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Enhancement of Qos For 4G Wireless Networks Using Cross Layer Design

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ABSTRACT

Quality of service (QoS) is considered as the backbone of any heterogeneous wireless networks. The goal is to come up with the work presents a improved QoS framework for multimedia streaming across 4G heterogeneous wireless networks that can be achieved by applying cross layer technique in the network design. We focus on three main places where the cross layer design that helps to improve the Quality of service for multimedia streaming over 4G heterogeneous wireless networks. The cross layer optimization framework by comparing WiMAX network with 4G heterogeneous wireless networks and last, the design issues should be considered by comparing various parameters to show the improved Quality of Service over heterogeneous wireless networks.

Keywords: Wireless multimedia, IEEE 802.16, cross layer design, QoS, Streaming, 4G

1. INTRODUCTION

Multimedia transmission over wireless posses many challenges, including bandwidth variations, data losses and heterogeneity of the receivers. The major issue is how to effectively transport such high quality multimedia streams across fluctuating radio channels. The traditional solution is based on OSI (Open System Interconnection) model which does not provide adequate support for multimedia applications in crowded wireless applications. This is due to the strategies available in the lower layer of stack are optimized without considering characteristics of multimedia applications and algorithms used in higher layers do not consider the mechanism provided by the lower layer.

The OSI model is designed based on the wired network. Strong interconnection between layers in OSI model for wireless networks makes the layered design approach inefficient. Moreover OSI model must undergo some modifications to support wireless transmission. So, a recent design principle that allows coordination, interaction, and joint design of protocols crossing different layers appropriately for wireless networks is the Cross Layer Design (CLD) approach.

A Cross-layer protocol interaction leads to increased network efficiency and better QoS support. A Cross-Layer Design is particularly important for any network using wireless technologies, since the state of the physical medium can significantly vary over time. It is required to meet the challenging data rates, higher performance gains and QoS requirement for various real time and non real time applications. Cross layer approach allows upper layers to better adapt their strategies to varying link and network conditions. It helps to give the end to end performance for the given networks resources (Bhuvaneswari & Seethalakshmi 2011).

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The current issues are forwarded to the demand in Quality of Service which leads to the deployment of cross layer design in 4G heterogeneous wireless networks to achieve the level by implementing framework over the multimedia streaming technique. (Bhuvaneswari & Seethalakshmi 2011)

Since Quality of Service remains as one of the major factor, this paper is focused on the analysis session by comparing the integrated UMTS and WLAN networks as given in (Tomislav& Toni 2011)

With the new proposal named as [Enhanced QoS –cross IP method] which is applicable for 4G heterogeneous wireless networks along with the implemented work on IEEE 802.16 networks. In IEEE 802.16 network there is a integration of proposed cross layer optimization with the cross design that interacts with the physical layer, medium access control layer and application layer as given in (Dionysia et al 2007) is implemented in order to achieve Quality of service over heterogeneous networks.

However cross layer optimization improves network capacity,[5] this article focus on implementing multimedia streaming over 4G heterogeneous wireless networks have a impact on integrating with cross layer design to achieve Quality of Service.

The remaining portion of this article is organized as follows. Section II gives an overview of the related research works for this concept. Section III illustrates the main objectives of 4G networks. In section IV, we listed out the challenges in cross layer design and its overcomes. QoS levels in 4G wireless networks have been discussed under section V. section VI presents the system model for the integrated cross layer design with optimization. In section VII, we simulated the analysis model whereas section VIII reveals the performance evaluation results. At last the final section IX concludes this paper.

2. RELATED WORK

There were many challenges in cross layer design for multimedia in cross layer design for multimedia transmission over wireless networks which have many constraints and parameters. The challenges in (Christos et al 2007), outlines the significant aspects that should be taken into consideration in this paper. This paper involves in explaining various challenges and its constraints that were not fitted to the area of multimedia transmission.

In (Bhuvaneswari & Seethalakshmi 2011), the cross layer design in 4G mobile networks were proposed to achieve high speed data internet to real time video conferences. The cross layered approach reveals the interaction between upper layers from application layer with lower layers such as physical and MAC layer to enhance the guarantee acceptable QoS. This paper suggested a implementation of cross layer optimization integrated with the cross layer design that enhance the QoS over 4G heterogeneous wireless networks.

So many frameworks and allocation techniques for tuning the QoS over WiMAX network have been proposed and implemented in (Elechi & Eze 2013). This insists on working with the cross layer optimization framework to improve QoS by considering the techniques and drawbacks behind it with the help of implementing them in 4G heterogeneous wireless networks.

