

Comparison Between WiMAX and LTE Based on System Level Simulation using NS2

Tilottama Dhake, Pratik Gala, Keval Jain, Bhavesh Mayekar, Priyal Shah

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 Interoperability for Microwave Access) became the two leading technologies considered for adoption to fulfill this need. The industry landscape in telecommunications is changing rapidly at the moment. 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. On the contrary, LTE upgrades from 3G networks are rumored to be as simple as slotting in a new card in the rack. LTE has gained far greater support and adoption in the industry thus leaving WiMAX future prospects limited*

Keywords- *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[1][4] (Long Term Evolution standardized by third generation partnership project (3GPP) and WiMAX[1][3] (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.

Manuscript Received on January 2015.

Prof. Tilottama Dhake, Department of E&TC, K.J. Somaiya Institute of Engineering and Information Technology, Mumbai, India.

Pratik Gala, Department of E&TC, K.J. Somaiya Institute of Engineering and Information Technology, Mumbai, India.

Keval Jain, Department of E&TC, K.J. Somaiya Institute of Engineering and Information Technology, Mumbai, India.

Bhavesh Mayekar, Department of E&TC, K.J. Somaiya Institute of Engineering and Information Technology, Mumbai, India.

Priyal Shah, Department of E&TC, K.J. Somaiya Institute of Engineering and Information Technology, Mumbai, India.

II. WiMAX---INTRODUCTION

WiMAX [3] is a technology to provide wireless broadband access in multiple deployment scenarios. The standardization entity of this technology is the IEEE (Institute of Electrical and Electronics Engineers) led by the 802.16 working group. In 2002 this group developed a line-of-sight operation standard, which used frequencies in the range of 11-66 GHz. Then in 2004 the IEEE 802.16-2004 (also 802.16d or Fixed WiMAX) standard was released, which offered point-to-point and point-to-multi-point operations. At the end of 2005 another standard (802.16-2005 or 802.16e) was approved which provided services to mobile terminals. This standard is well known as Mobile WiMAX. Lately, IEEE 802.16m, standardized in March, 2011, was considered for WiMAX Release 2.0. Release 2.0 offers many folds higher data rates than Release 1.0 and was lately officially recognized as 4G in 2012.

III. LTE--- INTRODUCTION

The work on 3GPP LTE [4] Release 8 started in 2004. The development of LTE was driven by certain aspects. First, the wire line data networks improved and higher data rates were possible. This led to new applications and services which are often referred to as the Web 2.0. Second, to cover the mentioned tremendous growth of mobile subscribers new technologies that are specifically designed for higher capacities are needed. In addition, competing standards, for instance WiMAX (IEEE802.16), were under development and the 3GPP was challenged by this competition. Furthermore, the drop of prices for data delivery made it essential for the telecommunication companies (as key partners of 3GPP) to have competing and efficient telecommunication network architecture. With the LTE technology the mobile network operators are not required to maintain an additional complex circuit-switched domain. LTE networks are superior to 3G/HSPA in terms of control plane scalability.

IV. LIMITATIONS Of WiMAX & LTE —[2]

Operating area is the major limitation. Existing wireless networks do not serve rural areas and many buildings in metropolitan areas efficiently. This limitation of today's networks will carry over into future generations of wireless systems. Moreover new cell towers and cell components are required due to use new frequencies. Some other limitations are such as battery life is degraded considerably, it is hard to implement, and it needs complicated hardware.

Another disadvantage is that there is a need to design new devices which can support the use of 4G technology. Hence consumer is forced to buy a new device to support the 4G services.

V. SIMULATION SOFTWARE: NS2

Many network simulation softwares are available in market. Some of the leading network simulators are Qualnet, Ns-2, JiST/SWANS, Opnet, Omnet, Netsim REAL, SSFNet, J-Simetc. Here we present a quick comparison of various available network simulation softwares. 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 (requires Cygwin)

Simulation System Architecture

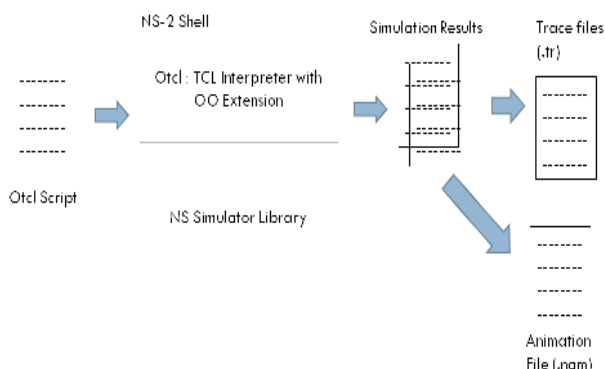


Figure 1: Working in NS2

VI. SIMULATION SETUP

- We have developed 7-cell scenarios for comparison.
- Coverage area of base stations would be 20m in both cases.
- Base station antennas are omni-directional.

