IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 5, Issue 4, November 2016)

Review on Global Planning of Fourth Generation (4G) Mobile Networks

Surbhi Vyas
M. Tech. Scholar
Department of Electronics and Comm. Engg.
Shrinathji Institute of Technology &
Engineering, Nathdwara (India)
surbhi8vyas@gmail.com

Pankaj Rathi
Asst. Professor
Department of Electronics and Comm. Engg.
Shrinathji Institute of Technology &
Engineering, Nathdwara (India)
rathi.panks@gmail.com

Abstract –**In the current environment where the information is the key to success context, no matter the field where one stands, the telecommunication networks are increasingly solicited. Enormous amounts of information circulating on the networks at every second. It is essential to ensure the availability of these networks to ensure the transmission of such data in all circumstances. This paper survey a global model including survivability for the planning of 4G (WiMAX) networks.**

Keywords –**4G, OFDM, LTE, WiMAX.**

I. Evolution of Mobile Networks

As the name suggests, wireless systems operate via transmission through space rather than through a wired connection. This has the advantage of permitting users to make and receive calls almost anywhere, including while in motion. Wireless communication is sometimes called mobile communication since many of the new technical issues arise from motion of the transmitter or receiver.

Since the mid-1990s, the cellular communications industry has witnessed explosive progress. Wireless communications networks have become much more pervasive than anyone could have imagined when the cellular concept was first developed in the 1960s and 1970s. As shown in Figure 1, the worldwide cellular and personal communication subscriber base surpassed 600 million users in late 2001, and the figure of individual subscribers is projected to reach 2 billion (about 30% of the world's human population) by the end of 2006.

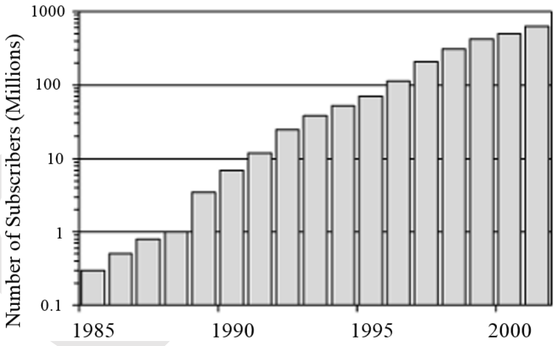

Figure 1: Growth of cellular telephone subscribers throughout the world [1]

Certainly, most countries throughout the world continue to experience cellular subscription increases of 40% or more per year. The widespread implementation of wireless communications was accelerated in the mid-1990s, when governments during the world provided increased competition and new radio spectrum licenses for personal communications services (PCS) in the 1800–2000 MHz frequency bands.

Mobile networks have evolved much since their introduction in the 1970s to the present day. This development, from the first to the fourth generation of cellular networks, is illustrated in Figure 2.

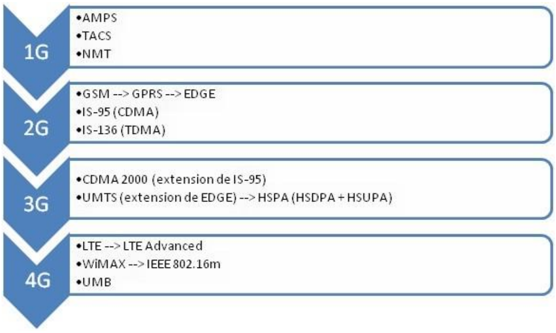

Figure 2: Evolution of Mobile Networks

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 5, Issue 4, November 2016)

The first generation of cellular networks (1G) appeared to the early 1970s with fashion analog transmission and relatively large size devices. The most used standard is the era were the AMPS (Advanced Mobile Phone System), the TACS (Total Access Communication System) and NMT (Nordic Mobile Telephone).

The digital transmission mode appeared in the early 90s with the second generation mobile networks (2G). This makes it possible to transmit, in addition to voice, data num'eriques small volume such as SMS (Short Message Service) and MMS (Multimedia Message Service). The most used are standard 2G GSM, IS-95 (Interim Standard-95), which is based on the CDMA coding (Code Division Multiple Access) and IS-136 (Interim Standard-136) which is based on encoding the TDMA (Time Division Multiple Access). GSM is the standard however having experienced the greatest breakthrough with the use of the 1900MHz band in North America and Japan and the band of 900MHz and 1800Mhz on other continents. This is also on this standard that are based GPRS networks (General Packet Radio Service: 2.5G) and EDGE (Enhanced Data for GSM Evolution: 2.75G) who came to fix the weak d'ebits GSM (about 9 , 6 kbps). The GPRS offers a theoretical throughput of 114 kbps enabling the simultaneous transmission of voice and Data supplied. The use of multimedia applications is made possible by EDGE which offers flow rates of up to 384 kbps.

