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Effect of Node Trajectory on VoIP QoS in WiMAX Networks

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Abstract: In wireless network mobility is an important issue because internet connectivity can only be effective if it's available during the movement of a node. To enhance mobility, the IEEE 802.16e standard has set procedures to designed wireless access systems to operate on the move without any disruption of services. The major difference between mobile WiMAX and fixed WiMAX is mobility support. However, speed and trajectory of node are unpredictable and can vary even in identical circumstances. In this paper mobile node trajectory is studied under different codecs schemes in order to evaluate the effect of node movement towards or away from the base station on the end to end delay, jitter, mean opinion score and throughput of a VoIP application. The results showed that trajectory inward improves network performance since mobile node gets closer to base station and hence signal is improved and requires less power.

KeyWords : *Trajectory, jitter, throughput, VoIP,Codecs, mobility.*

I. Introduction

WiMAX stands for Worldwide Interoperability for Microwave Access. (WiMAX) embodies the IEEE802.16 family of standards that provide wireless broadband access to residential and commercial Internet subscribers [1].

Due to the growing demand for newer application that requires mobility features as well as the very rapid advancement in technology. The IEEE 802.16 workgroup presented the IEEE 802.16e standard version based on the IEEE 802.16-2004 standard (fixed version) in order to support such mobile wireless broadband access service which in turn provides high-speed information transmission through this proposed wireless broadband solution as well as supporting high speed mobility[2].

Mobile WiMAX performance is influenced by many external factors such as traffic type, network size, traffic load and node mobility (trajectory)[3]. QoS is the fundamental premise of the IEEE 802.16 MAC architecture . It defines a number of Service Flows which can map to DiffServ code points that enable end-to-end IP based QoS. In addition it provides a flexible mechanism for optimal scheduling of space, frequency and time resources over the air interface on a frame-by-frame basis using the sub-channelization schemes [4].

The performance of the VoIP calls which are mapped to the BE service class are analyzed and evaluated to investigate the effect and functions of QoS mapping in VoIP applications. Different trajectories were applied to the MS with the G.711 and G.729 encoders in order to identify which encoder gives the best performance to the VoIP application. It was concluded that the G.729 is better than G.711 in terms of QoS parameters and can support up to 80 mobile users [5].

In this paper performance of VoIP that are mapped to UGS service class are evaluated when different trajectories are applied to different mobile nodes under different codecs schemes.

II. **Quality of service**.

Quality of Service (QoS) is the ability to communicate a type of traffic in good conditions, in terms of availability, throughput, transmission delay, jitter, packet loss, and rate…etc. It has become an important factor to support variety of applications that use network resources. These

applications include multimedia services, Voice over IP…etc.
The traffic engineering term Quality of service refers to the probability of the telecommunication network meeting a given traffic contract, or the probability of a succeeding packet in the transition between two points in the network.[6].
In order to guarantee QoS multiple constraints need to be addressed by Mobile WiMAX such as the wireless nature of the channels, QoS requirements violation due to transmission errors, the negative effect by the mobility of users on the real time services and security level. Standardized mechanisms for supporting QoS are defined by Mobile WiMAX amendments but in the mean time have left many QoS functions unspecified so that researchers and constructors could design and adopt the mechanisms best suited to fulfilling particular requirements [7].

III. Node Mobility

In wireless network mobility is an important issue because internet connectivity can only be effective if it's available during the movement of a node. To enhance mobility, the IEEE 802.16e standard has set procedures to designed wireless access systems to operate on the move without any disruption of services.
In simple mobility the subscriber may move at speeds up to 60 km/h (Kilometer per Hour) with brief interruptions (less than 1 sec) during handover and Full mobility supports up to 120 km/h speed and seamless handover (less than 50 ms latency and < 1% packet loss) [8]. The major difference between mobile WiMAX and fixed WiMAX is mobility support. However, speed and trajectory of node are unpredictable and can vary even in identical circumstances. The speed of mobile node has a significant effect on network performance as well as network size, traffic types and traffic loads. Some experimental work showed that throughput is increased when MSs move towards the BS and it decreased when MSs moved away from the BS [9]. Movement of a mobile station (MS) in a mobile wireless network, can take different forms . Therefore mobility models are designed to describe the movement pattern of mobile users. Hence the protocol performance is determined by these mobility patterns [10].

