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Modulation Scheme for Video Conference Multimedia Application Over Worldwide Interoperability for Microwave Access (WIMAX) Technology

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Abstract:
The problems being experienced by video conferencing are voice and video packet end-to-end delay, video packets delay, and throughput. Worldwide Interoperability for Microwave Access (WIMAX) comes into use as subscribers demand for better quality of service in the area of voice and video multimedia applications with high-speed data connection, excellent security and mobility. There is a great need to show improvements in modulation scheme with respect to packet end-to-end delay, throughput and packet delay variation performance metrics. Hence, a quantitative approach was developed using the Optimized Network Engineering Tool (OPNET) Modeler to show improvements in modulation scheme for the performance of video conference multimedia application over the WIMAX technology with respect to several performance metrics. The results obtained shows that packet end-to-end delay, throughput issues and packet delay variation issues that have caused delays in the network and errors in transmission can be managed and minimized through the use of the right modulation scheme better suited for each issue. For all delays, the QPSK 1/2 is noted to be steady, having less delays and interruptions. Hence, this particular quadrature amplitude modulation scheme is better for use when compared to the 16 QAM 1/2 and 64 QAM 1/2 with respect to the need to have shorter delays. Whereas for throughput, data transferred over a specific period of time in 16 QAM 1/2 is better than the 64 QAM 1/2 or QPSK 1/2.

Key Word*: Modulation scheme, OPNET, Video Conference, WIMAX.*

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I. Introduction

In today's world, multimedia has great relevance. The application of technological systems and tools has significant values in our world today. These changes in technology are generating an era in multimedia, in which users can easily have access to, and generate contents in audio and video cost-effectively and always readily available. Multimedia is one of the major technological advancements which is used in academics, businesses, communication, healthcare, and in lots of other disciplines. Multimedia therefore, combines different forms of media like; text, video, sound, graphics and animation in a unified system. Multimedia had limitations because there were lack of resources which were expensive, but in today's world, through the introduction of software, hardware, and the internet, multimedia has developed to a great extent. Currently, various aspects of multimedia have developed like; Voice over Internet Protocol (VoIP), Video conferencing between two or more participants, etc[1]

Currently, residential and business users need high-speed internet and general multimedia service and this need is seriously on the rise. IEEE 802.16 (which is also referred to as Worldwide Interoperability for Microware Access System) is a recent technology having Broadband Wireless Access. The need for broadband wireless network and mobile communication technology gave room for the development of WiMAX (Worldwide Interoperability for Microwave Access). WiMAX is a 4G (Fourth Generation) wireless broadband technology that establishes wireless broadband services to both fixed and mobile terminals respectively. It is a technology having major enhancements over WiFi and UMTS (Universal Mobile Telecommunication Services)/HSDPA (High Speed Downlink Packet Access). It is a Wireless Metropolitan Area network (WMAN). WiMAX technology was developed specifically for the provision of better quality of service in the area of voice and video multimedia applications with high-speed data connection, excellent security and mobility[5].

The earlier generation of mobile network technologies had solely voice communication but the advancements in the functionality of mobile devices of the fourth generation (4G) wireless technology gave birth to high-quality video conferencing communication over an all-Internet Protocol (IP) network. 4G is an

upgrade in the scope of the 3G technology having increased services, measures and Information[6]. WiMAX was established on the IEEE 802.16 standard (PHY and MAC layers). It is a great and fast developing technology of the broadband wireless project. Its transmission rate can get up to 75 Mbps with a distance of 50 km and above coverage area. WiMAX makes provision for a high transmission speed of up to 100 km/hr. There are two existing versions of WIMAX which handle requests for different kinds of access. The first version is the IEEE 802.16-2004 WIMAX. This first version enables access in line-of-sight and non-line-of-sight environments and uses Orthogonal Frequency Division Multiplexing (OFDM). For this first version, bit rate spans from 32 Mbps to 134 Mbps. The second version is the IEEE 802.16e WIMAX. It is based on 802.16e modification and guarantees roaming and handoff. This version enables access in non-line-of-sight environments and has a bit rate of up to 15 Mbps[5]. The WiMAX network, includes Subscriber Station (SS) and Base Station (BS), and two transmission modes of network topology namely, mesh and Point to Multi Point (PMP). WiMAX has the ability to achieve QoS, using a bandwidth demand and providing scheme on the subscriber stations, and this helps the WiMAX base station to retain its existing resources. The applications of WiMAX are quite numerous. The applications comprises of several programs as shown in Figure 1

