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ANALYSIS OF WIRELESS NETWORK THROUGH WIMAX IN QUALNET

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Abstract-*WiMax stands for Wireless Interoperability of Microwave access. WiMax [1] is a new technology which gives the fast access to data even when in long distances through various ways for point to point or point to multi point communication. The main objective of WiMax in cellular communication [2] is to make the handovers as soon as possible and efficient so that there will be no loss of data during this handover process. WiMAX has developed to provide last mile connectivity to the devices in metropolitan area with high data rates. WiMAX is associated with a variety of frequency spectrum[3]s. Combination of contention and scheduling techniques used to manage access to the air interface. The next generation of wireless communication systems will include heterogeneous broadband wireless networks which will coexist and will use a common IP core to offer a diverse range of high data rate multimedia services to end users. Basically this paper includes an efficient soft handover during the congestion in the network and there must be fast base station switching during a soft handover considering various parameters like distance, congestion, and delay and signal strength. All the simulations have done in scalable network simulator through QualNet simulator. The result is in the form of total received messages, received throughput, average jitter, and average end to end delay in mobile WiMAX cell.*

***Key words*- Wimax, Handover process, Frequency spectrums, Heterogeneous broadband wireless networks, Congestion in the network, Qualnet Simulator.**

1.INTRODUCTION

The global demand for multimedia data services with high data rates has grown at a remarkable place in recent years. The increase in demand will likely to grow at an even faster in the future due to advance technology in the multimedia distribution services. So, network scalability has become an important consideration for the equipment manufacturers and also for the service providers. Basically WiMAX technology is based on the IEEE 802.16 standards[4] family which can support high sector throughput, multiple handoff mechanisms, and power-Saving mechanisms for mobile devices advanced QoS and low latency which can support real-time applications. The overall capacity of the whole system has to be made expandable in terms of the data rate, number of supported subscribers, and geographical coverage area. There can be many factors which may hamper the scalability of the network. The 802.16 Medium Access Control (MAC) layer uses a scheduling algorithm by which the subscriber stations can enter into the network. Then it allocates an access slot for its operation given by the base station. The time slot of the system may be large and contract, but it still remains assigned to the subscriber station, i.e. other subscribers cannot use that. A WiMAX network has multimedia applications such as in voice over IP (VoIP), IPTV, voice conference, online gaming etc. Belonging to the IEEE 802.16 series, WiMAX networks can support data transfer rates up to 70 Mbps over a link distance up to 30 miles. This standard promotes it for a wide range of applications as in fixed, portable, mobile and nomadic environments. Also several frequency bands can be used for developing WiMAX network [5]. Each band has unique characteristics which results a significant impact on the overall system performance in the wireless network. Selection of a suitable frequency spectrum within 2-11GHz is found to be most suitable for commercial and technical studies which are also being conducted by many researchers to find the optimal range. In a global perspective, the 2.5GHz and 3.5GHz bands are more popular in WiMAX deployments. So, WiMAX technology is expected to deliver the broadband access services to residential and also enterprise customers in at low prices.

1.1WIMAX TECHNOLOGY

WiMAX or IEEE 802.16 is a standard which describes air interface for the wireless broadband access. Development of the WIMAX started in 1998 by establishment of 802.16 working group with a mandate to develop Wireless Metropolitan Area Network (MAN) Standard. Initially, 802.16a standard was developed to provide the Line of Sight (LOS) communication, without supporting the mobility [5]. In the year 2003, 802.16d standard was released with improved data rates and started supporting Non-Line of Sight (NLOS) communication. It operated in 2-11 GHz range with 256 sub-carriers which used OFDM encoding [6]. WIMAX gained its popularity in the year 2005 when 802.5e standard was also released with OFDMA encoding, 2048 sub-

carriers, which provided data rates of around 75 Mbps and supported the mobility. Now it is used widely to provide Internet access among the fixed and mobile users and also advertised as one of the cheapest alternative to the wire-line broadband access.