- OFDM network interface is used.
- We have worked assuming Two ray propagation model.
- Modulation Scheme chosen for simulation is 64 QAM with FEC correction.
- Interference is enabled.
- We have implemented CBR trace with cbr Interval 0.1 seconds and cbr Packet Size of 1000 bytes.
- The agent type would be UDP and the sink type would be Loss Monitor.
- Bandwidth would be 20Mhz for both the scenarios.
- Frame duration in case of WiMAX would be 5ms and in case of LTE, it is 10ms but since it is divided into 10 sub frames we will consider the frame rate to be 1ms.
- Scheduler used is Wimax Scheduler for WiMAX.
- For LTE since there is no such equivalent present in NS2,we chose Wimax Scheduler for LTE also, since it best approximates the process in LTE.
- We have also simulated duplex links of 100Mbps between Correspondence node and Local Mobility Anchor and, Local Mobility Anchor and Router which are parts of PMIPv6.
- The link delays of the two links mentioned are set to be 10ms and 1ms respectively.

VII.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
 $PDR = (\text{No. of Packets received} / \text{No of Packets sent}) * 100$
- Jitter: **Jitter** is defined as a variation in the delay of received packets. At the sending side, packets are sent in a continuous stream with the packets spaced evenly apart.
 $Jitter J = (D_{i+1}) - (D_i)$ seconds
 where D_{i+1} is delay of i th +1 packet and D_i is the delay of the i th packet.
 A low value of jitter is ideal.
- 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.
 $Throughput T = \text{No.of bytes} * 8 / (\text{Finish time} - \text{Start time}) \text{ bps}$
- 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 tracefile obtained after the execution of code.

End to end delay $D = (T_d - T_s)$ seconds
where T_d is the packet receive time at the destination and T_s is packet send time at source node.

VIII. SIMULATION RESULTS

- Seven cell structure:

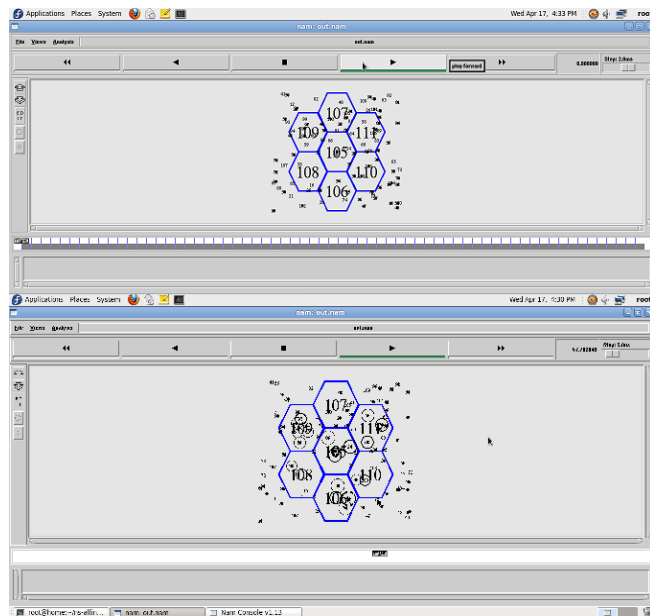


Figure 2: 7-Cell scenario for LTE and WiMAX as seen in our NS-2 simulation

- Delay:

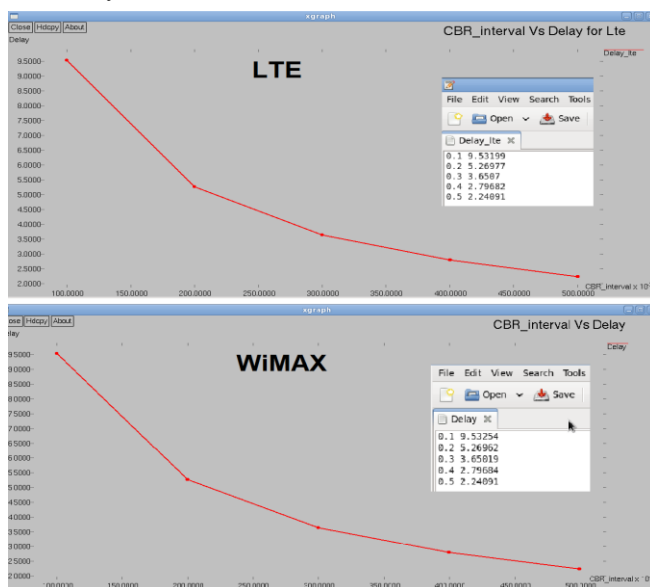


Figure 3: Delay comparison

- Packet Delivery ratio:

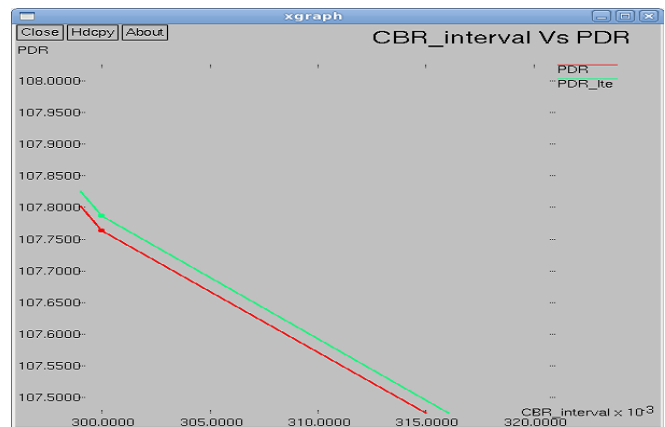
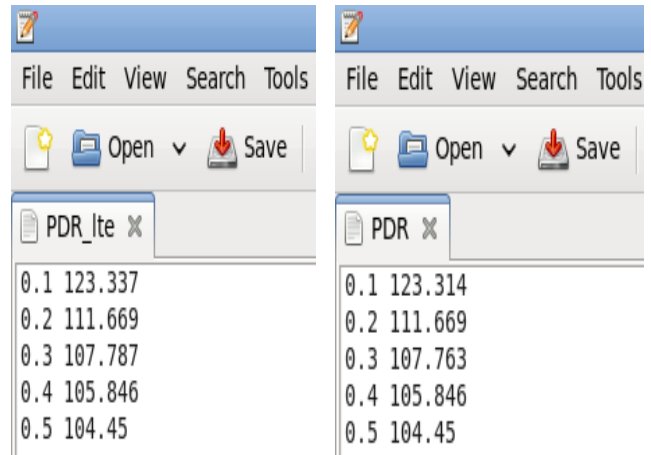


Figure 4: PDR as seen in our NS2 simulation

- Jitter:

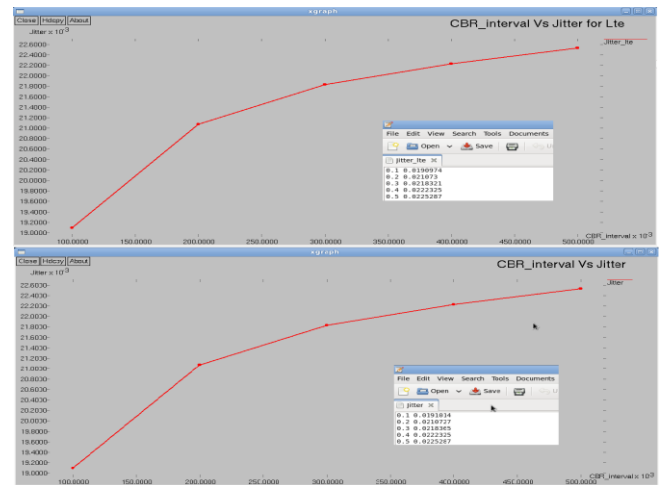


Figure 5: Jitter as seen in our NS2 simulation

- Throughput:

Throughput_lte	Throughput
0.1 107816	0.1 107735
0.2 68136.1	0.2 68136.1
0.3 54936.5	0.3 54856
0.4 48336.7	0.4 48336.7
0.5 43588.1	0.5 43588.1

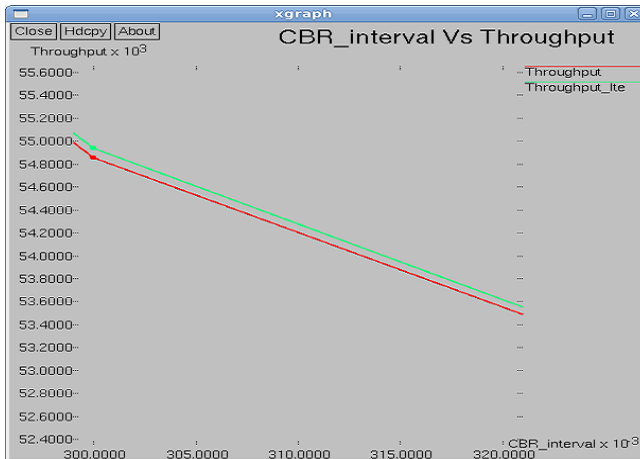


Figure 6: Throughput as seen in our NS2 simulation

IX. SCOPE OF LTE & WiMAX

- Review the current technologies, regulatory factors and industry support impacting the adoption of 4G technologies.
- Identify key changes in consumer usage behavior that drive the need for the greater speed and spectral efficiency afforded by 4G.
- Understand how legacy technologies will influence vendors' choice of 4G protocol due to the economic and technical implications of deploying each technology.
- Identify the technology family best suited to a chosen 4G strategy based on each technology's characteristics and individual corporate circumstances.
- Identify the various initiatives in support of each technology candidate in order to revise considered strategies if necessary.

X. CONCLUSION

We conclude that both WiMAX and LTE are technically similar standards. However, there are some differences present in the uplink access method used by both technologies. LTE uses SC-FDMA whereas WiMAX uses OFDMA as an access method. The adaptation of SC-FDMA in the uplink gives edge to LTE over WiMAX because it resolves the PAPR problem of OFDMA due to its single carrier nature. We also conclude that LTE systems have less jitter and Delay as compared to WiMAX. Also LTE systems have greater Packet Delivery Ratio and Throughput over WiMAX. So clearly LTE has advantage over WiMAX according to the given parameters.

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