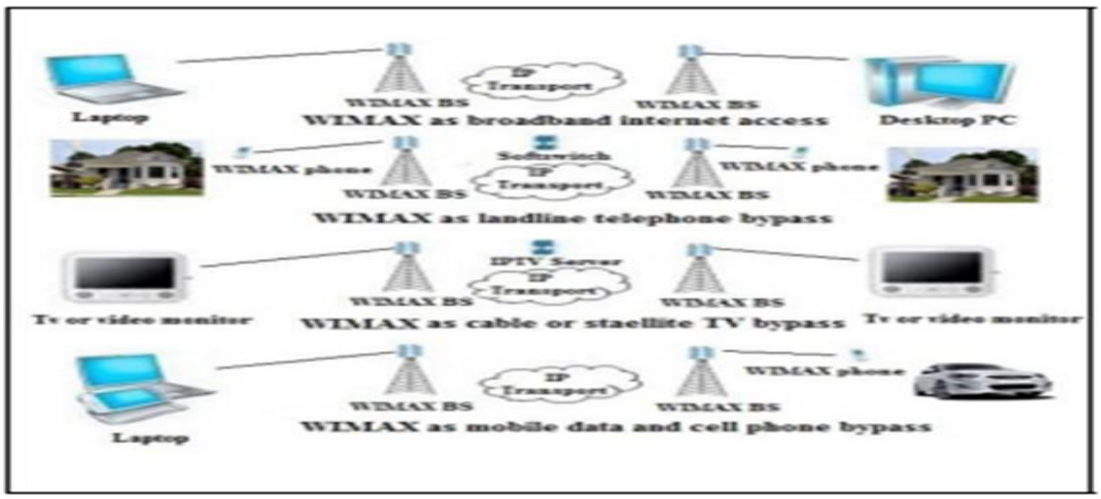

Figure 1: WiMAX Applications.

II. Literature Review

Wireless technology evolution is due to the necessity of high-definition multimedia transmission, therefore, more research findings should be expected in the area of reduction of delays and increase in capacity[4]. Another publication introduced a new design and proposed a current protocol to enhance videoconferencing. This protocol uses connection of subjective and objective End-to-End Quality of Experience with collected video data in real-time, application-level QoS measurements, and network-level QoS measurements[7]. The Performance was evaluated for throughput, packet delay variation load, packet end to end delay and other QoS performance parameters. This work noted that it would be beneficial in years ensuing for QoS parameters to be upgraded in order to have less delays and increased throughput over diverse modulation schemes[8]. There are various research works and contributions that discuss the QoS performance evaluation of Video conferencing over the WiMAX network. Some works have researched about WiMAX network and how it performs with respect to throughput, delay and jitter[9]. Different Modulation techniques were looked into having similar voice and video application framework while being linked to a server, behaviour of WIMAX system for individual workstations using the OPNET Modeler. The findings suggest that Video end-to-end delay has higher values when compared with voice. This goes generally for all modulation techniques with the exception of voice 64 QAM 1/2. There is a similar value for the voice application for all modulation techniques. Also, a WiMAX/Wi-Fi network model was created when a video conference application is being streamed for knowledge on how the network performs regarding the QoS prerequisite of a high-resolution video conference application. It was determined from the results obtained that there is a possibility of streaming a high-resolution video conference application on the network considering that the parameters needed to obtain a QoS which is high are gotten except packet loss, which is 2. Hence, it is quite close to the accepted standard required for QoS which is high, with some improvements being looked into[11]. The research gap for this work is the lack of sufficient research papers using different modulation schemes to manage issues of packet end-to-end delay, traffic in the network, packet delay variation and throughput in WiMAX network using the Optimized Network Engineering Tool (OPNET). Hence, this research work will contribute to knowledge and serve as a benchmark for further future studies.