OFDM and OFDMA are methods of encoding where the subcarriers are placed orthogonally to each other, which results achievement of higher efficiency without interference. Data capacity also increased for this. The WiMAX system mainly consists of two parts: base station and subscribers. The typical size of a WiMAX base station is usually between 7 and 10 kilometers. However, it can extend up to 50 kilometers with favorable conditions and can be further extended by the technique of Backhauls. Backhauls are nothing but WiMAX towers which act as repeaters for WIMAX base stations which helps to extend the overall range. A WiMAX base station may be connected to the internet using high-bandwidth wired connection (for example 1 T3 line). Customers use the Customer Premise Equipment (CPE) for connecting to the base station. CPE is simply a receiver antenna which is oriented towards the WiMAX base station to get optimal signal. The receiver antenna also could be built into laptops or other mobile devices. WiMAX subscribers that want to be part of the network have to request bandwidth from the base station. Then the subscriber station is assigned a time slot by the base station, which can be enlarged or restricted. This time slot remains allotted to the subscriber for its exclusive use. Sub - carriers may be modulated using different digital modulation techniques to carry data. These modulation schemes can be Binary Phase Shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Modulation (16-QAM and 64 QAM).

1.2HANDOVER IN WIMAX

Handover is a process in telecommunication where a data session or a cellular call is transferred from one BS to another BS without disconnecting the running session. A network must have the ability to provide the access during the mobility of the user. It means that when a user is moving from one place to another with accessing the network for communication there should be no interruption or disturbance appears when one BS handover[4] its channel to another BS within the range. Handover is the basic element through which a cellular system is being planned and deployed. Handovers are mainly of two types: Hard handover and soft handover. Hard handover is simply called as Break before Make. In this type of handover when a new connection is established with a new BS, it is necessary to break the previous connection with the old BS. Whereas the Soft handover called as Make before Break. In this type of handover there is no need to break the previous connection with the BS when there is establishment of the new connection to the new BS. In this paper we are considering Soft handover using WiMax through which they can give the different methods for an efficient handover. The main factors that makes WiMax popular is the speed to access the network and can covers a large area.

1.3MOBILE WIMAX

MOBILE WIMAX uses standard 802.16e that uses a system of mobile broadband wireless access. Mobile WiMax physical layer uses the OFDMA technology which used the division of channels and each channel works in parallel. Mobile WiMAX is built around the IP core network that makes it easy to design and integrate with existing networks. The IP core for WiMAX is based on advanced technologies and protocols which provides the needed Quality of Service (QoS) and security features related with the network. This makes WiMAX ideal to support Voice over IP (VOIP),IPTV[6] which are now a days very popular especially in enterprise networks.Mobile WiMax provides full scalability to radio waves technology and network architecture as a result it becomes more flexible in network and offering services. Mobile WiMax[7] also provides the various modes of transmission like point to point, point to multi point to portable devices and various internet accesses on mobile phones.

2.INTEGRATION OF NETWORKS

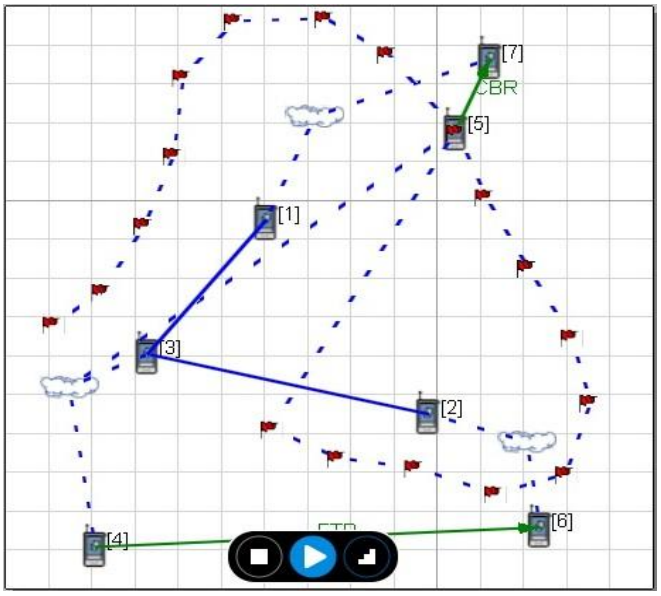
Integration of networks are combination two or more different networks (e.g. WLAN and WiMAX) to form a heterogeneous network. The unique similarities between WLAN and WiMAX that both of them make the integration promising and meaningful as both the technologies are fully packet switched and use IP based technologies [6] to provide connection services for internet. The inter-working capabilities between WLAN and WiMAX enable service providers to deliver consistent, transparent, and user-friendly broadband services to their subscribers. Achieving this transparency requires two key elements: A) Multi-mode subscriber devices that can communicate on both WLAN and