The third generation mobile networks (3G) appeared to establish international standards to ensure worldwide compatibility, global mobility, compatibility with 2G networks and 2 Mbps for low flow rates and mobility of up to 144 kbps for a high mobility. Main 3G standards are CDMA2000 and UMTS (Universal Mobile Telecommunication System). The CDMA2000 standard is an improvement of the IS-95 standard and is not compatible with GSM. Other improvements were made later in terms of flow to the UMTS HSDPA giving rise to the standards (High Speed Downlink Packet Access: 3.5G) which offers a theoretical maximum throughput of 14.4 Mbps and HSUPA downlink line (High Speed Uplink Packet Access: 3.75G) offering a theoretical maximum throughput in the ascending line of 5.76 Mbps [2]. These two standards are grouped under the name HSPA (High Speed Packet Access).

The fourth generation (4G) wireless networks is characterized by increased mobility, the diversified services and more students debits. It projects the theoretical flow rates of 100 Mbps for high mobility and up to 1 Gbps for low mobility. [3] The main 4G standards LTE (Long Term Evolution) and WiMAX. LTE was developed by the 3GPP group (Third Generation Partnership Project) and is an extension of HSPA.

The first version of LTE was designed to offer maximum th'eorique throughput of 100 Mbps downlink and 50 Mbps line in the ascending line for a maximum bandwidth of 20 MHz. [4] Some improvements are being giving the LTE-Advanced standard which provides up to a maximum throughput of 1 Gbps in descending line and bottom-line half [5]. WiMAX, as it is, is powered by a new group, the WiMAX forum. WiMAX technology is generally used for the deployment of networks on a large scale (WAN) using a reduced number of base stations (BS), due to its long reach. Based on the IEEE 802.16 standard, WiMAX was, at its origin, designed for use in fixed networks at broadband offering a bandwidth of 10 to 66 GHz with a theoretical scope of 50 km. WiMAX sest much improved since the release of the first version of the IEEE 802.16 standard in December 2001 [6]. Mobility was introduced in 2005 [7], making it competitive compared to 3G networks before its evolution to IEEE 802.16m [8] which is known as being 4G WiMAX standard. Another less known standard, UMB (Ultra Mobile Brodband) was developed by the 3GPP2 group to the fourth generation. These three standards use the same air interface, OFDMA (Orthogonal Frequency Division Multiplexing Access). Their long-term objective is to converge to form the 4G IMT-Advanced standard (International Mobile Telecommunications - Advanced) [9] whose specifications are Data supplied in Table 1.

The UMB standard being very little known, we study in the suite only to WiMAX and LTE standards.

Table 1: Specifications required by the IMT-Advanced for 4G networks [10]

Specifications		**IMT-Advanced [10]**	
		Downlink	**Uplink**
Spectral Efficiency by sector (bits/s/Hz/sector)	**Indoor**	3	2.25
	Microcellular	2.6	1.80

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 5, Issue 4, November 2016)

	Base coverage urban	2.2	1.4
	High Speed	2.1	0.7
Spectral Efficiency Boundary of the cell (bit/s/Hz)	**Indoor**	0.1	0.07
	Microcellular	0.075	0.05
	Base coverage urban	0.06	0.03
	High Speed	0.04	0.015
Spectral Efficiency	**Maximum (bits/s/Hz)**	15	6.75
Mobility (bits/s/Hz)	**Indoor: 0 to 10 Km/h**	1.0	
	Microcellular: 10 to 30 Km/h	0.75	
	Base coverage urban: 30 to 120 Km/h	0.55	
	High Speed: 120 to 350 Km/h	0.25	
Bandwidth (MHz)	**Up to 40 MHz**		
Latency (ms)	**Plane of control**	100 ms	
	User Plane	10 ms	
Interruption time (ms)	**Intra-frequency**	27.5 ms	
	Inter-frequency (Intra-band)	40 ms	
	Inter-frequency (Inter-band)	60 ms	
Min VoIP capacity (Active users/sector/MHz)	**Indoor**	50	
	Microcellular	40	
	Base coverage urban	40	
	High Speed	30	

II. WIMAX

WiMAX is called the next generation broadband wireless technology which offers high speed, secure, sophisticate and last mile broadband services along with a cellular back haul and Wi-Fi hotspots. The development of WiMAX began a few years ago when scientists and engineers felt the need of having a wireless Internet access and other broadband services which works well everywhere especially the rural areas or in those areas where it is hard to establish wired infrastructure and economically not feasible.