III. Modulation Schemes for Video Conference Multimedia Application

Digital modulation can be defined as the process whereby the amplitude, frequency, phase or a combination of them is varied in accordance with the Information to be transmitted. A scheme that uses: Amplitude is called ASK (Amplitude Shift Keying), Frequency is called FSK (Frequency Shift Keying)**,** Phase is called PSK (Phase Shift Keying) and Combination of Phase and Amplitude is called QAM (Quadrature Amplitude Modulation) as shown in figure 2

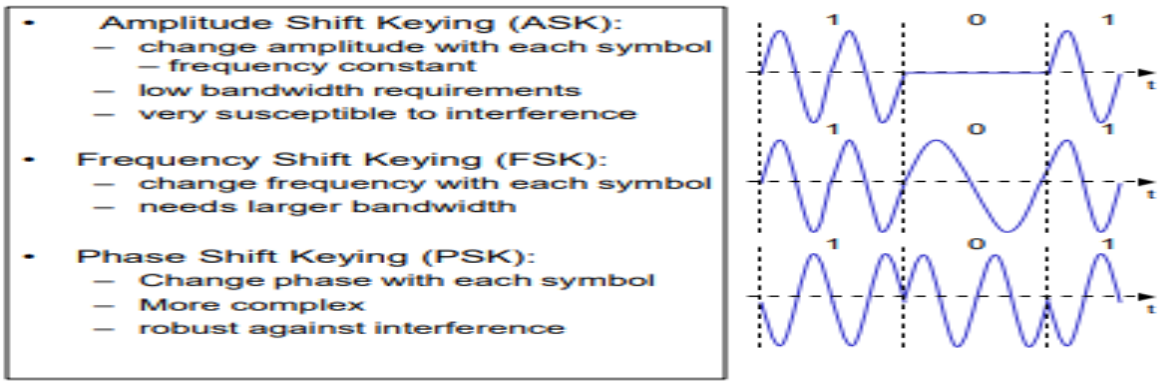

Figure 2: Digital Modulation Techniques

3.1 Quadrature Amplitude Modulation (QAM)

In this type of modulation, a modulation and combination of two carriers shifted in phase by 90 degrees is carried out. It uses amplitude shift keying (ASK) and phase shift keying (PSK) components to guarantee a type of modulation that can ensure high levels of spectrum usage efficiency. It is capable of providing a very efficient way to modulate data. It is utilized in basically anything, from cellular phones to WiFi including all different forms of high-speed data communication technology[10].

3.2 Quadrature Phase Shift Keying Modulation (QPSKM)

This is a type of phase shift keying whereby two bits are modulated at the same time, with a selection of four (4) possible carrier phase shifts (0, 90, 180 or 270 degrees). QPSK enables the signal to take two times the information for an ordinary Phase Shift Keying (PSK) through the use of same bandwidth[10].

IV. Materials and Method

4.1 Materials

The materials used include:

- A Computer System.
- Data source: Observation, journals, articles, papers, etc.
- Software: Microsoft word, Excel spreadsheet and graph
- Simulator: OPNET Modeler 14.5 shown in Figure 3

