International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
(Volume 13, Issue 01)
Publishing Month: June 2015
An Indexed and Referred Journal
ISSN: 2347-601X
www.ijemhs.com

A QoS Review between WiMAX and UMTS

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Abstract

Quality of Service (QoS) is generally used to assess communication systems. In this paper, UMTS, and WiMAX system QoS performance are investigated by analyzing published research work. The investigation will focus on the QoS parameters that include network delay, packet delay variation (PDV), packet end-to-end delay, jitter, and mean-opinion-score (MOS).

Keywords: *QoS, UMTS, WiMAX, networking.*

1. Introduction

The universal mobile telecommunications system (UMTS) and WiMAX are both technology systems that are built over third generation 3G mobile cellular systems. The UTMS wireless protocol is part of the International Telecommunications Union's IMT-2000 vision of a global family of 3G mobile communications systems. Fig.1 shows both systems number of users over the last decade globally [1], where it is obvious the drastic increase of users over the recent years.

The success of 3G/3.5 G and next generations of wireless technologies depend on the network user satisfaction and affordability for different services in real time applications. UMTS system is expected to deliver low-cost, high-capacity mobile communications, offering data rates up to 2Mbps. This enables the effective data flow over the network specially for multimedia contents such as video streaming and telephony using mobile devices and smart phones [2]. UMTS radio access network consist of radio network controller (RNC) and Node B as shown in Fig.2. The RNC in UMTS networks plays a role similar to the base station controller (BSC) unit in GSM/GPRS networks. Node B in UMTS networks is equivalent to the base transceiver station (BTS) in GSM/GPRS networks.

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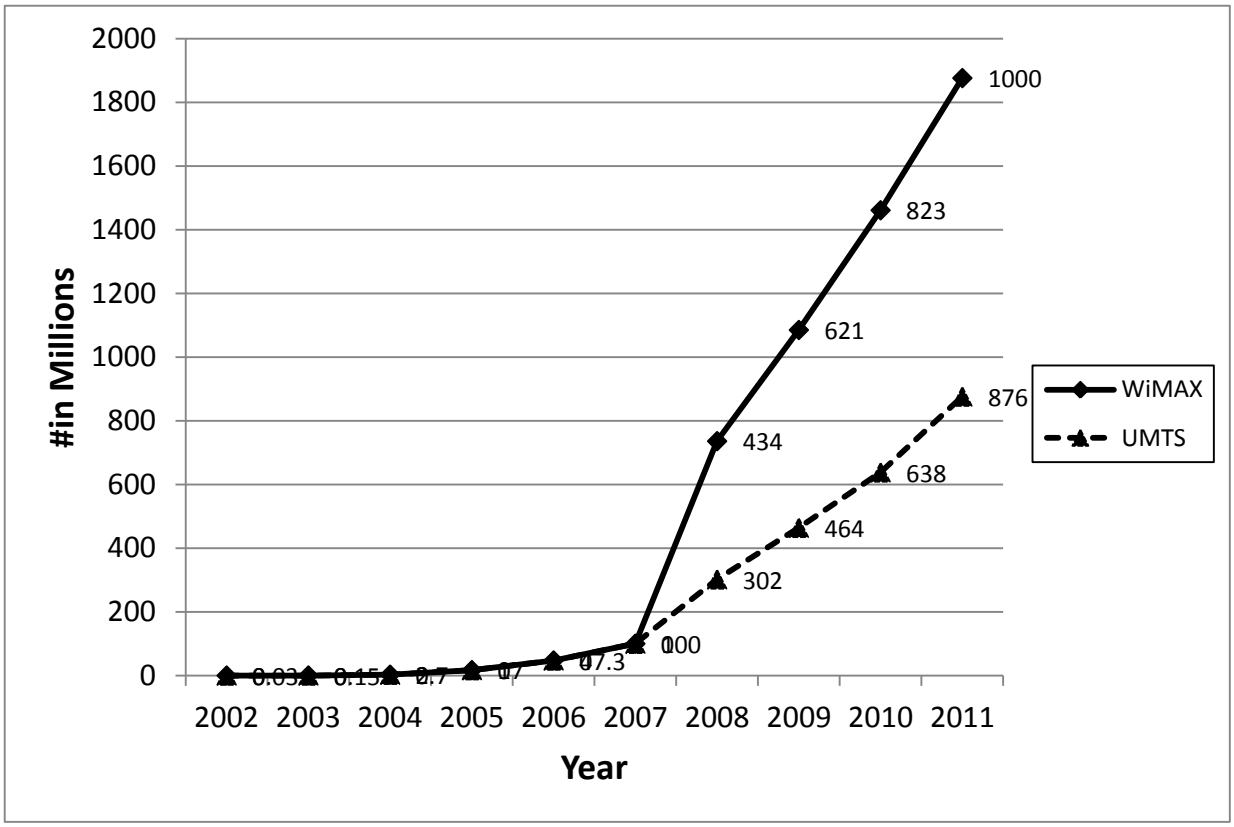

