Survey on WI-MAX System Based on Wavelet Packet Modulation Technique

Pooja Patel[1], Dr. Jaipal Singh Bisht [2], Department of EC, RITS, Bhopal (M.P), India
[1]puja05patel@gmail.com, [2]jaipalsingh@gmail.com

ABSTRACT: *A study within the field of Worldwide ability for Microwave Access system or communication system is way required as communication services. rippling Packet Modulation is AN helpful technique of multicarrier modulation that has high information measure, potency and adaptability. This paper inquires, simulation of IEEE802.16 in MATLAB software package victimization rippling packet modulation in WIMAX. The results show that BER performance of words per minute system is best than OFDM that uses cyclic prefix and consequently has higher SNR. The study is simulated over AN AWGN channel and frequency selective Rayleigh channel. BER performance of various rippling families is planned for this channel conditions OFDM is being wide utilized in wireless communication systems for its ability to cut back the information measure and enhance the information rate. The scheme provides lustiness against interference and may adapt simply to weakening eventualities. This paper offers a comparison of channel performance victimization numerous modulation techniques over completely different weakening environments. Modulation schemes include BPSK, QPSK, 64- QAM that are utilized beneath the influence of AWGN, Rayleigh, flat weakening, frequency selective and Rican attenuation channels. BER (Bit Error Rate) and SNR (Signal to Noise ratio) functions are wont to analyze the performance of information transmitted over these channels Mat research lab is employed to develop the OFDM model and analysis the performance of WiMAX system.*

Keywords- Wireless Network, WiMAX, OFDM, Adaptive Modulation Techniques, BER, Wireless Fidelity, Binary Phase Shift Keying, DQPSK .

I. INTRODUCTION

WiMAX stands for worldwide ability for microwave access. It's a telecommunications protocol that has mounted and mobile net access. WiMAX is also a wireless digital communications system, in addition referred to as IEEE 802.16 that is supposed for wireless metropolitan house networks. WiMAX can provide broadband wireless access (BWA) up to thirty miles (50 km) for mounted stations, and 3 – 10 miles (5 - fifteen km) for mobile stations. In distinction, the native space network / 802.11 wireless native house network commonplace is taboo in most cases to exclusively 100 - 300 feet (30 - 100m). to grasp the WiMAX technology, the term Wireless mesh network is there. Wireless mesh networks (WMNs) embody mesh routers and mesh shoppers, where mesh routers have minimal quality and sort the backbone of WMNs. they provide network access for every mesh and ancient shoppers. WiMAX technology permits gift delivery

of wireless broadband service for mounted and/or mobile users, and became a reality in two006 once Chosen telecommunication started the preparation of a pair of.3 GHz version of mobile WiMAX service cited as WiBRO. The growth of the utilization of the information networks ends up in the need for brand spanking new communication networks with higher data rates. The telecommunication business is in addition aiming to modification, with a demand for a much bigger vary of services, like video conferences, or applications with multimedia contents, wireless communication has perforated nearly all acts of human life. WiMAX stands for the worldwide ability for microwave access. It's a telecommunications protocol that has fastened and mobile net access. WiMAX is also a wireless digital communications system, in addition cited as IEEE 802.16 that's supposed for wireless "metropolitan house networks". WiMAX will offer broadband wireless access up to thirty miles for mounted stations, and three ten miles for mobile stations. Worldwide ability for Microwave Access is also a 4G technology and wireless communications ancient designed to produce twenty-eight to forty megabit-per-second information rates Error free transmission is one altogether the foremost aims in wireless communications [1]. fashionable wireless communication systems provide fully totally different services like spoken language & amplifier; multimedia services to the users. as a result of it wants high rate, this may be not achieved by single carrier communication as a result of it suffers from multipath weakening & amplifier; bury image
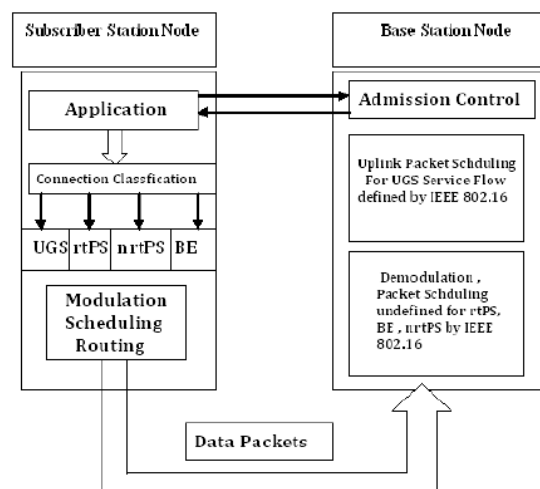