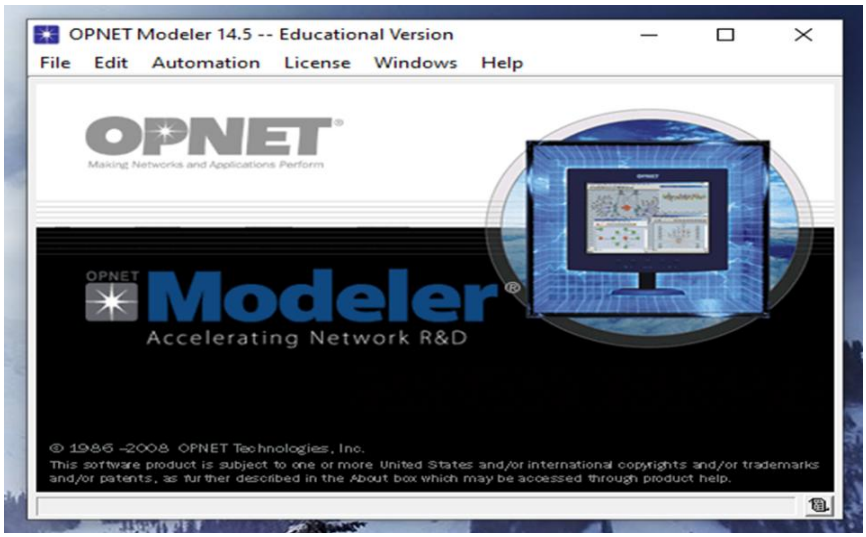

Figure 3: OPNET MODELER 14.5 Home Page

4.2Method

The research methods employed in this study is based on a quantitative approach which is:

- To investigate and evaluate video quality with respect to packet delay variation, end-to-end delay, throughput, load, traffic sent and traffic received in the network.
- To assign 3 different modulation schemes to the uplink and downlink channels for video conferencing
- Modulation Schemes used to achieve Simulation Results: The chosen modulation schemes are QPSK 1/2, 16-QAM 1/2 and 64-QAM 1/2. After the network configuration, these modulation schemes were used to achieve our simulation results based on the parameter challenges being investigated which are; packet end-to-end delay (sec), traffic received (packets/sec), delay (sec), load (packets/sec), throughput (packets/sec), traffic sent (packet/sec), packet delay variation

Simulation is an imitation of the operation of a real-world process or system. Before live implementation, testing of the developed technique is required. Most of the time, testing and evaluating the protocols or theories proposed is not practically feasible through real experiments as it would be more complex, time consuming and even costly. So, to overcome this problem, "SIMULATORS and TESTBEDS are effective tools to test and analyze the performance of protocols and algorithms proposed[12].

4.2.1Simulation Parameters

Table 1: Simulation Parameter

Parameters	**Values**
PHY Layer	IEEE 802.16
BS transmission power	0.5W
Base Station antenna gain	15dBi
Mobile Station antenna gain	-1dBi
Modulation schemes	QPSK 1/2 16-QAM 1/2 64-QAM 1/2
Pathloss parameter	Vehicular environment
Radius of cell	1km
Number of mobile nodes	36 mobile nodes
PHY profile	Wireless OFDMA 20 MHz
Simulation time(sec)	360
Efficiency mode	Mobility and Ranging enabled

The efficient and economical way to deploy live implementation is to perform adequate testing of the developed technique. But the environment to carry out the required test for wired/wireless network is not readily available especially for live experimental study which could be very challenging, costly and time wasting. Hence, the solution is to use "SIMULATORS, EMULATORS and MODELERS which is a helpful tool to adequately analyze and test the performance of algorithms and protocols[13].

The simulation was carried out by initially installing the Optimized Network Engineering Tool (OPNET) 14.5 Modeler version on the computer system. After the installation process was carried out, the modeler home page and a new simulation environment was opened where the actual simulation work was done. The next step was to click on the topology option on the menu bar and select object palette tree. Here, the WiMAX application configuration node, profile configuration definition node and application configuration definition node were all dragged and dropped onto the modelling page as shown in figure 3. The internet protocol (IP) router and ethernet server were also chosen. Six (6) cells were set-up to manage the Six (6) WiMAX mobile subscriber stations and one (1) WiMAX base station for each of the cells making it a total number of 36 WiMAX mobile subscriber stations and 6 WiMAX base stations.

