ANALYSIS OF MAC TO MAC VIDEO STREAMING OVER MOBILE WIMAX 802.16E

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ABSTRACT

In this research article efficient transmission of video streaming across PHY(Physical) and MAC(Medium Access Control) layer of Mobile WiMAX (Worldwide Interoperability for Microwave Access) IEEE 802.16e using HARQ (Hybrid Automatic Repeat Request) technique is proposed. HARQ utilizes both FEC (Forward Error Correction) and ARQ (Automatic Repeat Request) technique which reduces the delay, packet loss rate and increases the throughput efficiently under the prescribed quality of service constraint. In this research work, the authors have made a comparative analysis of the throughput, delay and jitter on a video traffic application with and without ARQ implementation. Adaptation of Modulation and coding scheme at PHY layer along with MAC layer HARQ are considered in this work .Both QoS parameters and service classes of PHY layer and MAC layer are analysed and the parameters of PHY layer are to be mapped with the QoS parameters of MAC layer ,so that video streaming can be easily and efficiently transferred with proper mapping of QoS service classes and by using Hybrid ARQ technique. For the proposed design the performance measures like the end to end delay, average throughput, and average jitter are numerically analysed. Numerical results indicate that performance factors and throughput are expected to further increase with this proposed method.

KEYWORDS: *Mobile WiMAX, OFDM, QoS Service Classes, ARQ, HARQ.*

I. INTRODUCTION

Mobile WiMAX is an enhanced version of IEEE 802.16 standard with mobility support [1]. It offers scalability and supports flexible network architecture. Amendments support scalable channel bandwidths from 1.25 to 20 M Hz. Mobile WiMAX IEEE 802.16e supports mobility and is also capable to provide fixed access. It adopts Orthogonal Frequency Division Multiple Access (OFDMA)[9] for improved multi-path performance in non-line-of-sight environments. The Mobile WiMAX profiles will cover 5, 7, 8.75, and 10 MHz channel bandwidths for licensed worldwide spectrum allocations in the 2.3 GHz, 2.5 GHz, 3.3 GHz and 3.5 GHz frequency bands [2]. Characteristics of IEEE 802.16e are Advanced antenna diversity schemes, hybrid automatic repeat-request (HARQ),Adaptive Antenna Systems (AAS), MIMO technology [8]. It provides denser sub-channelization, thereby improving indoor penetration: Turbo and Low-Density Parity Check (LDPC) are introduced. Automatic Repeat request (ARQ) or Forward Error Correction (FEC) are the error correction techniques that are adopted. A combination of both the above mentioned methods is called Hybrid ARQ (HARQ) [5]. All three error correction mechanisms are implemented on physical and/or Medium Access Control (MAC) layer.

The rest of the paper is organised as follows. We develop the cross layer design in section II by combining the AMC at PHY layer and HARQ at the MAC layer. We also present the related work, proposed work and the Scheduler used the work in section II. Simulation setup and simulation results are shown in section III. Finally conclusion remarks and future work are presented in section IV.