Fig1: Wi-max Network Architecture

WIMAX Standards: The IEEE specifications area unit required to understand the family of IEEE standards. As 802.16 is one in each of the IEEE traditional specification

used for Wi-MAX technology, there are a unit some factors that affects the performance of Wi-MAX in step with information measure, rate, and speed etc. A member of the IEEE802 family of specifications: IEEE802.16-2004 includes P2P, P2MP and mesh access networks. During 2005 IEEE 802.16e includes quality. During 2005 MIB standardized moreover. IEEE802.16 is supported by the business cluster Wi-MAX. A Wi-Max network includes a spread of initial base stations and associated antennas act by wireless to a so much larger form of shopper devices some extent to multipoint configuration. Base stations area unit either directly wired to cyber web or use Wi-Max links to completely different base stations that unit of measurement so connected. Shopper devices at the beginning area unit sometimes very little, building mounted antenna/transreceiver systems to it in building LANs (such as WLANs) area unit connected. but future purchasers - reckoning on the frequency bands used - will generally integrate into user devices, like notebook PCs and, eventually, mobile devices, like sensible phones. each base station provides wireless coverage over a district referred to as a cell. although the utmost radius of a cell is on paper fifty-kilometer, typical deployments will used cells of radii from 3 to 10 kilometer. like normal cellular mobile networks, the base-station antennas are Omni directional, giving a circular cell kind, or directional to administer an expansion of linear or sectoral kind for purpose - to purpose use or for increasing the network's capability by effectively dividing large cells into several smaller sectoral areas. a lot of WiMAX is faster as compared to LAN in most of the cases for users. WiMAX might likely erase the community and rural blackout areas that presently haven't got any broadband internet access as a results of phone and cable firms haven't but run the obligatory wires to those remote locations.[3]

QOS design IN WIMAX NETWORKS

The Wi-Max Forum's Network social unit [3], is chargeable for developing the end-to-end network needs, architecture, and protocols for Wi-Max, victimization IEEE 802.16e-2005 because the air interface. The network reference model envisions unified specification for supporting mounted, nomadic, And mobile deployments and is predicated on a scientific discipline service model. Figure 1.8 shows a simplified illustration of IP-based Wi-Max specification. [2] the network could also be logically divided into 3 parts: Mobile Station (MS): it's for the tip user to access the mobile network. it's a conveyable station able to move to wide areas and perform information and language. it's all the mandatory user equipments like AN antenna, amplifier, transmitter, receiver and code required to perform the wireless communication. GSM, FDMA, TDMA, CDMA and WCDMA devices etc area unit the samples of Mobile station. Mobile stations employed by the tip user to access the network. Access Service Network (ASN): it's closely-held by NAP,

shaped with one or many base stations and ASN gateways (ASNGW) which creates radio access network. It provides all the access services with full quality and economical measurability. Its ASN-GW controls the access within the network and coordinates between knowledge and networking parts. ASN includes one or a lot of base stations and one or a lot of ASN gateways that type the radio access network at the sting Digital Modulation Technique.

