Comparison of VoIP and Video Content Performance Over WiMAX and LTE

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***Abstract*—IEEE 802.16 Worldwide Interoperability for Microwave Access (WiMAX) is an emerging broadband wireless communication standard used as a model of transmission and high speed Internet access. 3G Long Term Evolution (LTE) is the leading standard for wireless communication of high-speed data for mobile users. In this report we compare the performance of voice and video applications over WiMAX and LTE. We use Opnet 16.0.A and Riverbed modeler 18.5 to build simulation models for WiMAX and LTE, respectively.**

I. Introduction

Mobile communication technology evolved rapidly due to the increasing demands for higher data rates and higher quality mobile communication services. Fulfilling these demands was done by defining a new air interface for mobile communications which enhances the overall system performance and increases the capacity of the system.It has been proved, in both theory and in practice that some novel key technologies such as multiple input, multiple output (MIMO) and orthogonal frequency division multiplexing (OFDM) improve the performance of current mobile communication systems [1] [2].

Worldwide Interoperability for Microwave Access (WiMAX), is a wireless communication system that can provide broadband access on a large-scale coverage. It enhances the WLAN (IEEE 802.11) by extending the wireless access to Wide Area Networks and Metropolitan Area Networks. The initial version of WiMAX, IEEE 802.16-2004, was designed to provide broadband wireless connectivity to fixed and nomadic users for the last mile [3]. The coverage can go up to 50 km, allowing users to get broadband connectivity in NLOS conditions. IEEE 802.16-2005 (Mobile WiMAX) comes with enhanced QoS and mobility up to 120 km/h. Mobile WiMAX is designed to fill the gap between wireless local area networks and high mobility cellular wide area networks. In order to obtain downlink peak data rates up to 75 Mbps in mobile scenarios, the standard uses scalable OFDMA to dynamically modify FFT size, depending on the channel conditions [4].

Both WiMAX and 3G Long Term Evolution (LTE) are technically similar standards. The expectations from these technologies are great, the most important aspect being the VoIP service which is supposed to offload a lot of congested 2G or 3G networks because the voice can now be delivered very efficiently over IP, as timing and synchronization over packet networks are mature enough.

This report proposes a comparative study between WiMAX and LTE by focusing on the use and study the behavior of voice and video applications and heavy browsing over the two networks.

The report is structured as follows. In Section II, we introduce WiMAX and LTE technologies. In Section III, we introduce network models and configurations for VoIP over WiMAX and LTE. Performance evaluation is presented in Section IV. We conclude with Section V.

II. Overview of WiMAX and LTE

A. WiMAX Technology

WiMAX is a wireless communication system that can provide broadband access on a large-scale coverage. It enhances the WLAN (IEEE 802.11) by extending the wireless access to Wide Area Networks and Metropolitan Area Networks. The initial version of WiMAX, IEEE 802.16-2004, was designed to provide broadband wireless connectivity to fixed and nomadic users for the last mile. The coverage can go up to 50 km, allowing users to get broadband connectivity in NLOS conditions. IEEE 802.16-2005 (Mobile WiMAX) comes with enhanced QoS and mobility up to 120 km/h. Mobile WiMAX is designed to fill the gap between wireless local area networks and high mobility cellular wide area networks. In order to obtain downlink peak data rates up to 75 Mbps in mobile scenarios, the standard uses scalable OFDMA to dynamically modify FFT size, depending on the channel conditions [4].

B. LTE Technology

LTE technology evolved from UMTS/HSDPA cellular technology to meet current used demands of high data rates and increased mobility. The LTE radio access is based on OFDM technique and supports different carrier frequency bandwidths (1.4-20 MHz) in both frequency-division duplex (FDD) and time-division duplex (TDD) modes [5]. The use of SC-FDMA in the uplink reduces Peak-to-Average Power Ratio compared to OFDMA, increasing the battery life and the usage time on the UEs. In downlink peak data rates go from 100 Mbps to 326.4 Mbps, depending on the modulation type and antenna configuration used. LTE aims at providing IP backbone services, flexible spectrum, lower power consumption and simple network architecture with open interfaces.

