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Performance Analysis of WiMAX and LTE Using NS-2

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Abstract
The increasing use of wireless devices and in particular smart phones has resulted the need for greater capacity and higher speed than the existing network technologies. Hence, LTE (Long Term Evolution) and WiMAX (Worldwide Interoper- ability for Microwave Access) became the two leading technologies. Services are increasingly shifting from voice to data and from circuit-switched to packet-switched ones. Battle between LTE and WiMAX technologies is already heating up with WiMAX being ahead due to availability of standards through IEEE 802.16 and is up and running but lacks in substantial roll out plans due to cost. The targets for LTE indicate bandwidth increases as high as 100 Mbps on the downlink, and up to 50 Mbps on the uplink. However, this potential increase in bandwidth is just a small part of the overall improvement LTE aims to provide. This study illustrates the model and representation of LTE links and traffics using NS-2 network simulator and observation of TCP performance investigated. The Evaluation of the network performance with TCP is mainly based on congestion window behavior, throughput, average delay and lost packet.

Keywords- NS-2 (Network Simulator-2), LTE (Long Term Evolution), Wimax (Worldwide Interoperability For Microwave Access), Technologies.

I. INTRODUCTION

In telecommunications, 4G is the fourth generation of cell phone mobile communications standards. There are many features associated with 4G, which make it promising. On the other hand, New applications required to be supported by new mobile systems include a variety; VoIP, video conference, multimedia messaging, multi-player games, virtual private networks (VPN), etc. All these applications require higher throughput, wider BW, smaller delay and innovative transmission methods that will give higher spectral efficiency and good quality. Two leading emerging technologies are: LTE (Long Term Evolution standardized by third generation partnership project(3GPP)and WiMAX (the IEEE802.16e,the worldwide interoperability for microwave access) are considered able to fulfill the 4G requirements announced by ITU-R which is known as International Mobile Telecommunications Advanced (IMT-Advanced).Future scope of both these technologies is enormous. Also, both the technologies have their own advantages and disadvantages. In future, a network may be possible which combines the advantages of both these technologies. Our report hopes to bring forth ns2 simulations of two of the most widely used wireless network technologies. In particular we will be running simulations of both LTE and WiMax network, and then compare their performances to each other, in hopes to discover which one of the two technologies is better.

II. WIMAX

WiMAX stands for Worldwide Interoperability for Microwave Access, which supports point to multi-point (PMP) broadband wireless access. WiMAX technology enables ubiquitous delivery of wireless broadband service for fixed and mobile users, and became a reality in 2006 when Korea Telecom started the deployment of a 2.3 GHz version of mobile WiMAX service called WiBRO in the Seoul metropolitan area to offer high performance for data and video. In a recent market forecast published in April 2008, WiMAX Forum Subscriber and User Forecast Study, the WiMAX Forum projects a rather aggressive forecast of more than 133 million WiMAX users globally by 2012 (WiMAX Forum, 2008c). The WiMAX Forum also claims that there are more than 250 trials and deployments worldwide. The air interface of WiMAX technology is based on the IEEE 802.16 standards. In particular, the current Mobile WiMAX technology is mainly based on the IEEE 802.16e amendment (IEEE, 2006a), approved by the IEEE in December 2005, which specifies the Orthogonal Frequency Division Multiple Access (OFDMA) air interface and provides support for mobility. The IEEE wireless standard has a range of up to 30 miles, and can deliver broadband at around 75 megabits per second. This is theoretically, 20 times faster than a commercially available wireless broadband. WiMax can be used for wireless networking like the popular WiFi. WiMax, a second-generation protocol, allows higher data rates over longer distances, efficient use of bandwidth, and avoids interference almost to a minimum. WiMax can

be termed partially a successor to the Wi-Fi protocol, which is measured in feet, and works, over shorter distances.

III. LTE

Long Term Evolution (LTE) is a significant project of 3rd Generation Partnership Project (3GPP), initially proposed on the Toronto conference of 3GPP in 2004 and officially started as LTE work item in 2006. LTE, as a transition from the 3rd generation (3G) to the 4th generation (4G), has achieved great capacity and high speed of mobile telephone networks without doubt. It defines a new packet-only wideband radio with flat architecture and assumes a full Internet Protocol (IP) network architecture in order to assure voice supported in packet domain in design. In addition, it is combined with top-of-the-line radio techniques in order to gain better performance than Code Division Multiple Access (CDMA) approaches. LTE provides scalable carrier bandwidths from 1.4 MHz to 20 MHz and frequency division duplexing (FDD), as well as time division duplexing (TDD). In this paper, it presents an overall description of LTE technology separately in different aspects of LTE architecture and technical principles to clarify how LTE as a radio technology achieves a high performance for cellular mobile communication systems. LTE has multiple access principles such as OFDMA for DL and SC-FDMA for UL.