1. Binary section shift keying: In BPSK, the section of a seamless amplitude carrier is switched between two values in keeping with the 2 potential signals money supply and M2 love binary one and 0 severally. This modulation is that the foremost sturdy of all the PSKs since it takes the most effective level only able to modulate at one bit/symbol of noise or distortion to form the rectifier reach an incorrect decision. It is, however, then is unsuitable for prime data-rate applications. BPSK is functionally adore 2-QAM modulation. The BPSK signal is similar to a double sideband suppressed carrier amplitude modulated wave. thus a BPSK signal is usually generated employing a balanced modulator. reception in BPSK Receiver desires the reference of transmitter signal therefore on properly change section, therefore it is necessary to transmit carrier aboard signal. It desires complicated and expensive receiver electronic equipment. It offers smart BER for low SNR giving power efficiency.

2. QPSK - construction section Shift Keying: construction section Shift Keying has double the data live potency of BPSK. for every single modulation image, two bits are transmitted. The section of carrier takes on four equally spaced values like zero, $\pi/2$, π, $3\pi/2$.The two modulated signals, each of which could be thought-about to be a BPSK signal, square measure summed to provide a QPSK signal. QPSK transmitters and receivers are more tough than those for BPSK. However, with stylish natural philosophy technology, the penalty in price is incredibly moderate. Like BPSK, there are section ambiguity issues at the receiving end, and differentially encoded QPSK is sometimes utilized in follow e [6].

II. EXISTING WORK.

Seyedzadegan et al. [13]. "IEEE 802.16: WiMAX summary, WiMAX Architecture". This paper could be a fast-technical summary and covers: WiMAX summary technological primarily based : customary update and WiMAX design. it's designed for delivering broadband seamless quality transmission services to the top users by combining the similarity of Wi-Fi with the quality of cellular which will deliver personal mobile broadband that moves with you, WiMAX, the Worldwide ability for Microwave Access could be a new technology addressing provision of information over long distance victimization

wireless communication methodology in many alternative ways that. supported IEEE 802.16 WiMAX is claimed as an alternate broadband instead of cable and telephone line. This paper could be a fast-technical summary and covers: WiMAX overview(Fundamental Concept; Technology; customary update) and WiMAX architecture(Network and Node Architectures; Physical Layer; mac Layer), WiMAX (Worldwide ability for Microwave Access) could be a connection-oriented wide space network . It supports high information measure and many users per channel at speeds like presently seen for telephone line, Cable or a T1 connection; guarantees to produce a variety of thirty miles as an alternate to wired broadband like cable and telephone line. It may probably give broadband access to foreign places. Use point-to-multipoint (P2MP) design. it's designed for delivering broadband seamless quality transmission services to the top users. "WiMAX combines the familiarity of Wi-Fi with the quality of cellular which will deliver personal mobile broadband that moves with you

Yi Qian et al. [14] WiMAX, Worldwide ability for Microwave Access, is associate rising wireless communication system which will give broadband access with large-scale coverage. As a cheap answer, multihop communication is changing into additional and additional necessary to WiMAX systems. To with success deploy multihop WiMAX networks, security is one in all the main challenges that has to be addressed . Another crucial issue is a way to support completely different services and applications in WiMAX networks. Since WiMAX could be a comparatively new customary, little work has been given within the literature. during this article we have a tendency to propose a secure and service-oriented network management framework for WiMAX networks. within the style of this framework we take into account each the protection necessities of the communications and therefore the necessities of potential WiMAX applications that haven't been absolutely addressed antecedently within the network layer style. The planned framework consists of 2 basic components: a service-aware management framework and a unified routing theme. Besides the look of the framework, we any study variety of key enabling technologies that area unit necessary to a sensible WiMAX network. Our study will give a suggestion for the look of a safer and sensible WiMAX network; WiMAX (Worldwide ability for Microwave Access) is associate rising wireless communication system that's expected to produce high rate communications in metropolitan space networks (MANs).