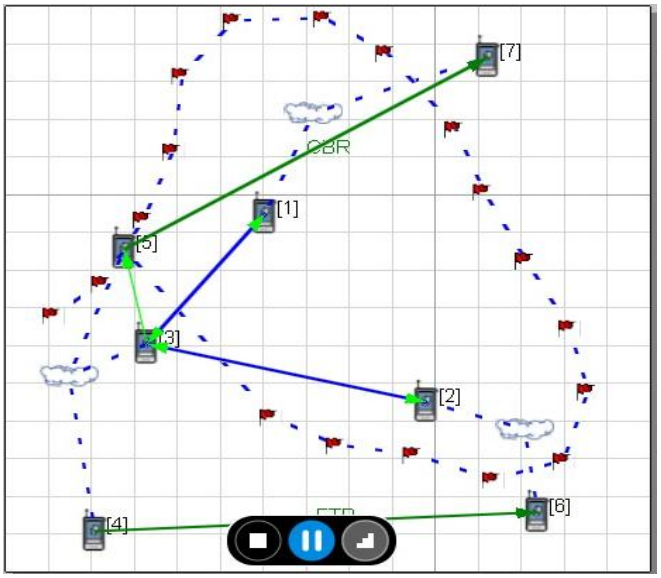
WiMAX networks. B) The ability to provide service across WLAN and WiMAX networks when users move between them. This is generally implemented through a controlling Access Service Network Gateway (ASN GW) and common Authentication, Authorization, and Accounting (AAA) service functionality located in the service provider network.

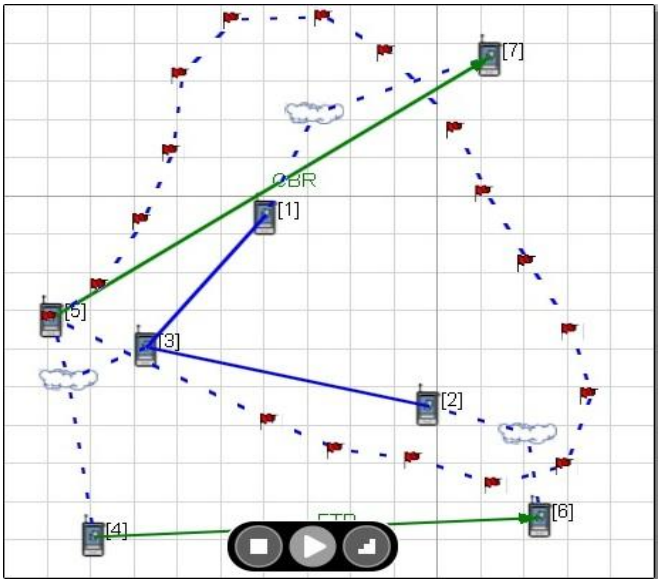
Network integration is essential for the next generation wireless networks, where the diverse of the technologies available have been optimized for different usage models. WLAN and WiMAX are the most promising techniques for future generation wireless networks; interworking between these technologies is inevitable for better usability of networks infrastructure [7] and support for seamless mobility and roaming. By combining WLAN and WiMAX access together, service providers can deliver high-speed Internet connectivity to the subscriber.

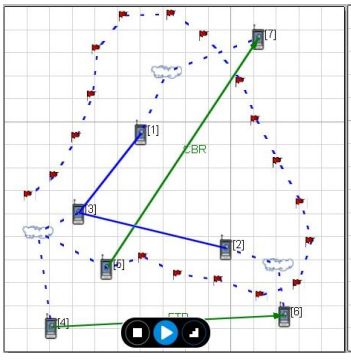
3.WIMAX SCENARIO IN QUALNET 7.3 SIMULATOR