A cross layer optimization mechanism for IEEE 802.16 networks have been proposed in (Dionysia et al 2007) is considered to be the significant part of this paper that works on the architectural framework with a cross layer optimizer. This paper handles the multimedia messages that were exchanged between the uplink and downlink cases to improve the transmission quality of service over the networks.

As per in (Dionysia et al 2007), cross layer optimization mechanism for the next generation wireless networks have been proposed, in [5] by implementing them either in centralized or distributed. This paper concentrates on the wireless video streaming cross layer architecture along with the working principle behind the cross layer optimization cycle that brings the QoS over multimedia transmissions.

The novel adaptive QoS module named as QoS-cross-IP module have been proposed in (Tomislav & Toni 2011), is compared with the networks like UMTS, WLAN as it is implemented on upper IP network layer to achieve the QoS at a certain Level.

Since there were many parameters discussed in (Tomislav& Toni 2011), this paper introduces a new QoS module named as Enhanced QXIP which includes parameters like delay, throughput jitter and packet delivery ratio (PDR) is implemented on the WIMAX network to achieve the desired QoS during multimedia transmission. This makes the comparison better with (Tomislav& Toni 2011) on basis of QoS module.

Cross layer design issues have been proposed in (Shashi & Svetlana 2014), which equally compared with the QoS required by application layer of the cross layer design issue. This paper concentrates on the interaction between each and every layer should be taken place in cross layer design approach which provides desired information flow across all layers based upon the QoS requirements by the network. Furthermore, in the upcoming section this paper elaborates the system model behind the 4G heterogeneous wireless networks with their simulation results evaluated with the proper comparisons.

3. 4G OBJECTIVES

1. Speeds up to 50 times higher than of 3G. However, the actual available bandwidth of 4G is expected to be about 100 Mbps
2. 4G will solve problems like limited bandwidth in 3G when people are moving and uncertainty about the availability of bandwidth for streaming to all users at all times
3. The 4G networks will also provide access to support services such as authentication, security, and billing mechanisms as well as mobile-specific services such as mobility management and location-based computing

4. CHALLENGES IN CROSS LAYER DESIGN FOR MULTIMEDIA TRANSMISSION OVER WIRELESS NETWORKS

There were some challenges with constraints and parameters to be considered during the implementation process of cross layer design for multimedia transmission over heterogeneous wireless networks.

4.1. Elements of Network

There were three main entities like sender, link routers and receiver that take part during the exchange procedure of informations between the systems. Since there were pros and cons in the design approach (Christos et al 2007), the cross layer design scheme relies on the four categories for the participation of the entities during transmission of multimedia informations. The entities that were performs the cross layer adaptation where based on sender, receiver, network and the combination of two or more entities based hybrid method.

4.2. Inter Layer optimization

As per (Christos et al 2007), the cross layer adaptation cannot be implemented over the network layer since it can be processed using QoS schemes. This paper carries out the progress of applying cross layer design throughout all the layers.

4.3. Intra Layer optimization

The major two actions were given in (Christos et al 2007) for the adaptation parameters that one affect the layer in which they appear and that affect two or more layers. Each and every layer of the network that supports the cross layer design by considering the listed parameters by (Christos et al 2007).

4.4. Signaling procedure

In (Christos et al 2007), there were various approaches for signaling performed in cross layer design. Network services is responsible for gathering parameters from the difficult layers. This allows the usage of parameters for the layered network of design. Local profile holds the parameters as file system for the purpose of information needed by the other layers.

A new type of extension header has been proposed in (Christos et al 2007) for the purpose of handling the notification for other layers in the network. The signaling of packet headers appeals the functionality of sending and receiving multimedia information around the network.

The signaling protocol ICMP (Internet Control Message Protocol) in (Christos et al 2007) is always encapsulates the packets of information from one layer to other layer throughout the network.

Since there were various approaches followed in (Christos et al 2007) for the adaptation process of cross layer, this paper adopts the integrated approach of resolving all the layers jointly together by applying cross layer design in the network because of its complexity in involving parameters.

Even the constraint occurs in devices, network and application part, there a possibility of not adopting the layer design completely in the network (Christos et al 2007). This paper concentrates mainly on the network constraints where the parameters like delay, throughput, and QoS support were included.