II. PROPOSED BLOCK DIAGRAM

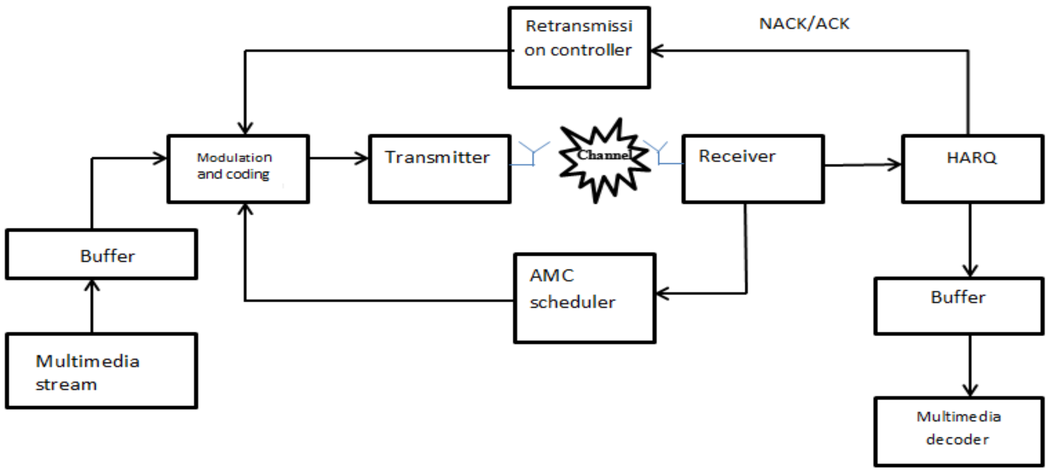

Figure 1. Block diagram of the proposed model

The simulation model is shown in the above Fig 1. Here multimedia stream of data is buffered using a finite-length queue (buffer) ,which is implemented at the transmitter and operates in a first- in-first-out mode [4]. The queue feeds data in to Modulation and coding unit which is controlled by the AMC controller/scheduler at the transmitter. Channel is considered as AWGN. HARQ performs error correction and detection mechanism. Regenerative controller block has controlling circuit which enable to retransmit the lost data depending upon the reception of NACK/ACK signal from the receiver .At the wireless link (PHY), multiple transmission modes are available, with each mode representing a pair of a specific modulation format, and a Forward Error Correcting (FEC) code as in IEEE 802.11/15/16 standards. The AMC design considered assigns the exact mode based on channel estimation at the receiver. The AMC scheduler determines the modulation-coding pair (mode), which is sent back to the transmitter through a feedback channel, to update the transmission mode [6].There are different schedulers available for the WiMAX. Some are standard schedulers and some others are designed by the user according to their proposed model. In this work mmSIR scheduler is used which is spec ifically used for rtPS service class. It allocates the resource according to priority wise, first priority is given to the one which has the highest Signal to Interference Noise (SIR). Some multimedia decoders are used at the receiver to decode the bits. The decoded bit streams are mapped to packets, which are pushed upward to the data link layer.

2.1 mmSIR SCHEDULER

In this scheduler BS allocates symbols for the UGS, then rtPS and finally BE connections. For the allocation of symbols for rtPS connection, the BS allocates periodical unicast request opportunities and then, according to these requests, the symbols needed for the rtPS connections. If the BS allocates unicast request opportunities and resource grants for rtPS connections in the same frame, the BS cannot immediately take into account the new length of the uplink data connection of the subscriber. The reason is that the BS allocates symbols for rtPS connections before receiving the latest unicast bandwidth request. Moreover, the mmSIR scheduler serves those subscribers having the highest SIR at each frame. So, subscribers having a slightly smaller SIR may be not served and then the mean delay to deliver the data increases. This means delay can be reduced by using modified maximum Signal-to-Interference Ratio (mmSIR) scheduler [3]. The main steps of this scheduler are shown in Fig. 2

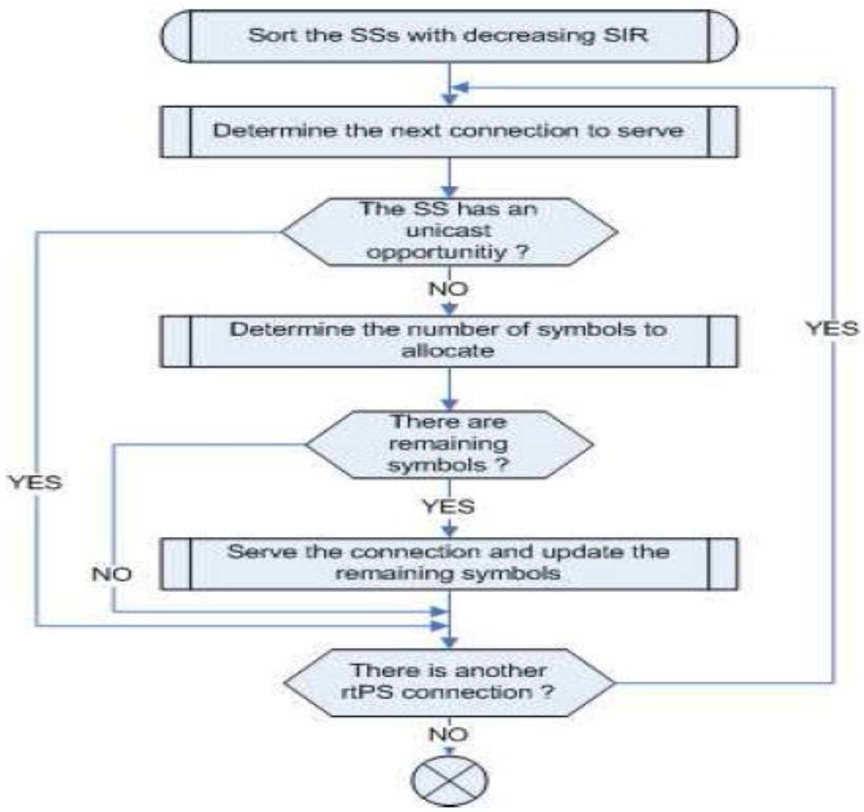

Figure 2. mmSIR Scheduler

2.2 Related Work

To improve the video quality transmission efficiency the authors proposed MAC/PHY cross layer issue that enhance the received video quality over mobile WiMAX while maintaining required QoS constraint. The authors have estimated QoS parameter like throughput, end to end delay, average jitter and Packet loss rate using ARQ techniques [7] .On doing this there is a decrease in the packet loss rate and increase in the video quality with increase in delay and jitter.

