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Quality of Service Optimization of Ultrasound Video Streaming over LTE Network

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Abstract: The proposed work addresses the medical quality of service (QOS) requirements for ultrasound video streaming in LTE network. Medical video streaming varies from normal video streaming applications as the information content at the receiver is very much important for proper diagnosis. The key challenge is loss of information cannot be allowed for medical data and videos. The developed model consists of six UE's and one eNodeB. Using the developed platform and also with the help of video codec ffmpeg tool, the user streams ultrasound video clips to the end user. The perormance is evaluated in terms of PSNR, Throughput and RTT.

Keywords: *QoS, PSNR, Throughput, RTT, Video streaming. and LTE*

I. INTRODUCTION

Different wireless entities support video streaming applications but not all of them could support all kind of applications as their performance varies in terms Bandwidth, Data rate, delay, Channel conditions and so many other factors. The previous generation such as 2G (GSM) is suitable for High mobility and low cost video and can only be used for still images not for medical video transmission. The 2.5G and 3G they provide sufficient data rates for medical image whereas in 3.5G technologies and above enable the transmission of High quality videos.[13]

Quality may be affected in varying channel conditions which require adaptive modulations and coding schemes. The Satellite systems provide variety of data rates and worldwide coverage possibly with the required Line of sight and higher power. The goal of this paper is to improve streaming over LTE network.LTE stands for Long Term Evolution is the Evolution of the 3GPP radio-access technologies towards high data-rate,low-latency and packet-optimised radio-access technologies supporting flexible bandwidth deployments conforming to theInternationalMobileTelecommunication(IMT-Advanced) requirements.LTE supports a channel bandwidth of 20MHz[1].LTE system support Frequency Division Duplexing(FDD) and Time Division Duplexing(TDD) based on spectrum flexibility[2].The LTE FDD uses separate band for uplink and downlink transmission whereas in LTE TDD they use a single band for both uplink and downlink transmission.

LTE uses the multiple access scheme SCFDMA(Single Carrier FDMA) in uplink and OFDMA(Orthogonal Frequency Division Multiple Access) in downlink to overcome the multipath fading problem in UMTS.The data is divided into several parallel data streams or channels; one for each sub carrier.OFDMA allows neighbours to share each time symbols between multiple users. Dynamic allocation enables better use of the channel. OFDMA

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mandates MIMO(multiple in multiple out) antenna, particularly in LTE four MIMO antenna is used for reception each antenna can independently send up to 2048 subcarriers having a spacing of 15KHZ [3].The SCFDMA is mainly employed for power related issues.OFDM supports three types of modulation QPSK,16QAM and 64QAM.

The proposed work is concentrated on 16QAM with help of this modulation streaming is carried out that is the Ultrasound video sequence being delivered from a proficient station which is located at a hospital centre in a wireless network to a patient end that is Ultrasound machine located at distant location.

II. LTE ARCHITECTURE

Figure 1 shows the Evolved Packet System architecture used in LTE-A. Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) is the access network and the Evolved Packet Core (EPC) is the core network of LTE-A.The access network consists of a collection of base stations called as eNodeBs. The eNodeBs in LTE are interconnected directly through X2 interface [4].

Streaming and Optimization

The growth of wireless mobile communications, network technologies and multimedia applications is bringing multimedia applications into every day usage [5]. Wireless channels remain error prone, loss of data which in turn decrease the quality of received video is an issue in health domain and applications. The key challenge is to provide advanced multimedia services over radio network without degrading the quality of services. The issue faced in streaming and optimization is congestion control, through which the video sequence is converted in terms of frames per second(fps), frame size and PSNR(Peak signal to noise ratio) to enhance the QOS against erratic wireless conditions [7]. The bottom most layer is the link layer which includes the media access control (MAC) layer and physical layer are responsible for streaming based on QOS classes with efficient modulation and coding schemes. The layer 2 and 3 which are used as transport agent and error detection tools.[14]

