WiMAX or LTE: Which Technology to Adopt? A Comprehensive Comparative Study

Dr. Suhas Raut, Senior Software Engg., Motorola India Pvt. Ltd. Hyderabad, India.
Suhas.raut@motorola.com, suhasraut@gmail.com

Abstract:
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. LTE and WiMAX are the two technologies poised to dominate next generation mobile networks. Battle between LTE & 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. Researchers and business community is divided over the choice of LTE and WiMAX. Few researchers feel that 3G LTE can bring substantial technologies and economical benefits to operators deploying mobile networks beyond 3G. This paper presents a comprehensive comparative study to help arrive at the choice between LTE and WiMAX.

Keywords: WiMAX, LTE, NGMN, WiMAX Vs LTE

1. Introduction:

The industry landscape in telecommunications is changing rapidly at the moment. The competition from other technologies, both fixed and mobile, is also putting pressure on current cellular systems [3]. Revenues for the telecom industry will come from new business models like mobile video, handheld media, broadband entertainment, user contents etc. All these business models stress necessity of broadband, either cabled or wired.

The competitive outlook of the telecommunications industry requires a new approach to reducing costs and complexity, while delivering value-added services for mobile end-users [22]. As a result, the reduction of cost and complexity are key drivers for Next Generation Mobile Networks (NGMN), such as WiMAX and 3G Long Term Evolution (LTE). OAM systems are expected to support all tasks needed to provide carrier quality since day one. It is therefore of vital interest to operators to minimize operating expenditures (OPEX) by means of self-configuring and self-optimizing mechanisms [16]. As price and performance issues become increasingly important, there is a trend towards simplified network architecture evolution. Users are also becoming accustomed to broadband connections, making it more and more difficult for cellular networks to cope with expectations [3]. With the recent increase of the number of Fiber-to-the-Home deployments worldwide, and the corresponding huge investment in infrastructure, there is a need to devise a migration path that assures the full future usability and enhanced performance of the installed fiber plant as last mile solutions for wireless technologies [6]. Most carriers are going to continue the path of GSM➔HSPA➔LTE which is going to be a natural evolution.

Mobile devices can aid in e-commerce because the majority of 79% of young adults of the UK population owns a mobile phone [13, 17]. Most common purchase through mobile phones is mobile Ring tones and profits of up to $600 million have been generated by purchasing mobile phone Ring tones [18]. This sales concept can be applied to mobile phones, since the new 3rd generation of mobile phones have improved display screen with better colors and supports HTML text which enables purchases of CD or books on the mobile device directly. A recent survey indicated that 18% of respondents suggest that the use of mobile technology can improve CRM activity [19]. Nissan automobiles are also using wireless PDAs to improve their quality of service where staff members equipped with their PDAs can deal with customer enquiries concerning spare parts. The salesperson can check prices and equipment availability on the spot and provide direct feedback to the customer [7, 20]. The use of mobile application software has helped insurance company Drive Assists in saving road traveling per year with the use of their mobile devices [21]. A survey of 400 IT managers suggests that 36% of employees rely on the use of mobile devices to check their emails, 24% use mobile applications to amend documents while in transit and 50% of the companies suggests it is essential to improve mobile bandwidth in order to promote mobile business applications [18].

Keeping the above analysis in mind, along with present world-gripping recession, it is imperative for the telecom industry to chose LTE and/OR WiMAX very carefully. Cost of starting the services, OAM, sustainability, interoperability, and above all convergence will play key role in the decision.

What follows now is discussion of potencies of the technologies. Then covered is the techno-economical comparison, and similarities between the two technologies.

2. LTE and its Potency:

3G Long-Term Evolution (LTE) can bring substantial technological and economical benefits to operators deploying mobile networks beyond 3G. With significant improvements in the radio interface, enabling a lower data access cost per megabyte as well as several potentially important new services, 3G LTE could have a decisive advantage over alternative wireless technologies that currently compete with 3GPP technologies. 3G LTE provides a cost-efficient way to deliver the most popular services to large numbers of people, with a technology that is directly based on existing 2G and 3G systems [1]. The road to 4G has a mandatory milestone in Long Term Evolution (LTE) as it is a promising technology which will allow backwards compatibility besides a higher performance [5].