IEEE 802.16, also known as IEEE Wireless-MAN, explored both licensed and unlicensed band of 2-66 GHz which is standard of fixed wireless broadband and included mobile broadband application. WiMAX forum, a private organization was formed in June 2001 to coordinate the components and develop the equipment those will be compatible and inter operable. After several years, in 2007, Mobile WiMAX equipment developed with the standard IEEE 802.16e got the certification and they announced to release the product in 2008, providing mobility and nomadic access.

The IEEE 802.16e air interface based on Orthogonal Frequency Division Multiple Access (OFDMA) which main aim is to give better performance in non-line-of-sight environments.

IEEE 802.16e introduced scalable channel bandwidth up to 20 MHz, Multiple Input Multiple Output (MIMO) and AMC enabled 802.16e technology to support peak Downlink (DL) data rates up to 63 Mbps in a 20 MHz channel through Scalable OFDMA (S-OFDMA) system [11].

IEEE 802.16e has strong security architecture as it uses Extensible Authentication Protocol (EAP) for mutual authentication, a series of strong encryption algorithms, CMAC or HMAC based message protection and reduced key lifetime [12].

III. WIMAX-OFDM SYSTEM

WiMAX's main objectives are to cover those remote areas where cable connection is not feasible or expensive and for better coverage especially for mobile networks where users are always moving than the other broadband technologies like, Wi-Fi, UWB and DSL. This subsection describes the network architecture, mechanism and some technical issues of WiMAX mobile in brief with potential diagrams.

A. WiMAX Architecture

WiMAX architecture comprises of several components but the basic two components are BS

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 5, Issue 4, November 2016)

and SS. Other components are MS, ASN, CSN and CSN-GW etc. The WiMAX Forum's Network Working Group (NWG) has developed a network reference model according to the IEEE 802.16 air interface to make sure the objectives of WiMAX are achieved. To support fixed, nomadic and mobile WiMAX network, the network reference model can be logically divided into three parts [12].

B. *Mobile Station (MS)*

It is for the end user to access the mobile network. It is a portable station able to move to wide areas and perform data and voice communication. It has all the necessary user equipment such as an antenna, amplifier, transmitter, receiver and software needed to perform the wireless communication. GSM, FDMA, TDMA, CDMA and W-CDMA devices etc. are the examples of Mobile station.

C. *Access Service Network (ASN)*

It is owned by NAP, formed with one or several base stations and ASN gateways (ASN-GW) which creates radio access network. It provides all the access services with full mobility and efficient scalability. Its ASN-GW controls the access in the network and coordinates between data and networking elements.

D. *Connectivity Service Network (CSN)*

It Provides IP connectivity to the Internet or other public or corporate networks. It also applies per user policy management, address management, location management between ASN, ensures QoS, roaming and security [14].

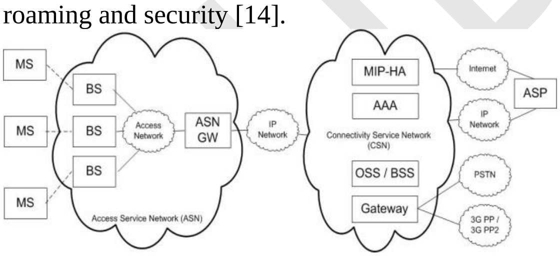

Figure 2: WiMAX Network Architecture [14]

E. *Mechanism*

WiMAX is capable of working in different frequency ranges but according to the IEEE 802.16, the frequency band is 10 GHz - 66 GHz. A typical architecture of WiMAX includes a base station built on top of a high rise building and communicates on point to multi-point basis with subscriber stations which can be a business organization or a home. The base station is connected through Customer Premise Equipment (CPE) with the customer. This connection could be:

1. Line-of-Sight (LOS) or
2. Non-Line-of-Sight (NLOS) [15].

F. *Practical Scenarios*

WiMAX comprises of two main parts; WiMAX base station and WiMAX receiver.

1. WiMAX base station

It is often called WiMAX tower or booster. The base station broadcasts radio frequencies to the receiver end. This station consists of electronic devices and WiMAX tower - works as like GSM network. The WiMAX base station may be connected with other base stations by high speed microwave link which is called backhaul [16].

Responsible for: Providing air interface to the MS and it performs in MAC and PHY.

Additional functions: Frequency reuse, handoff, tunnel establishment, QoS &classification of traffic etc.

Management: Session management, bandwidth management for uplink and downlink and multicast group management etc.