2.3 Proposed Work

We the authors propose that by using HARQ technique instead of ARQ across the MAC/PHY cross layer, it is expected that there will be a increase in the throughput and hence improvement in the video quality (in terms of number of frames) received with a reduction in the delay and jitter. The network simulator Qualnet 6.1 is used to simulate transmission of video traffic across PHY/MAC layer over WiMAX for two different scenarios, one by disabling ARQ and other one by enabling ARQ. In the case where ARQ is incorporated, more delay and jitter exist in the received data but there is a decrease in the packet loss rate and thereby increase in the throughput [10]. Since HARQ uses both ARQ and FEC, we expect further reduction in the packet loss rate and improvement in the video quality [9].

III. SIMULATION

Simulation is being carried out using Qualnet 6.1 Wireless network Simulator. WiMAX scenario was created using nodes and subnet. Three homogeneous n/w s are considered ,and one node of each network is assigned to act as a Base Station(BS) whereas all other nodes are assigned to act as a subscriber station(SS).System Parameters like channel frequency, Bandwidth, transmission power etc. were specified as per IEEE standard 802.16e as shown in the Table 1 .Bellman Ford routing protocol is used as a default one. Video traffic is applied between a SS node of one network to a SS node of another network .Mobility is assigned to one of the connected SS node.

In the first case, WiMAX scenario was simulated for video traffic application without enabling ARQ techniques and the results were noted down. Next case, it was simulated by enabling ARQ in the MAC layer and the two results are compared. These comparisons are indicated in the Table 2. ARQ techniques achieve reduced packet loss but with increase in the end to end delay and jitter. Authors propose to further reduce this delay associated with ARQ by using HARQ technique which combines both FEC and ARQ .Hence both throughput and bandwidth increases significantly. Fig 3 shows WiMAX scenario for video traffic application.

Table 1. Simulation Parameters

Parameter	Value
Carrier Frequency	2.4 GHz
Channel Bandwidth	20 MHz
FFT size	2048
Cyclic prefix factor	8
Transmission Power	20dBm
ARQ window size	1024 bytes
ARQ Block size	64 bytes
ARQ retry timeout	4 frames

3.1 Simulation Setup

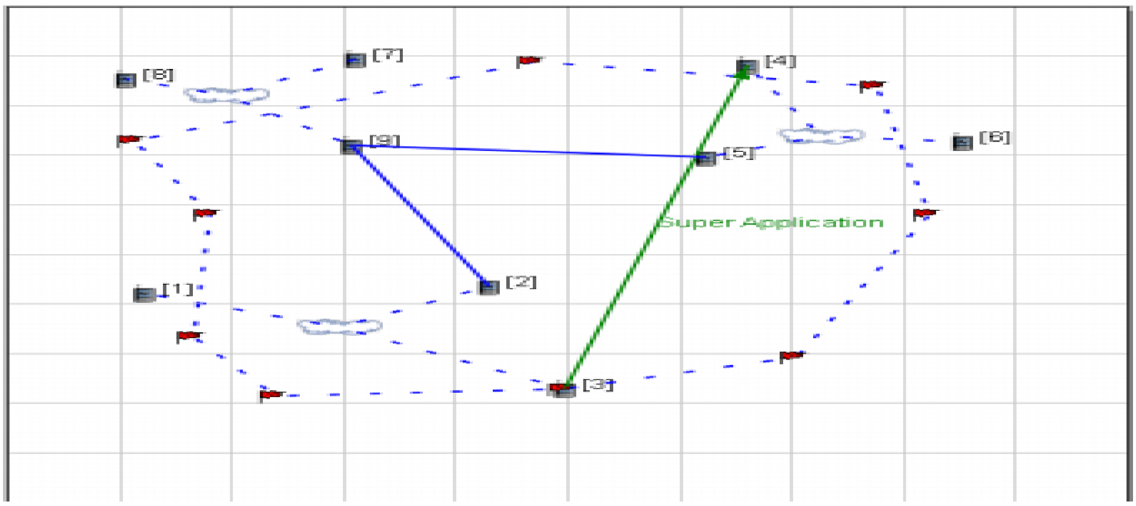

Figure 3. WiMAX Scenario

Simulation set up is shown in Fig 3.Three homogeneous network are considered (in this work WiMAX).Each network connected with 3 nodes .Node 2, 9 and 5 are base station connected by wired line. Super application is connected between node 3 and node 4.

