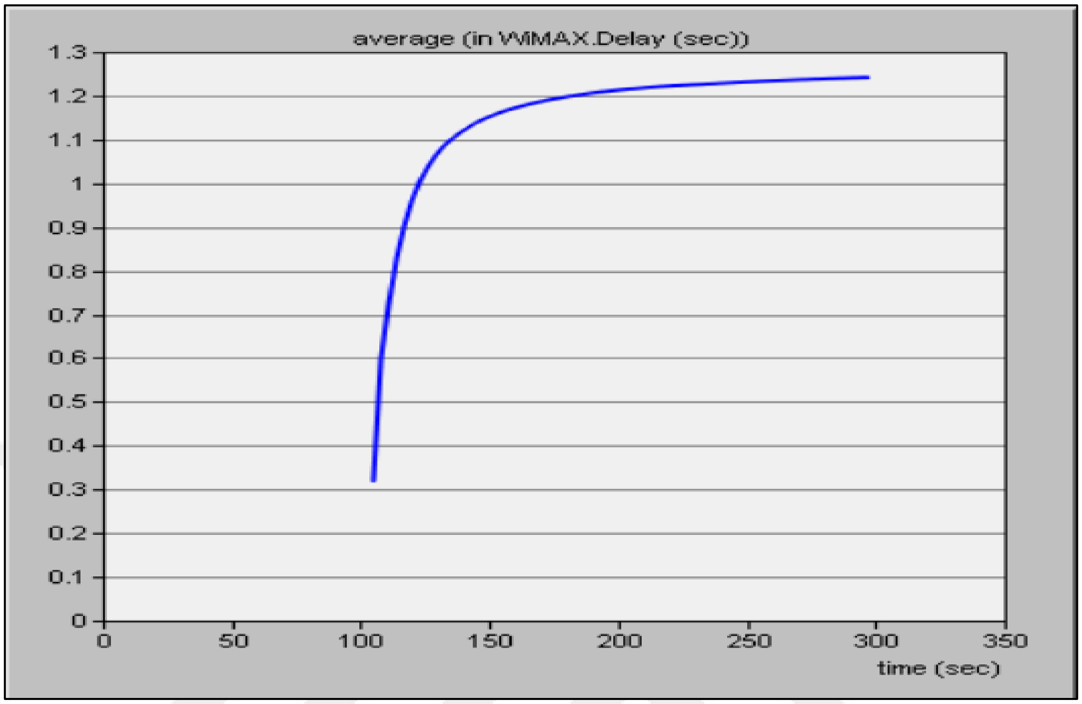

Figure 4.6: WiMAX Delay in Seconds.

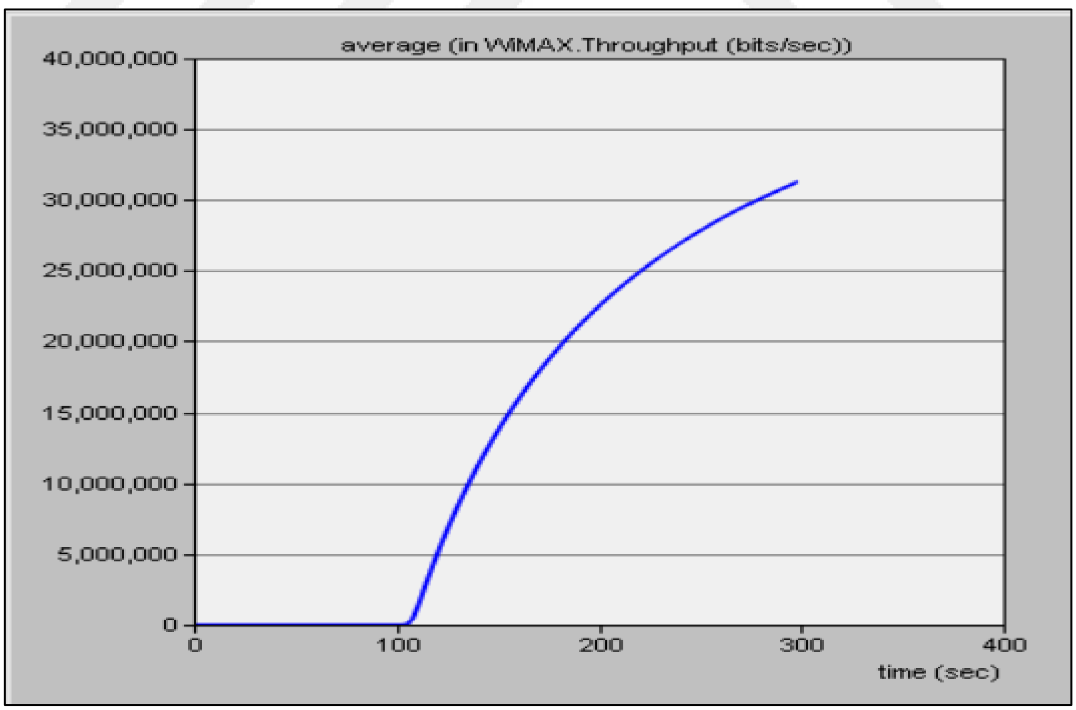

Figure 4.7: Overall WiMAX Throughput in Data/sec.