Practical Face: Tower in outdoor environment and electronic equipment in indoor environment.

2. WiMAX receiver (CPE)

WiMAX receiver receives the radio frequency from the WiMAX base station and makes sure the connectivity of WiMAX network is in range. This receiver and antenna could be stand alone in a small box or PCMCIA slot card or built in a computer (either laptop or desktop). WiMAX tower may connect directly to the internet using higher bandwidth and also connect to another tower using non line of sight microwave link which is known as backhaul. This base station might allow the WiMAX subscriber one base station to another which is similar to GSM networks [17].

Responsible for: Providing connectivity between subscriber equipment (such as mobile phone or laptop) and a WiMAX base station.

Additional function: Packet priority, network interoperability and QoS.

Connection: Backhaul, high speed microwave link which is also referred to a connection between core network and WiMAX system.

Provides User: VoIP, multimedia and Internet access and many mobile applications.

Practical face: Customer Premises Equipment (CPE) for indoor and outdoor purposes.

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 5, Issue 4, November 2016)

G. WiMAX-OFDM Block Diagram

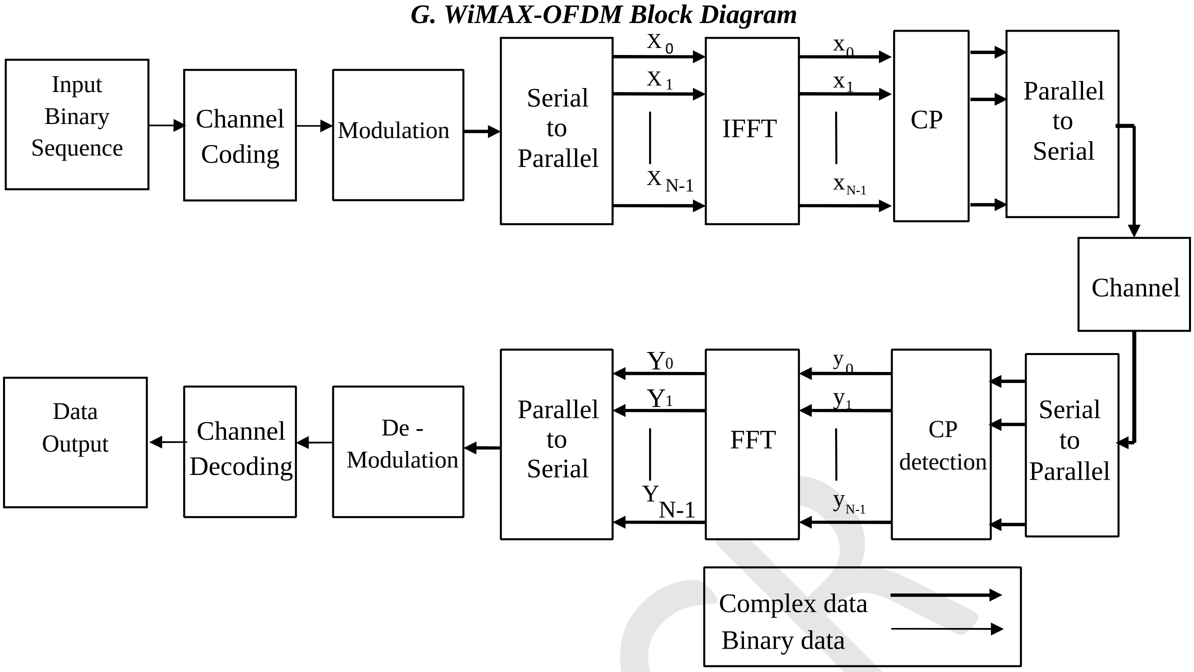

Figure 3: Basic block diagram for proposed work

Figure 3 shows a baseband transceiver structure for WiMAX-OFDM utilizing the Fourier transform for modulation and demodulation. Here the encoded serial data is modulated to complex data symbols (BPSK/QPSK/16-QAM/64-QAM) with a symbol rate of $\frac{1}{T_s}$. The data is then T_s demultiplexed by a serial to parallel converter resulting in a block of N complex symbols, X_0 to X_{N-1}. The parallel samples are then passed through a N point IFFT (in this case no oversampling is assumed) with a rectangular window of length $N.T_s$, resulting in complex samples x_0 to x_{N-1}. Assuming the incoming complex data is random it follows that the IFFT is a set of N independent random complex sinusoids summed together. The samples, x_0 to x_{N-1} are then converted back into a serial data stream producing a baseband transmit symbol of length $T = N.T_s$.