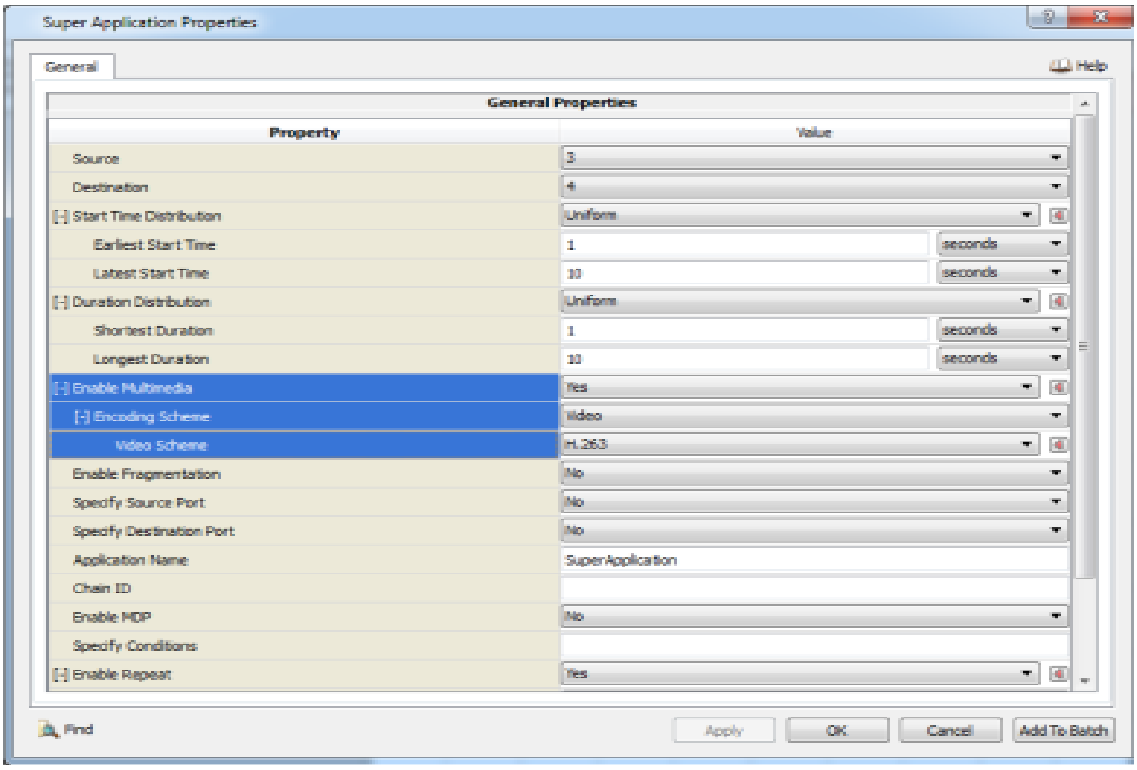

Figure 4. Multimedia application parameters

Fig 4.shows the parameter considered for multimedia application .In this work H.263 video encoding scheme is used.