Fig.1 UMTS and WiMax global user numbers over the last decade

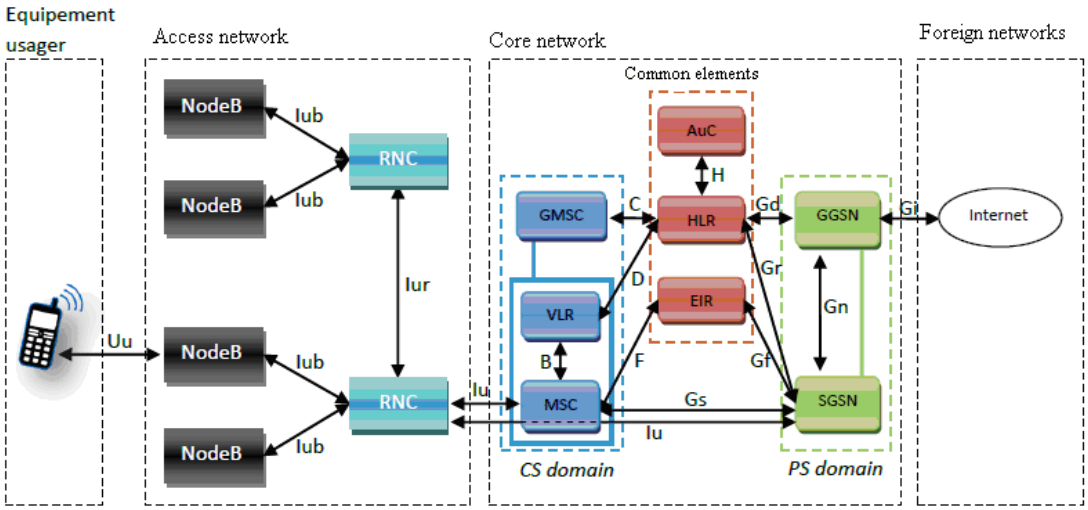

Fig. 2. Example of UMTS network

Other components of the UTMS network are the equipment user: EU (To use Equipment), the Universal Terrestrial Radio operator Network Access (UTRAN), and the core network (CN).

The brief description of each of these units function are:

- User Equipment(EU): The domain of the UE includes the set of the terminal equipment
- Access Network: The domain of the access network as shown in Fig.2
- (UTRAN) provides the required resources and mechanisms necessary to the EU to reach the core network. The UTRAN calls upon technology UTRA, with its two alternatives FDD and TDD, founded on the access method broad band CDMA.
- Core Network: The Core Network includes all the equipment performing the functions of safety control and management of the interface with external networks[3,4]

The WiMAX is a technology that provides wireless broadband access in multiple deployment scenarios. The standardization entity of this technology is based on the IEEE 802.16[5] . The WiMAX aims to provide wireless broadband internet access in a radius of several kilometers and is intended primarily for metropolitan area networks (MAN). The WiMAX network architecture shown in Fig.3 consist of fixed (non mobile) stations that are described as follows [5]:

- Subscriber Stations (SS) which serves units such as building for business or residence.
- Base station (BS) which connects to public network and provides the SS with first-mile access to public networks The communication path between SS and BS has two directions:
    - Uplink (from SS to BS)
    - Downlink (from BS to SS)

Worldwide interoperability for Microwave Access systems presents new challenges and requirements in terms of spectrum limitations, architecture scalability and reliability. Both next generation telecommunication networks (UMTS, and WiMAX) meet these challenges with similar approaches. As LTE, WiMAX uses OFDM for the network wireless connection to its subscribers. Table 1 . Shows a system comparison between UTMS and WiMAX [6].