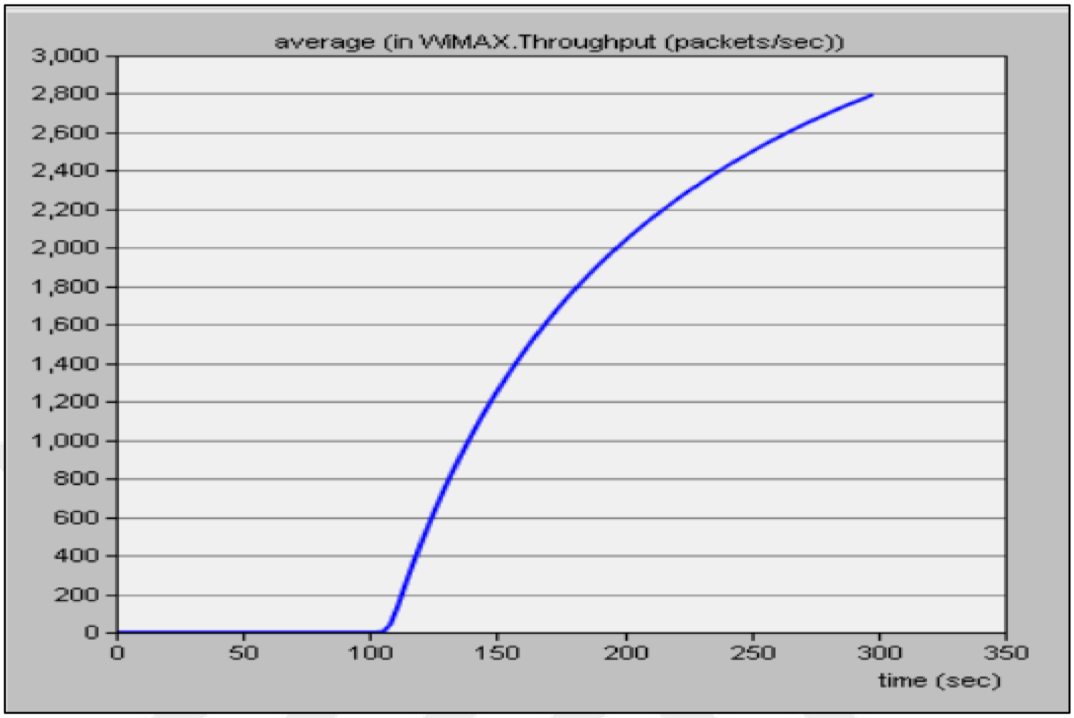

Figure 4.8: Overall WiMAX Throughput in Packets over Seconds.

In the Figure 4.9, which present the comparison speed between both WiMAX load and throughput over data rates while the raising occurred and reached at 110 seconds and settled for load at 4500000 while for throughput around 3900000 over data rates.

Figure 4.10, 4.11, 4.12, and 4.13 presents the comparison speed between both WiMAX load and throughput over Packets rates while the raising occurred and reached 110 seconds and settled for load at 410 while for throughput was around 350 over packets.