3.2 Simulation Result

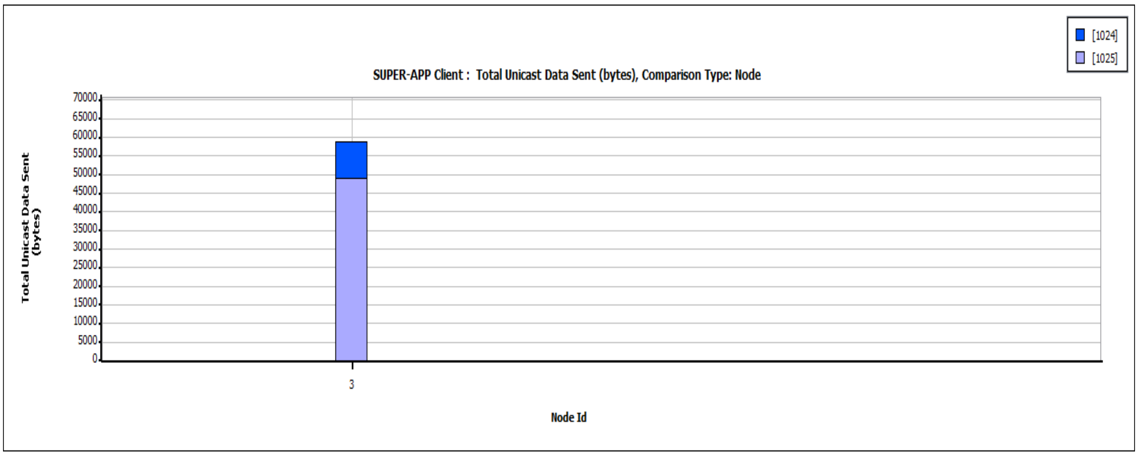

Figure 5. Total Unicast data sent (59200 bytes)

Number of data packets sent is 100.Each packet is of length 592 bytes, totally 59200 bytes of data is sent from transmitter to the receiver over WiMAX network.

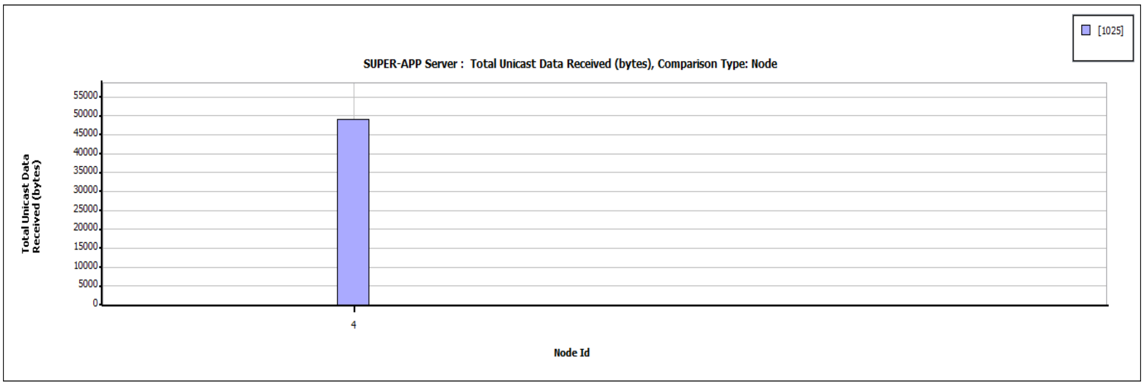

Figure 6. Total Unicast data received (49120 bytes)

Data received at the receiver is 49120 bytes, there will be loss of data due to the error in the channel.

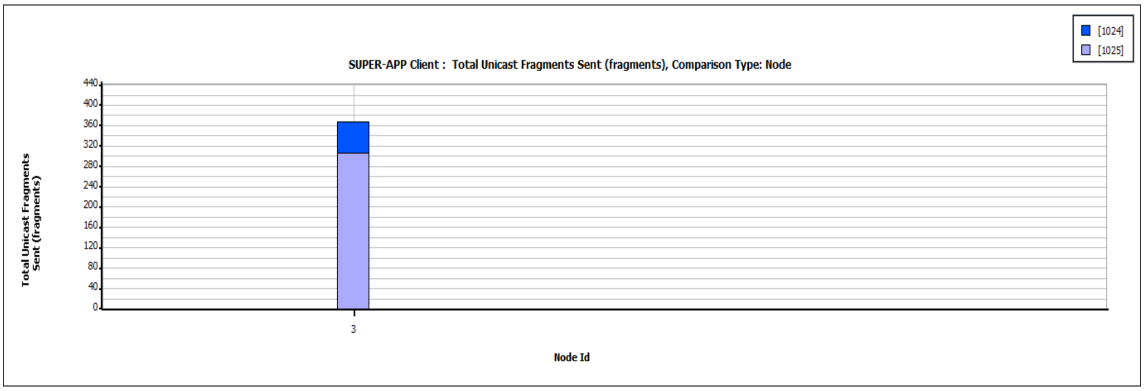

Figure 7 Total Fragments sent (370 frames)

The above figure shows the total number of fragments sent from source to destination. Each packet is divided in to various numbers of frames. Each frame is identified by the sequence number. In this work totally 370 frames are transmitted.