5. QOS LEVELS IN 4G WIRELESS NETWORKS

A few QoS parameter for cross layer design is compared with ISO-OSI layers has been discussed in (Bhuvaneswari & Seethalakshmi 2011). The following Table 1 illustrates the cross layer parameters for QoS taken from (Bhuvaneswari & Seethalakshmi 2011) is considered in this paper to achieve the QoS levels in 4G wireless networks by implementing cross layer parameters among the different layers.

As a part of QoS levels in 4G wireless networks, the main two challenges should be discussed. The main part concerned about the access on different types of cellular network. The secondary part concerned about the maintenance of end to end QoS between different network that has various requirements of throughput, delay, jitter, bandwidth, bit rate, channel characteristics and also handover which may lead to maintain QoS at various levels.

5.1. Physical Layer

The responsibility of physical layer is to achieve the packet level QoS that can be applied to different parameters with the accountance of cross layer parameters such as channel condition, transmit power, coding and modulation. This layer provides a functionality of interacting with the upper layers to the network.

Table 1
Cross layer parameters for QoS

Layer	*Cross layer parameter for QoS*	*QoS levels*
Physical	Channel condition, BER, transmit power, coding and modulation.	Packet level QoS applies to jitter, throughput and error rate.
Link/MAC	Acceptable delay and packet loss.	Transaction level QoS
Network	Handoff latency	Circuit level QoS
Transport	Packet loss	User level QoS
Application	Throughput	End to end QoS

5.2. Link/MAC Layer

The major function of the Link/MAC layer is to achieve the transaction level QoS with the cross layer parameters that are considered under acceptable delay and packet loss. This helps to identify the retransmitted frames, frame length during the transmission initiates and computes.

5.3. Network Layer

This layer allow the network to interact with the upper layer and having functionality of achieving circuit level QoS with the support of cross layer parameters such as handoff latency.

5.4. Transport Layer

This layer concentrates on attaining user level QoS within different types of cellular network. This relies on the cross layer parameters for QoS with the concentration on the packet loss.

5.5. Application Layer

The end to end QoS is achieved in the application layer by considering the throughput as the major parameter to attain the level in the different cellular network.

6. SYSTEM MODEL

Quality of Service is the major backbone of broadband media access network. In this paper, a novel based Enhanced QoS-Cross-IP module (EQXIP) is implemented with a cross layer design and its optimization framework is compared with different wireless technology like UMTS WiMAX and also with the model defined in (Tomislav& Toni 2011).

In (Elechi & Eze 2013), a survey has been presented on WiMAX networks to improve its Quality of Service by enforcing Cross-Layer optimization framework into it. This WiMAX utilizes the usage of spectrum more efficiently by considering the limited available network resources with an in-built quality of service enhanced in this first generation of 4G broadband access wireless technology.

To design a proper and efficient cross layer optimized WiMAX network the requirements to attain the QoS such as reliability, minimized data rate, low latency, and controlled jitter were necessary. Cross layer optimized framework achieves those requirements by exchanging the information across different layers in the network.

Cross layer optimization proposals have been referred in (Dionysia et al 2007) for multimedia transmission over heterogeneous wireless networks in the aspect of downlink and uplink channel quality. The information flow between the two major parts of the cross layer optimizer for wireless networks is proposed in (Dionysia et al 2007) with the signaling messages such as Report request and Response [REP_REQ, REP_RSP].

As mentioned in (Dionysia et al 2007), the Base Station (BS) and Subscriber station (SS) is relied on PHY and MAC Layers of the cross layer optimizer. It abstracts the Layer-specific information around the network in the form of three major steps such as Layer Abstraction, Layer Optimization and Layer Reconfiguration. In this paper, the independent functionality of the Cross Layer optimizer occupies the major portion of the base station (BS) part. The subscriber station (SS) part optimizes the QoS and the system throughput with the contribution of BS part in it. The information flow between BS part and SS part by creating a connection (both uplink and downlink) is discussed in following Figure 1 and Figure 2 shows the exchange of signaling messages in the uplink and downlink respectively.