III. VoIP over WiMAX and LTE

Voice over IP (VoIP) enables voice communications to be delivered over Internet Protocol networks. VoIP applications such as Skype and FaceTime are widely used in practice. The quality of users experience are allowed to be evaluated by measuring VoIP metrics, such as packet loss, throughput, jitter, End-to-End (ETE) delay, and mean opinion score (MOS) [5].

A. Network Topology

1) WiMAX Scenario: The network topology of VoIP over WiMAX model is shown in Figure 1. The network scenario consists of 1 mobile user that conducts handover between 2 WiMAX base stations (BSes). These BSes are connected to a server via a gateway router. Router and server are connected using 1000BaseXT Ethernet cable with a maximum speed of 1000Mpbs.

Cell radius is 25 km. We assume the mobile user is drving a car with the speed of 60 km/h. The network allows handover of data sessions as the mobile user travels between 2 BSes.

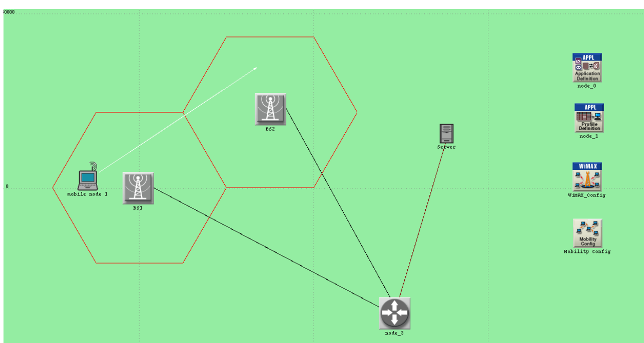

Fig. 1. VoIP over WiMAX topology.

2) LTE Scenario: The network topology of VoIP over LTE model is similar with WiMAX, as shown in Figure 2.

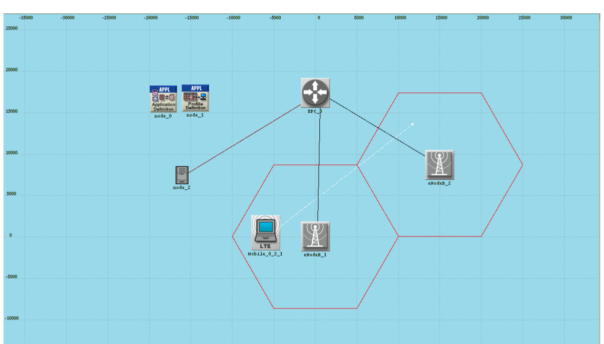

Fig. 2. VoIP over LTE topology.

B. Application Configuration

WiMAX service class attributes capture the Quality of Service (QoS) requirements of traffic flows between BS and SS. We used Gold class service and Unsolicited grant service (UGS) scheduling with 0.5 Mbps sustainable data rates for both uplink and downlink.

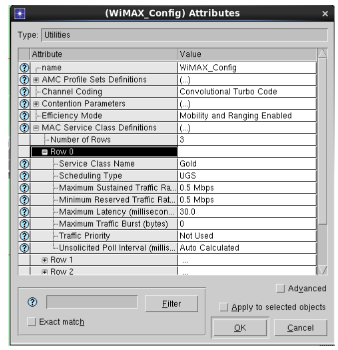

Fig. 3. WiMAX service class configuration

WiMAX BS configuration is shown as Figure 4. We used transmission power of 0.5 w, receiver sensitivity of -200 dBm, and Port Physical Layer (PHY) profile wireless Orthogonal Frequency-Division Multiplexing (OFDMA) with 20 MHz.

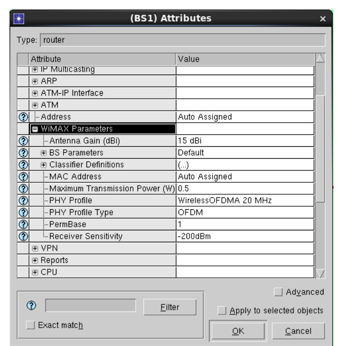

Fig. 4. WiMAX BS configuration

LTE BS configuration is similar with WiMAX except for the PHY profile, which is LTE Frequency-Division Duplexing (FDD) with 20 MHz.

IV. Performance Evaluation

In this section, we compare simulation results for VoIP and video content over WiMAX and LTE, respectively.