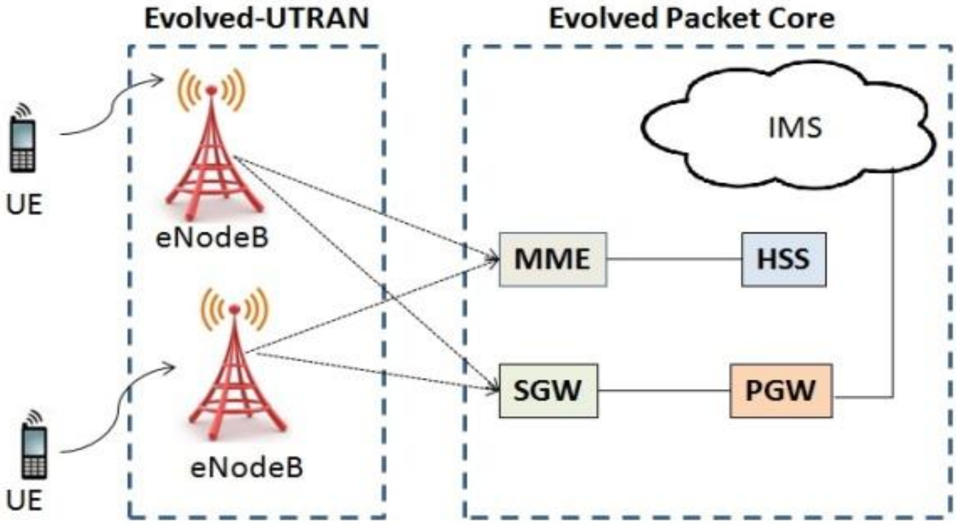

Fig.1 EPS Architecture of LTE

The decision in above one of the layers affects QOS parameters in other layers in order to overcome this problem we use a system called cross layer design(CLD). The CLD is required to

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optimize the usage of wireless medium and to provide acceptable QOS to wireless users.

III. RELATED WORK

Robert S. H. Istepanian, Nada Y. Philip,and Maria G. Martini, etal [5]focused on Medical QoS Provision Based on Reinforcement Learning in Ultrasound Streaming over 3.5G Wireless Systems. The authors have developed rate control algorithm QOS Ultrasound Streaming Rate control (Q-USR),based on the Q-learning approach, that satisfies medical quality of service requirements in bandwidth demanding ultrasound video streaming. The quality of service metrics considered here is Utilization, Packet Loss, End-to-End delay and jitter.

Ali Alinejad, N. Philip, R. S. H. Istepanian, etal [9]extended the work on Performance Analysis of Medical Video Streaming over Mobile WiMAX which investigated the effect of the packet loss on the quality of teleultrasound streaming over WiMAX wireless network environment. The simulations results show that packet loss greater than 0.09% is not acceptable clinically for the wireless ultrasound video streaming application.

Ali Alinejad, Nada Y. Philip, and Robert S. H. Istepanian, et .al **[1]** carried out their work on Cross-Layer Ultrasound Video Streaming Over Mobile WiMAX and HSUPA Networks which is a comparative analysis study of optimized cross-layer video streaming over mobile WiMAX and HSUPA networks based on a new cross-layer approach and reinforcement learning (CRL) method to provide the real-time adaptability of the rate and quality control in the transmitted ultrasound images. The simulations results indicate that optimized ultrasound video streaming over mobile WiMAX provides better performance than HSUPA in terms of frames per second, PSNR, and frame size, with an average uplink throughput of 1.2 Mb/s that is acceptable for remote clinical diagnostics.

Md. ShowketHossen, Md. Neharul Islam, etal [12] proposed their work on QoS Performance Evaluation of Video Conferencing over LTE. The work addresses the quality of service (QoS) performance and its effects when video is streamed over a GBR (Guaranteed bit rate) and non-GBR bearers over LTE. The performance analysis of video streaming model is carried out using LTE OPNET modeler the result shows that GBR and Non GBR bearers havegreat impact on video conferencing under congested network. End to end delay for low load scenario is almost zero for both GBR and NGBR bearers. This indicates that packet partially rejected for NGBR

T.N. Minhasin paper [10], the authors analyzed the perception of users towards the videos encoded with H.264 baseline profile in laptops and mobile devices. The videos are streamed through an emulated network with packet losses and packet delay variations. The obtained results from both devices are compared using matched-sample-test. The conclusion infers that the device does not show any impact on user perception for videos of same resolution.