A Cyclic Prefix (CP), which is a copy of the last part of the samples is appended to the front of the serial data stream before Radio Frequency (RF) up conversion and transmission. The CP combats the disrupting effects of the channel which introduce Inter Symbol Interference (ISI). In the receiver the whole process is reversed to recover the transmitted data, the CP is removed prior to the FFT which reverses the effect of the IFFT. The complex symbols at the output of the FFT, Y_0 ..Y_{N-1} are then demodulate and the original bit steam recovered [18].

IV. Conclusion

Carrying out literature review is very significant in any research project as it clearly establishes the need of the work and the background development. It generates related queries regarding improvements in the study already done and allows unsolved problems to emerge and thus clearly define all boundaries regarding the development of the research project. This paper firstly discusses the evolution of the mobile networks; first generation, second generation, third generation and fourth generation. Furthermore it explains the WiMAX-OFDM system.

References

[1] T. S. Rappaport, “Wireless Communications, Principles and Practice”, New Jersey: Prentice Hall, 1996.
[2] Isotalo, Tero, and Jukka Lempiäinen. "Measurements on HSUPA with uplink diversity reception in indoor environment." In Wireless Conference (EW), 2010 European, pp. 523-527. IEEE, 2010.
[3] Gavrilovska, Liljana M., and Vladimir M. Atanasovski. "Interoperability in future wireless communications. Systems: a roadmap to 4G." Microwave Review 13, no. 1 2007.
[4] Toskala, Antti, Harri Holma, Kari Pajukoski, and Esa Tiirola. "UTRAN long term evolution in 3GPP." In 2006 IEEE 17th International Symposium on Personal, Indoor and Mobile Radio Communications, pp. 1-5. IEEE, 2006.

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 5, Issue 4, November 2016)

[5] Holma, Harri, and Antti Toskala, eds. LTE advanced: 3GPP solution for IMT-Advanced. John Wiley & Sons, 2012.

[6] Cooklev, Todor. "Air interface for fixed broadband wireless access systems." Wireless Communication Standards: A Study of IEEE 802.11™, 802.15™, and 802.16™, pp. 225-333, 2011.

[7] EEE LAN/MAN Standards Committee. "IEEE Standard for local and metropolitan area networks Part 16: Air interface for fixed and mobile broadband wireless access systems amendment 2: Physical and medium access control layers for combined fixed and mobile operation in licensed bands and corrigendum 1." IEEE Std 802.16-2004/Cor 1-2005, 2006.

[8] Ahmadi, Sassan. "Overview of IEEE 802.16 m Radio Access Technology." WiMAX Technology and Network Evolution, pp. 87-145, 2010.

[9] Ergen, Mustafa. Mobile broadband: including WiMAX and LTE. Springer Science & Business Media, 2009.

[10] ITU, ITURM. "2134, Requirements related to technical performance for IMT-Advanced radio interface (s)." International Telecommunications Union, 2008.

[11] WiMAX Forum, “Mobile WiMAX – Part 1: A Technical Overview and Performance Evaluation”, August 2006.

[12] Johnston D., Walker J., “Overview of IEEE 802.16Security”, IEEE Computer Society, 2004.

[13] Mirnall Bansal, Maninder Kaur, Mohinder Pal Joshi, “Implementation of Wimax Simulator in Simulink”, IOSR Journal of Engineering (IOSRJEN), ISSN: 2250-3021, Vol. 2, Issue 8, PP 102-106, August 2012.

[14] “WiMAX QoS Classes”, Whitepaper, Tranzeo Wireless Technologies Inc., 2010.

[15] Rajinder Kumar, Kaushik Adhikary, Rohit Vaid, “WiMAX Propagations”, IJCSET, ISSN: 2231-0711, Vol. 1, Issue 8, pp. 480-483, September 2011.

[16] “Mobile WiMAX Base Station”, The Mobile World Congress, Japan Radio Co. LTD, Japan 2008.

[17] Ruby Verma, Pankaj Garg, “Interpretation of IEEE 802.16e (Wimax)”, Global Journal of Computer Science and Technology Network, Web & Security, Vol. 13, Issue 10, 2013.

[18] L. J. Cimini Jr, Ye, L., “Orthogonal Frequency DivisionMultiplexing for Wireless Channels”, in IEEE Global Telecommunications Conference GLOBECOM, pp. 82, Sydney, Australia, 1998.

[19] Philip Koopman, Tridib Chakravarty, “Cyclic Redundancy Code (CRC) Polynomial Selection for Embedded Networks”, the International Conference on Dependable Systems and Networks, DSN-2004.