Selvarani et al. [15] Wireless networking provides an alternate declare the matter of accessing data from the remote areas wherever the wired networks aren't possible because of high value. it's merely modified the

method during which individuals will communicate and share data, without fear concerning the situation or distance. 2 such common wireless broadband networks area unit Wi-Fi (Wi-Fi) and worldwide ability for Microwave Access (WiMAX). Wi-Fi is for Wireless native space Network with the quality IEEE802.11 and WiMAX is for Wireless Metropolitan space Network with the quality IEEE 802.16. These technologies aim to produce broadband wireless access to residential areas and little business enterprises, additionally to providing web access in countries with none wired network infrastructure. This paper provides a summary of Wi-Fi and WiMAX technologies together with the options, specifications, design, advantages, limitations and security. Finally a comparison is created between Wi-Fi and WiMAX. it's steered that once Wi-Fi is synergized with WiMAX, it'll give the simplest answer for walk coverage.

Verulkar et al. [16] IEEE 802.16 network protocol is intended to produce a worldwide ability for Microwave Access (WiMAX). Because of restricted information measure and a chic radio-frequency spectrum on the market for communication, it's necessary to use one information measure over just the once during a same network once it became unused. For that purpose "Bandwidth Recycling" idea is introduced. The spectrum (bandwidth) is specifically allotted by agency to varied users, however persistently it's seen that the spectrum isn't totally used by the users within the specific interval. This unused information measure is allotted to alternative users UN agency demands for additional information measure for that specific interval while not dynamical existing information measure scheme. during this paper we have a tendency to analyses completely different algorithms that will the exercise of information measure as per want is conferred. To recycle the unused information measure priority primarily {based} programming (PSA) formula has been developed the exercise effectiveness rejected information measure request initial formula (RBRFA) and history-based programming formula (HSA) are made public. By implementing these all formula in NetBeans (Version seven.4) machine, we've evaluated the performance of our system. Our simulation and analysis result confirmed that the projected system will recycle unused information measure. a person (Metropolitan space Network) covers town. The simplest legendary samples of MANs are the cable TV (TV) networks on the market in several cities. These systems grew from earlier community antenna systems used in areas with poor air TV reception. Cable TV isn't solely MAN, though' out; recent developments in high speed wireless net access have resulted in MAN. It's been projected by IEEE 802.16 and is often referred to as WiMAX.

Pathak et al. [`17] this paper provides a summary regarding the varied PHY and mac layer specification that outline the IEEE 802.16 commonplace and that outline the mounted Wi-MAX (Ver. 802.16d-2004) and Mobile Wi-MAX (Ver. 802.16e-2005) network eventualities. we tend to additionally discuss regarding the assorted updates within the Advanced Air Interface update (802.16m – 2011), that aims at fulfilling the 4G necessities as imply by the ITU IMT-Advanced necessities. 4G is that the term accustomed consult with succeeding wave of high-speed mobile technologies that may be accustomed replace current 3G networks. As per the standards of 4G below ITU (International Telecommunication Union), the new technology should give peak speed for web communication at one hundred Mbps for prime quality users and one Gbps for low quality users. 4G additionally guarantees quicker cellular system. The fourth-generation can inter-operate with third generation systems; it additionally intends to integrate mounted wireless access (FWA), wireless native space network (WLAN), wireless native loop (WLL) and private space network (PAN), to produce totally IP-based wireless web. the 2 high contenders are LTE and WiMAX, each of that are informatics based mostly networks that are designed from similar, nevertheless incompatible, technologies ,The growing demand for mobile web and wireless multimedia system applications has driven the event of broadband wireless access technologies in recent years. Mobile WiMAX was the primary mobile broadband wireless access resolution supported the IEEE 802.16e2005 commonplace. The paper reports on history of WiMAX and mobile WiMAX analysis. There are 3 key themes examined on this report. These are Mobile WiMAX and Its Historical development, Mobile WiMAX analysis, and benefits of Mobile WiMAX. The growing demand for mobile web and wireless multimedia system applications has driven the event of broadband wireless access technologies in recent years. IEEE 802.16, an answer to broadband wireless access (BWA) ordinarily called Worldwide ability for Microwave Access (WiMAX), could be a recent wireless broadband commonplace that has secure high information measure over long-range transmission .