Cross Layer optimization for video streaming systems is discussed in [5] with the N number of nodes in the network which can delivers streaming videos through the base station. By jointly optimizing in the

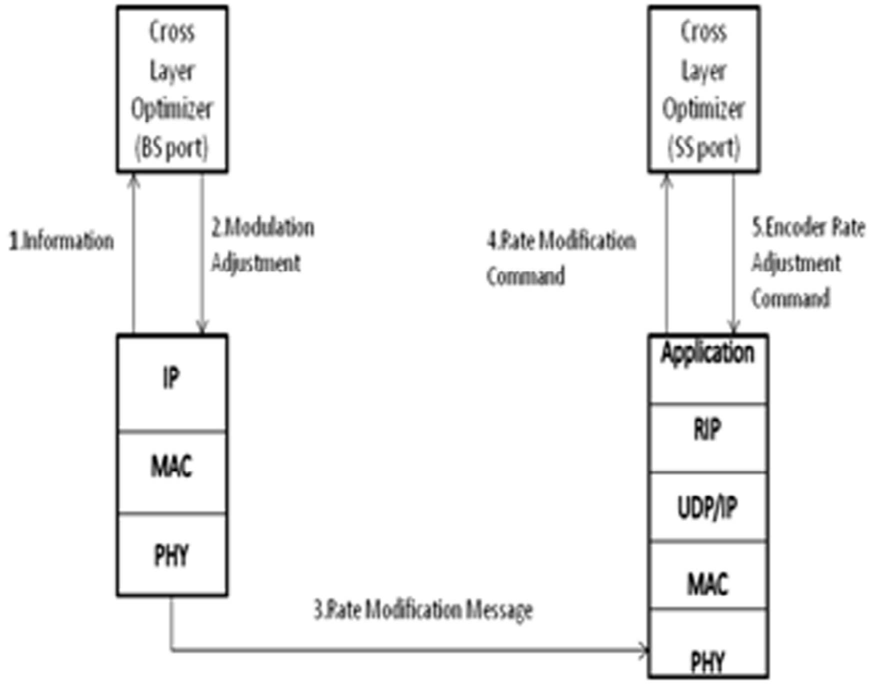

Figure 1: Cross-Layer Optimization mechanism: Uplink

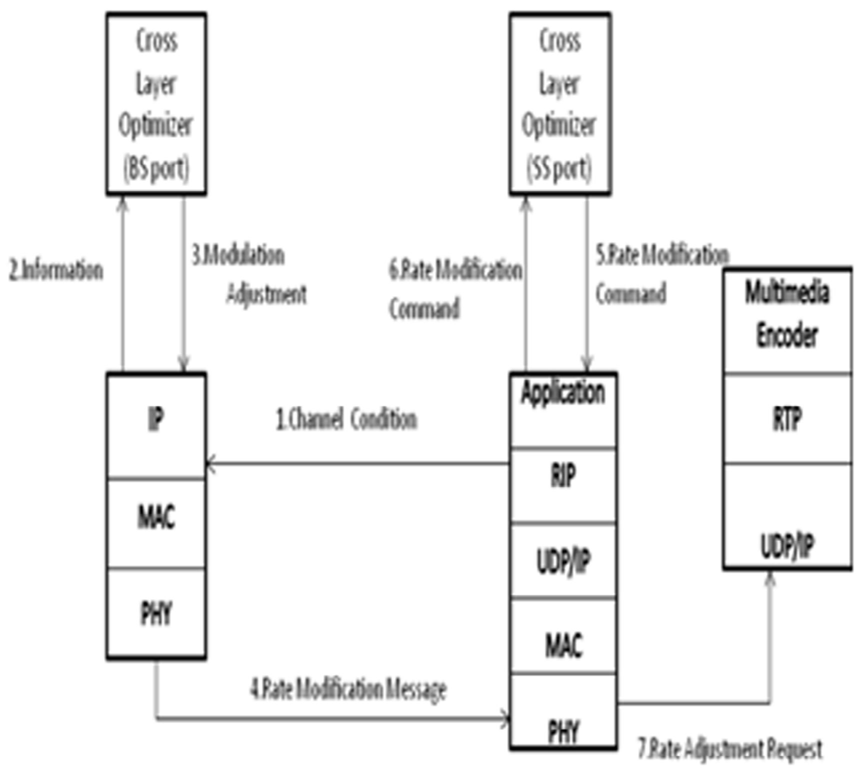

Figure 2: Cross-Layer Optimization mechanism: Downlink

cross layers with the network, the individual layers are responsible for the abstraction of parameters from the knowledge of other layers for the purpose of fast and effective utilization of the wireless video streaming system.

The network with large bandwidth is required sufficiently to deliver the high quality video and to optimize, a network should allocate resources for the individual layers for the abstraction of parameters from the other layers such as importance of packets, distortion if there any packet lost, and channel information.