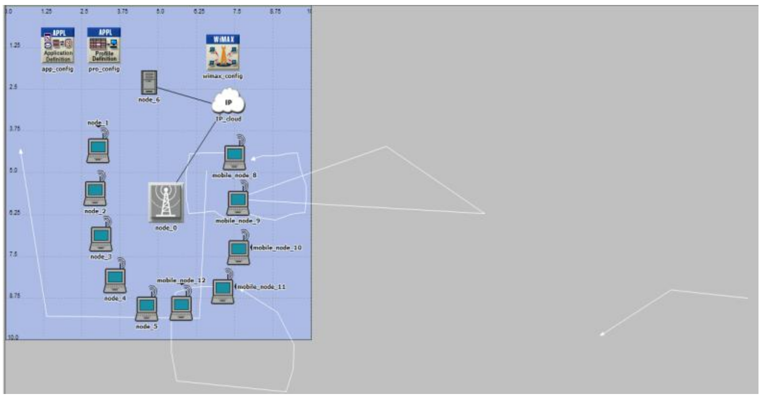
IV. Voice over IP

VoIP(voice over internet protocol) is a way to utilize a data network IP to carry voice calls. VoIP carries voice signals as digital packetized signal by converting the original analog voice signal into digitized packets.
This process is called encoding and the reverse of this process is called decoding. Both of the processes are done by voice codecs[11]. Voice over Internet Protocol (VoIP) brings new challenges along with the benefits. Since VoIP has an extreme sensitivity to delay and packet loss in comparison to other network applications such as web and e-mail services , a basic understanding of VoIP traffic and of the quality metrics provided by VoIP monitoring tools will help to keep VoIP network running smoothly[12].
A VoIP codec is an algorithm used to encode and decode the voice stream. Different algorithms are used for different codecs to compress and decompress the voice stream. The main difference between the various codecs is the type of modulation and demodulation scheme being adopted[13]. Voice Codecs are used on the client side to convert the analog voice signal to digital signal and vice versa. There are many types of codecs depending on the selected data rate, sampling rate, and compression algorithm being implemented .
In order to locate the bandwidth requirements of VoIP connections, common VoIP Codecs are employed such as G711, G729 and G723[14].

V. Simulation and Results

To test the effect of node trajectory on QoS under different codec schemes when using VoIP as testing application the topology in fig(1) is used. As can be seen it consists of 5 fixed subscriber stations (SS) , five mobile stations (MS). one base station (BS), one server and cloud. The application implemented in this scenario is VoIP in order to test QoS of this WiMAX network. For the VoIP application, the "Application Config" node is used to specify applications using available application types. or to create new applications where a name for the new application can be specified and the corresponding description of the application.. the "Profile Config" node is used to create user profiles. These user profiles can then be specified on different nodes in the network to generate application layer traffic. The application defined in the "Application Config" objects are used by this object to configure profiles. Therefore, applications must be created using the "Application Config" object before using this object. The service class used for all the scenarios is the unsolicited grant service (UGS) since as per the IEEE802.16 standard is the recommended class for VoIP. Six scenarios are run in this test, three of which use the codecs G711, G729A and G723 without applying trajectories to the mobile nodes. The other three scenarios use the same codecs but this time different trajectories are applied to the mobile nodes to check the effect on the QoS parameters, which are the jitter, end to end delay , mean opinion score (MOS), packet delay variation and throughput.

Fig. 1 Network topology with trajectories



Table(1) details the parameters of the WiMAX that have been used for the test.

Table(1) WiMAX configuration parameters

Parameter	Value
Scheduling class	UGS
Codecs	G711, G729A, G723
Max. latency millisecond	30
Efficiency mode	Mobility and Ranging
Profile	OFDMA 20 MHz
Frame duration millisecond	5
Symbol duration millisecond	102.86
Number of subcarriers	2048
Duplexing mode	TDD

The following set of graphs show the effect of the movement of mobile nodes in a defined trajectory on QoS of the test WiMAX network topology under different codecs schemes. The parameters that have been chosen for comparison are those once that effect QoS of the running application on the tested network platform which are end to end delay, jitter, packet loss variation and MOS as well as throughput for the WiMAX network.