Khanduri et al. [18] A recent technology for successive generation (fourth generation [4 G]) of mobile broadband networks is usually referred to as Worldwide ability for Microwave Access (WiMAX) that's designed to produce high information measure over long vary transmission. IEEE 802.16e mobile WiMAX is in charge of the duty of creating ability and conformity between merchandise. This paper provides associate transient summary of mobile WiMAX, its options and challenges on the wireless native and metropolitan space Network (MAN) standards IEEE 802.16 and IEEE 802.16e. IEEE 802.16- 2004 Air Interface normal usually referred to as WiMAX play a very important role in fastened broadband wireless metropolitan space networks. the quality specifies fastened broadband wireless access (BWA) techniques for purpose to purpose and purpose to multipoint links. IEEE 802.16e- 2005, adds the options and attributes to the quality necessary to support quality. IEEE 802.16e could be a recent wireless broadband normal, give an answer to broadband (high speed) wireless access in a very metropolitan space. many WiMAX profiles are developed by WiMAX forum for testing of ability. 2 system profiles supported IEEE 802.16 and IEEE 802.16e , known as fastened and mobile system profiles designed by the WiMAX forum embody obligatory and nonobligatory physical (PHY) layers and medium access management (MAC), of BWA. For rising multipath performance in non-line- of-sight environments, the mobile WiMAX Air interface adopts Orthogonal Frequency Division Multiple access (OFDM). so as to empower quick growth in manufactured quantities, market share and ability, the WiMAX forum give the Network social unit (NWG) for developing associate end-to-end network reference model design supported information science supporting each fastened and mobile WiMAX .

Ben-Mubarak et al. [19].Mobile WiMAX could be a broadband technology that's capable of delivering baseball play services (voice, data, and video). However, quality in mobile WiMAX system remains a problem once the mobile station (MS) moves and its association is two-handed over between base stations (BSs). Within the handover method, scanning is one in every of the desired phases to search out the target bachelor's degree. throughout the handover scanning method, the MS should synchronize with all the publicized neighbor bachelor's degrees (nBSs) to pick out the most effective BS candidate for the incoming relinquishment action. While not terminating the association between the SBS and MS, the SBS can schedule the scanning intervals and sleep-intervals (also referred to as interleaving interval) to MS for the handover scanning. However, throughout the scanning interval amount, all the approaching transmissions are paused. Therefore, the redundant or redundant scanning of neighbor bachelor's degree cause delay and raincoat overhead which can have an effect on period applications. During this paper, the MS movement direction prediction (MMDP) primarily based relinquishment scanning theme is introduced to beat the mobile WiMAX relinquishment scanning issue. It supported dividing the bachelor's degree coverage space is into zones and sectors. per the signal quality; there are 3 zones, no handover (No-HO), low handover (Low-HO) and high handover (High-HO) zones severally and 6 sectors. During this theme, only 2 BSs will become candidates; the 2 that the MS moves toward them are chosen because the candidate for the relinquishment scanning purpose. Hence, the relinquishment scanning

method repetition are reduced with these 2 shortlisted bachelor's degree candidates rather than scanning all nBSs. Thus, MMDP can cut back scanning delay and therefore the range of exchange messages throughout the handover scanning scrutiny to the standard scanning scheme. Although, the MMDP might have an additional process time, the prediction and scanning method are finished before the MS reach the High-HO zone, that mean the end-user's running application are affected. Simulation results show that the projected MMDP scheme reduces the overall handover scanning delay and scanning interval period by twenty-five and fifty nothing severally. Also, the dimension of scanning message is reduced, that ends up in reduced signaling overhead.