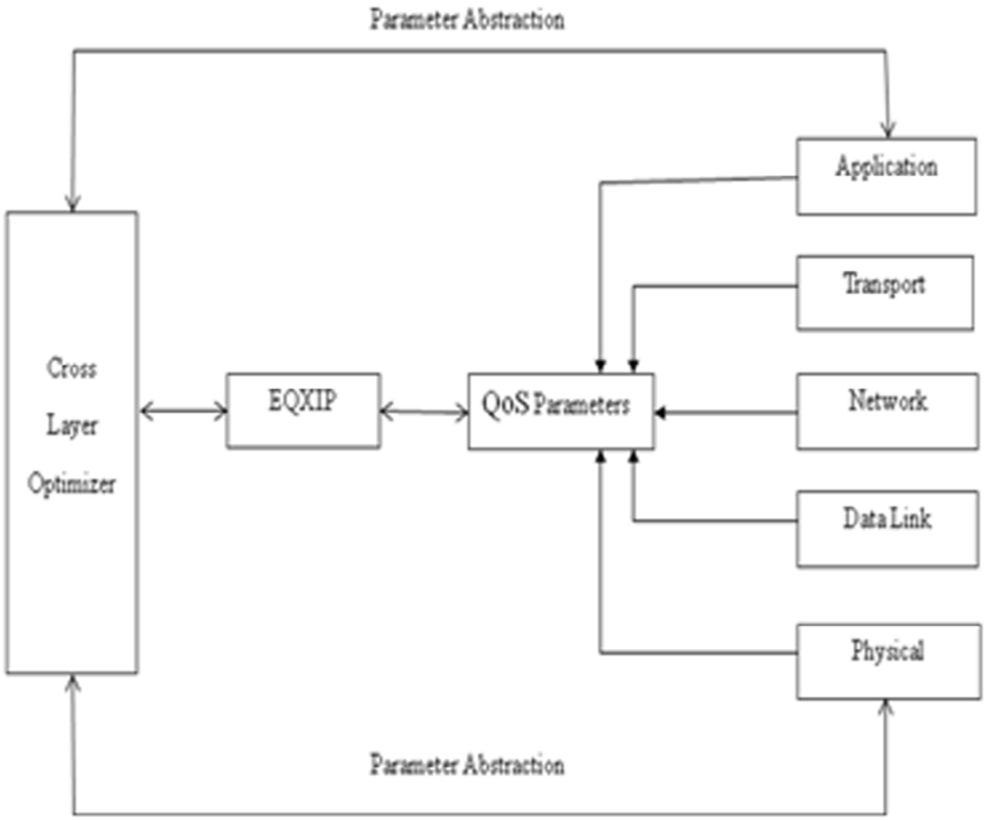

Figure 3: System Model-EQXIP

The following Figure 3 shows the cross layer architecture with the different layers and its QoS parameters compared with the novel based Enhanced QoS-Cross-IP module (EQXIP) implemented along with the abstraction of parameters utilized in cross layer optimizer

The motive that led to develop novel based Enhanced QoS-Cross-IP module (EQXIP), which will provide high level of QoS in wireless heterogeneous network is integrated with UMTS/WiMAX network is taken from (Tomislav& Toni 2011).For the proposed EQXIP, the mobile node must collect the QoS abstraction of parameters from different layers such as Constant Bit Rate(CBR), Variable Bit Rate(VBR), Data packet size, Delay, Throughput, Jitter control and Packet Delivery Ratio. This EQXIP relies on the signaling messages exchanged between the different layers of the network and ensure the high level of QoS during the transmission of multimedia streaming data over the heterogeneous wireless network systems.

7. SIMULATION RESULTS AND ANALYSIS

The scenario for the multimedia streaming system over 4G heterogeneous wireless networks using cross layer design is simulated in network simulator NS2 and the performance comparison of the various networks is presented with the graph values. The scenario is illustrated with one UMTS node B, and to WiMAX access point connected through the gateway to the core network. In the initialization process of the simulation, the MN (Mobile Nodes) is randomly deployed within the area of 600*600m^2. For the Mobile Node mobility, the 'setdest' command is utilized in NS2 to set the destination in simulated area once after the simulation starts. The mobility of the node relies on the average speed in the range of 2-18m/s. Representation of simulation scenario model is shown in the following Figure 4.