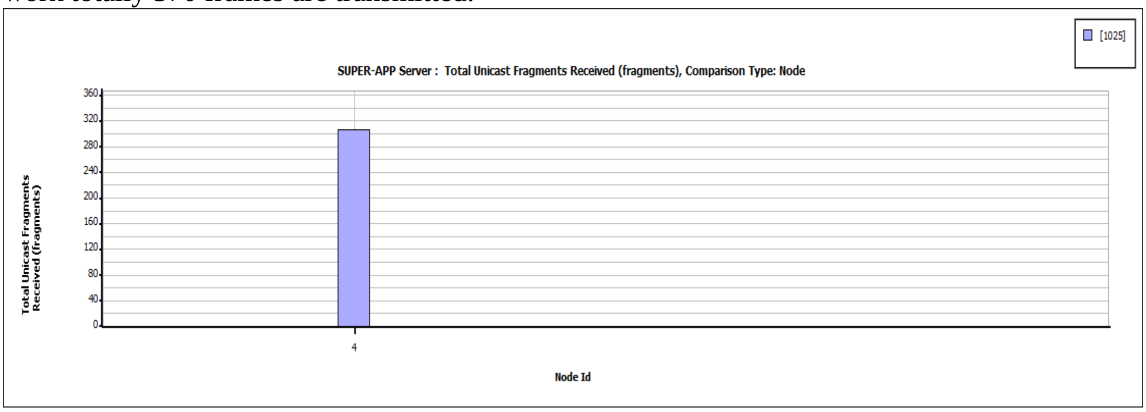

Figure 8. Total Fragments received (307 frames)

Without enabling the ARQ technique, total number of fragments received at the receiver is 307 frames .There is a loss in the number of frames received, which is due to the channel error. By enabling ARQ techniques the number of frames received is 370 frames. This is because of retransmission of lost frames or error frames.

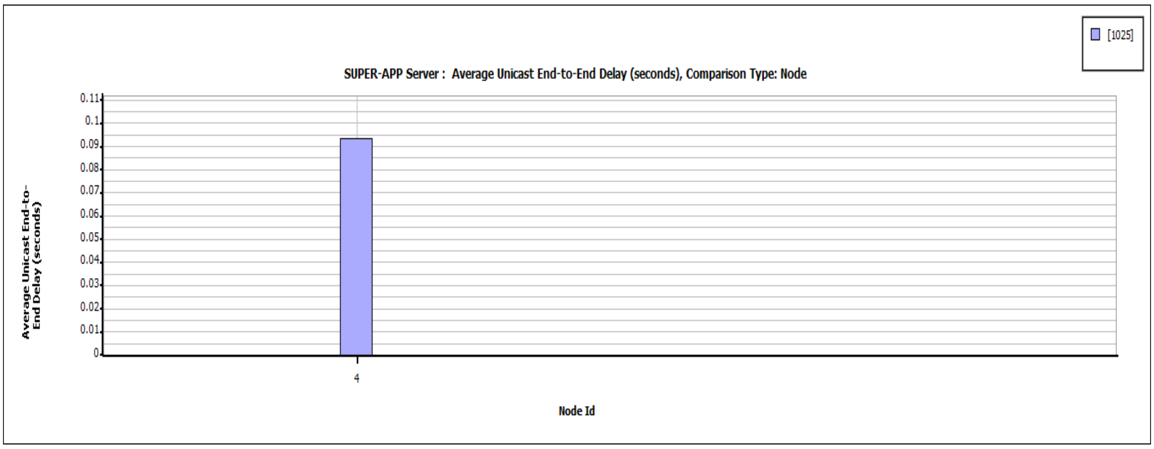

Figure 9 End to End delay with ARQ (0.0935 sec)

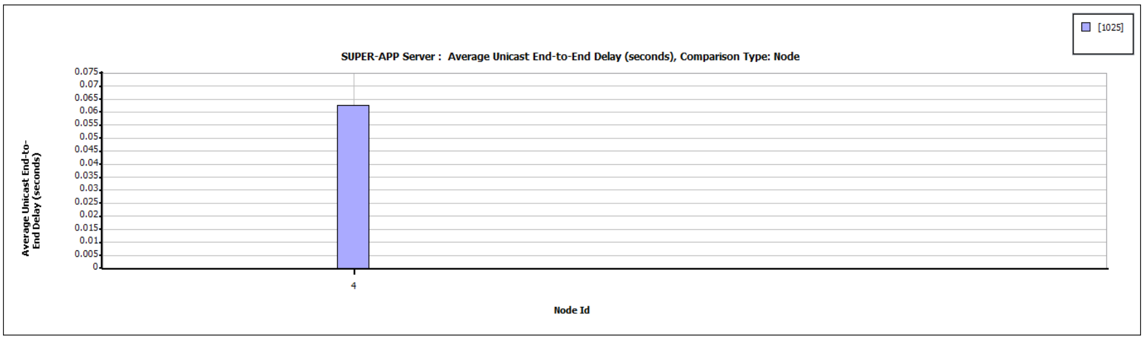

Figure 10. End to End delay without ARQ (0.0626 sec)

Fig 9 and 10 shows the End to End delay achieved to transmit 59200 bytes of data over WiMAX network. Without ARQ the delay will be 0.0626 sec whereas with ARQ delay will be 0.0935sec .This increase in delay is due to the retransmission of lost or error packets.