Table 1: LTE Requirements

Technical Items	**LTE-Advanced, IMT Requirement**
Downlink peak data rates	1 Gbps (low mobility 15 km/hr)
Uplink peak data rates	500 Mbps (low mobility 15 km/hr)
Bandwidth	Scalable up to 100 MHz
User plane latency	10 ms
Control plane latency	50 to 100 ms
Uplink peak spectral efficiency	15 bps/Hz
Downlink peak spectral efficiency	30 bps/Hz
Access Scheme	OFDMA

IV. SIMULATION SOFTWARE: NS2

Many network simulation softwares are available in market. Some of the leading network simulators are Qualnet, Ns-2, JiST/SWANS, Opnet, Omnett, Netsim REAL, SSFNet, JSimetc. Here we present a quick comparison of various available network simulation software. But we have decided to use NS-2(Network Simulator-2) because of its following features and advantages over other simulators:

Popular used in academia and industries
Open Source software

- Provides greater accuracy and speed of testing
- Supports large number of external protocols
- Programming can be done using tclscript and/or C++
- Provided with visualization tools
- Complex scenarios can be easily tested

More ideas can be tested in a smaller timeframe Network Simulator version 2 (NS-2) is discrete event packet level simulator. The network simulator covers a very large number of application of different kind of protocols of different network types consisting of different network elements and traffic models. NS-2 is a package of tools that simulates behavior of networks such as creating network topologies, log events that happen under any load, analyze
the events and understand the network.
Platform required to run network Simulator
1. Unix and Unix like systems

- Linux
- Free BSD
- SunOS/Solaris

2. Windows 95/98/NT/2000/XP/7/8.1 (requires Cygwin).

Simulation System Architecture

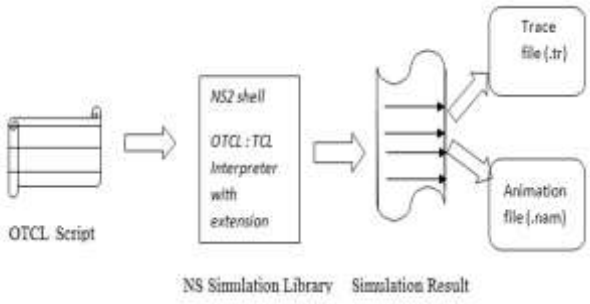

Figure 1: Working in NS2

V. PARAMETERS COMPARED

- Packet delivery ratio:

Packet dropping is where network traffic fails to reach its destination in a timely manner. Most commonly packets get dropped before the destination can be reached
PDR = (No. of Packets received / No of Packets sent)*100

- Throughput:

Network throughput is the average rate of successful message delivery over a communication

channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

Throughput T =No.of bytes*8/(Finish time-Start time) bps

- Delay:

Delay refers to the amount of time it takes for a bit to be transmitted from source to destination. It can take a long time for a packet to be delivered across intervening networks. In reliable protocols where a receiver acknowledges delivery of each chunk of data, it is possible to measure this as round-trip time. One way to view latency is how long a system holds on to a packet. That system may be a single device like a router, or a complete communication system including routers and links. Delay of packets in the network can be measured through the trace file obtained after the execution of code. End to end delay D = (Td - Ts) seconds where Td is the packet receive time at the destination and Ts is packet send time at source node.