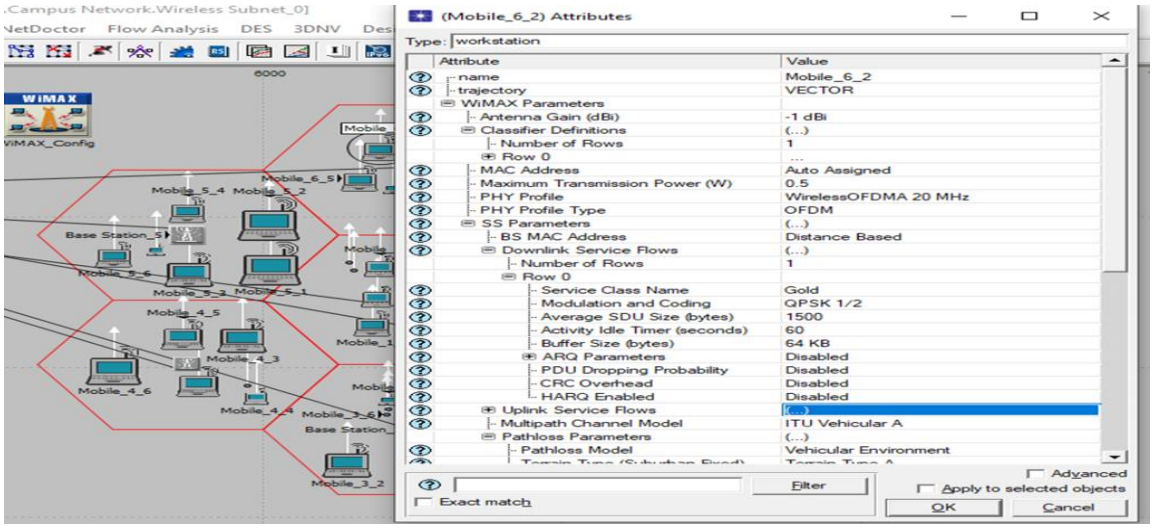

Figure 4: WiMAX Parameters Configuration and Simulation Page

V. Result and Discussions

5.1 Packet End-to-End Delay

Packet end-to-end delay is measured in seconds. For the packet End-to-End delay results obtained, the QPSK 1/2 is noted to be steady, having less delays and interruptions.

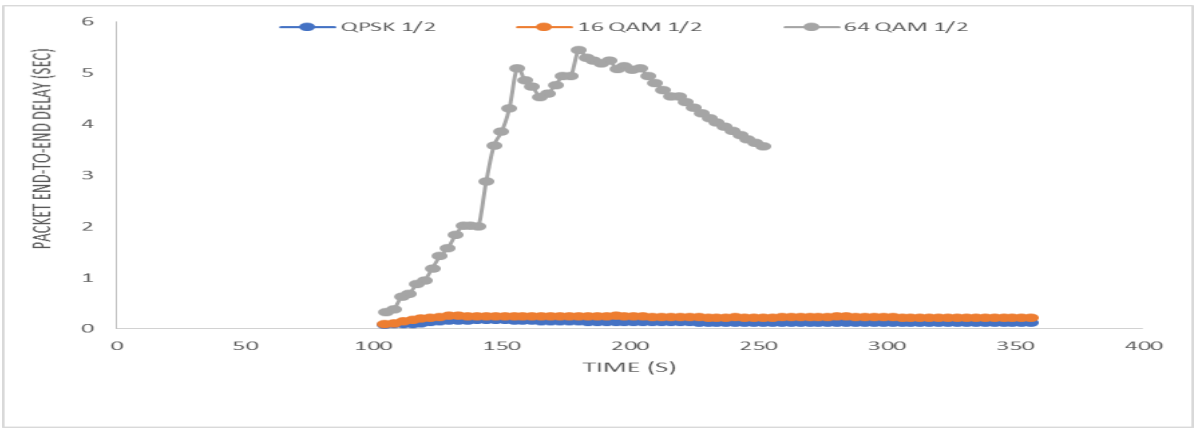

Figure 5: Comparative Analysis of Packet End – to- End Delay

This particular quadrature amplitude modulation scheme is better for use when compared to the 16 QAM 1/2 and 64 QAM 1/2.

5.2 Traffic Received

Traffic received is measured in packets/second. It is the amount of data which is received by the mobile station. From the simulation results obtained, it is observed that 16 QAM 1/2 receives more traffic than the QPSK 1/2 and 64 QAM 1/2. 64 QAM receives less traffic.