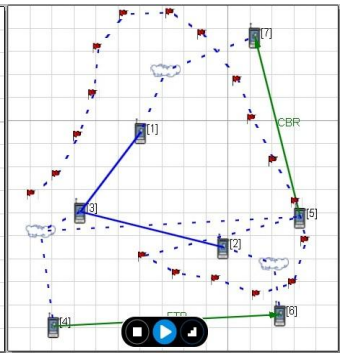
WiMAX provides fixed, nomadic, portable, and mobile wireless broadband connectivity without any direct line-of-sight with a base station. To evaluate the performance of WiMAX, we can develop several simulation scenarios using theQualnet software. These scenarios may be designed to analyse WiMAX performance under specific conditions such as load, traffic type, mobility and coverage. The main scenario consists of three base station network provider and several subscriber stations. CBR traffic application here used to provide constant data transmission from the source to destination. The simulation of the handover process in mobile WiMAX is implemented using QualNet 7.3 simulator. Some performance matrices selected to be used in the experiment are: Throughput, End to End delay, and Jitter within the WiMAX environment. It uses the TCP/IP network protocol stack which is a layered architecture. The Scenarios simulation time was set as 600sec. The results analysed are compared to each other and different performance metrics are evaluated such as total received messages, received throughput, average jitter, and average end to end delay.











4.OBSERVATION OF PARAMETERS

4.1PHYSICAL LAYER OVERVIEW

WiMAX physical layer is mainly based on orthogonal frequency division multiplexing (OFDM). OFDM[10] is the transmission technique to enable high-speed data communication in broadband system. OFDM divides a given high-bit rate data stream into several parallel lower bit rate stream and modulates each of the stream on separate subcarrier. For performance analysis of Mobile WiMAX, it is important to know the Orthogonal Frequency Division Multiple Access (OFDMA). Now a days OFDMA has been fully adopted and implemented by Mobile WiMAX technology and for upcoming broadband access technology.

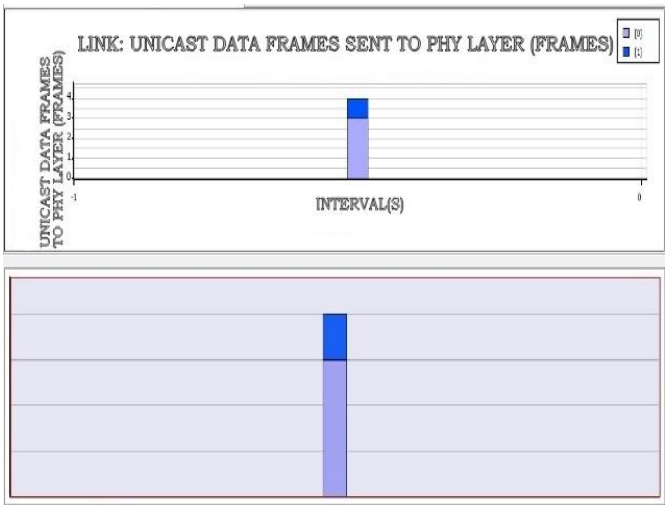


Fig: Unicast data frames sent to physical layer (frames)

The total channel is divided into many equally spaced subcarriers. There are four types of sub-carrier are in an OFDMA-1) Data sub carrier (used for data transmission), 2) Pilot sub-carrier (for monitoring quality of the channel), 3) guard sub-carrier (for providing safety zone between the channel) and 4) DC sub-carrier (use as reference frequency). For example, a 10MHz channel is divided into 1024 subcarriers forming 35 uplink (UL) sub channels. A sub-channel is the minimum transmission unit in the OFDMA frequency dimension. In the downlink, a slot consists of 2 clusters again each cluster has 14 subcarriers over 2 symbol times. It is the minimum possible data allocation unit in the 802.16 standard, having both time and sub-channel dimension. Thus the downlink sector is made up of 28 groups of subcarriers called a sub-channel resulting in 30 DL sub-channels from 1024 sub-carriers at 10 MHz.