As there is no frequency band dedicated to LTE use only, it is expected that both LTE and legacy systems such as UMTS (Universal Mobile Telecommunication Services) or GSM (Global System for Mobile Communications) will share the same frequency band. To ensure the harmonious coexistence of LTE with currently deployed systems, coexistence studies involving LTE need to be carried out [2].

In order to ensure long-term competitiveness of 3G technology, a new study item has been started by 3GPP to define the Long Term Evolution (LTE) of 3G. The scope of the LTE concept is to improve the system performance in terms of data rate, throughput, latency, coverage and cost. LTE introduces pure packet based architecture, with distributed mobility management, where active mode handover decisions are done by E-UTRAN Node-Bs (eNB). During handover, downlink user data is forwarded between the involved eNBs [4].

Main LTE features are [8]:

- Scalable bandwidth from 1.25 MHz up to 20 MHz.
- Peak data rate up to 100 Mbits/s in downlink and 50 Mbits/s in uplink (for 20 MHz bandwidth). Support latency below 5 ms in the user plane and below 20 ms in the control plane.
- Support for Multiple-Inputs-Multiple-Outputs (MIMO) up to 4x4.
- Adaptive Modulation and Coding (AMC) that allows to keep the average Bit Error Rate (BER) below a predefined target value.
- It is based on Orthogonal Frequency Multiple Access (OFDMA), which allows frequency-dependent link adaptation for dynamic resources allocation.

3. WiMAX and its Potency:

WiMAX has emerged as a promising technology for broadband access in wireless metropolitan area network (WMAN) environment. The need of emerging markets telecom, specifically in the Indian telecom scenario; WiMAX is being looked as a broad- band access solution ahead of LTE and other competing technologies due to its long range and high bandwidth [15]. There are a number of aspects to realizing the promise of WiMAX and careful business planning is likely to be required in reconciling short and long term objectives [11]. Among several first mile solutions proposed so far, the key advantage of the IEEE 802.16 standard, widely known as WiMAX, is to ensure large area coverage and rather inexpensive equipment at the subscriber side [14].

IEEE 802.16 is a recent wireless broadband standard that has promised high bandwidth over long-range transmission. The standard specifies the air interface, including the medium access control (MAC) and physical (PHY) layers, of BWA. The key development in the PHY layer includes orthogonal frequency- division multiplexing (OFDM). . In an OFDM system, the data is divided into multiple parallel sub-streams at a reduced data rate, and each is modulated and transmitted on a separate orthogonal sub-carrier.

First published in 2001, the IEEE 802.16 standard specified a frequency range of 10–66 GHz with a theoretical maximum bandwidth of 120 Mb/s and maximum transmission range of 50 km. However, the initial standard only supports line-of-sight (LOS) transmission and thus does not seem to favor deployment in urban areas. A variant of the standard, IEEE 802.16a-2003, approved in April 2003, can support non-LOS (NLOS) transmission and adopts OFDM at the PHY layer. It also adds support for the 2–11GHz range.

From the initial variants, the IEEE 802.16 standard has undergone several amendments and evolved to the 802.16-2004 standard [2] (also known as 802.16d). The standard provides technical specifications for the PHY and MAC layers for fixed wireless access and addresses the first or last-mile connection in wireless metropolitan area networks (WMANs).

IEEE 802.16e [3] released earlier this year has added mobility support. This is generally referred to as mobile WiMAX. Mobile WiMAX adds significant enhancements:

- It improves NLOS coverage by utilizing advanced antenna diversity schemes and hybrid automatic repeat request (hARQ).

- It adopts dense sub-channelization, thus increasing system gain and improving indoor penetration.
- It uses adaptive antenna system (AAS) and multiple input multiple output (MIMO) technologies to improve coverage.
- It introduces a downlink sub-channelization scheme, enabling better coverage and capacity trade-off. This brings potential benefits in terms of coverage, power consumption, self-installation, frequency reuse, and bandwidth efficiency. One of the key complications is that the incompatibility in the newly introduced scalable OFDM (SOFDM) in IEEE 802.11e with the original OFDM scheme forces equipment manufacturers to come up with mechanisms to ease the transition.