A. VoIP Performance

The duration for VoIP simulations is 50 minutes. Packet loss for WiMAX and LTE are shown as Figure 5 and Figure 6, respectively. Packet loss rate for WiMAX is around 60% to 80%, which is much higher loss rate than LTE (less than 1%).

The throughput for WiMAX is up to 80 packets per second while LTE achieves 200 packets per second, as shown in Figure 7 and Figure 8.

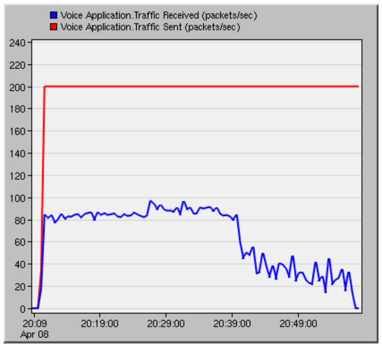

Fig. 5. WiMAX traffic sent and received

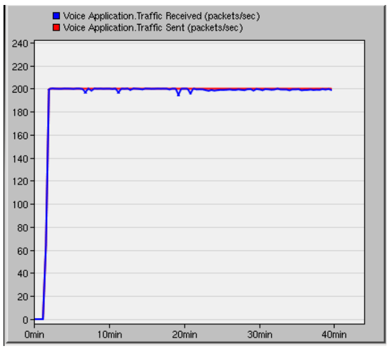

Fig. 6. LTE traffic sent and received

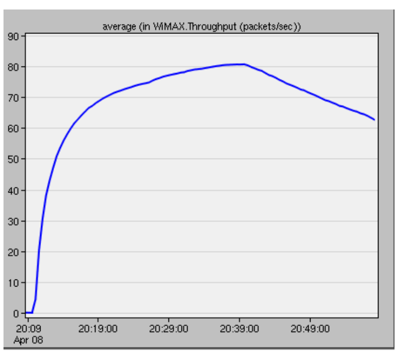

Fig. 7. WiMAX throughput

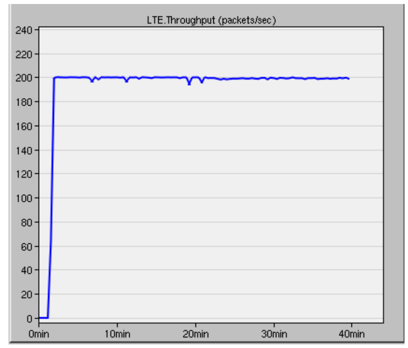

Fig. 8. LTE throughput

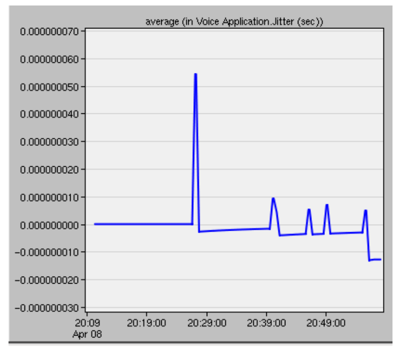

Fig. 9. WiMAX average jitter

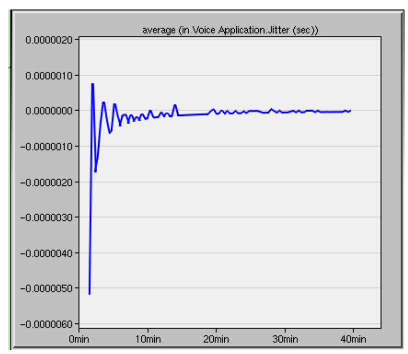

Fig. 10. LTE average jitter

Average jitter for WiMAX and LTE are shown as Figure 9 and Figure 10, respectively. The results indicate the jitter of WiMAX damped up to 0.5 microsecond while LTE approaches stable and ideal jitter around 0.0 second.

End-to-End delay for WiMAX and LTE are shown as Figure 11 and Figure 12, respectively. The results indicate that WiMAX exhibits a increasing delay from 0.061 to 0.065 seconds while LTE is around 0.11 seconds.

Average MOS value for WiMAX and LTE are shown as Figure 13 and Figure 14, respectively. MOS value for WiMAX is around 1.2, which indicates the mobile user experienced poor voice quality. However, LTE obtained an average MOS of 4, which represents excellent voice quality.