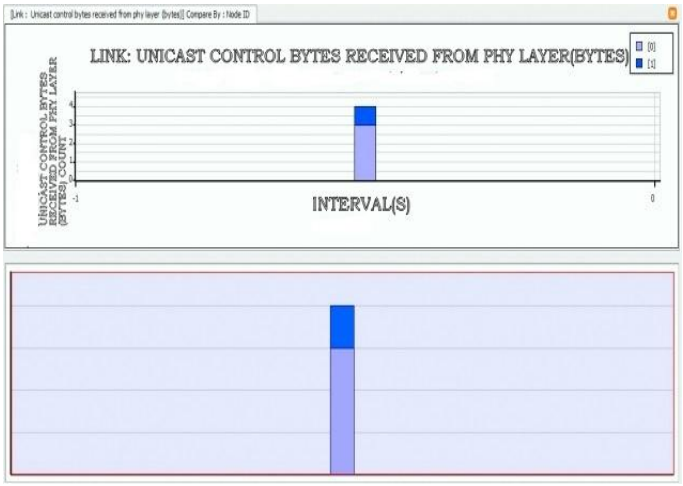


Fig: Unicast control bytes received from physical layer

4.2MAC LAYER OVERVIEW

The MAC layer is based on time-proven DOCSIS (Data Over Cable Service Interface Specification) standard and can support burst data traffic with high peak rate and supports streaming video and latency-sensitive voice traffic over the same channel.

The MAC layer [11] is formed with three sub layers: Service specific convergence sublayer (CS), Privacy sub layer and MAC common part sub layer (CPS).

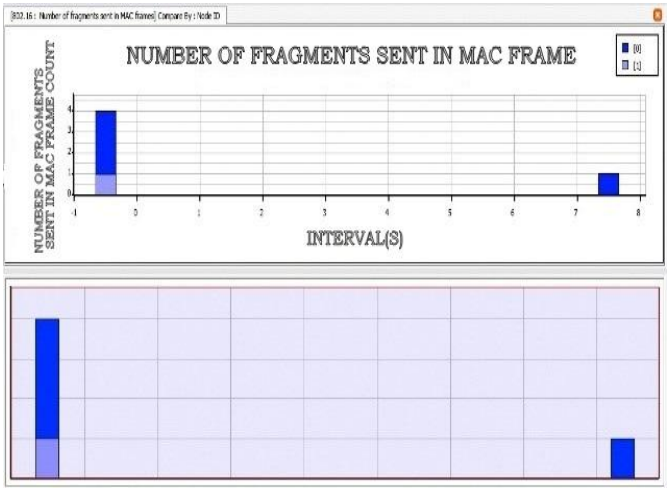


Fig: Number of segment sent in MAC frame

The MAC CS receives higher level data through CS Service Access Point (SAP) and provides transformation and mapping into MAC Service Data Unit (SDU). The Privacy sublayer lies between the MAC CPS and the PHYSICAL layer.

As security is one of the major issues for public networks, this sub layer provides the mechanism for encryption and decryption of the data transferring to and from the PHYSICAL layer and is also used for authentication and secure key exchange.

The CPS provides functions related to duplexing and channelization, channel access, PDU (Protocol Data Unit) framing, network entry and initialization. This also provides the rules and mechanism for the system access, bandwidth allocation and connection maintenance.

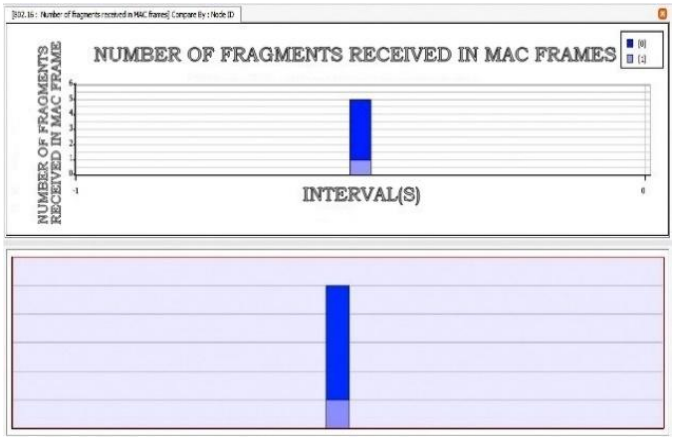


Fig: Number of segment received in MAC frame

4.3TOTAL UNICAST FRAGENTS SENT & RECEIVED

Total unicast data sent refers to the total no of data sent from the signal source to the single destination.