The node B is deployed of the coordinates (450,500) which providing the coverage distance of 500m for the mobile nodes that were deployed around the simulated area. In the deployment of Access points, the two access points are coordinated at (180,180) and (250,250) respectively by providing the coverage distance

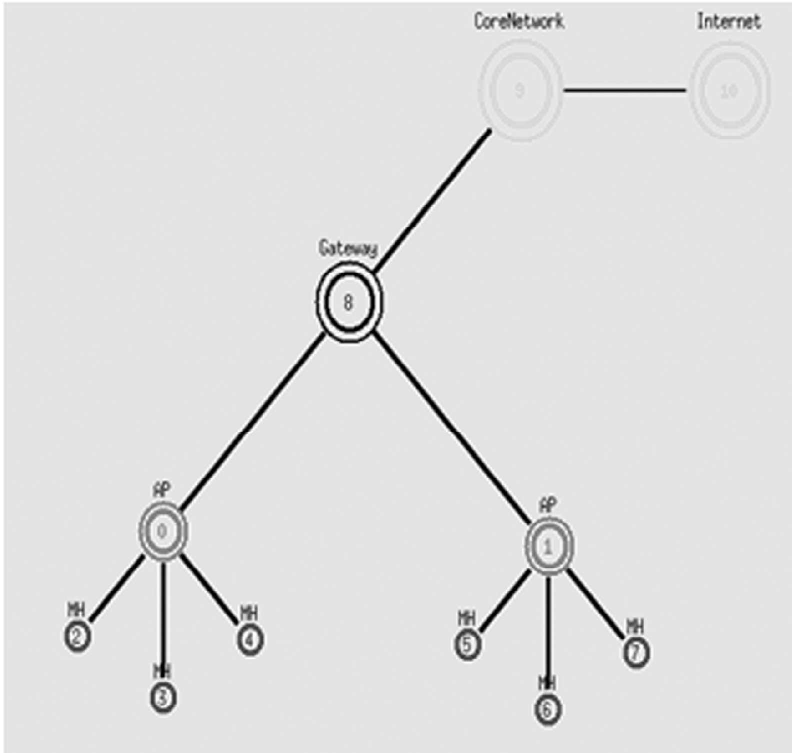

Figure 4: Simulation Scenario Model for the proposed system

Table 2
Simulation parameters

Parameters	*Values*
CBR packet size	1000 bytes
VBR packet size	1000 bytes
Speed-mobility	2-18m/s
Mobile Nodes	10
Simulation time	16 seconds
Packet inter arrival time	5 seconds

if 150m for the mobile nodes. The entire scenario is provided with the total network coverage for all the mobile nodes, UMTS coverage and also for WiMAX network coverage. The Constant Bit Rate and a Variable Bit Rate value of 1000 bytes is initialized at the beginning of the simulation time. The transmission of multimedia streaming data flow between internets via core network is taken place through the gateway which is wired UMTS node B and transmitted over wireless networks between different mobile nodes. The abstraction of parameters illustrated in our simulation is summarized in the following table.

As given in (Tomislav& Toni 2011) dual mode mobile equipment with two interfaces, one for UMTS and another for WLAN network in the simulation environment is compared with our proposed module of novel based Enhanced QoS cross-Layer-IP module. The messages are communicated within the cross layers with the modules as in exchange of data between the layers.

Figure 5 shows the graphical representation between the throughput for the different velocity varies from 2 up to 18 m/s of the individual mobile nodes. This shows the increases in average throughput for the EQXIP_MN module when compared with the range of other networks of QXIP_MN module within UMTS_MN and WiMAX_MN network. The throughput attained during transmission, having a range from

0 to 5000kbps. As the mobility of nodes increases, the average throughput increases accordingly to the networks compared.

The graphical value comparison for the delay and different velocity ranges from 2 up to 18m/s is shown in the following Figure 6. The delay value for the network ranges from 0 to 3000m/s as the velocity of 2m/s increases the probability of the delay value gets decreases consequently with the expected value that the mobile nodes must reach. There is a descends in the value of delay for the higher velocity values where there is almost a balanced values between the QXIP and EQXIP modules, only because the mobility of the nodes are fixed at a velocity of 2m/s.

Furthermore, the average packet delivery ratio values for the first case of EQXIP module attained almost a balanced range when the QXIP module within other network have tendency to reach some points.