B. Video Content Performance

The duration for video content simulation is 90 minutes. Due to the time limit, we only compared packet loss for WiMAX and LTE as Figure 15 and Figure 16, respectively. During the first 50 minutes, WiMAX and LTE both have acceptable packets loss. From time 20:45 to 21:00, the mobile user takes a handover from BS1 to BS2, which lead to no traffic flow. After time 21:00 a huge packet loss exhibits. We zoomed in traffic received graph from time 21:04 to 21:29 and observed the traffic is around 1.5 packets/second. This result may be caused by the high packet transmission frequency, which lead to the packets number exceed the buffer size.

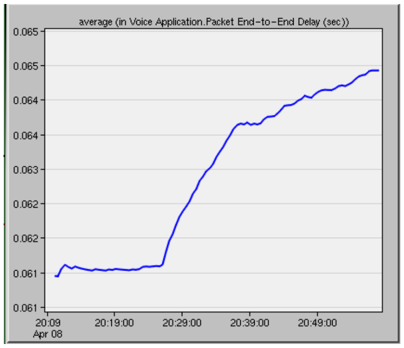

Fig. 11. WiMAX End-to-End Delay

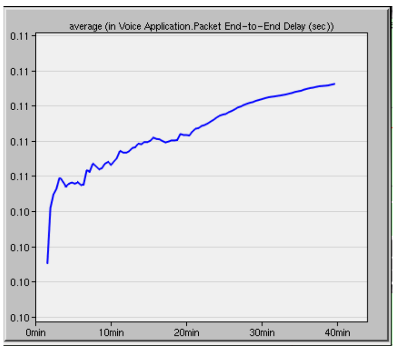

Fig. 12. LTE End-to-End Delay

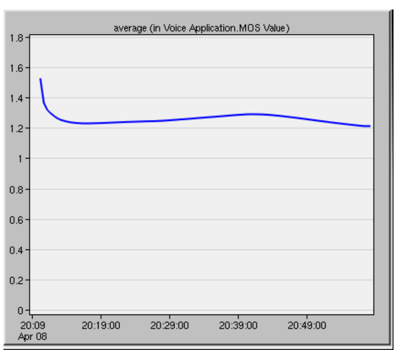

Fig. 13. WiMAX average MOS value

V. Conclusion

In this report, we compared WiMAX and LTE performance using OPNET and Riverbed simulators. Simulation results comparison showed that average throughput is lower in WiMAX than LTE. The range of the jitter is bigger in WiMAX than LTE, however, maximum jitter ¡ 3ms is negligible. The average End-to-End delay in WiMAX is less than LTE. MOS value in WiMAX is much lower than LTE. We can conclude that for both VoIP and video content, LTE outperforms WiMAX in the simulated network.

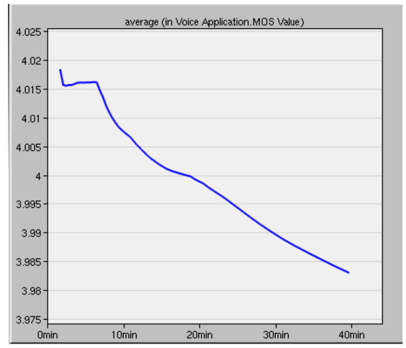

Fig. 14. LTE average MOS value

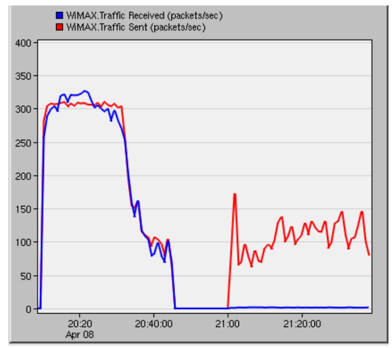

Fig. 15. WiMAX packet loss over video content

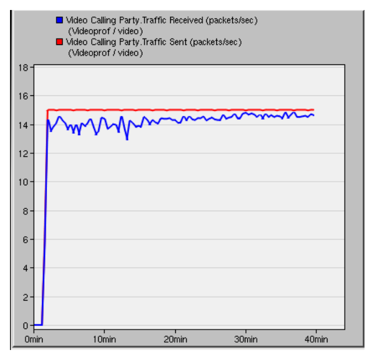

Fig. 16. LTE packet loss over video content

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