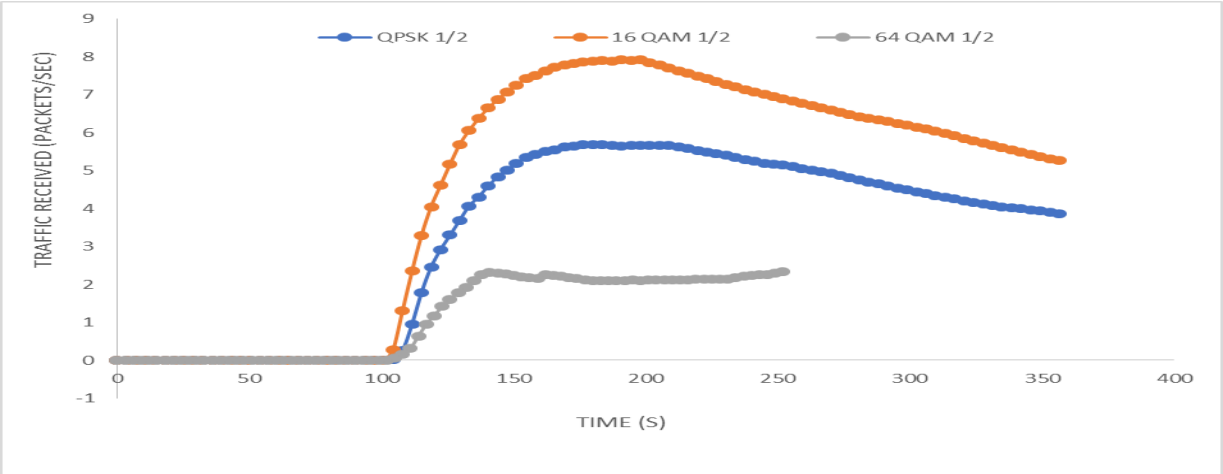

Figure 6: Comparative Analysis of the Traffic Received

From Figure x above, it is more advantageous to use the 16 QAM 1/2 whenever there is a need to receive more traffic.

5.3 Delay

Delay is measured in seconds. With respect to the results for delay, the QPSK 1/2 is noted to be steady, having less delays and interruptions

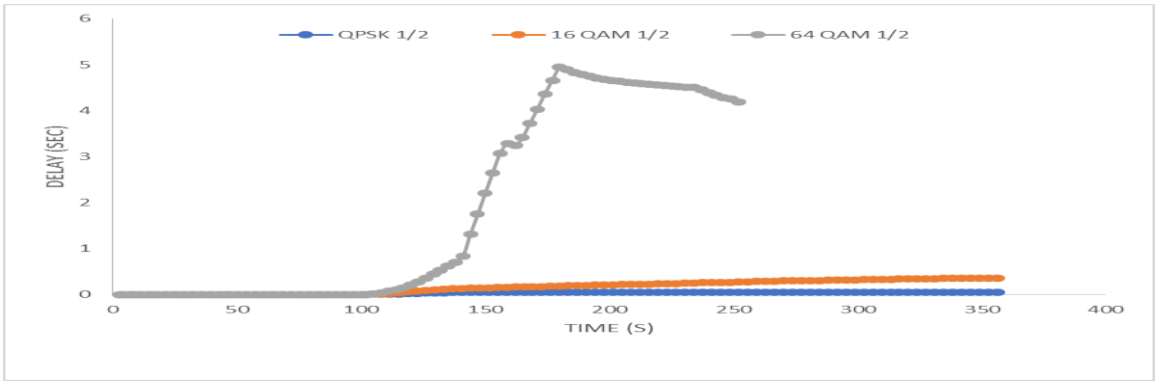

Figure 7: Comparative Analysis of the Delay

This particular quadrature amplitude modulation scheme is better for use when compared to the 16 QAM 1/2 and 64 QAM 1/2 with respect to the need to have shorter delays.