VI. SIMULATION RESULTS

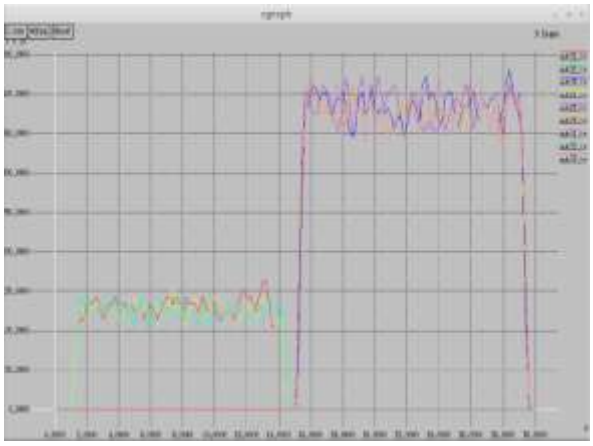

Figure 2: LTE Throughput

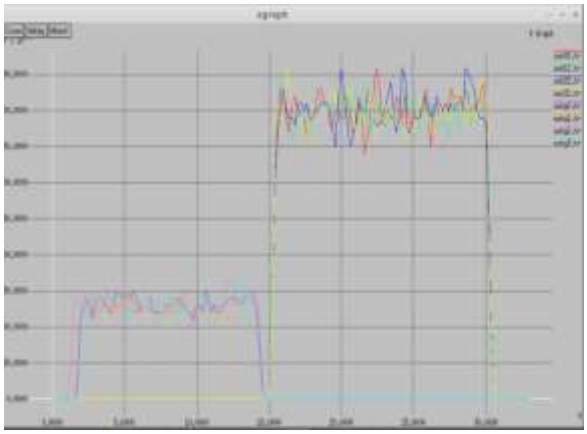

Figure 3: WiMax Throughput

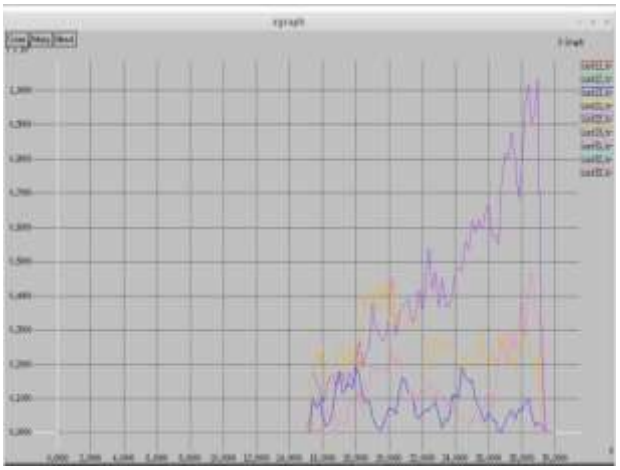

Figure 4: LTE Packet Loss Rate

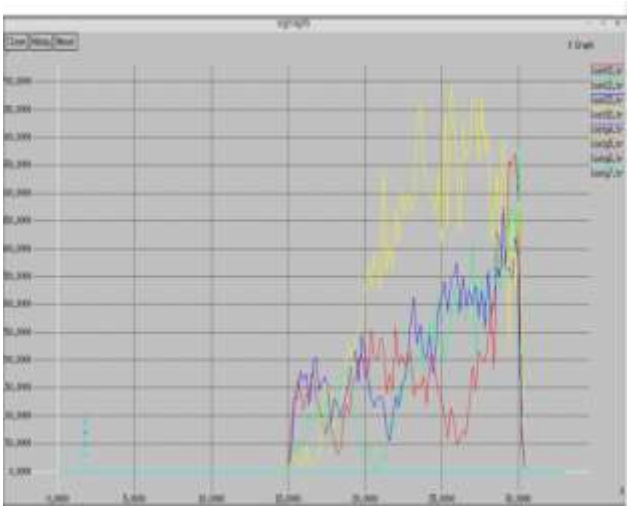

Figure 5: Wimax Packet Loss Rate

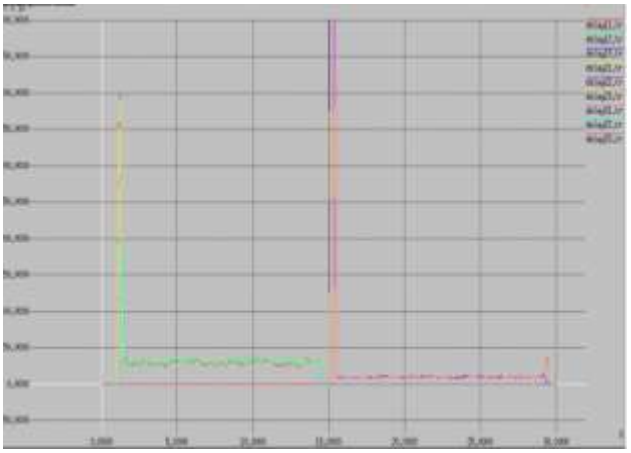

Figure 6: LTE Delay

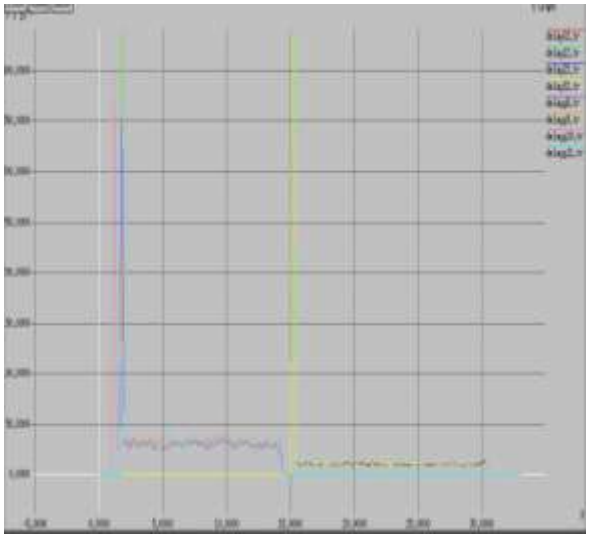

FIGURE 7: WIMAX DELAY

VII. FUTURE IMPROVEMENTS

For future work individuals may choose to implement the 802.11ac standard for WiMax instead of our 802.11g standard. This will undoubtedly result in a simulation more concurrent with today's technologies. Individuals may also implement larger traffic to represent high-definition video calling by users.

VIII. CONCLUSION

For our report we have brought forth ns2 simulations of LTE and WiMax, currently the two most widely used network technologies. Using the capabilities of ns2 we have successfully simulated and collected data from both the LTE and WiMax topologies. From the data, it can be seen from their established graphs that the throughput, delay for both technologies are very similar. Small performance differences in the two technologies can be seen from the packet loss and delay graphs, which show LTE as the prevailing technology. As a result, it is fair to conclude that LTE provides a more fluid experience when performing voice calls over the internet. Although LTE has prevailed as the better technology.

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