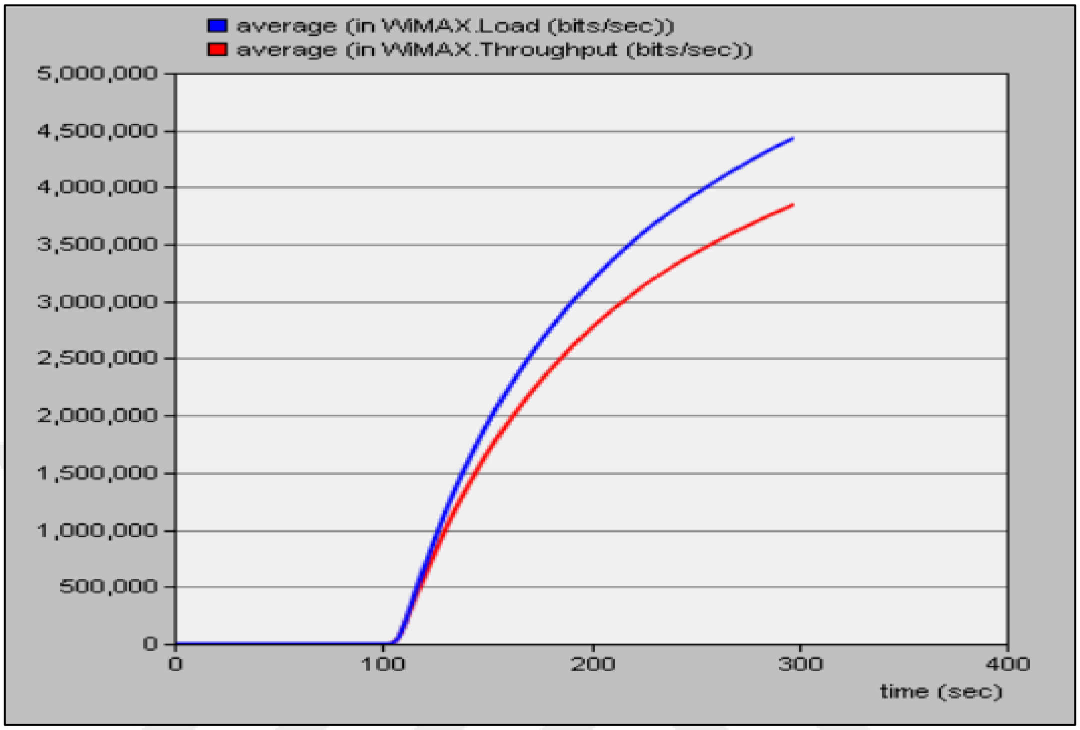

Figure 4.9: Comparison Between WiMAX Load and Throughput in Data/sec.

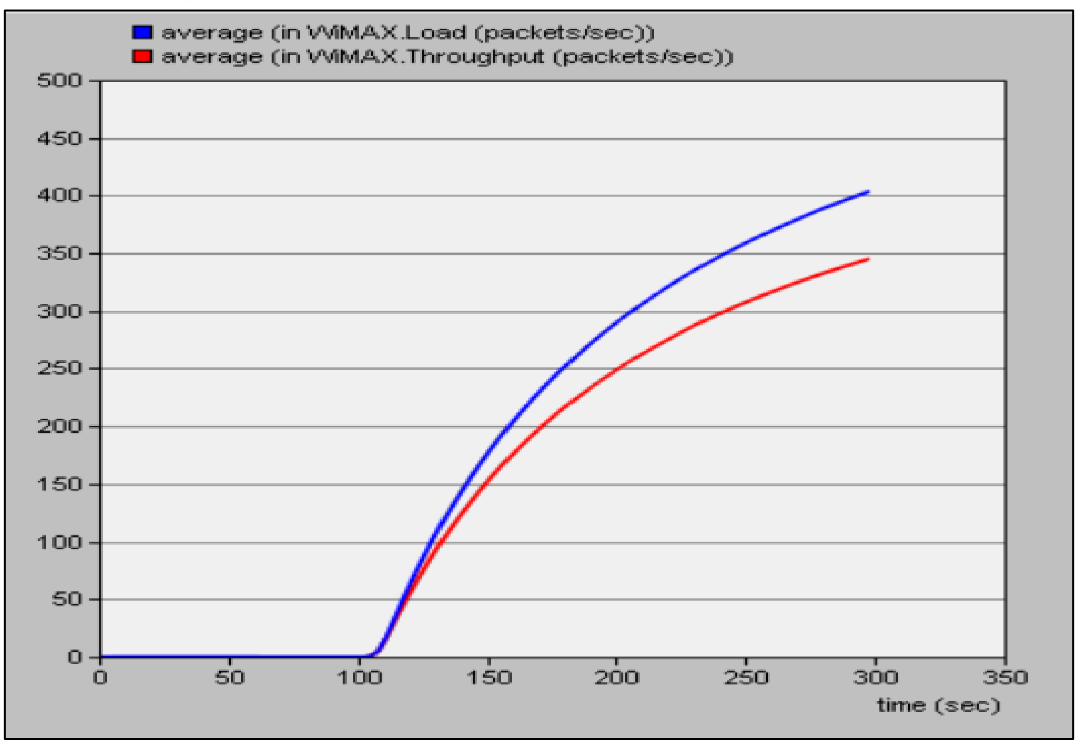

Figure 4.10: Comparison Between WiMAX Load and Throughput in Packets over Seconds.

