Design and Performance Analysis of QoS Parameters of 4G – Long Term Evolution (LTE) based Architecture for m-Health Application

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Abstract : LTE is becoming an ultimate choice for 4G services around the world due to its higher data rates and lower latency objectives. E-Health services comprise a wide range of healthcare services delivered by utilizing information and communication technology. In order to help existing and emerging e-Health services over converged next generation network (NGN) architectures, there is a need for network QoS control mechanisms that meet the often stringent requirements of such services. However, there are several challenges and issues that need to be addressed. In this paper we have proposed m-health care system based on 4G LTE network communication instead of existing 3G communication system. We have provided a comparison of QoS parameter evaluation of 4G LTE and 3G network. The experimental results shows better throughput and delay in proposed methodology as compared to existing 3G and 4G implementations of m-health systems.

***IndexTerms* - NGN, QoS, 4G, LTE, Health Care**

I. Introduction

Mobile WiMAX and LTE technologies have been considered for wireless broadband access as they evolve towards the 4G networks that can deliver up to 100Mbps and beyond. Mobility support and provision of high data rates make 4G networks the choice of the future broadband Internet access. In rural areas where only the deployment of wireless is feasible and cost effective the 4G networks are inevitable. The wireless broadband portion of the NBN covers many rural communities of different shapes and sizes from the small areas with high population density to vast geographical areas that are sparsely populated. Clearly, appropriate dimensioning of the whole access network is crucial to ensure the overall cost is minimized under a constraint that the specified data rates are guaranteed to all the users regardless of their geographical locations. Once the network has been dimensioned, its characteristics may change. For instance, the load at the core network, which connects a base stations to the Internet increases or the traffic demand of a cell increases beyond the forecast due to changes in population density or application distributions. In these situations, a network without appropriate QoS schemes may not be able to manage these dynamic changes and as a result QoS of connections degrades. Consequently, it imposes a requirement on the network operators to re-dimension the network. Whereas, with the employment of appropriate QoS schemes the network operators are able to manage increase in the data demand and the load at the core network to a certain extent, without the need to dimension.

The concept of m-health was first introduced and defined in these exchanges as "mobile computing, medical sensor, and communications technologies for health care" [2]. Since then, it has become one of the key domains inside the e-health and wireless telemedicine, uniting major academic research and industry disciplines worldwide. This essential concept of the first definition of m-health is illustrated in Fig. 1. One of the key notes stated that the "convergence of information and telecommunications around telemedicine and mobile telecare systems is fostering a diversity of financially savvy and efficient mobile applications and will provide a new dimension to the first definition and concept of telemedicine as 'medicine practiced at distance' that will envisage new mobility directions in reshaping the structure of healthcare delivery comprehensively into the next millennium." [1].This potent prediction was the key to the massive successes of m-health systems that we witness today. Furthermore, since then major advances in these m-health sub disciplines were introduced inside the worldwide research community. Specifically, major advances were introduced in the mobile broadband and wireless internet m-health systems [4]. Similar advances in wearable and body area sensor networks and challenges were additionally reported [3].

One of the major breakthroughs and defining moments in this evolution is the presentation of the fourth-generation (4G) mobile communication systems.[5],[6],[7]. The presentation of 4G technologies and networks in this decade will bring new services and consumer usage models that will be compatible with these emerging mobile network architectures. It is timely that such major evolution is likewise reflected in corresponding m-health systems and services and introduced as 4G health. This new concept is defined as "The evolution of m-health towards targeted personalized medical systems with adaptable functionalities and compatibility with the future 4G networks."