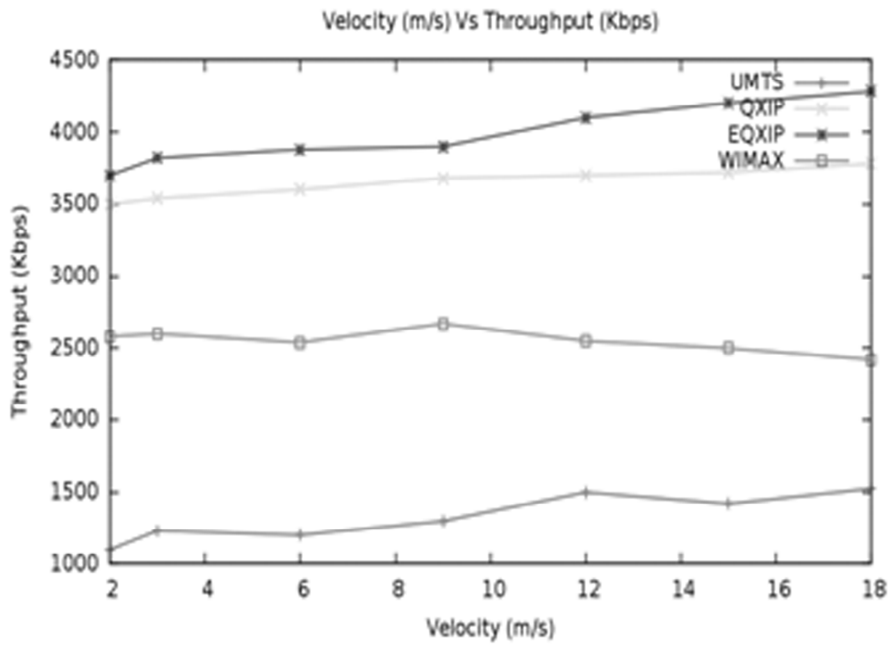

Figure 5: Throughput vs. Velocity

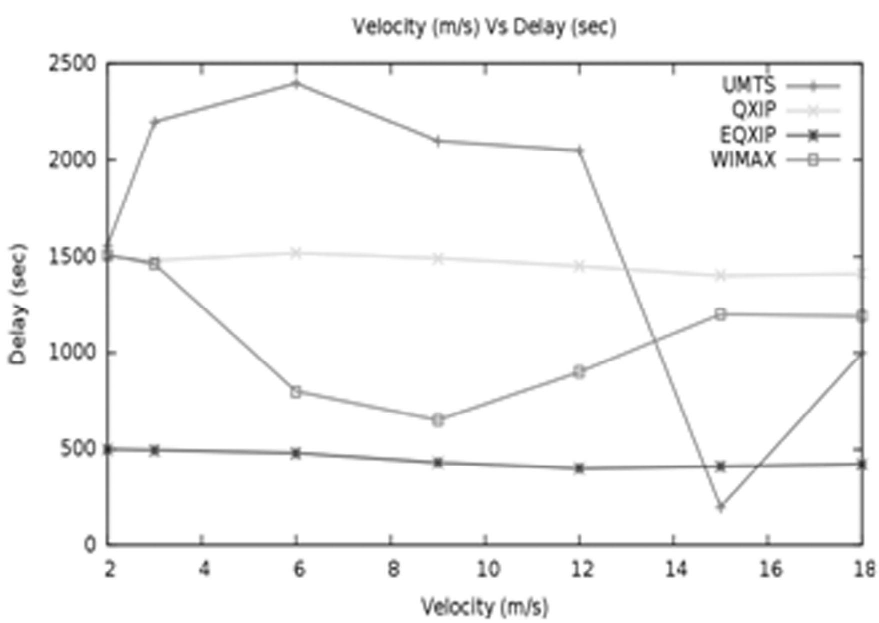

Figure 6: Delay vs. Velocity

As the number of mobile nodes increases, the PDR from a single node to a various deployment of nodes balanced within the ranges. The PDR value in our case is better while compared with other case. There is a chance of packet losses which may lead to the reduction of values for other cases. The illustrated graphical representation is shown in the following Figure 7.

Finally, the Figure 8 is shown the jitter curves for the mobile nodes is drawn with the corresponding overall simulation time ranges from 10 to 60 seconds. The jitter values of QXIP are in ascending due to the high variations in the signals whereas EQXIP achieved with lower average jitter as a simulation time increases for every connection of networks. The jitter value ranges from 0 to 1800 m/s and there is a increasing trend of jitter curve at the simulation time of 60 seconds with the oscillating mean value of 400ms.