Liang et al. [12] presented a technique for enhancing LTE e MBMS with Broadened OFDM Parameters and Layered-DivisionMultiplexing to accomplish upgraded communicates benefit conveyance ability, higher range proficiency, enhanced administration quality, and more efficient single frequency systems (SFN) arrangement choices.

IV. PROPOSED METHODOLOGY

The network system model for the proposed work is dipicted in Fig.2. In the network model, some network configuration parameters can easily be changed with TCL (Tool Command Language), for example we can define any number of UE (user equipment), bandwidth between the network elements and the usage of the optimization features, others cannot be changed so easily due to the limitation of the implementationmodel, such as eNodeb and gateway (aGW).The proposed topology consists of one eNodeB followed by 6 UE placed in a hexagonal shaped manner. The single eNodeB is interconnected with 6 UE with 2 MBpsbandwidth. To avoid the handover scenario we have implemented a limited number of users and a single eNodeB.

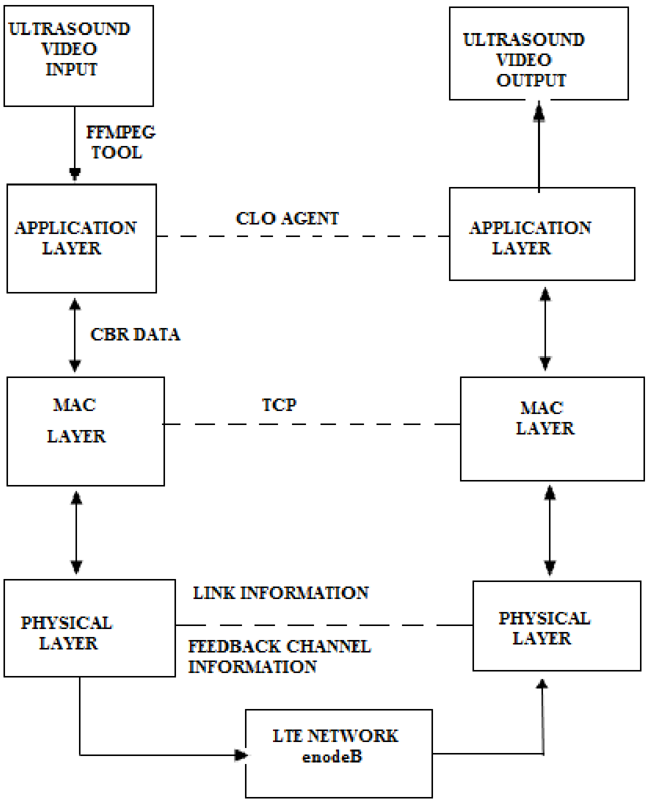

Fig.2 Simulation system block

The cross layer design (CLD) approach is implemented in LTE network need to take optimal solution from all the requirements and pass the parameters between the layers and transferring ultrasound video from users to eNodeB and implementing QAM 16 (Quadrature amplitude modulation) modulation for video data. The ultrasound video sequence is converted into frames using a tool called ffmpeg. The converted frames are sequenced in binary translations which are being attached to one of the node in network topology.

Fig.3. shows the simulation scenario of the proposed work in NS2. In the simulation tool, all the data are available, thus the performance of the network can be easily analysed. Totally six User Equipments (UE) are used in the simulation. The simulation scenario uses one eNodeB where theUE'S generating ultrasound video streaming. The stored ultrasound video sequence is simulated in the created network topology using LTE patch, applied in NS2.

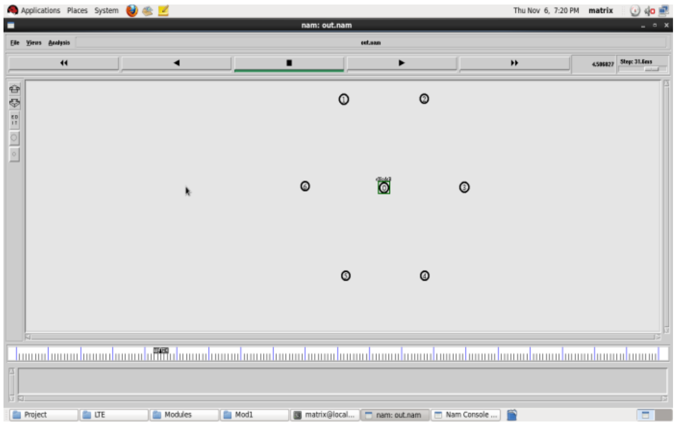

Fig.3. Simulation Scenario with six UEs

IV. RESULTS AND DISCUSSIONS

The simulation is carried out using the NS2 software. The stored ultrasound video sequence is simulated in the created network topology using LTE patch applied in NS2. Different packet sizes are tested to characterize the performance of LTE network.