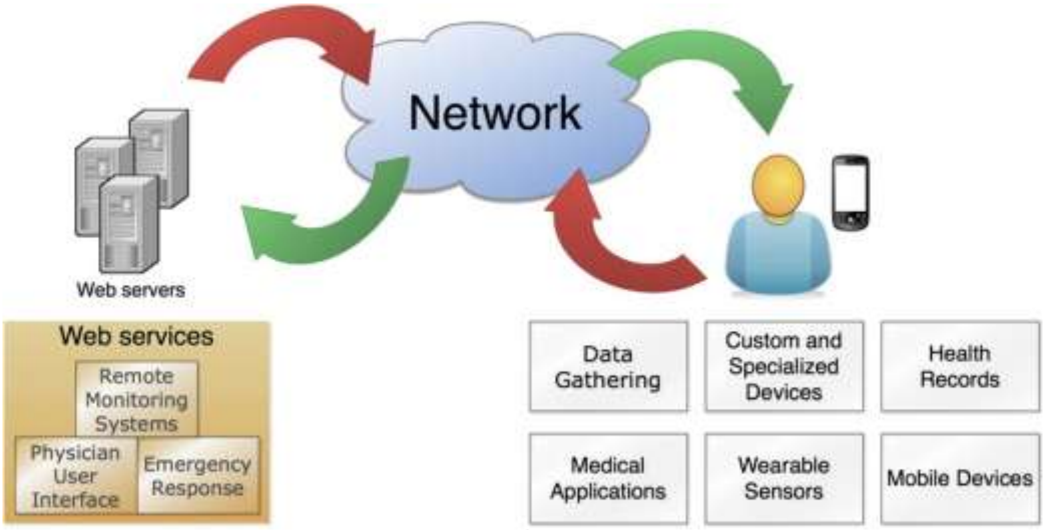

Figure.1: Concept of m-Health

II. Literature Review

QoS arrangements proposed for 4G network can be classified based on the layer in which the mechanism works. Despite the fact that research to provide QoS in 4G network has happened in information connect, physical, transport and application layer, predominant architectures are available in network layer. A different approach is cross layer design for giving QoS in 4G networks where it tries to optimize architecture crosswise over adjacent layers. Conventional approach has been to treat the layers as different entities. A higher layer convention just makes use of services at lower layers and isn't concerned about the implementation of service.

Marques et al. proposed an IP-Based QoS Architecture which bolsters multiple access networks and multiple service provider scenarios. It is an integrated management way to deal with service on account of heterogeneous network. Mobile network access is based on the relationship between QoS brokers and Authentication, Authorization, Accounting and Charging systems (AAAC) [3]. QoS flagging architecture which integrates resource management and mobility management is likewise presented. Architecture is developed with the concept of domain resource manager and capable of supporting different handover types [4]. Few approaches consider core issues in the design of QoS mechanism (e.g. [5]). In any case, they neglect to provide a completely integrated QoS way to deal with IP-based communication for variety of utilizations and conventions. Typically adaptive applications are disregarded and mobility issues are not taken care.

Rui et al proposes an end-to-end QoS answer for 4G IPbased networks capable of supporting a wide range of services, from legacy to adaptive multimedia. It likewise bolsters user mobility, both intra-and inter-domain crosswise over different access technologies [6]. It is a scalable arrangement, based on DiffServ to provide layered resource control. Resource management is performed on a per-aggregate premise in the core. Several access networks (A), which are capable of supporting different access technologies, are present in each Administrative Domain (AD). A core subdomain is additionally present inside each AD to provide interconnection between the access networks through Subdomain Routers (SR). Connection to other administrative domains is provided through Edge Routers (ER). To provide QoS to variety of services, novel functionalities are added to the Access Routers (AR). ARs mark and recognize singular streams. ARs likewise translate other QoS reservation mechanisms, for example, the IntServ [7], Resource Reservation Protocol (RSVP) [8] into Differentiated Service Code Point (DSCP) markings and QoS Broker requests. Collection of every one of these capacities is called Advanced Router Mechanisms (ARM) [9]. In each domain, an Authentication, Authorization, Accounting, Auditing and Charging (A4C) server is available.

III. Proposed Methodology

In proposed work we are using 4G LTE networks for data communication in m-heath devices. We will be comparing QoS parameters of 3G and 4G LTE network with respect to Delay, Jitter, Throughput, Energy efficiency and Packet Data Rate (PDR). The below figure demonstrates the working of proposed system.

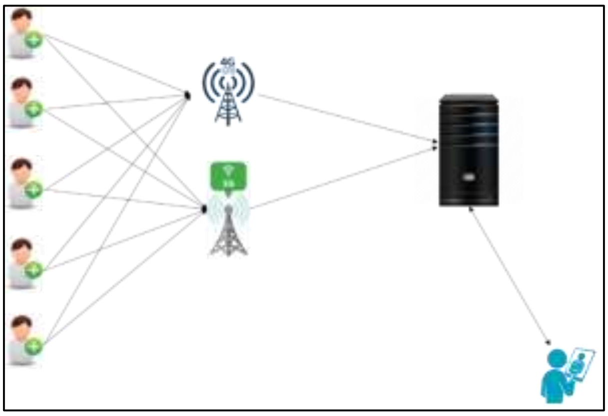

Figure 2: Proposed System Workflow

In proposed system N number of patient health monitoring devices are connected to both 3G and 4G LTE network. Using such system we can easily compare the working of both networks and their QoS parameters. The system indicates a server that is used to receive and transmit data from patient devices to the application available with doctors that are monitoring the status of patients. The simulation of the system will be done in NS3 with required setup like number of client nodes and application nodes with server and bandwidth configuration. Below are various configurations that needs to be done in 4G LTE network.