5.4 Load

Load is measured in packets/second. Load is explained as load that is by all other higher layers to WiMAX layer

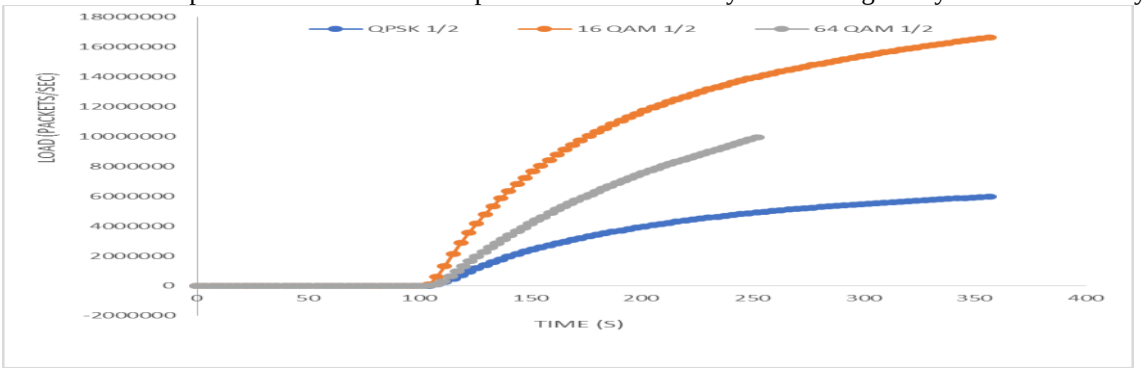

Figure 8: Comparative Analysis of the Load

The simulation results obtained for load clearly show that QPSK 1/2 is lowest while 16 QAM 1/2 is highest.

5.5 Throughput
Throughput is measured in packets/second.

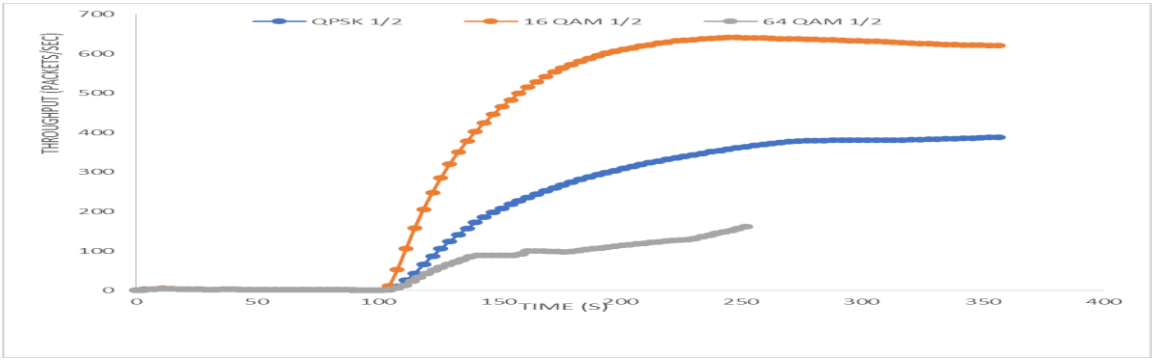

Figure 9: Comparative Analysis of Throughput

Looking at the results, it is clear to see that data transferred over a particular time frame, 16 QAM 1/2 is best to use, followed by QPSK 1/2 and lastly the 64 QAM 1/2.

5.6 Traffic Sent
Traffic sent is measured in packets/second. It is the total amount of traffic sent by the base station to the mobile stations. The rate of traffic needs to be high to ensure that any loss occurring will not be too much, if data is delayed or lost along the path to its destination.