Mahfooz et al.[20] WiMAX network has perpetually been an appropriate candidate for providing high rate broadband access. With the increasing demand of any improved services, femtocells (FC) square measure introduced in WiMAX networks. Femtocells not only increase the cell coverage and system capability, they additionally give high outturn inside. However, some ambiguity relating to macro /femtohm handover and quality of service (QoS) still exists. This paper suggests a procedure for handover between macro and femtocells. The tactic projected provides higher services to the mobile station (MS). Moreover, it lessens the quantity of inessential handover selections to the FC(s). Higher information rates in wireless networks have perpetually been a requirement of contemporary day users. vocalization information processing (VOIP), radical broadband access, real- time and streamed transmission, diversion services and plenty of alternative such activities need multiplied information measure for perfect communication. Several new technologies square measure being introduced with higher information rates however it might take tons of your time to modify the challenges they'll face. Mobile WiMAX and future evolution (LTE) are among the longer-term wireless technologies which can type the idea of 4G wireless networks. 4G wireless network isn't only backward compatible to previous technologies however also will build widespread use of femtohm, Pico and small cells for multiplied capability of network, load equalization with macro cells and better outturn .

Hung-Yu et al.[21] Interference-Aware IEEE 802.16 WiMAX Mesh Networks. During this paper authors projected an interference-aware analysis framework for the rising IEEE 802.16 Mesh mode to boost spectral utilization. victimization this framework, they additionally introduced an interference-aware route construction rule for 802.16 mesh network initialization method to boost the network outturn by choosing routes with token interference to existing nodes.

III. EXPECT OUTCOME

To research in the field of wi-max system and identify various challenges. The WiMAX technology to make it more secure, robust and give the customer more reliable service. Our objective is a higher SNR and less BER.

IV. CONCLUSION

Efficient resource utilization and system dependability were known as 2 useful system necessities that are consummated by each, the quality tetra and LS solutions. moreover, these system characteristics were recognized as being subject to degradation by the planned system modification and so, maintainability of those high-level system necessities were set because the primary objective. The task was to search out system performance limits so it advantages the end-users the foremost whereas still avoiding any violation of those targets, therefore evading any event that may severely degrade the general system performance and usefulness. this implies that the most purpose wasn't to realize the most effective output out of the system, however to proportion the pursued LS service potentialities with the measured impacts in step with the ensuing end-user gain. Improved performance of WIMAX system victimization WPMT with DQPSK Modulation Technique and AWGN with DQPSK Modulation Technique. To analysis within the field of WiMAX system and establish numerous challenges. Our projected methodology is termed projected AWGN with DQPSK Modulation Technique secret writing uses quality programmer in similar having interleave between them. This paper has given an analysis of the electronic equipment modulation techniques that are utilized in the foremost recent wireless standards, like IEEE-802.11 and IEEE-802.16 in addition known as Wi-MAX. The Wi-MAX technology is very fast and advances technique used for mobile functions. The WiMAX system doesn't want a fixed scheme that's planned for the worst-case things whereas cyclic prefix is additional so as to reduce the inter symbol interference that occurs in multipath channels and to enhance the bit error rate. WiMAX technology is considered one amongst the most prominent solutions capable of supplying a Broadband Wireless Access in metropolitan areas. This paper concludes the options and characteristics of WiMAX and also the protocol IEEE 802.16 is additionally represented.

REFERENCES

[1]. Deepak Pareek, "WiMAX: Taking Wireless to the MAX," in WiMAX: Taking Wireless to the MAX.: Taylor & Francis Group, LLC, 2006, pp. 149-189

[2]. Will Hrudey, "Streaming Video Content over IEEE 802.16 / WiMAX Broadband Access," 2009.

[3]. A. Ghosh, D. R. Wolter, J. G. Andrews, and R. Chen, "Broadband Wireless Access with WiMAX/802.16: Current performance benchmarks and future potential," in IEEE Commun. Mag., vol. 43, no. 2, pp. 129– 136, Feb. 2005.