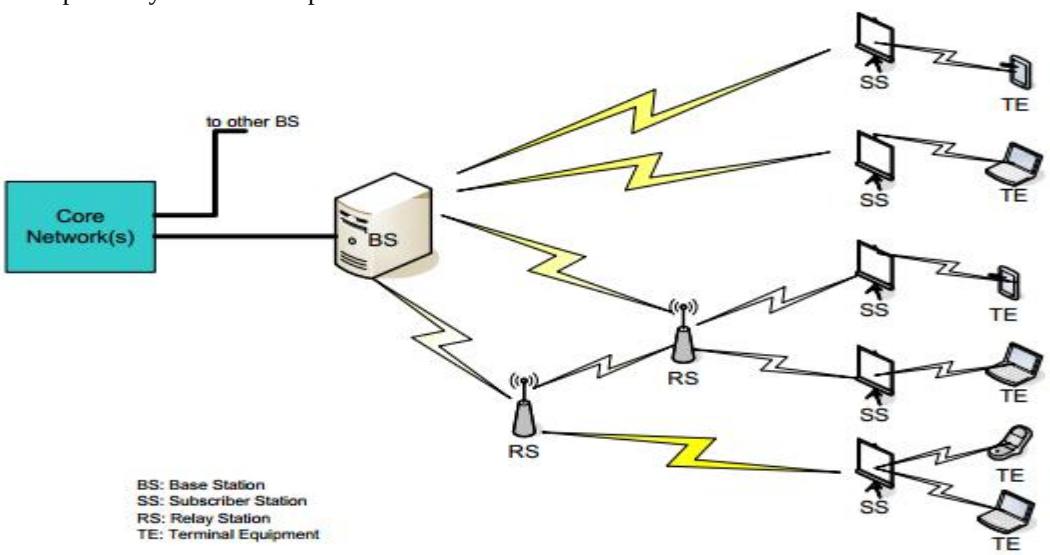

Fig 3. WiMAX network architecture

Table 1: Comparison between UMTS/HSDPA and Mobile WiMAX

Attributes	UMTS/HSDPA	Mobile WiMAX
Standard	WCDMA	IEEE 802.16e
Duplex Method	FDD	TDD
Multiple Access	CDMA	SOFDMA
Channel Bandwidth [MHz]	5	5, 7, 8.75, 10
Frequency [GHz]	2	2.5, 3.5, 5.8
Frame Size [ms]	2	5
Modulation	QPSK / 16QAM	QPSK / 16QAM / 64QAM
DL PHY Peak Data Rate [Mbps]	14.4	31.68 (for a 10 MHz channel)
Coverage [km]	Typically 2 to 5	Up to 5
HARQ	Yes	Yes
Fast Scheduling	Yes	Yes
AMC	Yes	Yes

2. Comparison of QoS between UTMS and WIMAX

The quality of service (QoS) is defined in [ITU-T E.800] as the collective effect of performance which determines the degree of user satisfaction of the service as a measure of performance at the packet level. The QoS also refers to a set of technologies that enables the network administrator to manage the traffic congestion on application performance as well as providing differentiated service to selected network traffic flows or to selected users. When trying to migrate to 4G, network administration are faced with QoS provisioning challenges and security services for mobile users' communication flows [7]. The QoS problems consist of two major issues:

a) Mapping QoS parameters over different access/ connectivity network at call setup.

b) Maintain QoS parameters when users are mobile, i.e. move to different access networks that may cause changes in backbone and connectivity networks.

The different radio access and connectivity networks have defined QoS parameters and classes through their standardization and specifications [8]. The ITU-T recommendation focuses on four different points of view as QoS. These are

- Customers QoS requirements
- Service providers offering of QoS
- QoS achieved or delivered
- Customer survey rating QoS

Both UMTS with evolved High Speed Packet Access (HSPA) and WiMAX technologies are being developed simultaneously, which makes possible that WiMAX services will complement existing and future broadband technologies to best assure the coverage and capacity requirement of consumers[6]. To assess network performance let us consider the following characteristics and different applications:

A. Network Delay:

This parameter is an important design and performance characteristic of a computer or telecommunications network. The delay of a network determines how much time does a bit of data needs to travel across the network from one node or endpoint to another. Generally regular users only pays attention to the total delay of a network, while engineers need to perform more precise delay measurements. Therefore, engineers

tend to divide network delay into several portions as follows:

- Processing delay - time routers take to process the packet header
- Queuing delay - time the packet spends in routing queues
- Transmission delay - time it takes to push the packet's bits onto the link
- Propagation delay - time for a signal to reach its destination.