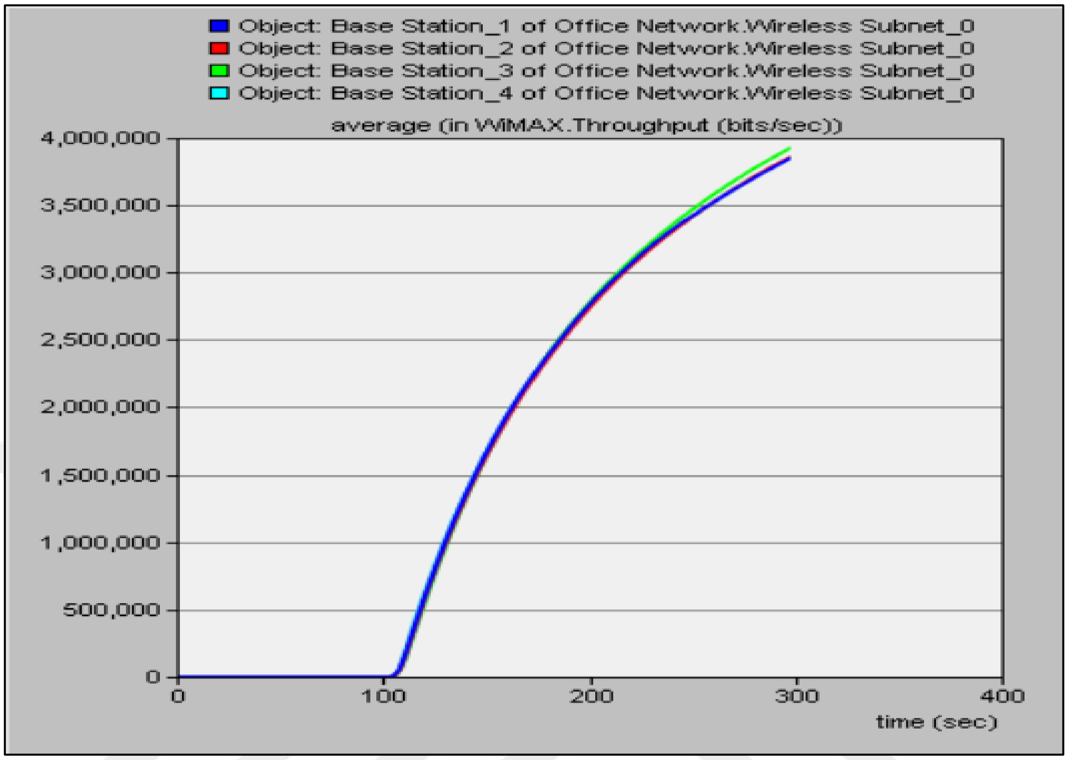

Figure 4.11: WiMAX Throughput for Base Station Nodes.