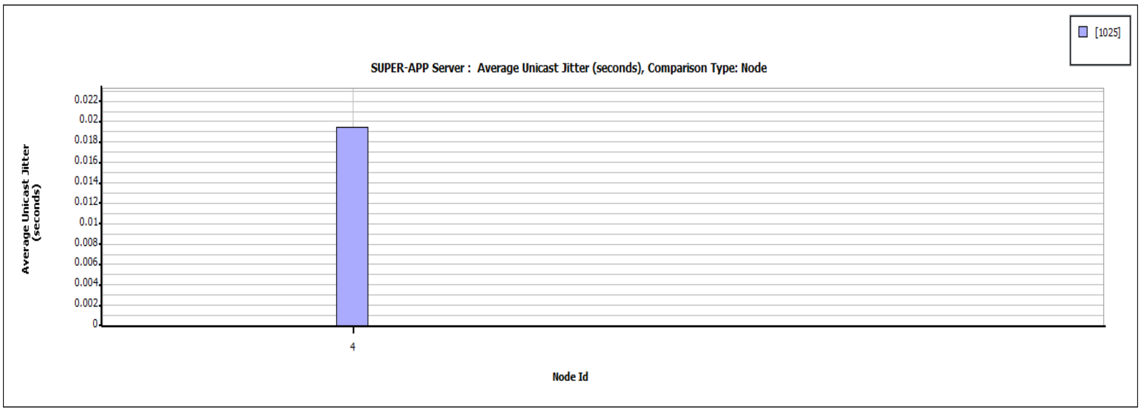

Figure 11. Average Jitter with ARQ (0.01947 sec)

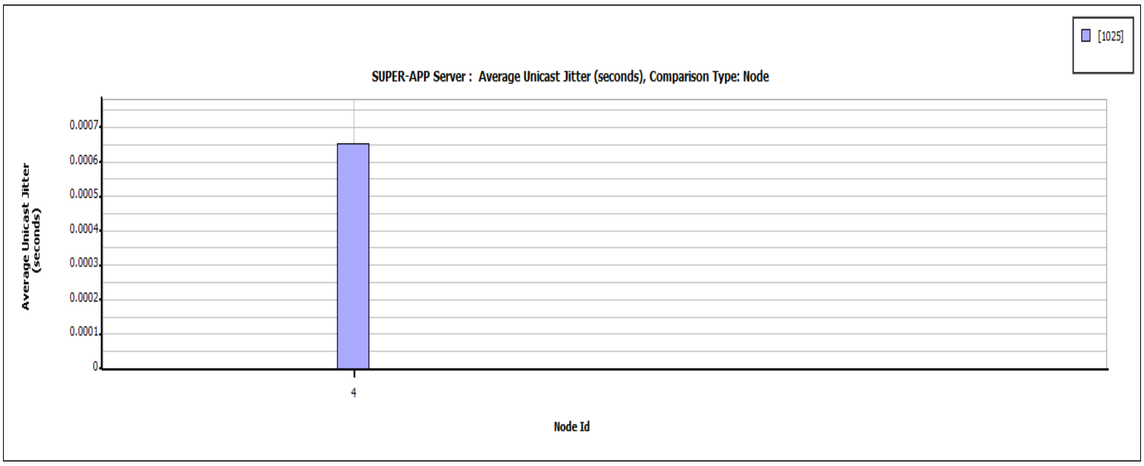

Figure 12. Average Jitter without ARQ (0.0006535 sec)

Average Jitter obtained after simulation is shown in Fig 11 and 12.It is 0.01947sec when ARQ is enabled, 0.0006535sec when ARQ is disabled. This decrease in average jitter is due to time taken for retransmission of lost and error packets.