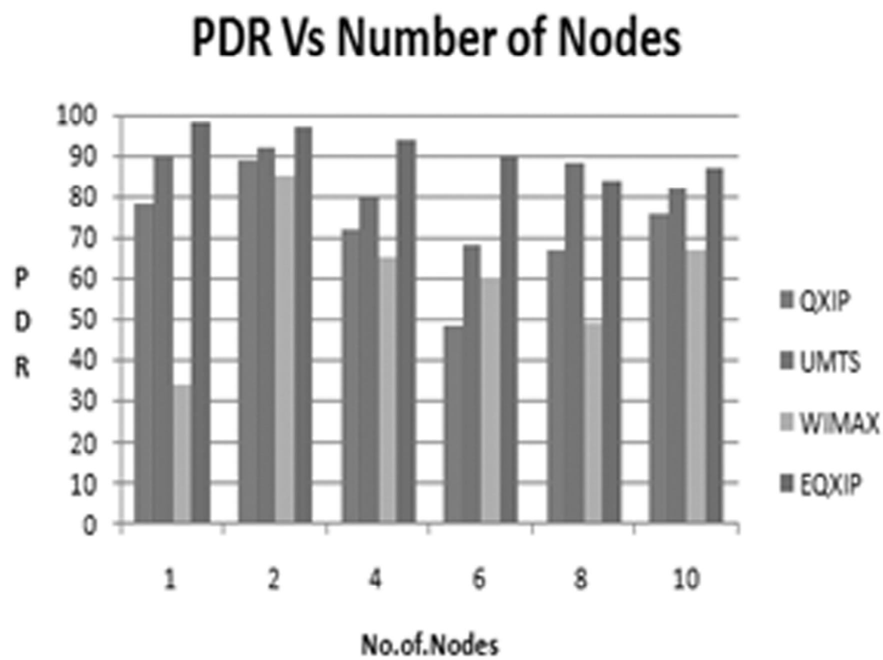

Figure 7: PDR vs. Number of Nodes

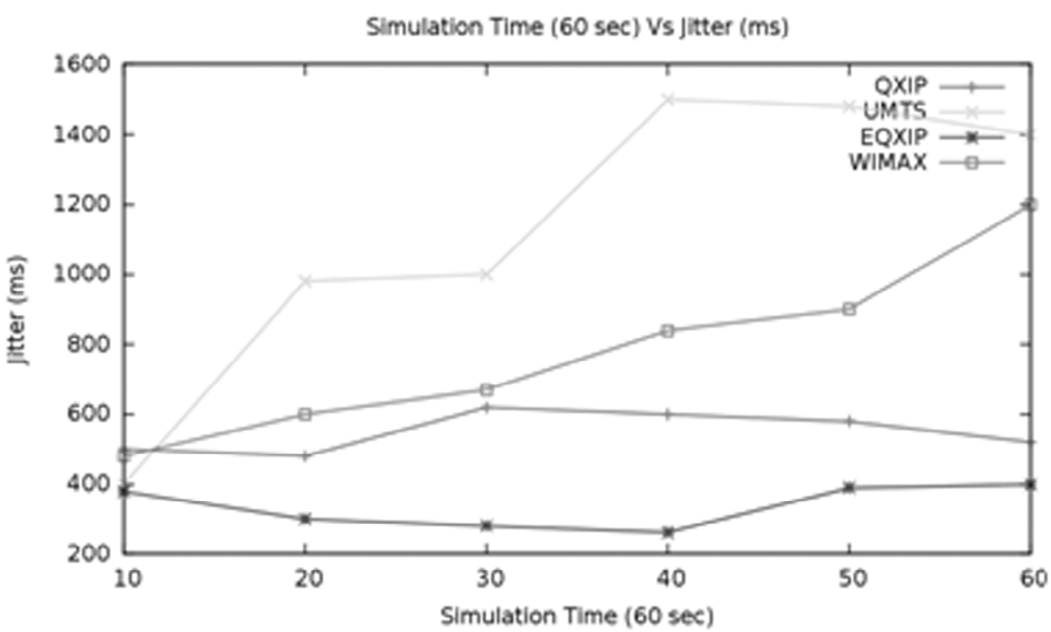

Figure 8: Jitter vs. Simulation time

8. CONCLUSION

In this paper, we have delivered a novel simulation results for the enhanced QoS cross-Layer-IP module by abstracting the QoS parameters such as throughput, delay, jitter and packet delivery ratio in 4G heterogeneous wireless network. This proposed the novel adaptive module attains a achievement of high level QoS within the comparison of different networks of UMTS and WiMAX around the simulated area. As given in (Shashi & Svetlana 2014), this proposed novel concentrated on some of the cross layer design issue by incorporating time QoS parameters into the network. This layer proposes module could handle information flow across all layers depending on the QoS parameters. This novel achieved less packet loss, lower average jitter, with minimized delay and maximized throughput throughout the 4G heterogeneous wireless networks. The capabilities of novel based framework together with several case files its importance in the heterogeneous wireless network scenario.

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