One of the potential applications of WiMAX is to provide backhaul support for mobile WiFi hotspots. Traditionally, a WiFi hotspot is connected to the Internet via a wired connection (e.g., digital subscriber line, DSL). However, by using an IEEE 802.16e/WiMAX-based backbone network to connect WiFi hotspots to the Internet, costly wired infrastructure can be avoided, and, again, mobile hotspot services can be provided (e.g., for intelligent transportation system [ITS] applications) [10]. It is anticipated that IEEE 802.16 is fully capable of supporting multimedia transmissions with differentiated QoS requirements through the use of scheduling mechanisms [9].

Much of the focus, at present, is on mobility support and there is much debate regarding how successful 802.16-based mobile technologies can be. Whilst this work is very interesting, there is still work to be done on assessing the capabilities of 802.16 technology in the application it was originally intended for – delivering Fixed Broadband Wireless Access (FBWA) [12]. IPTV – which includes the transmission of both live television and Video on Demand (VoD) services over broadband access networks, is also the subject of much interest at present

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4. WiMAX-LTE Techno-Economical Differences:

Table 1 shows differences between WiMAX & LTE at a glance.

It is clear that both WiMAX and LTE, both cover a better option in terms of speed as well as number of devices they cater for providing the broadband connectivity.

WiMAX is having higher strength in speed as well as devices. However, the cost factor for WiMAX remains as main hindrance as compared to LTE.
Even though the WiMAX economy is going to be driven by greenfield companies, migration path from GSM->HSPA->LTE is a natural evolution.

5. WiMAX-LTE Similarities:

Table 2 show differences between WiMAX & LTE at a glance.

	LTE	WiMAX
Foundation	3G an evolution from a voice traffic design	Based on IP
Deployment	3G has a substantial base station population (128 commercial HSPA networks rolled out and over 300 HSPA devices)	Yet to deploy in Volume
Maturity	3G Technology is maturing	Mobile WiMAX under ratification
	3G customer base is established by evolution from GSM	Mobile WiMAX has to win a customer base
User Devices	3G Uses dedicated hardware or plug in cards	WiMAX will be part of existing hardware such as laptops and PDAs
Equipment Cost	No standards available as on date, hence may be costlier	Owing to standards, cheaper
Deployment Cost	Lower	Higher

Table 1: Techno-Economic Differences between LTE & WiMAX

OFDMA	OFDMA supports advanced antenna technologies, such as MIMO, STC, and Beamforming
	OFDMA is adopted as the basis of Mobile WiMAX
	3GPPP's Long Term Evolution (LTE) project plans to incorporate OFDMA7
IP	LTE is moving from a circuit-switched to all IP
	IP is built into mobile WiMAX based on the IEEE 802.16 air interface standard
Customers	Want the same experience when mobile as they have when at home or in office

Table 2: Similarities between LTE & WiMAX

6. Conclusion:

There's a strong temptation to suggest that WiMAX has just sneaked out of the gate, before the winds of recession slam it shut. And that LTE is still cooped up, and will have to wait a bit longer for its chance to shine. LTE gets delayed by recession, Come back in 2013 for mass market volumes. WiMAX is up and running, but remains too patchy to get true scale globally.

One option is that with the exception of sprint that is going to WiMAX, most carriers are going to continue the path of GSM->HSPA->LTE which is going to be a natural evolution. The WiMAX economy is going to be driven by greenfield companies who are the same companies who have been pushing WiFi.
Vodafone, T-Mobile and France Telecom have all announced plans to deploy LTE-based 4G networks. Some of these service providers are also planning to support WiMAX, another 4G technology, in addition to LTE.

In one side we have the up and coming LTE and on the other side we have the already out WiMAX. LTE upgrades from 3G networks are also rumored to be as simple as slotting in a new card in the rack, although one can imagine no 3G handset would work with LTE.

With WiMAX it is here and now, fairly proven to work but having the disadvantage of no substantial roll out plans due to cost. WiMAX looks to have an upgrade path available by the work going on with the 802.16m standard and for all intents and purposes is far more advanced than LTE in so far that it is able to be deployed today not in three years time.

So for all intents and purposes it would seem to be a battle like the VHS and Beta. Both similar technologies, both all IP with the exception one is here now and the other is still years away from deployment. Which one will win out in the end remains to be seen.

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