default ns3::LteHelper::Scheduler "ns3::PfFfMacScheduler"
default ns3::LteHelper::PathlossModel "ns3::FriisSpectrumPropagationLossModel"
default ns3::LteEnbNetDevice::UlBandwidth "25"
default ns3::LteEnbNetDevice::DlBandwidth "25"
default ns3::LteEnbNetDevice::DlEarfcn "100"
default ns3::LteEnbNetDevice::UlEarfcn "18100"
default ns3::LteUePhy::TxPower "10"
default ns3::LteUePhy::NoiseFigure "9"
default ns3::LteEnbPhy::TxPower "30"
default ns3::LteEnbPhy::NoiseFigure "5"

The QoS parameters that we will be monitoring are briefed in below section. It will provide a brief overview of what we need to compare in 3G and 4G LTE Networks.

a) Throughput: It is the data rate (bits per second) of the successfully received traffic on the network.

b) Queuing Delay: It indicates delay of packets at the queue of a base station's buffer. In situations, when the packets departure rate from the buffer is less than the arrival rate to the buffer, the queuing delay increases. Queuing delay has a significant impact on the performance of real time applications, such as voice, live streaming and online gaming.

c) Packet Loss: In this thesis it refers to the packet loss at the output buffer due to an overflow. It happens only when the rate at which packets arrive in the buffer is more than the rate at which they leave the buffer. Similar to queuing delay, packet loss has a significant impact on the QoS of real time applications.

IV. Experimental Results

Below provided are the graphs calculated after the simulation done in NS-3 environment for m-health system with multiple nodes.

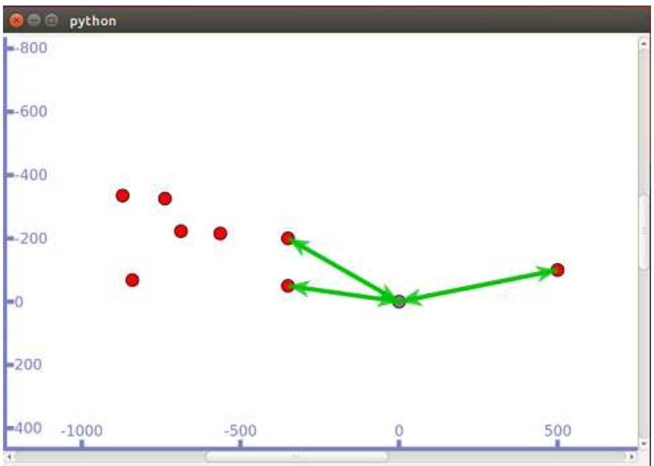

Figure 3: ns3 python simulation

Figure 3 shows the topology structure of proposed system in Python Simulation interface of ns3. All nodes represent client or server nodes.

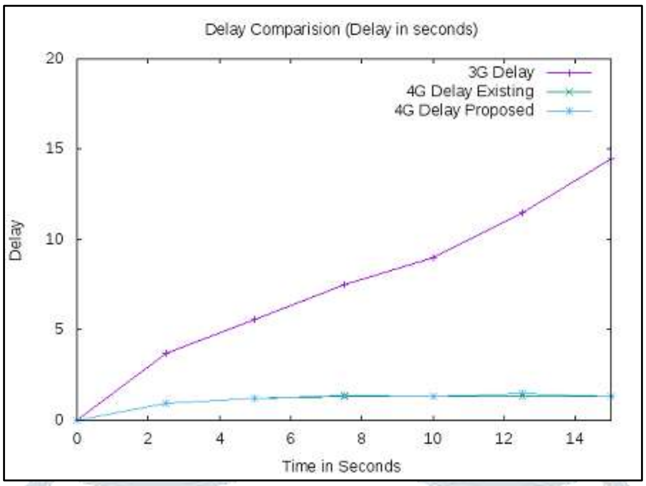

Figure 4: Delay Comparison

Figure 4 provides the delay comparison of 3G, 4G and proposed system. As we can see the proposed system has less delay as compared to existing systems.