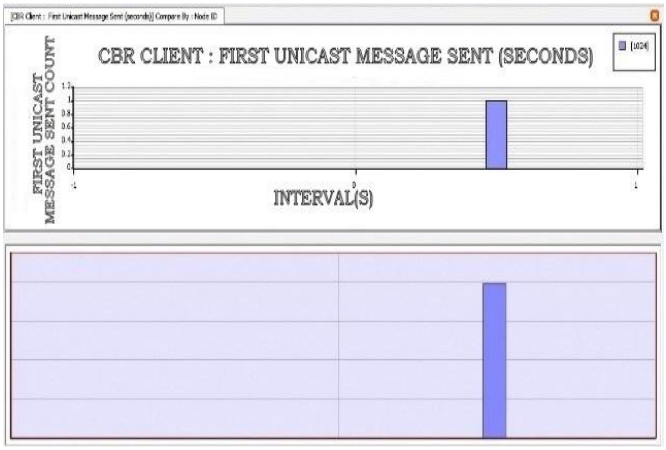


Fig: CBR client: first unicast message sent (seconds)

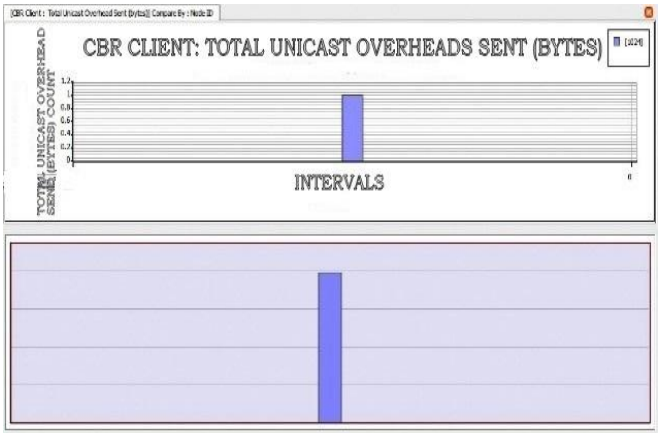


Fig: CBR client: Total unicast overhead sent(bytes)

Total unicast data received refers to the total no of data received from the signal source to the single destination.

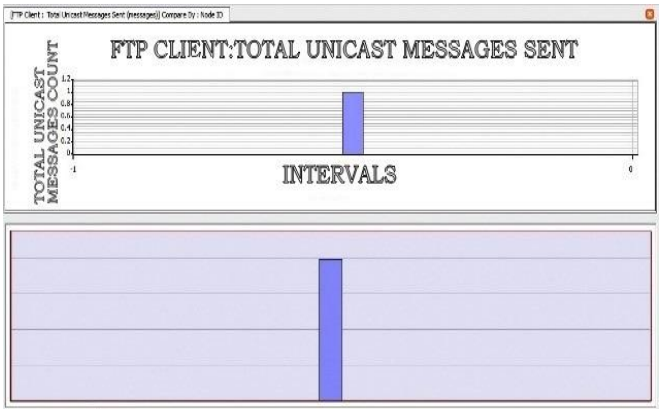


Fig: FTP client: Total unicast overhead sent (messages)

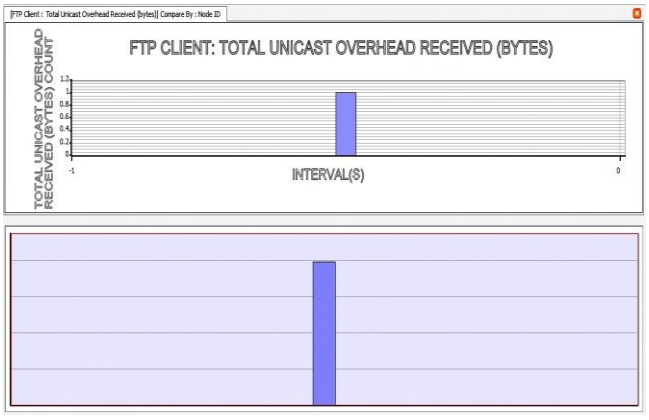


Fig: FTP client: Total unicast overhead received (bytes)

4.4RECEIVED THROUGHPUT

The average Throughput is the ratio of total amount of data that reaches to its destination to the time taken for the data to transfer from the source to the destination. In the context of communication networks, such as Ethernet or packet radio, throughput or network throughput is the rate of successful message delivered to the destination over a communication channel. The throughput is measured in bits per second (bit/s or bps).