1. End to end delay

From fig.2 it can be seen that the node trajectory has a very minimal effect on the end to end delay for the VoIP application under the three implement codecs schemes, where for the G711 and G723 there is no effect at all but for the G729A , the node trajectory has improved the delay slightly

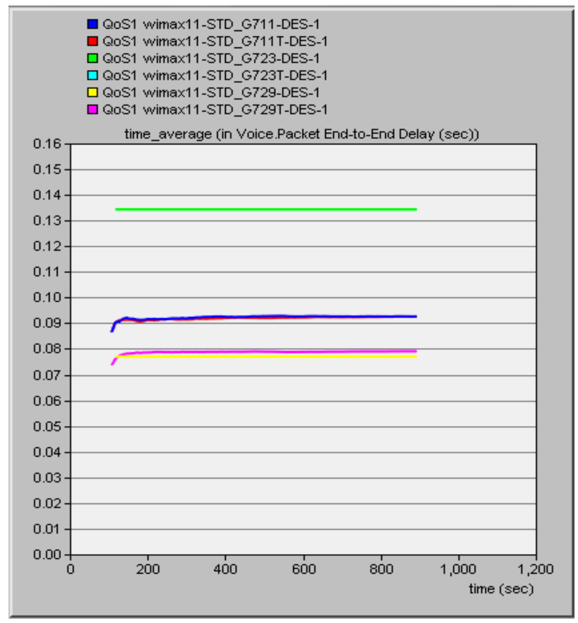


Fig. 2 End to end delay

2. Jitter

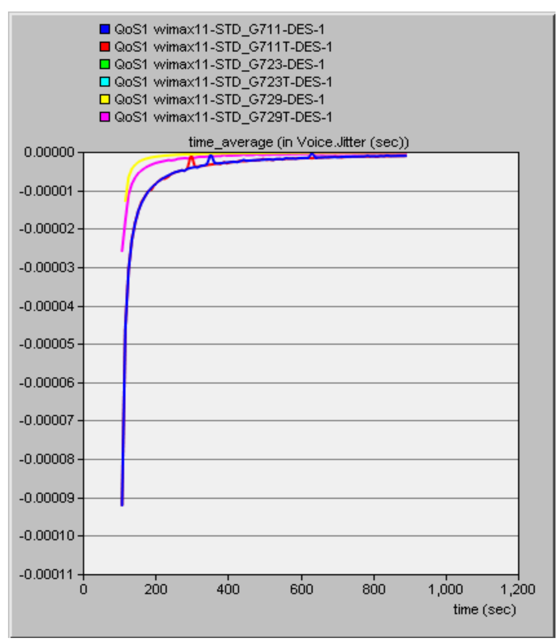


Fig. 3 Jitter

It is quite clear form fig.3 the effect of node trajectory as far as voice jitter's concerned is not significant except for the G729A codec where it minimizes jitter marginally.

3. Mean Opinion Score

For this parameter it can be noted from fig. 4 that there is no change for the G711 codec. For the G729 there is a little improvement in the MOS value due to nodes trajectory but for the G723 codec the nodes trajectory made the MOS value worse.