[4]. José A. Gutierrez, Marco Naeve, Ed Callaway, Monique Bourgeois, Vinay Mitter, Bob Heile, "IEEE 802.15.4: A Developing Standard for Low-Power Low-Cost Wireless Personal Area Networks"; IEEE Network, pp. 12-19, September/October 2001

[5]. (2006, October). IEEE 1451 Family of Smart Transducer Interface Standards [Online]. Available: http://grouper .ieee.org /groups/ 1451/0/ body %20 frame_files /Familyof-1451_handout.htm

[6]. J. T. Haitham, M.F.M Salleh, Multi-carrier Transmission Techniques for Wireless Communication Systems: A Survey, WSEAS Transactions on Communications, ISSN: 1109-2742, Vol. 8, Issue 5, May 2009.

[7]. B. W. Hiroshi, W.M. Ramjee, Digital Communication, Artech House, London, 2005, pp 5-8.

[8]. G. Tharakanatha, S.K. Mahaboob, V.B. Chanda, I. Hemalatha, Implementation and Bit Error Rate analysis of BPSK Modulation and Demodulation Technique using MATLAB, IJETT, Volume 4, Issue 9, Sep-2013.

[9]. V. Chauhan, M. Arora, R.S. Chauhan, Comparative BER Performance of PSK based Modulation Techniques under Multipath Fading , Advances in Applied Science Research , 2011, 2(4): 521-524.

[10]. J. Bagga, N. Tripathi, Study and Comparison of Various Modulation Classification Techniques under Noisy Channel Conditions ,IJETAE, ISSN: 2250-2459, Vol.-2,Issue-4, April 2012.

[11]. R. Pandey, K. Pandey, An Introduction of Analog and Digital Modulation Techniques in Communication System, Journal of Innovative Trends in Science Pharmacy & Technology, Vol. 1 2014.

[12]. Digital Modulation in Communications Systems- An Introduction, Agilent Technologies, Application Note-1298.

[13]. Seyedzadegan, Mojtaba, and Mohamed Othman. "IEEE 802.16: WiMAX overview, WiMAX architecture." International Journal of Computer Theory and Engineering 5, no. 5 (2013): 784.

[14]. Yi Qian ,Lu, Kejie, and H. Chen. "A secure and service-oriented network control framework for WiMAX networks." IEEE Communications Magazine 45, no. 5 (2007): 124.

[15]. Selvarani, D. Roselin, and T. N. Ravi. "Comparative analysis of Wi-Fi and WiMAX." In International Conference on Information Communication and Embedded Systems, pp. 1-7. IEEE, 2014.

[16]. Verulkar, Nilesh M., and Dr Umesh S. Bhadade. "Analysis of Bandwidth Recycling in IEEE 802.16 Network using PSA, RB-RFA & HSA‖." International Journal of Engineering Trends and Technology (IJETT) 12, no. 2 (2014).

[17]. Pathak, Shantanu, and Shagun Batra. "Next generation 4G WiMAX networks-IEEE 802.16 standard." In Computer Science Conference Proceedings (CSCP), pp. 507-518. 2012.

[18]. Khanduri, Rachana, Chhavi Choudhary, and Vishal Gupta. "The Role of IEEE802. 16e Mobile WiMAX." International Journal of Computer Applications 70, no. 16 (2013).

[19]. Ben-Mubarak, Mohammed Awadh, Borhanuddin Mohd Ali, Nor Kamariah Noordin, Alyani Ismail, and Chee Kyun Ng. "Mobile station movement direction prediction (MMDP) based handover scanning for mobile WiMAX system." Wireless personal communications 73, no. 3 (2013): 839-865.

[20]. Mahfooz, Saeed, and Abeera Ilyas. "Algorithm for an improved MacroFemto handover decision in mobile WiMAX." In Proc. 15th Annual Postgraduate Symp. the Convergence of Telecommunications, Networking and Broadcasting, pp. 1-5. Liverpool, UK: Liverpool John Moores University, 2014.

[21]. Wei, Hung-Yu, Samrat Ganguly, Rauf Izmailov, and Zygmunt J. Haas. "Interference-aware IEEE 802.16 WiMAX mesh networks." In 2005 IEEE 61st Vehicular Technology Conference, vol. 5, pp. 3102-3106. IEEE, 2005.