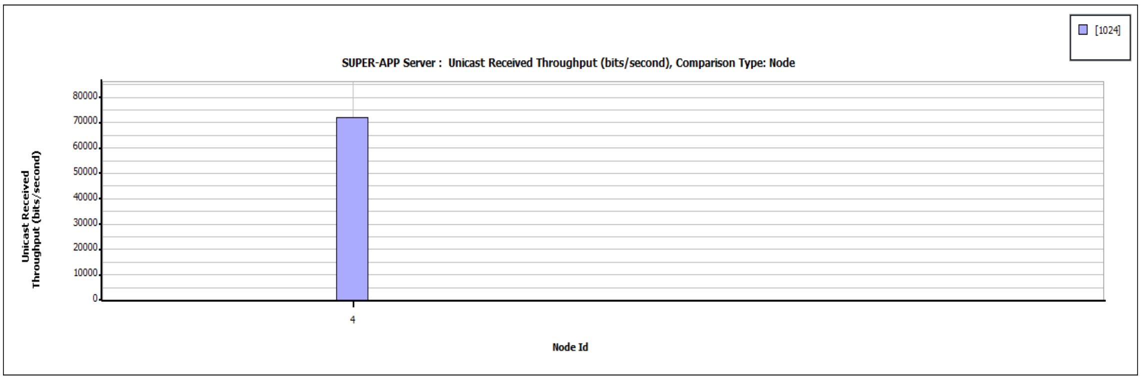

Figure 13. Throughput with ARQ (72112.7 bits/s)

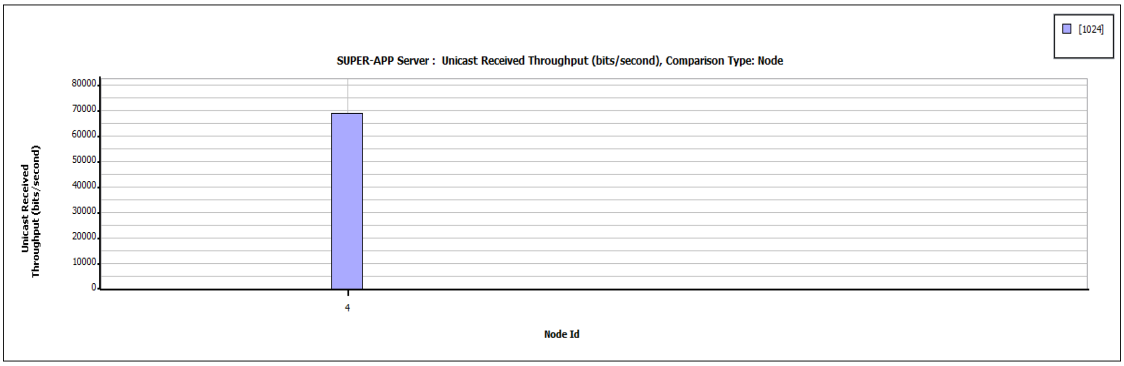

Figure 14. Throughput without ARQ (69182.2 bits/s)

Fig 13 and 14 indicates throughput achieved by enabling and disabling ARQ techniques respectively. It indicates 72112.7 bits are transmitted per second when ARQ technique is used. This reduces to 69182.2 bits/sec when ARQ is not used. This indicates that throughput can be increased significantly by using ARQ.

Table 2.Comparitive result of Video traffic application

Sl.No.	Parameters	With ARQ	Without ARQ
1	Total Unicast Data sent(in bytes)	59200	59200
2	Total Unicast Data received	49120	49120
3	Total Fragments Sent (in frames)	370	370
4	Total Fragments received	370	307
5	End to End delay (in sec)	0.0935	0.0626
6	Average Jitter (in sec)	0.01947	0.0006535
7	Throughput (in bits/sec)	72112.7	69182.2

IV. CONCLUSIONS

The model has been proposed for efficient streaming of video application over mobile WiMAX using HARQ scheme. Since HARQ utilizes both ARQ and FEC, it reduces the latency associated with the data and hence increases the throughput efficiently. Proposed model is first analysed for ARQ technique and the results obtained shows that there is reduction in packet loss rate but with more delay and jitter. The corresponding results are indicated in Fig 9, 10, 11, 12, 13, 14.It indicates ARQ performs better than FEC with good throughput and packet loss rate. Further delay minimisation and higher throughput can be obtained by using HARQ technique for any multimedia applications like video, image. Since video application is used, HARQ technique will enable to receive more number of frames with less delay and jitter, hence quality of video will increase efficiently under the required QoS constraint.

4.1 Future Work

The effect of coding efficiency and the network performance can be further studied as future work. In this work we have used mmSIR scheduler for allocation of resources, performance can be further improved by using other schedulers, and it can be considered as a open research issue. . The effect of this proposed work for real time video application can be studied in future.

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