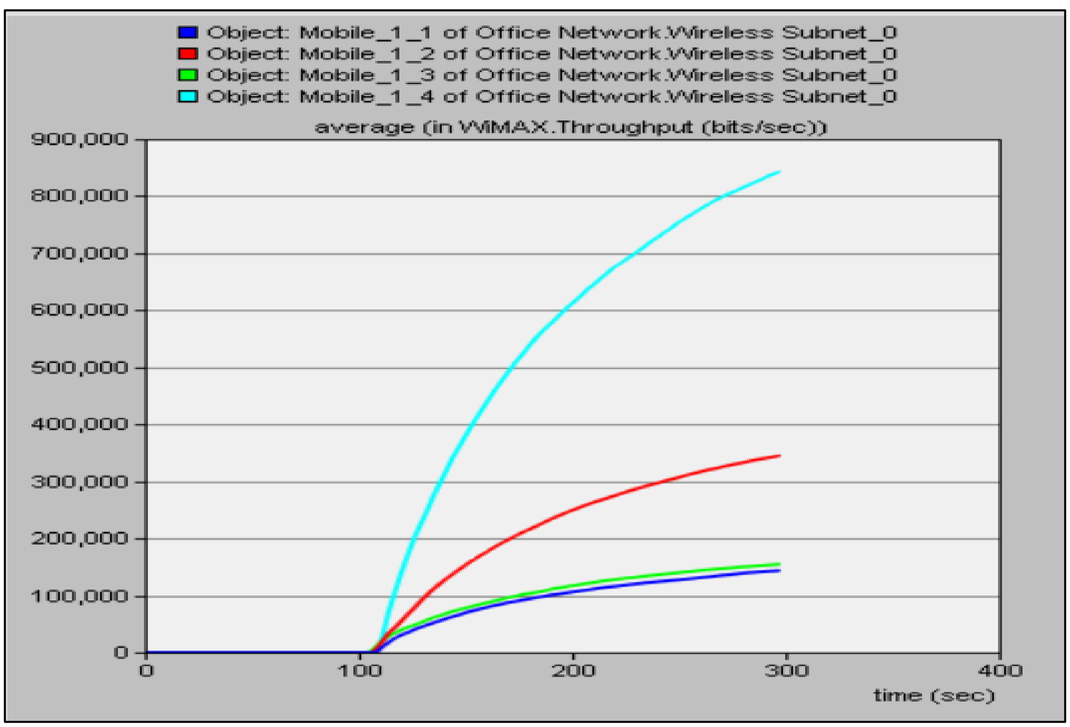

Figure 4.12: WiMAX Throughput for Mobile Station Nodes.

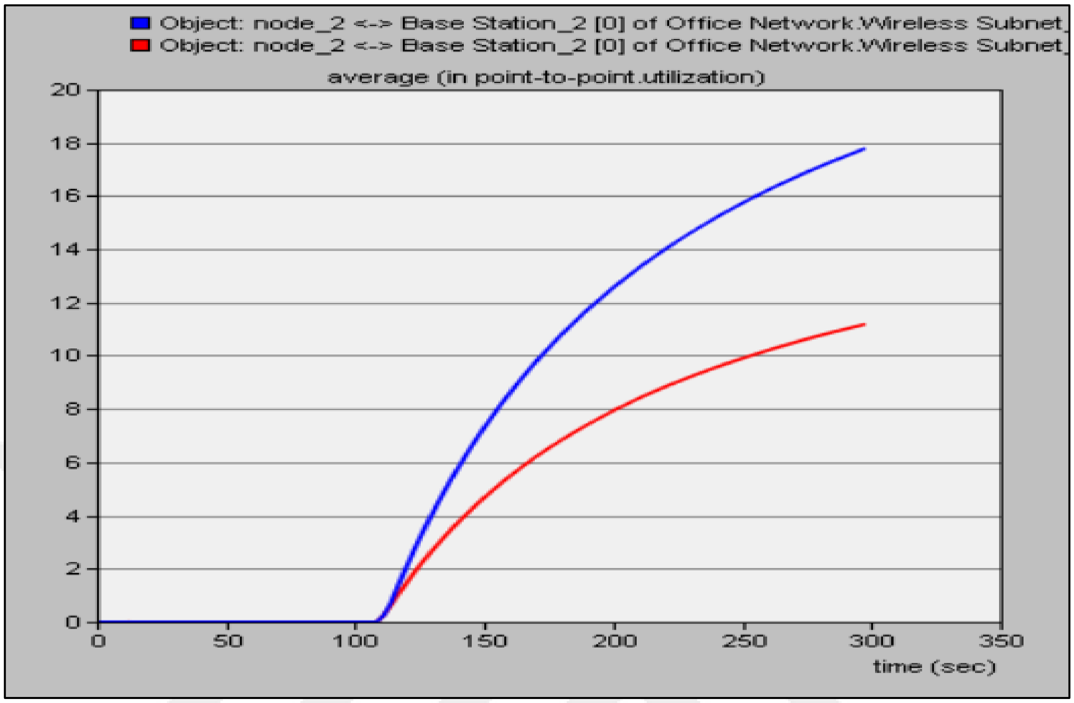

Figure 4.13: Utilization Between Base Station and Mobile Station.

5. CONCLUSION

In this thesis, we will lead wide entertainment study to take a gander at the introduce of Video Conferencing over helpful WiMAX affiliations. We will accomplish this through the appraisal of WiMAX QoS association. We will isolate two or three basic essential cutoff points like throughput and start-to-finish delay. The outcomes will get through virtual experience utilizing OPNET Modeler 14.5A. Reenactment results show the UGS association classes have the greatest introduced limits to serve Video Conferencing. Absolutely, UGS association classes are supposed to oversee consistent help streams that with making fixed-size groups at standard reach, which is what's going on for Video Conferencing.

In future scope, I would recommend utilizing:

i. To achieve high density for data rates, it is necessary to consider estimated parameters like throughput and transmitted power that support this proposed model.

ii. Various equipment strategies are being tested to find ways to extend the transmitting lengths for a wide coverage area.

iii. Other applications, including a printer, remote login, VoIP, and FTP with quality checks for each service and their responses, might be added to improve the mobile WiMAX network.

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