It worth noting that the delay on a UMTS network delay is usually more than WiMAX network delay due to WiMAX high throughput. The long delays in UMTS causes more jitter in UMTS compared to WiMAX[9]

B. Packet delay variation (PDV):

Packet delay variation plays a crucial role when evaluating network performance and degradation. This delay affects the user-perceptual network quality. Higher packet delay variation results in higher packet congestion which in turns causes higher network overhead. WiMAX is having a smaller delay variation because of buffering and jitter and therefore the WiMAX architecture provides a stable QoS for the service. The UTMS architecture on the other hand is characterized with a higher delay variation which results in disturbed QoS particularly while streaming services[2,7].

C. Packet End-to-End Delay

Packet End-to-End Delay or knows sometimes as One-way delay refers to the time taken by a packet to be transmitted across a network from source to destination. It is considered one of the most important performance metric in VoIP applications. This delay in WiMAX is much more steady than that in UMTS and for that reason the WiMAX can provide better VoIP services in terms of end-to-end packet delay[2]. The reason behind this advantage is that the WiMAX is an all-IP network while the UMTS is still made as a combination of circuits and packet switched technologies. For instance, a VoIP call in UMTS architecture has to go through a selection procedure to choose the circuit switched network or the packet switched network. This selection process consumes a considerable amount of time and hence elongates end-to-end delay of the UTMS network [7].

D. Jitter

The jitter is defined as the variation in arriving time of sent packets or variation in delay suffered by different data packets reaching a destination. Therefore, it is desired to have as low as possible jitter effects. The WiMAX has no less jitter when compared to UMTS. The jitter factor causes a decrease of the Mean-Opinion-Score (MOS) value. The UMTS exhibits higher jitter than the WiMAX, This is expected since the distance covered by umts is greater than that covered by wimax[2,9].

E. MOS

Mean opinion score (MOS) is a test that has been used for decades in telephony networks to obtain the human user's view of network quality. The average MOS decreases with the increase of connections number in UMTS. The average MOS remains roughly steady in WiMAX irrespective of VoIP connections number when compared to UMTS. The WiMAX has less congestions , less traffic burst, and better bandwidth. Hence the WiMAX is capable of providing better voice quality than UMTS. Sheetal J. et. al. [2] has demonstrated through measurement of voice signal quality transmitted over a mobile WiMAX that higher MOS were accomplished for WiMAX when compared to mobile UMTS for the same number of connections.

Table 2. Summarized results of reviewed published work

Publication	Contribution	Research domain
Sheetal J. et.al. [2] Almontaser B. et. al. [7] Nafissa B et.. al. [10]	• WiMAX outperform UMTS on MOS, end-to-end delay, jitter and packet delay variation parameters. • WiMAX is a better technology for VoIP applications compared to UMTS.	VoIP applications using UMTS & WiMAX
Dina M. et. al. [9]	• WIMAX is more efficient than UMTS • WIMAX network has high performance, which has demonstrated by measuring and analyzing QoS parameters.	QoS parameters of delay, throughput, and queuing delay
Karthika A. et. al. [11]	• simulated two different heterogeneous networks of UMTS-WLAN, and WiMAX WLAN. • The advantage of this network is coverage area, hot spot, low cost, high data rate and easy integration. • The router plays its role in improving the voice clarity by reducing jitter	integration of two network ratio of UMTS and WiMAX
Rajiv C. et. al. [12]	• Studied the QoS Parameters of three technology Wi-Fi, WiMAX and UMTS • Networks are completely different • Studies of technologies give a motivation for integrating the three technologies that shows an improvement of parameters such as QoS handover	this paper analyzes three communication technologies with focus on QoS

3. Conclusions

In this review paper, various recently published works focusing on QoS parameters for UTMS and WiMAX technologies are studied and results are summarized. Various researchers have concluded that the MAX offers a better performance for VoIP application when compared to the UTMS. Researchers have reported and demonstrated measured and simulated results on QoS parameters such as MOS, Jitter, and Delay and found these parameters have better characteristics using the WiMAX compared to the UMTS.

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