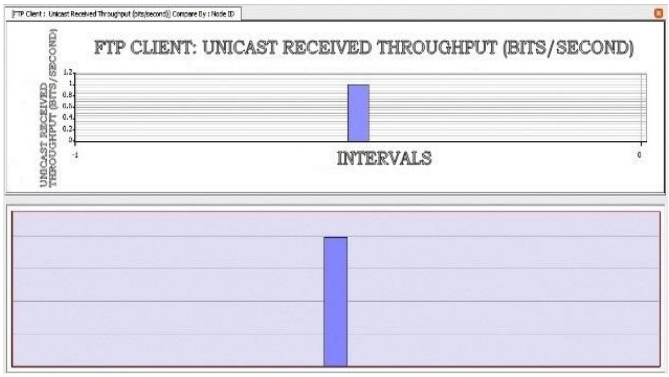


Fig: Unicast received throughput

4.5AVERAGE UNICAST END TO END DELAY

End-to-end delay indicates how long it took for a packet to travel from the CBR source to the application layer of the destination. This metric describes the packet delivery time as the lower the E-2-E Delay, better the application performance and vice versa. The E-2-E Delay value is averaged over the number of packets.

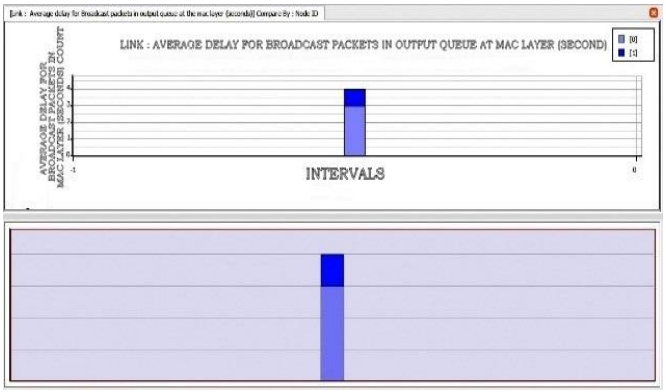


Fig: Average delay for broadcast packets

4.6AVERAGE UNICAST JITTER

Jitter is the variation in delay by different data packets that may be reach to the destination and can seriously affect the quality of the audio/video and thus an unwanted thing. Jitter is also the variation in the time difference between packets arriving caused by network congestion, timing drift, or route changes in the network. It signifies the Packets from the source till they reach to their individual destination with different delays. A packet's delays vary with its location inthe queues of the routers along the path between source and destination. This location is not predictable due to network circumstances.

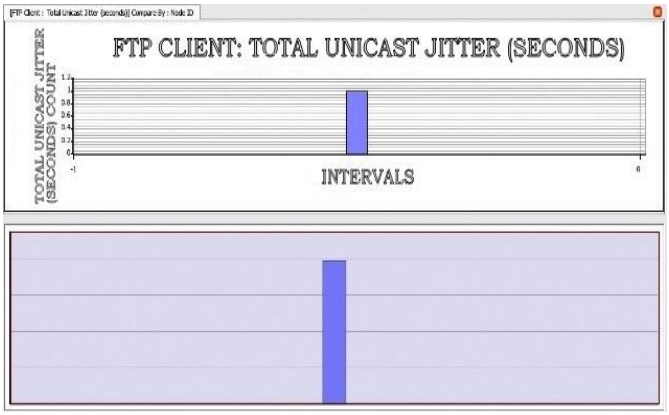


Fig: Total unicast Jitter

5.Conclusions

In this paper several scenarios were simulated using the simulation tool Qualnet7.3 for a single cell WiMAX. As mentioned earlier, one of the main features of IEEE802.16e is that it can operate in the unlicensed band (ISM band) which makes it attractive and cost effective to be set up in the campus based networks such as universities, military bases and airports. The main point here is to introduce a complete understanding of handover process in WiMAX network, as it is considered as one of the most important process to achieve the mobility within wireless networks. The main task of the simulation process is to determine which parameters are affected during the handover process in the mobile networks within WiMAX environment.

The results shows the performance metrics of some parameters such as total transmit messages, total received messages, throughput, average jitter and average end to end delay. Based on the analyses that have been done in this project, an optimization is required for the handover process of mobile WiMAX to improve its performance in terms of Delay and moving speed. Thus, the handover optimization process in mobile WiMAX may be one of the recommendations for future work.

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