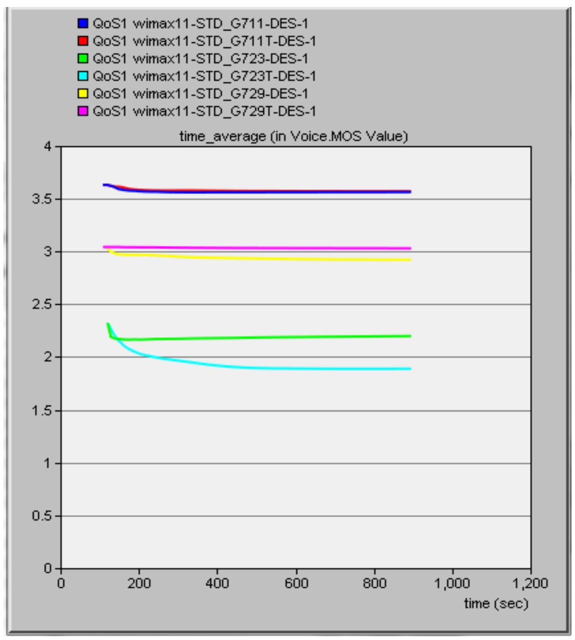


Fig 4 MOS value

4. Throughput

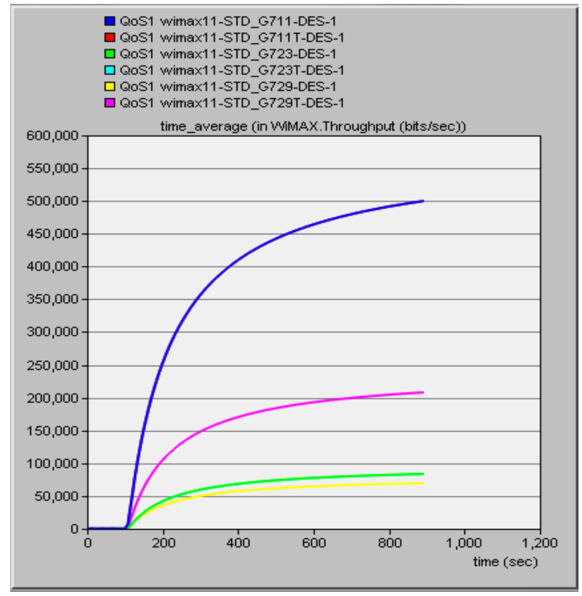


Fig. 5 throughput

From fig. 5 the nodes trajectory did not induce any effect on the network throughput in the case of G711 and G723 codecs. But it improved the throughput significantly for the G729A codec..

5. Packet Delay Variation

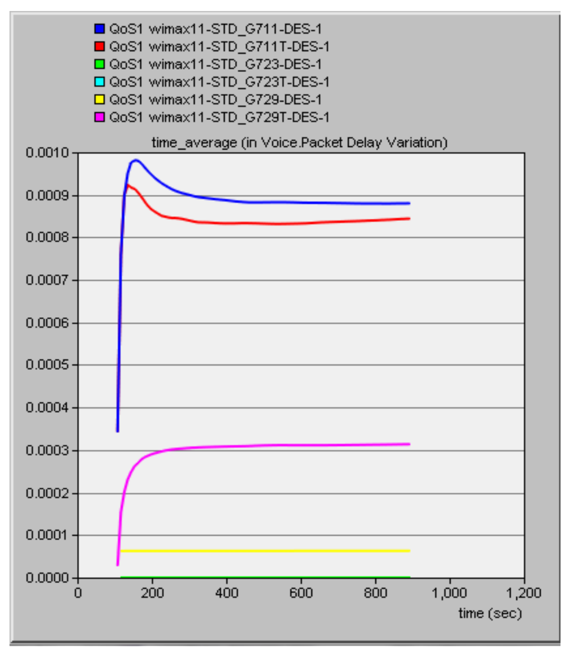


Fig. 6 Packet Delay Variation

Fig. 6 shows that the G711 trajectory case has a lower delay variation value whereas the G729A has the reverse effect where the trajectory case has increased the packet delay variation sizably. On the other hand the trajectory has no effect on the G723 case.

IV. Conclusion

In this paper the OPNET simulation tool was used to test the effect of node movement in defined trajectories on the QoS for a WiMAX network under different voice codecs schemes when a VoIP application is implemented in the network. Six scenarios were executed and some results were collected to check the effect of nodes trajectory on QoS parameters, end to end delay, jitter, MOS, packet delay variation and throughput.

From the obtained results it can be concluded that the effect of node trajectory depends on the type of codec being implemented since as it was shown from the results the G729A codec is the most affected by the node trajectory since in general improves the network performance for most of the tested parameters.

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