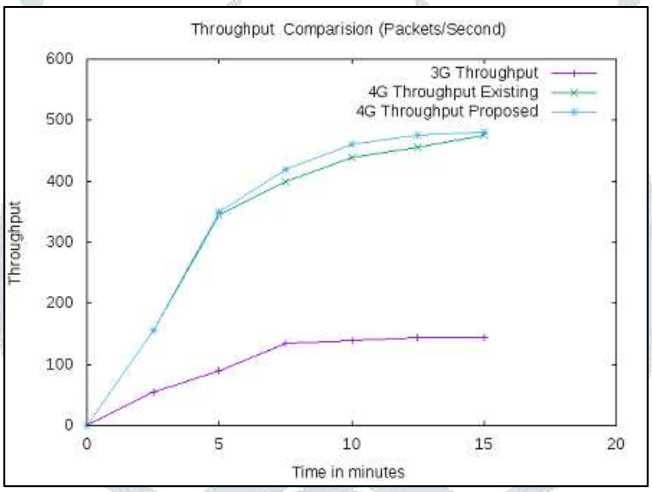

Figure 5: Throughput Comparison

Figure 5 provides the throughput comparison of 3G, 4G and proposed system. As we can see the proposed system has higher throughput as compared to existing systems.

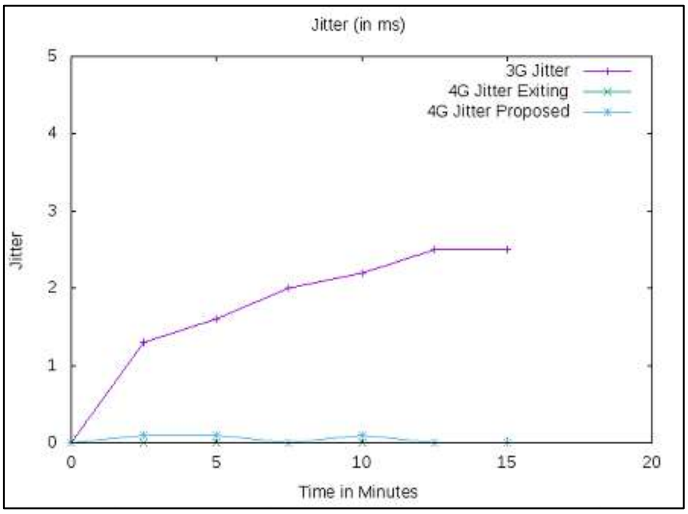

Figure 6: Jitter Comparison

Figure 6 provides the jitter comparison of 3G, 4G and proposed system. As we can see the proposed system has less jitter as compared to existing systems.

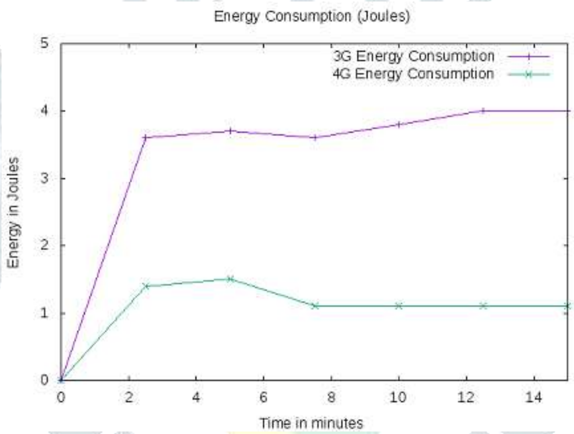

Figure 7: Energy Consumption Comparison

Figure 7 provides the energy consumption comparison of 3G and proposed system. As we can see the proposed system has less energy consumption as compared to existing systems.

V. Conclusion

In this paper, we analyzed the performance of the LTE network using ns3 network simulator. The performance of the LTE network is analyzed on the basis of the QoS parameters such as latency, packet loss and delivery ratio. These parameters vary depending upon the traffic and the type of application the user interacts with the network. The traffic variations are done mainly with the packet sizes of the data to be transmitted in the network. The variations in the packet sizes and the distance of the users from the node can be satisfied to achieve the desired QoS in the LTE network with minimum losses and delay. Using the proposed system we are able to enhance the working of 4G LTE network for m-health system for moving nodes. The proposed system shows better improvements in Throughput and Delay parameters as compared to exiting 3G and 4G techniques.

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