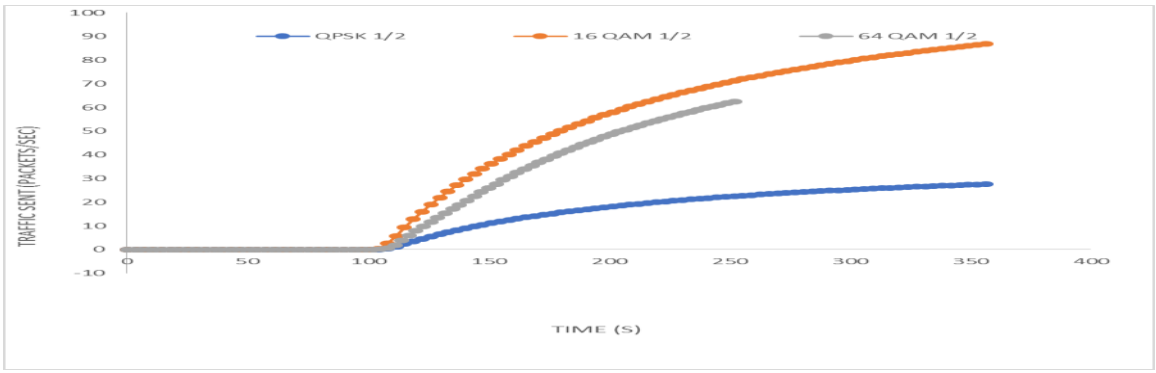

Figure 10: Comparative Analysis of Traffic Sent

From the simulation results, it is clear to note that 16 QAM 1/2 modulation scheme performance is best for use, followed by the 64 QAM 1/2 modulation scheme, and lastly followed by the QPSK 1/2.

5.7 Packet Delay Variation
This is also known as packet jitter.

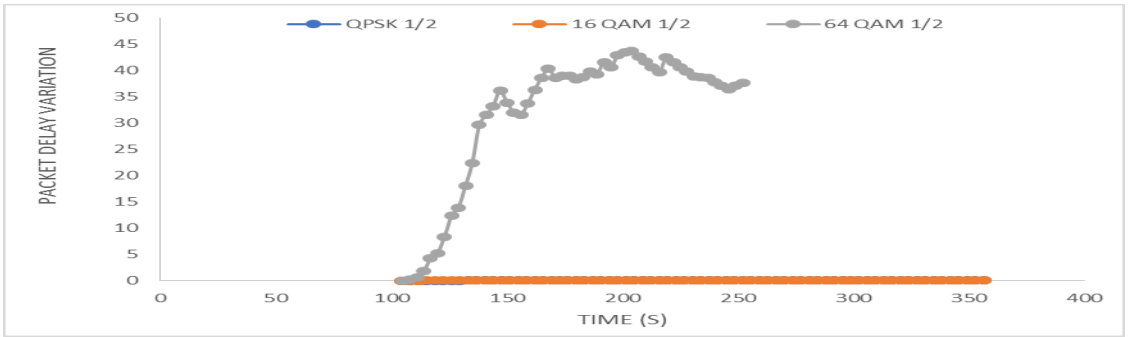

Figure 11: Comparative Analysis of Packet Delay Variation

For packet delay variation simulation results, it is analyzed that the delay in QPSK 1/2 is lower than the 16 QAM 1/2 and 64 QAM 1/2 modulation schemes, whereas, in 64 QAM 1/2, delay is analyzed to be higher than the 16 QAM 1/2 and the QPSK 1/2. Hence, QPSK 1/2 modulation scheme is best for use with respect to packet delay variation.

For all delays, the QPSK 1/2 is noted to be steady, having less delays and interruptions. Hence, this particular quadrature amplitude modulation scheme is better for use when compared to the 16 QAM 1/2 and 64 QAM 1/2 with respect to the need to have shorter delays in a system. Whereas for throughput, data transferred over a specific period of time in 16 QAM 1/2 is better to be used than the 64 QAM 1/2 or QPSK 1/2 with respect to the need to receive more traffic in the network. This will ensure that if data is delayed or lost along the way to its destination, loss occurring will not be too much.

VI. Conclusion

Packet end-to-end delay, throughput issues and packet delay variation issues that have caused delays in the network and errors in transmission can be managed and minimized through the use of the right modulation scheme better suited for each issue. Also, traffic sent and received in the network has also taken part to cause delays and errors in the network. Therefore, it was imperative to come up with the best suited modulation schemes to manage each of these issues being experienced. For all delays, the QPSK 1/2 is noted to be steady, having less delays and interruptions. Hence, this particular quadrature amplitude modulation scheme is better for use when compared to the 16 QAM 1/2 and 64 QAM 1/2 with respect to the need to have shorter delays in a system. Whereas for throughput, data transferred over a specific period of time in 16 QAM 1/2 is better to be used than the 64 QAM 1/2 or QPSK 1/2 with respect to the need to receive more traffic in the network. This will ensure that if data is delayed or lost along the way to its destination, loss occurring will not be too much.

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