RTT is used to test the delay time performance and itis the timetaken to transmit one packet from server to terminal.The ultrasound video sequence converted to frames are attached to node 2 which acts as transmission node the transmitted packets are received in node 5 with image magic tool the received frames are combined to form a video sequence.

The results were analyzed using the Network Simulator software. The Throughput of the ultrasound data stream captured by the LTE network for different PSNR values is shown in figure 4. The experimental results show that there is a gradual increase in throughput for the PSNR values ranging from 35 to 40 dB. Figure 5 dipicts the graph plotted between the packet size and RTT of the video streaming.Different packet sizes are tested to characterize the various delay performances in LTE network. Round trip time (RTT) is the Elapsed time between time of sending

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of a packet and receiving the correspondingacknowledgment.

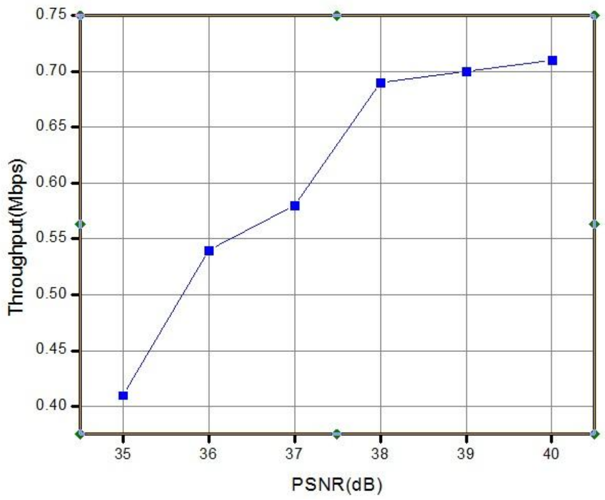

Fig.4 PSNR Vs Thoughput

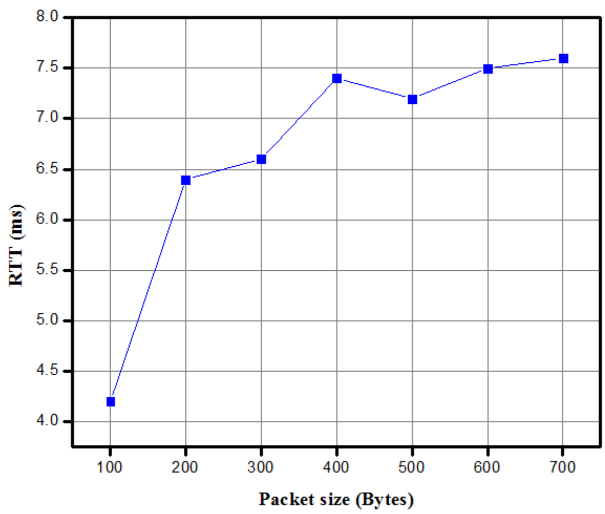

Fig.5 Packet size Vs RT

RTT calculates the time between generating and sending the Sender Report (SR) and receiving the Receiver Report (RR).The experimental results show that when packet size increases RTT also increases which is because LTE provides better RTT performance due to the higher available downlink and uplink bandwidth supported in the LTE network.

V. CONCLUSION

The optimized cross layer video streaming over LTE network model and its implementation in NS2 are presented in this paper. However, LTE is not supported in NS2.33 we have added LTE patch file to support the proposed work and used an external tool called ffmpeg to convert the ultrasound video sequence into frames. Thus created an LTE network with six UEs and one eNodeB also transmitted ultrasound video data from one user to another user using NS2.33. The proposed method was validated in terms of Quality of services parameters such as PSNR, Throughput and RTT.

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